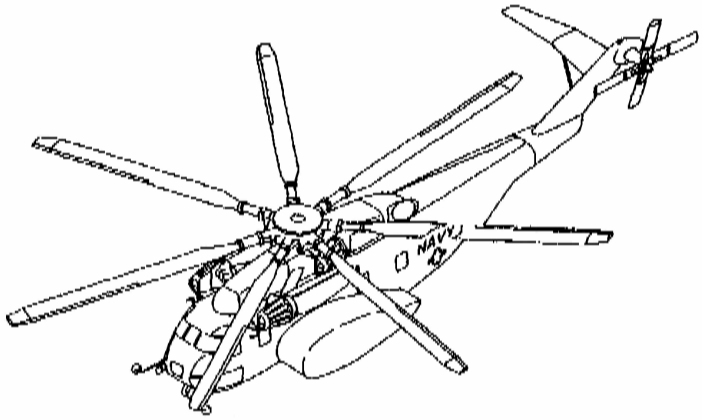
NATOPS FLIGHT MANUAL
NAVY MODEL
MH-53E
HELICOPTERS

THIS MANUAL SUPERSEDES A1-H53ME-NFM-000 DATED 1 OCTOBER 1986 CHANGED 15 APRIL 2000, WHICH SHOULD BE DESTROYED



ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS AND UNDER THE DIRECTION OF THE COMMANDER, NAVAL AIR SYSTEMS COMMAND

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DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
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15 December, 2000

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization (NATOPS) Program is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft mishap rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the commanding officer in increasing the unit's combat potential without reducing command prestige or responsibility.

2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual requirements and procedures is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, commanding officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by OPNAVINST 3710.7, for the purpose of assessing new ideas prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operating procedures found in this manual and those found in other publications, this manual will govern.

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and carried for use in naval aircraft.

M. J. McCABE
Rear Admiral, U.S. Navy
Director, Air Warfare

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RECORD OF CHANGES

Change No. and Date of Change	Date of Entry	Page Count Verified by (Signature)

INTERIM CHANGE SUMMARY

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 - 12	Previously Incorporated

The following Interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
13	Bearing Monitor System Procedure Updates (012119Z DEC 00)

Interim Changes Outstanding - to be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER(S)	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

Information relating to the following applicable technical directives has been incorporated in this manual.

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION
AFC 365	Incorporation of Tension/Skew Angle Indicator Lighting (ECP 2619)	15 Oct 1987	AMCM INDICATOR LTS panel
-	Incorporation of Crash-attenuating Pilot/Copilot Seats (ECP 2632)	15 Dec 1988	VLEA control dial on seat
AFC 407	Incorporation of Takeoff/Land List Placard (ECN 46070 portion of ECP 2638)	15 Dec 1988	Placard on instrument panel
AFC 408	Incorporation of ADI/HSI Indicator System (ECP 2638R1)	15 Feb 1990	None
AFC 409	Incorporation of Landing Gear Warning System (ECP 2638R1)	15 Feb 1990	None
AFC 410	Incorporation of Tow Cable High Tension Warning (ECP 2638R1)	15 Feb 1990	None
AFC 414	Incorporation of Ramp Control Electrical Circuit	15 Feb 1990	None
AFC 443	Incorporation of Fuel Cell Drain Valves, Diverter Strap Covers (ECP 2663A1)	15 Apr 1993	Forward & aft fuel cell drain valves (left & right sponsons)
AFC 440	Propulsion Systems, T64-GE-419 Engine; Installation of (ECP SA-MH-53E-2626R1A1)	30 Jun 1996	Engine gauge markings, five-position Fire Warning Test panel, MAIN XMSN FIRE warning light, MAIN XMSN FIRE DET circuit breaker in EMER DC BUS panel.
AFC 490	Electrical Systems, Alternate Voltage Source for Flight-Critical Avionics; Incorporation of (ECP SA-MH-53E-2648R1)	15 Jul 1996	No. 3 primary ac bus circuit breakers on cockpit overhead circuit breaker panel.
AFC 483 Part 2	Electrical, Installation of No. 2 Engine Dual Thermal Detectors on the MH-53E Helicopter. (ECP PNCLA PN-56)	31 Jan 1998	Caution/advisory panel
AFC 479 Part 4	Incorporation of Night Vision Goggle (NVG) Compatible Exterior Lighting (ECP H53-PN57)	31 Dec 1998	IR Beacon

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

Information relating to the following applicable technical directives has been incorporated in this manual.

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION
AFC 497	Installation of the Improved Troop Seats for the CH/MH-53E Helicopters (ECP H-53-002)	31 Dec 1998	Telescopic legs
AFC 491 Part 2	Transmission system, Tail Rotor Drive Shaft Duplex Bearing Monitor Sensor, Incorporation of (ECP SA-MH-53E-2666R4)	15 Jan 1999	Caution/advisory Panel and Bearing Monitor Panel in cabin
AFC 501, Part 3	Installation of AN/AYQ-23(V) Ground Proximity Warning System (GPWS) (ECP H53-003)	31 Mar 2000	GPWS annunciator lights on advisory panel
AFC 455, Part 4	Avionics, Installation of AN/ARC-210(V) Radio Set (ECP H53-006 Rev. 1)	15 Apr 2000	AN/ARC-210(V) control panel on cockpit console

Information relating to the following applicable technical directives will be incorporated in a future change.

CHANGE NUMBER	DESCRIPTION	VISUAL IDENTIFICATION

PREFACE

SCOPE

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

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

A1-H53ME-NFM-500 (Pilot's Pocket Checklist)

A1-H53ME-NFM-900 (Aircrew Pocket Checklist)

A1-H53ME-NFM-700 (Functional Checkflight Checklist)

A1-H53ME-NFM-100 (AMCM Mission Systems Supplement) A1-H53BE-CLG-000 (Cargo Loading Manual)

FMFRP 5-3; NWP 42-1 VOL I, II, and III (Basic Operation/Equipment and Single-/Dual-point Hook Procedures)

NAVAIR 00-80T-110 (NATOPS Air Refueling Manual)

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UPDATING THE MANUAL

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

CHANGE RECOMMENDATIONS

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

Routine change recommendations are submitted directly to the Model Manager on OPNAV 3710/6 (4-90) shown herein. The address of the model manager of this

helicopter is: Commanding Officer
Department of the Navy
Airborne Mine Countermeasures Weapon Systems
Training School (AWSTS)
483 A Street
Norfolk, Virginia 23511-4289
Attn: Model Manager MH-53E
Telephone:
Commercial (804) 444-1615
Autovon 564-1615

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

YOUR RESPONSIBILITY

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

NATOPS FLIGHT MANUAL INTERIM CHANGES

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

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, like the one printed next to this paragraph. The change symbol shows where there has been a change. The change might be material added or information restated. A change symbol in the margin by the chapter number and title indicates a new or completely revised chapter.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to "WARNING," "CAUTION," AND "Note" found throughout the manual.

WARNING

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

CAUTION

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

Note

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

WORDING

The concept of word usage and intended meaning used in preparing this manual is as follows:

"Shall" has been used only when application of procedure is mandatory.

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

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

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

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

DATE _____

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (originator)	Unit
TO (Model Manager)	Unit

Complete Name of Manual / Checklist	Revision Date	Change Date	Section / Chapter	Page	Paragraph

Recommendation (be specific)

☐ CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit or Command

TO BE FILLED IN BY MODEL MANAGER *(Return to originator)*

FROM	DATE

TO

REFERENCE

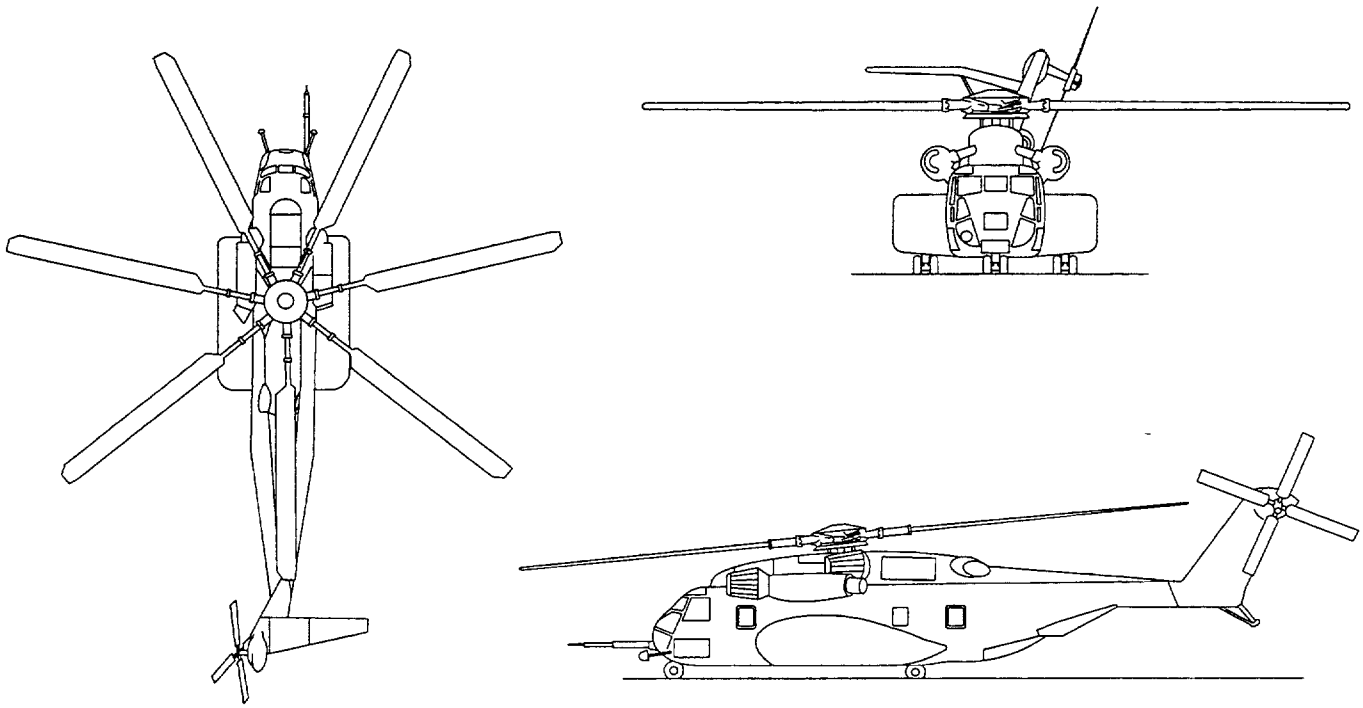
(a) Your Change Recommendation Dated _____

☐ Your change recommendation dated _____ is acknowledged. It will be held for action of the review conference planned for _____ to be held at _____

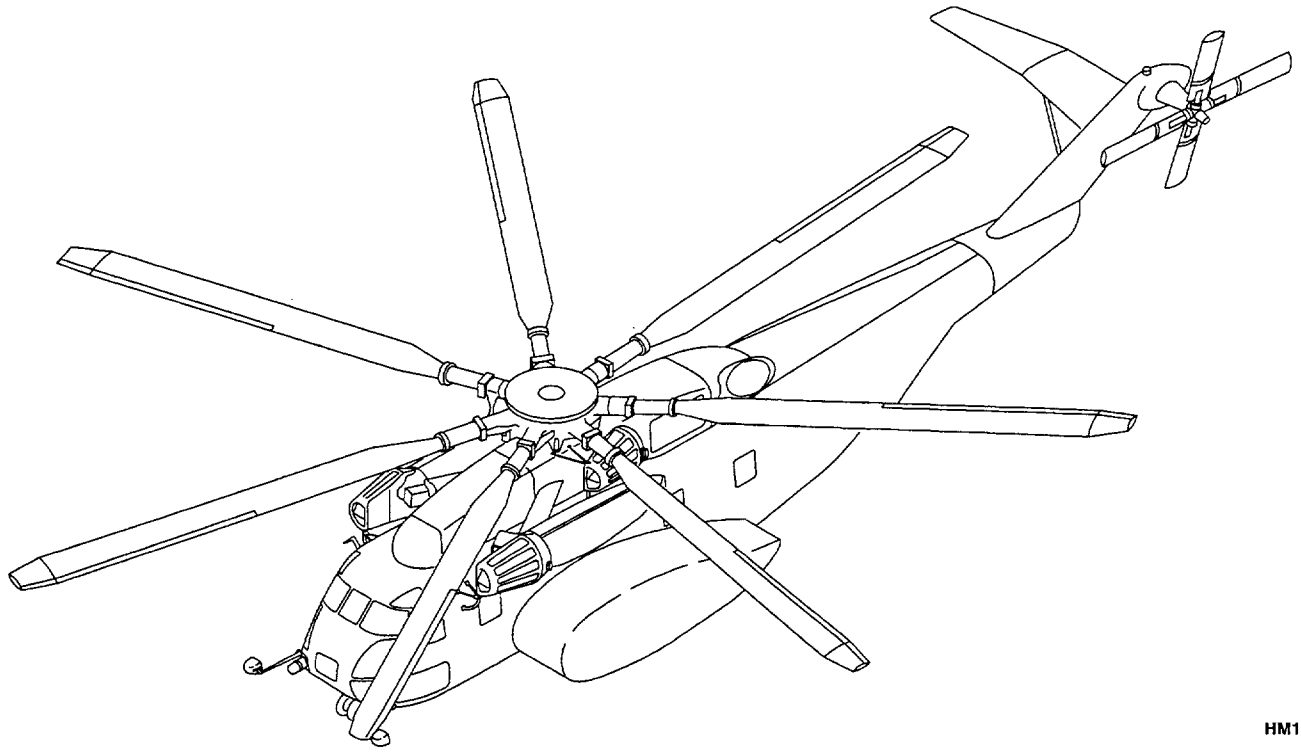
☐ Your recommendation is reclassified URGENT and forwarded for approval to _____ _____ by my DTG _____

/ S / _____ MODEL MANAGER | _____ AIRCRAFT

NP5190
SA



MH-53E
HELICOPTER



HM1302
SA

PART I

THE AIRCRAFT

Chapter 1	General Description
Chapter 2	Systems
Chapter 3	Aircraft Servicing
Chapter 4	Aircraft Operating Limitations

CHAPTER 1
General Description

1.1 THE HELICOPTER

The MH-53E airborne mine countermeasures (AMCM) helicopter is manufactured by Sikorsky Aircraft Corporation, 6900 Main Street, P. O. Box 9729, Stratford, CT 06615-9129. The helicopter is a Class 2 aircraft equipped with a seven-blade main rotor and a four-blade canted tail rotor designed for land and ship-based operations, with an emergency water operating capability. Power is furnished by three T64-GE-416, T64-GE-416A, or T64-GE-419 engines, manufactured by General Electric Aircraft Engines, Lynn, MA 01901. At a power turbine output speed of 14,280 rpm, each 416 or 416A engine is capable of producing 4380 shp, while each 419 engine is capable of producing 4750 shp. The 419 engine also has a contingency power capability of up to 5000 shp for up to two minutes.

Note

The T64-GE-416 and T64-GE-416A engine designations shall be collectively abbreviated to 416 engines unless it is necessary to differentiate between the models. In this instance, they shall be called 416 engine or 416A engine, as appropriate. The T64-GE-419 engine shall be referred to as the 419 engine.

Automatic flight control and engine anti-icing systems give the helicopter an all-weather flight capability. An auxiliary powerplant (APP) gives the helicopter a self-starting capability. The helicopter is equipped with a fuel dump system, a rescue hoist, and dual external rearview mirrors. In addition, the helicopter is equipped with a rear ramp loading system, cargo winch, roller conveyors, and cargo tiedown facilities. Provisions are made for helicopter in-flight refueling (HIFR) capabilities, air-to-air refueling, AMCM winches, and structural provisions for two flexible guns. The primary mission of the helicopter is AMCM, which includes minesweeping, mine neutralization, mine hunting, floating mine destruction, channel marking, and surface towing such as the towing of surface craft and ships. The secondary utility mission involves the movement of cargo and equipment and the transportation of passengers. The helicopter has a tow boom, approach/hover coupler, tow coupler, precise navigation system, and provisions for mine hunting and mine sweeping. The helicopter is capable of rescuing personnel during an overwater or overland hover. The maximum gross weight with internal or external cargo is operationally limited to 69,750 pounds. The empty weight is about 36,745 pounds (Figure 6-1), and the tow capability is steady state 25,000 pounds with surges to 30,000 pounds. See FO-1, FO-5, and FO-7 for illustrations of the instrument panel and upper and lower consoles.

1.1.1 Performance. The helicopter is designed for a standard day sea level AMCM mission to include a 5-minute warmup, takeoff at maximum continuous power with a useful mission load of about 61,500 pounds, hover-out-of-ground-effect (HOGE) for 5 minutes during AMCM gear hookup (using MK-105 countermeasures set), tow the equipment 12.5 nautical miles without exceeding maximum continuous power, sweep for 3.6 hours, tow AMCM equipment 12.5 nautical miles to base without exceeding maximum continuous power, HOGE for 5 minutes during AMCM disengagement, allow 10 minutes for approach and landing at speed for best range, and have 20-minute fuel reserve at speed for best range. Mission will be flown with APP off and heater and EAPS operating. The useful load at takeoff includes pilot, copilot, five crewmembers, and 3200 gallons of fuel.

1.1.2 General Arrangement. See Figure 1-1, FO-11, and FO-13.

1.1.3 Dimensions. See Figure 1-1. Dimensions are:

Length:	
Maximum, rotor and pylon spread, probe retracted	99 ft 0.5 in.
Minimum, rotor and pylon folded, probe retracted	71 ft 0.02 in.
Minimum, rotor and pylon folded, probe removed	60 ft 6 in.
Height:	
Maximum, to top of rudder, blade vertical	28 ft 4 in.
Minimum, pylon folded	18 ft 7 in.

Width:	
Maximum, rotor extended	79 ft 0 in.
Minimum, rotor and pylon folded	27 ft 7 in.
Rotor diameter	79 ft 0 in.
Rudder diameter	20 ft 0 in.
Main landing gear tread	13 ft 0 in.

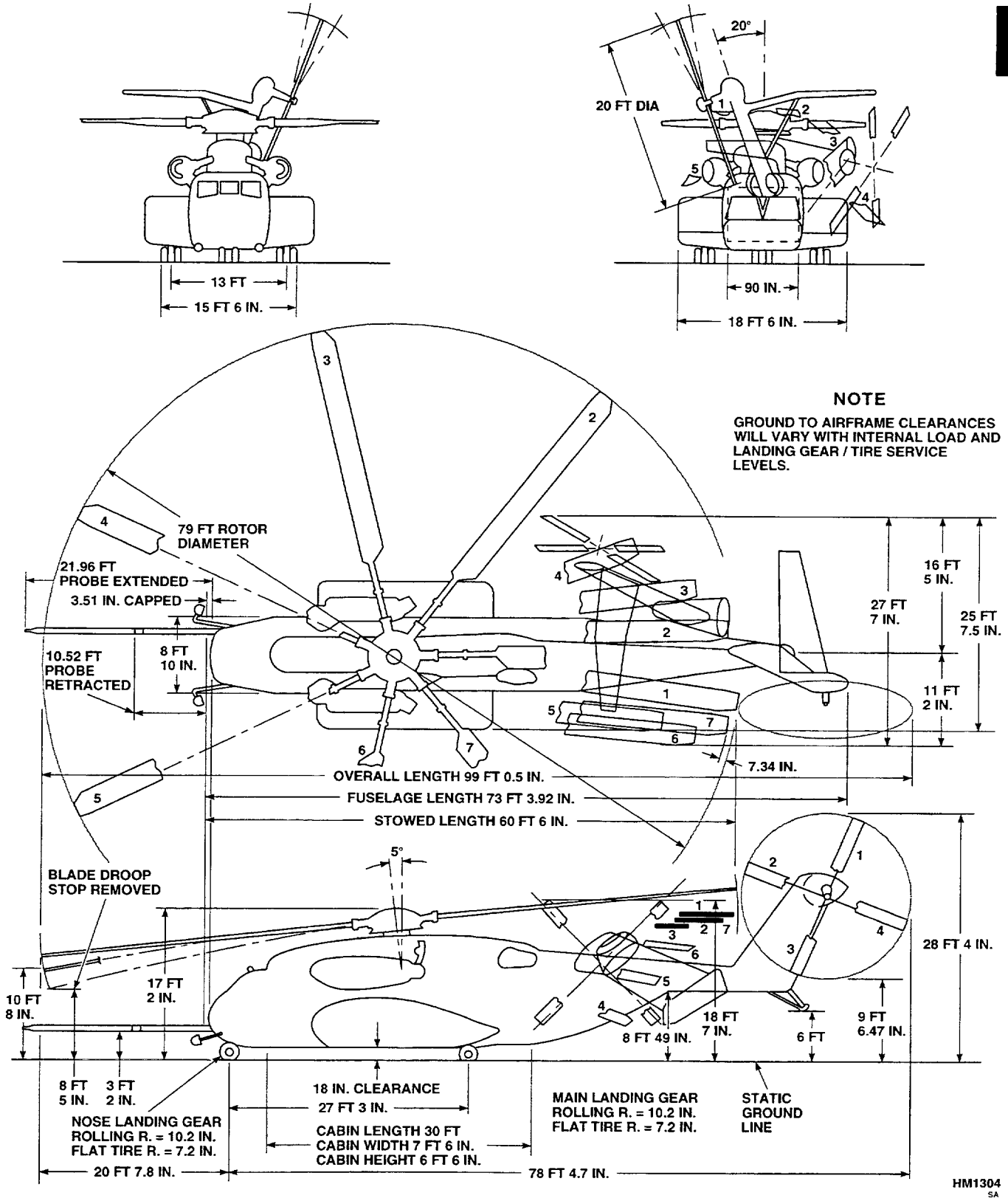
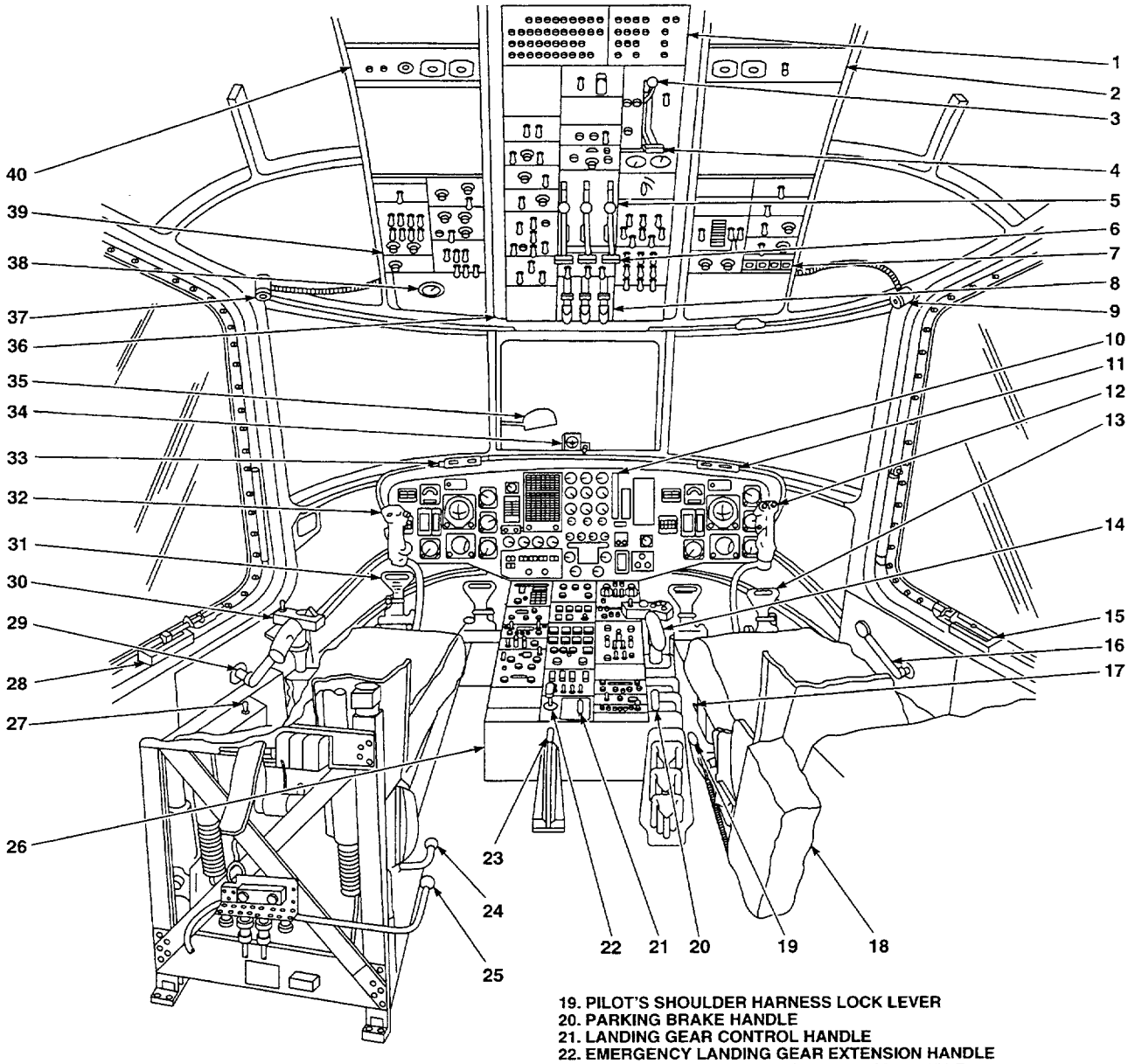


Figure 1-1. Dimensions Diagrams



1. EMERGENCY AC AND DC BUS CIRCUIT BREAKER PANEL
2. PILOT'S DOME LIGHT PANEL
3. APP CONTROL LEVER
4. APP FIRE EXTINGUISHER T HANDLE
5. FUEL SELECTOR LEVERS
6. ENGINE EMERGENCY T HANDLE
7. PILOT'S OVERHEAD CONTROL PANEL
8. ENGINE SPEED CONTROL LEVERS
9. PILOT'S UTILITY LIGHT
10. INSTRUMENT PANEL
11. MASTER CAUTION AND FIRE WARNING LIGHTS
12. PILOT'S CYCLIC
13. PILOT'S RUDDER AND BRAKE PEDALS
14. PILOT'S COLLECTIVE
15. PILOT'S WINDOW RELEASE HANDLE
16. PILOT'S WINDOW EMERGENCY RELEASE HANDLE
17. PILOT'S SEAT BLOWER SWITCH
18. JUMP SEAT
19. PILOT'S SHOULDER HARNESS LOCK LEVER
20. PARKING BRAKE HANDLE
21. LANDING GEAR CONTROL HANDLE
22. EMERGENCY LANDING GEAR EXTENSION HANDLE
23. CARGO HOOK EMERGENCY RELEASE HANDLE (INOPERATIVE WITH SINGLE POINT SUSPENSION)
24. COPILOT'S FORWARD AND AFT SEAT ADJUSTMENT LEVER
25. COPILOT'S SEAT HEIGHT ADJUSTMENT LEVER
26. CONSOLE
27. COPILOT'S RUDDER PEDAL ADJUSTMENT SWITCH
28. COPILOT'S WINDOW RELEASE HANDLE
29. COPILOT'S WINDOW EMERGENCY RELEASE HANDLE
30. COPILOT'S COLLECTIVE
31. COPILOT'S RUDDER AND BRAKE PEDALS
32. COPILOT'S CYCLIC
33. MASTER CAUTION AND FIRE WARNING LIGHT
34. STANDBY COMPASS
35. MIRROR
36. OVERHEAD CONTROL PANEL
37. COPILOT'S UTILITY LIGHT
38. FREE-AIR TEMPERATURE GAGE
39. COPILOT'S OVERHEAD CONTROL PANEL
40. COPILOT'S DOME LIGHT PANEL.

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Figure 1-2. The Cockpit

CHAPTER 2
Systems

2.1 ENGINES

The T64-GE-416, T64-GE-416A, or T64-GE-419 turboshaft engines (FO-15) are mounted on each side of the upper outboard fuselage, and behind the main gear box. The basic engine consists of a torque sensor shaft and housing, compressor section, combustion section, and turbine section. A clock numbering system is used to locate engine components. From the rear looking forward, the right and left sides of the engine correspond to the observer's right and left. The top of the engine is the 12-o'clock position, with the other clock numbers following clockwise.

2.1.1 Torque Sensor Shaft and Housing Assembly. This assembly (FO-15) transmits engine power to the nose gear box from the No. 1 and 3 engines and to the main gear box from the No. 2 engine. The shaft assembly, consists of a shaft and sleeve, is used for torque measuring purposes.

2.1.2 Compressor Section. The section consists of a 14-stage compressor rotor assembly (FO-15) and the compressor stator assembly. The compressor rotor assembly is driven by a direct coupling to the gas generator turbine, and the compressor stator assembly contains the inlet guide vanes and 13 stages of stator vanes. The inlet guide vanes and the first four stages of stator vanes are variable and change their angular position to permit efficient operation throughout the entire speed range. The primary purpose of the compressor section is to compress air for combustion.

2.1.3 Combustion Section. The section includes a combustion chamber and frame, combustion liner, exit guide vanes, and the combustion air deflector. The combustion chamber contains twelve fuel nozzles (FO-15) to provide fuel to the compressed air, and two ignitor plugs to ignite the charge during engine starts. The combustion liner consists of inner and outer shells that are perforated by louvers and thimble hole spaces to provide the airflow required for liner cooling, combustion, and dilution of combustion products to maintain required engine temperatures.

2.1.4 Turbine Section. The section contains the gas generator and power turbines. Both turbines rotate counterclockwise but not necessarily at the same speed, as they are not mechanically coupled to each other. The gas generator turbine rotor (FO-15) receives hot combustion chamber gases, decreases their velocity, and extracts the power necessary to drive the compressor. The remainder of the power generated by the combustion is used to drive the power turbine. The power turbine rotor contains a shaft that extends coaxially through the engine to provide power output. Power turbine speed may be maintained, or regulated independent of output power, when operating within the normal operating range. This principle provides more rapid acceleration because of the availability of high engine torque at low output speeds. The free power turbine principle allows the pilot to set a desired power turbine speed (N_f) with the engine speed control lever. The N_f governor will set the gas generator speed (N_g) at a level necessary to maintain the selected N_f and provide constant rotor rpm (N_r). N_g is primarily dependent upon fuel flow and is monitored by the engine fuel control. N_g is monitored to control acceleration and deceleration characteristics, prevent overspeed, and establish a minimum idle setting. N_f is dependent upon engine speed control lever position, and is monitored to regulate fuel flow to maintain an essentially constant speed for a given engine speed control lever position.

2.1.5 Engine Air Particle Separator (EAPS) System. A removable EAPS (FO-11), in front of each engine air inlet duct is self-cleaning and can be swung away from the engine for maintenance accessibility. The EAPS removes visible moisture, sand, dust, and other foreign particles entrained in the engine inlet air, scavenges and exhausts the foreign particles overboard, and allows clean air to enter the engine. In addition when icing conditions are anticipated, engine ice ingestion can be prevented by manually closing the EAPS doors and keeping them closed until after engine shutdown.

The EAPS control panel on the overhead control panel (FO-1) contains three-position switches, one for each EAPS. Placing a switch to OPEN manually opens the EAPS door, stops the scavenge blower, and uncleaned air then enters the engine air inlet. Placing a switch to CLOSED manually closes the EAPS door, starts the scavenge blower, and cleaned air then enters the engine air inlet. Placing a switch to AUTOMATIC causes the EAPS door to automatically close below 78 to 88 KIAS, and automatically open above this airspeed.

The EAPS DOOR CLOSED advisory light goes on when all EAPS doors are closed, and goes off when any door is open.

Two redundant primary pressure switches sense when airspeed is above or below 78 to 88 KIAS from the pitot static system. When the automatic mode is selected the primary pressure switches automatically open the EAPS door above 78 to 88 KIAS and automatically close the door below that airspeed.

Each EAPS contains two separator panels, mounted in a D-shape around the frame, which contain a total of 759 STRATA-TUBES. As the inlet air passes through the STRATA-TUBES, it travels in a cyclonic motion that causes the foreign particles to migrate toward the walls of the tubes and pass into the scavenge ducting. The cleaned air continues on into the engine, and the scavenge blower exhausts the particle-laden scavenge air overboard. The scavenge blower operates whenever the EAPS door is closed and the main transmission oil pressure is above 14 psi.

Each EAPS has a secondary pressure switch that senses when the EAPS is partially clogged from the pressure loss that occurs across the separator panels. When the EAPS is partially clogged below 78 to 88 KIAS the secondary pressure switch causes the EAPS HIGH PRESS LOSS caution light to go on. The caution light is inoperative above 78 to 88 KIAS. When the EAPS is partially clogged below 78 to 88 KIAS and the automatic mode is selected, the secondary pressure switch automatically opens the EAPS door. When the door opens, the secondary pressure switch senses normal pressure and automatically closes the door. In this configuration the door cycles from open to closed and the EAPS HIGH PRESS LOSS caution light and EAPS DOOR CLOSED advisory light alternately go on and off. In addition, if both primary pressure switches fail when operating in the automatic mode the secondary pressure switch automatically opens the door at 120 to 130 KIAS and the door cycles as previously described. With the door closed at 120 to 130 KIAS the secondary pressure switch senses a pressure loss similar to that created by a partially clogged EAPS.

Note

If all EAPS are in the automatic mode any secondary pressure switch can cause all EAPS doors to cycle.

The automatic control circuit and the EAPS caution light are powered from the No. 1 primary dc bus through a circuit breaker marked EAPS WARN, in the cabin. The manual control circuit is powered from the No. 1 primary dc bus, through a circuit breaker marked EAPS OVRD, in the cabin. This circuit breaker also controls the power supply to the EAPS DOOR CLOSED advisory light. Power is supplied to the No. 1 and 3 EAPS ac-operated scavenge blowers by disconnecting the nose gear box fairing anti-ice controllers, and connecting the nose gear box fairing anti-ice power leads to the scavenge motors. Power is supplied to the No. 2 ac-operated scavenge blower from the No. 2A primary ac bus through three circuit breakers in the cabin marked NO. 2 ENG EAPS BLOWER.

2.1.6 Engine Overspeed Protection System. Each engine has an overspeed protection system to prevent destructive overspeed of the power turbine. The electrical overspeed system is automatically controlled by an overspeed switch at the engine front frame, which receives an electrical signal from the transducer at the rear of the power turbine shaft. The overspeed switch actuates at about 110% ±2% N_f to protect against actual overspeed. A solenoid in the fuel control will energize and reduce fuel flow to 75% N_g. The engine will cycle near 110% until corrective action is taken. The engine overspeed test switches on the master switch panel (FO-1), marked NO. 1, NO. 2, and NO. 3, under the general heading ENGINE OVERSPEED, have marked positions OFF and TEST. The switches provide a test feature only and do not control the overspeed protective circuit. Placing a respective overspeed switch to TEST will energize the fuel control solenoid after 95% ±2% N_f has been attained, with a resultant decrease in operating parameters. Engine overspeed checks are made at 100% N_f and should indicate 100% N_f after the spring-loaded switch is released to OFF. The No. 1, No. 2, and No. 3 engine overspeed protection systems receive power from the No. 1, No. 2, and No. 3 primary dc buses respectively, through three circuit breakers, marked NO. 1, NO. 2, and NO. 3 ENGINE OVSP, respectively, in the cabin.

2.1.7 Engine Fuel System. Each system consists of an engine-driven fuel pump and filtration system, engine fuel control unit, a flow divider, two stator vane actuators, and the fuel manifold and discharge nozzles. The engine-driven fuel pumps are driven by the engine accessory gear box (FO-15). Fuel is supplied from the helicopter fuel system to the filtration system and engine-driven fuel pump, which passes the fuel to the engine fuel control, where it is filtered and metered. The fuel is then passed to the fuel flow divider, where it is filtered and directed to the fuel discharge nozzles. The fuel is first directed to the primary orifice of each nozzle for engine starting; then, as the fuel pressure reaches about 210 psi, fuel is allowed to also flow to the secondary orifice of each nozzle.

2.1.7.1 Engine Fuel Control Unit. The unit (FO-15), mounted on each engine, senses engine speed control lever position, N_g, compressor discharge pressure (P_3), compressor inlet temperature (T_2), N_f, and load signal to hold a desired N_f. N_g is controlled by the power turbine governor and load signal. Major fuel control components consist of a filter, a pressure regulating valve, a metering valve, a computing section, and gas generator and power turbine speed governors. All fuel entering the fuel control passes through the filter to the pressure regulating valve where a constant 40 psi pressure drop is maintained across the metering valve by returning excess fuel to the engine fuel pump inlet. The metering valve controls fuel flow to the engine according to a fuel flow to compressor discharge pressure ratio sensed by the computing section. The N_g governor positions the control to one that matches gas generator speed, and the power turbine speed governor maintains a constant N_f by correcting for any deviation between selected and actual N_f. The engine fuel control functions to prevent compressor stall, turbine overtemperature, rich or lean blowouts, govern gas generator idle speed, limits maximum N_g to 102.5%, and schedules inlet guide and stator vane positions to provide optimum compressor performance. Fuel control system malfunctions may be indicated by a relationship of engine speed control lever position to N_f, N_g, T_5, and fuel flow indicator readings. A malfunctioning fuel control will not produce the desired N_f for a corresponding engine speed control lever position, or will cause the engine to accelerate past GRD IDLE. Malfunctions would also be noted on the N_g tachometer by unusual indications and the inability to control the indicated N_f while in the governing range. Malfunction would also be indicated on the T_5 indicator when abnormal temperatures are indicated, excessive temperatures are noted after shutdown, and if the maximum T_5 cannot be reached when the engine is not otherwise limited. Abnormal indications on the fuel flow indicator may also indicate a fuel control malfunction, especially high readings.

2.1.7.2 Remote Topping Trim Adjustments. The trim adjustments, one of each fuel control unit, are on each side of the cabin and overhead. The locations are identified by the marking TOPPING INSIDE stenciled on the soundproofing. The marking DECREASE and INCREASE, with corresponding directional arrows, are stenciled next to the trim adjustment recess to indicate the direction the cable is to be turned to increase or decrease N_g (resulting in a higher or lower T_5). The trim adjustments permit a crewmember, upon direction of the pilot, to do ground or in-flight topping adjustments. The trim adjustments are connected to flexible shafts that are routed to fuel control units. The trim adjustment is then turned to obtain desired topping setting.

2.1.8 Engine Oil System. Each engine has an independent oil tank, a dry sump full scavenge oil system, and is replenished from an auxiliary oil system. Oil is gravity-fed from the oil tank to the oil pump mounted on the rear face of the engine accessory gear box. The oil pump is a six-element gear-type pump with all elements in tandem and driven by a common shaft. One element supplies oil to the engine and the other five elements scavenge the three engine oil sumps plus the accessory gear box. The oil pump distributes the oil under pressure through a filter to the accessory gears and engine bearings. Scavenge oil is used to heat the 6-o'clock frame strut, which aids in engine anti-ice. Oil from the scavenge elements is returned through an oil cooler to the oil tank.

2.1.8.1 Oil Tanks. There is an oil tank installed on the top forward end of each engine. Each fully-serviced tank contains 1.32 gallons of usable oil and expansion space for 1.15 gallons. It also holds 0.10 gallon of unusable oil and 1.45 gallons of dwell oil. It is necessary to have dwell oil in the tank to provide time for air to separate from returning oil. Depletion of dwell oil will furnish air-laden oil to the engine. The tanks shall be serviced by the engine auxiliary oil system.

2.1.8.2 Oil Coolers. For aircraft powered by the 416 engines, the No. 1 and 3 engine oil cooler assemblies (FO-13) are on each nose gear box. Cooling air for the No. 1 and 3 engine oil coolers is supplied by oil cooler blowers mounted aft of the oil cooler radiators and belt-driven by the input shaft to the main transmission. The No. 2 engine oil cooler is mounted on the left side of the main transmission oil cooler. Operation of the oil cooler radiators is automatic. For the No. 1 and No. 3 engines, the engine and nose gear box oil cooler cores are housed in the same radiator and use the same blower assembly. The No. 2 engine oil cooler and main transmission oil cooler are in the same radiator. During cold engine starts, high oil pressures may be encountered until the oil has warmed. To hasten the warming of engine oil, oil bypasses the radiator until the oil has warmed, after which it is directed through the cores of the radiator, where it is cooled. The cooling air is exhausted into the helicopter slipstream.

Aircraft powered by the 419 engine have engine-mounted fuel/oil heat exchanger/coolers. These coolers are mounted on the lower right side of the engine front frame. Heat is extracted from the scavenge return oil before the oil returns to the tank. Oil is circulated through the heat exchanger which is cooled by fuel on its way to the engine. An integral temperature/pressure bypass

valve is included within the cooler assembly to hasten cold oil warm-up. The oil coolers serve to cool the nose gear boxes and main transmission, exclusively.

2.1.8.3 Engine Oil Pressure Lights. Each engine oil system has a high/low pressure switch and two caution lights to visually indicate that engine oil pressure is either too low or too high. The caution lights are marked #1, #2, or #3. ENG OIL PRESS LOW or HIGH. The ENG OIL PRESS LOW light will go on whenever oil pressure is 10 ±3 psi or below; and the ENG OIL PRESS HIGH light will go on whenever oil pressure is 100 ±3 psi or above. When abnormal oil pressure indications are noted, all other associated engine instruments should be cross-checked to verify the malfunction. After it has been determined there is a malfunction, if flight conditions permit, the engine should be shut down immediately to prevent further damage. The engine oil pressure caution lights receive power from the emergency dc bus circuit breaker panel in the cockpit through circuit breakers marked OIL PRESS, under the general heading of its associated engine.

2.1.8.4 Engine Oil Low Level Caution Lights. The lights are marked #1, #2, or #3 ENG OIL QTY LOW. With the helicopter in level attitude, illumination of a light indicates the associated tank has been depleted by 25% of its fully serviced capacity and shall be replenished by the auxiliary oil system. The caution lights receive power from the No. 1, 2, or 3 primary dc bus, through circuit breakers, marked #1, #2, or #3 OIL QTY LOW in the cabin, under the general heading of its associated engine.

2.1.8.5 Engine Chip Detector System. Metallic chips circulating in an engine lubrication system are an indication of engine deterioration. Each engine has a chip detector (Figure 2-7) in the engine accessory gear box, that will cause chip locator lights, on the instrument panel, to go on when chips are detected. The engine lubricating system routes lubricating oil past the magnetic chip detector, causing ferrous chips to be deposited on the chip detector. When there are enough chips to form a conductive bridge, an electrical circuit is completed and the chip detector's associated chip locator light goes on. It is possible for conductive nonferrous material to pile up on the chip detector and cause the chip locator light to go on. The CHIP DETECTED caution light goes on simultaneously with the lighting of any chip locator light. The Nos 1, 2, and 3 engine chip detectors operate the NO. 1 ENG, NO. 2 ENG, and NO. 3 ENG chip locator lights, respectively. Operating power is furnished by the emergency dc bus through three circuit breakers, marked NO. 1 ENG, NO. 2 ENG, and NO. 3 ENG, under the general heading CHIP DETECTOR, in the cockpit.

Note

It is possible for the engine chip detector light to go on, and remain on, because of minute metal particles that may have washed away. This condition is caused by holding relay action and can be verified by pulling out and resetting the appropriate circuit breaker. If the minute particles have washed away, the light will not go on when the circuit breaker is reset.

2.1.8.6 Engine Auxiliary Oil System. The system (Figure 2-1) consists of one tank, equipped with a handpump, three tank-full lights, three selector valves, and the necessary plumbing to allow the system to replenish the oil supply in the engine oil tanks. The engine oil tanks are replenished by holding the appropriate selector valve open and actuating the handpump until the NO. 1, NO. 2, or NO. 3 TANK FULL light goes on.

2.1.8.7 Auxiliary Oil Tank. The tank, on the right-forward side of the cabin compartment, has a capacity of 2.6 U. S. gallons. The tank is equipped with a filler cap, a drain valve, and the necessary plumbing to carry the oil to the handpump.

2.1.8.8 Handpump. This is mounted on the cabin wall next to the auxiliary oil tank, and is manually operated by moving the handle up and down.

2.1.8.9 Engine Oil Full-Level Lights. The lights, marked NO. 1, NO. 2, and NO. 3 TANK FULL, are above the auxiliary oil tank. The lights go on to indicate that the engine oil tanks have been replenished to the full-level by the auxiliary oil system. The lights shall not be used to determine when the engine oil tanks need servicing. The engine oil high-level lights are powered from the No. 3 primary dc bus, through a circuit breaker marked ENG OIL LEVEL, in the cabin.

2.1.9 Engine Speed Control Levers. Three levers, marked SPEED CONT and identified further on the quadrant as NO. 1 ENG, NO. 2, and NO. 3 ENG, with marked positions SHUT OFF, GRD IDLE, MIN GOV, and MAX GOV, are on the engine control quadrant (FO-1). Moving the engine speed control levers to SHUT OFF will stopcock the engines. The stopcock is open whenever an engine speed control lever is 6.5° or more from SHUT OFF. Ground idle N_g is variable with OAT and its range is 60.5% to 70%. The engine speed control levers may be advanced or retarded from the GRD IDLE stop by pulling down on the engine speed control lever. Engine speed control lever travel is divided between SHUT OFF, GRD

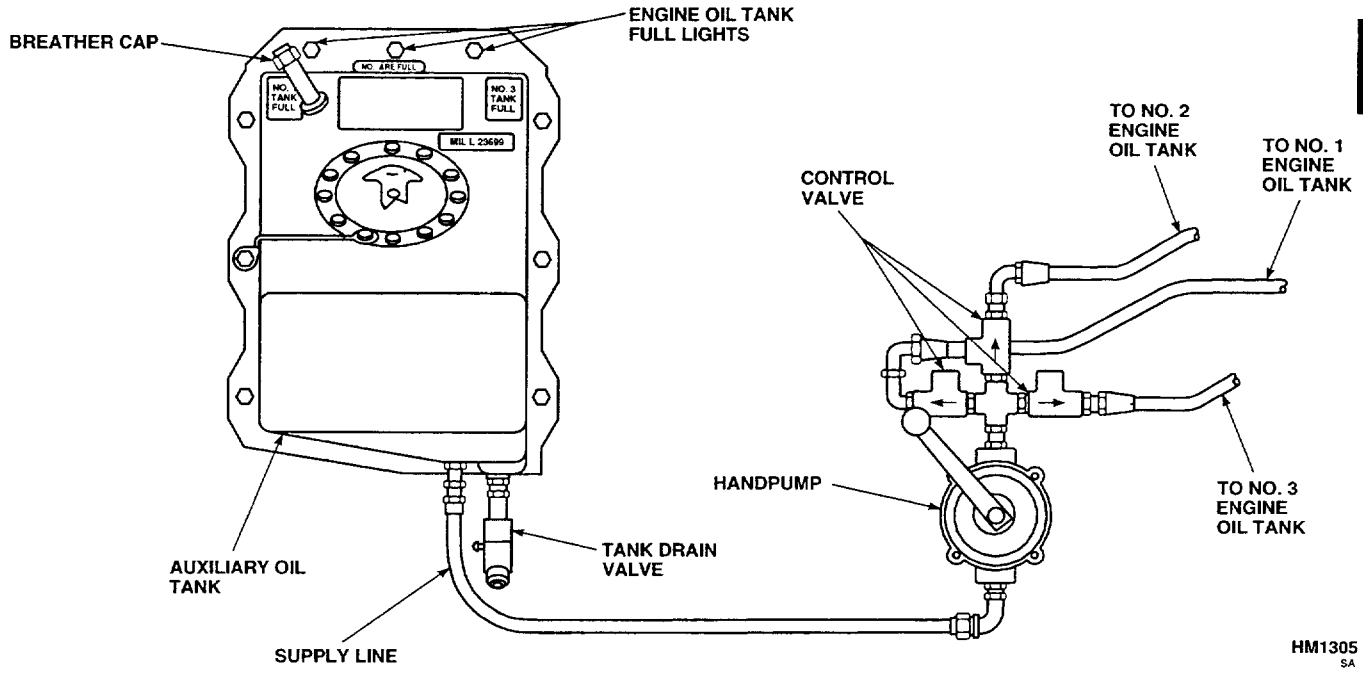


Figure 2-1. Engine Auxiliary Oil System

IDLE, MIN GOV, and MAX GOV. MIN GOV is the minimum power turbine governing range. MAX GOV produces maximum N_f. Accurate power changes and engine synchronization can be obtained by the engine trim switches, on the collective pitch lever grips. A load signal shaft (collective bias), directly connected to the collective pitch lever by linkage, provides anticipation of load changes for reduction of transient droop; by resetting the fuel control governor proportional to the power required, it maintains rotor speed constant with changes in load. Since the connection of the load signal shaft to the collective is mechanical and fixed, minor changes (increases or decreases) in rotor speed can be experienced as ambient conditions change. Maximum power is indicated by lack of further increase in N_g, T_5, and W_f, when collective is increased. When at this condition, an increase in speed lever position will not provide an increase in power. The rotors must be engaged and the engine speed control lever at or above MIN GOV for the load signal shaft to be effective.

2.1.9.1 Engine Speed Trim Switches. Three switches, on each collective pitch lever grip (FO-7), are used to make fine speed adjustments for engine synchronization. Two of the switches are marked #1 and #3 + (plus) and - (minus) under the general heading ENGINE TRIM. The unmarked No. 2 switch is between the #1 and #3 switches and operates the same as the other two. The engine speed trim switches are moved forward to increase engine speed, aft to decrease engine speed, and are spring-loaded to return to the center position when they are released. The pilot's switches always have overriding authority over the copilot's. The engine speed trim switches are effective any time when beeping to increase, but can only be beeped to decrease when the engine speed control levers are above MIN GOV. The No. 1, No. 2, and No. 3 engine speed trim switches receive power from the No. 1, No. 2, and No. 3 primary dc buses, respectively, through three circuit breakers marked NO. 1, NO. 2, and NO. 3 ENGINE SPEED TRIM, respectively, in the cabin.

2.1.10 Ignition System. The system consists of an ignition unit, two ignitor plugs, and a control circuit for each engine. The system provides ignition for starting only, as combustion is self-sustaining once ignition has been accomplished. Continuous ignition is provided whenever the respective engine anti-ice is selected to reduce the possibility of engine flameout during icing conditions. The system normally operates on 28 vdc. Normally, the ignition system circuit operates through the starter relay and will be disconnected from its power source any time the start speed switch or start abort switch de-energizes the starter system control relay. The ignition unit will be energized whenever the starter system control relay is energized and the engine speed control lever is advanced from SHUTOFF to GRD IDLE, or the associated engine anti-ice system is on. The No. 1, No. 2, and No. 3

engine ignition systems receive power from the No. 1, No. 2, and No. 3 primary dc buses, respectively, through three circuit breakers marked NO. 1, NO. 2, and NO. 3 EMER START respectively. In addition, a NO. 1, NO. 2, and NO. 3 ENG IGN circuit breaker allows turning off electrical power to the respective engine ignitor

2.1.11 Start System. Each engine start system has a hydraulic starting motor with a speed switch. The speed switch is electrically connected to the main engine start valve to close the start valve upon completion of a starting cycle. Power for starting engines is furnished by the engine start hydraulic pump. Since the engine start pump is driven by the accessory gear box, the APP must be used for all normal ground starts. The APP is not required for airborne starts, as the main rotor head will drive the accessory gear box. When the start valve is energized by depressing the engine starter button, the engine start pump provides 4000 psi hydraulic pressure for engine starting. The starter circuit to the start valve is routed through six protective interlocks. The starter will not operate if any of the interlocks are in this configuration:

1. Pylon is unsafe for flight.
2. Blade fold safety valve is open.
3. Pitch locks are advanced.
4. Rotor brake is not fully pressurized (975 psi).
5. Mechanical gust lock is engaged.
6. Head is not in start position.

An emergency mode that bypasses all interlocks may be selected.

CAUTION

If the emergency start mode is selected, the pilot must be sure the aircraft configuration (such as, head in start position, etc.) and its surrounding area is safe for engine start.

When the rotor is turning and main gear box oil pressure is up, as evidenced by the MGB OIL PRESS caution light out, the oil pressure switch automatically causes the pitch locks advanced, pylon unsafe, and blade fold safety interlocks to be bypassed. When airborne, the rotor brake not fully pressurized, mechanical gust lock engaged, and head not in start position, interlocks are automatically bypassed by a microswitch on the main landing gear scissors switch.

The ENG STARTER ON advisory light will go on any time a starter circuit is energized. The start system cannot be energized unless the engine speed control lever is at SHUT-OFF. Fuel will be supplied to the fuel control when the fuel control lever is placed to DIRECT or either crossfeed position, and the engine is motoring. Low or inadequate fuel pressure will be indicated by the #1, #2, or #3 ENG FUEL BOOST caution lights. With the starter and ignition systems energized, the engine will start and accelerate as the engine speed control lever is moved to GRD IDLE. The starter speed switch will then automatically de-energize the ignition and start systems, and ignition will be self-sustaining. If the speed switch does not automatically disengage, the starter will have to be manually disengaged.

2.1.11.1 Start Switches. The switches, one for each engine, are in the engine control quadrant behind the appropriate engine speed control lever (FO-1). The starter circuit is energized by holding the speed control lever at SHUT OFF and depressing the starter button, which energizes the start switch, start valve, ENG STARTER ON advisory light, and starter control relay. The starter control relay and start valve are energized through the speed switch as soon as the start switch is activated. Therefore, the start switch does not have to be continually activated throughout the start cycle, and the speed switch will automatically deactivate the starter circuit as soon as the cutout speed is reached. If the speed switch should fail, the engines may be started by manually overriding the start system. The manual override system is used only when it is necessary to make an alternate engine start. An alternate engine start is made by keeping the starter button depressed until N_g readings indicate the engine is self-sustaining, then releasing the starter button. The No. 1, No. 2, and No. 3 engine starting circuits receive control power from the No. 1 primary dc bus through a circuit breaker marked NO. 1 ENGINE START CONT, in the cabin. In addition, the No. 1, No. 2, and No. 3 engine starting circuits operate on power from the No. 1, No. 2, and No. 3 primary dc buses, respectively, through three circuit breakers, marked NO. 1, NO. 2, and NO. 3 EMER START, respectively.

2.1.11.2 Emergency Start Switch. The switch, marked EMER START, with marked positions NORM and EMER, is on the emergency control panel (FO-1). With the switch at NORM, any one of the six protective interlocks can prevent the starter from operating, if the interlocks are

not automatically bypassed by the helicopter configuration. The EMER position bypasses all six interlocks for emergency starts.

Note

All six interlocks should be bypassed in flight; however, to be sure the starter will operate in case of an emergency air start, the switch should be placed to EMER.

2.1.11.3 Start Abort Switch. The switches, one for each engine, are in the engine control quadrant behind the appropriate engine speed control lever. The abort switch, when activated by pulling down on the appropriate engine speed control lever, deactivates the starter circuit by deenergizing the starter control relay.

Note

Since the start abort switches do not shut off fuel flow to the engines, the engine speed control lever should also be placed to SHUT OFF when aborting an engine start.

2.1.12 ROTOR POSITIONER Switch. The ROTOR POSITIONER switch positions the head for engine start so that hot engine exhaust gases do not damage the main rotor blades (Figure 7-3). The switch (spring-loaded to off) is on the pilot's overhead control panel. It uses the same hydraulic system that positions the head for blade and pylon fold. An advisory light, marked ENG START HEAD POS, indicates when the head is in the proper position. The advisory light will operate only while the ROTOR POSITIONER switch is held on. After the head positions, an additional 5 to 6 seconds are required before the ROTOR BRAKE ON advisory light goes back on. An interlock prevents engine start until the head is in the proper position.

CAUTION

Placing the rotor positioner switch to ENG START POSN opens the safety valve. Pitch locks will advance if the pitchlock switch is placed to PITCHLOCK position.

2.1.13 Engine Instruments. The engine instrumentation system provides the pilot with indications of proper and efficient engine operation, and warns of unsafe engine operating conditions.

2.1.13.1 Torquemeters. Two torquemeters (FO-5) are on the instrument panel one in front of each pilot. Each torquemeter is marked TORQUE % × 10 and contains three tape indicators, marked 1, 2, and 3, which indicate the amount of torque produced by each engine. (100% torque is the equivalent of 3200 hp at 100% N_f for each engine.) The torquemeter also contains a power failure flag marked OFF that will appear in a window whenever electrical power is removed from the torque system, and a torque digital window marked TOTAL. The TOTAL window displays the total average torque of the three engines. For example, with three engines operating at 100% the window will read 100%; with one engine shut down and the other two operating at 100%, (100% total average torque is the equivalent of 9600 hp from three engines) the window will read 66%. The torquemeter faces, marked in percent torque, are marked in units of 10% from 0% to 160%. Torquemeters are necessary so the pilot may monitor the power output of each engine and also limit the power output, to prevent overtorquing the engines or main gear box. The torque sensing system contains a shaft connected to the engine load and a reference sleeve. Both the shaft and sleeve have teeth machined on their outside diameter for torque measuring purposes. As the shaft rotates, the twist caused by the engine load will displace the teeth from each other. This displacement produces a phase angle difference that is converted to a proportional output voltage, which is read on the torquemeter as percent of torque. The emergency ac bus furnishes power to the torquemeters through two circuit breakers in the cockpit, marked TORQUE PILOT and TORQUE COPILOT.

2.1.13.2 Overtorque Warning System (416 Engines). An overtorque warning system alerts the pilots when conditions exist which may cause engine overtorque or high tail rotor stress. The ENGINE OVERTORQUE caution light goes on anytime total average engine torque is over 137%. The TAIL ROTOR HIGH STRESS caution light goes on when all these conditions occur: indicated airspeed is greater than 60 knots, total average engine torque is equal to or greater than 110%, and climb rate is greater than 2800 feet per minute. When any of the initiating conditions are removed, the caution lights will go off. The overtorque warnings are initiated from the overtorque warning unit in the left electronics bay. It takes its signal for the ENGINE OVERTORQUE caution light from the copilot's triple torque indicator. Signals for the TAIL ROTOR HIGH STRESS caution light come from the copilot's triple torque indicators and the air data transducer, which provides both vertical velocity and airspeed information. Power for the system is provided from the No. 3 primary dc bus through a circuit breaker marked OVER TRQ WARN.

2.1.13.3 Overtorque Warning System (419 Engine). The Overtorque Warning unit (OTWU) alerts the pilots when an overtorque condition exists and provides a fault indication when the main rotor speed exceeds 118% RPM. Power for the system is provided from the No. 3 Primary dc bus through a circuit breaker marked OVER TRQ WARN.

The OTWU continuously monitors the output torque of all three engines. Whenever the torque on any engine exceeds a threshold of 137 ±3%, the OTWU lights the MASTER CAUTION and ENGINE OVERTORQUE caution lights, and activates an audible warning tone in the Intercommunication System (ICS). Both caution lights and aural tone go out once engine torque goes below 137 ±3%. Depressing the MASTER CAUTION capsule turns off the MASTER CAUTION indication and silences the audible warning tone. The OVERTORQUE caution light will remain lit while any engine exceeds 137 ±3% torque.

Whenever the torque on any single engine exceeds 153% to 156%, the OVERTORQUE caution light remains on continuously. It will not go out as the torque decreases to any level. The OTWU will display the level and duration of overtorque after power is removed from the system until reset by maintenance action. Depressing the MASTER CAUTION capsule will turn off the MASTER CAUTION indication and silence the audible warning tone when this threshold has been exceeded. The OTWU processes signals received from the pilot's and copilot's triple torquemeter. If one torquemeter is inoperative, the other will provide the signal.

The OTWU continuously monitors the main rotor RPM and provides a fault indication when rotor RPM exceeds 118%. The OTWU accepts rotor speed signals from either the pilot or copilot quad tachometer. If one tachometer is inoperative, the other provides the rotor speed signal. The OTWU will record, store, and display the peak level of main rotor RPM above 118% on the display unit located in the left electrical bay. This display will remain on after power is removed and can only be reset by maintenance action.

2.1.13.4 N_f/N_r Tachometer. Two quad tape tachometers (FO-5) are on the instrument panel, one in the pilot's instrument group and one in the copilot's instrument group. Each tachometer contains four tape indicators. The indicators marked 1, 2, and 3 indicate the power turbine speed of the No. 1, No. 2, and No. 3 engines, respectively, and the indicator marked R indicates main rotor speed. An OFF flag indicates electrical power removal. Each engine tachometer and the rotor tachometer are powered by their own tachometer-generator. Each indicator dial, marked TACH % RPM × 10 ENG, 1, 2, 3, and R, is marked in units of 20%, from 0% to 80%; 10% from 80% to 90%, 2%, from 90% to 110%; and 10%, from 110% to 130%. A green RTR BK light, on the lower portion of the tachometer, goes on whenever N_r is between 50% ±4% and 25% ±4%. The emergency ac bus furnishes power to the tachometers through a circuit breaker in the cockpit, marked QUAD TACH.

2.1.13.5 N_g Tachometers. Three gas generator tachometers (FO-5), one for each engine, are on the instrument panel. They indicate gas generator speed in percent of total rpm. Each engine gas generator tachometer is powered by a tachometer-generator that is mounted on, and driven by, the engine accessory gear box assembly.

2.1.13.6 T_5 Gage. Three power turbine inlet temperature indicators (FO-5), one for each engine, are on the instrument panel. The indicators are marked in °C and operate from thermocouples in the turbine casing of each engine. The Nos 1, 2, and 3 power turbine inlet temperature indicators are powered from the No. 1 primary ac bus through three circuit breakers, marked NO. 1, NO. 2, and NO. 3 ENGINE PTIT (T_5), respectively, in the cabin.

2.1.13.7 Fuel Flow Indicators. Three indicators (FO-5), on the instrument panel, are calibrated in pounds-per-hour, and indicate the fuel consumption of the engines. The No. 1 and No. 3 indicators receive power from the No. 1 and No. 3 primary ac buses through two circuit breakers, marked NO. 1 and NO. 3 ENGINE FUEL FLOW, respectively, in the cabin. The No. 2 indicator receives power from the No. 2B primary ac bus through a circuit breaker marked NO. 2 ENG FUEL FLOW, in the cabin.

2.1.13.8 Engine Oil Temperature Gages. Three engine oil temperature gages (FO-5), on the instrument panel, are marked in °C and indicate the engine oil temperatures sensed by each engine oil temperature bulb on each engine oil inlet line. The Nos 1, 2, and 3 gages receive power from the No. 1, No. 2, and No. 3 primary dc buses through three circuit breakers marked NO. 1, NO. 2, and NO. 3 ENGINE OIL TEMP, respectively, in the cabin.

Note

On aircraft powered by the 416 engines, the engine oil temperature gages should be constantly monitored when the engines are operating and the rotor is not turning, as the engine oil cooler blowers are then not operating. On aircraft powered by the 419 engine, the oil coolers are functioning whenever the engines are running.

2.2 ROTOR SYSTEMS

The rotor systems consist of a single, articulated main rotor and an antitorque tail rotor. Both systems are driven by the engines through the transmission system, and are controlled by the flight controls.

2.2.1 Main Rotor System. The main rotor system consists of the rotor head assembly (FO-11) and seven rotor blades. The rotor head assembly, mounted directly to the output shaft of the main gear box, consists of a hub assembly and a swashplate assembly. The hub assembly, consisting of the upper and lower hub plates, seven sleeve-spindle assemblies, and seven hydraulic dampers, is splined to the main rotor drive shaft. The root ends of the rotor blades are attached to extenders that, in turn, are attached to the sleeve-spindle assemblies, which permit each blade to flap vertically, hunt horizontally, and turn about their span-wise axis. Antiflapping restrainers and droop stops prevent excessive flapping of the blades when the main rotor head is static or is turning at low rpm. The antiflapping restrainers are automatically released as main rotor speed is increased to about 25%, while the droop stops are automatically released as main rotor speed is increased to about 75%. The hydraulic dampers minimize the hunting movement of the blades about the vertical hinges as they rotate, prevent shock to the blades when the main rotor head assembly is started or stopped, and position the blades against the lag stops after rotor shutdown. The swashplate assembly consists of a rotating swashplate, driven by the main rotor hub assembly, and a stationary swashplate that is secured to the main gear box by a scissors assembly, to prevent rotation. The swashplate assembly is mounted on a ball ring and socket assembly that keeps it parallel at all times, but allows it to be tilted, raised, or lowered by components of the flight control system control connected to the stationary swashplate. Cyclic or collective pitch changes introduced at the stationary swashplate are transmitted to the blades by linkage on the rotating swashplate. A blade positioner assembly, installed on the back of the main gear box, will position the rotor blades before folding if it has been activated. The blade positioner also positions the head for engine starting.

2.2.1.1 Main Rotor Blades. The rotor blades (FO-11) are attached to extenders that, in turn, are attached to the sleeve-spindle assemblies on the rotor hub assembly. The blades have an abrasion strip bonded to the leading edge to prevent damage from dust and adverse weather conditions. The blades are made by forming a fiberglass and resin airfoil around a tubular titanium spar. Each rotor blade has a light assembly installed on the top of the blade tip to provide tip path lighting. Each rotor blade spar is pressurized and incorporates a spar pressure indicating system for spar crack detection.

2.2.1.2 IBIS (In-Flight Blade Inspection System). The system (Figure 2-2) consists of each main rotor blade's spar being pressurized with nitrogen to about 10 psi at an ambient temperature of 18 to 24°C, a pressure indicator (with a radioactive source) on the root of each spar, a radiation detector aft of the main rotor pylon area, a signal processor with a test panel in the cabin, and a BIM® (Blade Inspection Method) caution light. For visual inspection the pressure indicator shows two white stripes indicating spar pressure is safe.

If spar pressure drops to 5 ±0.5 psi or less, the pressure indicator will show two black stripes, indicating pressure is escaping through a crack in the spar or through a faulty seal. A pressure indicator with a safe indication (two white stripes) can be checked by pressing the manual test button, on the indicator, causing an unsafe indication (two black stripes) to be displayed. Once two black stripes are displayed, regardless of the cause, the reset button, on the pressure indicator, has to be pressed to replace the black indication with a white indication, if spar pressure is normal. The test button is always pressed with the clear plastic shield over the indicator to prevent radiation escape.

The pressure indicator contains a radioactive source that is shielded when the indicator is at the safe (white) indication. When the indicator goes to the unsafe (black) position the radioactive source moves out of the shielded position and is exposed. As the rotating unsafe blade passes over the radiation detector the radioactive rays being released by the blade's unsafe indicator are sensed by the radiation detector. This sends an electrical signal to the signal processor, that deenergizes a relay in the processor and causes the BIM caution light to go on.

To be sure the detector is capable of detecting radiation, a small radioactive source, incorporated in the detector, continuously emits radiation at a lower rate than the radioactive source in the spar pressure indicator. The detector continuously senses its own radiation and sends a signal to the signal processor to energize a relay that

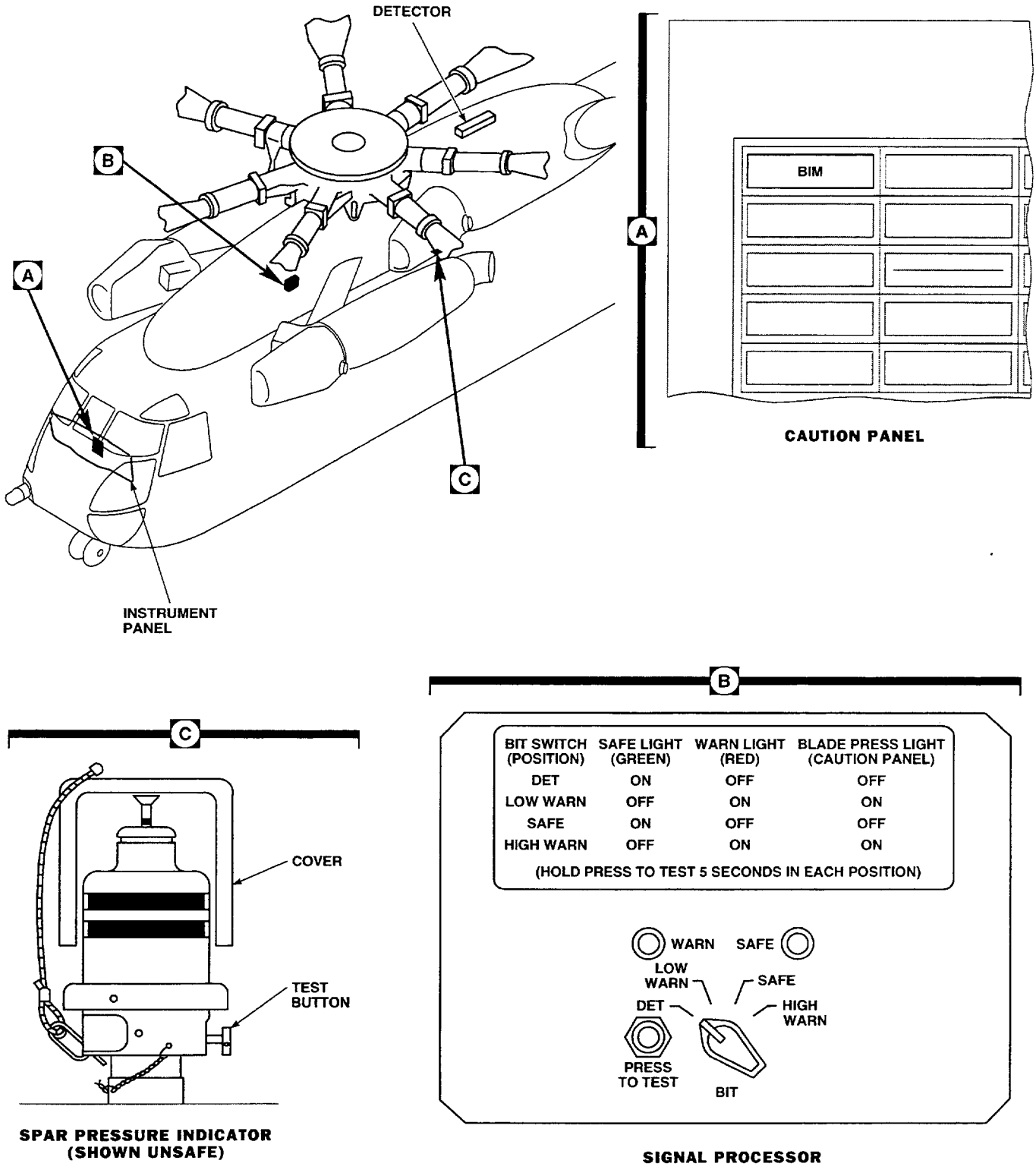


Figure 2-2. IBIS (In-Flight Blade Inspection System)

extinguishes the BIM caution light. Therefore, loss of pressure in the spar, failure of the radiation detector, failure of the signal processor, or loss of 115 vac will result in the BIM caution light going on.

The No. 3 primary ac and the No. 2 primary dc buses furnish power to the system through two circuit breakers marked BIM, in the cabin.

2.2.1.3 Signal Processor Test Panel. The panel is on the signal processor (Figure 2-2), which is in the center of the cabin on the right side. The panel is used for built-in-test (BIT), to verify operation of the radiation detector and the signal processor. The panel contains a BIT SWITCH, a PRESS-TO-TEST pushbutton, a red WARN light, a green SAFE light, and a decal that gives the BIT procedure and the desired displays.

Selecting DET with the BIT SWITCH and pressing the PRESS-TO-TEST pushbutton simulates the detector's normal sensing of its own low radiation rate and lights the green SAFE light. This is an operational checkout of the detector.

Selecting LOW WARN and pressing the pushbutton simulates loss of the detector's own low radiation rate and lights the BIM caution light and the red WARN light. This is a functional checkout of the signal processor.

Selecting SAFE and pressing the pushbutton simulates the detector's normal sensing of its own low radiation rate and lights the green safe light. This is functional checkout of the signal processor. The BIM caution light goes on for 8 to 12 seconds when the PRESS-TO-TEST pushbutton is released.

Selecting HIGH WARN and pressing the pushbutton simulates the detector sensing a high radiation rate from a spar pressure indicator with low pressure. The BIM caution light comes on for 8 to 12 seconds and the red WARN light comes on. This is a functional checkout of the signal processor.

2.2.2 Tail Rotor System. The system consists of the rotor hub assembly, sleeve and spindle assembly, pitch changing mechanism which is supported by a bearing housing, and four rotor blades. The rotor hub assembly, mounted on the upper end of the pylon, is splined to and driven by the output shaft of the tail gear box. The rotor blades are attached to the sleeve and spindle assembly and flapping hinges, which permit them to flap and turn about their spanwise axis for pitch variation. Flap restrainers are provided to prevent the tail rotor blades from flapping when the tail rotor is stopped. The blades are all composite construction of laminated skin over an I-beam and honeycomb core. The leading edge is protected by a nickel abrasion strip.

2.2.3 Bearing Monitor System (AFC 491). The bearing monitor system (BMS) senses vibration and temperature levels of the swashplate and the tail rotor driveshaft (TRDS) disconnect coupling bearings. The BMS provides cockpit and cabin indications of degraded bearing condition. Primary BMS components include the following:

1. Two independent compound (vibration/ temperature) sensors on the main rotor swashplate, one sensor on the tail rotor driveshaft (TRDS) disconnect coupling duplex bearing housing, and one sensor on the main transmission oil cooler support

2. BEARING VIB LIMIT, BEARING TEMP DETECT and BEARING TEMP LIMIT caution lights on the caution/ advisory panel (FO-6)

3. Bearing monitor panel (BMP) on the left side of the cabin wall, forward of the gunner's window (Figure 2-3)

The swashplate and TRDS disconnect coupling compound sensors send vibration and temperature signals to the BMP. The compound sensor on the main transmission oil cooler support is currently disabled. The BMP monitors, analyzes, and conditions these input signals. If the BMP identifies a signal that may indicate a degraded bearing condition, it gives cockpit and/or cabin indications as necessary.

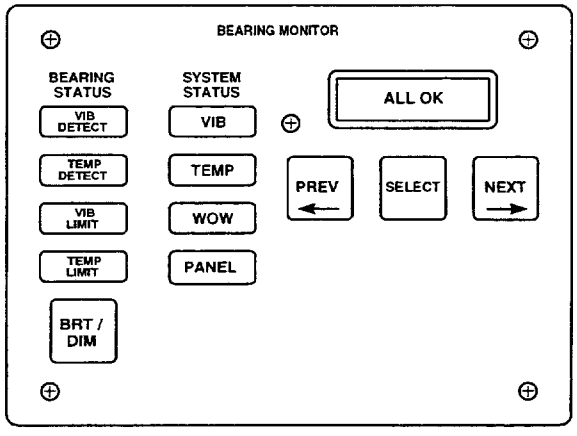


Figure 2-3. Bearing Monitor Panel (BMP)

Bearing condition indications depend on the level of degradation determined by the BMP using sensor temperature and vibration signals. Normal bearing wear is indicated by a gradual increase in bearing vibration levels over time. Bearing failure is caused by excessive bearing temperature that may or may not be associated with high vibration levels. Under normal conditions, the BMP lights are off. If bearing vibration levels are higher than normal, the VIB DETECT light on the cabin BMP panel comes on. VIB DETECT indicates that the bearing is approaching replacement limits. If vibration levels continue to increase, the VIB LIMIT light on the BMP and the BEARING VIB LIMIT caution light in the cockpit come on. The VIB LIMIT and BEARING VIB LIMIT lights indicate that the bearing has reached the replacement limit for vibration. If a bearing temperature level indicates a possible bearing failure, the TEMP DET and/or TEMP LIMIT lights on the BMP come on with their related cockpit caution lights. Refer to the BEARING VIB LIMIT, BEARING TEMP DETECT, or BEARING TEMP LIMIT Caution Lights procedure in Chapter 12.

The emergency dc bus supplies electrical power for the BMS through the BRG MON circuit breaker. The BRG MON circuit breaker is on the cockpit overhead circuit breaker panel.

2.2.3.1 Bearing Monitor Panel. The bearing monitor panel (BMP) in the cabin is the heart of the bearing monitor system. If there is a bearing and/or system fault condition, the BMP allows the operator to isolate the fault source(s). The BMP also provides for diagnostic information and built-in test (BIT) functions for aircrew and maintenance personnel. These functions are normally done during pre/postflight maintenance.

The BMP has four BEARING STATUS annunciator lights and four SYSTEM STATUS annunciator lights. An eight-character alphanumeric display shows system status or bearing/sensor location. The PREV, SELECT, and NEXT switches provide for operator select menu options. A BRT/DIM switch adjusts the display intensity. The BMP is NVG-compatible.

BMP BEARING STATUS INDICATORS

VIB DETECT	The BMS has sensed bearing vibration level(s) which are higher than normal. VIB DETECT indicates that swashplate bearing vibration levels have reached 1.2 g's or TRDS disconnect coupling bearing vibration levels have reached 1.5 g's. The bearing is approaching replacement criteria and will require maintenance action. For aircrew actions, refer to the Aircrew Pocket Checklist, A1-H53ME-NFM-900.
	NOTE Vibration limit levels are multi-sample averages and may not correspond to a one-time VATS reading
TEMP DETECT	The BMS has sensed bearing temperature level(s) which are higher than normal. The BEARING TEMP DETECT caution light also comes on in the cockpit. TEMP DETECT indicates a bearing has reached 275°F and may be progressing toward failure. For pilot/aircrew actions, refer to Chapter 12.
VIB LIMIT	The BMS has sensed bearing vibration level(s) which are beyond normal replacement limits. VIB LIMIT indicates that swashplate bearing vibration levels have reached 2.5 g's or TRDS disconnect coupling bearing vibration levels have reached 4.0 g's. The BEARING VIB LIMIT caution light also comes on in the cockpit. For pilot/aircrew actions, refer to Chapter 12.
TEMP LIMIT	The BMS has sensed bearing temperature level(s) which are beyond maximum limits. The BEARING TEMP LIMIT caution light also comes on in the cockpit. TEMP LIMIT indicates a bearing has reached 350°F and is indicative of impending bearing failure. For pilot/aircrew actions, refer to Chapter 12.

SYSTEM STATUS INDICATORS

VIB	The vibration signal from any bearing sensor has failed.
TEMP	The temperature signal from any sensor has failed.
WOW	A weight-on-wheels signal fault has been detected.
PANEL	The BMP has an internal hardware or software failure.

The BMP alphanumeric display normally shows ALL OK. With an ALL OK indication, the PREV and NEXT switches change menu selections between LMP TEST, SYS TEST, and RESET. The SELECT switch starts the function shown on the display. The system provides for identifying a failed sensor or a sensor that is signalling a bearing degradation (VIB DET, VIB LIMIT, TEMP DET, or TEMP LIMIT light is on). The sensor status is shown by either the bearing or system status indicators. If the BMS indicates a system fault, refer to the applicable maintenance manuals for alternate bearing inspection requirements.

Note

- A plus sign (+) next to a fault indication means that additional faults exist. The PREV or NEXT switches let the operator review the status of other sensors. If the sensor shown on the BMP display is sending a sensor fault signal, an appropriate SYSTEM STATUS annunciator light comes on. If the sensor is indicating high vibration or temperature levels, an appropriate BEARING STATUS annunciator light comes on.

- Failure of both the swashplate (SP) SP1 and SP2 sensors, or failure of the bearing monitor panel (BMP) will result in a loss of swashplate monitoring capabilities. Refer to Chapter 12 for pilot/aircrew actions.

- Swashplate temperatures above 230°F will cause attenuation of signals from the vibration portion of compound sensors and will result in a VIB fault light and the corresponding alphanumeric display on the BMP.

BMS SENSOR LOCATION INDICATIONS ON THE BMP ALPHANUMERIC DISPLAY

SP-1 or SP-2	Swashplate
DISC	Tail rotor driveshaft disconnect coupling
TDS-2 through TDS-5	Tail rotor driveshaft bearings (N/A with AFC 491)
T-REF	Thermal reference sensor on the main transmission oil cooler support (N/A with AFC 491)
WOW NG	Weight-on-wheels
PNL NG	BMS bearing monitor panel

When a bearing or system fault is detected, the alphanumeric display reads FAULT instead of ALL OK and the associated bearing or system status light comes on. The operator can use PREV or NEXT to get the LMP TEST, SYS TEST, and RESET menu options.

Note

- Bearing and system faults are held in the non-volatile RAM of the BMP after electrical power is removed from the bearing monitor system. Existing BMS faults are seen each time electrical power is applied. The only way to reset the system is with the RESET switch.

- The system test cannot be done while the helicopter is off the ground (no WOW).

2.3 TRANSMISSION SYSTEM

The system (Figure 2-4) consists of the two nose gear boxes, a main gear box, an accessory gear box, an intermediate gear box, and the tail rotor gear box. A freewheeling unit, at each main gear box input, permits any or all engines to be disengaged from the main gear box. The freewheeling units can disengage the engines during autorotation, or one or two engines for single- or dual-engine operation, or any time engine rpm decreases below rotor rpm. Engine torque is transmitted, through the No. 1 and No. 3 engine nose gear boxes and the gimbal assembly on the main gear box accessory section for No. 2 engine, to the main gear box, where it is transmitted to the main rotor drive shaft and aft to the tail rotor drive shaft.

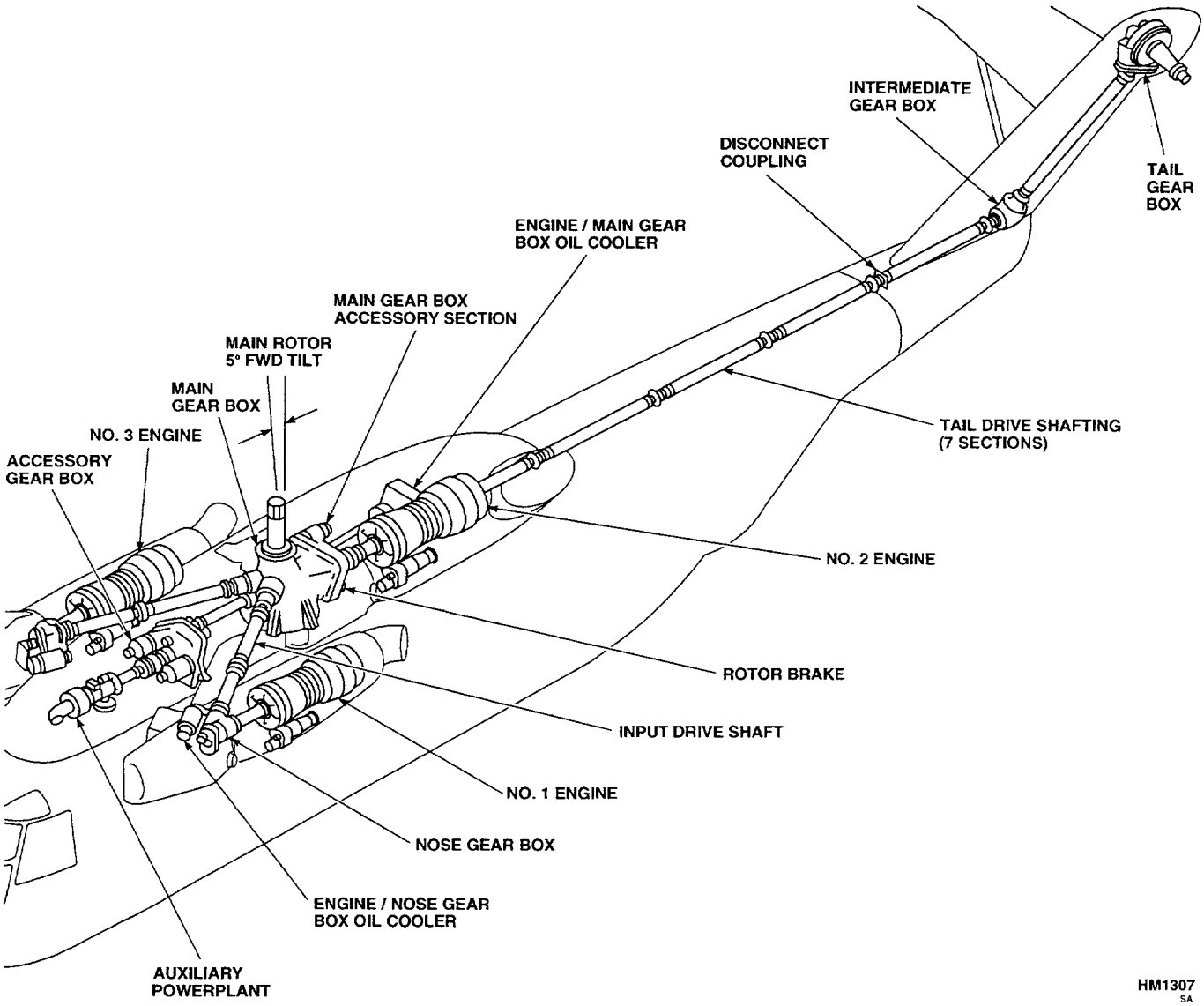


Figure 2-4. Transmission System

The tail rotor drive shaft transmits the torque to the intermediate gear box at the base of the pylon. From the intermediate gear box, a pylon drive shaft extends upward to the tail rotor gear box to drive the tail rotor. All six gear boxes have chip detectors. The main gear box has five, the accessory gear box has two, and the intermediate, tail rotor and both engine nose gear boxes each have one.

2.3.1 Nose Gear Boxes. The nose gear boxes (Figure 2-4), each forward of the No. 1 and No. 3 engines, contain high-speed bevel gears that reduce engine rpm from 14,280 rpm to about 6323 rpm for input into the main gear box. The input drive to the main gear box from the No. 2 engine is through a gimbal assembly. Initial reduction gearing for the No. 2 engine is contained in the main gear box.

2.3.2 Main Gear Box. The gear box (Figure 2-4), mounted above the cabin, couples the three engine inputs and provides output power for the main rotor head and tail rotor and accessory gear boxes. The main gear box reduces the 6323 rpm inputs to 179 rpm (100% N_r) for the rotor head, and to 4271 rpm for the intermediate gear box. Shafting extends vertically from the main gear box to the main rotor head, and aft from the rear cover housing to the intermediate gear box. The main gear box also drives the main gear box accessory section, which drives

the No. 2 engine and main gear box oil cooler, the No. 2 generator, the rotor tachometer-generator, and the first-stage servo hydraulic pump. The main gear box drives the accessory gear box when N_r exceeds APP rpm, or when APP is not operating.

2.3.3 Accessory Gear Box. The accessory gear box (Figure 2-4), mounted forward of the main gear box, drives the No. 1 and No. 3 generators, second-stage servo hydraulic pump, engine start hydraulic pump, utility 1 hydraulic system pump, and the utility 2 hydraulic system pump. The accessory gear box may be driven by the main gear box when the main rotor is turning, or by the APP when the rotor is stopped. The APP, forward of the accessory gear box, is connected to the accessory gear box through a clutch and shaft assembly. The APP will drive the accessory gear box until the main gear box drive rpm exceeds APP rpm. The clutch disengages the APP from the accessory gear box when the APP is shut down.

2.3.4 Intermediate Gear Box. The intermediate gear box (Figure 2-4), at the base of the tail rotor pylon, changes the angle of drive and provides an rpm reduction from 4271 to 2628 rpm.

2.3.5 Tail Rotor Gear Box. The tail rotor gear box (Figure 2-4), at the upper end of the tail rotor pylon, provides power transmission through a right angle at a reduction in rpm from 2628 to 699 rpm.

2.3.6 Transmission Oil Systems. Each of the six transmission system gear boxes has an individual oil system and all are pressure-lubricated.

2.3.6.1 Nose Gear Box Oil Systems. Each of the nose gear boxes is pressure-lubricated by a gear-type oil pump mounted on the lower housing of the gear box. Oil pressure is controlled by a pressure regulating valve, and oil temperature is controlled by the nose gear box oil coolers. After passing through the oil cooler, the oil is returned to the gear box and sprayed through jets to lubricate the gears and bearings. Each gear box has a filter, oil filler, drain plug, chip detector, and dipstick. The nose gear box is serviced through a filler port, on top of each gear box, and holds 5.5 quarts of usable oil.

2.3.6.2 Nose Gear Box Oil Coolers. These oil coolers (Figure 2-4) use the blower and ducting of the engine oil cooler system; however, the nose gear box oil coolers have individual cooler radiators and plumbing. The oil cooler assemblies are inboard of the nose gear boxes. Cooling air for the oil coolers is supplied by oil cooler blowers that are mounted aft of the oil cooler radiators and are belt-driven by the input shaft to the main gear box. During cold starts, high oil pressure may be encountered until the oil is warm. In this case oil bypasses the radiator until it has warmed. Once the oil is warm, it is directed through the cores of the radiator for cooling, then returned through external lines to the gear boxes.

2.3.6.3 Nose Gear Box Oil Temperature Gage. The gages (FO-5), on the instrument panel, indicate the oil temperature of a respective nose gear box in °C, and indicate the temperature of the oil in the nose gear box sump. The temperature is sensed by a bulb on the front cover of each nose gear box. The No. 1 and No. 3 gages receive power from the No. 1 and No. 3 primary dc buses, respectively, through two circuit breakers, marked NO. 1 ENGINE NGB TEMP and NO. 3 ENGINE NGB TEMP, respectively, in the cabin.

Note

Nose gear box oil temperature indicated on the gage is detected from a separate source and may not coincide with nose gear box oil hot caution light illumination.

2.3.6.4 Nose Gear Box Oil Temperature Caution Lights. The #1 and #3 NGB OIL HOT caution lights are activated by a plugstat temperature control unit installed in each nose gear box. Each plugstat has switch contacts that close when the oil temperature reaches 121° ±5.5 °C, completing a circuit to light the warning lights on the caution panel. The caution light indicates the nose gear box oil temperature after it leaves the nose gear box oil cooler. The #1 and #3 NGB OIL HOT caution lights receive power from the No. 1 and No. 3 primary dc buses, respectively, through two circuit breakers, marked NO. 1 ENGINE NGB HOT and NO. 3 ENGINE NGB HOT, respectively, in the cabin.

2.3.6.5 Nose Gear Box Oil Pressure Caution Lights. The #1 and #3 NGB OIL PRESS caution lights will go on when the oil pressure decreases to 14 ±2 psi. The caution lights receive power from the emergency dc bus through two circuit breakers, marked NO. 1 ENG NGB OIL PRESS and NO. 3 ENG NGB OIL PRESS, in the cockpit.

2.3.6.6 Accessory Gear Box Oil System. The accessory gear box is pressure-lubricated by a vane-type pump mounted on the back of the accessory case. The gear box is internally-lubricated and does not incorporate oil coolers for temperature control. The ability to dissipate heat through convection and radiation eliminates the need for supplementary oil cooling. The gear box has one oil filter, two chip detectors (one for the gear box, the other

for returning oil from the APP clutch), a drain plug, and a dipstick. The dipstick is mounted on the lower aft side of the gear box. The accessory gear box is serviced through a filler port, on top of the gear box, and it holds 8 quarts of usable oil.

2.3.6.7 Accessory Gear Box Oil Temperature Caution Light. The ACC GB OIL HOT caution light will go on when the oil temperature is over 145°C. The caution light receives power from the No. 1 primary dc bus through a circuit breaker marked ACC GB OIL HOT, in the cabin.

2.3.6.8 Accessory Gear Box Oil Pressure Caution Light. The ACC GB OIL PRESS caution light will go on when the oil pressure decreases to 7 ±1 psi. The caution light receives power from the emergency dc bus through a circuit breaker marked ACCESS GB PRESS, in the cockpit.

2.3.6.9 Main Gear Box Lubrication System

2.3.6.10 Primary Lubrication System. The main gear box is pressure-lubricated by a vane type oil pump mounted on the sump housing of the gear box (Figure 2-5). Oil pressure is controlled by a pressure regulating valve and the oil temperature is controlled by the main gear box oil cooler. Oil is passed through external lines to the oil cooler, then returned to the gear box to jet-lubricate the gears and bushings. The gear box has a filter, an oil filler port, drain plug, chip detectors, and dipstick. The main gear box is serviced through a filler port, on the right side of the gear box.

2.3.6.11 Auxiliary Lubrication System. This system (Figure 2-6) furnishes a limited amount of lubrication to the main gear box, to give the pilot more time to initiate emergency procedures if the primary oil system fails. The system is self-contained within the gear box and is not connected to the primary oil system, except for its oil supply. The auxiliary oil system has its own vane type pump, lubrication jets, chip detector and caution light. The pump's oil supply is furnished from the auxiliary section of the sump, which is lower than the primary pump's source.

2.3.6.12 Main Gear Box Oil Cooler. The oil cooler (Figure 2-4) for the primary lubrication system is mounted aft of the main gear box. Cooling air for the oil cooler enters the main gear box fairing through a screened intake, and is forced through the cooler radiator by an oil cooler blower. The oil cooler blower is driven by a takeoff shaft from the main gear box. The air is then

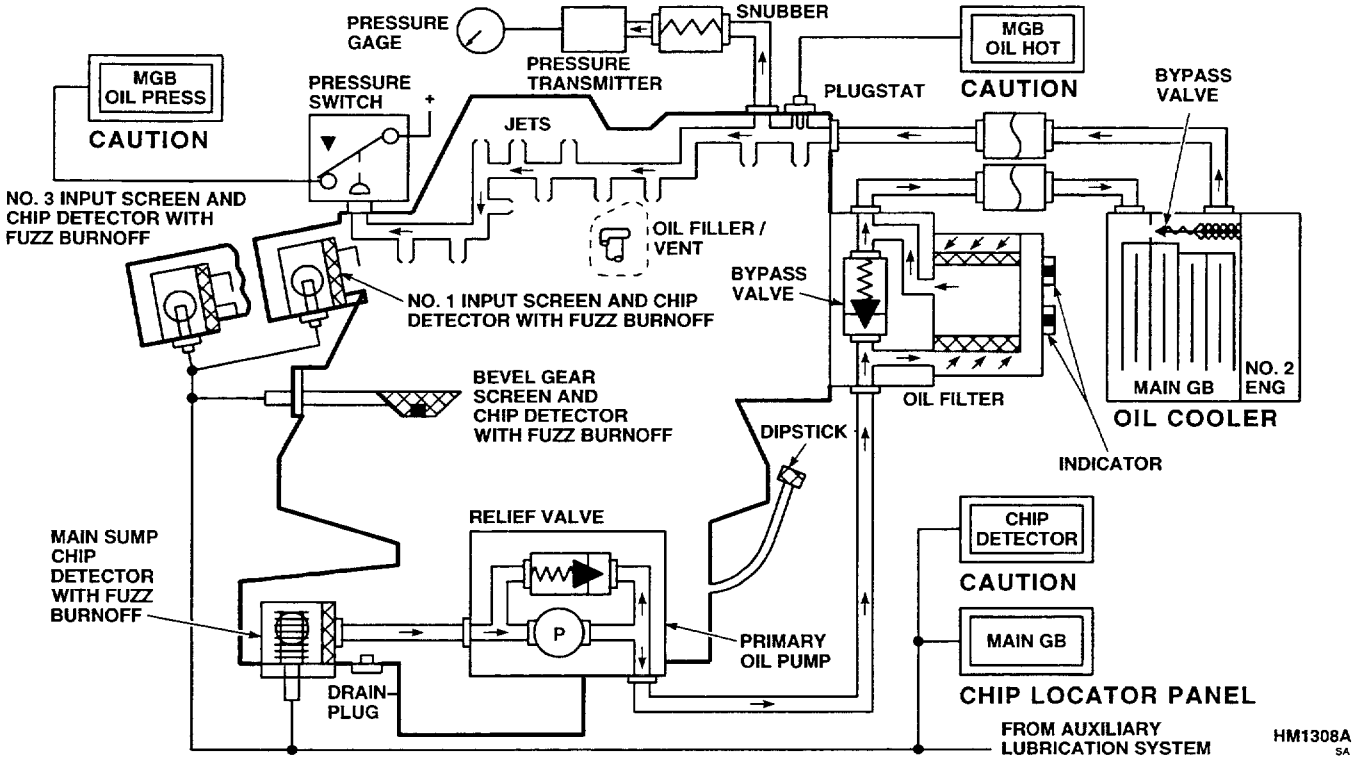


Figure 2-5. Main Gear Box Primary Lubrication Schematic

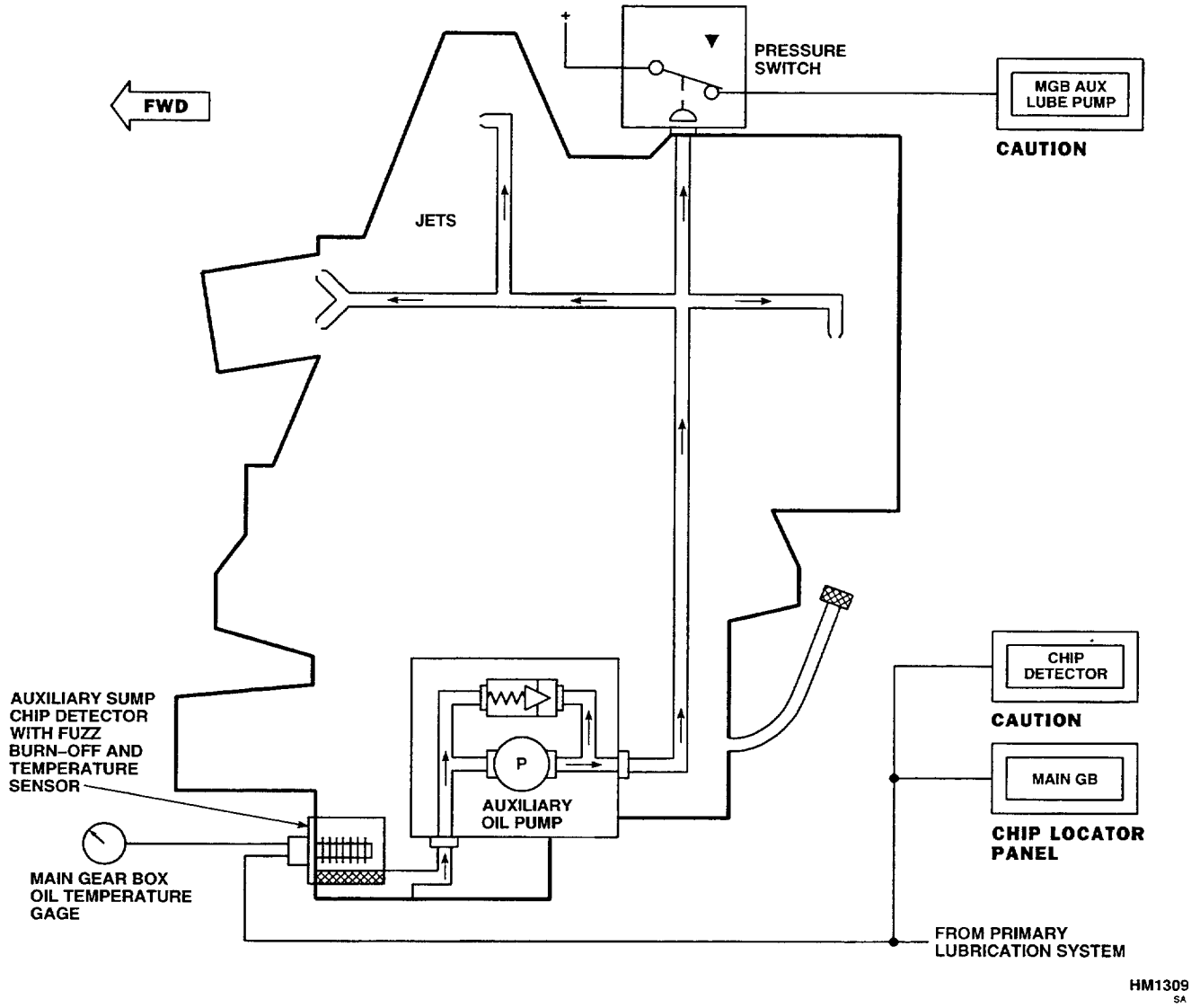


Figure 2-6. Main Gear Box Auxiliary Lubrication Schematic

exhausted through an air outlet. After passing through the oil cooler, the oil is returned to the gear box, where it is sprayed onto the gears and bearings through lubricating jets.

2.3.6.13 Main Gear Box Oil Temperature Gage. The gage (FO-5), on the instrument panel, indicates the oil temperature in °C. The temperature is sensed by a combination chip detector and temperature sensor in the auxiliary sump. The chip detector and temperature sensor operate independently. The gage receives power from the No. 2 primary dc bus, through a circuit breaker marked MAIN GB OIL TEMP, in the cabin.

Note

Main gear box oil temperature indicated on the gage is detected from a separate source, and will not coincide with main gear box oil hot caution light going on.

2.3.6.14 Main Gear Box Oil Temperature Caution Light. The MGB OIL HOT caution light is activated by a plugstat temperature control unit installed in the main gear box manifold. It has switch contacts that close when the temperature of oil returning from the oil cooler reaches 121° ±5.5°C, completing a circuit to light

the caution light. The caution light receives power from the No. 2 primary dc bus through a circuit breaker, marked MAIN GB OIL HOT, in the cabin.

2.3.6.15 Main Gear Box Oil Pressure Gage. The gage (FO-5), on the instrument panel, indicates oil pressure in pounds per square inch. The gage reads the pressure of the primary lubrication system. The gage operates on 26 vac power from the autotransformer and the No. 3 primary ac bus, through a circuit breaker marked MGB OIL PRESS 26V, in the cabin.

2.3.6.16 Main Gear Box Oil Pressure Caution Light. The MGB OIL PRESS caution light will go on when the oil pressure decreases to 14 ±2 psi. The caution light monitors the primary lubrication system. The caution light receives power from the emergency dc bus through a circuit breaker marked MAIN/TR INT GB, in the cockpit.

2.3.6.17 Main Gear Box Auxiliary Oil Pressure Caution Light. The MGB AUX LUBE PUMP caution light will go on whenever oil pressure decreases to 14 ±2 psi. The caution light monitors the auxiliary lubrication system. Power to operate the light is furnished by the emergency dc bus through a circuit breaker marked MAIN/TR INT GB, in the cockpit.

2.3.6.18 Intermediate and Tail Rotor Gear Box Oil Systems. Both the intermediate and tail rotor gear boxes are pressure-lubricated from individual sump pump systems. The tail gear box contains a scavenge pump to collect the oil and return it to the sump. An oil filler plug, drain plug, combination chip and temperature detector, a pressure switch to light the caution light if pressure drops to 7 ±1 psi, and a sight gage, are in each gear box casing. Screened air inlets in the pylon fairing permit the intermediate gear box to be cooled by circulating air. The tail rotor gear box is cooled by circulating air. Both gear boxes are serviced through filler ports at the top of each gear box. The intermediate gear box holds 3-1/4 quarts of usable oil, and the tail rotor gear box holds 6-3/4 quarts of usable oil.

2.3.6.19 Intermediate and Tail Rotor Pressure Caution Lights. The IGB OIL PRESS and TGB OIL PRESS caution lights will go on whenever oil pressure decreases to 7 ±1 psi. The caution lights receive power from the emergency dc bus through a circuit breaker marked MAIN/TR INT GB, in the cockpit.

2.3.6.20 Transmission Chip Detector System. Metallic chips circulating in a gear box lubrication system are an indication of gear box deterioration. The gear boxes have chip detectors (Figure 2-7) that will cause chip locator lights, on the instrument panel, to go on when chips are detected. The gear box lubricating systems route the lubricating oil past magnetic chip detectors, which will attract ferrous chips. When there are enough chips deposited to form a conductive bridge, an electrical circuit is completed and the chip detector's associated chip locator light goes on. If chips wash away and/or the conductive bridge is broken, the chip locator light goes off. The chip detectors (except the three engines) have automatic fuzz burn feature that electrically burn off accumulations of small inconsequential particles that would cause a chip locator to light and give a false warning. The CHIP DETECTED caution light goes on simultaneously with the lighting of any chip locator light.

The tail rotor gear box combination fuzz burn chip and temperature detector lights the TAIL GB chip locator when chips are detected, or when lubricating oil rises to a temperature of 140° ±5°C. The emergency dc bus furnishes operating power through the ACCESS INT/TAIL circuit breaker.

The intermediate gear box combination fuzz burn, chip and temperature detector lights the INTMD GB chip locator light when chips are detected, or when lubricating oil rises to a temperature of 140° ±5.5°C. The emergency dc bus furnishes operating power through the ACCESS INT/TAIL circuit breaker.

The No. 1 nose gear box chip detector lights the NO. 1 NGB chip locator light when chips are detected. The emergency dc bus furnishes operating power through the NO. 1 NGB circuit breaker.

The No. 3 nose gear box chip detector lights the NO. 3 NGB chip locator light when chips are detected. The emergency dc bus furnishes operating power through the NO. 3 NGB circuit breaker.

The accessory gear box has two chip detectors, and either one will light the ACCESS GB chip locator light when chips are detected. The fuzz burn feature is disabled when the ACC GB OIL HOT or ACC GB OIL PRESS caution lights go on, to prevent possible high lubricating oil temperature vapor ignition. The emergency dc bus furnishes operating power through the ACCESS INT/TAIL circuit breaker.

The main gear box has five chip detectors and any one will light the MAIN GB chip locator light when chips are detected. The fuzz burn feature is disabled when the MGB OIL HOT, MGB OIL PRESS, or MGB AUX LUBE PUMP caution lights go on to prevent possible high lubricating oil temperature vapor ignition. The main gear box sump chip

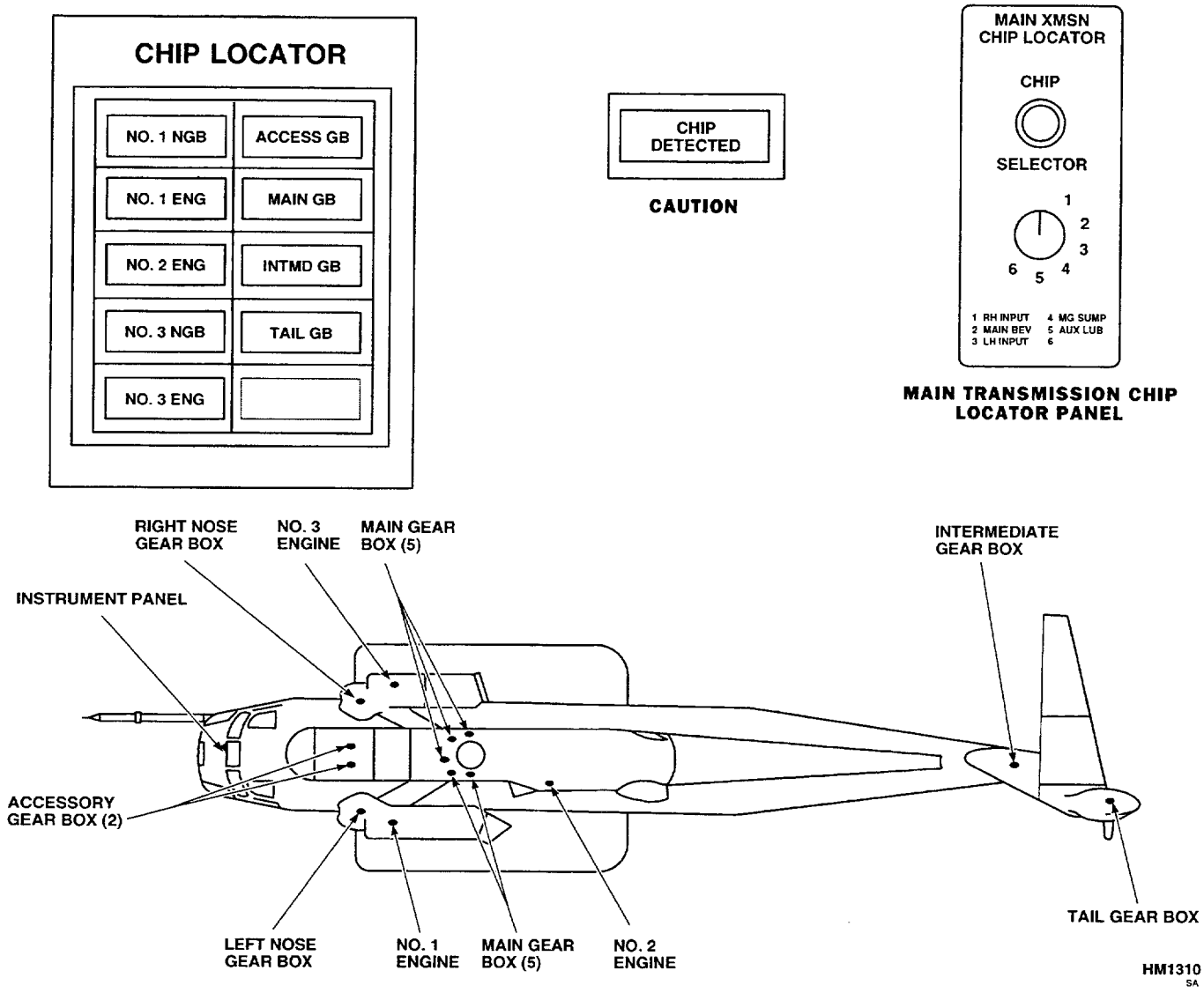


Figure 2-7. Chip Detector Locations

detector and the auxiliary sump chip detector/ temperature bulb are connected to a 30 second time delay relay which will energize when a chip has been present for approximately 30 seconds. The 30-second time delay relay ensures that a warning is not given for transient conditions or due to normal wear particles that could wash away or burn off. The emergency dc bus furnishes operating power through the MAIN GB circuit breaker.

2.3.6.21 Fuzz Burn. All aircraft transmission system gear boxes are equipped with fuzz burn chip detectors. Fuzz burn is designed to reduce nuisance chip lights by removing ferrous buildup on a chip detector through capacitive discharge. Fuzz burn is a nearly instantaneous single action and will not recharge until the chip or chips that have formed a conductive bridge in the respective system are gone for greater than 40 seconds. Since power must be on the system and the conductive bridge gone for recharging to take place, pulling and resetting chip detection circuit breakers will not cause fuzz burn to occur again.

Fuzz burn control unit No. 1 controls electrical power for fuzz burn to the main gear box and nose gear box chip detectors. Whenever one or more of the MGB OIL HOT, MGB OIL PRESS, or MGB AUX LUBE PUMP caution

light illuminates, fuzz burn control unit No. 1's capacitive charge is dissipated to ground and fuzz burn is no longer available to the main gear box or nose gear boxes.

Fuzz burn control unit No. 2 controls electrical power for fuzz burn to the two accessory gear box chip detectors. Whenever the ACC GB OIL HOT and/or ACC GB OIL PRESS caution lights illuminate, fuzz burn control No. 2's capacitive charge is dissipated to ground and fuzz burn is no longer available to the accessory gear box chip detectors.

Fuzz burn for the intermediate and tail rotor gear boxes is provided by circuitry within each gear box's combination overtemperature/fuzz burn chip detector. Whenever the thermal switch within the detector senses an overtemperature condition, the CHIP DETECTED caution light and respective gear box caution light illuminates, the detectors' internal capacitive charge is dissipated to ground and fuzz burn is no longer available to that gear box chip detector.

2.3.6.22 Main Transmission Chip Locator Panel. The panel (Figure 2-7), on the left side of the cabin, allows the aircrewman to identify which chip detectors have picked up chips. Turning the SELECTOR knob permits each of the five chip detectors to be isolated. Lighting of the CHIP light indicates that the chip detector associated with the knob position has picked up chips. The knob positions are 1. RH INPUT, 2. MAIN BEV, 3. LH INPUT, 4. MG SUMP, 5. AUX LUB.

2.4 ROTOR BRAKE SYSTEM

An electrically-actuated hydraulically-powered rotor brake, mounted on the main gear box at the tail drive shaft takeoff flange, stops rotation of the rotor system and locks it in position for prolonged periods. The two-pressure (low and high) rotor brake system consists of an independent hydraulic system and hydraulically-actuated pucks acting on a disc attached to the tail rotor takeoff flange. The low-pressure system operates at 350 ±35 psi and the high-pressure system at 975 ±25 psi. The rotor brake hydraulic system contains its own electric motor, hydraulic pump, a 1300-psi relief valve, internal low-and high-pressure switches, a 1-minute time-delay relay, and a combination spring-loaded accumulator and reservoir. The spring-loaded accumulator acts as a reservoir and provides thermal compensation of fluctuating ambient temperatures when the brake is on. Failure of a pressure switch or a shutoff circuit may cause the electric motor to operate excessively and overheat. A thermal protector is incorporated to shut the motor off when it overheats.

The system is electrically actuated by either of two rotor brake switches. Interlocks on the engine speed control tensioners prevent the brake from being actuated unless two speed control levers are at SHUT-OFF and the other speed control lever is at GRD IDLE, or SHUT-OFF.

For rotor brake engagement reference, a RTR BK light on the N_f/N_r tachometers goes on when N_r decays to 50 ±4% N_r, and remains on until N_r decays below 25 ±4%.

The rotor brake system receives power from the No. 2 primary dc bus through two circuit breakers under the general heading ROTOR BRAKE, marked CONT and PWR, in the cabin.

2.4.1 Rotor Brake Switches. Both switches are overhead on the MASTER SWITCH panel under the general heading ROTOR BRAKE. The low-pressure switch has marked positions ON (momentary) and OFF. Holding the low-pressure switch at ON for about 5 seconds engages the rotor brake with 350-psi hydraulic pressure and after a 1-minute delay 975 psi is automatically applied to the rotor brake. The high-pressure switch has marked positions RELEASE (momentary), OFF, and EMER. Momentarily holding the switch at RELEASE releases the rotor brake immediately. Placing the switch OFF permits the low pressure brake to be used. Placing the switch to EMER engages the rotor brake with 975 psi. The ROTOR BRAKE ON advisory light goes on when brake pressure reaches 975 psi, and the pressure switch will automatically deenergize the electric motor. If the high-pressure switch is at EMER and dc power is available, the pressure switch will monitor and maintain pressure.

2.4.2 Rotor Brake Advisory and Caution Light. The ROTOR BRAKE ON advisory light visually indicates that the rotor brake system pressure is 975 psi. The light will remain on as long as system pressure is maintained and dc power is available. The advisory light is powered by the same source and uses the same protective circuit breaker as the rotor brake control system. To warn the pilot that rotor brake pressure is building up when it is not called for, the ROTOR BRAKE PRESS caution light will go on whenever the manifold pressure is above 10 psi, and will go off when the manifold pressure drops below 10 psi. The caution light receives power from the No. 3 dc primary bus through a circuit breaker marked ROTOR BRAKE PRESS, in the cabin.

2.4.3 Rotor Brake Operation

2.4.3.1 Normal Brake Engagement. For prolonged brake life, the rotor brake is normally engaged with the low-pressure system after all engines are shut

down and N_r has decayed to 25% (RTR BK light goes off) or less. The brake is activated by holding the low-pressure switch ON for about 5 seconds. For parking purposes, after the rotor has stopped, the high-pressure switch is placed to EMER. Brake lining life is estimated at 10,000 engagements.

2.4.3.2 High Energy Brake Engagement. The rotor brake may be engaged with two engines shut down and the other at GRD IDLE after N_r has decayed to 50% (RTR BK light goes on). The brake is actuated by placing the high-pressure switch to EMER. Brake lining life is estimated at less than 100 engagements.

2.4.4 Rotor Brake Manual Release Handle. The release handle is overhead in the center section of the cabin on the right side aft of the main gear box, and is reached through an access panel. The handle is marked ROTOR BRAKE MANUAL OVERRIDE, TO RELEASE ROTOR, PULL HANDLE. It is pulled to manually release the rotor brake, and is spring-loaded to return to the normal position when released. The manual release system releases rotor brake pressure, providing the capability to engage the rotor, if the APP should malfunction after the first engine is started. After the rotor is accelerated to about 91% to 96% N_r, the necessary hydraulic and electrical power will be available to start the second engine.

CAUTION

Before releasing the rotor by pulling the manual override release handle, be sure the high pressure rotor brake switch is OFF. This will prevent the high pressure rotor brake from reengaging unintentionally the next time two speed control levers are in SHUT OFF and the other is in GRD IDLE with electrical power applied (most typically upon shutdown after flight).

2.4.5 Mechanical Gust Lock. With the rotor stopped the gust lock can lock the rotor system when the hydraulically-operated rotor brake system is not being used. The gust lock is operated by the mechanical gust lock control handle, overhead in the center of the cabin, and is marked GUST LOCK, with marked positions, LOCKED and UNLOCKED. Placing the control handle to LOCKED causes the gust lock tooth to intermesh with teeth on the rotor brake disc and lock the rotor system; it also causes the ROTOR LOCKED and BLADE PYLON FOLD caution lights to go on. Protected circuits, described under appropriate headings, are routed through the mechanical gust lock to prevent inadvertent actuation of a system when the mechanical gust lock handle is at the engaged position.

CAUTION

- The mechanical gust lock shall not be applied when the main rotor head is turning.
- Operation of the protected circuits and caution lights associated with the gust lock are a function of the handle's position, not the gust lock's position. It is possible to have the gust lock engaged with the handle in the disengaged position, and have no cockpit indication.

2.5 FUEL SYSTEM

(Refer to Figure 3-3 for fuel grades and specifications.) The helicopter has three independent suction/pressure type fuel systems (FO-17), one for each engine, that are joined by a crossfeed system for maximum fuel utilization. The fuel system has ground, air-to-air, and HIFR pressure refueling systems, and inter-tank, towed vehicle, fuel dump, and range extension fuel transfer systems. The fuel system is designed to reduce crash-induced fuel spillage and ignition to enhance post-crash survivability of personnel and the helicopter. To this end, the engines are suction fuel fed and the fuel lines are over the fuselage. A crash-generated force automatically causes the fire extinguishers to discharge into the engine compartments. The bottom third of each bladder-type main fuel cell is self-sealing. Each tank is set in ballistic foam to provide fuel spillage control and physical support for the tank. In addition, the pressure refueling and fuel transfer lines can be purged after completion of system operation. Pressure-regulated engine bleed-air is introduced into the refueling system high point for pressurization, and low points drain residual fuel to the tanks.

2.5.1 Fuel Supply System. Three separate fuel systems supply fuel from four main fuel tanks, two in each sponson, which are normally serviced through the ground, air-to-air, or HIFR pressure refueling systems, and may be replenished from the range extension transfer system. The main fuel tanks can also be gravity-fueled through filler accesses on top of the sponsons. Strainers are incorporated in the gravity-refueling ports of the main fuel tanks, to prevent foreign objects from entering the fuel system during gravity-refueling operations. Fuel boost

pumps (FO-17), mounted on the engine accessory gear box, draw fuel from the main fuel tanks to the engine fuel pump and filtration system. Each main fuel supply line has a check valve to make sure that fuel does not gravity-feed from the boost pump back into the tanks and cause the boost pumps and lines to lose their prime. A handpump, on the right side of the cabin, is used to replenish any fuel system prime that may have drained from the supply line between the boost pump and the line check valve. Instructions for priming the fuel system are on a decal next to the handpump. Three fuel selector levers, on the fuel selector quadrant, shut off fuel flow to the engine and control the crossfeed system. The No. 1 and No. 3 fuel selectors each manually operate a fuel selector and firewall shutoff valve. The No. 2 fuel selector manually operates its fuel selector valve and electrically controls its firewall shutoff valve. Electrical control to the No. 2 engine firewall shutoff valve comes from the No. 2 primary dc bus through a circuit breaker marked NO. 2 FUEL SHUT OFF VALVE. The crossfeed system permits any engine to be operated from any main fuel tank. Fuel for the APP is supplied from the No. 2 right tank, and fuel for the cabin heater is supplied from the No. 2 left tank. The helicopter may be gravity-defueled through the sump drain valves, suction-defueled through the single-point refueling adapter, or partially-defueled in flight through the dump system.

2.5.1.1 Main Tanks. The No. 1 (left aft) and No. 3 (right aft) fuel systems each contain a single bladder-type fuel cell, one installed in each sponson. The No. 2 fuel system contains two cells, one installed in each sponson (forward left & right). The bottom third of each cell is self-sealing and the tank is set in ballistic foam to provide fuel spillage control and physical support for the tank. The tanks have the lines and components required for ground, air-to-air, or HIFR pressure refueling, and intertank, towed vehicle, fuel dump, and range extension transfer systems. Each tank contains a dual-diaphragmed pressure-refueling shutoff valve, a dual high-level sensor, a surge relief valve, a vent system, and a sump drain valve. The No. 2 left and right main fuel tanks contain air lockout valves which prevent air intake to the engine from a dry tank. The tanks are vented through the bottom of the fuselage. To prevent water from entering the tanks when the helicopter is on the water, atmospheric pressure from inside the cabin enters the tanks through the antisiphon check valves on each side of the cabin. The sump drain valves are manually-operated to drain water from the tank or to completely drain the tank. Aluminum diverter straps are provided to reduce the possibility of internal fuel cell arcing caused by a lightning strike on aircraft modified by AFC 443. Access to the fuel cell drain valves is permitted by one quick-release, quarter-turn fastener, allowing the diverter strap cover to hinge downward on aircraft modified by AFC 443. The pressure refueling shutoff valves permit fuel flow during pressure refueling and fuel transfer, and are shut off by the high-level sensors when the tanks are full. The surge relief valves prevent damage from pressure surges by relieving excessive pressure. Fuel may be transferred from the range extension tanks into the main fuel tanks. The fuel dumping system permits dumping of fuel from each main tank to reduce gross weight. The towed vehicle supply line provides for fuel transfer to the towed vehicle.

2.5.1.1.1 Automatic/Manual Fuel Transfer System. Inter-tank transfer is done automatically or initiated manually to balance internal fuel storage. Automatic internal transfer of fuel from the No. 2 tanks to the No. 1 and No. 3 tanks will initiate after about 1 hour of flight to equalize available fuel for each engine. The automatic transfer initiates when about 5200 ±100 pounds of fuel remains in the No. 1 and No. 3 tanks, and stops when about 3100 pounds of fuel remains in each of the No. 2 tanks. Initiation and termination of fuel transfer occurs in each sponson independently and will not transfer simultaneously. A time feature stops automatic transfer in each sponson after 105 seconds if not already completed. Manual fuel transfer when initiated will transfer in each sponson independently and automatically stops after 60 seconds if not terminated earlier. For fuel tank capacities, refer to Figure 2-8.

2.5.1.2 Range Extension Tanks. These fuel tanks, molded from reinforced plastic, each have a capacity of about 285 gallons. Each tank contains a fuel quantity indicator, fuel transfer pump and float switch, a high-level sensor, and a refueling shutoff valve. Each tank also has eight mooring rings, two on each side, that are used as tiedown chain attaching points when securing the tanks to the tiedown rings in the cabin floor. A drain valve is on the lower left side of each tank, so fuel samples can be taken from the tank's sump. Unlimited operations are permitted with tanks which incorporate accessory change (AYC) 566. Tanks which do not incorporate AYC 566 are limited to flights of operational necessity (as defined by OPNAVINST 3710.7) and then only when JP-5 fuel is used.

2.5.1.3 Fuel Boost Pumps. Three engine-driven fuel boost pumps, one mounted on each engine accessory gear box, supply fuel under pressure to a respective engine, any time that engine is operating. Because the boost pumps are not submerged in the tank and are above the fuel supply, it is necessary that the main fuel supply lines be primed with fuel for boost pump operation. The boost pumps draw fuel from the fuel tanks; then deliver it to the appropriate engine fuel pump and filtration system.

FUEL QUANTITY DATA - PRESSURE FUELING - LEVEL ATTITUDE

TANKS		USABLE	
		U. S. Gallons	Pounds
(JP-4, 6.5 LB/GAL, FUEL DENSITY AT STANDARD DAY TEMPERATURE)			
NO. 1		914.6	5944.9
NO. 2	(691.6)×2	1383.2	8990.8
NO. 3		914.6	5944.9
TOTAL MAIN		3212.4	20880.6
Range Extension		285.0	1853.0
(JP-5, 6.8 LB/GAL, FUEL DENSITY AT STANDARD DAY TEMPERATURE)			
NO. 1		914.6	6219.3
NO. 2	(691.6)×2	1383.2	9405.8
NO. 3		914.6	6219.3
TOTAL MAIN		3212.4	21844.4
Range Extension		285.0	1938.0
(JP-8, 6.7 LB/GAL, FUEL DENSITY AT STANDARD DAY TEMPERATURE)			
NO. 1		914.6	6127.8
NO. 2	(691.6)×2	1383.2	9267.4
NO. 3		914.6	6127.8
TOTAL MAIN		3212.4	21523.0
Range Extension		285.0	1910.0

Figure 2-8. Fuel Quantity Data

A check valve in each main fuel supply line makes sure that the systems retain their prime.

2.5.1.4 Fuel Boost Pump Failure Caution Lights. Each of the three fuel boost pumps has a pressure switch connected to the pressure feedline from each pump. The fuel pressure switches actuate the #1, #2, and #3 ENG FUEL BOOST caution lights. A fuel boost pump caution light will go on any time fuel boost pump pressure has decreased to 8.5 ±0.5 psi. The caution light will stay on until fuel boost pump pressure is increased above 8.5 ±0.5 psi. The #1, #2, and #3 ENG FUEL BOOST caution lights receive power from the No. 1, No. 2, and No. 3 primary dc buses, respectively, through circuit breakers, marked FUEL PUMP, under the general heading of the associated engine, in the cabin.

2.5.1.5 Fuel Selector Levers. Three levers, one for each engine, are overhead on the fuel selector quadrant (FO-1). Each selector selects the No. 1, No. 2, or No. 3 fuel tank or shuts off fuel to its associated engine. The DIRECT positions select the No. 1 tank for the No. 1 engine, No. 2 tank for the No. 2 engine, and No. 3 tank for the No. 3 engine. For crossfeed operation, each lever selects either of the remaining tanks not selected by the DIRECT position. Each fuel selector lever will be moved to SHUT OFF when its associated ENG EMER OFF T-handle is moved aft.

2.5.1.6 Fuel Quantity Gages and Test Switch. Four fuel gages on the instrument panel (FO-5) display fuel quantity in pounds. Two are marked FUEL QUANTITY for the No. 1 and No. 3 tanks, one is marked FUEL QTY and has two pointers for the No. 2 left and right tanks, and one marked TOTAL FUEL displays the total of the other three gages. The fuel quantity indicating system may be tested by pressing the FUEL GAGE TEST pushbutton, above the TOTAL FUEL gage, for about 10 seconds. This will cause all tank pointers to drop to zero. Upon release of the test switch, the pointers should return to the previous reading. This test shows that the fuel quantity indicating system is operating correctly. When electrical power is removed from the helicopter, the indicators will stay at the reading they were recording when power was removed. Fuel quantities are measured by probes in each tank. The No. 1 main tank and totalizer indicating systems receive power from the No. 1 primary ac bus through two circuit breakers, marked NO. 1 and TOTAL under the general heading FUEL QTY. The No. 2 main fuel tank indicating systems receive power from the No. 2B primary ac bus through a circuit breaker, marked FUEL QTY, under the general heading NO. 2. The No. 3 main tank indicating system receives power from the No. 3 primary ac bus through a circuit breaker, marked FUEL QTY NO. 3.

2.5.1.7 Fuel Low-Level Caution Lights. The #1 FUEL LOW caution light will go on when about 30 minutes of fuel to operate one engine at normal cruise remains in the No. 1 tank (about 544 pounds of JP-5 fuel (80 gallons)). The #3 FUEL LOW caution light operates the same way for the No. 3 tank. The #2 FUEL LOW caution light will go on to indicate that 15 minutes of fuel (about 272 pounds of JP-5 fuel (40 gallons)) remains in either the No. 2 left or right tank. Normally, when the #2 FUEL LOW caution light goes on, there will be a total of 544 pounds of JP-5 fuel (80 gallons) remaining in the No. 2 tanks. The amount of remaining fuel that will cause a tank's fuel low-level caution light to go on is sensed by a sensor attached to a probe in the tank. The sensor is independent of the fuel quantity indicating system. In addition, when a tank has been selected for fuel transfer or fuel dump, the respective function will stop automatically when the tank quantity decreases to 544 or 272 pounds of JP-5 (80 or 40 gallons), as appropriate. The fuel low-level caution lights and low-level controls for the No. 1 and No. 3 tanks receive power from the No. 1 and No. 3 primary dc buses, respectively, through circuit breakers in the cabin, marked FUEL LOW NO. 1 WARN, and FUEL LOW NO. 3 WARN. The fuel low-level caution light and low-level control for the No. 2 tank receives power from the No. 2 primary dc bus through a circuit breaker panel in the cabin marked FUEL LOW NO. 2 WARN.

2.5.1.8 Fuel Filter Bypass Caution Light. An airframe fuel filter system, consisting of a dual fuel filter and an engine filter bypass caution light, are between the fuel boost pump and the engine in each engine fuel supply system. Each fuel filter contains a filter and an impending bypass pressure switch, which is connected to the #1, #2, or #3 ENG FLTR BY-PASS caution light, as appropriate. The ENG FLTR BY-PASS caution light will go on when the pressure drop across any one of the filters is over 1.37 $\pm$0.5 psi. Each fuel filter will bypass when the pressure drop across it is over 2.80 psi.

2.5.1.9 Fuel Filter Bypass Valve. The valve consists of a motor-operated bypass valve installed in parallel with the airframe dual filter for each engine (FO-17). The bypass valves operate with the associated fuel boost pump caution light, marked #1, #2, or #3 ENG FUEL BOOST. It uses the same power source, pressure sensor switch, and circuit breakers as the caution lights. The bypass valve will open, routing fuel around the dual airframe filters whenever the associated ENG FUEL BOOST caution light goes on, and during engine starts until enough pressure is available at the switch to put the caution light off. During loss of boost pump pressure, the bypass valve will bypass the fuel filter to provide a more direct flow of fuel to the engine-driven fuel pump. When the fuel filters are bypassed, the associated ENG FLTR BY-PASS caution light will also go on.

2.5.2 Range Extension Tank Transfer System. The helicopter has connecting points to the main fuel system and electrical power sources for installation of the range extension fuel transfer system. The system (FO-21) consists of one to seven range extension tanks, a range extension control panel, and the fuel and electrical components necessary to operate the system. The number of range extension tanks installed is dependent upon mission requirements. The system provides the capability to transfer fuel from the range extension tanks in the cabin to the main tanks in the sponsons. Fuel is transferred by turning on the fuel transfer pumps, one for each tank, and opening the fuel selector valve, on the forward tank. When more than one range extension tank is installed, fuel is transferred through a common line that is connected to all tanks. Only two range extension tanks, one per control panel circuit breaker, can be operational at one time, due to the electrical load involved. The fuel selector valve is installed in the common line to control the flow of fuel to the main fuel tanks. Check valves prevent transfer fuel from entering other range extension fuel tanks. High-level sensors, in each main fuel tank, will automatically shut off the flow of fuel to the main tank when it is full.

The RANGE EXT CONT circuit breaker in the cabin furnishes No. 3 primary dc bus power to the FUEL circuit breaker on the range extension control panel. The RANGE EXTENSION circuit breaker, in the cabin, furnishes No. 2A primary ac bus power to two circuit breakers on the range extension control panel, marked TANKS 1-3-5-7 and TANKS 2-4-6.

WARNING

- Do not troubleshoot the range extension fuel system in flight. Removal of tank filler cap is prohibited any time electrical power is on the helicopter.
- An electrical malfunction is indicated if a circuit breaker trips or if fuel transfer stops while the pump is turned on (main fuel tanks not full). Do not reset the circuit breaker. Immediately turn off the transfer pump switch and remove the electrical harness from the control panel. Do not attempt to troubleshoot the cause of the malfunction or reconnect the harness in flight or when power is applied to the helicopter.
- When using multiple range extension fuel tanks, CG and gross weight must be carefully monitored to avoid exceeding the prescribed limits.

2.5.2.1 Range Extension Control Panel. When installed, the control panel (FO-21), marked RANGE EXTENSION CONTROL, is on the forward cabin compartment bulkhead. The panel contains the fuel transfer pump switches, tank empty lights, and circuit breakers for the tank components. The fuel transfer pump switches and tank empty lights, both under the heading FUEL CELL, are on each side of the numbers, 1 thru 7, that identifies them with their associated tank.

AC operating power for the fuel transfer pumps is furnished through the two circuit breakers, marked TANKS 1-3-5-7 and TANKS 2-4-6, which identify the circuit breakers with their associated tanks. DC control power for the tanks is furnished through the circuit breaker marked FUEL.

Operation of the transfer switches is discussed under RANGE EXTENSION TRANSFER PUMPS AND FLOAT SWITCHES, and the tank empty lights are discussed under RANGE EXTENSION TANK EMPTY LIGHTS in this section.

2.5.2.2 Range Extension Fuel Quantity Indicators. The indicators on top of each tank indicate the amount of fuel, in gallons, that is in the tank. The indicator also provides a continuous reading while the tank is being serviced, so that known intermediate amounts of fuel may be added.

2.5.2.3 Range Extension Transfer Pumps and Float Switches. Each fuel transfer pump is controlled by a switch with marked positions PUMP and OFF, on the range extension control panel, and a float switch. Each switch is numbered 1 thru 7, to identify it with the tank in which the pump is installed. When a switch is placed to PUMP, and the fuel selector valve handle is at MAIN TANKS, fuel will be simultaneously transferred to all main fuel tanks. To prevent the pump from overheating, the float switch causes the transfer pump to automatically shut off when all fuel is transferred from the tank.

Note

Both ac and dc power are furnished to each range extension tank when the electrical harness is connected. Placing a tank's transfer pump switch OFF does not remove electrical power from the tank. FO-21 does not depict the actual electrical system configuration.

2.5.2.4 Range Extension High-Level Sensors and Refueling Shutoff Valves. The high-level sensors, one for each tank, sense when the tank is full and cause the refueling shutoff valve to automatically shut off the flow of fuel to the tank.

2.5.2.5 Range Extension Tank Empty Lights. The lights, one for each tank, are on the range extension control panel. Each light marked EMPTY is next to the fuel transfer pump switch for the tank for which it is installed. The numbers 1 thru 7 identify each light with its associated tank. The lights go on to indicate that the respective range extension tanks are empty. The lights receive dc power from the FUEL circuit breaker on the range extension control panel.

2.5.2.6 Range Extension Fuel Selector Valve. The valve is externally-mounted on the first range extension tank in the fuel line that connects to all tanks. The valve has marked positions REFUEL DEFUEL, MAIN TANKS, and AUX TANKS. The selector valve handle is moved to REFUEL DEFUEL when it is desired to pressure refuel the range extension fuel tanks. The handle is moved to MAIN TANKS when it is desired to transfer fuel simultaneously to all main fuel tanks. The handle is moved

to AUX TANKS when it is desired to transfer fuel from one range extension fuel tank to other range extension fuel tanks.

CAUTION

Immediately after pressure refueling, when the helicopter is to be left idle for any length of time, move the selector valve from REFUEL DEFUEL to AUX TANKS. This will prevent overboard fuel siphoning by isolating the internal range extension tanks from the main tanks.

Note

- To completely defuel the helicopter when range extension fuel tanks are installed, the selector valve should be moved to MAIN TANKS while applying a negative pressure at the helicopter pressure refueling adapter, and selectively actuating the transfer pumps.
- To completely defuel the range extension tanks, fuel must be transferred to the main tanks, and the main tanks then defueled normally.

2.5.2.7 Range Extension Precheck Valve. A precheck valve, next to the fuel selector valve, is used to check the integrity of the system. When the normally-closed precheck valve is placed to the open position, pressure refueling will be interrupted to indicate the system is operating satisfactorily. If fuel continues to flow, there is a malfunction in one or more of the refueling shutoff valves.

Note

The range extension fuel tank manual precheck system must be relieved of pressure following its use, by moving the fuel selector valve to AUX TANKS for about 15 seconds, in order to continue filling the range extension fuel tanks.

2.5.3 Pressure Refueling Systems. The ground, air-to-air, and HIFR pressure refueling systems use the same plumbing and system components, except the ground and HIFR refueling systems do not use bleed-air (FO-18). The ground pressure refueling system is refueled through a single-point refueling adapter, on the left side of the forward fuselage. The air-to-air refueling system is refueled through a probe extending from the right side of the nose section, and the HIFR refueling system is refueled through a Wiggins quick-disconnect pressure refueling nipple, mounted overhead in the forward section of the cabin. Refer to LIGHTING EQUIPMENT, in this chapter, for a description of the probe and drogue lights that aid night air refueling operations. The left main and right main fuel tank refueling control systems receive power from the No. 1 and No. 3 primary dc buses through two circuit breakers, marked LH and RH FUEL CONT, respectively. All control switches, indicator lights, and control components operate the same for all pressure refueling systems, and are discussed under Air-to-Air Refueling Systems in this chapter.

2.5.3.1 Ground Pressure Refueling System. The system is used to pressure refuel the main and range extension tanks on the ground. The main tanks or the range extension fuel tanks may be serviced (but not selectively) without electrical power. Ground pressure refueling is controlled through the pressure refueling panel.

2.5.3.2 Pressure Refueling Panel. The pressure refueling panel (Figure 3-2), on the left side of the forward fuselage, provides a single-point refueling system. The pressure refueling panel contains the connecting adapter, four tank air pressure gages, and two manually-operated precheck valves marked PRI and SEC for the primary and secondary systems, respectively. When the access door is closed, the precheck valve handles are locked CLOSED. The main tank vent system, an open line system containing no closing devices, must have the vent lines open for pressure refueling. When a precheck valve selector is placed to the open position, ground pressure refueling will be interrupted to indicate the system is operating satisfactorily. If fuel continues to flow, there is a malfunction in a shutoff valve. Pressure that may have built up in the tank, due to a clogged vent, will always register on the respective pressure gage. A dual high-level sensor, in the top of the tank, will cause the tank shutoff valve to shut off the flow of fuel to that tank when the tank is full. The shutoff valve, in the bottom of each tank, makes sure that defueling is terminated before all the fuel in the tank is removed, to prevent the defueling action from collapsing the sides of the fuel cell. Specific instructions for conducting a pressure refueling precheck are on a decal below the four air pressure gages.

2.5.3.3 Refueling Control Panel. The control panel (FO-5) contains the control switches and condition lights to control and monitor ground, air-to-air, and HIFR

pressure refueling, purge, and towed vehicle and intertank transfer. The control panel consists of the refuel power pushbutton, probe condition light, probe toggle switch, manual transfer pushbutton, mission fuel pushbutton, fuel gage test pushbutton, fuel shutoff test pushbutton, fuel purge pushbutton, and eight fuel transfer/fill pushbuttons. The eight main tank pushbutton indicators provide flow status. Each control, when pressed, will light a flow arrow indicating flow direction (four transfer switches show flow out of each tank, and four fill switches show flow into each tank.) Each fill switch also has a flow light which will illuminate to show fuel transfer. Turning on a main tank pushbutton activates the necessary valves and pumps to provide the desired fuel flow. Fuel flow and low- and high-level sensors will be affected to stop fuel flow.

Note

During manual fuel transfer the 60 second timing cycle is initiated when the transferring tank fuel flow pushbutton is pressed.

Fuel flow may be cross-checked with the appropriate fuel quantity gages. The test switch, marked FUEL SHUTOFF TEST, when pressed will test the integrity of the dual high-level sensor and pressure refueling shutoff valves in the fuel tanks. Pressing the test switch after pressure refueling or transfer operations have started will cause the main tank dual high-level sensors to simulate a tank full condition and cause the flow lights to go off, and pressure refueling shutoff valves to close and stop the flow of fuel. Releasing the test switch will restore the system to normal conditions. The REFUEL PWR pushbutton opens the probe bleed-air valve, allowing bleed-air to the probe control valve. Placing the PROBE toggle switch to EXTEND opens the extend port of the control valve and allows bleed-air to extend the probe. The REFUEL PROBE condition light shows amber while the probe is extending and shows READY when the probe is fully extended and locked. The probe nipple is opened mechanically when hookup is made with the drogue. Fuel flows into the fuel manifold and the flow lights to the respective tanks go on. Placing the PROBE toggle switch to STOW will retract the probe. The REFUEL PROBE light will go off and show amber until the probe is stowed and locked. REFUEL PWR should be pressed off when refueling is complete. The MISSION FUEL condition light goes on when fuel is flowing to the MK-105 towed vehicle. Pressing and lighting the PURGE pushbutton causes the pressure refueling and fuel transfer systems to start purging. It also arms the system so that automatic purging will occur any time additional pressure fueling or fuel transfer occurs. The PURGING advisory light goes on during the 8.5 minutes required for purging. Interlocks prevent purging if pressure refueling or fuel transfer is taking place. The XFR pushbutton show AUTO or MANUAL for the transfer mode selected. Pressing the button will alter the mode selected.

2.5.3.4 Air-to-Air Refueling System. The system consists of a refueling probe, a probe bleed-air valve, a probe bleed-air control valve, flow sensors, precheck valves, vent valves, surge valves, pressure refueling and high-level sensor valves, and a control panel, to pressure refuel the main and range extension fuel tanks. Power for the refueling probe is provided from the No. 1 dc primary bus through a circuit breaker marked REFUEL MASTER PWR. Control is provided through the No. 1 dc primary bus through a circuit breaker marked REFUEL PROBE CONT.

WARNING

- If a water landing has been made, air refueling operations should not be attempted, and the probe should not be extended or retracted until an inspection has been done to make sure that the probe has not been damaged and the nozzle has not opened to permit water to enter the fuel system. Tank sumps and lines shall be inspected and drained following a water landing.

- Do not purge after a water landing until the probe has been inspected. Purging with a damaged probe may cause water to enter the fuel system, or fuel under pressure to be sprayed on the nose of the helicopter.

2.5.3.5 Refueling Probe. The retractable refueling probe (FO-18), on the right side of the nose section, can extend and retract. The extension/retraction system is operated by bleed-air from either the No. 1 or No. 3 engine, or from both engines simultaneously. Check valves prevent bleed-air from flowing to an inoperative No. 1 or No. 3 engine if either fails. The probe contains lock actuators that lock the probe in the extended or retracted position and cause the PROBE READY light to go on when the probe is fully extended and ready for refueling.

2.5.3.6 Probe Bleed-Air and Probe Bleed-Air Control Valves. The valves control the flow of bleed-air to the refueling probe. Both valves are controlled from the fuel control panel. The bleed-air valve controls the flow of bleed-air to the bleed-air control valve, and the bleed-

air control valve selects bleed-air to extend or retract the refueling probe. Both valves contain relief valves to vent very high pressures.

2.5.3.7 Flow Switches. There are four switches, one for each main tank. The switches will sense a fuel flow above 2 ±1 gpm and cause the appropriate fuel flow indicator light to go on. During fuel transfer mode fuel flow should be confirmed by change in fuel quantity indicated on both the transferring and receiving tank fuel gages.

2.5.3.8 Precheck Valves. The main tank precheck valves, two manually-operated and four electrically-operated, permit testing the system, and control the flow of fuel during fueling or fuel transfer. The manually-operated precheck valves, on the ground pressure refueling panel, are spring-loaded CLOSED. When the primary or secondary precheck valve is placed to OPEN during ground pressure refueling operations, pressure refueling will be interrupted to all tanks to indicate the respective system is operating satisfactorily. If a precheck valve should be left at OPEN, the fuel transfer and air-to-air refueling systems would not be effective. The electrically-operated precheck valves, controlled from the fuel control panel, are normally closed. The electrically-operated precheck valves are open only when energized. The valves are closed during actual pressure refueling operations. If the appropriate tank control switch is placed to OPEN, pressure refueling will be interrupted as shown by the appropriate flow light going off, to indicate the system is operating satisfactorily.

2.5.3.9 Pressure Fueling Shutoff and Level Sensor Valves. Each main fuel tank has a pressure fueling shutoff, dual high-level sensor valves, and a low-level sensor. When either high-level sensor valve senses the tank is full, it will cause the pressure fueling shutoff valve to close and stop the flow of fuel. A low-level sensor will cause the pressure shutoff valve to close when the tank is near empty during defueling.

CAUTION

When pressure fueling the aircraft to maximum fuel loads, ensure that all main fuel tanks remain selected after high level shutoff is achieved, fuel flow light out. Securing main fuel fill switches, with refuel master power at ON, during pressure fueling will allow precheck fuel to enter the tank, which may overfill. In addition, overpressurization may damage the fuel tanks.

2.5.3.10 HIFR Refueling System. The HIFR refueling system consists of a Wiggins quick-disconnect pressure refueling fitting and a go/no-go filter canister to pressure refuel the main and range extension tanks. The Wiggins fitting is overhead in the center of the forward cabin. The go/no-go filter canister is mounted overhead on the left side of the cabin aft of the emergency escape hatch and permits only acceptable fuel to pass through. Flow is reduced to an extremely low level if the fuel is contaminated with water and particulate matter above a predetermined level.

2.5.4 Fuel Dump System. Fuel can be dumped selectively or simultaneously from the four main tanks (FO-18). Dumping is controlled from each sponson through a dump pump, a dump valve, and an individual tank fuel valve for each tank. Switches on the console emergency control panel automatically activate the appropriate pump and valves to cause dumping. Each sponson will dump fuel at a rate of about 135 gallons-per-minute with one tank selected for dump or about 158 gallons-per-minute with both tanks in the sponson selected for dump. Dump fuel is pumped overboard through an outlet and connecting discharge tube. The location of the fuel dump port in the No. 1 and No. 3 tanks permit all fuel to be dumped except the amount required to operate one engine for about 30 minutes (about 544 pounds of JP-5 fuel (80 gallons)) at normal cruise power. The No. 2 left and No. 2 right tanks will each dump down to about 15 minutes of fuel (about 272 pounds of JP-5 fuel (40 gallons)). The fuel dump switches, when actuated, simultaneously actuate the fuel dump valve, tank valve, and fuel dump pump for the tank selected. A low level sensor in each tank senses the 30- or 15-minute low fuel state as appropriate, causing that tank's FUEL LOW caution light to light and automatically closing that tank's fuel valve. When the low level sensors for both tanks in the same sponson senses low level, that sponson's dump pump and dump valve automatically shut off. Fuel cannot be dumped when the weight of the helicopter is compressing the landing gear scissor switches.

The left sponson fuel dump system receives control power from the No. 1 primary dc bus through two circuit breakers, marked LH FUEL DUMP CONT and LH FUEL DUMP VALVE, and operating power from the No. 2A primary ac bus through a circuit breaker marked FUEL DUMP PUMP. The right sponson fuel dump system receives control power from the No. 3 primary dc bus through circuit breakers, marked RH FUEL DUMP CONT and RH FUEL DUMP VALVE, and operating power from the No. 3 primary ac bus through a circuit breaker marked RH FUEL DUMP PUMP.

2.5.4.1 Fuel Dump Switches. There are four, two-position, ON-OFF dump switches, one for each main tank on the FUEL DUMP portion of the emergency control panel, on the cockpit console (FO-7). Selecting No. 1 or No. 3 ON starts fuel dumping from the No. 1 or No. 3 tanks, respectively. Selecting L or R ON under the general heading No. 2 starts fuel dumping from the No. 2 left or No. 2 right tanks, respectively. Fuel can also be dumped using the switch marked FUEL DUMP ALL on the emergency control panel (FO-7). The guarded switch has a marked position OFF that is the normal switch position with the guard closed. When the guard is raised and the switch is thrown, all tanks will dump simultaneously.

2.5.5 Purge System. The purpose of the system (FO-18) is to purge the refueling and transfer lines, within the fuselage, to eliminate fuel from this area in case of a crash-induced line separation or puncture. Purging is done by introducing regulated engine bleed-air into the upper portion of the refueling system. Pressurization forces fuel from these lines into the No. 2 left and No. 2 right fuel tanks via the precheck lines. Varying capacities of the refueling lines require that they be isolated from each other for specific time periods. This is done by an electric controller activating specific valves for limited time periods. Pressing the PURGE pushbutton, on the refueling control panel, to ON initiates the purge cycle, and arms the system to automatically initiate the purge cycle each time additional fuel transfers occurs. The PURGE light shows PRNG at all times the system is purging. An advisory panel PURGING light is also on any time the system is purging. The purging cycle lasts 8.5 minutes and shuts down automatically without further action. The automatic purge feature can be shut down by pressing the PURGE pushbutton off. The purge system receives power from the No. 1 primary dc bus through the FUEL PURGE circuit breaker.

2.5.6 Towed Vehicle Refueling System. The towed vehicle refueling system enables the helicopter to refuel a towed vehicle while under tow. Fuel is transferred from the helicopter's main fuel tanks by use of the four tank valves, two transfer valves, and the fuel dump pumps. Fuel may be transferred from a selected main fuel tank or simultaneously from all.

Fuel flow rate is determined by the size of the refuel line to the receiving vehicle. Fuel is transferred at a rate of 3 gpm to the MK-105. The towed vehicle connect/ disconnect coupling is stored on the right side of the aft cabin. The vent line for the towed vehicle is connected to a fitting to the No. 3 tank vent. Power for refueling is furnished by the No. 3 ac primary bus through a circuit breaker marked MK 105 PWR, and control is provided by the No. 3 primary dc primary bus through a circuit breaker marked MK 105 PWR.

2.5.6.1 Towed Vehicle Refuel Switches. The towed vehicle refueling system is controlled by switches on the fuel control panel in the cockpit, and two control panels in the aft cabin. All three panels must have switches properly positioned for fuel to transfer to the towed vehicle. Instructions for the government-furnished panels and transfer hose attachment are provided with the towed vehicle kit. The control programmer mode switch marked MAN-OFF-AUTO is normally set to AUTO, and the PWR switch is pressed on. The PWR switch provides power to all functions of the control programmer and must be on during all towed vehicle operation. The valve and junction box enable switch marked ON-OFF is ON. Transfer is then controlled from the refuel control panel. Press the desired tank flow control pushbutton on. Also, select an aircraft receiving fuel cell as in normal aircraft intertank transfer procedures. This will prevent damaging the fuel transfer pump when fueling the towed vehicle, due to pressure differential across the pump. Once a supply and a receiving tank are selected, pressing the MISSION FUEL push button on will cause fuel to be transferred to the towed vehicle. When the desired fuel is transferred, pressing the MISSION FUEL off will stop transfer. Turn the control programmer mode switch OFF and the valve and junction box enable switch OFF when towed vehicle fuel transfer is complete.

CAUTION

- During fuel transfer to the towed vehicle, a receiving aircraft fuel cell must also be selected to prevent damaging the fuel transfer pump.
- When towed gear fuel tanks are full turn transfer pumps off. If left on, the pumps may overheat and actuate the protective thermal cutoff switches.

2.6 AUXILIARY POWERPLANT (APP)

The T-62T-27 auxiliary powerplant (FO-13), forward of the accessory gear box, enables ground starting of the engines and ground operation of the electrical and hydraulic systems. The APP is adjusted for operation up to 10,000 feet pressure altitude. The APP system consists of a control panel, an indicator panel, a hydraulic starting

system, a turbine engine, a fuel system, a self-contained oil system, clutch, and a mechanical drive. The hydraulic start system consists of a No. 1 accumulator, a No. 2 accumulator, and a hydraulic motor. Normally the No. 1 accumulator furnishes the necessary hydraulic pressure to the hydraulic motor for APP start. If the first start fails a second start can be attempted by using the No. 2 accumulator. If necessary, a longer start interval may be obtained by using both accumulators simultaneously. The No. 2 accumulator is brought into the system by turning the T-handle (located at sta 232 right side cabin wall aft of the personnel door) 45 degrees to unlock, pulling down, and rotating 45 degrees to the locked position. To reset the No. 2 accumulator, rotate the T-handle 45 degrees to unlock, push the T-handle back in place, and turn 45 degrees to lock. The accumulators are normally charged from the utility hydraulic system to 3000 psi. A handpump (Figure 7-11), on the right side of the cabin aft of the personnel door can be used to manually recharge the accumulators, manually fold or spread the tail pylon, or manually raise or lower the ramp. A selector valve, above the handpump, with marked positions A (No. 2 accumulator/ramp), B (tail pylon fold/unfold), and C (No. 1 accumulator) is used to select the accumulator to be manually recharged or to manually fold or spread the tail pylon. The APP control lever has to be at RUN or below before the accumulators can be recharged with the handpump. APP starting is independent of external or helicopter electrical power, since ignition and control electrical power is supplied by the APP drive generator.

When the APP control lever is moved to START during the starting cycle, No. 1 accumulator hydraulic pressure is released to activate the start motor. An overrunning clutch will disengage the turbine from the starter motor when the APP has started and the turbine rpm exceeds that of the starter motor. As soon as the APP is driving the accessory gear box the APP accumulators will be recharged with 3000 psi hydraulic pressure. The APP should light off at about 20% rpm, and bleed-air causes the clutch to start to engage the accessory gear box when rpm is 92% and exhaust temperature reaches 204°C. As the clutch engages, the acceleration will slow down; then continue on until operating rpm is reached. The APP control lever should be held at START until clutch engagement is confirmed by illumination of the #1 GEN, #3 GEN, #1 RECT, and #2 RECT caution lights. Make sure that APP ON light is on. Release lever, APP control lever should automatically return to RUN and APP will continue to accelerate to operating rpm (100%). The start fuel valve and ignition are turned off and the clutch engages as the 92% rpm switch closes, and burning is self-sustaining as long as there is a flow of fuel from the APP main fuel valve.

An advisory light marked APP ON, on the advisory panel, will go on when the APP is operating. Fuel is supplied to the APP from the No. 2 right fuel tank and there is a prime handpump on the right side of the cabin. Fuel consumption is 80 to 180 pph, depending on OAT and the accessory loads being used. A mechanical drive with an automatic clutch drives the accessory gear box. This automatically disengages to enable shutdown of the APP when the main rotor head is engaged.

CAUTION

If emergency conditions warrant, the APP may be started and operated during flight. However, N_r settings above 103% may result in an unsuccessful APP start or uncommanded APP shutdown due to overspeed.

2.6.1 APP Control Panel. The APP CONTROL panel, on the overhead control panel (FO-1), contains a control lever, a circuit breaker control switch, and circuit breakers for high exhaust temperature, overspeed, and low oil pressure. The T-handle, forward of the control lever, is used to discharge the APP and cabin heater compartment fire extinguisher system and shut off fuel to the APP and cabin heater.

2.6.1.1 APP Control Lever. The APP control lever, with marked positions START, RUN, and SHUT-OFF, controls the operation of the APP. Moving the lever to START energizes the components of the automatic start system, and starts the APP. The lever should be held at START until clutch engagement, since it is spring-loaded to RUN. When the lever is released and it returns to RUN, the APP will run normally to drive the accessory gear box. The lever is moved to SHUT-OFF to close the main fuel valve and shut down the APP. The APP control circuit receives electrical power from the APP generator through the circuit breaker marked CKT BKR CONTROL, on the APP control panel.

2.6.1.2 Low Oil Pressure Circuit Breaker. The LOW OIL PRESS circuit breaker is on the APP control panel under the general heading AUTO SHUT-DOWN MODE PRESS TO RESET. The circuit breaker, colored black, will pop out and show white to indicate the APP has automatically shut down due to a low oil pressure of 6 ±1 psi. The circuit breaker must be reset before restarting the APP. The automatic shut-down feature of the APP, due to low oil pressure, is bypassed during the main engine start

cycle. The low oil pressure circuit breaker receives electrical power from the APP generator.

2.6.1.3 High Exhaust Temperature Circuit Breaker. The HIGH EXH TEMP circuit breaker is on the APP control panel under the general heading AUTO SHUT-DOWN MODE PRESS TO RESET. The circuit breaker, colored black, will pop out and show white to indicate the APP has automatically shut down due to a high exhaust temperature of 621°C. The circuit breaker must be reset before restarting the APP. The automatic shutdown feature of the APP, due to high exhaust temperature, is bypassed during the main engine start cycle. The high exhaust temperature circuit breaker receives electrical power from the APP generator through a temperature control relay that is energized by an APP thermocouple.

2.6.1.4 Overspeed Circuit Breaker. The OVERSPEED circuit breaker is on the APP control panel, under the general heading AUTO SHUT-DOWN MODE PRESS TO RESET. The circuit breaker, colored black, will pop out and show white, to indicate the APP has been automatically shut down because of an overspeed of 110%. The circuit breaker must be reset before restarting the APP. The circuit breaker is energized through the overspeed switch by electrical power from the APP generator.

2.6.1.5 APP Circuit Breaker Control Switch. The switch is on the APP control panel. The circuit breaker switch, marked CKT BKR CONTROL, with marked positions ON and OFF, provides circuit protection. The 5-ampere switch circuit breaker receives electrical power from the APP generator and furnishes electrical control power and ignition for APP operation.

2.6.2 APP Emergency Start Switch. The switch, marked APP, with marked positions NORM-EMER, is on the emergency control panel (FO-1). The emergency start switch is used to bypass the low oil pressure and high exhaust temperature circuit breakers, if either or both have popped, for an APP start. The emergency start switch uses the same power source and protective circuit as the normal APP control circuit.

CAUTION

The low oil pressure and high exhaust temperature circuit breakers should be bypassed only in an emergency.

2.6.3 APP Indicator Panel. The panel, on the overhead control panel (FO-1), contains the APP tachometer and the APP exhaust gas temperature indicator.

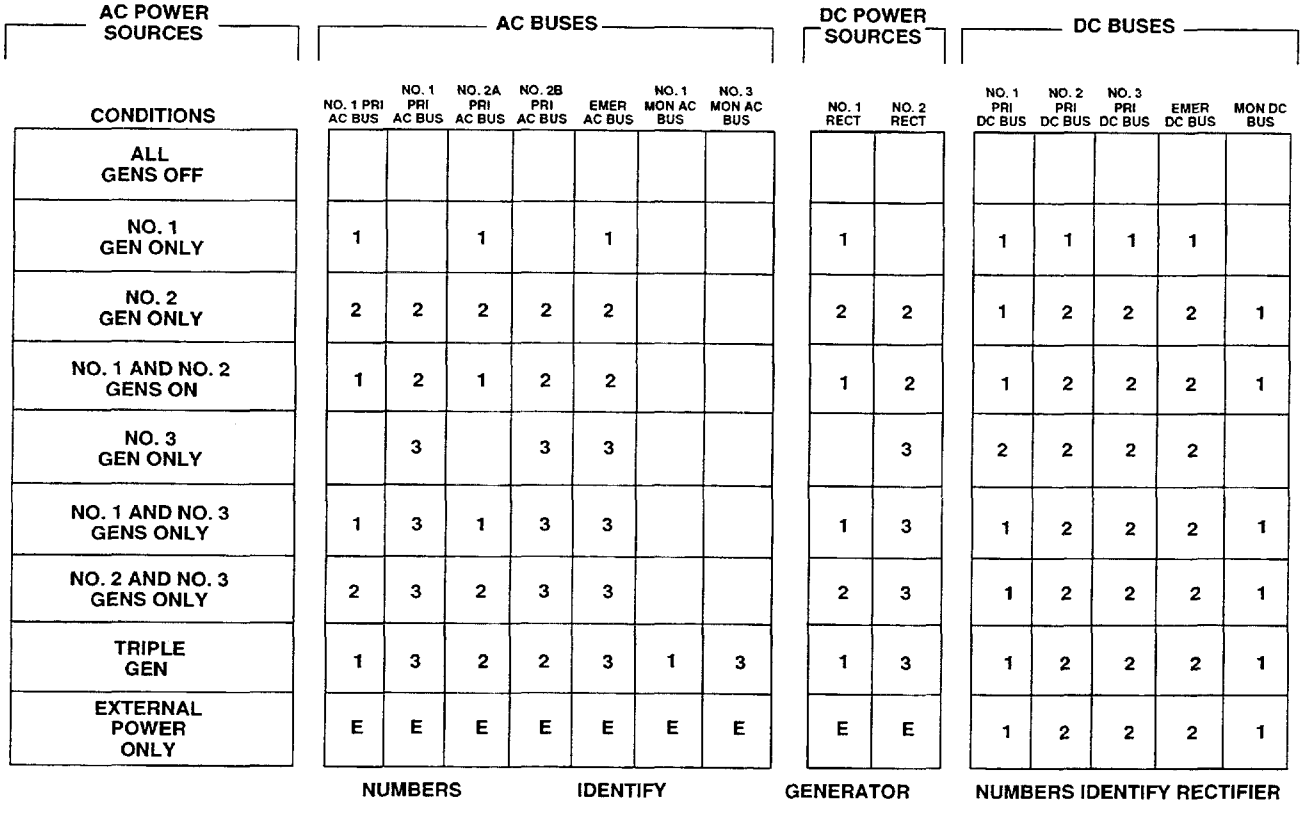
2.6.3.1 APP Tachometer. The tachometer indicates the percentage of APP engine rpm. The tachometer receives power from the APP driven tachometer-generator.

2.6.3.2 APP Exhaust Gas Temperature Indicator. The indicator indicates the temperature of the APP exhaust in °C. A thermocouple, in the APP exhaust, measures temperature and displays it on the indicator.

2.7 ELECTRICAL SYSTEM

Electric power is obtained from three ac generators and two ac to dc converters (FO-22). In normal operation each generator supplies power to its associated primary ac bus. A No. 1 monitor ac bus is connected to the No. 1 primary ac bus. A No. 3 monitor ac bus and an emergency ac bus are connected to the No. 3 primary ac bus. In normal operation, the No. 1 rectifier furnishes power to the No. 1 primary dc bus and also to the No. 1 monitor dc bus. The No. 2 rectifier furnishes power to the No. 3 primary dc bus and also to the No. 2 primary and emergency dc buses. If a generator fails, only the No. 1 monitor ac and No. 3 monitor ac buses are dropped, and normal rectifier operation continues. If a rectifier fails, only the No. 1 monitor dc bus is dropped. For ground operation, electrical power can be supplied by external power or the APP driving the No. 1 and No. 3 generators. For ac/dc power distribution, see Figure 2-9.

2.7.1 Generators. Three self-cooled brushless generators with a nameplate rating of 40 kVA (overload 60 kVA) supply 115/200 volts, 400 Hz, three-phase power. The No. 2 generator is driven by the main gear box accessory section. The No. 1 and No. 3 generators are driven by the accessory gear box. The accessory gear box is driven by the rotor, or by the APP, when it is on the line and rotor speed is below 100% N_r. When rotor speed exceeds APP rpm, the accessory gear box is driven by the main gear box. Each generator output is directed through a respective supervisory panel that provides control and protection of the electrical system from underfrequency, overvoltage, undervoltage, and feeder fault. Feeder fault protection will cause a generator to be disconnected from the ac load when there is a short in any of the main power lines from the respective generator to the primary ac bus. The underfrequency protection is provided to prevent possible equipment damage when N_r drops below 91% - 96%. When the N_r initially drops below the operating level, a time delay keeps the relays from being energized



CONDITIONS	AC POWER SOURCES: NO. 1 PRI AC BUS	AC BUSES: NO. 1 PRI AC BUS	NO. 2A PRI AC BUS	NO. 2B PRI AC BUS	EMER AC BUS	NO. 1 MON AC BUS	NO. 3 MON AC BUS	DC POWER SOURCES: NO. 1 RECT	NO. 2 RECT	DC BUSES: NO. 1 PRI DC BUS	NO. 2 PRI DC BUS	NO. 3 PRI DC BUS	EMER DC BUS	MON DC BUS
ALL GENS OFF														
NO. 1 GEN ONLY	1		1		1			1		1	1	1	1	
NO. 2 GEN ONLY	2	2	2	2	2			2	2	1	2	2	2	1
NO. 1 AND NO. 2 GENS ON	1	2	1	2	2			1	2	1	2	2	2	1
NO. 3 GEN ONLY		3		3	3				3	2	2	2	2	
NO. 1 AND NO. 3 GENS ONLY	1	3	1	3	3			1	3	1	2	2	2	1
NO. 2 AND NO. 3 GENS ONLY	2	3	2	3	3			2	3	1	2	2	2	1
TRIPLE GEN	1	3	2	2	3	1	3	1	3	1	2	2	2	1
EXTERNAL POWER ONLY	E	E	E	E	E	E	E	E	E	1	2	2	2	1

NUMBERS IDENTIFY — GENERATOR — NUMBERS IDENTIFY RECTIFIER

NOTE: 1, 2, 3, = GENERATOR POWERING BUS.
E = EXTERNAL POWER TO RESPECTIVE BUS.
NORMAL IN-FLIGHT CONDITION

HM9023
SA

Figure 2-9. AC/DC Power Distribution

and de-energized for intermediate periods. If the underfrequency condition is sustained for a period of 2 to 5 seconds, the underfrequency protection circuit disconnects the generator from the ac load. When N_r rises to the acceptable level, the generator is automatically reconnected to the ac loads. The underfrequency protection is not available when the weight of the helicopter is removed from the landing gear. The No. 1 generator normally furnishes power to the No. 1 primary ac and No. 1 monitor ac buses. The No. 2 generator normally furnishes power to the No. 2A and No. 2B primary buses. The No. 3 generator normally furnishes power to the No. 3 primary, No. 3 monitor ac, and emergency ac buses. Each generator is controlled by an individual generator switch on the main switch panel in the cockpit. The generators are connected directly to the helicopter's ac system when the generator switches are placed ON and the supervisory panels are satisfied that voltage and frequency to outputs are within prescribed limits (115 + 3 volts, 400 ±20 Hz). Generator failure is indicated by respective failure caution lights marked #1 GEN, #2 GEN, and #3 GEN on the caution panel. The generator caution lights are normally powered by permanent magnetic generator (PMG) voltage from each generator. However, if no PMG voltage is available from a generator, backup voltage is provided from the respective primary dc bus. Backup voltage to operate the generator caution lights is furnished through the No. 1, No. 2, and No. 3 primary dc bus circuit breaker panels in the cabin, through circuit breakers marked PMG BACKUP, under the respective general headings NO. 1 GEN, NO. 2 GEN, and NO. 3 GEN. All generators will continue to generate power during autorotation.

2.7.1.1 Generator Switches. The switches, on the master switch panel on the overhead control panel (FO-1), under the general heading GENERATOR, have switches marked 1, 2, and 3, respectively. The switch positions are marked TEST-RESET/OFF-ON. When the generator switches are placed ON, generator power is connected through the respective primary bus relay to the appropriate buses. When either generator switch is placed to RESET/OFF, the respective generator will be turned off. Placing the switch to RESET/OFF; then ON, will bring the generator back on the line if a temporary overvoltage or undervoltage condition occurred and no longer exists. The TEST position of each switch is used by ground personnel when doing maintenance checks.

Note

If the generators have not been turned off when external power is connected and the APP and/or main rotor head is to be shut down, relay chatter may be encountered on the next turn-up. Relay chatter can be eliminated by recycling the generator switches.

2.7.2 AC Buses. Normally the No. 1 generator furnishes power to the No. 1 primary ac bus and also the No. 1 monitor ac bus and No. 1 rectifier. If the No. 2 generator fails, the No. 1 primary ac bus will furnish power to the No. 2A primary ac bus and the No. 1 and No. 3 monitor ac buses will be dropped. Normally the No. 3 generator furnishes power to the No. 3 ac primary bus, its associated autotransformer, No. 3 monitor ac bus, and to the emergency ac bus (and its associated autotransformer on aircraft without AFC 490). In addition, the No. 3 primary ac bus furnishes power to the No. 2 rectifier. If the No. 2 generator fails, the No. 3 primary ac bus will furnish power to the No. 2B primary ac bus and its associated autotransformer. The No. 1 and No. 3 monitor ac buses will be dropped. Normally the No. 2 generator furnishes power to the No. 2A primary bus and the No. 2B primary ac bus and its associated autotransformer. If the No. 1 generator fails, the No. 2A primary ac bus will furnish power to the No. 1 primary ac bus and the No. 1 and No. 3 monitor ac buses will be dropped. All other functions of the No. 1 primary ac bus will continue. If the No. 3 generator fails, the No. 2B primary bus will furnish power to the No. 3 primary ac bus and emergency ac bus for normal operation. The No. 1 and No. 3 monitor ac bus will be dropped. If the No. 1 and No. 2 generators fail, the No. 3 generator will furnish power to the No. 2B primary ac bus and the emergency ac bus. The No. 1 and No. 3 monitor ac buses, No. 1 primary ac bus, and the No. 2A primary ac bus will be dropped. If the No. 2 and No. 3 generators fail, the No. 1 generator will furnish power to the No. 2A primary ac bus and the emergency ac bus. The No. 1 and No. 3 monitor ac buses, No. 2B primary ac bus, and the No. 3 primary ac bus will be dropped. If the No. 1 and No. 3 generators fail, the No. 2 generator will furnish power to the No. 1 primary ac bus, No. 2A primary ac bus, No. 2B primary ac bus, No. 3 primary ac bus, and the emergency ac bus. The No. 1 and No. 3 monitor ac buses will be dropped (Figure 2-10).

Note

(AFC 490) When operating the aircraft with the No. 1 generator on, and the No. 2 and No. 3 generators off or failed; the No. 3 primary ac bus will be lost, failing the No. 2 AFCS computer, AHRS, TACAN, VOR, No. 1 and No. 2 HSIs, and the radar altimeter.

EMERGENCY AC BUS (COCKPIT)

- ADI, pilot (AFC 490)
- ADI gyro, copilot
- AFCS
  - Computer, No. 1 (and No. 2 without AFC 490)
  - Rate gyro, No. 1 (and No. 2 without AFC 490)
- AHRS (N/A with AFC 490)
- Auto Transformer, 115 V (N/A with AFC 490)
- Coupler
- HSI, No. 1 and No. 2 (N/A with AFC 490)
- Quad tachometers, copilot and pilot
- Torquemeters, pilot and copilot
- Two-point suspension solenoid
- Engine
  - No. 2 engine dual thermal detection system (AFC 483)

No. 3 PRIMARY AC BUS (COCKPIT, AFC 490 ONLY)

- ADI, copilot
- AFCS
  - Computer, No. 2
  - Rate gyro, No. 2
- AHRS
- Auto Transformer, 115 V
- HSI, No. 1 and No. 2
- HSI, 26 VAC, No. 1 and No. 2

EMERGENCY DC BUS (COCKPIT)

- AFCS
  - FAS, turn on
  - Primary
  - Secondary
  - Trim, turn on
- ADI gyro, pilot and copilot
- Caution panel master
- Chip detectors
  - Accessory, intermediate/tail gear boxes
  - Main gear box
  - No. 1 engine and nose gear box
  - No. 2 engine
  - No. 3 engine and nose gear box
- Coupler
- Engine
  - Fire detection; No. 1, No. 2, and No. 3
  - Fire Extinguisher; No. 1, No. 2, and No. 3
  - No. 2 engine dual thermal detection system (AFC 483)
  - Nose gear box oil pressure; No. 1 and No. 3
  - Oil pressure; No. 1, No. 2, and No. 3
- Fire, cabin heater/APP
- Fire extinguisher control
- Gear box pressures
  - Accessory
  - Main/tail rotor, intermediate
- Radio
  - COMM 1
  - COMM juliet
  - Compass failure
  - ICS copilot
  - ICS pilot
- Secondary instrument lights
- Servo; primary, 1 and 2 interlock
- Bearing monitor system (AFC 491)
- Transmission fire detection (AFC 440)
- Two-point suspension control

NO. 2A PRIMARY AC BUS (LH CABIN)

- Fuel dump pump, left
- Heat exchanger, utility 2
- No. 2 engine EAPS blower
- Ranger extension
- Vent blower

Figure 2-10. Electrical Buses (Sheet 1 of 5)

NO. 2B PRIMARY AC BUS (LH CABIN)

- Autotransformer, 115V
- Combustion air blower
- Formation lights; input circuit, fuselage, and tip
- Fuel
  - Flow, No. 2 engine
  - No. 2 tank quantity
- Heat exchanger, second stage power
- Hydraulic pressure, 26V
  - Second stage
  - Utility
- Ice detector
- Mine countermeasures console
- Quad hydraulic quantity, 26V
- Radio
  - Altimeter encoder
  - IFF
  - Radar altimeter 1
- Stick position indicator
- Weight and balance indicator
- Windshield wiper

No. 1 PRIMARY DC BUS (LH CABIN)

- Accessory gear oil hot
- Anticollision light, forward and control (without AFC 479, Part 4)
- Avionics lighting console
- Cabin heater control
- Cable shear, port
- Countermeasures dispenser, power and control
- EAPS, warning and overload
- Fuel, left
  - Control
  - Dump control
  - Dump valve
- Fuel low warning, No. 1 tank
- Heat exchanger, utility 1
- Ice detector
- Infrared lights, beacons, and position (AFC 479, Part 4)
- Lights
  - Cargo loading
  - Cockpit dome
  - No. 1 hover
  - Probe light
  - No. 1 engine
  - Anti-ice warning
  - Emergency start
  - Fuel pump
  - Ignition
  - IGV anti-ice, warning and control
  - Nose gear box temperature
  - Oil quantity low
  - Oil temperature
  - Overspeed
  - Speed trim
  - Start control
- No. 1 generator test receptacle and PMG backup
- No. 1 monitor bus control
- Oil hot, second stage
- Pedal adjustment, copilot
- Pitot heat, left
- Quad hydraulic quantity
- Radio
  - ADF
  - HF coupler
  - HF, receiver and transmit
  - ICS, left cabin
  - IFF, test and power
- Ramp open and control
- Refuel
  - Master power
  - Probe control
  - Purge
- Servo, first stage fail and pressure
- Skew tension indicator
- Tail skid
- Tow hook release
- Two-point suspension control
- Weight-on-wheels, left side
- Winch, cargo
- Windshield anti-ice, copilot

No. 1 MONITOR DC BUS (LH CABIN)

- Lights
  - Light/mirror control, copilot
  - Spotlight power, copilot
- Utility receptacle

Figure 2-10. Electrical Buses (Sheet 2 of 5)

No. 1 PRIMARY AC BUS (LH CABIN)

- Anti-ice, No. 1 engine
  - Nose gear box
  - Removable section
- Battery charge
- Converter, No. 1
- Cushion blower, copilot
- Doppler fan
- Drogue dim control
- Engine PTIT; No. 1, No. 2, and No. 3
- Fuel
  - Flow, No. 1 engine
  - No. 1 tank quantity
  - Total quantity
- Heat exchanger, utility 1 power
- Landing gear warning
- Lights
  - Cargo load
  - Console, upper and lower
  - Flight; copilot, pilot, and non-flight
- Windshield anti-ice, copilot

NO. 1 MONITOR AC BUS (LH CABIN)

- Suit blower, copilot
- Utility receptacles, No. 3 and No. 4
- Windshield anti-ice, center

No. 3 PRIMARY AC BUS (RH CABIN)

- Anticollision light, aft
- Anti-ice, No. 3 engine
  - Nose gear box
  - Removable section
- Auto transformer, 115V
- BIM
- Converter, No. 2
- Cushion blower, pilot
- Fuel
  - Dump pump, right
  - Flow, No. 3 engine
  - No. 3 tank quantity
- GPWS (AFC 501 PT 3)
- HSI, No. 1 and No. 2
- Hydraulic pressure
  - First stage, 26V
  - Utility 2, 26V
- Main gear box oil pressure, 26V
- MK 105 power
- Omega-VLF
- Radio
  - Doppler
  - Radar altimeter 2
- Radio, 26V
  - LF-ADF
  - Omega-VLF
  - TACAN
  - UHF-DF
  - VOR
- Two-point suspension power
- Utility receptacle, No. 1 and No. 2
- Windshield anti-ice, pilot

NO. 3 MONITOR AC BUS (RH CABIN)

- Suit blower, crew
- Suit blower, pilot

Figure 2-10. Electrical Buses (Sheet 3 of 5)

NO. 3 PRIMARY DC BUS (RH CABIN)

Cable shear, starboard
Cargo hook jettison
Engine oil level
External power control
Fuel right
  Control
  Dump control
  Dump valve
Fuel low warning No. 3 tank
Ground Proximity Warning System (AFC 501 PT 3)
Landing gear warning
Lights
  Cabin dome
  Light/mirror control, pilot
  Position
  Spotlight power, pilot
MK-105 control
No. 3 engine
  Anti-ice warning
  Emergency start
  Fuel pump
  Ignition
  IGV anti-ice warning and control
  Nose gear box temperature
  Oil quantity low
  Oil temperature
  Overspeed
  Speed trim
No. 3 generator, test receptacle, and PMG backup
Overtorque warning
Pedal adjustment, pilot
Pitot heat, right
Radio
  Doppler
  ICS, cabin, right side
  Omega-VLF
  Mode select, copilot and pilot
  Radar altimeter 2
  Radar beacon
  TACAN
  VHF DF
  VOR, LOC-GS
Range extension control
Rotor brake pressure
Servo, second stage, failure and pressure
Skew tension indicator
Tail rotor servo pressure
Tow hook release
Transfer hook, control and initiation
Two-point suspension warning
Utility oil hot
Utility receptacle, pilot
Utility 1 pressure
Utility 2 oil hot
Warning light test
Weight-on-wheels, right side
Winch, starboard
Windshield anti-ice, pilot
Windshield washer control

Figure 2-10. Electrical Buses (Sheet 4 of 5)

NO. 2 PRIMARY DC BUS (RH CABIN)

BIM
Blade fold
Cargo hook control and power
Davit control
Fuel low warning, No. 2 tanks
Fuel shutoff valve, No. 2 tanks
Heat exchanger, No. 2
Isolation valve
Landing gear; down, position, and control
Lights
  Emergency cockpit lights
  Emergency exit lights
  Land hover lights; No. 2 lamp, No. 3 lamp, and control
Main gear box oil temperature
Mine countermeasures console
No. 2 engine
  Emergency start
  Fuel pump
  Ignition
  IGV anti-ice warning and control
Oil quantity low
  Oil temperature
  Overspeed
  Speed trim
No. 2 generator, test receptacle, and PMG backup
Radio
  Communication 1 antenna (Removed by AFC 455, Part 4)
  Communication 2 radio
  Radar altimeter 1
Raydist
Rescue hoist
  Light power and control
  Power
Rotor brake control and power
Stick position indicator
Utility 2 hydraulic
  Heat exchanger
  Pressure warning
  Pump control
Weight/balance
Winch, port
Windshield anti-ice, center

Figure 2-10. Electrical Buses (Sheet 5 of 5)

On aircraft modified by AFC 490, a three-phase voltage sensing relay also monitors the emergency ac bus for an open or short (undervoltage) condition in any phase. This feature is incorporated between the No. 3 primary ac bus and the emergency ac bus relay. If the voltage of any phase is degraded, the No. 1 primary ac bus provides power to the emergency ac bus.

2.7.3 Autotransformers. The electrical system has three autotransformers that reduce 115 vac to 26 vac for operation of certain instruments and avionics gear. One transformer is associated with the emergency ac bus, one with the No. 3 primary ac bus, and one with the No. 2B primary ac bus. Aircraft with AFC 490 have two transformers associated with the No. 3 primary ac bus and one with the No. 2B primary ac bus.

The emergency ac bus (or the No. 3 primary ac bus on aircraft with AFC 490) circuit breaker panel in the cockpit furnishes power to the emergency ac bus (or the No. 3 primary ac bus on aircraft with AFC 490) autotransformer through a circuit breaker marked AUTO XFMR 115V, and the autotransformer furnishes power to two circuit breakers marked No. 2 and NO. 1 under the general heading HSI (or HSI, 26 VAC on aircraft with AFC 490).

The NO. 3 primary ac bus circuit breaker panel furnishes power to the No. 3 primary ac bus autotransformer through a circuit breaker marked AUTO XFMR 115V, and the autotransformer furnishes power to three circuit breakers above the general heading 26V, marked HYDR 1 STG, PRESS UTIL 2, MGB OIL PRESS, and to five circuit breakers under the general heading 26V RADIO, marked TACAN-UHF DF-VOR-LF ADF-OMEGA VLF.

The No. 2B primary ac bus circuit breaker panel in the cabin furnishes power to the No. 2B primary ac bus autotranformer through a circuit breaker marked AUTO XFMR 115V, which furnishes power to three circuit breakers above the general heading 26V marked QUAD HYDR QTY-HYDR PRESS UTIL-HYDR PRESS 2ND STAGE.

2.7.4 External Power Receptacle. The receptacle is used to introduce 400 Hz, 115/200 vac power into the helicopter from an ac external power source. This receptacle is on the lower right side of the fuselage, forward of the personnel door. Power to operate the necessary relays and light the EXT PWR CONNECTED advisory light is furnished by the external power monitor panel, which converts a portion of the ac power cart's input into 28 vdc. Introduction of external ac power into the helicopter is controlled by the external power monitor panel, which samples a portion of the external power for correct voltage, frequency, and phase rotation. If the external power is not within prescribed limits, the external power monitor panel will not energize the external power relays that would enable the external power to enter the helicopter. The EXT PWR switch, beside the receptacle, must be momentarily placed to RESET every time the external power monitor panel rejects the ac power cart's input. When the external power monitor panel is satisfied that the cart's power inputs are within the prescribed limits, dc power will energize the external power bus relays, ac power will enter the helicopter, and subsequently all ac and dc buses will be energized. The external power rectifier, associated relays, and circuits are protected by the EXT PWR circuit breaker, beside the receptacle. When the helicopter is generating its own electricity, the EXT PWR CONNECTED advisory light is powered by the No. 3 primary dc bus circuit breaker panel in the cabin through a circuit breaker marked EXT PWR CONT. With external power on and the No. 1 or No. 3 generators on the line, there is load sharing between external power and the generator. With three generators, or No. 2 generator only on the line; external power is automatically cut out.

2.7.5 DC Buses. Normally the No. 1 rectifier furnishes power to the No. 1 primary dc bus and subsequently to the No. 1 monitor dc bus. If the No. 2 rectifier fails, the No. 1 primary dc bus will furnish power to the No. 2 and No. 3 primary dc buses and the emergency dc bus. The No. 1 monitor dc bus will be dropped. Normally the No. 2 rectifier furnishes power to the No. 3 primary dc bus and also to the No. 2 primary dc bus and the emergency dc bus. If the No. 1 rectifier fails, the No. 3 primary dc bus will furnish power to the No. 1, No. 2, and emergency dc buses. The No. 1 monitor dc bus will be dropped (Figure 2-10).

2.7.6 Rectifiers. Two 200-ampere, 28 vdc rectifiers are incorporated in the electrical system. Direct current will automatically be provided whenever the ac system is energized. The No. 1 primary ac bus furnishes three-phase operating power to the No. 1 rectifier. The No. 3 primary ac bus furnishes power to the #2 rectifier. Power to light the #1 RECT caution light when the No. 1 rectifier fails is furnished by the No. 1 generator's supervisory panel. Power to light the #2 RECT caution light when the No. 2 rectifier fails is furnished by the No. 3 generator supervisory panel. The No. 1 primary ac bus circuit breaker panel in the cabin furnishes power to the No. 1 rectifier through a circuit breaker marked CONVERTER NO. 1. The No. 3 primary ac bus circuit breaker panel in the cabin furnishes power to the No. 2 rectifier through a circuit breaker marked CONVERTER NO. 2.

2.7.7 Circuit Breaker Panels. These panels (FO-1 and FO-3), protecting various ac and dc circuits, are in the cockpit and cabin. The emergency ac and dc circuit breaker panel is on the cockpit's overhead control panel. The No. 3 primary ac and No. 3 monitor ac circuit breaker panel is on the forward right side of the cabin. Aircraft with AFC 490 also have some of the No. 3 primary ac circuit breakers on the cockpit overhead control panel. The No. 3 primary dc bus and the No. 2 primary dc bus circuit breaker panels are also on the forward right side of the cabin. Circuit breaker panels on the forward left side of the cabin are the No. 2A and 2B primary ac bus circuit breaker panel, the No. 1 primary dc and No. 1 monitor dc bus circuit breaker panel, and the No. 1 ac and No. 1 monitor ac bus circuit breaker panel. All circuit breakers are the push-pull type that can be reset and are marked to identify the circuit they protect.

To protect the No. 1 primary ac bus if a short develops in the emergency ac bus, three ac circuit breakers, one for each phase, are incorporated between the No. 1 primary ac bus and the emergency ac bus relay. The circuit breakers are on the No. 1 ac power junction box above the test receptacle. To protect the No. 3 primary ac bus if a short develops in the emergency ac bus, three ac circuit breakers, one for each phase, (and a three-phase voltage-sensing relay on aircraft with AFC 490) are incorporated between the No. 3 primary ac bus and the emergency ac bus relay. The circuit breakers are on the No. 3 ac power junction box above the test receptacle.

An additional exposure suit blower ac circuit breaker is beneath each pilot's position.

2.7.8 Current Limiters. A current limiter restricts the maximum flow of current to a specific amount, regardless of applied voltage. A current requirement beyond the capacity of the current limiters, as caused by a short circuit, will cause the current limiter to break the flow of current and subsequently protect the power generation line from overload. A three-phase current limiter protects the No. 1 primary ac bus circuits when it is furnishing power to the No. 2A primary bus. A three-phase current limiter protects the No. 2A primary bus when it is furnishing power to the No. 1 primary ac bus. A three-phase current limiter protects the No. 3 primary ac bus when it is furnishing power to the No. 2B primary bus. A three-phase current limiter protects the No. 2B primary ac bus when it is furnishing power to the No. 3 primary ac bus. Four current limiters are in the dc current crossfeed lines to protect the primary dc buses if a short develops in the emergency dc bus. One is between the No. 1 and No. 2 primary dc buses, one between the No. 2 and No. 3 primary dc buses, one between the No. 1 and No. 3 primary dc buses, and one between the emergency dc bus relay and the emergency dc bus.

2.7.9 Utility Receptacles. There are four capped ac and four capped dc utility receptacles in the helicopter. One ac and one dc receptacle is in each electronics compartment. One ac and one dc receptacle is in each electronics compartment. One ac and one dc receptacle is in the cabin at the ramp station on the left side. One ac receptacle is on the left side of the cabin aft of the circuit breaker panel. There is a dc receptacle in the cockpit on the copilot's floodlight panel. Each ac utility receptacle is marked 115/200 VAC, and each dc utility receptacle is marked 28 VDC; both under the general heading UTILITY RECEPTACLE. The ac receptacles receive power from the No. 1 monitor ac bus circuit breaker marked UTILITY RCPT NO 3 & 4, and the No. 3 primary ac bus circuit breaker marked UTIL RCPT NO 1 & 2. The dc receptacles receive power from the No. 1 monitor dc bus circuit breaker marked UTIL RECP under the general heading CO PILOT, and the No. 3 primary dc bus circuit breaker marked UTIL RCPT PILOT.

2.8 LIGHTING EQUIPMENT

The lighting equipment operates on alternating and direct current through appropriately marked circuit breakers on the circuit breaker panels. Switches and rheostats for operating all lights, except the standby compass light, controllable spotlights, and the rescue hoist floodlight, are on the overhead control panels (FO-1) in the pilot's compartment.

2.8.1 Pilot's and Copilot's Instrument Lights. The pilot's and copilot's flight instrument lights (Figure 2-11) are individually controlled by rheostats on the pilot's and copilot's overhead interior lights control panels. The pilot's flight instrument lights are controlled by a rheostat marked PILOT FLIGHT INST LTS, with marked positions OFF and BRT, on the pilot's overhead INT LTS control panel. The pilot's flight instrument light rheostat is also used to control the dimming circuit for the landing gear handle light (when on), AFCS control panel lights, the blade/pylon fold panel lights, the refueling panel lights, and the pilot's and copilot's miscellaneous switch panel lights. All lights on the dimming circuit will be dimmed to one setting when the pilot's flight instrument light rheostat is turned on. In addition, when the pilot's flight instrument light rheostat is advanced out of OFF, the caution and advisory lights will be bright. The caution and advisory lights are dimmed by placing the momentary BRT/DIM toggle switch on the advisory panel to DIM. The copilot's flight instrument lights are controlled by a rheostat, marked COPILOT FLT INST LTS with marked positions

OFF-BRT, on the copilot's overhead INTERIOR LTS control panel. The intensity of the flight instrument lights may be varied by turning the individual rheostats.

The pilot's flight instrument lights receive power from the No. 1 primary ac bus through two circuit breakers marked CPLT FLT and PLT FLT under the general heading LIGHTS INSTL.

2.8.2 Nonflight Instrument Lights. These lights provide indirect lighting of the instrument panel for the engine and transmission instruments, hydraulic pressure gages, fuel gages and landing gear position indicators. The lights are controlled by a rheostat marked NON FLIGHT INST LTS, with marked positions OFF and BRT, on the pilot's overhead INT LTS control panel. The intensity of the lights may be varied by turning the rheostat. The nonflight instrument lights receive power from the No. 2B primary ac bus through a circuit breaker in the cabin, marked NON FLT under the general heading LIGHTS.

2.8.3 Upper and Lower Console Lights. The lights are individually controlled by two rheostats on the copilot's INTERIOR LTS control panel. The rheostat marked UPPER controls the upper console lights. The rheostat marked LOWER, controls the lower console and the ICS control panel. Both rheostats have marked positions OFF and BRT and are under the general heading CONSOLE LTS. The intensity of the lights may be varied by turning the proper rheostat. The upper and lower console lights receive power from the No. 2B primary ac bus through two circuit breaker in the cabin, marked CONSOLE UPPER and LOWER under the general heading LIGHTS.

2.8.4 Secondary Floodlights. These floodlights (Figure 2-11) provide a secondary source of lighting for the instrument panel, upper console, and the ICS control panels. Controls for the lights consist of a switch and a rheostat on the pilot's INTERIOR LIGHTS control panel. The rheostat, marked PILOT INSTRUMENTS, with marked positions OFF and BRT, may be turned to vary the intensity of the red secondary lights above the instrument panel and pilot's and copilot's ICS panels when the CONSOLE switch is either in the OFF or DIM position. Placing the CONSOLE switch with marked positions DIM, OFF, and BRT to the DIM position will provide dimmed lighting to the center overhead console. The cockpit red lights will also go on dim, even if the COCKPIT RED LIGHT switch is in the OFF position. When the CONSOLE switch is placed to BRT, the PILOT INSTRUMENTS knob (rheostat) is bypassed and all secondary lights (14) will come on bright (6 instrument panel lights, 4 center overhead console lights, and 2 cockpit red lights). The cockpit red lights may be operated independently of the other secondary lights by placing the cockpit red light switch (FO-1) marked COCKPIT RED LIGHT to ON. The secondary floodlights receive power from the emergency dc bus through a circuit breaker in the cockpit, marked SEC INST LTS.

2.8.5 Cockpit White Lights. These lights are controlled by a switch and rheostat on the pilot's INTERIOR LIGHTS control panel, both of which are under the general heading COCKPIT WHITE LIGHT. The control switch, with marked positions CONTROL, OFF, and BRT, is used to turn the cockpit white lights on. When the control switch is placed to CONTROL, the intensity of the lights may be varied by turning the rheostat marked DIM and BRT. Placing the control switch to BRT bypasses the rheostat control and increases the intensity of the lights. The cockpit white lights receive power from the No. 1 primary dc bus through a circuit breaker in the cabin, marked CKPT DOME, under the general heading LIGHTS.

2.8.6 Utility Lights. There are two portable utility lights, with coiled extension cord, secured on swivel-type mountings overhead on each side of the cockpit canopy (Figure 2-11). They may be adjusted on their mountings to direct the light beams as desired. The utility lights are each controlled by a rheostat with marked positions OFF and BRT, and a pushbutton switch on the end of each light casing. Pressing the pushbutton switch provides full intensity of the lights. The rheostat provides control of the intensity of the lights. The lens casing of the light may be turned to focus the beam and to position a red filter, converting the white light to a red light. The lights operate from the No. 2 primary dc bus through a circuit breaker in the cabin, marked CKPT LTS, under the general heading EMERGENCY.

2.8.6.1 Tension/Skew Angle Indicator Lighting. The pilot and copilot's tension/skew angle indicators each have a light assembly on the glare shield to provide day time illumination. The lights are controlled by the ON-OFF switch on the AMCM INDICATOR LTS panel located on the lower console (FO-7). The lights receive power from the No. 1 primary ac bus through two circuit breakers marked CPLT FLT and PLT FLT under the general heading LIGHTS INSTL.

2.8.7 Cabin Dome Lights. The six cabin dome lights are controlled by a switch marked CABIN DOME, with marked positions WHITE, OFF, and RED, on the copilot's INTERIOR LTS control panel. The cabin dome lights each have a red and white lamp. Placing the cabin dome light switch to WHITE or RED will turn on the white (or red) lamp in that light. The cabin dome lights operate

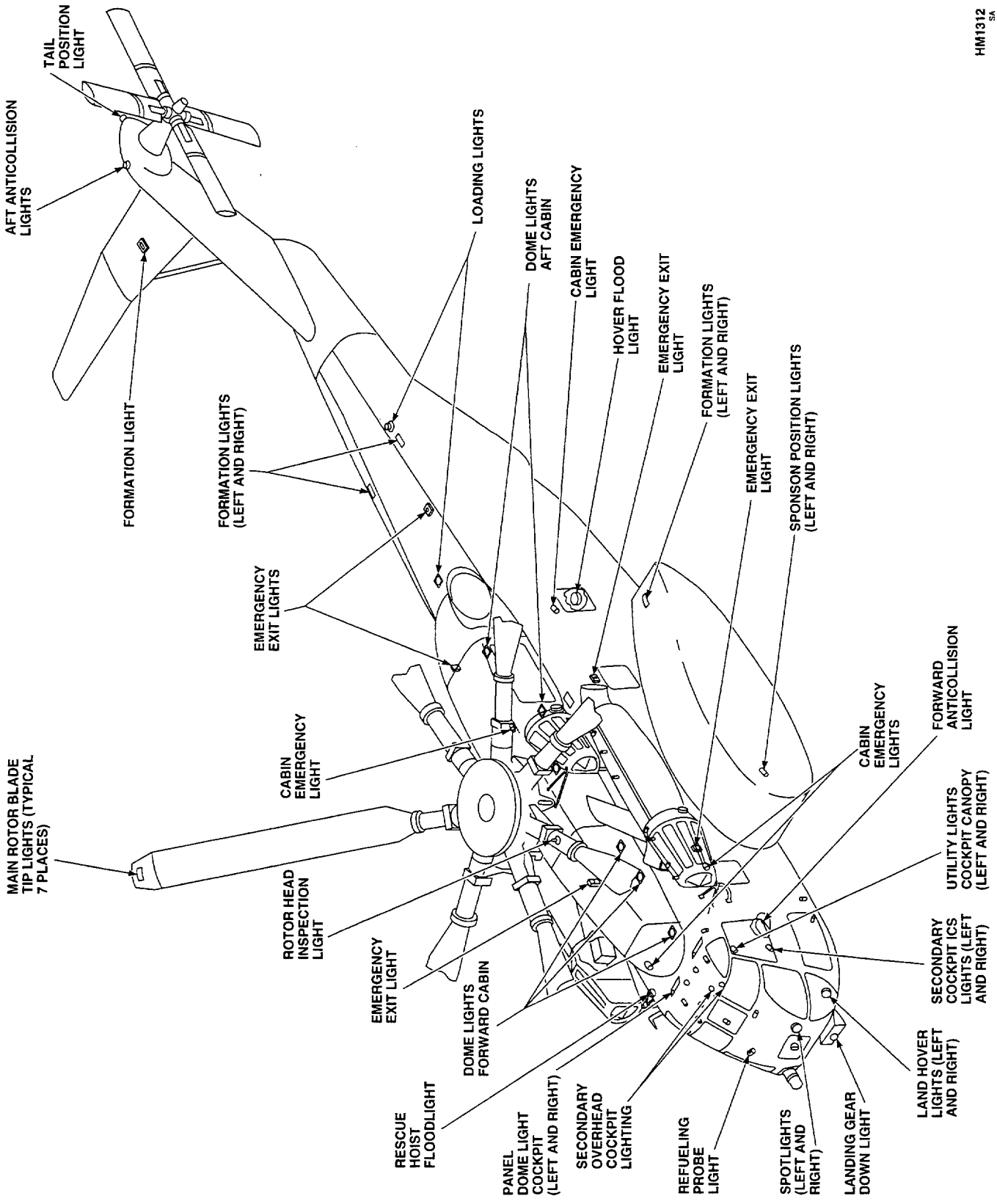
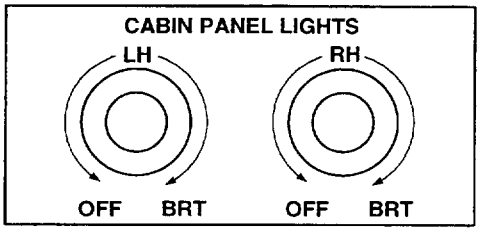


Figure 2-11. Lighting

from the No. 3 primary dc bus through a circuit breaker in the cabin, marked CABIN DOME, under the general heading LIGHTS.

2.8.8 Cabin Panel Lights. The lights are controlled by two rheostats on the CABIN PANEL LIGHTS control panel (Figure 2-12) mounted above the circuit breaker panels on the left side of the cabin. The rheostat marked LH controls the panels on the left side of the cabin and the rheostat marked RH controls the panels on the right side. Turning the rheostats toward BRT increases panel lighting intensity, and turning the rheostats to OFF extinguishes the panel lights.

2.8.9 Emergency Lights. Emergency lights (Figure 2-11) are installed in the cabin. The power source for the emergency lights are two batteries, charged from the No. 1 primary ac bus through a circuit breaker marked BATT CHARGE. There are nine emergency lights; four are designated cabin emergency lights and five are emergency exit lights. The four cabin emergency lights above the forward cabin door and each of the three cabin escape hatches light automatically when the helicopter's dc electrical system fails, upon impact of 10 Gs, or when immersion switches at floor level are immersed in water (salt or fresh). The five removable emergency exit lights, two on the right and two on the left cabin walls and one above the ramp opening on the aft cabin wall, have a self-contained battery that will cause the light to go on whenever dc electrical power to the light is interrupted. The five emergency exit lights may be removed in case of emergency by pulling on the handle marked PULL, at the top of the light. When the light is removed, a switch on the light housing is activated, causing the light to operate on battery power. Once the light is removed, it may be turned off by pushing the handle in, and turned on again by pulling the handle out. All emergency lights are controlled by a switch marked EMER EXIT, with marked positions ARM-TEST-OFF, on the copilot's interior light control panel, marked INTERIOR LTS. The lights and battery are tested by moving the switch to TEST. The ARM position charges the batteries and arms the system. In this position the lights will automatically switch on when the appropriate initiating emergency condition(s) exist. The system is controlled by the No. 2 primary dc bus through a circuit breaker marked EXIT LTS under the general heading EMERGENCY.



HM1313 SA

Figure 2-12. Cabin Panel Lights

Note

If electrical power is momentarily interrupted to the No. 2 dc primary bus with the EMER EXIT switch at ARM, the emergency lights will go on.

2.8.10 Loading Lights. Two loading lights, one above the ramp and one in the bottom of the tail cone, provide light for the ramp loading area. The lights are controlled from the CAR LDG panel on the overhead control panel (FO-1). The control switch under the general headings CARGO and LOADING LTS is marked CREW-OFF-ON. The lights are also controlled by a rheostat marked LOADING LT, with marked positions OFF-BRT, on the crew miscellaneous control panel in the cabin (FO-43). When the switch in the cockpit is placed to CREW, the intensity of the lights can be controlled by the crewmember's rheostat. The crewmember's rheostat cannot be used when the pilot's switch is ON. The loading lights receive electrical power from the No. 1 primary dc bus through a circuit breaker marked CARGO LOAD, under the general heading LIGHTS; and from the No. 1 primary ac bus through a circuit breaker marked CARGO LOAD LIGHTS.

2.8.11 Exterior Light Master Switch. The MASTER switch is on the EXTERIOR LIGHTS panel on the copilot's overhead control panel. The master switch must be placed ON before any of the position lights, anticollision lights, main rotor blade tip lights, rotor head light, or landing gear down light will operate. Placing the switch OFF will turn off all of the exterior lights controlled through the master switch.

2.8.12 Land-Hover Lights. These consist of three lights: two are on either side of the lower nose section and the third is on the bottom aft section of the fuselage. The lights are controlled by a switch on the EXTERIOR LIGHTS panel on the copilot's overhead control panel. Marked positions are LAND, OFF, and HOVER. When the switch is placed to HOVER, the hover light on the bottom aft

section of the fuselage goes on and lights an area directly below the helicopter. Placing the switch to LAND will cause the hover light and the two landing lights on either side of the lower nose section to go on and light areas forward of and directly below the helicopter. Placing the switch OFF turns off all the land-hover lights. Control power for the land hover lights is provided from the No. 2 primary dc bus, through a circuit breaker in the cabin, marked CONT, under the general heading LAND HOVER LT. The hover light receives electrical power from the No. 1 primary dc bus through a circuit breaker, marked HOVER NO. 1 under the general heading LIGHTS. The left and right landing light receives electrical power from the No. 2 primary dc bus through circuit breakers in the cabin, marked NO. 2 LAMP and NO. 3 LAMP, respectively, under the general heading LAND HOVER LT.

2.8.13 Position Lights. These consist of a red light on the outboard side of the left sponson, a green light on the outboard side of the right sponson, and a white light on top of the tail pylon. The lights are controlled by three switches on the copilot's EXTERIOR LIGHTS control panel. A two-position switch, marked positions FLASH-STEADY, to the left of the position light control switches, offers selection of either a steady or flashing mode of operation. The flasher operates only when the switch is at FLASH. The two position lights, one on the outboard side of each sponson, are controlled by the switch marked SIDE, with marked positions, DIM-OFF-BRT. The position light, on top of the tail pylon, is controlled by the switch marked TAIL, with marked positions DIM-OFF-BRT. The side and tail position lights may be operated independent of each other. However, none of the position lights will operate until the exterior light master switch is placed ON. Placing the position light switches to DIM will cause the respective position lights to operate at a low intensity. Placing the position light switches to BRT will cause the respective position lights to operate at a high intensity. The position lights receive power from the No. 3 primary dc bus through a circuit breaker, marked POS, under the general heading LIGHTS, in the cabin.

2.8.14 Anticollision Lights. Two anticollision lights are provided. A rotating anticollision light is on the bottom of the forward fuselage and a two strobe anticollision light is on the top of the tail pylon. Three switches to control the lights are on the copilot's exterior lights control panel under the general heading ANTI-COLL. The left switch marked BOTH, with marked positions ON and OFF, is used to operate both lights simultaneously. Placing the switch ON will cause both anticollision lights to go on, and placing the switch OFF will cause both anticollision lights to go off. The center switch marked FWD, with marked positions OFF and RESET, is spring-loaded to center. If it is desired to have only the aft anticollision light operating, the forward anticollision light may be turned off by placing the FWD switch OFF. Placing the switch to RESET will restore the forward anticollision light to operation. The right switch, marked AFT, has marked positions DAY-NIGHT. When placed to DAY, the strobes will pulse white. When placed to NIGHT the strobe will pulse red. The aft anticollision strobe is omnidirectional and pulses at 30 to 40 flashes per minute. The exterior lights master switch must be on to operate the anticollision lights.

An anticollision beacon selector switch is added for the forward anticollision light, which permits a choice of either amber or red, during tow operations. The beacon selector switch, marked ANTI-COLL BEACON, with marked positions AMBER-RED, is on the MCM TOW panel. The switch enables the forward anticollision light to be selected for use as an amber or red light without affecting operation of the aft anticollision light. When the switch is placed to AMBER, with the forward anticollision light switch to RESET, the forward light will light amber and turn counterclockwise to indicate that towing is being done. When the switch is placed to RED, both lights operate normally. The aft anticollision light receives power from the No. 3 ac primary bus through a circuit breaker marked ANTI-COLL LT AFT. The forward anticollision light receives power from the No. 1 primary dc bus through a circuit breaker marked FWD, and the anticollision lights control circuit also receives power from the No. 1 dc primary bus through a circuit breaker marked CONT. Both circuit breakers are under the general heading ANTICOLLISION LIGHT.

Note

The forward rotating anticollision light should be turned off during flight when visibility is reduced, where the pilot might experience vertigo from the reflections of the rotating light against the clouds.

2.8.15 Formation Lights. These consist of one white light installed in each rotor blade tip, and seven green electroluminescent formation lights installed on the fuselage (Figure 2-11). The blade tip lights provide rotor blade tip path lighting that may be viewed only from 0° to an up angle of 25°. The fuselage formation lights are on the upper surface of each sponson, the top left and right sides of the fuselage aft of the main gear box, the top left and right sides of the fuselage forward of the tail pylon, and one on top of the horizontal stabilizer. They can only be viewed from above the helicopter. The lights are controlled by knobs marked FUSELAGE and BLADE TIP, under the general heading FORMATION LIGHTS, on the

copilot's EXTERIOR LIGHTS control panel. Both switches have marked position OFF and BRT, and may be turned to vary the intensity of the lights. Both the blade tip and fuselage formation lights receive power from the No. 2B primary ac bus. The blade tip lights are protected by a circuit breaker marked TIP, the fuselage formation lights are protected by a circuit breaker marked FUSLG, and the input circuit is protected by a circuit breaker marked HV. All three circuit breakers are under the general heading FORMATION LIGHTS, in the cabin.

2.8.16 Spotlights. Two controllable spotlights, one for each pilot, are mounted beneath the fuselage nose section. The lights may also be used for refueling drogue illumination. The spotlights are controlled by switches under the heading SPOT LIGHT, on the pilot's and copilot's collective pitch lever grips (FO-7); and two switches marked MIRROR-SPOTLIGHT, on panels marked CLTV BEEPER MODE SEL on the pilot's and copilot's overhead panels (FO-1). The pilot's or copilot's switch must be at SPOTLIGHT to operate the respective controllable spotlight. The lights are then operated by the switches on the collective pitch lever grips as described below. The switch marked MASTER has marked positions ON-OFF-STOW. The TRAIN switch is a spring-loaded five-position, thumb switch, center position (OFF), with marked positions L-R-UP-DN. Placing the MASTER switch ON lights the controllable spotlight and furnishes power to the switch to control the direction of the spotlight. When the TRAIN switch is placed to UP, the spotlight is extended and may be stopped by releasing the switch to direct the light beam at any vertical angle between the stowed position to about 30° above the horizon. By placing the switch to DN, the light beam may be directed at a progressively decreasing angle until the spotlight is fully stowed. Placing the switch to L or R will cause the spotlight to turn to the left or right at any point in a 360° arc. If the master switch is placed to STOW while the spotlight is extended, the spotlight will automatically turn off and retract to the stowed position. The pilot's controllable spotlight receives power from the No. 3 dc primary bus through circuit breakers, marked SPOT PWR and LT/MIR CONT under the general heading PILOT. The copilot's controllable spotlight receives power from the No. 1 dc monitored bus through circuit breakers marked SPOT PWR and LT/MIR CONT, under the general heading COPILOT. The controllable spotlights are also used as drogue lights with the drogue light dimmer control and selector switch, on the REFUEL LTS control panel on the copilot's overhead control panel. After selection and intensity have been established, the controllable spotlights are operated normally.

2.8.16.1 Drogue Light Controls. The REFUEL LTS panel, on the copilot's overhead control panel, contains two drogue light controls under the general heading DROGUE. The selector switch, with marked positions CO-PLT, OFF, and PLT, is used to select either the pilot's or copilot's controllable spotlight for use as a drogue light. The light is then operated in the normal manner. The dimmer control, with marked positions OFF, and BRT, is turned out of OFF to vary the intensity of the controllable searchlight that has been selected. The drogue light dimmer control receives power from the No. 1 primary ac bus through a circuit breaker, marked DROGUE DIM CONT, in the cabin.

2.8.17 Probe Light. This light, on the nose of the helicopter, lights the refueling probe. The REFUEL LTS panel, on the copilot's overhead control panel, contains the PROBE light control knob. The probe light is turned on and the intensity varied by turning the knob out of OFF. The light receives power from the No. 1 primary dc bus through a circuit breaker, marked PROBE LT, in the cabin.

2.8.18 Main Rotor Head Light. This light, mounted on the main gear box fairing, permits the main rotor droop stops to be visually checked at night. The light is controlled by a switch marked ROTOR HEAD LIGHT with marked positions ON and OFF, on the MASTER SWITCH panel. The switch is placed ON to light the main rotor head area. The light receives power from the No. 2 primary dc bus through the LANDING GEAR DOWN circuit breaker in the cabin.

2.8.19 Rescue Hoist Floodlight. The floodlight, mounted externally on the hoist support structure, furnishes the necessary illumination for night hoist operations. The light is controlled by a switch marked HOIST LIGHT, with marked positions ON and OFF, on the hoist panel in the cabin. The light receives operating and control power from the No. 2 primary dc bus, through two circuit breakers in the cabin, marked PWR and CONT, under the general headings of RESCUE HOIST and LIGHT.

2.8.20 Infrared Beacons (AFC 479, Part 4). IR beacons are installed to furnish the necessary illumination during NVG operations. The anti-collision IR beacon assemblies replace the upper and lower anti-collision light assemblies. The IR (red/green) position lights replace the sponson red/green position lights. The IR tail light is installed between the tail position light and the pylon fairing. Power is supplied to the IR beacon assemblies from the NO. 1 PRI DC BUS through the IR BEACON and IR POSITION circuit breakers. The IR light assemblies are controlled by the IR control panel installed on the overhead copilot console.

2.9 HYDRAULIC POWER SUPPLY SYSTEM

The helicopter has four separate hydraulic power supply systems; the utility 1 hydraulic power supply system, the utility 2 hydraulic power supply system, and the flight control hydraulic power supply systems (FO-24, FO-30, FO-32, FO-34, and FO-37). The engine start hydraulic system has its own hydraulic pump, but is associated with the utility 1 hydraulic power supply system. Each system is powered by a separate hydraulic pump that operates at 3000 psi pressure. The engine start hydraulic system provides 4000 psi for engine starting. All pumps are driven when the main rotor is turning, to provide hydraulic pressure during autorotation. All pumps, except the first stage flight control system pump, may be driven by the auxiliary powerplant to provide system hydraulic pressure when the rotor is not turning. The utility 1, utility 2, first stage flight control, and second stage flight control hydraulic systems each have individual reservoirs.

First stage, second stage, and U1 reservoirs are pressurized and equipped with a color-coded mechanical quantity indicator, quantity tape gage, and a low-quantity caution light. The U2 reservoir is pressurized and equipped with a sliding quantity indicator bar, quantity tape gage, and a low-quantity caution light. When the aircraft is shut down, only the first stage, second stage, and U2 reservoir remain pressurized. The utility 1 hydraulic system furnishes fluid to replenish and control the engine start system. A hydraulic inflight refill system is provided to service the four hydraulic power supply systems.

2.9.1 Heat Exchangers. The second stage, utility 1, and utility 2 hydraulic systems have heat exchangers that maintain the temperature of the hydraulic fluid below 107 °C. The hydraulic fluid is cooled as it returns to its respective hydraulic system reservoir. The heat exchanger blower motors for the utility 1, utility 2, and second stage systems operate only when the respective systems hydraulic fluid is hot. Each motor turns on when fluid temperature rises above 74 ±3 °C, and turns off when temperature drops below 57 ±3°C. The blower motors are protected by an overheat thermal switch which will shut down the motor when it becomes hot. Utility 1 and 2, and second stage motors will not restart until it has cooled and electrical power to the motor is turned off. (Electrical power can be turned off by opening the system's power circuit breaker and then resetting it.)

The utility 1 blower is powered by the No. 1 primary ac bus through a circuit breaker marked HEAT EXCHANGER UTILITY-1 PWR. Control power for utility 1 blower is furnished by the No. 1 primary dc bus through a circuit breaker marked HEAT EXCH UTIL-1.

The utility 2 blower is powered by the No. 2A primary ac bus through a circuit breaker marked HEAT EXCHANGER UTIL 2. Control power for utility 2 blower is furnished by the No. 2 primary dc bus through a circuit breaker marked HEAT EXCH under the general heading UTILITY 2.

The second stage blower is powered by the No. 2B primary ac bus through a circuit breaker marked HEAT EXCHANGE 2ND STAGE PWR. Control power for second stage blower is furnished by the No. 2 primary dc bus through a circuit breaker marked HEAT EXCH NO. 2.

In addition, the first stage hydraulic system is cooled by a heat exchanger (finned tube) at the inlet of the main transmission oil cooler, and uses the air flow of this blower. Further, a finned tube is mounted along the trailing edge of the tail rotor pylon, providing additional cooling for the first stage hydraulic system.

2.9.2 Hydraulic Mechanical Quantity Indicator. A color-coded mechanical quantity indicator is mounted on the first stage, second stage, and U1 reservoirs. The indicators display red (underfilled) when servicing is required, green (safe) when serviced satisfactorily, and yellow (overfilled) when serviced excessively. A properly serviced system could indicate an overfilled or underfilled condition depending on ambient or system temperature (as temperature increases, hydraulic fluid expands). The U2 reservoir has a sliding bar to mark reservoir quantity.

2.9.3 Cockpit Hydraulic Quantity Status Gage. The gage (FO-5 and Figure 2-13), marked HYD QTY, is on the instrument panel. An indicator for each reservoir is incorporated on the gage and the indicators are marked 1, 2, U1, and U2, respectively. Each indicator is composed of a vertical tape with color-coded marking to the left, to display the fluid status of its associated reservoir. The color codes are green (adequately serviced), yellow (servicing required) and crosshatch black and white stripes (fluid quantity unsatisfactory). The gage is powered by the No. 2B primary ac bus through a circuit breaker in the cabin, marked QUAD HYDR QTY, above the general heading 26V.

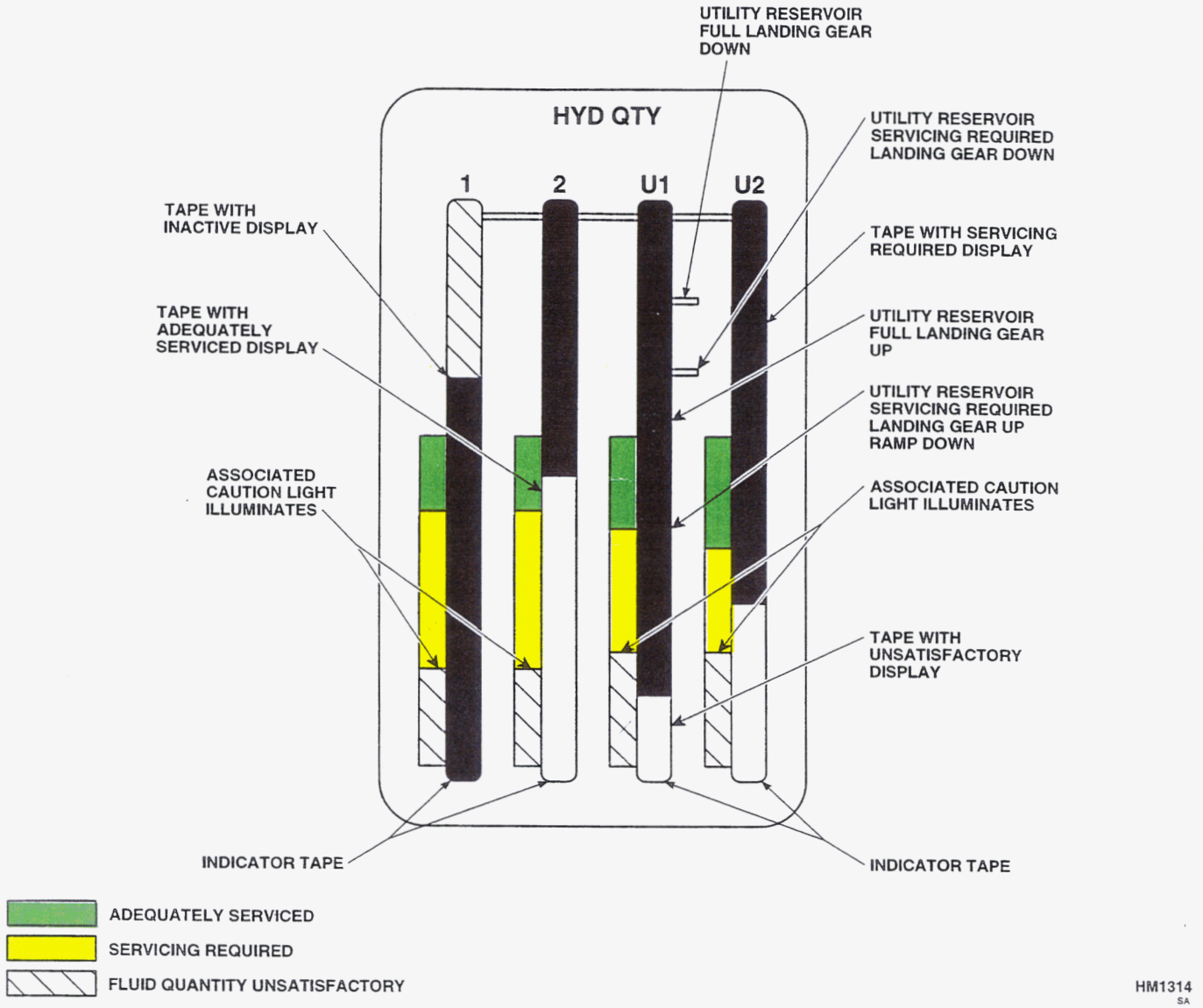


Figure 2-13. Cockpit Hydraulic Quantity Status Gage

2.9.4 Hydraulic Quantity Caution Lights. Caution lights for each reservoir are marked 1 STG QTY M/R T/R, 2 STG QTY M/R, UTILITY 1 QTY T/R, and UTILITY 2 OIL QTY, respectively. The caution light will go on when its associated hydraulic gage indicator tape moves from a yellow to a crosshatch indication, and will remain on as long as the indicator tape is in the crosshatch area. The caution light warning system is powered from the No. 1 primary dc power through a circuit breaker, marked QUAD HYD QTY.

2.9.5 Utility 1 Hydraulic System. The system (FO-24) provides subsystem pressure for the following: utility hoist, APP and engine starting, landing gear extension and retraction, cargo door and ramp operation, cargo winch operation, main wheel power brakes, main rotor and pylon folding, second stage of the tail rotor tandem servo, AFCS SERVO 2, and the FAS actuator if AFCS SERVO 2 is selected. The reservoir is on the left side of the accessory compartment. A 3000 psi pump on the accessory gear box furnishes hydraulic pressure to the utility 1 module. The module is the distribution point for all subsystems. The module contains a pressure filter, a return filter, a tail rotor servovalve, an AFCS turn-on valve, a landing gear emergency bypass valve, a landing gear control valve, an engine start control valve, a 1000 psi AFCS pressure reducer, a 1500 psi wheel brake pressure reducer, an 80 psi pressure reducer for engine start

replenishment, a 250 psi engine start supercharge relief valve, a main system relief valve, an isolation valve, and a priority valve. The isolation valve remains closed in flight to render subsystems inoperative, except when a subsystem is activated. The isolation valve is continually energized (open) when electrical power is applied to the helicopter and the weight of the helicopter is on the landing gear. The flight control, landing gear, and APP accumulator recharge subsystems are not isolated by the isolation valve. The priority valve maintains pressure at the tail rotor tandem servo, SERVO 2 of the AFCS servo, and APP accumulator precharge by closing if system pressure drops below 2100 psi.

2.9.5.1 Utility 1 Hydraulic System Pressure Gage. The UTIL 1 HYD PRESS gage, on the instrument panel, displays system pressure in psi. The gage operates on 26 vac power from the No. 2B primary ac bus through a circuit breaker marked HYDR PRESS UTIL, above the general heading 26V.

2.9.5.2 Utility 1 Hydraulic System Oil Temperature Caution Light. The UTILITY 1 OIL HOT caution light will go on when utility 1 hydraulic fluid temperature is over 107°C and/or the utility 1 heat exchanger blower motor shuts down. The caution light receives power from the No. 3 primary dc bus through a circuit breaker marked UTIL OIL HOT.

2.9.5.3 Utility 1 Hydraulic System Pressure Caution Light. The UTILITY 1 PRESS caution light will go on when utility 1 hydraulic fluid pressure is below 1500 psi. The caution light receives power from the No. 3 primary dc bus through a circuit breaker marked UTIL-1 PRESS.

2.9.6 Utility 2 Hydraulic System. The system (FO-30) provides subsystem pressure for the AMCM winch pallets, tow boom, and davit controls. The reservoir is in the accessory compartment. A two-system pressure level, 3000 psi pump on the accessory gear box furnishes hydraulic pressure to the system. The 3000 psi level is used for the tow boom, davit, and all winch operations. The 1000-psi level has been deactivated at the pump. The pump is controlled by an ON-OFF switch under the heading UTIL-2 PUMP on the center overhead console. A blocking/depressurization valve is actuated whenever the system is not operating, to reduce power consumption, reduce heat generation, and increase pump life. The UTILITY 2 PUMP ON advisory light goes on when the pump switch is on. Control power comes from the No. 2 primary de bus through a circuit breaker marked PUMP CONTROL under the general heading UTILITY 2.

2.9.6.1 Utility 2 Hydraulic System Pressure Gage. The UTIL 2 HYD PRESS gage, on the instrument panel, displays system pressure in psi. The gage operates on 26 vac power from the No. 3 primary ac bus through a circuit breaker marked HYDR PRESS UTIL 2, above the general heading 26V.

2.9.6.2 Utility 2 Hydraulic System Oil Temperature Caution Light. The UTILITY-2 OIL HOT caution light will go on when utility 2 hydraulic fluid temperature is over 107°C and/or the utility 2 heat exchanger blower motor shuts down. The caution light receives power from the No. 3 primary dc bus through a circuit breaker marked UTIL-2 OIL HOT.

2.9.6.3 Utility 2 Hydraulic System Pressure Caution Light. The UTILITY 2 PRESS caution light will go on when utility 2 control switch is on and utility 2 hydraulic fluid pressure is below 675 psi. The caution light receives power from the No. 2 primary dc bus through a circuit breaker marked PRESS WARN under the general heading UTILITY 2.

2.9.7 Flight Control Hydraulic Pressure Supply. Pressure is supplied to the primary and tail rotor tandem servos by the first stage, second stage, and utility 1 hydraulic systems. Three main rotor primary tandem servos are mounted on the main gear box and are designated forward, lateral, and aft. The primary tandem servos furnish the power boost to transmit control movements to the stationary swashplate of the main rotor head. Each primary tandem servo consists of two independent cylinder sections, which share a common housing, piston shaft, and input linkage. The top cylinder of each primary tandem servo is the second stage servo and the bottom cylinder is the first stage servo. Normally both work in unison. Either the first or second stage servos can provide control of the main rotor if the other servo is not operating. Each stage contains bypass valves interconnecting both sides of the respective power piston to each other and to return. This prevents hydraulic lock, by making the unit act as a pure mechanical linkage in the control system if a pilot valve or system malfunctions. All loads are then taken over by the alternate stage without increase in control forces. The tail rotor tandem servo operates the same way as the main rotor tandem servos. One stage is powered by the first stage hydraulic system and the other by the utility 1 hydraulic system.

2.9.7.1 First Stage Hydraulic System. This system (FO-34) provides pressure to operate the first stage of the primary tandem servos, and the first stage of the tail rotor primary tandem servo. The 3000 psi first stage hydraulic pump is mounted on and driven by the main

gear box, and will not operate unless the main rotor is turning. This arrangement will provide first stage hydraulic pressure in an autorotation. The reservoir is on the right side of the helicopter in the aft main rotor pylon.

2.9.7.2 Second Stage Hydraulic System. This system (FO-34) provides pressure to operate the second stage of the primary tandem servos, AFCS SERVO 1, and the FAS actuator if AFCS SERVO 1 is selected. The second stage 3000 psi hydraulic pump is mounted on the accessory gear box. The reservoir is in the accessory compartment on the right side.

2.9.7.3 Flight Control Servo Switches. Power for the first and second stage primary and tail rotor servo is controlled by either of the three-position SERVO OFF switches on the pilots' collective grips (FO-7). Normally both servos are in operation when both pilots' switches are in the unmarked center (ON) position and the main rotor is turning. The first stage side of the primary tandem servos and the first stage of the tail rotor tandem servo are turned off if either pilot selects 1 STG. The second stage side of the primary tandem servos and the utility side of the tail rotor tandem servo are turned off if either pilot selects 2 STG. The first and second stage sides of the main rotor primary tandem servos are interconnected electrically so that regardless of switch position, neither side of the tandem servos can be turned off unless there is 2000 psi in the other side, providing there is no electrical malfunction.

WARNING

- There are no interlocks to prevent turning off pressure to the tail rotor first stage if there is no utility 1 pressure.

- There are no interlocks to prevent turning off pressure to either hydraulic stage when a servo in the other stage is in bypass. Turning off pressure to the unbypassed stage results in loss of control.

Before blade/pylon fold, second stage hydraulic pressure is maintained on the primary tandem servos to permit the servos to position the swashplate for blade/pylon fold. When the pitch lock switch is placed to PITCH LOCK, the second stage isolation valve is closed and second stage hydraulic power is reduced to the primary tandem servos to prevent accidental damage to the swashplate. Then the pitch locks advance. The second and first stage servo shutoff valves receive power from the emergency dc bus circuit breaker panel in the cockpit through two circuit breakers, under the general heading PRIMARY SERVO, marked INTLK 1 AND INTLK 2.

The first and the second stage hydraulic lines have a motor-driven flight control hydraulic isolation valve. The valves prevent damage to the swashplate caused by movement of the collective and cyclic controls when the pitch locks are engaged. Each valve closes or opens when a pitch lock engage or disengage command is received from the fold control panel. The valves move only on electrical command, remain in position in case of electrical power interruption, and are independent of hydraulic pressure. When closed, the second stage isolation valve bypasses, through an 800-psi pressure reducer which provides adequate fluid for positioning the swashplate during pitch lock engagement. Interlocks for the second stage main rotor servo bypass valve are: (1) main gear box oil pressure switch below 14 psi, (2) gust lock UNLOCKED, (3) engine speed control lever at SHUT OFF, and (4) blade fold master power switch at MASTER POWER.

2.9.7.4 Flight Control Hydraulic Pressure Gages. The gages are on the instrument panel and indicate first stage, second stage, and utility 1 hydraulic pressure in psi. Power to operate the first stage gage is furnished by the No. 3 primary ac bus circuit breaker panel in the cabin through a circuit breaker marked HYDR PRESS 1 STG above the general heading 26V. Power to operate the second stage gage is furnished by the No. 2B primary ac bus circuit breaker panel in the cabin, through a circuit breaker marked HYDR PRESS 2ND STAGE, above the general heading 26V.

2.9.7.5 Second Stage Hydraulic System Oil Temperature Caution Light. The 2 STG OIL HOT caution light goes on when second stage hydraulic fluid temperature is over 107°C and/or the second stage heat exchanger blower motor shuts down. The caution light receives power from the No. 1 primary dc bus through a circuit breaker marked 2 STG OIL HOT.

2.9.7.6 Flight Control Servo Pressure Caution Lights. The first and second stage servo caution lights will go on when pressure in the respective system drops below 2000 psi. The second stage tail rotor servo caution light will go on when utility 1 pressure drops below 1500 psi. The 1 STG PRESS M/R T/R caution light receives power from the No. 1 primary dc bus circuit breaker panel in the cabin through a circuit breaker marked SERVO PRESS, under the general heading 1ST STG. The 2 STG PRESS M/R caution light receives power from the No. 3 primary dc bus circuit breaker panel in the cabin

through a circuit breaker marked SERVO PRESS, under the general heading 2ND STAGE. The UTILITY T/R PRESS caution light (utility pressure) receives power from the No. 3 primary dc bus circuit breaker panel in the cabin, through a circuit breaker marked TAIL RTR SERVO PRESS.

2.9.7.7 Flight Control Servo Failure Caution Lights. The 1 STG M/R SERVO BYPAS or 2 STG M/R SERVO BYPAS caution light will go on to indicate one or more cylinder sections on one side of the main rotor tandem servos may be jammed and is bypassing hydraulic pressure as detected by a 2000 psi pressure switch on each servo's respective pilot valve. Further, the caution lights will go on any time the electrical system is energized and the first or second stage systems are not pressurized. The 1 STG M/R SERVO BYPAS caution light receives power from the No. 1 primary dc bus circuit breaker panel in the cabin, through a circuit breaker marked SERVO FAIL, under the general heading 1ST STG. The 2 STG M/R SERVO BYPAS caution light receives power from the No. 3 primary dc bus circuit breaker panel in the cabin, through a circuit breaker marked SERVO FAIL, under the general heading 2ND STG.

The 1 STG T/R SERVO BYPAS or the 2 STG T/R SERVO BYPAS caution light goes on to indicate one side of the tail rotor tandem servovalve may be jammed and is bypassing hydraulic pressure as detected by a 2000 psi first stage T/R pressure switch or a 1500 psi second stage T/R pressure switch mounted on the tail rotor servo pilot valve. Further, the caution lights go on any time the electrical system is energized and the first stage flight control or the utility hydraulic systems are not pressurized. The 1 STG T/R SERVO BYPAS caution light uses the same electrical power source as the 1 STG M/R SERVO BYPAS caution light and the 2 STG T/R SERVO BYPAS caution light uses the same electrical power source as the 2 STG M/R SERVO BYPAS caution light.

2.9.8 Hydraulic Refill. A manual hydraulic refill system, to replenish the first stage, second stage, utility 1, and utility 2 hydraulic systems is on the left cabin wall (Figure 2-14). It consists of a reservoir, handpump, service disconnect, and selector valve. The 4-quart reservoir has high-level and low-level sight gages, and a removable cap for filling. Attaching a hydraulic service unit to the disconnect valve provides for filling the reservoir or directly servicing the respective systems. Hydraulic oil gravity flows from the reservoir to a hand-operated pump which will deliver oil to the hydraulic system reservoir selected on the four-position selector valve. An integral filter element is included in the pump.

2.10 FLIGHT CONTROL SYSTEM

Pitch, roll, yaw, and vertical maneuvering of the helicopter is done with the pilots' controls by tilting the tip path plane, formed by the rotating main rotor blades, and varying the thrust of the tail rotor. The helicopter is maneuvered by the cyclic in pitch and roll, by the rudder pedals in yaw, and by the collective vertically (FO-41 and Figure 2-15).

2.10.1 Main Rotor Control System. The cyclic and collective are connected to the main rotor primary tandem servos by mechanical linkage. The linkage from these flight controls are connected first to the AFCS pitch, roll, and collective servos, which function as mechanical connections with AFCS hydraulic servo off. To smooth out pilot roll inputs, a viscous damper is incorporated in the roll linkage between the cyclic and the AFCS roll servo. The damper permits limited continued flight with reduced damping if the damper fails. A failed damper will be indicated by lighter than normal lateral forces. The force felt with a failed damper is fixed and almost imperceptible, about 1 pound. A slight decrease in this force is felt at the cyclic as it passes over the detent.

CAUTION

- If the roll damper fails, the flight shall be aborted.

To smooth out pilot pitch inputs, the FAS actuator also acts as a damper, with FAS on or off. The FAS actuator (FO-41) is just above the AFCS pitch servo. The actuator's output piston is connected to the rod and shearpin assembly that extends through the pitch servo housing. The rod and shearpin connects the actuator output to the flight control linkage at the point where the cyclic linkage is attached to the servo input. The pitch, roll, and collective linkage continues on to the mixing unit where the necessary control couplings are made. In the pitch linkage between the AFCS pitch servo and the mixing unit there is a longitudinal bias actuator that functions as a mechanical connection with AFCS off. Finally, the linkage goes to the forward, aft, and lateral main rotor primary servos. These servos furnish the necessary hydraulic boost required to tilt, raise, and lower the stationary swashplate. In addition, the servos eliminate any feedback of the aerodynamic forces generated by the rotating main rotor. If the control linkage to a primary tandem servo fails, a self-centering spring cylinder assembly attached to the last control component before attachment to the primary tandem servo, sets that servo to an intermediate position to

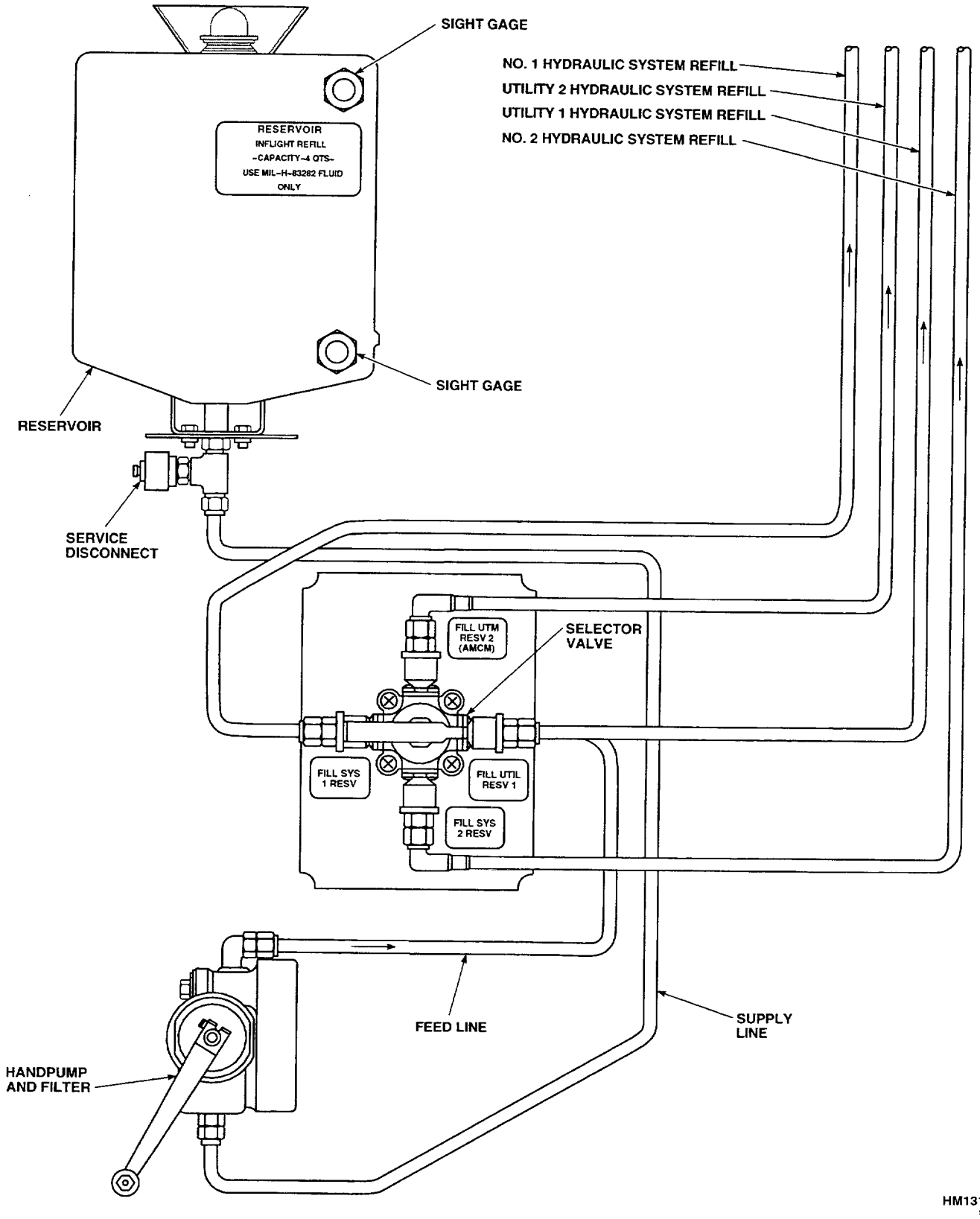


Figure 2-14. Hydraulic Refill System

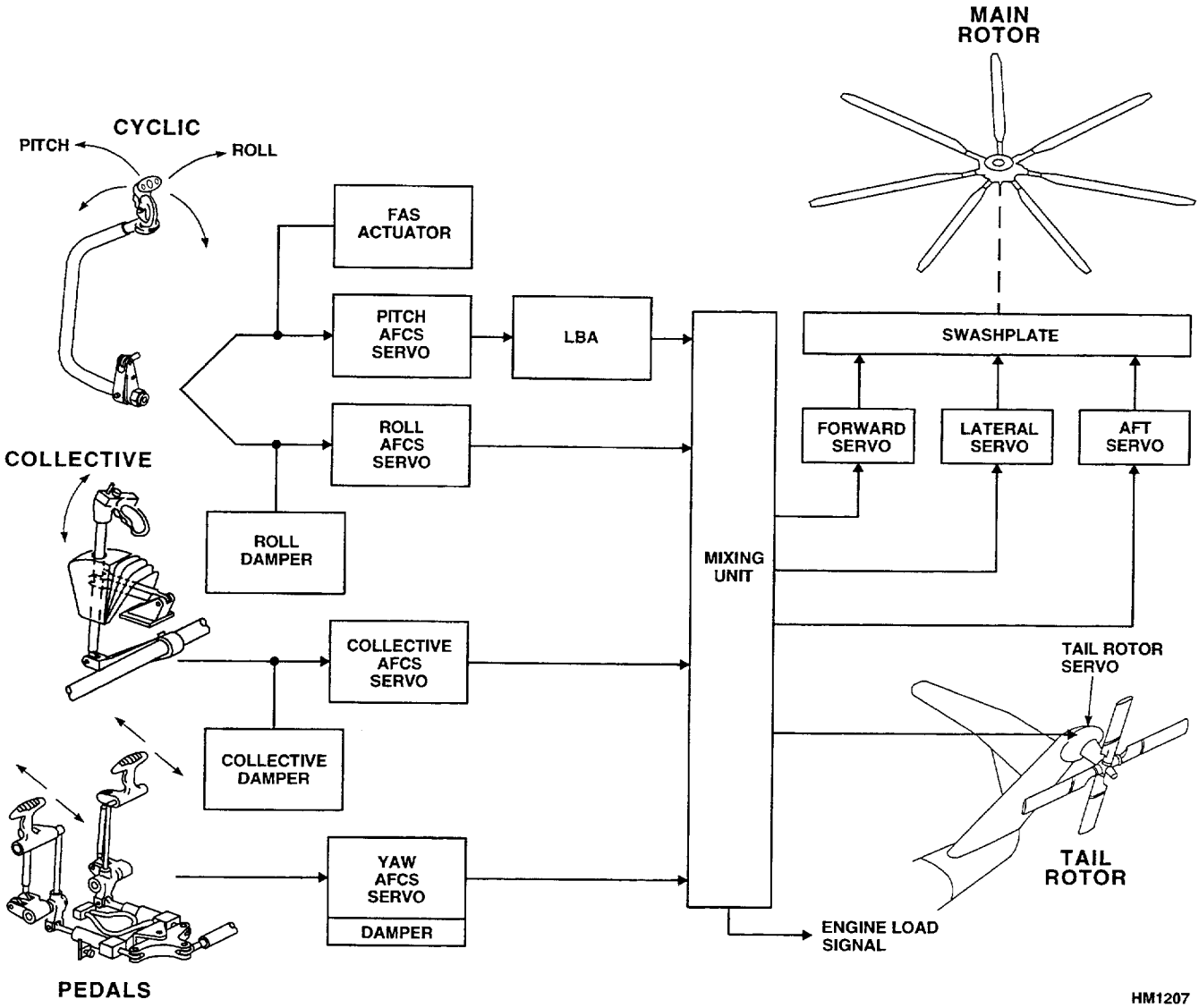


Figure 2-15. Flight Control Systems (Simplified)

prevent a hardover. If a self-centering cylinder assembly jams the controls, a shearpin is incorporated in the support of the assembly that is sheared by the force of AFCS power boost. The pin is sheared by movement of the rudder pedals, cyclic or collective. The stationary swashplate causes the pitch control rods to change the pitch angle of the main rotor blades, that subsequently tilts the tip path plane of the main rotor blades.

2.10.1.1 Collective. The collective on the left side of the pilots' seats operates simultaneously to change the collective pitch of the main rotor blades and change tail rotor pitch. To smooth out pilot collective inputs, a viscous damper is installed on the copilot collective torque arm in the left electronics compartment. The collective grips (FO-7) contain the switches to turn the first and second stage of the primary servos on and off, the collective trim release switches, pedal trim release switches, plus other switches to operate auxiliary equipment.

2.10.1.2 Cyclic. The cyclic in front of the pilot's seats operates simultaneously to provide pitch and roll control. Moving the cyclic in any direction tilts the tip path plane of the main rotor blades and moves the helicopter in the same direction. The cyclic grips (FO-7) contain the cyclic beeper trim buttons, the cyclic trim release buttons, plus other switches to operate auxiliary equipment.

2.10.2 Tail Rotor Control System. The system compensates for main rotor torque and permits changing the heading of the helicopter. The torque developed by the main rotor blades rotating counterclockwise tends to turn the fuselage clockwise. Tail rotor control couplings are programmed to compensate for all main rotor variations. The rudder pedals are connected to the tail rotor tandem servo by mechanical linkage. The linkage is connected first to the AFCS yaw servo, that functions as a mechanical connection with AFCS hydraulic power off. To prevent overstressing the helicopter from too rapid movement of the rudder pedals, a damper is incorporated in the AFCS yaw servo that functions with AFCS on or off. The linkage continues on to the mixing unit, where control couplings are made. Finally, the linkage leads to the tail rotor tandem servo, that hydraulically assists control inputs. The servo extends and retracts the tail rotor actuator shaft, causing the pitch beam and pitch change links to vary the pitch of the tail rotor blades. A self-centering spring that is part of the tail rotor tandem servo will set the tail rotor pitch angle to a position that may permit continued flight to a landing site if the tail rotor control system fails and the tail rotor tandem servo is pressurized.

2.10.2.1 Rudder Pedals. The rudder pedals in front of each pilot operate simultaneously to change the pitch/thrust of the tail rotor and subsequently the heading of the helicopter. Footrests on the outboard side of each rudder pedal prevent inadvertent actuation of the rudder pedal microswitches. The wheel brake power boost cylinders for the main landing gear are mounted on the rudder pedals.

2.10.2.2 Rudder Pedal Adjustment Switches. The PEDAL ADJ switch (FO-7) is alongside each pilot in front of the ICS control panels. Placing the switch to FWD or AFT enables the pilot to individually select a comfortable rudder pedal distance. Power to operate the copilot's adjustment is furnished by the No. 1 primary dc bus circuit breaker panel in the cabin through a circuit breaker marked PEDAL ADJ CO-PILOT. Power to operate the pilot's adjustment is furnished by the No. 3 primary dc bus circuit breaker panel in the cabin, through a circuit breaker marked PEDAL ADJ PILOT.

2.10.3 Control Couplings. The mixing unit (FO-41) make these couplings: collective to yaw, collective to pitch, collective to roll, yaw to pitch, and yaw to roll. These couplings provide automatic proportional transfer between the axes when the appropriate control is moved.

2.10.3.1 Collective to Yaw Coupling. The collective to yaw coupling provides increased tail rotor thrust for collective increases. This transfer is irreversible, and combinations of collective pitch and rudder pedal motion that would exceed the tail rotor pitch limit cannot be realized. If the control positions are such that the left tail rotor pitch limit is reached; additional upward movement of the collective pitch lever is always possible. During this upward movement, the left rudder pedal will move aft, but the tail rotor pitch limit will still be realized. A yaw breakaway rod (FO-41) is incorporated in the yaw linkage aft of the mixing unit. Movement of the collective will shear a shearpin within the rod and permit continued control of the main rotor, if the tail rotor linkage jams. The pin is sheared by the mechanical advantage exerted through the collective channel.

CAUTION

If the tail rotor linkage jams aft of the mixing unit, the force required on the collective to shear the shearpin is about 65 pounds with AFCS servo on and about 122 pounds with AFCS servo off.

2.10.3.2 Collective to Pitch Coupling. The collective to pitch coupling provides longitudinal cyclic (pitch) inputs proportional to collective inputs to compensate for pitching moments produced by main rotor thrust changes.

2.10.3.3 Collective to Roll Coupling. The collective to roll coupling provides lateral cyclic (roll) inputs proportional to collective control changes to compensate for tail rotor thrust produced roll moments caused by the collective to yaw coupling.

2.10.3.4 Yaw to Pitch Coupling. The yaw to pitch coupling provides longitudinal cyclic (pitch) inputs proportional to pedal inputs, to compensate for the pitching moment produced by the vertical thrust component of the canted tail rotor.

2.10.3.5 Yaw to Roll Coupling. The yaw to roll coupling provides lateral cyclic (roll) inputs proportional to pedal inputs, to compensate for tail rotor thrust produced roll moments caused by directional control inputs.

2.11 AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

The Digital AFCS is a limited authority/rate system used to improve the flight control characteristics and flight stability. Pilot workload is reduced by providing short and long term dynamic stability, autopilot, approach/hover, and tow coupler functions. Both the inner and outer loop allow complete pilot override through normal use of the

cockpit flight controls. Whenever the pilot overrides the AFCS, producing pitch, roll, and yaw rates beyond the capabilities of the AFCS, saturation may occur and the pilot should manually fly the aircraft until the next desired trim state is reached. The aircraft must then be retrimmed and the AFCS can then resume normal operation. The AFCS functions are accomplished through a system of sensors, computers, actuators, controls, and malfunction indicators which interface with the mechanical flight controls at the AFCS servos (FO-37 and Figures 2-15 and 2-16). Simplistically, the sensors monitor helicopter displacement, rate and direction, and position of cockpit controls. This information is fed to the computers which output correction signals to the actuators depending upon aircraft flight regime, pilot control inputs, and control switch logic. Control inputs consist of physical movement of the flight controls as well as selection of AFCS related switches on the control panels. The actuators, in turn, move the flight control surfaces via the mechanical flight control system. Malfunction indicators are available to warn the pilot of problems with the system.

Two primary types of control are employed to accomplish automatic flight control system functions: inner loop control and outer loop control. Inner loop control improves short term dynamic stability through correction signals sent to the AFCS actuators and does not move the cockpit controls. It has unlimited rate response, but limited control authority (approximately 10% of total flight control system authority). The inner loop functions include stability augmentation (SAS), hover augmentation, gust alleviation, cyclic, collective and pedal desensitization, and turn coordination. Outer loop control, primarily the autopilot system in the AFCS, improves long term dynamic stability by maintaining the flight regime selected by the pilot when the controls are trimmed. Outer loop has 100% authority but at a limited rate (approximately 10% per second). Additionally, outer loop error signals sent to the AFCS actuators cause movement of the pilots flight controls. Outer loop functions include trim, attitude hold, airspeed hold, heading hold, automatic turn, force augmentation (FAS-pounds per "g"), and pedal force limiting. Both inner and outer loop control can be overridden by the pilot by movement of the flight controls under normal conditions.

Another AFCS function, not considered within inner or outer loop, is operation of the longitudinal bias actuator (LBA).

2.11.1 AFCS Sensors. AFCS sensors consist of rate gyros, attitude/heading reference gyros, the air data transducer, accelerometers, control position transducers, RDR ALT sensors, tow function sensors, and the Doppler system. These sensors provide the AFCS computers with current aircraft condition information necessary to maintain the selected flight regime.

The AFCS rate gyros are powered through cockpit circuit breakers under the general heading of AFCS RATE GYRO. They are powered by the emergency ac bus through circuit breakers marked NO 1 and NO 2. On aircraft with AFC 490, the No. 1 rate gyro circuit breaker is marked AFCS RATE GYRO NO 1 on the emergency ac bus and the No. 2 rate gyro circuit breaker is marked AFCS RATE GYRO NO 2 on the No. 3 primary ac bus. Power for other AFCS sensors comes directly from the AFCS CONTROL panel or AFCS computers or as indicated in the section for the respective system.

2.11.2 AFCS Computers. Two computers (Figure 2-16) are used for normal AFCS operation. The computers process incoming aircraft condition information from the sensors, and feedback information from the actuators and output correction signals to the actuators depending upon control switch logic and aircraft flight regime. Each computer normally supplies one-half of the correction signal to the actuator. The computers exchange and compare input/output data across a digital data link, monitor one another, self-test for malfunctions, and indicate their status by the use of fail advisory lights, the AFCS caution light, the AFCS DEGRADED advisory light and/or up to five stored flight bite codes (FBC) in each computer. The first four and the last FBCs detected are stored in each computer's nonvolatile memory and can be read and erased after each flight by maintenance personnel to aid in troubleshooting the system. Using two computers running identical programs ensures that errors are detected and prevented from being output to the actuators. If the self-test of one computer fails, then that computer shuts itself off.

Both computers are powered through cockpit circuit breakers under the general heading of AFCS COMPUTER. They are powered by the emergency ac bus through circuit breakers marked NO. 1 and NO. 2. On aircraft with AFC 490, the No. 1 computer circuit breaker is marked NO 1 on the emergency ac bus and the No. 2 computer circuit breaker is marked NO 2 on the No. 3 primary ac bus. The emergency dc bus furnishes power to the No. 1 and No. 2 computers through two circuit breakers under the general heading AFCS, marked PRI and SEC, respectively.

2.11.3 AFCS Actuators. The AFCS actuators include the AFCS servos, the Longitudinal Bias Actuator (LBA), and the Force Augmentation System (FAS) actuator.

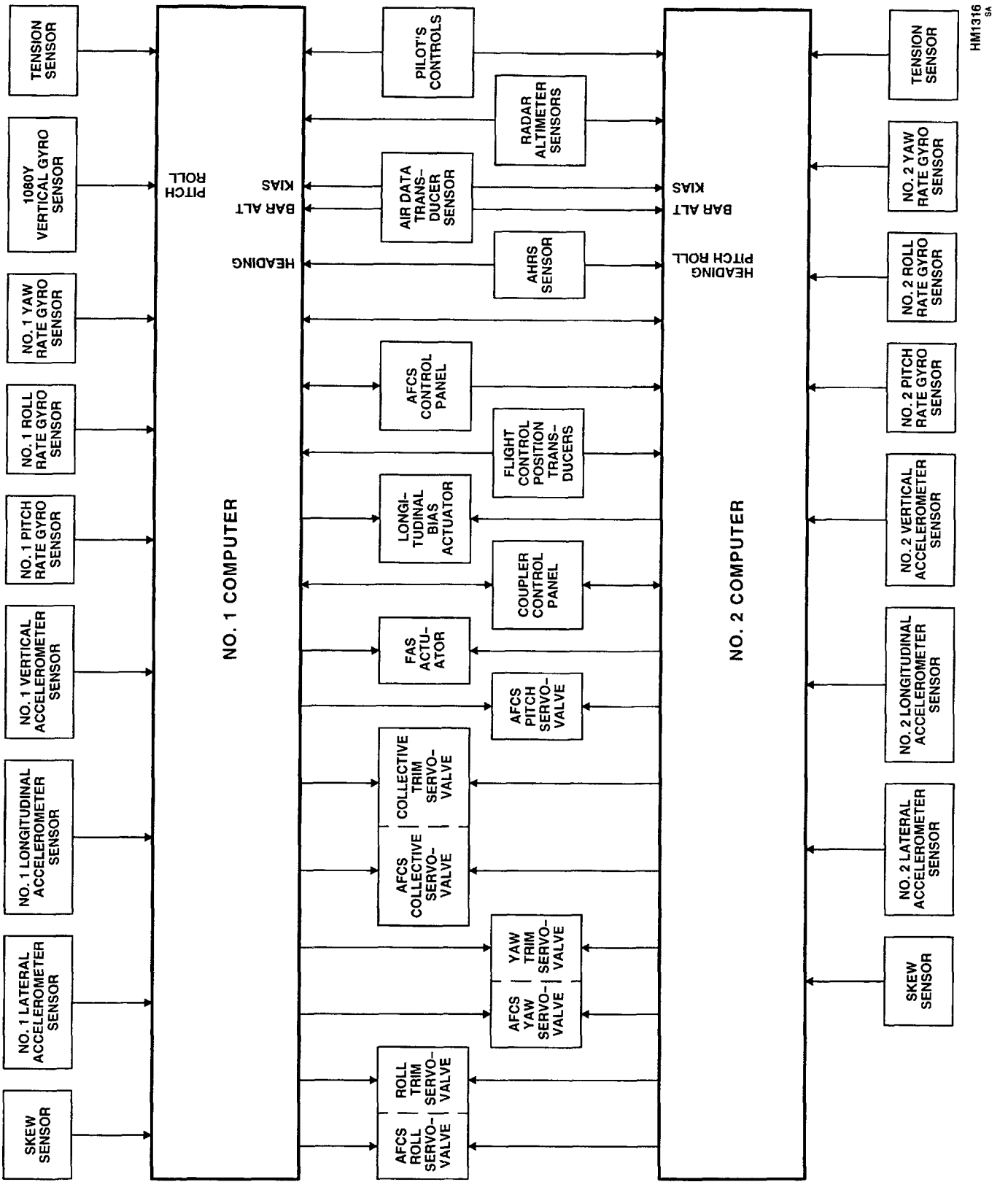


Figure 2-16. AFCS Block Diagram

2.11.3.1 AFCS Servos. The four AFCS servos (pitch, roll, yaw, and collective) provide an interface between the electrical inputs supplied by the AFCS computers, the pilot's flight control and the mechanical flight control system. The servos provide several functions including: (1) power boost for pilot-initiated control inputs, (2) conversion of electrical inner loop error signals from the computers into mechanical motion of the AFCS servo power pistons, resulting in actuation of main and tail rotor servos, without moving the cockpit controls, and (3) conversion of electrical outer loop error signals from the computers into mechanical motion of the AFCS servo trim pistons, resulting in movement of the cockpit flight controls thereby moving the flight control surfaces. Additionally, the AFCS yaw servo provides pedal damping to limit the rate of pedal motion with AFCS on or off.

The AFCS servos (FO-37 thru FO-41) are similar to the primary tandem servos; however, due to integral mechanical and electrical interlocks, they can have only one stage pressurized at a time. The first stage of the AFCS servos, when selected, is pressurized by the second stage flight control hydraulic system at a reduced pressure of 1000 psi. The second stage of the AFCS servos, when selected, is pressurized by the utility 1 flight control hydraulic system at a reduced pressure of 1000 psi. Selection of the first stage of the AFCS servos is controlled by the SERVO 1 pushbutton on the AFCS CONTROL panel and selection of the second stage of the AFCS servos is controlled by the SERVO 2 pushbutton.

When the servos are not pressurized, their only function is to provide a mechanical link between the cockpit flight controls and control rods leading to the mixing unit. When the AFCS servos are pressurized, pilot flight control inputs result in movement of mechanical input linkages which displace the servo pilot valves, which in turn route pressure and return to the power pistons, causing them to drive in the required direction. Feedback of power piston movement to the input linkage recenters the servo pilot valve to stop power piston movement at the appropriate new position. Since the force at the servo output is the product of piston area and operating pressure, pilot inputs need only move the pilot valves to achieve power assist.

Additionally, when pressurized, the servos convert inner loop (short term) and outer loop (long term) electrical error signals from the computers to mechanical motion. The outer loop signals are applied at the trim servo valve, except in pitch where the signals are applied to the FAS actuator. These signals cause an internal flapper to deflect, producing an unbalance in pressure at the trim piston. The result of this unbalance is motion of the trim piston. Trim piston position, sensed electrically by trim position transducers, is fed back to the computers to close the loop when trim pistons have moved the appropriate amount. Trim position transducers for yaw, roll, and collective axes are connected to the trim piston and are mounted atop the servos. The pitch trim position transducer is internal to the FAS actuator. Any trim piston movement as described above displaces the servo input linkage resulting in motion of the flight control surfaces as well as the pilot's flight controls. A force gradient spring in each trim piston provides force feel to the pilot whenever the controls are moved against trim, except in the case of the pitch servo where the FAS actuator provides force feel. Inner loop error signals are applied to the AFCS servo valve. These signals cause the flapper inside the servo valve to deflect, which causes an unbalance on the servo pilot valve. This pressure unbalance results in pilot valve movement within its carriage thereby moving the power piston and flight control surfaces. (The pilots flight controls do not move.) Mechanical feedback in the servo limits power piston travel to approximately 10% of its total range.

All four axes have two additional sensors called stick position transducers, each monitoring cockpit flight control positioning and providing an electrical signal to the computers. Both stick position transducers for yaw, roll, and collective axes are connected to the input linkage for each servo although mounted atop the servos. For the pitch channel, one stick position transducer is mounted adjacent to and connected to the AFCS servo input control rod and the other is internal to the FAS actuator.

The output of the AFCS pitch servo is linked via the longitudinal bias actuator (LBA) to the mixing unit, providing mechanical inputs to the forward and aft primary servos. The output of the AFCS roll servo is linked directly to the mixing unit, which furnishes a single input to the lateral primary servo. The output of the AFCS yaw servo is linked directly to the mixing unit, which furnishes inputs to the tail rotor servo plus the forward, aft and lateral primary servos. The output of the AFCS collective servo is linked to the mixing unit, which provides inputs to the tail rotor servo and the forward, aft and lateral primary servos.

2.11.3.2 Force Augmentation System (FAS) Actuator. The FAS actuator provides the following functions: stick force proportional to load factor (lb. per "g"), damping forces, stick trim, detent and gradient, pitch autopilot (airspeed, attitude hold), and coupler functions. It is connected to the pitch AFCS servo input linkage.

Operation of the FAS actuator is similar to the AFCS servos in that there is a flapper valve that deflects, causing a pilot valve to displace, driving the FAS piston which is attached, via a piston and shearpin assembly, to the input linkage of the AFCS pitch servo. The FAS actuator receives either second stage hydraulic pressure or utility 1 hydraulic pressure depending upon AFCS servo 1 or AFCS servo 2 selection. It is capable of moving the cyclic full travel at an unlimited rate. Differential pressure transducers and pitch trim and stick position transducers monitor the action of the actuator to detect any malfunctions.

2.11.3.3 Longitudinal Bias Actuator (LBA). The LBA acts as a variable length control rod in the pitch axis to provide a positive airspeed vs. cyclic position gradient. It is an electrical screwjack actuator installed in series with the longitudinal flight control rods between the AFCS pitch servo and the mixing unit. Electrical dc power is furnished to the LBA from the AFCS CONTROL panel on computer command

2.11.4 AFCS Controls and Malfunction Indicators. AFCS controls include switches mounted on the AFCS CONTROL panel, the cyclic, collective, and pedals and the FAS PRESS switch.

2.11.4.1 AFCS CONTROL Panel. The panel (FO-7 and Figure 2-17) is located on the cockpit lower center console.

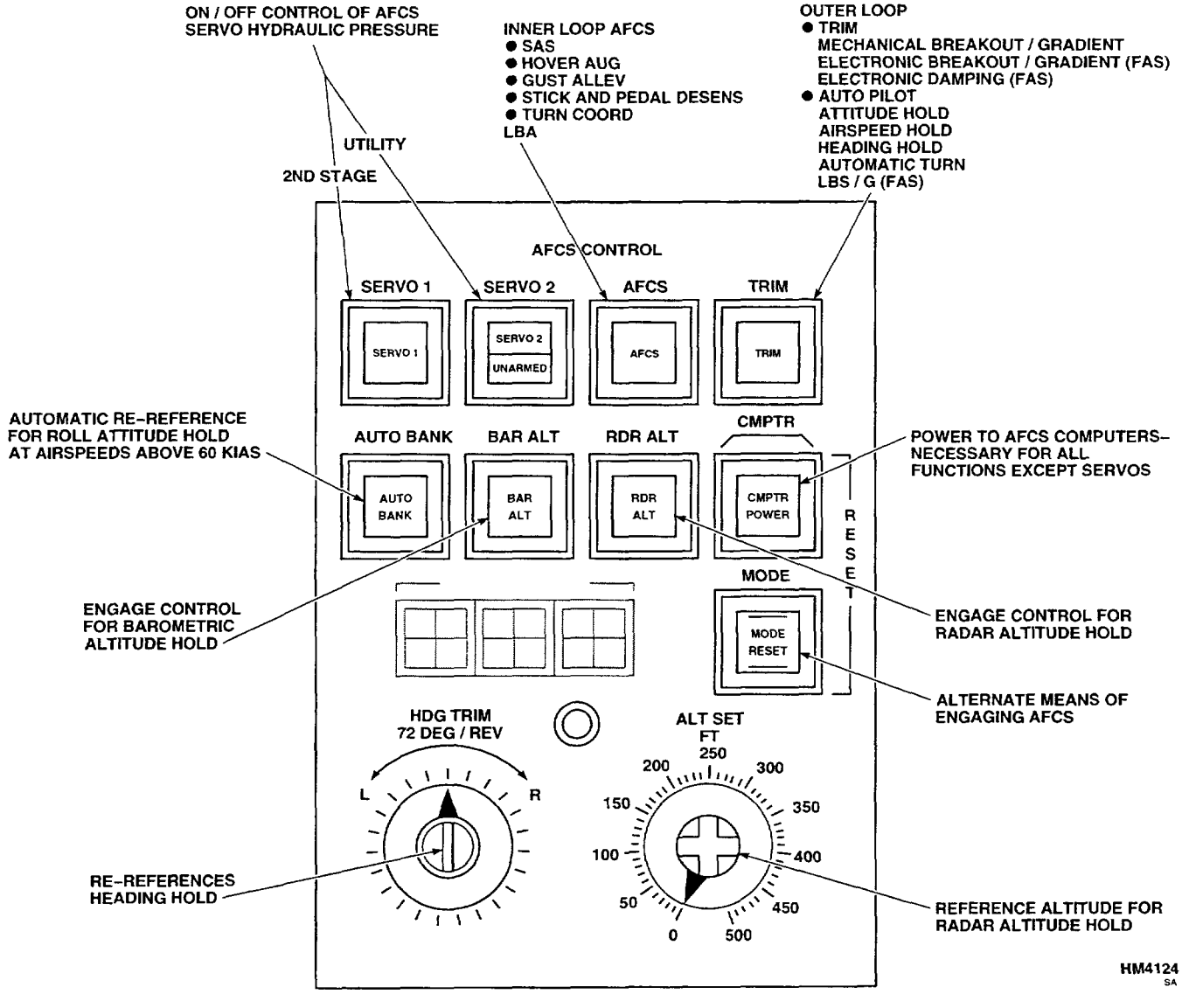


Figure 2-17. AFCS Engage Controls

2.11.4.1.1 SERVO 1 Pushbutton. This pushbutton has a single capsule which reads SERVO 1. Pressing and lighting the SERVO 1 pushbutton to read SERVO 1 indicates that second stage flight control hydraulic pressure is being used to operate the AFCS pitch, roll, yaw and collective servos, and the FAS actuator. Pressing the SERVO 1 pushbutton and turning the light off removes second stage flight control hydraulic pressure.

Note

The AFCS servo 1 shutoff valve is spring loaded open unless electrical power is applied to close it. Therefore, when electrical power is removed from the aircraft while the second stage hydraulic pump is operating, the AFCS servo 1 shutoff valve will be open and second stage hydraulic power will be applied to AFCS servo 1, regardless of the position of the SERVO 1 pushbutton.

2.11.4.1.2 SERVO 2 Pushbutton. This pushbutton has a dual capsule which reads SERVO 2 and UNARMED. Pressing and lighting the SERVO 2 pushbutton to read SERVO 2 indicates that utility 1 hydraulic pressure is being used to operate the AFCS pitch, roll, yaw and collective servos and the FAS actuator. Pressing the SERVO 2 pushbutton and turning the light off indicates utility 1 pressure is removed. Pressing and lighting the SERVO 2 pushbutton to read UNARMED while SERVO 1 is on, indicates SERVO 2 pushbutton is physically off.

2.11.4.1.3 AFCS SERVO Pushbutton Operation. Both servos cannot be pressurized simultaneously. SERVO 1 pushbutton operation is between on (light on to read SERVO 1) and off (light off). SERVO 2 pushbutton operation with SERVO 1 off is between off (lights off) and on (lit to read SERVO 2). SERVO 2 pushbutton operation with SERVO 1 on is between armed (lights off) and unarmed (lit to read UNARMED).

The normal AFCS configuration for flight is having AFCS SERVO 1 on and AFCS SERVO 2 ARMED. In this configuration, failure of SERVO 1 automatically turns SERVO 2 on (SERVO 1 extinguishes and SERVO 2 illuminates). Once this transfer has occurred automatically, an electrical latch in the AFCS control panel prevents any automatic reengagement of SERVO 1. Should the failure of SERVO 1 subsequently clear itself or should second stage hydraulic pressure return, no change in servo status will occur. No further action by the pilot is necessary.

SERVO 1 may be manually reengaged by depressing the SERVO 1 button twice. However, even if there is no second stage hydraulic pressure in SERVO 1, the system will still attempt to transfer to SERVO 1 and then revert back to SERVO 2 operation. During this transfer sequence, all AFCS hydraulics will momentarily be lost for approximately 0.7 seconds.

Should the AFCS control panel be configured for flight such that SERVO 1 is selected on and SERVO 2 is left UNARMED, failure of SERVO 1 will again automatically turn SERVO 2 on. The SERVO 2 pushbutton will have both the SERVO 2 and UNARMED lights illuminated together. Again, an electrical latch in the AFCS control panel will prevent automatic reengagement of SERVO 1. To extinguish the UNARMED portion of the capsule and properly configure the AFCS control panel, depress the SERVO 2 pushbutton once. If necessary, SERVO 1 can be reengaged by depressing the SERVO 1 pushbutton twice, as discussed above.

2.11.4.1.4 AFCS Pushbutton (Inner Loop and LBA). In order for the AFCS pushbutton to operate, SERVO 1 or SERVO 2, and CMPTR POWER must first be on. Pressing and lighting the AFCS pushbutton to read AFCS turns on SAS, hover augmentation and gust alleviation, cockpit flight control desensitizers, inner loop turn coordination and the LBA.

2.11.4.1.5 TRIM Pushbutton (Outer Loop). In order for the TRIM pushbutton to operate either SERVO 1 or SERVO 2, and CMPTR POWER must first be on. The AFCS pushbutton may be either on or off.

With the AFCS pushbutton off, pressing and lighting the TRIM pushbutton to read TRIM turns on cyclic, collective, and pedal position trim. Trim (breakout/gradient) in the pitch axis is electronically generated. With the AFCS pushbutton on, pressing and lighting the TRIM pushbutton to read TRIM turns on autopilot functions including attitude hold, airspeed hold, heading hold, auto turn (outer loop turn coordination), pedal force limiting, and force augmentation (lb. per "g"). It also arms the AUTO BANK, BAR ALT, RDR ALT, APPR/HVR and DEPART pushbuttons.

2.11.4.1.6 AUTO BANK Pushbutton. This pushbutton has a single capsule which reads AUTO BANK. It can be pressed to engage (AUTO BANK illuminates) or disengage (AUTO BANK extinguishes) the AUTO BANK function. In order for the AUTO BANK pushbutton to operate, either SERVO 1 or SERVO 2 must be engaged, and CMPTR POWER, AFCS and TRIM must be engaged.

2.11.4.1.7 BAR ALT Pushbutton. The BAR ALT pushbutton can be pressed to engage (BAR ALT illuminates) or disengage (BAR ALT extinguishes) the BAR ALT hold function. In order for the BAR ALT pushbutton to operate, either SERVO 1 or SERVO 2, and CMPTR POWER, AFCS and TRIM must be on. Additionally, the RDR ALT pushbutton must be off. BAR ALT hold will also be automatically engaged if RDR ALT hold has been selected and the RDR ALT hold fails. Pressing the CLTV TRIM REL trigger switch will disengage the BAR ALT hold temporarily and cause the switch legend to flash.

2.11.4.1.8 RDR ALT Pushbutton. The RDR ALT pushbutton can be pressed to engage (RDR ALT illuminates) or disengage (RDR ALT extinguishes) the RDR ALT hold function. In order for the RDR ALT pushbutton to operate, either SERVO 1 or SERVO 2, and CMPTR POWER, AFCS and TRIM must be on. Additionally, the BAR ALT pushbutton must be off. Pressing CLTV TRIM REL will also permanently disengage the RDR ALT hold.

2.11.4.1.9 ALT SET FT Knob. With RDR ALT hold engaged, the ALT SET FT knob, with the cross-coded head, may be turned to select a referenced altitude from 0 to 500 feet.

2.11.4.1.10 HDG TRIM Knob. The HDG TRIM knob, with the bar-coded head, is normally used to make small heading trim changes. One full turn of the knob equals about 72°.

2.11.4.1.11 CMPTR POWER Pushbutton. Pressing and lighting the CMPTR POWER pushbutton to read CMPTR POWER, normally turns on both AFCS computers. If one or both computers shuts down all its outputs due to a malfunction, it may be reengaged by cycling the CMPTR POWER pushbutton (from on to off to back on).

2.11.4.1.12 MODE RESET Pushbutton. Failure of an AFCS mode will be indicated by appropriate light(s) on the FAIL ADVISORY light section of the AFCS CONTROL or TOW COUPLER panel and the AFCS DEGRADED light on the advisory panel. If the malfunction is temporary, the function(s) may be reengaged by momentarily pressing the MODE RESET pushbutton. The MODE RESET pushbutton may also be used as an alternate means of engaging AFCS. The MODE RESET pushbutton will not reset the AFCS computers.

2.11.4.1.13 FAIL ADVISORY Panels. The nomenclature for the AFCS CONTROL panel FAIL ADVISORY lights and their significance are shown and discussed in Figures 2-18 and 2-19. The nomenclature for the TOW COUPLER panel FAIL ADVISORY lights and their significance are shown and discussed in Figures 2-24 and 2-25. Any AFCS failure, other than a dual computer failure, will cause a flashing of the AFCS DEGRADED advisory light. The modes lost by the failure will be displayed by flashing FAIL ADVISORY lights.

2.11.4.1.14 ACK FAIL ADVISORY Pushbutton. Flashing AFCS CONTROL panel and TOW COUPLER panel FAIL ADVISORY lights can be made to show a steady light by pressing the momentary ACK (acknowledged) FAIL ADVISORY pushbutton. This also stops the flashing of the AFCS DEGRADED advisory light to permit notification of a subsequent failure. Subsequent additional mode failures, affecting fail advisories that are not already lit, will cause the AFCS DEGRADED advisory light and the additional appropriate AFCS CONTROL panel and TOW COUPLER panel FAIL ADVISORY lights to flash. Fail advisories that have been acknowledged will flash if: (1) The mode failure recurs after a mode reset or computer reset; or (2) an alternate failure condition capable of illuminating that mode failure occurs (FO-52).

2.11.4.2 FAS PRESS Switch. This guarded switch is on the overhead control panel labeled HYDRA/AFCS MISC. Hydraulic pressure from the AFCS pitch servo is furnished to the FAS actuator with the FAS PRESS switch on (guard closed). The switch is used to remove hydraulic pressure from the FAS actuator, as an alternative to securing the AFCS servos, in case of hydraulic leak in the FAS actuator.

The emergency dc bus circuit breaker panel furnishes power to the FAS switch through a circuit breaker marked FAS TURN ON.

2.11.4.3 Cyclic

2.11.4.3.1 STICK TRIM (Beeper) Switch. The trim (beeper) switch, marked STICK TRIM, on top of the cyclic grip (FO-7 and Figure 2-20), is spring-loaded to null and has four marked positions, FWD-AFT-L-R. Deflecting the switch toward any of the positions will beep the cyclic in that direction. The switch can beep the cyclic trim (5% per second) in any direction with weight on wheels or AFCS pushbutton secured. Airborne below 60 KIAS, the switch beeps helicopter attitude in pitch (2° per second), as airspeed hold is not available. Beeping the switch L (left) or R (right) beeps helicopter attitude in roll (4° per second).

The switch may be used in either axis, at any airspeed, to trim out cyclic trim forces. Above 60 KIAS and for large airspeed changes, longitudinal beep may be used to

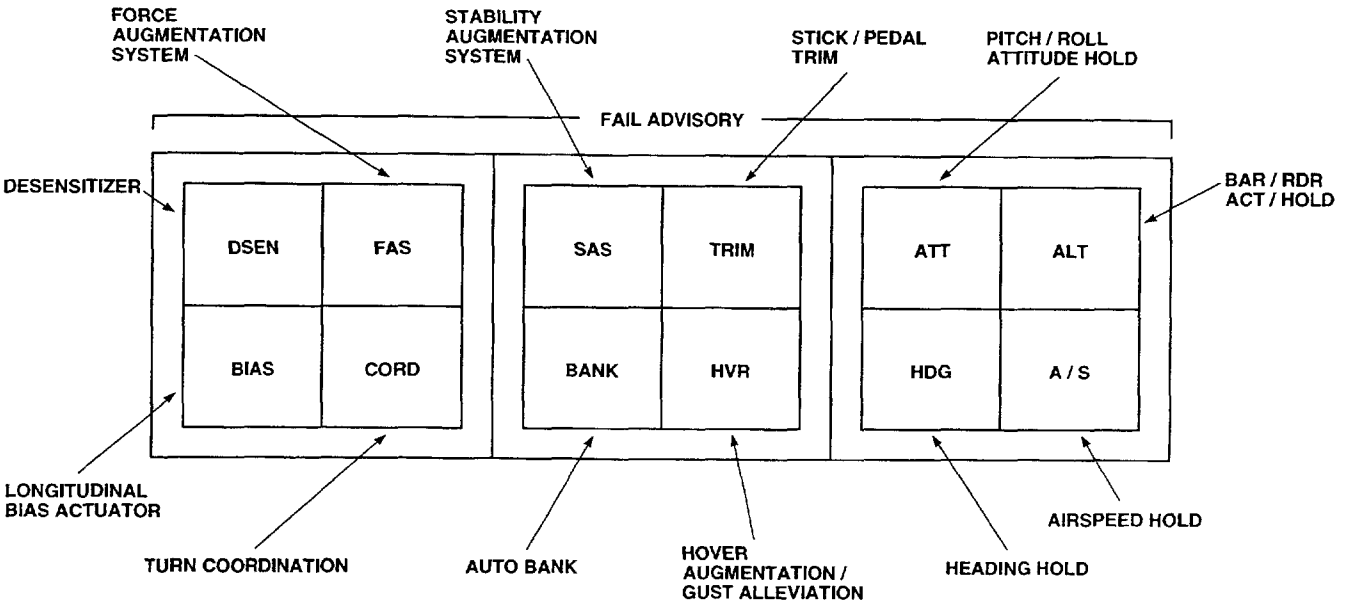


Figure 2-18. AFCS Control Panel Fail Advisory Lights

accelerate, decelerate, and trim the helicopter to new airspeed. Upon establishing the required airspeed and being close to or in unaccelerated flight, the airspeed reference may be synchronized to the actual airspeed by momentarily pressing the switch. Small airspeed changes, about 10 knots or less, may be obtained by timing the duration the switch is pressed, (e.g., at a beep rate of 6 knots per second, a 6 knot change will be accomplished by pressing the switch for 1 second.) During automatic towing, tension hold, and ground speed hold functions can be automatically re-referenced with the switch. Also, with tow heading hold engaged, lateral beeping establishes/stops turn rates. See function description under TOW COUPLER panel.

2.11.4.3.2 TRIM REL Pushbutton Switch. The cyclic TRIM REL switch is on the left side of the cyclic grip (FO-7 and Figure 2-20). Pressing the switch permits the pilot to reposition the cyclic manually for trim. With AFCS and trim engaged, the switch permits referencing pitch and roll attitude hold or airspeed and roll attitude hold, above 60 KIAS.

During automatic towing, tow heading hold, tension hold and ground speed hold can be manually re-referenced with the TRIM REL switch. Pressing the switch will temporarily release the cyclic channels of the coupler during automatic approach or hover; and permanently release the cyclic channels of the coupler during automatic departure.

2.11.4.4 Collective

2.11.4.4.1 CLTV TRIM REL Trigger Switch. The CLTV TRIM REL trigger switch (FO-7 and Figure 2-20) is on the bottom of the collective grip. When pressed, it temporarily releases collective trim, BAR ALT hold, and collective channel of the coupler for approach if RDR ALT hold has not yet engaged. In addition, RDR ALT hold and collective channel of the coupler for hover will be disengaged permanently, and must be reengaged if needed.

2.11.4.4.2 PED TRIM REL Pushbutton Switch. The PED TRIM REL switch is on the collective grip (FO-7 and Figure 2-20). When pressed, it temporarily releases pedal trim and permits re-referencing of heading hold and skew at any airspeed.

2.11.4.5 Rudder Pedal Switches. There is a switch on each of the 4 rudder pedals (Figure 2-20). With only trim engaged, pressing any of the pedal switches releases pedal trim at all airspeeds. With AFCS and TRIM

FAIL ADVISORY LIGHT ON	EFFECT	POSSIBLE RECOVERY
NONE, but AFCS caution light on	Loss of all AFCS functions.	CMPTR POWER
DSEN	Loss of cyclic, collective, or pedal control desensitizer(s).	MODE RESET
FAS	Loss of longitudinal force feel system. Loss of pitch trim. Loss of pitch autopilot.	MODE RESET
SAS	Loss of pitch, roll, or yaw SAS.	MODE RESET
TRIM	Loss of pitch, roll, yaw or collective trim.	MODE RESET
ATT	Loss of pitch or roll attitude retention.	MODE RESET
ALT	Loss of radar or barometric altitude hold.	MODE RESET
BIAS	Loss of bias actuator or bias actuator degraded due to airspeed or pitch SAS failure.	MODE RESET
CORD	Loss of turn coordination.	MODE RESET
BANK	Loss of auto bank.	MODE RESET
HVR	Loss of pitch or roll hover augmentation/gust alleviation.	MODE RESET
HDG	Loss of heading hold.	MODE RESET
A/S	Loss of airspeed hold. Computer selects 120 knots for all calculations.	MODE RESET

Figure 2-19. AFCS Control Panel Fail Advisory Light Meaning

engaged, the pedal switches are only effective below 60 knots (except for skew hold which can be re-referenced with weight off wheels and tow tension above 400 lbs.).

2.11.5 AFCS Functions and Modes of Operation. In discussing AFCS modes of operation, the terms FAIL SAFE and FAIL OPERATIONAL will be used. FAIL OPERATIONAL describes a mode important enough that it will continue to operate with a single failure, i.e., a failure of a single sensor, computer, AFCS servo valve or associated wiring. FAIL SAFE describes a mode not necessary for minimum safe operations and a single failure will cause such a mode to stop operating.

In order for any AFCS function to operate, servo 1 or 2, and computer power must first be on (pushbutton legends illuminated) (See Figure 2-17).

When computer power is off, the AFCS caution light should be on, indicating that both computers are shutdown. When computer power is on (pushbutton legend illuminated), the AFCS caution light should be off and the AFCS DEGRADED advisory light and all FAIL ADVISORY lights on the AFCS CONTROL panel should be off to indicate both computers are receiving power and are operating. Depressing the AFCS pushbutton sends a discrete signal to both computers to actuate inner loop AFCS and LBA. The computers in turn illuminate the AFCS pushbutton legend to indicate to the pilot that inner loop AFCS modes are operating. Depressing the TRIM pushbutton only, sends a discrete signal to both computers to activate cyclic, collective, and pedal trim. The computers in turn illuminate the TRIM pushbutton legend to indicate that trim is engaged. If the AFCS pushbutton legend is illuminated, depressing the TRIM pushbutton will activate trim and, if weight is off the wheels, auto pilot functions.

2.11.5.1 Inner Loop Modes (AFCS-ON)

2.11.5.1.1 Stability Augmentation System (SAS). SAS provides rate damping to improve short term dynamic stability in the pitch, roll and yaw axes. It has approximately ±10% authority, fast response, and is engaged with the AFCS pushbutton. The sensors used to control this mode are pitch, roll, and yaw rate gyros. This mode is FAIL OPERATIONAL.

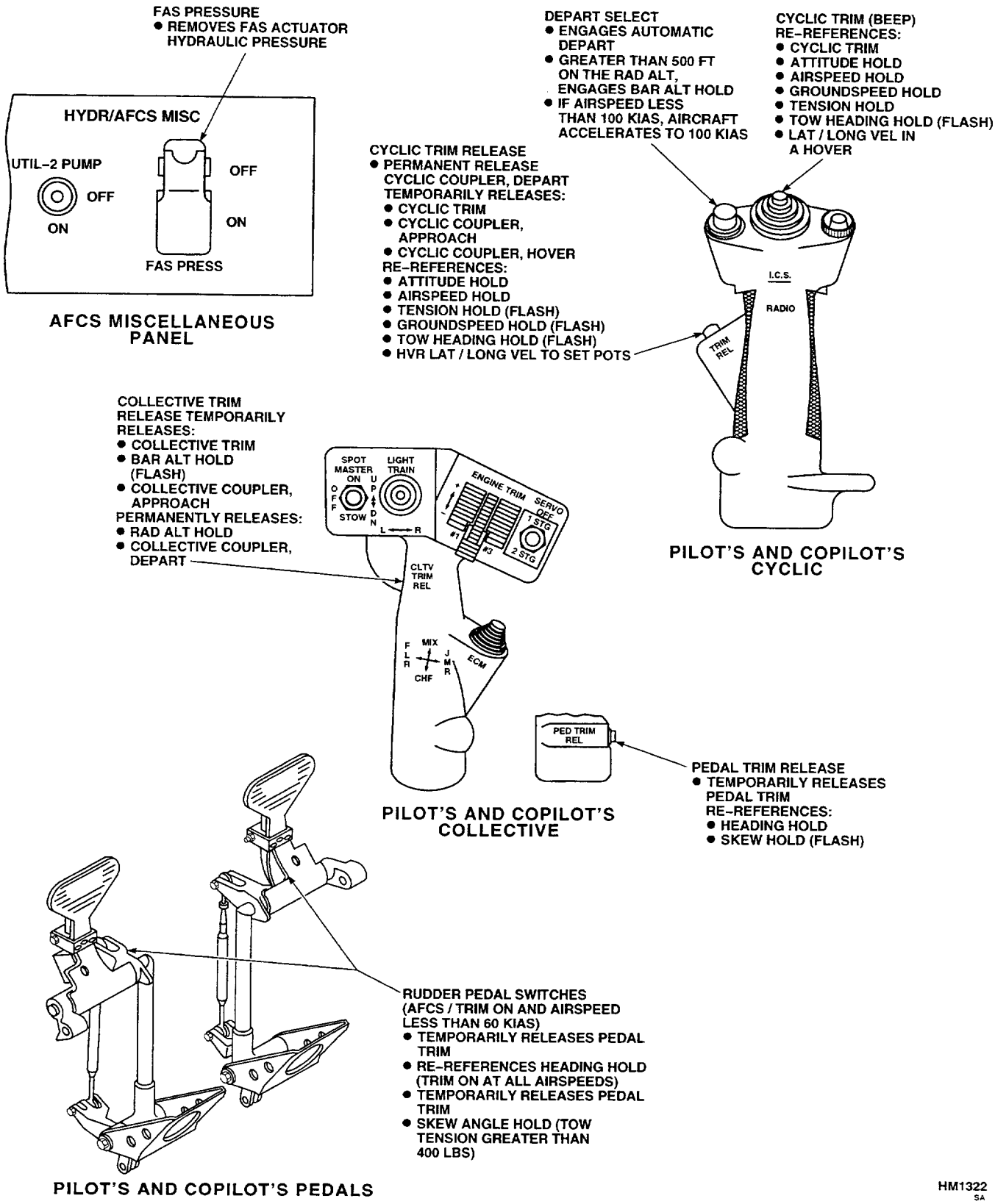


Figure 2-20. AFCS Switches

2.11.5.1.2 Hover Augmentation/Gust Alleviation. Hover augmentation and gust alleviation reduce pilot workload in the low airspeed regime and in gusty air conditions.

a. **Hover Augmentation.** Hover augmentation opposes aircraft acceleration along the lateral and longitudinal axes to improve helicopter stability in a hover. It has approximately 55% authority within the SAS authority. The monitoring sensors are the lateral and longitudinal accelerometers. Hover augmentation only works at airspeeds below 60 KIAS, and at attitudes between 13.3° nose up and 4.4° nose down and is FAIL SAFE.

b. **Gust Alleviation.** Gust alleviation improves aircraft stability at all airspeeds in gusty or windy conditions by using limited attitude error signals in pitch and roll inner loop. It has approximately 55% authority within the SAS authority. The sensors used to control this mode are pitch and roll signals from the vertical gyros. This mode is FAIL SAFE.

2.11.5.1.3 Control Desensitizers (DSEN). Collective, cyclic, and rudder pedal desensitizers reduce the effects of pilot interaction with the 1st (3.25 Hz) and 2nd (4.2 Hz) fuselage bending modes of the helicopter (PIO/PAO). The system attenuates pilot collective, cyclic, and pedal inputs in this frequency range, but does not affect handling qualities in the normal operating frequency range.

Any of the following conditions may indicate an inoperative desensitizer:

DSEN fail advisory light on the AFCS CONTROL panel is illuminated.

AFCS is OFF.

AFCS duplex (dual computer) failure.

FAS shear pin is sheared (loss of longitudinal cyclic trim).

The sensors used to control this mode are the cockpit flight control position transducers. Control desensitization is limited to SAS authority and is FAIL OPERATIONAL.

2.11.5.1.4 Turn Coordination. Inner loop turn coordination provides yaw channel inputs to coordinate turns above 60 KIAS. Roll rate and lateral acceleration are furnished to yaw inner loop. This capability is limited to the SAS authority. The sensors are the roll rate gyros, for initiating the yaw input, and the lateral accelerometers, for coordinating the turn. This mode is FAIL SAFE.

2.11.5.2 Outer Loop Modes (TRIM, or TRIM and AFCS - ON)

2.11.5.2.1 TRIM. (TRIM alone on, or AFCS and TRIM on deck). Trim capability does not require AFCS pushbutton be on and is used to maintain the cockpit flight controls at pilot selected positions via a closed servo loop system consisting of the outer loop actuator (trim piston and servo valve), trim position transducer, and computers. The monitoring sensor is the trim position transducer. The trim mode is FAIL SAFE except for simplex failure. The FAS actuator (in pitch) and a force gradient spring in each of the roll, yaw and collective servos allow for pilot to override trim forces in the flight controls. Alternately, the trim release switches on the cyclic, collective and pedals allow temporary release of the respective trim. Pitch and roll trim can also be released and re-referenced by using the STICK TRIM (beeper) switch on top of the cyclic grip. It re-references pitch or roll trim at a rate of 5% per second, moving the cyclic trim piston or FAS actuator automatically.

The emergency dc bus circuit breaker panel furnishes power to the collective, cyclic, rudder pedal trim release, and STICK TRIM (beeper) switches through a circuit breaker marked TRIM.

2.11.5.2.2 Autopilot (AFCS and TRIM - ON)

a. **Roll Attitude Hold.** The capabilities of roll attitude hold are ±1° up to 45° of bank angle and ±2° for bank angles between 45° and 60°. This mode uses roll attitude signals from the vertical gyros, has 100% authority and moves roll cyclic position (roll trim piston) at 7.5% per second. Cyclic TRIM REL switch actuation allows re-referencing of attitude. The STICK TRIM (beeper) switch re-references at a rate of 4° per second. This mode is FAIL SAFE.

b. **Pitch Attitude Hold.** This mode functions below 60 KIAS and holds pitch attitude ±1°. This mode uses pitch attitude signals from the vertical gyros, has 100% authority and moves the cyclic pitch position (FAS output rod) at 15% per second. Cyclic TRIM REL switch actuation allows re-referencing of this mode. STICK TRIM (beeper) switch re-references at a rate of 2° per second. This mode is FAIL SAFE.

c. **Airspeed Hold.** This mode holds airspeed ±5 knots up to 35° angle of bank (AOB), then fades out, and works only above 60 KIAS. The monitoring sensor

is the air data transducer. This mode has 100% authority and moves the cyclic pitch position (FAS output rod) at 15% per second. The cyclic TRIM REL switch allows re-referencing of this mode. STICK TRIM (beeper) switch re-references at a rate of 6 knots per second. If airspeed hold fails, the system degrades to attitude hold. This mode is FAIL SAFE.

d. **Heading Hold.** This mode holds heading ±2° and uses the heading signal from the AHRS gyro. This mode has 100% authority and moves the rudder pedals (yaw trim piston) at 10% per second. The heading trim knob is used to make fine adjustments to selected heading to a maximum rate of 3° per second (flat turns only). PED TRIM REL allows re-referencing of this mode. Below 60 KIAS, any rudder pedal switch disengages this mode and allows re-referencing. This mode is FAIL SAFE.

e. **Auto Turn.** When airspeed is above 60 KIAS, auto turn (outer loop turn coordination) improves turn coordination by applying lateral acceleration correction signals to yaw outer loop. It has 100% authority. The computers provide auto turn whenever any of the following occur: (1) Cyclic TRIM REL switch depressed, (2) Cyclic STICK TRIM (beeper) switch pressed, or (3) Cyclic displacement against roll trim greater than 3.4%. Any time auto turn logic is in effect, heading hold is automatically disengaged. To reengage heading hold all of the following criteria must be met: (1) Bank angle less than 2°, (2) yaw rate less than 0.66° per second, (3) roll rate less than 0.33° per second, and (4) the auto turn logic not being met. This mode is FAIL SAFE.

f. **Pedal Force Limiting.** This capability limits the amount of force needed at the pedals to override the autopilot. Pedal force is limited to a maximum of about 24 pounds depending upon sideslip angle. Heading hold is automatically disengaged when pedal force limiting is in effect.

g. **Force Augmentation System (FAS).** FAS provides cyclic back pressure to the pilot in the pitch axis proportional to aircraft load factor to cue the pilot as to the degree of airframe stress caused by his inputs. The computer derives the load factor by processing airspeed information from the air data transducer along with signals from the pitch rate gyros and/or bank angle information if bank angle is greater than 35 degrees. The computer provides outer loop signals to the FAS actuator to create the back pressure against pitch inputs. This mode has 100% authority and 100% per second rate. It is FAIL SAFE except for airspeed failures; at which time, the computer will assume an airspeed of 120 KIAS for all calculations.

h. **Auto Bank.** This mode provides for automatic re-reference of roll attitude hold at airspeeds greater than 60 KIAS. The monitoring sensors are roll stick and trim position transducers and roll rate gyros. With AUTO BANK engaged, if the pilot displaces the cyclic against roll trim (greater than 3.4%), roll attitude hold disengages until roll rate drops below 0.33° per second; whereupon, it automatically reengages. If the helicopter is within 2° of wings level and heading hold has reengaged, the computers will level the wings. This mode is FAIL SAFE.

Note

If heading hold has not reengaged (bank angle greater than 2°) and roll attitude hold reengages, AUTO TURN will remain engaged.

i. **Barometric Altitude (BAR ALT) Hold.** This mode provides barometric altitude hold of ±25 feet or 1% of engaged altitude, whichever is greater. The monitoring sensor is the air data transducer. The CLTV TRIM REL switch is a temporary release, causing the BAR ALT pushbutton legend to flash on and off to signify BAR ALT hold is not active. When released, BAR ALT hold is re-referenced. The BAR ALT pushbutton is used to engage/disengage permanently. RDR ALT hold must be disengaged to engage BAR ALT hold. This mode is FAIL SAFE.

WARNING

Do not rely on BAR ALT hold during low altitude operations.

j. **Radar Altitude (RDR ALT) Hold.** Radar altitude hold maintains altitude within ±7 feet or 5% of selected altitude, whichever is greater. The monitoring sensors are the radar altimeters, and ALT SET FT (knob) potentiometer (0 to 500 feet). Approaching the altitude selected, the rate is limited to 540 FPM down and 960 FPM up when RDR ALT is engaged. (At altitudes less than 200 feet, the rate of descent will not exceed 200 FPM.) The ALT SET FT knob is used to select pilot desired altitude which is compared with actual altitude, and the appropriate correction signals are applied to collective inner and outer loop. Vertical acceleration signals are used to develop additional inner loop

corrections. Provided the aircraft is not in a coupled hover, there is a one time, one way transfer from RDR ALT hold BAR ALT hold if RDR ALT hold fails. Such a failure is normally caused by an altitude miscompare, and should not occur if one radar altimeter is turned off or in a "no track" mode. The CLTV TRIM REL is used for permanent RDR ALT hold disengagement. BAR ALT hold must be disengaged to engage RDR ALT hold.

WARNING

- With RDR ALT hold turned on, any interruption of power to a radar altimeter can cause up to 30 feet of altitude loss before the AFCS detects the malfunction and switches to the BAR ALT hold.

- Failure of RDR ALT hold while in a coupled hover will cause RDR ALT hold to disengage and BAR ALT hold will not engage. The aircraft will climb or descend depending on the RAD ALT holds function's last input to the collective AFCS servo.

2.11.5.3 Longitudinal Bias Actuator (LBA). The LBA provides a positive cyclic position versus airspeed gradient. Electrical signals from the AFCS computers keep the LBA fully retracted below 60 KIAS and progressively extend it to full at 180 KIAS. It has 30% authority, is rate limited to 5.5% per second and does not move the flight controls. The sensors used to control this mode are the air data transducer and pitch rate gyros. This mode is FAIL SAFE for an actuator failure and FAIL OPERATIONAL for computer failures. If airspeed fails, the actuator is driven to its midposition (120 KIAS) and shutdown.

2.11.5.4 Flight Control Damping. Damping takes place in all axes. The FAS actuator provides damping in pitch. There are viscous dampers attached to both roll and collective flight control linkages. The yaw AFCS servo provides damping in yaw.

2.11.5.5 Degraded AFCS

2.11.5.5.1 Mode Failures. Mode failures, indicated by the AFCS DEGRADED advisory light and one or more but not all fail advisory lights flashing (Figures 2-18 and 2-24), are when one or more modes have shut down as indicated by the lights (Figures 2-19 and 2-25). If any degraded mode(s) cannot be cleared by using MODE RESET, pressing and releasing the ACK FAIL ADVISORY pushbutton will cause all flashing lights to go steady.

2.11.5.5.2 Simplex Failure. A simplex failure (when one computer has shut down all of its outputs) is indicated by the AFCS DEGRADED advisory light flashing and all fail advisory lights except SAS and DSEN flashing. The only AFCS modes operating are SAS, cockpit flight control desensitization, cockpit flight control trim (except pitch), and the LBA. There is no pitch trim because the FAS actuator is turned off, but there is damping in the pitch axis. Possible recovery is by cycling CMPTR POWER pushbutton off and then back on. If AFCS and/or TRIM were previously engaged (ON) with the aircraft in flight, AFCS and/or TRIM will automatically re-engage if the computer fully recovers.

2.11.5.5.3 Duplex Failure. With computer power on, a duplex failure (when both computers have shut down all outputs) is indicated by an illuminated AFCS caution light. All AFCS modes have been lost. Possible recovery is by cycling CMPTR POWER pushbutton off and then back on. If AFCS and/or TRIM were previously engaged (ON) with the aircraft in flight, AFCS and/or TRIM will automatically re-engage if the computers fully recover.

2.12 APPROACH/HOVER/DEPART COUPLER

The AFCS system provides the capability to perform coupled automatic approach, hover, and departure through interface with the Doppler Navigation System.

2.12.1 Automatic Approach to Hover Coupler. The automatic approach to hover coupler provides the capability to perform an automatic approach to a hover at preselected radar altitude and preselected longitudinal and lateral velocities. (See Figures 2-21 and 2-23.)

Before the approach capability can be engaged, AFCS and TRIM must first be engaged, the tow coupler modes and AUTO BANK disengaged (requiring deselection if energized) and bank angle must be less than 5°. The automatic approach can be initiated at any airspeed and altitude by pressing the APPR/HVR pushbutton on the APPR/HOVER COUPLER panel. The helicopter decelerates or descends until the approach profile conditions are met (Figure 2-21). If the approach mode is selected when the helicopter conditions are below the approach profile, the AFCS commands the helicopter to decelerate at 1 knot per second and maintains altitude until the approach conditions are met. If the approach mode is selected when the helicopter is above the approach profile, the AFCS commands the helicopter to descend at 400 FPM (200 FPM when less than 50 feet above the approach profile or when below 200 feet or when airspeed is less than

velocity set plus 2 knots) and maintain airspeed until the approach profile conditions are met. If the helicopter is below the selected altitude and the APPR/HVR pushbutton is pressed, coupled approach will engage and the helicopter will climb to the selected altitude, decelerate, and transition to a coupled hover. Prior to 60 KIAS, beeping laterally into a turn will not affect the approach coupler deceleration/descent profiles. (Bank angle may be increased above 5° after coupled approach has been engaged.) When the approach profile conditions are met, the helicopter simultaneously decelerates at 1 knot per second and descends at 200 FPM. This profile is maintained until the helicopter attains longitudinal velocity set plus 10 knots and selected radar altitude at which time RDR ALT hold engages and the RDR ALT pushbutton legend illuminates. The deceleration continues down to longitudinal velocity set plus 2 knots where hover is captured causing the APPR legend to extinguish and the HVR legend to illuminate. The helicopter then decelerates the last 2 knots to longitudinal velocity set. If the selected radar altitude is less than 100 feet, the system treats 100 feet as the selected altitude until a coupled hover is captured, after which the helicopter descends to the actual selected altitude. As the helicopter transitions through 60 KIAS, roll attitude hold changes to lateral velocity set hold and the VEL SET ON light illuminates. In addition, once below 60 KIAS, the system references the Doppler longitudinal velocity as it continues to decelerate. The approach profile can be modified by: (1) beeping (above 60 KIAS, airspeed and roll attitude, below 60 KIAS, pitch attitude, no effect on roll), (2) the CLTV/cyclic TRIM REL switches, or (3) changing the LAT VEL or LONG VEL hover velocity settings. The sensors used in this mode are the Doppler, radar altimeters, and the LAT and LONG VEL set (knobs) potentiometers. The automatic approach to hover is FAIL SAFE.

2.12.2 Hover Coupler. The hover coupler provides longitudinal and lateral ground speed control and stabilization about the selected ground speed, and automatic altitude retention using RDR ALT hold. The longitudinal and lateral ground speed are selectable on the APPR/HOVER COUPLER panel, and altitude is set on the AFCS CONTROL panel ALT SET FT knob. Longitudinal and lateral ground speed can also be beeped with the STICK TRIM (beeper) switch 100 KIAS above or below the ground speed selected on the APPR/HOVER COUPLER panel at 3 knots per second. The hover coupler mode is engaged automatically at the termination of the automatic approach or can be engaged manually when the helicopter is hovering, by pressing the APPR/HVR pushbutton on the APPR/HOVER COUPLER panel. The hover coupler

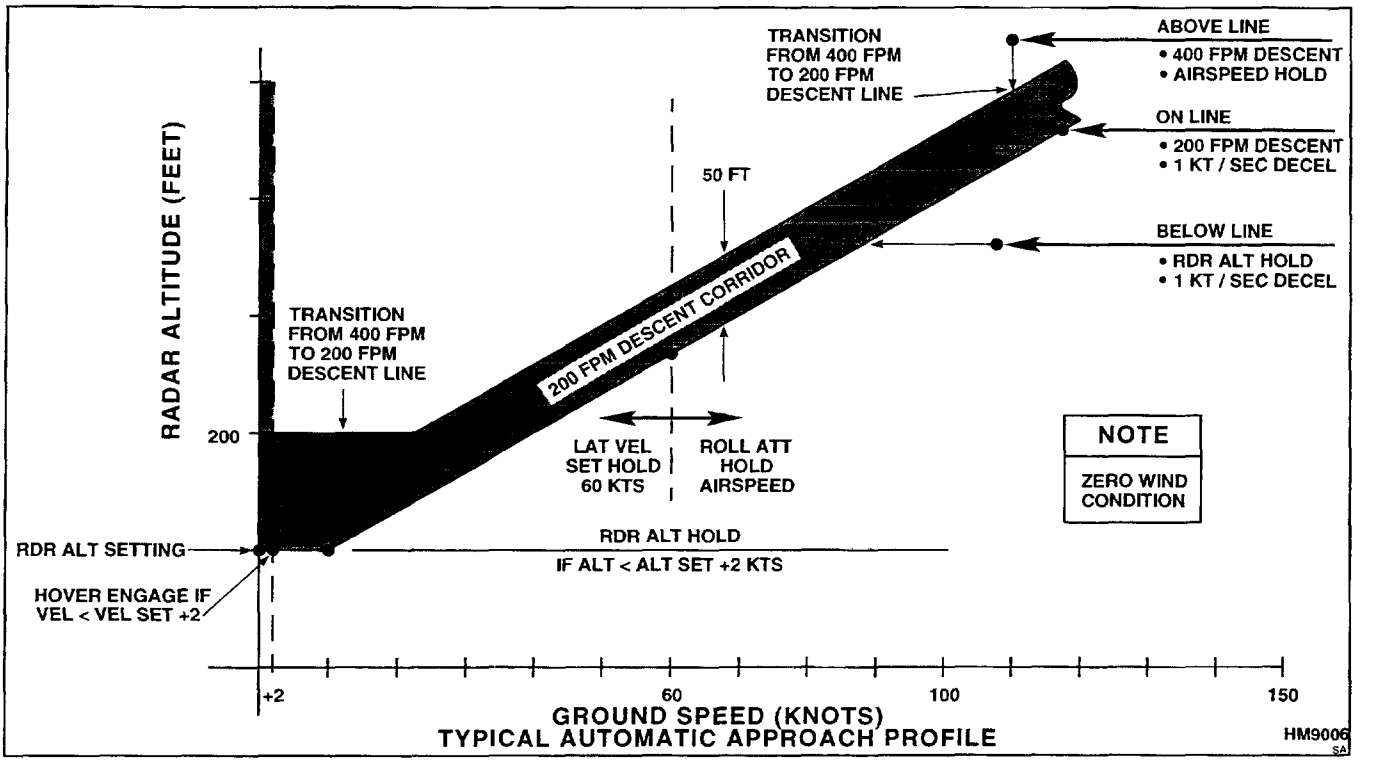


Figure 2-21. Automatic Approach Profile

engages when the longitudinal ground speed is within 2 knots of the longitudinal velocity set after an automatic approach or less than 5 knots above longitudinal set velocity, if engaged manually. Radar altitude hold engages automatically when the helicopter altitude is at or below the altitude selected on the ALT SET FT knob plus 2 feet (5 feet if Doppler in memory) and within 10 knots of the selected longitudinal velocity. If cyclic trim is released and longitudinal velocity is changed by more than 20 knots, hover coupler disengages and approach coupler engages until criteria for hover coupler are again met. Any time cyclic trim is released it will re-reference longitudinal and lateral velocities back to the basic set knob (potentiometer) values.

2.12.3 Crew Hover. Crew hover provides the aircrewman with limited control of the longitudinal and lateral movement of the helicopter while in a coupled hover. The aircrewman has a hover controller grip (Figure 2-36) with a switch/light mounted above it. Once in a coupled hover, the pilot can arm the crew hover function by selecting CREW HVR on the APPR/HOVER COUPLER panel. The aircrewman selects hover ENGA (engage) on his switch/light and the function is active when the ENGA legend illuminates. At this time the aircrewman can control 10 knots around the velocity set knob (potentiometer) values plus whatever the pilot has beeped. The pilot can always override crew hover. This mode is FAIL SAFE.

2.12.4 Automatic Depart. The automatic depart mode provides the capability to perform an automatic departure any time weight is off wheels to a cruise airspeed of 100 KIAS and altitude of 500 feet. The automatic depart mode can be engaged by either pressing the DEPART SELECT switch on the cyclic grip or pressing the DEPART pushbutton of the APPR/HOVER COUPLER panel. The depart mode can be engaged at any bank angle. Pressing either the DEPART SELECT switch or the DEPART pushbutton a second time disengages the automatic depart mode and returns helicopter control to the pilot. (See Figure 2-22.) Upon engagement, the helicopter accelerates at 2 knots per second, climbs at 480 FPM, and attempts to zero out any lateral drift until 60 KIAS at which time it will roll wings level. During the departure, the computer monitors engine torque to ensure that it does not exceed 121% average torque. At 100 KIAS, airspeed hold automatically engages, and at a radar altitude of 500 feet, BAR ALT hold automatically engages. Any alternate cruise airspeed or altitude condition less than 100 KIAS and 500 feet can be attained by pressing either the cyclic TRIM REL or CLTV TRIM REL switches at the desired airspeed and altitude respectively. If either trim release switch is pressed and released, the hold mode (pitch attitude/airspeed or altitude) associated with the control axis is engaged, and the helicopter continues to follow the depart profile for the other axis until the final cruise condition for that axis is met. If the helicopter is above 500 feet on the radar altimeter, depressing the DEPART pushbutton on the APPR/HOVER COUPLER panel or DEPART SELECT on the cyclic will immediately engage BAR ALT hold and cause the aircraft to accelerate if below 100 KIAS. A profile of the automatic departure mode is shown in Figure 2-22. To engage depart, tow coupler modes and AUTO BANK cannot be engaged and AFCS and TRIM must be engaged. This mode is FAIL SAFE.

2.12.5 APPR/HOVER COUPLER Panel. The control panel marked APPR/HOVER COUPLER, on the cockpit console (FO-7 and Figure 2-23), contains pushbuttons, indicators, and control knobs for automatic approach, hover, and departure modes of coupler operation.

2.12.5.1 APPR/HVR Pushbutton. The pushbutton is a split capsule marked APPR and HVR. Pressing the pushbutton engages either automatic approach or hover mode of the coupler (a function of the flight profile parameters recognized), and the appropriate legend illuminates. Pressing the pushbutton off will disconnect the coupler mode and extinguish the light.

2.12.5.2 DEPART Pushbutton. The pushbutton is marked DEPART. Pressing the pushbutton will engage the depart mode coupler and illuminates the pushbutton. Pressing the pushbutton off will disconnect the coupler mode and extinguish the light. Pressing DEPART SELECT on the cyclic will also engage the depart mode coupler condition and light the DEPART pushbutton, or disconnect the coupler mode and extinguish the light as applicable. The DEPART light will also extinguish when the depart profile is completed.

2.12.5.3 CREW HVR Pushbutton. The pushbutton is marked CREW HVR. Pressing the pushbutton while the hover mode is engaged arms the crew hover mode coupler and illuminates the pushbutton. Lateral and longitudinal velocity control is available at the HOIST HOVER TRIM panel (in the cabin adjacent to the personnel door). Pressing the pushbutton off will disconnect the crew hover mode and transfer control to the hover mode.

2.12.5.4 LAT VEL L-R (Lateral Velocity) Control Knob. The knob marked LAT VEL L-R is a control with a cloverleaf coded head that permits the pilot to set a reference lateral velocity in the automatic hover mode or during automatic approach mode below 60 KIAS. Lateral trim authority using the set knob is 20 knots left or right.

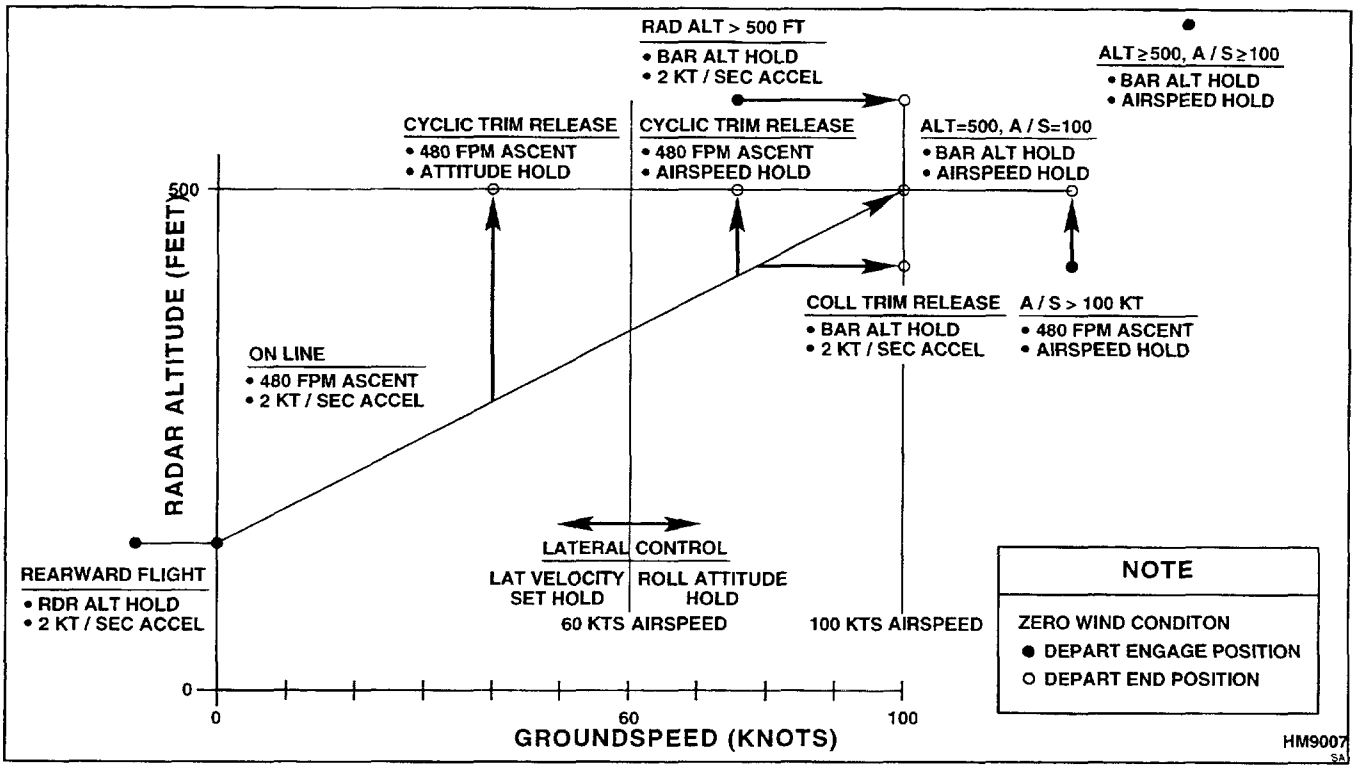


Figure 2-22. Automatic Departure Profile

2.12.5.5 LONG VEL F-A (Longitudinal Velocity) Control Knob. The knob marked LONG VEL F-A is a control with a triangular coded head that permits the pilot to set a reference longitudinal velocity in the automatic hover mode. Longitudinal trim authority using the set knob is + 50 to - 20 knots.

2.12.5.6 VEL SET ON (Velocity Indicator) Light. The light marked VEL SET ON is on when either longitudinal velocity or lateral velocity control is active.

2.13 TOW COUPLER

The tow coupler, using the pitch, roll, and yaw couplers, provides coupled tow functions consisting of tow skew hold, ground speed hold, tension hold, and tow heading hold.

2.13.1 Skew Hold. Skew hold maintains the tow boom at ±2° of the pilot desired position. The dual skew angle sensor provides sensing for skew hold. Skew hold has 100% authority and moves the rudder pedals. AFCS and TRIM must be engaged and the APPR/HVR/DEPART coupler and AUTO BANK disengaged. Tow tension must be greater than 400 pounds, the tow hook must be engaged, and the weight off wheels activated to engage skew hold. Yaw channel heading hold is disengaged when skew hold is engaged. Skew angle is referenced to the skew angle at the time of engagement and can be re-referenced by the following: (1) using the SKEW TRIM knob for small changes (20°/rev, left or right 10° from referenced skew angle), (2) PED TRIM REL switch re-reference, SKEW pushbutton legend flashes, or (3) pedal switches re-reference, SKEW pushbutton legend flashes. If tension drops below 400 pounds for more than 2 seconds, skew hold is temporarily disengaged and SKEW pushbutton legend flashes. This mode is FAIL SAFE.

2.13.2 Ground Speed Hold. Ground speed hold maintains pilot desired ground speed ±3 knots while operating at ground speed below 60 knots. Doppler provides the sensing for ground speed hold. AFCS and TRIM must be engaged but the APPR/HVR/DEPART coupler and AUTO BANK cannot be engaged. Ground speed is referenced to ground speed at the time of engagement and can be re-referenced by the following: (1) Cyclic TRIM REL switch re-references and causes GND SPD pushbutton to flash and remains flashing for 2.5 seconds after releasing the switch or (2) STICK TRIM (beeper) switch

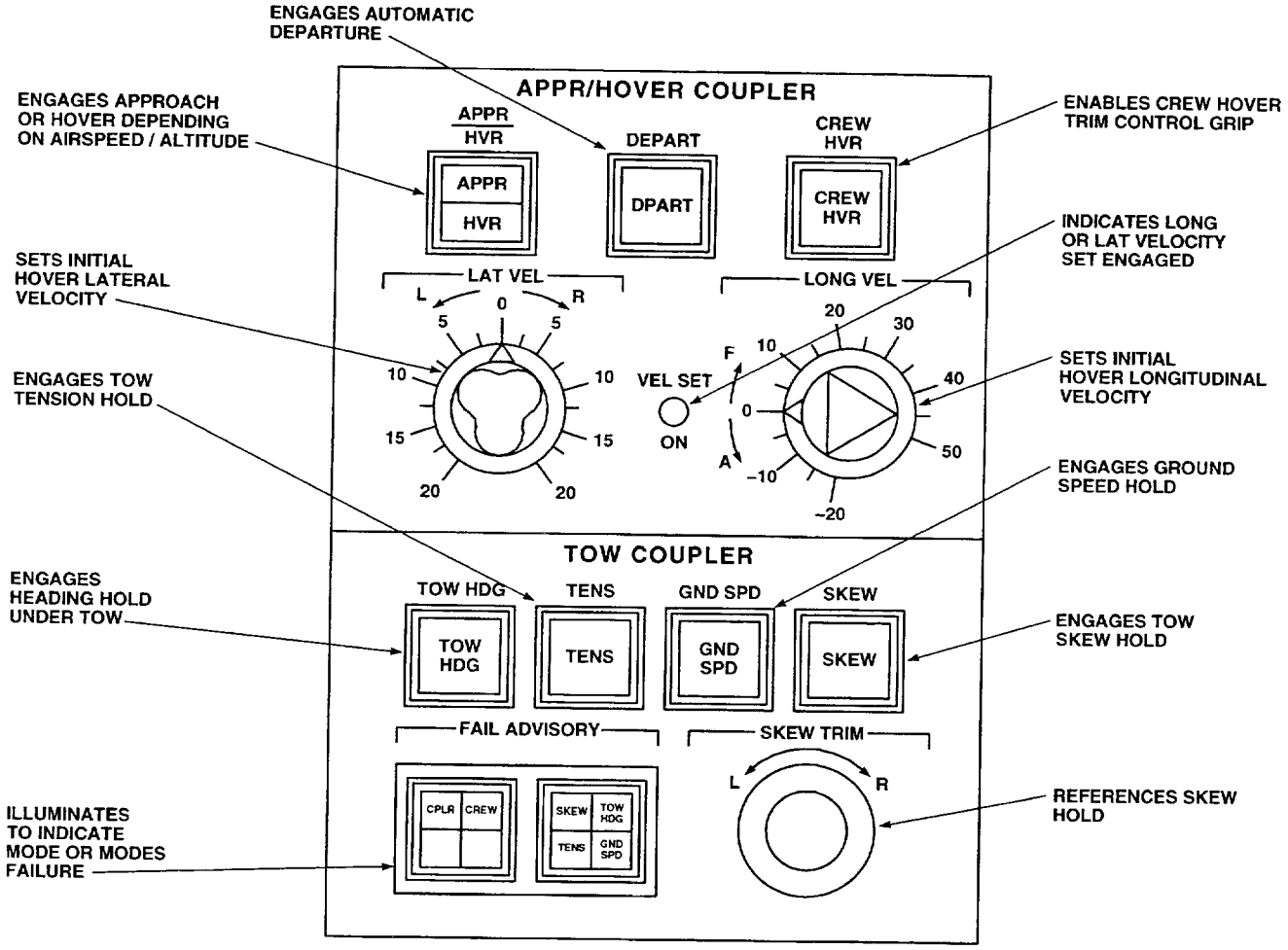


Figure 2-23. Approach/Hover and Tow Controls

re-references at a rate of 3 knots per second. Selecting ground speed hold will deselect tension hold. This mode is FAIL SAFE.

2.13.3 Tension Hold. Tension hold maintains pilot desired tension at ±10% or 100 pounds whichever is greater. The sensor used for tension hold is the tow boom load cell. AFCS and TRIM must be engaged but APPR/HVR/DEPART coupler and AUTO BANK cannot be engaged (requiring deselection if energized). Tow tension must be greater than 400 pounds, weight off wheels activated, and tow hook must be engaged to engage tension hold. Tension hold is referenced to tension at the time of engagement and can be re-referenced by the following: (1) Cyclic TRIM REL switch re-references, tow TENS pushbutton legend flashes and remains flashing for 2.5 seconds after releasing switch or (2) STICK TRIM (beeper) switch re-references at a rate of 10% of reference tension per second, minimum of 300 pounds per second. If tension drops below 400 pounds for more than 2 seconds, tension hold is temporarily disengaged. Selecting tension hold will deselect ground speed hold. This mode is FAIL SAFE.

2.13.4 Tow Heading Hold. Tow heading hold is designed to engage or maintain pilot desired heading ±3° with a turn rate of 1.5° per second or less. The sensor used for tow heading hold is the heading output of the

AHRS gyro. AFCS and TRIM must be engaged, APPR/HVR/DEPART coupler and AUTO BANK disengaged, tow tension greater than 400 pounds, weight off wheels activated, and the tow hook engaged to engage tow heading hold. Tow heading hold is referenced to heading at the time of engagement and can be re-referenced by the following: (1) HDG TRIM knob re-references at a rate of 1.5° per second (maximum), (2) Cyclic TRIM REL switch re-references, TOW HDG pushbutton legend flashes and remains flashing for 6 seconds after releasing the switch, or (3) displacing the cyclic against trim greater than 3.4%, TOW HDG pushbutton legend flashes and remains flashing for 6 seconds after the cyclic is returned to original position. Aircraft turn rate must be stabilized near zero for the AFCS to regain and maintain referenced heading. The STICK TRIM (beeper) switch interrupts tow heading hold and establishes a turn rate at a rate of 1.5° per second with a maximum of 3° per second (TOW HDG pushbutton legend flashes). The turn can be stopped by beeping opposite the direction of turn and tow heading hold resumes after the commanded (beeped) turn rate has returned to zero for 6 seconds (TOW HDG stops flashing).

CAUTION

- When beeping heading changes, the helicopter responds by rolling. Large rolling rates and bank angles are possible.
- If heading hold is engaged, pilots must carefully control skew when skew hold is either temporarily or permanently disengaged. Erratic skew control will cause the heading hold function to chase the referenced heading using the roll channel and possibly result in excessive rolling.

Note

Improperly nulled accelerometers may cause degraded AFCS tow heading hold performance.

2.13.5 TOW COUPLER Panel. The panel portion marked TOW COUPLER, on the cockpit console (FO-7 and Figure 2-23), contains pushbuttons, indicators, and a control knob for automatic tow functions as well as failure indications for both the approach/hover/depart coupler and tow coupler.

2.13.5.1 TOW HDG Pushbutton. The pushbutton is marked TOW HDG. Pressing the pushbutton engages tow heading hold and illuminates the pushbutton legend. Pressing the pushbutton off will disconnect tow heading and extinguish the legend.

2.13.5.2 TENS Pushbutton. The pushbutton is marked TENS. Pressing the pushbutton engages tow tension hold and illuminates the pushbutton legend. Pressing the pushbutton off will disconnect tow tension hold and extinguish the legend.

2.13.5.3 GND SPD Pushbutton. The pushbutton is marked GND SPD. Pressing the pushbutton engages ground speed hold and illuminates the pushbutton legend. Pressing the pushbutton off will disconnect ground speed hold and extinguish the legend.

2.13.5.4 SKEW Pushbutton. The pushbutton is marked SKEW. Pressing the pushbutton engages skew angle hold and illuminates the pushbutton legend. Pressing the pushbutton off will disconnect skew angle hold and extinguish the legend.

2.13.5.5 SKEW TRIM L-R Knob. The knob marked SKEW TRIM L-R is a control, with an indented circular coded head, that permits the pilot to manually change the referenced skew.

2.13.5.6 Coupler FAIL ADVISORY Panel. The panel provides advisory capsules to show failures in the approach/hover/depart coupler and the tow coupler. The nomenclature and their significance are shown and discussed in Figures 2-24 and 2-25. Any approach/hover/depart coupler or tow coupler failure, other than a duplex (dual computer) failure, will cause flashing of the AFCS DEGRADED advisory light. The modes affected by the failure will be displayed by flashing FAIL ADVISORY lights. SKEW, TOW HDG, TENS, and GND SPD illuminated fail advisory capsules reference failure in the respective tow coupler function. CPLR (coupler) illuminated FAIL ADVISORY capsule references failure in approach/hover/departure coupler. CREW (crew hover) illuminated FAIL ADVISORY capsule references failure in the crew hover mode of the hover coupler.

2.14 LANDING GEAR SYSTEM

The tricycle-configured landing gear system consists of dual-wheel retractable main and nose gear assemblies, tail skid, and a hydraulic system. The landing gear hydraulic system operates on 3000 psi hydraulic pressure from the UTILITY 1 hydraulic system. The landing gear system has a one-shot pneumatic emergency extension system to lower the landing gear in case of an electrical or hydraulic malfunction that should unlock landing gear

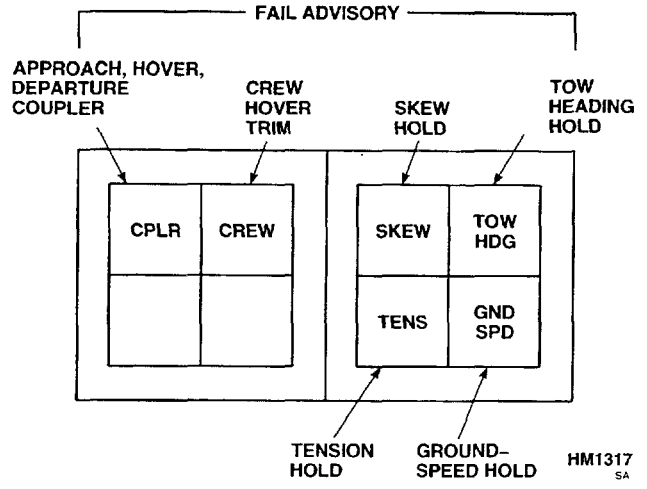


Figure 2-24. Tow Coupler Panel Fail Advisory Lights

from up position if hydraulic power to the landing gear fails, or there is an electrical malfunction that prevents the gear from unlocking. The landing gear control panel (FO-7) marked LDG GEAR CONT is on the center cockpit console. Electrical power for the landing gear system operation is provided from the No. 2 primary dc bus circuit breaker, marked CONT, under the general heading LANDING GEAR.

2.14.1 Main Landing Gear. The main landing gear assemblies are below the sponsons, and retract forward and upward into the sponsons (FO-13). Each assembly has dual wheels and hydraulic brakes, plus a drag strut that contains the retracting cylinder downlock mechanisms. There is a fluid indicating pin installed on top of the shock strut that extends when hydraulic servicing is necessary (Figure 3-1).

2.14.2 Nose Landing Gear. The dual-wheel nose landing gear assembly (FO-11) is mounted vertically at the centerline of the helicopter and is free to turn 360° about the strut centerline. The nose gear retracts rearward and upward into the nose section of the airframe. The nose gear assembly has dual wheels with a co-rotating shimmy damper, a retracting drag strut cylinder, a pneumatic hydraulic strut and shimmy damper, and attaching drag links and supports. The shock struts internal shimmy damper prevents nose gear vibration during forward motion on the ground. To dampen nose gear vibration further the nosewheels are interconnected with a co-rotating shimmy damper that causes both wheels to rotate together but allows them to split while making turns. An internal centering device, that starts to become effective at 75% of nose gear extension, holds the nosewheel centered during flight to provide proper wheel orientation for retraction/extension and landing. There is a fluid indicating pin installed on top of the strut that extends to indicate hydraulic servicing is necessary.

2.14.3 Tail Skid. The retractable tail skid (FO-13), mounted on the underside of the pylon, aids in the prevention of the tail rotor blades from striking the ground when landing with nose high attitudes. The tail skid is extended and retracted by an electrical actuator attached to the tail skid shock strut. The tail skid is automatically retracted when the main landing gear is retracted, and automatically extended when the main landing gear is down and locked. The tail skid electrical system is interconnected with the cargo ramp system and landing gear scissors switch so that the tail skid, if extended, will automatically retract when the cargo ramp is lowered and the landing gear struts are compressed (weight on wheels). The tail skid receives power from the No. 1 primary dc bus circuit breaker panel marked TAIL SKID.

2.14.4 Landing Gear Actuating System. This system operates on 3000-psi hydraulic pressure, supplied by the UTILITY 1 hydraulic system. Placing the landing gear control handle to UP retracts the landing gear, and placing the handle to DN lowers the landing gear. A mechanical spring-loaded downlock engages to lock the landing gear control handle in the down position when the weight of the aircraft compresses the landing gear struts. Each main landing gear oleo strut has a scissors switch that is opened and closed by the extension and compression of the strut. When the struts are compressed, electrical circuitry does this:

1. Disables the landing gear downlock solenoid to prevent inadvertent retraction of the landing gear.

2. Disables the attitude hold portion of the AFCS outer loop, but not cyclic trim, to prevent excessive driving of the cockpit controls.

3. Disables the fuel dump capability.

4. Causes IFF mode 4 codes to be zeroized when electrical power is removed, if HOLD has not been selected with the MODE 4 code switch.

5. Opens the isolation valve.

6. Enables generator underfrequency to be displayed by the #1, #2, and #3 GEN caution lights.

7. Enables the stick position indicator to operate.

FAIL ADVISORY LIGHT FLASHING	EFFECT	POSSIBLE RECOVERY
CPLR	Loss of approach, hover, or depart function. Doppler in memory.	MODE RESET
CREW	Loss of crew hover functions.	MODE RESET
SKEW	Loss of skew hold.	MODE RESET
TOW HDG	Loss of tow heading hold.	MODE RESET
TENS	Loss of tow tension hold.	MODE RESET
GND SPD	Loss of ground speed hold.	MODE RESET

Figure 2-25. Tow Coupler Panel Fail Advisory Light Meaning

8. Enables the tail skid to retract automatically when the ramp is lowered.

9. Disables ALE-39 countermeasures dispensing set (if installed).

10. Enables the interlock relay that secures hydraulic power from the AFCS servos when the pylon is unsafe for flight.

Two relays associated with the left scissors switch have power furnished by the No. 1 primary dc bus through a circuit breaker marked WT ON WHEELS LHS. Two relays associated with the right scissors switch have power furnished by the No. 3 primary dc bus through a circuit breaker marked WT ON WHEELS RHS.

When struts are extended, the following interlocks are bypassed to permit engine starting in flight; rotor brake not fully pressurized, mechanical gust lock engaged, and rotor head not in start position. In addition, strut extension enables normal ALE-39 operation.

When airborne, the oleo struts extend, closing the contacts of switches to energize the circuits that unlock the landing gear control handle and arm the system for retraction. Raising the landing gear control handle to UP retracts the landing gear, and lights the landing gear warning light in the control handle, while the landing gear indicators on the instrument panel indicate an unsafe (barber pole) condition. When the landing gear is fully retracted, the landing gear handle warning light will go off and the landing gear indicators on the instrument panel will show UP. Lowering the landing gear control handle DN extends the landing gear and lights the landing gear warning light in the control handle, while the landing gear indicators will show an unsafe (barber pole) condition. When the landing gear is fully extended, the landing gear handle warning light will go off and the landing gear indicators on the instrument panel will show a symbol depicting a wheel.

Note

During extension and retraction of the landing gear, UTILITY 1 hydraulic pressure may drop to 2000 psi.

2.14.4.1 Landing Gear Control Handle Downlock Release. A manually-operated downlock release, marked DN LOCK RELEASE, on the landing gear control panel (FO-7) provides a mechanical override of the landing gear control handle downlock solenoid in case of an interruption of electrical power to the solenoid. Should the downlock solenoid become inoperative, the downlock release can be actuated to mechanically release the landing gear control handle from the DN position.

2.14.4.2 Landing Gear Position Indicators. The indicators (FO-5), on the instrument panel, operate on direct current from No. 2 primary dc bus and are protected by a circuit breaker marked POS under the general heading LANDING GEAR. The indicators read UP if the landing gear wheels are up and locked, and a symbol depicting a wheel if the wheels are down and locked. During landing gear extension or retraction, when an unsafe condition exists, or whenever electrical power is not available, the indicators show a barber pole.

2.14.4.3 Landing Gear Warning Light and Test Button. The landing gear warning light, in the handle of the landing gear control lever, will go on when

any or all landing gear are in transit between the up and down positions, or when one landing gear is not in the position selected by the landing gear control handle. When all landing gear are fully up and locked, or fully down and locked as selected by the handle, the warning light will go off. The warning light operates on direct current from the No. 2 dc primary bus through the landing gear up warning system. A landing gear warning light test button, marked HANDLE LT TEST, is on the landing gear control panel. When pressed, it tests the warning light in the landing gear control handle.

2.14.5 Landing Gear Up, Attitude, Altitude, and Tow Tension Warning System. The landing gear up, attitude, altitude, and tow tension warning system provides a visual and/or audible warning under specific conditions to alert the pilots. Although several combinations of warning can occur the following indications are constant. An audible steady tone in the pilots' headsets is a warning of excess pitch attitude or excessive tow tension. An audible pulsing tone is a warning of gear up at low airspeed or low altitude. A flashing LDG GEAR UP warning light is a warning of gear up at low altitude. An ALTITUDE caution light alone or in conjunction with a flashing LDG GEAR UP light is a warning of an unreliable radar altimeter or that the helicopter is below the radar altimeter low-level warning index setting.

Note

Helicopters with the Ground Proximity Warning System (GPWS, AFC 501 PT 3) will also give an aural warning, "GEAR UP, GEAR UP" and a visual warning on the caution/advisory panel when the above conditions exist.

2.14.6 Landing Gear Up Warning System. The LDG GEAR UP warning light on the instrument panel will flash, and an ICS pulse tone will be heard in the headset when the landing gear is up, airspeed is below 60 knots, and radar altitude is below 150 feet. With the radar altimeter off or unreliable, the same warnings will be furnished at any altitude when the landing gear is up, and airspeed is below 60 knots. The warnings can be deactivated by lowering the landing gear, or increasing airspeed above 60 knots, or climbing above 150 feet with an operating radar altimeter. In addition, when the parameters that activate the warnings are in effect, the warnings can be deactivated by pressing the LDG GEAR UP warning light. However, the warnings will be reactivated any time the collective is lowered to lose altitude. An airspeed sensing switch activates the system below 60 knots and deactivates the system above 60 knots. The system senses altitude from the radar altimeter. The system's power circuit is routed through the landing gear limit switches to deactivate the system when the gear is down. The visual and aural warning indications may be disabled when engaged in AMCM or coupled hover operations. The system is disengaged by pressing the button marked LDG GEAR under the heading WRN SYS on the MCM TOW control panel. When depressed the capsule will light and show WRN SYS OFF. The warning system can be reengaged by placing the MCM TOW control panel switch under WRN SYS to RESET or upon accelerating above 60 KIAS or climbing above 150 feet with reliable radar altimeters. The system receives power from the No. 1 primary ac bus through a circuit breaker marked LDG GEAR WARN, and the No. 3 primary dc bus through a circuit breaker marked LDG GEAR WARN (Figure 7-8).

2.14.7 Attitude Warning System. With the landing gear down at low absolute altitude, to prevent damaging the tail skid, a steady ICS tone is heard in the heard in the headset. This tone alerts the pilot to the fact the helicopter is approaching a dangerous, nose-high attitude for the flight conditions. Normally, the ICS warning tone is activated by both AFCS computers; however, the system will operate with only one operating. The parameters analyzed by the computers to activate the warning tone are radar altitude, vertical velocity, pitch attitude, and pitch rate. Altitude and vertical velocity are furnished from the radar altimeters, pitch attitude from the AHRS and 1080Y gyros, and pitch rate from the pitch rate gyros. Two curves on Figure 7-8 show the attitudes and altitudes at which the AFCS computers will activate the warning tone. Note that for the same nose-up angle the warning is activated at a higher altitude for descent than for ascent. In addition, the system does not operate at nose-up attitudes of less than 5°. The aural warning indication may be disabled when engaged in AMCM or coupled hover operation. The system is disengaged by pressing the button marked LDG GEAR under the heading WRN SYS on the MCM TOW control panel. When depressed the capsule will light and show WRN SYS OFF. The warning system can be reengaged by placing the MCM TOW control panel under WRN SYS to RESET. The attitude warning system receives power from the No. 3 dc primary bus through a circuit breaker marked LDG GEAR WARN.

2.14.8 Tow Tension Warning System. While performing AMCM missions, the helicopter's flight regime may be such that all parameters for landing gear warning are present. A switch on the MCM TOW control panel can be used to disable the landing gear warning. The tow tension warning system can then be engaged by placing

the TENS AUDIO switch to ON and an audible steady tone will sound a warning whenever the pilot allows the tension on the tension skew angle indicator to go above the tension high segment set on the indicator. The tow cable high tension warning capability is available with either an active or disabled landing gear warning system as modified by AFC 410.

2.14.9 Altitude Warning System. The ALTITUDE caution light illuminates whenever any of the following conditions are met: (1) The selected radar altimeter is unreliable and the helicopter is either flying at less than 60 knots or in a coupled hover; (2) The selected radar altimeter is reliable, the helicopter is below the radar altimeter low-level warning index setting, and (a) the landing gear is up, or (b) the tow coupler and RDR ALT hold are engaged, or (c) the hover coupler is on.

2.14.10 External Landing Gear Down Light. An external landing gear down light, mounted on the nose gear door (Figure 2-11), is used to indicate to ground personnel that the landing gear is down and locked. The light will go on any time all landing gear are down and locked, and the exterior light master switch is on. The light operates on dc current from the No. 2 dc primary bus through a circuit breaker marked DOWN, under the general heading LANDING GEAR.

2.14.11 Landing Gear Emergency System. An orange-yellow and black colored T-handle lever, on the left side of the lower cockpit console (FO-7), is used to unlock the landing gear in case of an electrical or hydraulic failure. The T-handle, when turned and pulled, discharges a 3000 psi capacity nitrogen bottle. The pressure of the discharging nitrogen displaces the shuttle valve in each gear and allows the gear to unlock. Actuation of the emergency landing gear release handle also opens the landing gear emergency bypass valve to the utility module, which allows hydraulic fluid, from the up side of landing gear struts, to return to the Utility 1 reservoir. The nitrogen pressure may assist the extension and down-locking of the landing gear. If the landing gear unlocks but does not extend, the emergency gear handle must be reset to vent the nitrogen overboard and open the system to the atmosphere. This allows gravity or ground personnel to extend the landing gear without the need to overcome the vacuum caused by a closed system. After an emergency actuation, the bypass valve must be manually reset before the emergency landing gear nitrogen bottle can be recharged or the landing gear retracted.

Note

Be sure the landing gear control handle is at DOWN before using the emergency T-handle. The emergency landing gear system will lower the landing gear in a hover in the same length of time as the normal system. However, during forward flight, with an airload on the nose gear door, emergency extension may take from 1 to 2 minutes.

2.14.12 Wheel Brake System. The main landing gear wheels each have self-adjusting hydraulic boost power brakes that are operated by toe pedals on the pilot's and copilot's rudder pedals. Hydraulic power for the wheel brake system is supplied from the UTILITY 1 hydraulic system through the isolation valve, whenever the weight of the helicopter is on the landing gear wheels. Wheel brakes may be applied by either the pilot or copilot, and the left and right wheel brakes may be operated independently. The parking brakes may be set with the parking brake handle by either pilot. The parking brakes are set by pressing the brakes and pulling the parking handle. The handle operates parking brake valves, which contain accumulators to maintain pressure and compensate for temperature changes. A parking brake advisory light marked PARKING BRAKE ON, on the advisory panel, indicates to the pilot that the parking brake is on. The parking brake advisory light receives power from the emergency dc bus through the caution panel circuit breaker marked CAUTION PANEL MASTER, in the cockpit.

Note

With the UTILITY 1 hydraulic system not pressurized, the wheel brakes are capable of holding the helicopter, loaded to 46,500 pounds, on a 10° slope. With hydraulic pressure the helicopter is held on a 20° slope. It is recommended that consideration be given to starting the APP while on shipboard or during unusual ground handling operations.

2.14.12.1 Parking Brake Handle. The PARKING BRAKE handle is attached to the lower cockpit console (FO-7). The parking brakes are applied by pressing the rudder pedals, pulling the parking brake lever up; then releasing the rudder pedals. Pressing the rudder pedals will release the parking brakes, causing the parking brake handle to return to OFF.

Note

- The parking brake advisory light will go on any time the parking brake handle is pulled up, even though the parking brakes have not actually been set.

- Do not force the parking brake handle when releasing the parking brakes. This action may damage the parking brake actuating cable and cableway, causing the parking brakes to remain on when the advisory light is off.

2.15 BLADE AND PYLON FOLD SYSTEM

The blade and pylon fold system is designed to position the main rotor blades for either blade or pylon folding first, before folding. The spread cycle occurs in the reverse of that outlined for the fold cycle, and either cycle may be halted and reversed at any stage. Each may be selected and folded separately, but the main rotor blades cannot be folded if the pylon has already been folded. Any of the following interlocks prevent inadvertent actuation of the system: a speed control is out of SHUT-OFF, the gust lock is engaged, the pylon is unsafe for flight, or the main gear box oil pressure switch is pressurized. The system receives hydraulic pressure from the utility 1 hydraulic system through the isolation valve, and electrical power from the No. 2 dc primary bus through a circuit breaker in the cabin marked BLADE FOLD.

2.15.1 Fold Control Panel. The panel, marked BLADE/PYLN-FOLD, on the pilot's overhead control panel (FO-1), contains the fold system controls. The control panel also contains lights that show the sequence of fold and spread cycles as they occur. The master power switch, marked MASTER, with marked positions POWER-OFF, must be at POWER before the system can be energized. The PITCH LOCK switch is used to engage the pitch locks before folding and to disengage the pitch locks after spreading, or as locks to prevent blade/wind loads from feeding into the control system when the helicopter is parked. The blade fold position switch, marked BLADE, has marked positions FOLD POSN-OFF. The switch is used to position the blades before folding. The blade fold/spread switch, marked BLADE, has marked positions FOLD-OFF-SPREAD. The FOLD position, with the high-pressure rotor brake on, will fold the blades if the head is positioned for fold, the pitch locks are engaged, and the blade position switch is at FOLD POSN. The SPREAD position will spread the blades from the folded position. The pylon fold/spread switch, marked PYLON, at FOLD, will position the head for pylon fold (if folding the pylon only) and fold the pylon and, at SPREAD, will spread the pylon.

When the master power switch is placed to POWER, the SAFETY VALVE OPEN light will go on to indicate the safety valve has opened and hydraulic pressure is available to the rotor head positioning, blade fold, and pylon fold selector valves.

The FLIGHT READY light will go off and the BLADE FOLD PYLON caution light will go on to indicate an unsafe-for-flight condition.

Placing the blade fold position switch to FOLD POSN will cause the rotor brake pressure to be dumped and repumped to 40 psi, the ROTOR BRAKE ON advisory light to go off, and the rotor head to be driven to the proper position for blade fold. When the head is in the fold position, the HEAD IN FOLD POSITION light and ROTOR BRAKE ON advisory light go on.

Seat the collective in the collective detent to light the cyclic stick position indicator. Move the cyclic to light the stick-center position arrows, on the stick position indicator, to position the rotor head for pitch lock engagement.

Placing the PITCH LOCK switch to PITCH LOCK causes the pitch locks to advance from the retracted position, and the PITCH LOCK ADVANCED light will go on when any one of the six pitch locks advance. In addition, the 2 STG M/R SERVO BYPAS caution light will go on. The second stage hydraulic pressure gage remains at normal operating pressure. When all six pitch locks are fully extended, the PITCH LOCKS ENGAGED light goes on.

Placing the blade fold/spread switch to FOLD causes the blades to start folding and the BLADES SPREAD light to go off. When the blades are fully folded the BLADES FOLDED light goes on.

Placing the pylon fold/spread switch to FOLD will cause the PYLON UNSAFE FOR FLIGHT light to go on, to indicate the pylon is being folded. The tail rotor positioner actuator extends until it contacts the tail rotor cam and then internal force limiters shut off the actuator motor until the drive shaft coupling is disengaged. Both pylon lock-pins retract, and two red flags extend outward from the helicopter. The drive shaft coupling is disconnected, the coupling switch is actuated, and a third red flag extends downward from the helicopter. The pylon starts to fold after the previous conditions are met. The force limiters are now unloaded, the tail rotor positioner actuator

extends all the way, which drives the tail rotor cam to position the tail rotor for minimum height when folded, and locking the tail rotor so it will not turn while uncoupled.

CAUTION

Ensure main rotor head is properly positioned prior to pylon fold or spread operations. Before applying electrical power, check for main rotor blade at the 5:30 to 6:00 position.

Manual fold and spread of the tail rotor pylon may be accomplished using the hydraulic handpump mounted forward on the right side of the cabin. Electrical power is not required for manual operation and all system interlocks are bypassed (i.e., main rotor head in fold position and tail rotor positioner). If the tail rotor pylon is manually folded, the tail rotor positioner will remain the retracted position, allowing the tail rotor to rotate freely unless manually restrained. If electrical power is applied following a manual fold, the tail rotor positioner will extend, rotating the tail rotor up to 45° in either direction. Main rotor blade to tail rotor blade contact may occur when one of the seven main rotor blades is not in the 5:30 to 6:00 position.

Placing the pylon fold/spread switch to SPREAD will spread the pylon, and the PYLON UNSAFE FOR FLIGHT will go off. The pylon is fully spread when the pylon limit switch is actuated, both lockpins are in, the tail rotor coupling switch is deactuated, the tail rotor positioner is fully retracted, and the three red flags are retracted.

Placing the blade fold/spread switch to SPREAD causes the blades to start spreading and the BLADES FOLDED light to go off. When the blades are fully spread and all lockpins are in, the BLADES SPREAD light goes on.

Placing the PITCH LOCK switch to DISENGAGED causes the pitch locks to start to retract and the PITCH LOCKS ENGAGED light to go off. When all six pitch locks are retracted the PITCH LOCK ADVANCED light goes off.

At this time, the 2 STG M/R SERVO BYPAS caution light will go off.

Interlocks for the second stage main rotor bypass valve are: (1) main gear box oil pressure switch below 14 psi, (2) engine speed control lever at SHUT OFF, and (3) blade fold master switch at MASTER POWER.

Placing all switches off will cause the SAFETY VALVE OPEN light to go off and the FLIGHT READY light to go on.

2.15.2 Stick Position Indicator. The cyclic stick position indicator on the instrument panel permits the pilot, by use of the flight controls, to establish the necessary blade pitch position required for pitch lock engagement. The indicator is activated and lighted when the weight-on-wheels interlock is activated by compression of the oleo struts and the collective is positioned so that it is seated in the collective detent. The detent is slightly above the full down collective position.

The instrument has both a fore-aft (F-A) and a left-right (L-R) display axis. Each of the two axes consists of eight display segments on either side of the stick center segment. Each of these segments consists of two parallel lamp filaments. The center segment consists of four parallel lamp filaments. The segment in each axis, when lit, indicates a cyclic position displacement from neutral (flat blade pitch). The indicator does not display complete cyclic travel, since accurate cyclic position indication is only required about the flat blade pitch position. When an extreme segment is lit in each axis, this displays the quadrant the cyclic is in. The four stick-center arrows grouped around the stick-center lamp segment light when the cyclic is centered in both axes. The TEST pushbutton or positioning the collective in the detent lights all display segments at full intensity for a nominal 5 seconds. Instrument lighting intensity is controlled by turning the DIM knob.

No. 2 primary dc bus power is furnished to the instrument through a circuit breaker marked STICK POSN. No. 2B primary ac bus power is furnished through a circuit breaker marked STICK POSN IND PWR in the cabin.

2.16 FLIGHT INSTRUMENTS

2.16.1 Pitot-Static System. Two electrically-heated pitot tubes with static ports are on the top of the fuselage over the pilot and copilot. The left and right pitot tubes and static ports are interconnected to compensate for asymmetrical rotor downwash (swirl) and yaw effects. The common pitot pressure line supplies pitot pressure to the airspeed indicators, and to the air data transducer; and the common static pressure line supplies static air pressure to the altimeters, vertical velocity indicators, and to the air data transducer.

2.16.1.1 Airspeed Indicators. Two indicators (FO-5), mounted on the instrument panel, indicate the

forward airspeed of the helicopter in knots. The indicators are unreliable below about 40 KIAS.

2.16.1.2 Barometric Altimeter/Encoder. The AAU-32/A altimeter/encoder functions as a barometric altimeter for the pilot and a pressure altitude sensor for the APX-72 IFF transponder. The altimeter/encoder is on the pilot's side of the instrument panel (FO-5). The face of the altimeter is marked from 0 to 9 (X 100) feet, in 50-foot units. A counter window, next to the sweep hand, contains three digital drums that turn to indicate altitude in thousands and hundreds of feet. At altitudes below 10,000 feet, a barber pole appears in place of the left digit. The barometric pressure set knob permits altimeter settings from 28.10 to 31.00 inches Hg. A window in the lower right section of the altimeter displays the selected altimeter setting. The altimeter has a continuously operating dc powered vibrator to improve altitude indicating accuracy. The encoder provides a digital output of pressure altitude in units of 100 feet to the IFF transponder, with mode C selected, for automatic pressure altitude transmission. The encoder operates throughout the altimeter's operating range, but unlike the altimeter it uses a permanent altimeter setting of 29.92. If there is a loss of 115 vac, 400 Hz, the warning flag on the pilot's altimeter indicator, marked CODE OFF, will be displayed. The No. 2B primary ac bus circuit breaker panel in the cabin furnishes power through a circuit breaker marked ALT ENCODE, under the general heading RADIO. The No. 1 primary dc bus circuit breaker panel furnishes power through a circuit breaker marked IFF TEST, under the general heading RADIO.

2.16.1.3 Barometric Altimeter. The AAU-31/A altimeter, installed on the copilot's side of the instrument panel (FO-5), is identical to and operates in the same manner as the pilot's AAU-32/A altimeter/encoder, except there is no encoder associated with the altimeter, and there is no warning flag on the indicator. The No. 1 primary dc bus circuit breaker panel furnishes power to operate the altimeter's vibrator through a circuit breaker marked IFF TEST under the general heading RADIO.

2.16.1.4 Vertical Velocity Indicators. Two indicators on the instrument panel (FO-5) indicate vertical velocity in thousands of feet-per-minute. The common static pressure line supplies static air pressure to the indicator.

2.16.2 Attitude Heading Reference System (AHRS). The A/A24G-39 AHRS provides roll and pitch information for attitude control and indication, and directional information for navigation at all latitudes. As a heading reference, three modes of system operation are employed. In polar regions where magnetic heading references are not reliable, the system is operated in the directional gyro (DG) mode. In this mode, the system furnishes an inertial heading reference, with latitude corrections introduced manually. In areas where magnetic heading references are reliable, the system is operated in the SLAVED mode of operation. In this mode, the directional gyro is slaved to the compass transmitter, which supplies long-term magnetic reference for correction of the apparent drift of the gyro. During emergencies, when the DG or SLAVED modes are inoperable, the COMP mode of operation is used. In this mode, an emergency heading reference is provided by the compass transmitter. Pitch, roll, and heading (yaw) inputs are furnished to the AFCS. Pitch and roll inputs are furnished to the ADIs, and heading inputs are furnished to HSIs. In addition, the COMPASS FAIL caution light will go on when the AHRS malfunctions or fails. The caution light will go on for 2 minutes when the system is turned on, the period when the vertical gyro is in the automatic fast erect mode. The emergency ac bus (or the No. 3 primary ac bus on aircraft with AFC 490) circuit breaker panel in the cockpit furnishes power through a circuit breaker marked AHRS. The emergency dc bus circuit breaker panel in the cockpit furnishes power through a circuit breaker marked CMPS FAIL.

2.16.2.1 AHRS Controller. The controller is on the overhead control panel (FO-1). The DG position of the mode selector operates the system with the directional gyro. In SLAVED, the system works with the directional gyro slaved to the compass transmitter. The COMP position provides emergency operation with the compass transmitter. The N/S switch selects polarity of latitude correction signal; N for northern hemisphere, S for southern hemisphere. The LAT knob selects latitude of flight (0 to 90°) to correct heading gyro for apparent drift. When in the SLAVED mode, pressing and holding down the HDG/PUSH knob automatically causes synchronization of heading outputs with the compass transmitter heading. In the DG mode, the HDG/PUSH knob may be pushed and turned clockwise or counterclockwise to set heading on the HSIs. Pressing the HDG/PUSH knob when in the SLAVED mode also increases the roll and erection rates of the vertical gyro. In the SLAVED mode, the SYNC IND (synchronization indicator) window indicates synchronization between gyro heading and compass transmitter heading.

Note

The AFCS HEADING HOLD mode is automatically disconnected whenever the HDG/PUSH knob is pressed or the COMP position is selected. Reengagement of HEADING HOLD is delayed by 20 seconds following release of the HDG/PUSH knob or selection of the SLAVED or DG modes from the COMP mode.

2.16.2.2 VG Transfer Switch. Each pilot's miscellaneous switch panel (FO-1) has a two-position VG XFR switch. When pressed and lighted NORM, the 1080Y gyro system furnishes attitude information to the copilot's ADI and the AHRS furnishes information to the pilot's ADI. When either switch lights ALT, that ADI receives information from the other system. Control power for VG transfer is furnished by the emergency dc bus through two circuit breakers, marked PILOT and CO-PLT, under the general heading ADI GYRO.

2.16.2.3 Turn Rate Switch. Each pilot's miscellaneous switch panel (FO-1) has a two-position TURN RATE switch. When pressed and lighted NORM, the copilot's turn rate gyro furnishes rate-of-turn information to the copilot's turn indicator and the pilot's turn rate gyro furnishes rate-of-turn to the pilot's indicator. When either switch is lighted ALT, that turn indicator is furnished rate-of-turn information from the other gyro. Power for the turn rate gyro operation and switching is furnished by the emergency dc bus through two circuit breakers, marked PILOT and CO-PLT, under the general heading ADI GYRO.

2.16.3 Attitude Director Indicator (ADI). Two ADIs, installed on the instrument panel (FO-5), visually indicate the helicopter's pitch, roll, attitude, turn rate, slip, and certain navigational information. The system also monitors and displays warnings when selected navigation instrument readings lack reliability. The ADI face consists of a miniature airplane representing the helicopter, pitch and bank angle scales, an inclinometer (slip indicator), attitude adjustment knobs, warning flags, and advisory lights to provide appropriate function status indications, and navigation command bars and pointer scales to display navigational information. The copilot's ADI normally receives inputs from the 1080Y vertical gyro and the pilot's ADI receives inputs from the AHRS. There is an ATT warning flag in the face of each ADI. When the 1080Y gyro is selected to furnish inputs to either ADI, that ADIs warning flag will show to indicate loss of gyro power or ADI malfunction. In addition, the flag will be visible for about 1 minute after ac power has been applied to the circuit while the gyros come up to speed. When the AHRS is selected to furnish inputs to either ADI, that ADIs warning flag will show when there is ac power loss to the AHRS. Power to operate the 1080Y and AHRS gyros is furnished by the emergency ac bus through circuit breakers marked ADI GYRO CO-PILOT and AHRS. On aircraft with AFC 490, the pilot ADI is protected by a cockpit circuit breaker on the emergency ac bus marked ADI PILOT and the copilot ADI is protected by a cockpit circuit breaker on the No. 3 primary ac bus marked ADI CO-PILOT. See Chapter 15 for ADI navigation functions.

2.16.3.1 ADI Controls and Functions. The ADI (Figure 2-26) face contains a moving two-colored spheroid with an artificial horizon dividing the two colors, white above and black below. A miniature airplane provides the helicopters attitude orientation reference. The spheroid moves in two rotational degrees of freedom to indicate attitude of the helicopter in bank and pitch. A bank angle scale and bank angle index show the degree of helicopter bank. Perspective lines show a grid of imaginary lines and provide a pitch reference scale above and below the horizon. The roll and pitch knobs marked ROLL and PITCH respectively, adjust the attitude of the spheroid for pitch and roll. An attitude flag marked ATT shows when power to the ADI is removed or the system malfunctions. If the ATT flag shows in flight, select alternate VG XFR. The turn rate indicator provides rate of turn information; one needle width = 180°/minute turn rate (a standard rate turn). the slip indicator shows direction of slip or skid. Four warning flags on the face of the ADI marked GS-NAV-DOP-RAY for glide slope, navigation, Doppler, and precise AMCM navigation (Raydist) show when the individual function has power removed, is malfunctioning, or respective navigational signal received is below minimum usage. The advisory lights across the top of the ADI are marked DH-MB-BC. The DH (decision height) advisory light will go on whenever the radar altimeter is operating and the altitude indicator is at or below the radar altitude low bug setting. The MB (marker beacon) advisory light will go on and the associated marker beacon tone will be heard, depending upon volume control setting, when the helicopter is over the marker beacon transmitter. The BC (back course) advisory light will go on whenever BACK CRS is selected on the mode select panel. The horizontal pointer indicates to the pilot, during precise navigation operation, the helicopter's lateral position relative to the minefield. The scales represent right or left of course. The pilot must fly toward the needle to regain on-course track. The vertical pointer indicates to the pilot, during precise navigation operation, the helicopter's relative longitudinal position in the mine field. During Doppler selection the vertical pointer indicates helicopter vertical velocity. The vertical and horizontal command bars provide various

navigation information for precise AMCM and Doppler navigation. Each bar has twelve divisions for navigation measurement.

2.16.4 Horizontal Situation Indicator (HSI). Two HSIs, installed on the instrument panel (FO-5), present a plan view of the navigation situation as if the pilot were looking down from above the helicopter. The HSI uses navigation data from various sources to present the pilots with a symbolic display of the horizontal navigation situation needed to arrive at a predetermined point. The instrument consists of a rotating compass card, two bearing pointers, a heading indicator, course deviation indicator, range and course indication windows, heading and course selection knobs, and indicator flags. The compass card is driven by the AHRS to display magnetic heading in the slaved or compass mode, or heading reference in the directional gyro mode. Power for the HSIs is provided by the No. 3 primary ac bus through two circuit breakers marked HSI NO 1 and HSI NO 2, and two sets of emergency ac bus circuit breakers each marked HSI NO 1 and NO 2. On aircraft with AFC 490, the two sets of HSI circuit breakers on the cockpit overhead panel are on the No. 3 primary ac bus. One set, under the general heading of HSI, 26 VAC, is marked NO 1 and NO 2. The other set is labeled HSI NO 1 and HSI NO 2. See Chapter 15 for HSI navigation functions.

2.16.4.1 HSI Controls and Functions. The HSI (Figure 2-27) face contains a 360° compass card which turns to display helicopter heading data from the AHRS. The OFF warning flag shows when power is removed from the HSI, or AHRS malfunction. The course set knob marked CRS moves the course set pointer and adjusts the course set display (marked COURSE) to allow 360° course selection. Once set, the course pointer will turn with the compass card and will be centered on the upper lubber line when the helicopter is flying the course selected. The course deviation bar indicates lateral deviation from a selected course. When the helicopter is flying on a selected course, the course deviation bar will be aligned with the course set pointer and will be centered on the fixed aircraft symbol at the center of the instrument. The course deviation dots provide a scale for the course deviation bar based upon navigation equipment selected. The TO/FROM indicator pointer when pointing to the head of the course set pointer indicates the course selected will take the helicopter to a selected station or "fly-to-point". Pointing to the tail indicates the course selected will take the helicopter away from the station or "fly-to-point". The heading select knob marked HDG positions the heading indicator, allowing the pilot to select any of 360 headings. No. 1 and No. 2 bearing pointers indicate relative bearing to the signal source being tracked:

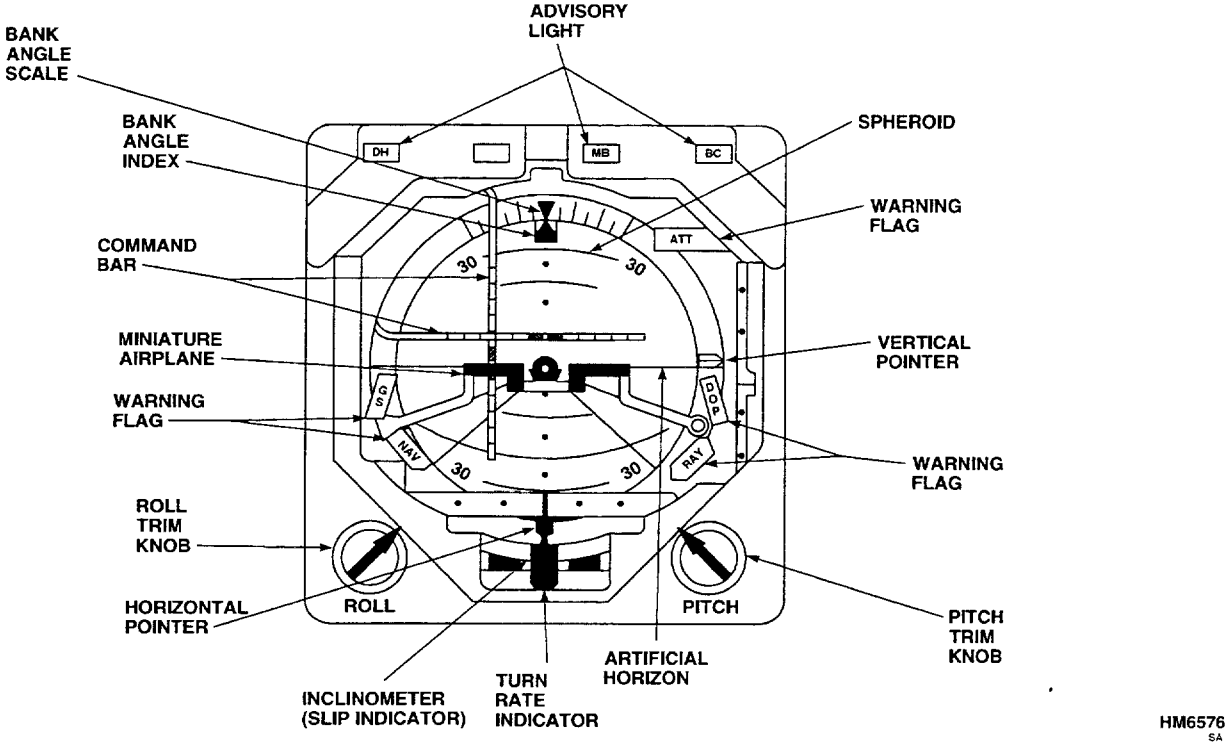


Figure 2-26. Attitude Director Indicator

Omega or ADF (LF, UHF) on No. 1, and TACAN or VOR on No. 2. The NAV flag shows when the selected navigation data is unreliable. The range display marked MILES shows digital range information in hundred, tens, units, and tenths of a nautical mile to a DME transponder. Distance is slant range to ground station or horizontal range to a "fly-to-point". The range display is masked when signal is unreliable. The glide slope pointer indicates deviation from glide slope and the GS flag shows when glide slope information is unreliable. The glide slope pointer and flag are used solely with ILS approach systems.

2.16.5 Radar Altimeter. The APN-171(V) dual radar altimeter system provides instantaneous indication of actual clearance between the helicopter and terrain from 0 to 5000 feet. Altitude, in feet, is indicated by the two radar altimeter indicators on the instrument panel (FO-5). Two systems are provided, which may be selected by two switches on the copilot's miscellaneous switch control panel (FO-1) marked ON-OFF under the general heading RAD ALT 1 and RAD ALT 2. Each system operates identically, using separate receiver transmitters and antenna pairs, providing input to the pilot and copilot indicators. A switch marked CHAN 1-CHAN 2 under the heading RAD ALT on the copilot's miscellaneous switch panel (FO-1) selects the RAD ALT 1 or RAD ALT 2 receiver/transmitters as the information source for both pilot and copilot radar altimeter indicators. The indicators contain a pointer that indicates altitude on a linear scale from 0 to 200 feet in 5-foot units, 200 to 1000 feet in 50-foot units, and 1000 to 5000 feet in 200-foot units. A control knob, on the lower left corner of the indicator, marked PUSH-TO-TEST, serves as a test switch and a low-level warning index set control. Clockwise turning of the control knob toward SET will permit the pilot to select any desired low-altitude limit, which will be indicated by the low-level warning index marker on the indicator. 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. The test capability is disabled when the AFCS RDR ALT mode is engaged. A low-level warning light, on the lower right corner of the indicator, will go on and show the marking LOW any time the helicopter is below the low-altitude limit that has been selected. Loss of system power or tracking condition will be indicated by a black

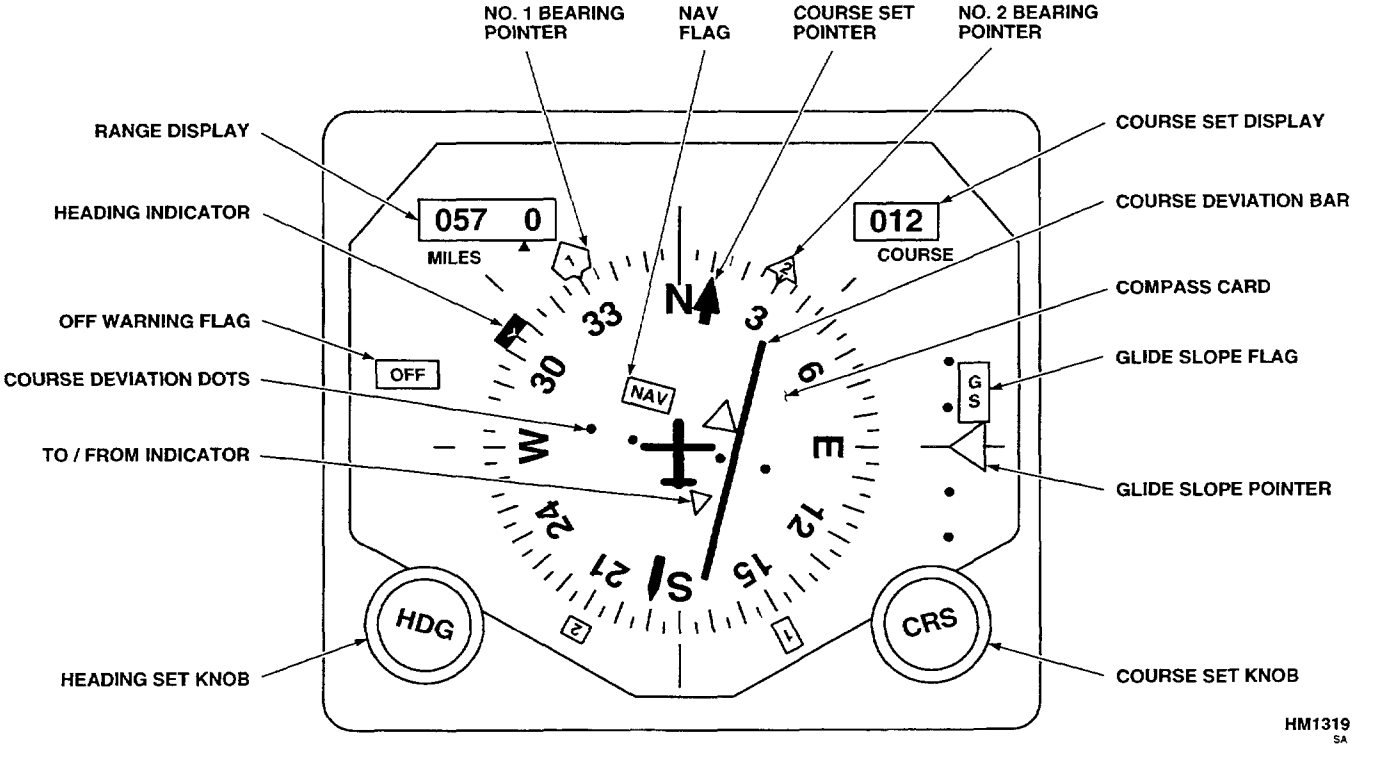


Figure 2-27. Horizontal Situation Indicator

and yellow striped flag in the indicator window, on the lower center portion of the indicator. At that time the indicator pointer will go behind a mask, marked NO TRACK, to prevent erroneous readings. Switching the RAD ALT CHAN 1 or CHAN 2 select switch to the alternate system should restore normal operation. Two lights marked RAD ALT 1 UNREL and RAD ALT 2 UNREL on the advisory panel go on when the respective radar altimeter system has a loss of power, or tracking condition. Fluctuations of about ±2.5 feet may be expected at altitudes below 200 feet. The RDR ALT mode select switch on the pilot's miscellaneous switch panel (FO-1) allows selection of the radar tracking rate. The LAND mode tracks at 2000 feet-per-second, while the SEA mode tracks at 50 feet-per-second.

WARNING

Both altimeters will lag in high rates of descent (autorotation) if the RDR ALT switch is at SEA.

Note

- Allow about 3 minutes, after system is turned on, for it to reach operating temperature.
- The altimeter may furnish erroneous indications when carrying external loads.

One radar altimeter receives power from the No. 2B primary ac bus through a circuit breaker marked RADAR ALT-1 under the general heading RADIO and from the No. 2 primary dc bus through a circuit breaker marked RADAR ALT-1 under the general heading RADIO. One radar altimeter receives power from the No. 3 primary ac bus through a circuit breaker marked RADAR ALT-2 under the general heading RADIO and from the No. 3 primary dc bus through a circuit breaker marked RADAR ALT-2 under the general heading RADIO.

WARNING

- Should both radar altimeters fail or a miscomparison is sensed by the AFCS computers and there is no OFF flag shown, RAD ALT hold will be disengaged.
- If a radar altimeter is manually shut off for any reason, do not attempt to turn the system back on if the radar altitude hold mode of the AFCS is engaged. Secure RAD ALT HOLD before troubleshooting any radar altimeter malfunctions. Failure to do so will result in an uncommanded climb or descent.

2.16.6 Clocks. The elapsed-time clocks, one each, for each pilot, are mounted on the instrument panel (FO-5). The control knob for the elapsed-time mechanism is at the upper right corner of the clock face. The clock is stemwound and stemset, using a knob in the lower left corner of the clock face.

2.16.7 Free-Air Temperature Gage. The gage, mounted forward of the copilot's overhead window, indicates outside air temperature in °C.

2.16.8 Standby Compass. A magnetic standby compass is at the top center of the instrument panel, and a compass correction card is on both sides of the instrument panel. A compass light switch, with marked positions ON and OFF, is attached to the compass case. The compass light receives power from the No. 1 dc primary bus through a circuit breaker in the cabin, marked AVIONIC LTG CONSOLE.

2.17 CAUTION AND ADVISORY PANELS

2.17.1 Caution Panel. The caution panel (FO-6), in the center of the instrument panel, visually indicates failure or unsafe conditions of certain critical equipment in the helicopter. The panel contains placard-type caution lights, each with its own operating circuit, to indicate a malfunction or unsafe indication in a particular system. The caution light for that particular system will remain on until the malfunction or unsafe indication is corrected. Bulbs are replaced by momentarily pressing the capsule, which releases a lock and extends the capsule out away from the face of the panel. The capsule can now be turned for bulb replacement. Resetting the lock is achieved, before reinserting the capsule into the panel, by pulling the capsule out until resistance is encountered. The caution panel operates on power from the emergency dc primary bus through a circuit breaker marked CAUTION PANEL MASTER, in the cockpit. See Figure 2-28 for capsule summary.

NAME	MEANING
BIM	Loss of main rotor spar integrity or spar pressure indicator malfunctioning. IBIS radiation detector, signal processor, or 115 vac power malfunction.
ICE DETECTED	Ice is building up on helicopter when system is selected.
COMPASS FAIL	AHRS has malfunctioned.
ROTOR LOCKED	Gust lock handle is in locked position.
ROTOR BRAKE PRESS	Rotor brake system is pressurized to at least 10 psi.
CHIP DETECTED	Gear box or engine metallic chips have been detected.
AFCS	Dual computer failure or power not applied.
#1 RECT	No. 1 transformer-rectifier has malfunctioned.
#2 RECT	No. 2 transformer-rectifier has malfunctioned.
#1 GEN	No. 1 generator not operating or has malfunctioned, or if on the ground and below 91% to 96% N_r, a momentary underfrequency has been experienced.
#2 GEN	No. 2 generator not operating or has malfunctioned, or if on the ground and below 91% to 96% N_r, a momentary underfrequency has been experienced.
#3 GEN	No. 3 generator not operating or has malfunctioned, or if in the ground and below 91% to 96% N_r, a momentary underfrequency has been experienced.
IGB OIL PRESS	Intermediate gear box oil pressure is below 7 ±1 psi.
#2 ENGINE OVERHEAT (AFC 483, otherwise blank)	Overheating condition exists in #2 engine compartment.
2 STG OIL HOT	Second stage hydraulic temperature above 107°C and/or the second stage heat exchanger blower motor is inoperative.
#1 ENG FLTR BYPASS	Pressure drop across No. 1 fuel system airframe fuel filter is over 1.37 ±0.5 psi, and filter is partially clogged.
#2 ENG FLTR BYPASS	Pressure drop across No. 2 fuel system airframe fuel filter is over 1.37 ±0.5 psi, and filter is partially clogged.
#3 ENG FLTR BYPASS	Pressure drop across No. 3 fuel system airframe fuel filter is over 1.37 ±0.5 psi, and filter is partially clogged.

Figure 2-28. Caution Light Summary Table (Sheet 1 of 4)

NAME	MEANING
TGB OIL PRESS	Tail gear box oil pressure is below 7 ±1 psi.
BLADE PYLON FOLD	Blade/pylon fold system activated and/or gust-lock engaged. Helicopter unsafe for flight.
UTILITY 1 OIL HOT	Utility 1 hydraulic temperature above 107°C and/or the utility 1 system heat exchanger blower motor is inoperative.
#1 ENG FUEL BOOST	No. 1 boost pump output below 8.5 ±0.5 psi.
#2 ENG FUEL BOOST	No. 2 boost pump output below 8.5 ±0.5 psi.
#3 ENG FUEL BOOST	No. 3 boost pump output below 8.5 ±0.5 psi.
1 STG M/R SERVO BYPAS	A servo has malfunctioned in a manner to cause it to bypass hydraulic pressure and/or loss of system pressure.
2 STG M/R SERVO BYPAS	A servo has malfunctioned in a manner to cause it to bypass hydraulic pressure and/or loss of system pressure.
UTILITY T/R PRESS	UTILITY 1 pressure, downstream of the second stage tail rotor servo shutoff valve in the utility module, has dropped below 1500 psi.
#1 ENG OIL PRESS LOW	Low oil pressure in No. 1 engine (10 to 13 psi).
#2 ENG OIL PRESS LOW	Low oil pressure in No. 2 engine (10 to 13 psi).
#3 ENG OIL PRESS LOW	Low oil pressure in No. 3 engine (10 to 13 psi).
1 STG T/R SERVO BYPAS	The servo has malfunctioned in a manner to cause it to bypass hydraulic pressure and/or loss of system pressure.
UTILITY 2 PRESS	Utility 2 hydraulic system pressure below 675 psi, with system selected.
2 STG T/R SERVO BYPAS	The servo has malfunctioned in a manner to cause it to bypass hydraulic pressure and/or loss of system pressure.
#1 NGB OIL PRESS	No. 1 nose gear box oil pressure below 14 ±2 psi.
MGB OIL PRESS	Main gear box oil pressure below 14 ±2 psi.
#3 NGB OIL PRESS	No. 3 nose gear box oil pressure below 14 ±2 psi.
1 STG PRESS M/R T/R	First stage flight control system below 2000 psi.
2 STG PRESS M/R	Second stage flight control system hydraulic pressure below 2000 psi.
UTILITY 1 PRESS	Utility 1 hydraulic system pressure below 1500 psi.
#1 NGB OIL HOT	No. 1 nose gear box oil temperature above 121°±5.5°C
MGB OIL HOT	Main gear box above 121° ±5.5°C.
#3 NGB OIL HOT	No. 3 nose gear box oil temperature above 121° ±5.5 °C.

Figure 2-28. Caution Light Summary Table (Sheet 2 of 4)

NAME	MEANING
1 STG QTY M/R T/R	Hydraulic fluid quantity is at an unsatisfactory low level.
2 STG QTY M/R	Hydraulic fluid quantity is at an unsatisfactory low level.
UTILITY 1 QTY T/R	Hydraulic fluid quantity is at an unsatisfactory low level.
#1 ENG OIL PRESS HIGH	High oil pressure in the No. 1 engine (100 ±3 psi or above).
#2 ENG OIL PRESS HIGH	High oil pressure in the No. 2 engine (100 ±3 psi or above).
#3 ENG OIL PRESS HIGH	High oil pressure in the No. 3 engine (100 ±3 psi or above).
C/G HOOK INOP	(Not operative. Replaced by DOPPLER with AFC 491. See DOPPLER.)
UTILITY 2 OIL QTY	Hydraulic fluid quantity is at an unsatisfactory low level.
ACC GB OIL PRESS	Accessory gear box oil pressure below 7 ±1 psi.
#1 ENG OIL QTY LOW	No. 1 engine oil at or below refill level.
#2 ENG OIL QTY LOW	No. 2 engine oil at or below refill level.
#3 ENG OIL QTY LOW	No. 3 engine oil at or below refill level.
ALTITUDE	1. Unreliable radar altimeter and (a) airspeed less than 60 kts or (b) helo in coupled hover. 2. Reliable radar altimeter, helo below radar altimeter low-level warning index setting and (a) landing gear is up, or (b) tow coupler and RDR ALT hold are engaged, or (c) hover coupler is on.
UTILITY 2 OIL HOT	Utility 2 hydraulic temperature above 107°C and/or the Utility 2 system heat exchanger blower motor is inoperative.
ACC GB OIL HOT	Accessory gear box oil temperature above 145°C.
#1 ENG ANTI-ICE	Duct temperature below 35°C, or electrical failure in system.
TAIL ROTOR HIGH STRESS (416 ENGINES)	Indicated airspeed >60 knots, total average engine torque >110%, and climb rate 2800+ feet per minute.
#3 ENG ANTI-ICE	Duct temperature below 35°C, or electrical failure in system.

Figure 2-28. Caution Light Summary Table (Sheet 3 of 4)

NAME	MEANING
TNSN/SKEW ANGLE	Anytime tow tension is greater than the high setting. Anytime skew angle is approximately 8° (extinguishes when skew angle goes beyond 12°).
DOPPLER	Doppler is in memory or has failed. (Replaced by BEARING VIB LIMIT with AFC 491.)
BEARING VIB LIMIT (AFC 491)	Vibration level from at least one of the swashplate sensors (SP-1 and/or SP-2) has reached 2.5 g's, or vibration level from the tail rotor drive shaft disconnect coupling bearing (DISC) has reached 4.0 g's.
GPWS INOP	(Not operative. Removed by AFC 501 PT 3 or replaced by BEARING TEMP DETECT with AFC 491.)
BEARING TEMP DETECT (AFC 491)	Temperature level from at least one of the swashplate sensors (SP-1 and/or SP-2), or the tail rotor drive shaft disconnect coupling bearing (DISC) has reached 275°F.
GPWS TAC INHB	(Not operative. Removed by AFC 501 PT 3 or replaced by BEARING TEMP LIMIT with AFC 491.)
BEARING TEMP LIMIT (AFC 491)	Temperature level from at least one of the swashplate sensors (SP-1 and/or SP-2), or the tail rotor drive shaft disconnect coupling bearing (DISC) has reached 350°F.
MGB AUX LUBE PUMP	Main gear box auxiliary oil pressure below 14 ±2 psi.
ENGINE OVERTORQUE	Any engine torque exceeds 137 ±3%. Remains lit when any engine torque exceeds 153% to 156%.
EAPS HIGH PRESS LOSS	Dual pressure switch or relay malfunction. Too much drop in system pressure due to filter clogging.
IFF	When operating in MODE 4, system has malfunctioned, or being interrogated and no reply being made.
2PT FLT UNARMED	LOAD/UNLOAD mode selected for two-point external cargo system.
#1 FUEL LOW	About 544 pounds of JP-5 fuel (80 gallons) remains in No. 1 tank.
#2 FUEL LOW	About 272 pounds of JP-5 fuel (40 gallons) remains in No. 2 left or right tanks.
#3 FUEL LOW	About 544 pounds of JP-5 fuel (80 gallons) remains in No. 3 tank.

Figure 2-28. Caution Light Summary Table (Sheet 4 of 4)

2.17.2 Advisory Panel. The advisory panel (FO-6), below the caution panel on the instrument panel, visually indicates certain operating conditions that exist while in flight or on the ground. The advisory panel contains placard-type advisory lights, each with its own operating circuit, to indicate a particular system is in operation or a certain flight condition exists. The advisory light for that particular system or condition will then go on and remain on until that system is turned off or the condition no longer exists. Bulbs are replaced as on the caution panel. The advisory panel operates on power from the emergency dc primary bus through a circuit breaker marked CAUTION PANEL MASTER, in the cockpit. See Figure 2-29 for capsule summary.

NAME	MEANING
ENG STARTER ON	Lights when any engine starter circuit is energized.
EXT PWR CONNECTED	External power connected to the helicopter.
RAMP OPEN	Cargo ramp or door is open.
#1 IGV ANTI-ICE ON	No. 1 engine air and inlet anti-icing system is turned on.
#2 IGV ANTI-ICE ON	No. 2 engine air anti-icing system is turned on.
#3 IGV ANTI-ICE ON	No. 3 engine air and inlet anti-icing systems are turned on.
APP ON	APP is operating above 92%.
ISOLATION VALVE OPEN	Isolation valve is open.
PARKING BRAKE ON	Parking brake handle is extended.
EAPS DOOR CLOSED	All three EAPS bypass doors are closed.
ROTOR BRAKE ON	Rotor brake system is fully pressurized to 975 ±25 psi.
ENG START HEAD POS	Main rotor head is positioned for engine start.
AUTO RELEASE ON	Single-point cargo hook switch is at AUTO to select automatic release mode.
FWD HOOK OPEN	Two-point hook release latch open or not fully closed.
UTILITY 2 PUMP ON	Utility 2 Hydraulic pump is on.
BLANK CAPSULE	
PURGING	PURGE pushbutton on the 8.5-minute purge taking place. Advisory light goes off when purge automatically terminates or PURGE ARM pushbutton pressed to off.
AFCS DEGRADED	Any AFCS failure, other than dual computer failure, will cause light to flash.

Figure 2-29. Advisory Light Summary Table (Sheet 1 of 2)

NAME	MEANING
SINGLE PT HOOK OPEN	Hook release latch open or not fully closed.
AFT HOOK OPEN	Two-point hook release latch open or not fully closed.
BLANK CAPSULE	(Replaced by GPWS INOP with AFC 491.)
GPWS ALERT	Dynamic state of helicopter will cause penetration of established minimum recovery altitude (AFC 501 Part 3, otherwise blank).
COMM 1 ANT EXTENDED	COMM 1 antenna extended with ramp unlocked. (Blank with AFC 455, Part 4)
BLANK CAPSULE	
RAD ALT 1 UNREL	Radar altimeter 1 receiver/transmitter unreliable or inoperative.
BLANK CAPSULE	(Replaced by C/G HOOK INOP with AFC 491.)
BLANK CAPSULE	(Replaced by GPWS TAC INHB with AFC 491.)
GPWS INOP	GPWS failure has been detected by the integrity monitoring function (AFC 501 Part 3, otherwise blank).
BLANK CAPSULE	
RAD ALT 2 UNREL	Radar altimeter 2 receiver/transmitter unreliable or inoperative.

Figure 2-29. Advisory Light Summary Table (Sheet 2 of 2)

2.17.2.1 Caution Advisory Panel Test. A press-to-test switch on the bottom of the panel is used to test the bulbs in the panel, blade and pylon fold lights, chip locator lights, landing gear up warning light, rotor brake lights, AFCS pale lights, and master warning lights.

2.17.3 Master Caution Lights. These lights (FO-5), marked MASTER CAUTION PUSH TO RESET, each at the top of the pilot's and copilot's instrument group, will go on any time a caution light on the caution panel goes on to alert the pilots of a malfunction or condition within the helicopter. After the specific malfunction or condition has been noticed, the press-to-reset master caution lights may be reset to provide a similar condition if a second malfunction or condition should occur while the first is still present. The master caution light and test circuit uses the same power source and protective circuit breaker as the caution panel. See Figure 2-30 for capsule summary.

2.18 ENVIRONMENTAL CONTROL SYSTEMS

2.18.1 Electronic Cooling System. A blower is installed in the Doppler compartment to cool AHRS and Doppler equipment. The blower operates continuously whenever there is power on the No. 1 primary ac bus. Power is furnished through a circuit breaker in the cabin marked DOPPLER FAN.

2.18.2 Heating System. The system (Figure 2-31) consists of fans, an internal combustion heater, a plenum chamber, and ducts which run along the upper left and right sides of the cabin, and into the pilot's compartment. The 600,000 BTU heater, forward of the APP, operates on fuel supplied from the No. 2 left fuel tank and uses about 54 pounds of fuel per hour. Heater combustion air is supplied by a combustion air blower and ventilating air by the vent fan. Both operate on electrical power from the No. 2A primary ac bus. The circuits are protected by circuit breakers in the cabin marked COMB AIR BLOWER and VENT BLOWER. The control circuit receives power from the No. 1 primary dc bus through a circuit breaker in the cabin, marked CAB HTR.

2.18.2.1 Heating System Control. The CABIN HTR control panel, on the overhead control panel (FO-1), controls the heating system with the HEAT rheostat. When the rheostat is beyond the OFF, the heater system is put into operation. Further turning of the rheostat will increase heater output until the desired heat level is reached. An overheat switch will shutoff the heater if for any reason the heat in the plenum chamber rises to 204°C. When the desired setting of the rheostat is reached, the temperature controller will automatically maintain the desired temperature. Ignition and fuel to the heating system is automatically shut off whenever the APP emergency T-handle is actuated, an overheat condition occurs, or if there is no ignition 45 seconds after the heater is turned on.

2.18.2.2 Vent Fan Switch. The ventilating fan switch marked VENT, with marked positions OFF and

NAME	LOCATION	MEANING WHEN LIT
MASTER CAUTION	Instrument panel (Two places)	Caution light on caution panel is on
LGD GEAR UP	Landing gear indicator on instrument panel	Landing gear up when helicopter below 150 feet, and airspeed below 60 KIAS
MAIN XMSN FIRE (419 engine)	Instrument panel (Two places)	Fire in No. 2 input area of main transmission
FIRE	Instrument panel (Two places)	Fire in ENGINE OR app/heater compartment
ENG EMER OFF	Engine emergency T-handles	Fire in engine compartment
APP EMER OFF	APP emergency T-handle	Fire in APP/heater compartment
Landing Gear Warning Light	Landing gear control handle	Landing gear is in transit or not locked up or down
UNLOCKED	Crewman's control panel (Left side aft cabin)	Cargo ramp or door unlocked

Figure 2-30. Warning Light Summary Table

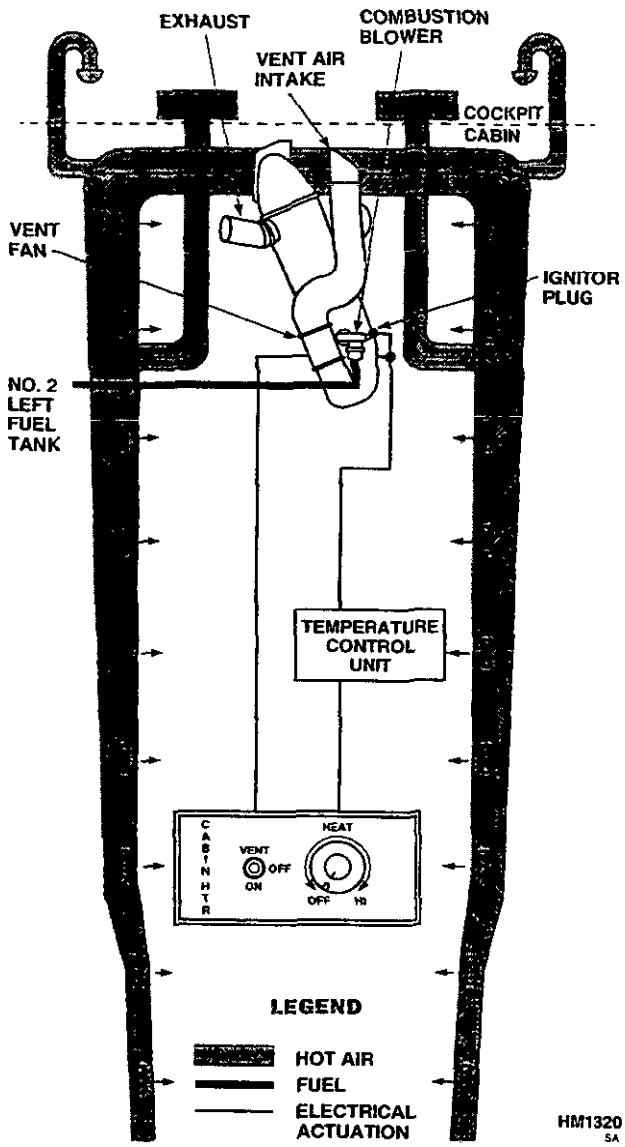


Figure 2-31. Heating/Ventilation Schematic

ON, is on the cabin heater control panel; and is marked CABIN HTR on the overhead control panel (FO-1). When the cabin heat rheostat control is moved out of OFF, the vent fan operates in conjunction with the heating system, regardless of the position of the vent fan switch. Placing the vent fan switch ON, with the cabin heat rheostat control OFF, will draw outside air into the heater system and ventilate the pilot's compartment and cabin.

2.18.2.3 Heating and Ventilating Diffusers. The diffusers are in each of the heating ducts that extend along the sides of the cabin and into the pilots compartment. The pilot's compartment has four diffusers, two in the floor and two on the bulkhead in front of the pilot's and copilot's heads. Turning the overhead diffusers clockwise opens the diffusers, turning counterclockwise closes. There are 18 diffusers in the cabin, nine in each duct on each side of the cabin. Each diffuser can be adjusted to regulate the flow of heated or ventilating air through the diffusers.

Note

The heater should be turned off 10 minutes before removing electrical power from the system. The heater is shut off by moving the cabin heater rheostat control OFF. The vent fan and combustion air fan will continue to operate after the heater is shut off, until the temperature in the plenum chamber drops to 49°C. If the temperature in the plenum chamber should rise to 49°C during hot weather, the fans will begin to operate as soon as the No. 2A primary ac bus is energized.

2.19 WINDSHIELD WASHER SYSTEM

The system consists of a reservoir, windshield washer motor/pump, and a control switch. The reservoir, behind the copilot's seat, holds 6 quarts. The windshield washer motor pumps the fluid through tubing to the spray bars in the windshield wiper blades. The windshield washer motor is controlled by a switch, with marked positions OFF and WASH, on the windshield wiper control panel (FO-1). Placing the switch to WASH causes the windshield washer motor to pump fluid through the wiper spray bars to the windshield. The windshield washer system is powered from the No. 3 primary dc bus through a circuit breaker marked WSHLD WSHR CONT, in the cabin.

2.20 WINDSHIELD WIPER SYSTEM

The electrically-operated system consists of a two-speed motor, two converters, and a rotary control switch. The windshield wipers are on the pilot's and copilot's windshields and have an approximate 56° range of travel. The system is controlled by a rotary-type switch with marked positions PARK, OFF, LOW, AND HIGH, on the overhead windshield wiper control panel, marked WINDSHIELD WIPER (FO-1). When the switch is placed to LOW or HIGH, the system is actuated and the desired speed range is selected. When the switch is turned to PARK, the wipers automatically position to the inboard edge of the windshields. The wiper arms have high tension springs installed to increase visibility by reducing wiper blade buffeting and lifting at high speeds. The windshield wiper system receives electrical power from the No. 2B primary ac bus through a circuit breaker in the cabin, marked WINDSHIELD WIPER.

CAUTION

To prevent scratching the windshields, do not operate the wipers on dry glass.

2.21 ANTI-ICING SYSTEMS

Ice protection is provided for the engines, windshields, and pitot tubes. Fourteenth-stage compressor air is used to anti-ice the engines' inlet guide vanes and five of the front frame struts. The 6-o'clock front frame strut is anti-iced by hot scavenge oil from the engine. Continuous ignition is provided whenever the respective engine anti-ice is selected to reduce the possibility of engine flameout during icing conditions. The No. 1 and No. 3 engines' inlet duct, inlet removable sections, and nose gear box fairing are electrically-heated. EAPS is installed permanently on the No. 2 engine. With EAPS installed on the No. 1 and No. 3 engines the nose gear box fairing anti-icing capability is disabled.

The anti-icing system (Figure 2-32) should be turned on and the EAPS doors manually closed when operating during conditions in which ice may be formed, thereby eliminating the possibility of ice being formed and subsequently ingested into the compressor to cause power loss or engine failure. When the EAPS doors have been manually closed to prevent engine ice ingestion, the doors shall be kept closed until the engines are shut down after landing. This is necessary even if icing conditions no longer exist, to prevent ingestion of accumulated ice.

2.21.1 Ice Detector System. The system visually indicates icing conditions, and consists of ice detector probes, an ice detector controller, a caution light, and necessary switches and electrical circuits. The ice detector probes, one in the heater intake duct and the other above the upper frame of the pilot's window, indicate icing conditions as they accumulate ice. The probe above the pilot's window frame is visually monitored to assist in determining icing conditions during flight. The probe in the heater duct indicates ice accumulation if the ice detector switch is ON, by lighting the ICE DETECTED caution light. The system is controlled by a switch marked ICE DET with marked positions TEST, OFF and ON, on the anti-ice control panel. When the switch is placed ON, the system will function automatically. When the switch is placed to TEST, the MASTER CAUTION and ICE DETECTED caution lights will go on. Pressing the MASTER CAUTION light for reset will turn it off; however, the ICE DETECTED caution light will not go off for about 35 seconds. The probe in the heater duct contains radioactive strontium 90 that emits beta particle radiation across an air gap. When the air gap is obstructed by ice accumulation, the reduced amount of radiation received by the detector causes a current change to activate the system. When ice is detected and the system activated (ICE DET switch ON), the ICE DETECTED caution light will go on and the ice detector controller will simultaneously apply an electrical current to the probe to melt the ice. The ICE DETECTED caution light will remain on 35 seconds, or longer, until the ice has been melted from the air gap. The light will go on again each time ice accumulates in the air gap. The frequency at which the light goes on is an indication of the severity of icing conditions. The system receives power from the No. 2B primary ac and No. 1 primary dc buses through the circuit breakers in the cabin, marked ICE DET.

WARNING

There is no significant radiation danger when more than 3 feet from the probe; however, do not spend more than a few minutes looking into the heater duct at the probe. If the helicopter is damaged, or the probe has been physically damaged, exposed to temperatures above 500°F, or is obviously discolored, the condition should be reported to maintenance personnel so that special handling procedures can be used.

Note

The ice detection system warns of ice accumulation only and does not automatically activate the helicopter anti-icing systems.

2.21.2 Engine Anti-Ice System

Note

- Interlocks are provided to prevent more than one engine's anti-ice system from operating when the helicopter's electrical systems are powered by an external power cart.
- With EAPS installed, No. 1 and No. 3 engines nose gear box fairing anti-icing capability is disabled.

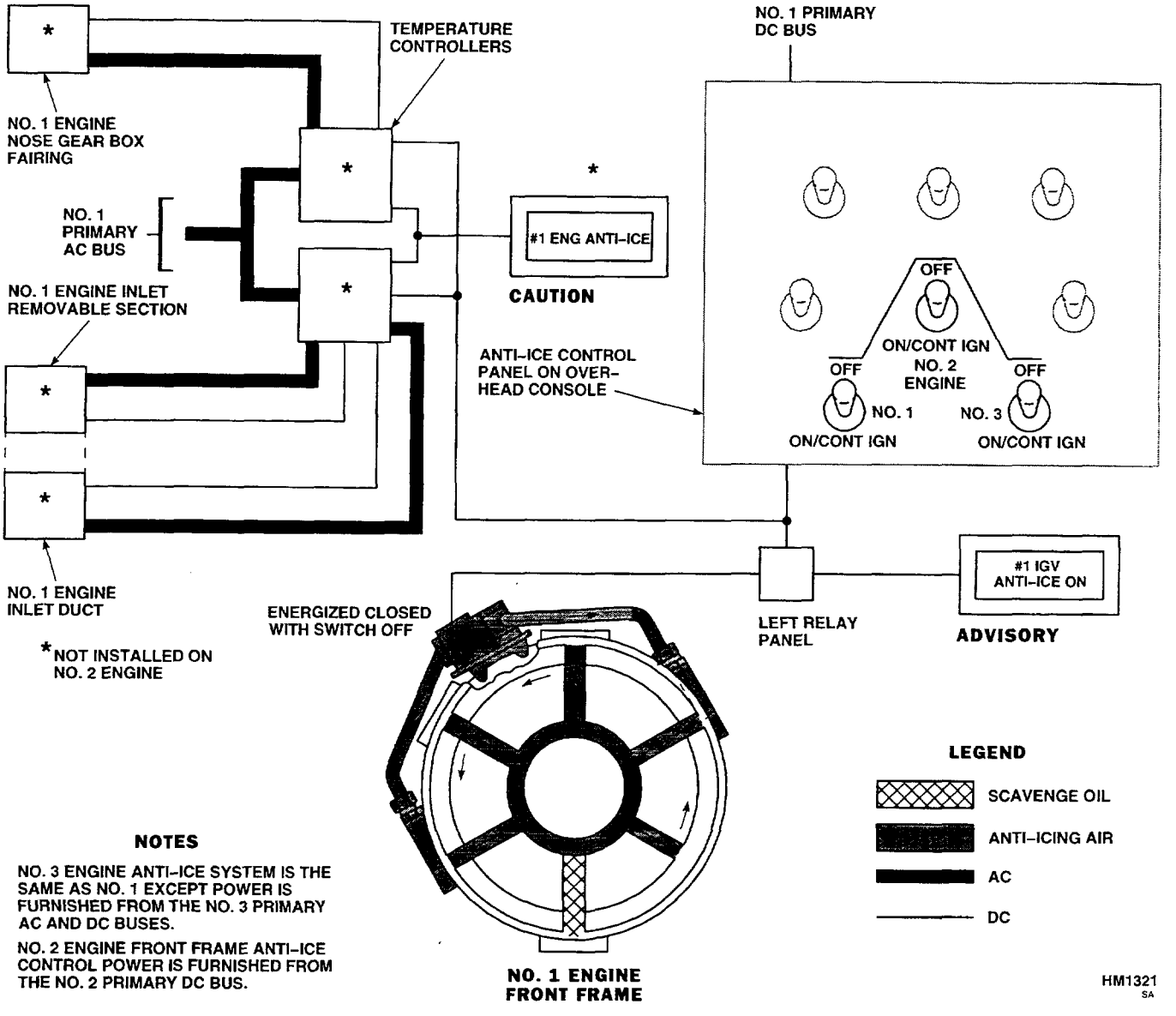


Figure 2-32. Anti-Icing Schematic

- Continuous ignition is automatically turned on whenever engine's anti-ice system is turned on.

2.21.2.1 Engine Inlet Anti-Icing System. The No. 1 and No. 3 engine air inlet ducts, engine nose gear box fairings, and the engine inlet removable sections are anti-iced by thermal-electric resistance elements embedded within epoxy glass linings. Temperature controllers will automatically maintain a normal anti-icing temperature, once the system has been turned on, between 88°C and 68°C. Low temperature sensors, in each area being anti-iced, will cause a respective engine anti-ice caution light to go on, provided the temperature is below the low temperature sensor setting, and the anti-icing system has been turned on. The engine anti-ice caution lights are marked #1 ENG ANTI-ICE and #3 ENG ANTI-ICE, respectively. If the caution lights go on after the engine anti-ice switches are turned on, they will remain on until the temperature increases above the low temperature sensor setting of 35°C. If the light does not go off, the system is not producing enough heat to raise the temperature above the low temperature sensor setting. Each engine anti-icing system is powered from a respective anti-ice bus.

CAUTION

Damage to the No. 1 and No. 3 engine inlet anti-icing heating elements may occur if the anti-icing system is left on for extended periods in non-icing conditions.

The No. 1 primary ac bus circuit breaker panel in the cabin furnishes power to the No. 1 engine nose gear box fairing heating element through circuit breakers marked NGB; to the removable section through circuit breakers marked REM SECT; and the inlet section through circuit breakers marked NO. 1 ENGINE ANTI-ICE INLET. The No. 1 primary dc bus circuit breaker panel in the cabin furnishes control power to the controllers and lights the #1 ENG ANTI-ICE caution light through a circuit breaker marked ANTI-ICE WARN. The No. 3 primary ac and dc bus circuit breaker panels in the cabin furnish control and operating power to the No. 3 engine anti-ice system in the same manner, through appropriately marked circuit breakers.

2.21.2.2 Engine Air Anti-Icing. The front frame struts and the inlet guide vanes of each engine are anti-iced by diverting fourteenth-stage compressor air to heat them. Actuating the engine anti-ice switches, on the anti-ice control panel, de-energizes an engine-mounted solenoid valve to the open position, allowing hot compressor air to flow through the front frame struts and inlet guide vanes. When the engine solenoid valves are de-energized, the advisory lights on the instrument panel (FO-6) marked #1, #2, and #3 IGV ANTI-ICE ON, will simultaneously energized, to indicate that the systems are on. The engine air anti-icing system is turned on simultaneously with the engine air inlet anti-icing system. The engine solenoid valves are energized to the off position to make sure of a flow of anti-icing air in case of a complete electrical power failure. A loss of about 3% of each engine's horsepower will result at maximum power, when the engine air anti-icing system is on.

The No. 1 primary dc bus circuit breaker panel in the cabin furnishes control power through a circuit breaker marked CONT, and power to operate the #1 IGV ANTI-ICE ON advisory light through a circuit breaker marked WARN. Both circuit breakers are under the heading IGV ANTI-ICE. The No. 2 and 3 engine air anti-icing systems are powered by the No. 2 and 3 primary dc circuit breaker panels, respectively, in the cabin, through appropriately marked circuit breakers.

2.21.2.3 Engine Anti-Ice Switches. The ANTI-ICE panel on the overhead control panel contains the ENGINE anti-ice switches. The systems are controlled by switches, marked NO. 1-NO. 2-NO. 3, respectively, each of which has marked positions OFF-ON/CONT IGN. Placing the No. 1 and No. 3 engine anti-ice switch to ON/CONT IGN simultaneously turns on engine inlet anti-ice, engine air anti-ice, and continuous ignition. Placing the No. 2 engine anti-ice switch to ON/CONT IGN simultaneously turns on engine air anti-ice and continuous ignition. The appropriate engine IGV ANTI-ICE ON advisory light will go on to indicate that the engine air anti-icing system is satisfactory. The OFF position will simultaneously turn the systems of the respective engine off.

2.21.3 Windshield Anti-Ice System. The pilot's, copilot's, and center windshields are constructed of a layer of glass over two layers of stressed acrylic plastic. They are anti-iced by electric current that passes through a transparent electrically resistant coating on the inner surface of the outer laminate of the windshields. The windshield anti-ice system also serves to defog the windshields. Sensors, molded into each windshield, vary resistance with changes in windshield temperature to maintain the windshields at a constant temperature. The pilot's windshield is anti-iced by power received from the No. 3 primary ac bus through three circuit breakers, marked WINDSHIELD ANTI-ICE PILOT, and is controlled by power from the No. 3 primary dc bus through a circuit breaker marked WSHLD ANTI-ICE PILOT, also in the cabin. The copilot's windshield is anti-iced by power received from the No. 1 primary ac bus through three circuit breakers, marked WINDSHIELD ANTI-ICE CO-PILOT, in the cabin, and controlled by power from the No. 1 primary dc bus through a circuit breaker marked WSHLD ANTI-ICE CO-PILOT, also in the cabin. The center windshield is anti-iced by power received from the No. 1 monitored as bus through three circuit breakers in the cabin, marked WINDSHIELD ANTI-ICE CENTER, and controlled by power from the No. 2 primary dc bus through a circuit breaker, marked WSHLD ANTI-ICE CTR, also in the cabin. Failure of any generator will cause the No. 1 monitor ac bus to be dropped from the system, and center windshield anti-icing system will be inoperative. The pilot's and copilot's chin bubbles, cockpit side windows, and cabin windows are all made from molded Plexiglas and do not contain an anti-icing capability.

2.21.3.1 Windshield Anti-Ice Switches. The ANTI-ICE panel on the overhead control panel contains the WINDSHIELD anti-ice switches. The windshield anti-ice switches are marked CO-PILOT, CENTER, and PILOT, to designate the respective windshield anti-ice system they

control, and all have marked position LOW, OFF, and HIGH. The LOW position is used for defogging and light icing conditions. The HIGH position is used to prevent ice formation on the windshields during heavy icing conditions. The OFF position is used to turn the system off.

2.21.4 Pitot Heaters. The ANTI-ICE panel, on the overhead control panel, contains the PITOT HEAT switch. When placed ON, an electric heater in each pitot head is turned on to prevent ice formation in the pitot head. The left (No. 1) pitot heater receives power from the No. 1 primary dc bus through a circuit breaker in the cabin, marked PITOT HEAT LEFT, and the right (No. 2) pitot heater receives power from the No. 3 primary dc bus through a circuit breaker, marked PITOT HEAT RIGHT, also in the cabin.

2.22 SEATS

2.22.1 Pilot and Copilot Seats (Helicopters Not Modified by Crash-attenuating Seats). Boron-carbide composite armored pilots' seats are track-mounted side by side in the cockpit. Each set accommodates back-type parachutes that are interchangeable with a back cushion. Each seat is equipped with an outboard armorplate wing release mechanism, adjustment levers, a lap belt, a shoulder harness attached to an inertia reel, and a shoulder harness lock lever. The outboard armorplate wing of each seat is hinged so that it may be opened outward to provide additional clearance for emergency exit.

2.22.1.1. Seat Cushion Blower (Pilots'). Each seat has an electrically operated blower assembly for ventilation and cooling, and a control switch. The blower assembly is under the seat pan by the left front corner of the seat, and has an identification plate marked CUSHION BLOWER (Figure 2-33). The control switch, next to each blower assembly, has marked positions ON and OFF. The control switch is placed ON by reaching down and under the left front corner of the seat and moving the switch upwards. The switch is placed OFF by moving the switch downward. The pilot's seat blower is powered from the No. 3 primary ac bus and protected by a circuit breaker marked CUSHION BLOWER PILOT. The copilot's seat blower is powered from the No. 1 primary ac bus and protected by a circuit breaker marked CUSHION BLOWER CO-PLT.

2.22.1.2 Anti-Exposure Suit Blower/Lower Cockpit Vent Blower (Pilots'). A blower is installed below each pilot's seat for ventilation when wearing

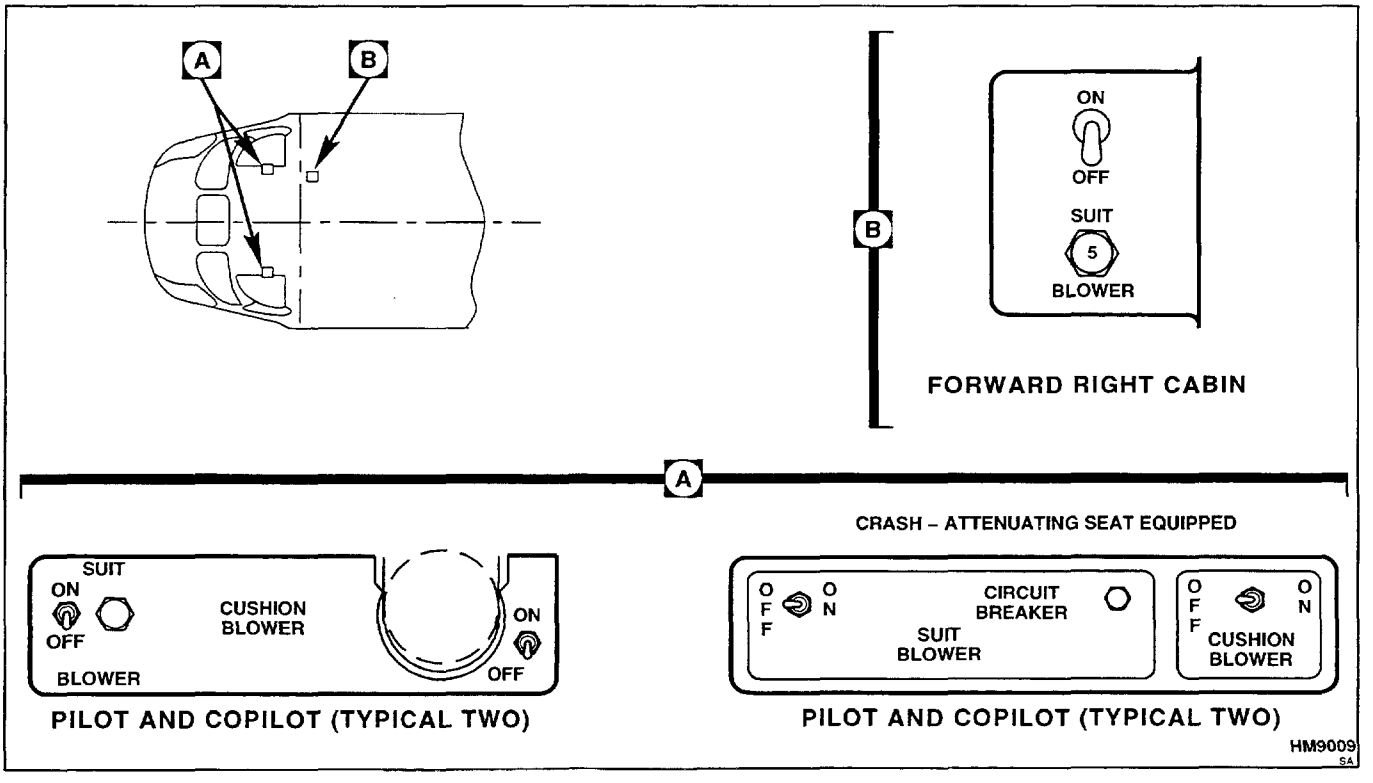


Figure 2-33. Anti-Exposure and Seat Cushion Blower Controls

exposure suits or lower cockpit ventilation. A control panel marked SUIT BLOWER is mounted beneath the forward lip of each seat (Figure 2-33). A toggle switch is mounted on the panel: up is on and down is off. Power to operate the pilot's blower is furnished by the No. 3 monitor ac bus through a circuit breaker marked PILOT SUIT BLOWER. The copilot's blower power furnished from the No. 1 monitor ac bus through a circuit breaker marked COPILOT SUIT BLOWER. Both are controlled through a circuit breaker on each SUIT BLOWER control panel.

Note

Since the blowers operate off the No. 1 and No. 3 monitor ac buses, they will operate only when all generators are on the line or external power is used.

2.22.1.3 Outboard Armorplate Wing Release Mechanism. The outboard armorplate wing of each seat is hinged so that it may be opened outward for additional clearance if necessary to exit or bail out. The outboard wing is released by striking the release bar, along the front edge of each outboard wing, with the hand or elbow. The wing is held in the open position by a latch. To close the outboard wing, press the release mechanism and pull the wing inward. The release mechanism is automatically reset when it has been returned to the closed position.

2.22.1.4 Seat Height Adjustment Levers. The seat height adjustment levers are the rear levers on the right of the pilots' seats. The levers are pulled up to release the height adjustment lockpins. The seats, aided by spring-loaded bungees, can then be adjusted for height by varying the weight upon them. The lockpins will automatically engage in any of 10 positions when the levers are released.

WARNING

When either pilot's seat is adjusted to a high and forward position, aft travel of the cyclic may be restricted.

2.22.1.5 Forward and Aft Adjustment Levers. These levers are the front levers on the right side of the pilots' seats. They are pulled up to release the forward and aft seat adjustment lockpins. The levers must be held up while the seat is moved on the tracks, forward or aft, as desired. The lockpins will automatically engage in any of 13 positions when the levers are released.

2.22.1.6 Shoulder Harness Lock Lever. A two-position shoulder harness inertia reel lock lever 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 of over two Gs is encountered in any direction. When this occurs, the inertia reel will remain locked until the lever is moved to the locked position and then to the unlocked position. When the lever is placed to the locked (forward) position, the shoulder harness cable is locked so that the occupant is prevented from leaning forward. The locked position is used as an added safety precaution over that of the automatic lock on the inertia reel, during takeoff or landing, or when a crash landing is anticipated.

WARNING

In the unlocked position, the pilot and copilot restraint system may be inadequate to prevent headstrikes into the cyclic/instrument panel. The MA-6 inertia reel may fail to lock with an impact force.

2.22.2 First Crewman's Seat. The first crewman's seat is mounted on the right side of the cabin, forward of the cabin door, facing inboard. The seat has seat and back cushions, and a safety belt.

2.22.2.1 Anti-Exposure Suit Blower (First Crewman's Seat). A blower for ventilation when wearing an anti-exposure suit is provided for the first crewman's seat. A fitting on the suit is connected to a hose on the blower. The blower is controlled by a control switch and circuit breaker (Figure 2-33) on the forward cabin wall. The blower is protected by the No. 3 monitor ac bus circuit breaker marked CREW SUIT BLOWER. The blower is additionally protected by a circuit breaker on the control panel.

Note

Since the blower operates off the monitor ac bus, it will operate only when all generators are on the line or external power is used.

2.22.3 Jump Seat. The jump seat is mounted on the right side of the entrance to the pilot's compartment. The

seat may be folded against the control closet when not in use. The seat is not equipped with a safety belt, seat cushion, or back strap, and shall not be occupied during takeoff, landing, or adverse weather conditions.

2.22.4 Troop Seats. Folding troop seats (FO-13), equipped with safety belts for 55 passengers, may be installed. The seating arrangement is 37 troops on the cabin walls aft of the personnel door, and 18 seats facing right along the cabin center. The seats are attached to the compartment side panels with the seat legs attached to the cargo tiedown ring studs at the front of the seat assemblies. The seats may be folded against the compartment walls by disconnecting the front legs from the cargo tiedown attaching points, then folding them against the compartment walls. The troop seats in front of the left front cabin escape hatch may be folded up to provide room for the left gun station. With AFC 497, the troop seats are attached to the cargo floor seat fittings. The seats may be stowed against the compartment walls by moving the seats to the up position and locking the seats with the quick disconnect pins located in the center of the leg. The center row troop seats are supported at the back by poles attached to the floor tiedown fittings, and at the front by support legs that can be folded for storage.

Note

The width of a fully combat-equipped troop may exceed the existing seat width, and thus prevent seating 55 troops. Care must be taken to be sure that the number of troops carried is restricted to the number for which there are adequate seats and safety belts.

2.22.5 Pilot and Copilot Seats (Helicopters Modified by Crash-attenuating Seats). The armor-plated crash-resistant pilot and copilot seats are mounted side by side in the pilots' compartment. Each seat has a seat bucket with metal structural members, a five-point restraint system, padded seat cushions, headrest, and adjustable lumbar support. Each seat also is equipped with a blower assembly and switch, and armorplate wing release mechanism. Each outboard armorplate wing is hinged so that it may be opened outward to provide additional clearance if it is necessary to have access to the cockpit side windows. The five-point restraint system consists of shoulder harness, lap belt, and lap tiedown strap. The lap tiedown strap has a rotary buckle to which the shoulder harness and lap belt fasten. The lumbar support pad is attached to Velcro fastener strips to the seatback cushion and is adjustable for maximum comfort. Each seat has a vertical adjustment control lever, horizontal adjustment control lever, and restraint system control lever. In addition a variable-load energy absorber (VLEA) control dial is provided which adjusts the VLEA system limits for the individual pilot. The VLEA system limits sudden vertical deceleration to acceptable limits.

CAUTION

When either pilot's seat is adjusted to a high and forward position, aft travel of the cyclic may be restricted.

2.22.5.1 Blower Assembly and Switch. Each seat is equipped with an electrically operated blower assembly, for ventilation and cooling, and a control switch. The blower assembly is under the seat pan by the left front of the seat and has an identification plate marked CUSHION BLOWER. The control switch, adjacent to each blower assembly, has marked positions ON and OFF. The control switch is placed to ON by reaching down and under the left front of the seat and moving the switch leftward. The switch is placed OFF by moving the switch rightward. The pilot seat blower is powered from the No. 3 ac primary bus and protected by a circuit breaker, marked CUSHION BLOWER PILOT, on the right side cabin circuit breaker panel. The copilot seat blower is powered from the No. 1 ac primary bus and protected by a circuit breaker, marked CUSHION BLOWER CO-PLT, on the left side cabin circuit breaker panel.

2.22.5.2 Outboard Armorplate Wing Release Mechanism. The outboard armorplate wing of each seat is hinged so that it may be opened outward for additional clearance if necessary to have access to the cockpit side windows. The outboard wing is released by striking the strike plate, along the front edge of each outboard wing, with the hand or elbow. The wing is spring-loaded to open 96° when the release mechanism is actuated. To close the outboard wing, depress the release mechanism and pull the wing inward. The release mechanism is automatically reset when it has been returned to the closed position.

2.22.5.3 Vertical Adjustment Control Lever. A vertical adjustment control lever is at the right front underside of each seat. The lever is pulled forward to release locking pins, allowing the seat to be adjusted at increments of 0.625 inch, and can be varied a total of 5 inches. Weight will move the seat downward. When weight on the seat is reduced, the spring-loaded adjusting mechanism will move the seat to the highest position. Releasing the lever will set the locking pins and hold the seat at the desired position.

2.22.5.4 Horizontal Adjustment Control Lever. A horizontal adjustment control lever is at the left front underside of each seat. The lever is pulled forward to release locking pins, allowing the seat to be moved fore and aft on tracks. The seats can lock in position at increments of 0.50 inch. Releasing the lever will set the track locking pins and hold the seat at the desired position.

2.22.5.5 Shoulder Harness Lock Lever. A two-position restraint system inertia reel lock lever 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 over two Gs is encountered in any direction. When this occurs, the inertia reel will remain locked until the lever is moved to the locked position and then to the unlocked position. When the lever is placed to locked (forward) position, the shoulder harness cable is locked so that the occupant is prevented from leaning forward. The locked position is used as an added safety precaution over that of the automatic lock on the inertia reel, during takeoff or landing, or when a crash landing is anticipated.

WARNING

In the unlocked position, the pilot and copilot restraint system may be inadequate to prevent headstrikes into the cyclic/ instrument panel. The MA-6 inertia reel may fail to lock with an impact force

2.22.5.6 Variable-Load Energy Absorber (VLEA) Control Dial. A VLEA control dial is mounted on the inboard side of each pilot seat near where the rear horizontal portion of the seat intersects with the bottom vertical portion of the seatback. There are eleven equally spaced numbers, depicted in 10-pound increments from 160 to 260, with an adjacent identification labeling of CREWMAN AND EQUIPMENT TOTAL WEIGHT. The weight of the pilot and flight gear on his person is set into the dial, adjusting an energy absorber, to provide optimum protection for the pilot.

WARNING

Adjustments either higher or lower than actual pilot/equipment weight will increase crash hazards.

2.22.5.7 Anti-Exposure Suit Ventilating System. The system provides the pilot and copilot with ventilating blowers for comfortable temperature regulation while wearing the anti-exposure suit. A fitting on the suit must be connected to the blower hose. The pilot and copilot blowers are mounted underneath their respective seats. The blowers are controlled by individual blower control switches and circuit breakers (Figure 2-33) in the vicinity of each blower. The pilot and copilot control switches and circuit breakers, marked SUIT BLOWER, are under the right front of their respective seats. The SUIT BLOWER ON/OFF switch positioned leftward, turns the blower on. The copilot station is powered from the No. 1 ac monitored bus through a circuit breaker, labeled COPILOT SUIT BLOWER, on the left side cabin circuit breaker panel. The pilot station receives power from the No. 3 ac monitored bus through a circuit breaker, labeled PILOT SUIT BLOWER, on the right side cabin circuit breaker panel.

Note

Since the blowers operate off the No. 1 and No. 3 monitor ac buses, they will operate only when all generators are on line or external power is used.

2.23 EXTERNAL CARGO HOOK(S)

External cargo can be carried with a single-point suspension system using one cargo hook or with a two-point suspension system using two cargo hooks. Both systems are operated from the CARGO HOOK control panel on the overhead control panel.

2.23.1 Single-Point Suspension System. A 36,000 pound capacity cargo hook (Figure 2-34) is suspended by a pendant below the fuselage, near the CG. This cargo hook is operationally limited to loads of 25,000 pounds. The pendant is attached to an explosive separator which is attached to a removable A-frame. The A-frame is attached to the main gear box supports. The hook is lowered beneath the helicopter through a hatch in the cabin deck with a steel cable. For a pickup, the helicopter is hovered over the load and a sling which is attached to the cargo is slipped into the cargo hook. The hook opens automatically when the weight on the hook is reduced to 525 ±225 pounds when in the automatic mode. Cargo release buttons, on each pilots' cyclic grip and on the aircrewman's pendant, are used to electrically release loads, either before or after ground contact.

CAUTION

Jettisoning of airborne cargo of over 20,000 pounds with the pilot's cargo release buttons or aircrewman's pendant may cause the cargo hook to recoil and strike the fuselage.

The single-point hook can be opened mechanically by turning a manual release knob on the hook. The hook incorporates an inspection window displaying internal linkages. A placard mounted on the cargo hook illustrates how the internal linkage should appear for a locked, safe hook or an unlocked, unsafe hook (see Figure 2-34). An emergency cargo hook jettison system allows cargo to be jettisoned by means of an electrically-actuated explosive separator. A hand-operated winch is attached to the A-frame for hook and pendant deployment and retrieval. A pip pin on the winch line attaches to a lug on the cargo hook. See Figure 2-34 for electrical power sources.

2.23.1.1 Cargo Hook Control Panel (Single-Point). The CARGO HOOK panel (Figure 2-34) on the overhead control panel contains the necessary control switches and test light. The PWR SEL switch at SNGLE PT activates the single-point suspension system and when at OFF or TWO PT deactivates the system. The CONTROL switch at COCKPIT selects only the pilot's cyclic CARGO REL buttons for cargo release. The CONTROL switch at ALL selects the aircrewman's pendant as well as the pilots' CARGO REL buttons for cargo release. The MODE switch at AUTO RLSE arms the cargo hook for automatic cargo release on ground contact. The MODE switch at NORM disarms the automatic release function. The AUTO RELEASE ON advisory light goes on when the MODE switch is placed to AUTO RLSE. The SINGLE PT HOOK OPEN advisory light goes on when the cargo hook is unlatched or open, regardless of the MODE switch position. The SINGLE PT switch and JETT TEST light are discussed in the following paragraph.

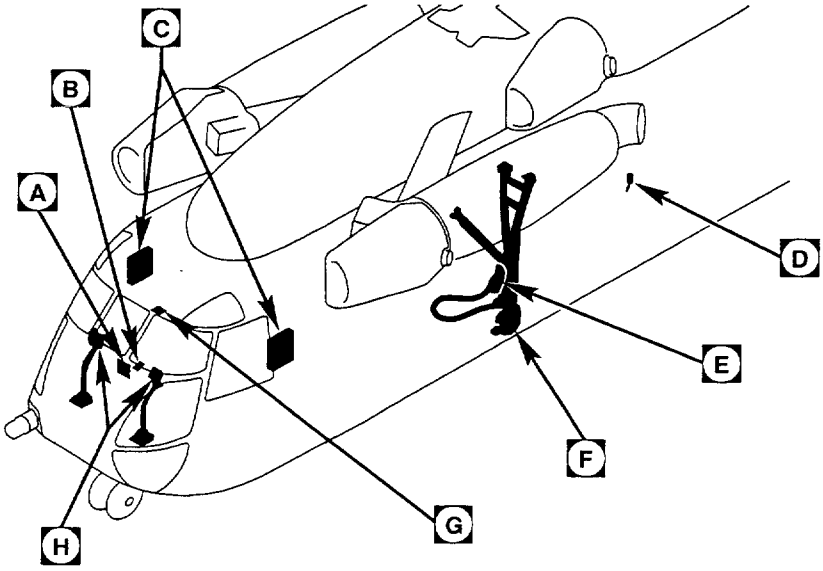
2.23.1.2 Cargo Hook Jettison System. In an emergency the cargo can be jettisoned by means of the electrically-activated explosive separator. Electrically activating the separator causes an explosive cartridge to ignite and separate the pendant and hook from the A-frame. The explosive separator is sealed, so no flame or fragments are emitted when the cartridge is ignited. The system can be tested for electrical continuity of the explosive cartridge, wiring, and switches. The explosive separator is controlled by the SINGLE PT switch on the CARGO HOOK panel (FO-1) and the guarded SINGLE POINT CABLE SHEAR switch on the EMERGENCY CONTROL panel (FO-7). The SINGLE PT switch at ARM arms the SINGLE POINT CABLE SHEAR switch. Placing the SINGLE POINT CABLE SHEAR switch to SHEAR with the SINGLE PT switch at ARM provides a signal to actuate the explosive separator. Placing the SINGLE PT switch to TEST and then placing the SINGLE POINT CABLE SHEAR switch to SHEAR causes the JETT TEST light to go on if the electrical continuity is satisfactory. Be sure the SINGLE POINT CABLE SHEAR switch is placed OFF before moving the SINGLE PT switch out of TEST. Placing the SINGLE PT switch OFF disarms the SINGLE POINT CABLE SHEAR switch. No. 3 primary dc power is furnished through a circuit breaker in the cabin marked CARGO HOOK JTSN.

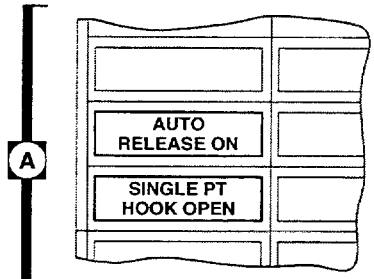
2.23.2 Two-Point Suspension System

WARNING

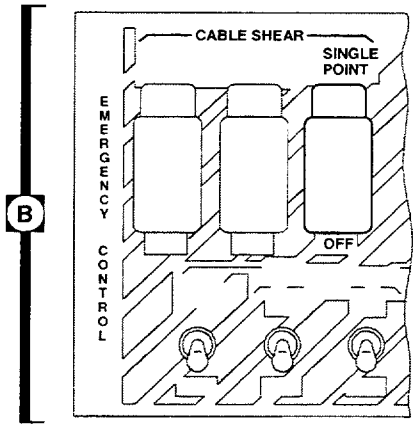
Two-point external cargo operation are prohibited in the MH-53E.

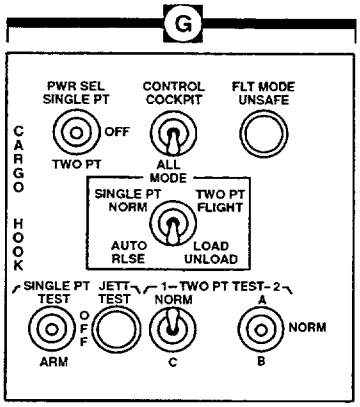
Two cargo hooks (Figure 2-35) limited to a combined capacity of 36,000 pounds, and a maximum of 60% of the external load on either hook, are tandem mounted on attachments under the cabin deck. The hooks are on the longitudinal axis of the helicopter, 10 feet apart. Each hook has its own access hatch in the cabin deck with a lever that is used to place the hook in either the stowed or operating position. The lever is marked PULL GRIP UP TO REL. For external cargo operations, the helicopter is positioned beside or hovered over the load, and slings attached to the hook end of the 7-1/2 foot pendants which are attached to the helicopter cargo hooks. The normal method of load release is accomplished through individual manual actuation of the release mechanism located on each pendant. This ensures that after release the pendants remain with the helicopter and not with the load. Emergency release of the load is accomplished electrically through either pilot's cargo release buttons located on the cyclic grip, through the aircrewman pendant release switch in the cabin, or through the EMERGENCY CARGO HOOK RELEASE handle at the foot of the cockpit center console. The initial upward movement of the emergency cargo hook release actuates an electrical switch to open both cargo hooks. In the event of an electrical switch failure, continued upward motion of the handle will result in the hooks being opened mechanically. The aircrewman can also release the load mechanically by pulling upward on the release lever on either hook. When any of the electrical/emergency release modes are



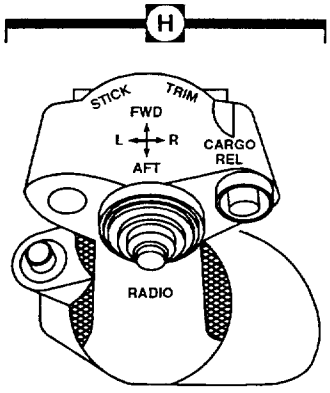


ADVISORY

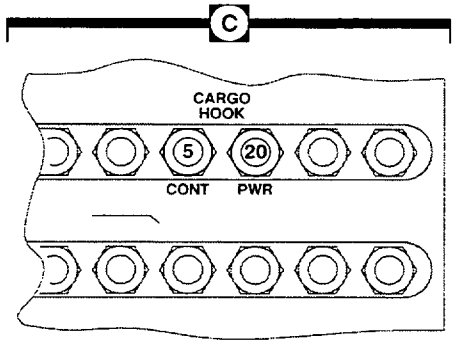




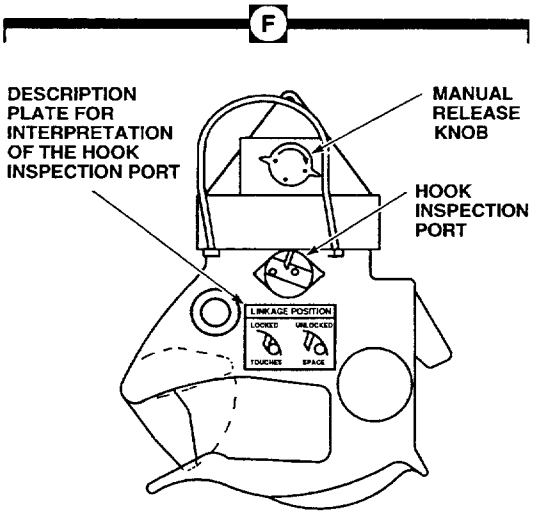
CARGO HOOK PANEL



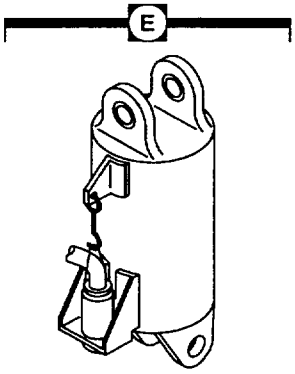
CYCLIC GRIP



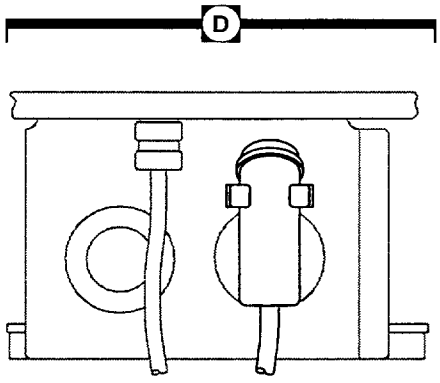
NO. 2 PRI DC BUS



CARGO HOOK



EXPLOSIVE SEPARATOR ASSEMBLY



AIR CREWMAN'S PORTABLE PENDANT CONTROL

HM1209
SA

Figure 2-34. Cargo Hook Installation (Single-Point)

used, the pendants will remain with the load. For inflight protection against exceeding CG limits in the event of a sling/pendant failure of one hook, a no load sensing system within each hook monitors for loss of load and will automatically open both hooks when a decreasing load of 200 ±50 pounds is sensed by either or both hooks, and the mode switch is set in the TWO PT FLIGHT position on the cargo hook control panel. Each cargo hook has a solenoid that opens the hook when energized. The hooks are interconnected with a mechanical link to ensure both hooks open simultaneously. Each hook has a manual release. FWD HOOK OPEN and AFT HOOK OPEN advisory lights goes on when either cargo hook release latch is open or not fully latched in the closed position. The advisory lights also go on briefly during the short period of time the hooks are open during cargo release.

The hook interconnect release system is incorporated to make sure that both hooks open simultaneously, regardless of circumstances. The hooks are interconnected with a mechanical linkage, and the opening of one hook causes the other hook to open. Normally, each hook is opened by its own solenoid. However, if one solenoid fails, that hook is then opened mechanically by the interconnect system at the same time that the solenoid operated hook is opened. The hook interconnect release system also has an emergency release solenoid which is actuated, causing both hooks to open, whenever the EMERGENCY CARGO HOOK RELEASE handle is pulled upward. In addition, there is a mechanical connection between the EMERGENCY CARGO HOOK RELEASE handle and the hook interconnect release systems linkage. The hooks can also be actuated mechanically from inside the cabin by simply pulling up on either hook's mechanical release lever. See Figure 2-35 for electrical power sources.

2.23.2.1 Cargo Hook Control Panel (Two-Point). The CARGO HOOK panel (Figure 2-35) on the overhead control panel contains the necessary control switches and a FLT MODE UNSAFE light. The PWR SEL switch at TWO PT activates the two-point suspension system. When at OFF or SINGLE PT, it deactivates the system. The CONTROL switch at COCKPIT selects only the pilot's cyclic CARGO REL buttons for cargo release. The CONTROL switch at ALL selects the aircrewman's pendant as well as the pilots' CARGO REL buttons for cargo release. The MODE switch at FLIGHT arms the hooks' no-load release switches for automatic hook opening when no load is sensed on either hook. The MODE switch at LOAD/UNLOAD disarms the hooks' no-load release switches for hook loading and unloading. The FLT MODE UNSAFE light goes on if either or both hooks are sensing no load. The light goes off when the load is lifted off the surface and both hooks' no-load switches sense the cargo's weight. If the light does not go off the MODE switch must not be placed to FLIGHT; the load shall be set back on the surface and released, and further lifts shall not be made until the system is fixed. With the PWR SEL switch set at TWO PT, setting the MODE switch to LOAD UNLOAD causes the 2PT FLT UNARMED caution light to go on. The caution light will not go off until the MODE switch is set to FLIGHT.

The TWO PT TEST-2 switch is used for system checking to verify independent operation of the hook solenoids. Holding the switch at B disables the forward hook's solenoid, and the dual emergency release solenoids. Holding the switch at A disables the aft hook's solenoid, and the dual emergency solenoids. In position A the signals from the No. 1 no load switches are prevented from reading the dual emergency release solenoids.

CAUTION

Do not use test functions with external loads. Hooks will open during test operation to verify independent operation of the emergency release solenoids.

The TWO PT TEST-1 switch is used for system checking. Holding the switch at C disables both hooks' solenoids and signals from the No. 2 no load switches are prevented from reading the hooks' solenoids.

2.24 RESCUE/UTILITY HOIST

A 600-pound capacity, variable speed (0 to 200 fpm) hydraulic hoist (Figure 2-36), with about 245 feet of usable cable length, is suspended on a fixed truss over the personnel door. The hoist is capable of raising or lowering a maximum load of 600 pounds. The cable has a breaking strength greater than 3700 pounds. Feed rollers and a level-wind mechanism prevent the cable from snarling, and a load-holding brake is incorporated to automatically lock the cable in an intermediate position if the winch should stop. Limit switches will automatically turn the hoist motor off when the cable is completely reeled in or out. An integral limit switch will automatically slow the cable speed to 50 fpm as the hook nears the extremities of cable travel. The last 10 feet of cable is painted to visually indicate that the full cable length is being reached. The hoist winch motor receives hydraulic power from the utility 1 hydraulic system and is controlled by an electro-hydraulic hoist control valve. An electrically-operated cartridge-type guillotine, controlled by switches in the cockpit and cabin, allows a crewmember to cut the cable

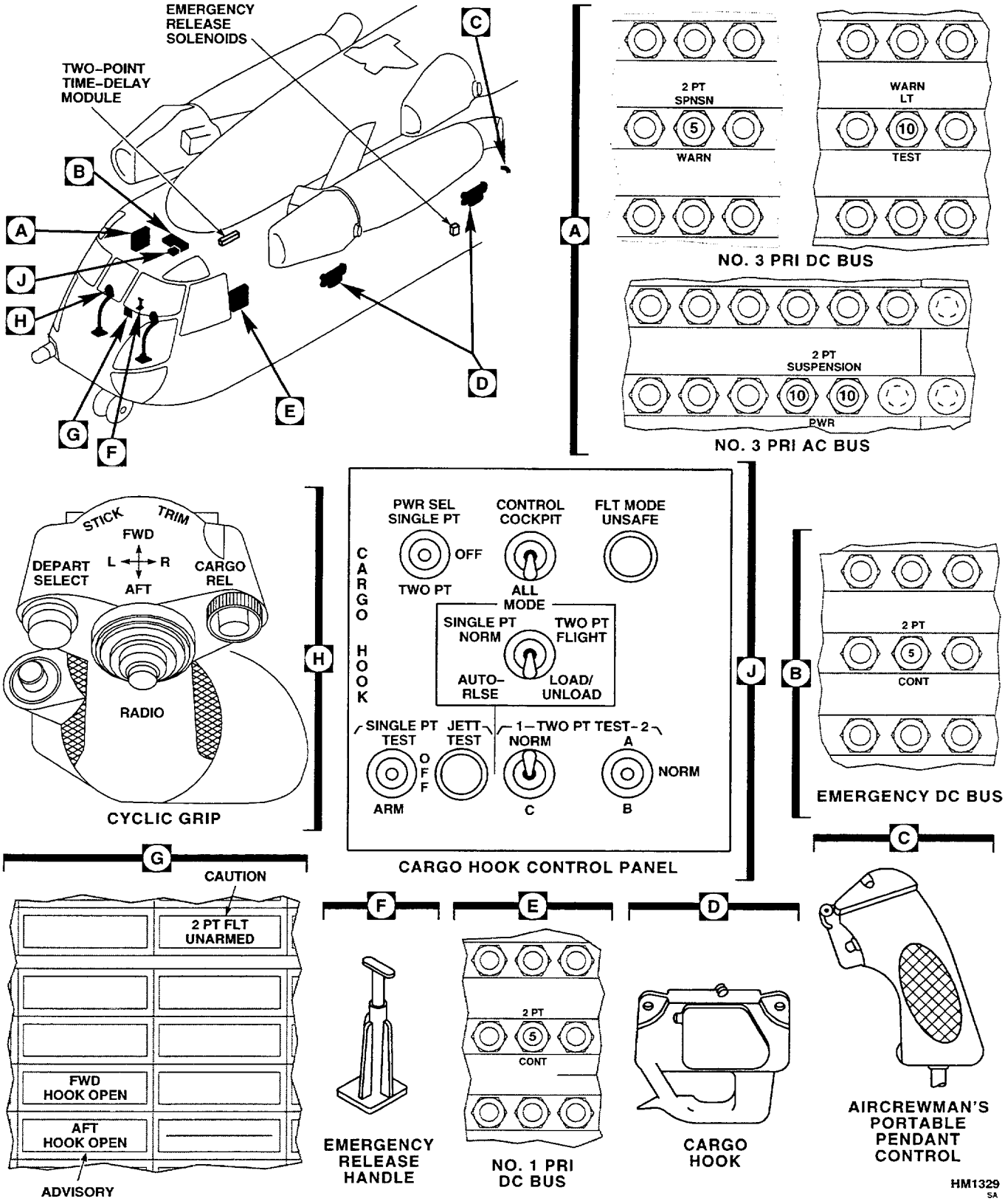


Figure 2-35. Cargo Hook Installation (Two-Point)

at the hoist winch if the hook becomes entangled in surface obstacles and cannot be released. The hoist receives electrical power from the No. 2 primary dc bus through a circuit breaker in the cabin, marked PWR, under the general heading RESCUE HOIST. A manual override system permits hydraulic operation of the hoist in case of electrical failure; however, the guillotine feature and limit switches will be inoperative.

2.24.1 Pilots' Hoist Control Panel. The panel (FO-1), marked HOIST CONTROL, is on the overhead control panel. The panel contains a master switch, with marked positions CREW-OFF-PILOT, and a control switch, with marked positions DOWN-OFF-UP. When the master switch is placed to CREW, the hoist can be operated only by the crewman in the cabin compartment. When the master switch is placed to PILOT, the hoist can be operated only by the pilot. The OFF position renders both stations inoperative. Placing the control switch to either UP or DOWN will cause the hoist cable to travel in the mode selected at a maximum cable speed of 50 feet-per-minute.

2.24.2 Crewman's Hoist Control. The crewman controls the lowering and raising of the hoist cable by means of a hoist grip (Figure 2-36) mounted to the right of the personnel door. The grip has a thumbswitch with marked positions UP and DOWN. Releasing the spring-loaded thumbswitch will stop cable movement. Cable speed is proportional to the displaced travel of the thumbswitch. A maximum cable speed of 200 fpm can be obtained. Limit switches will automatically turn the hoist motor off when the cable is completely reeled in or out. An intermediate limit switch automatically limits the cable speed to a maximum of 50 fpm when the cable approaches 4- to 10-feet full out, or 2 to 10 feet from the full-in position.

2.24.2.1 Hover Trim Control. The hover trim control switch is on the crewman's hoist grip (Figure 2-36). The control gives the aircrewman the capability to position the helicopter for hoist operations. The hoist grip has a positioning switch marked TRIM to provide lateral and longitudinal authority. The crew hover controller has a control authority of ±10 knots laterally and longitudinally about the reference values selected on the cockpit approach/hover coupler panel longitudinal and lateral velocity control knobs, plus the speeds beeped from the cyclic trim beep switch.

2.24.3 Crewman's Hoist Manual Override. The knob (Figure 2-36) mounted to the right of the hoist grip furnishes control of the hoist in case of electrical power failure. To lower the cable, turn the knob counterclockwise. To stop the hoist, return the knob to the center (detented) position. To raise the cable, turn the knob clockwise. Cable speed is proportional to the displaced turning of the knob.

CAUTION

The limit switches are inoperative when an electrical power loss has been experienced; adjust cable speed to avoid damage when operating near cable extremities.

2.24.4 Hoist Cable Shear Switches and Circuit Test Panel

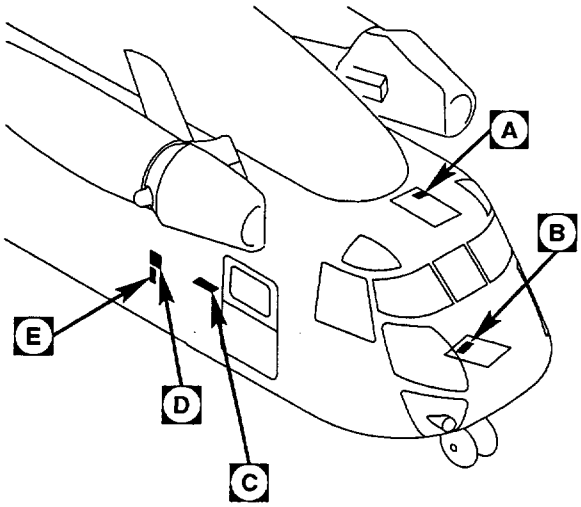
2.24.4.1 Pilots' Hoist Cable Shear Switch. The EMERGENCY CONTROL panel, on the center cockpit console, contains the RESCUE HOIST switch under the general heading CABLE SHEAR (FO-7 and Figure 2-36). The guarded switch has a marked position OFF that is the normal switch position with the guard closed. When the guard is raised and the switch is thrown, an electrically-actuated charge in the guillotine will fire and cut the hoist cable. The master switch, on the overhead control panel, must be at CREW or PILOT before the pilots' hoist cable shear switch can shear the cable.

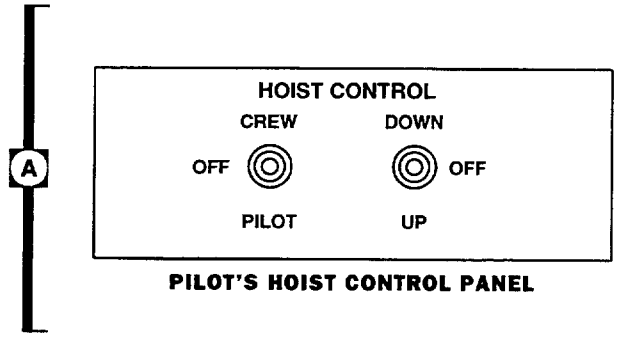
2.24.4.2 Crewman's Hoist Cable Shear Switch. The switch, marked HOIST CABLE SHEAR, is to the right of the personnel door above the hoist and hover trim controls (Figure 2-36). Raising the switch guard and throwing the switch will enable the crewmember to shear the cable. The master switch, on the overhead control panel, has to be at CREW before the crewman's hoist cable shear switch can shear the cable.

2.24.4.3 Hoist Cable Shear Circuit Test Panel. The panel, marked ELECTRO EXPLOSIVE CIRCUIT TESTER, to the right of the personnel door, contains a test light and guarded switch (Figure 2-36). The test light, marked TEST, lights during circuit testing to indicate the system is functioning properly. The guarded switch, with marked positions TEST-FIRE, is normally at FIRE. The switch is placed to TEST any time the circuit is being tested. For test procedures see Chapter 9, under RESCUE HOIST OPERATION.

2.25 COUNTERMEASURES DISPENSING SET

The ALE-39 countermeasures dispensing set provides effective countermeasures against radar-guided weapons systems and/or infrared seeking missile threats. It is a manually initiated, electrically actuated, fully automatic





PILOT'S HOIST CONTROL PANEL

OPERATING INSTRUCTIONS FOR F

EMERGENCY OPERATION
RESCUE HOIST

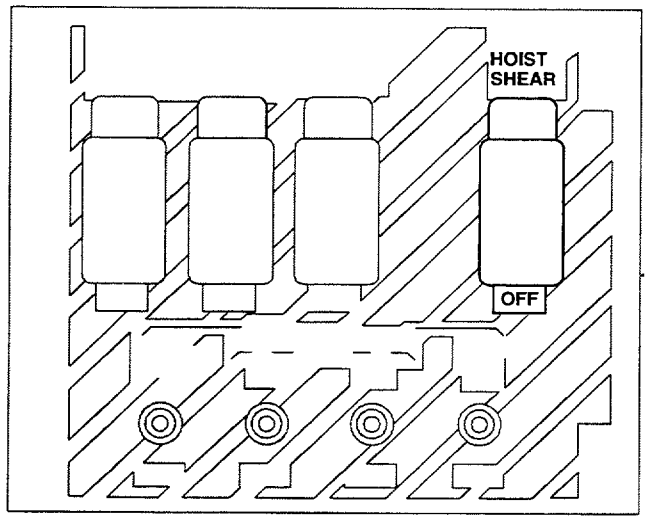
TO LOWER HOIST, ROTATE MANUAL OVER-RIDE KNOB ON HOIST CONTROL VALVE COUNTERCLOCKWISE.

TO STOP HOIST, RETURN OVERRIDE KNOB TO CENTER (DETENTED) POSITION.

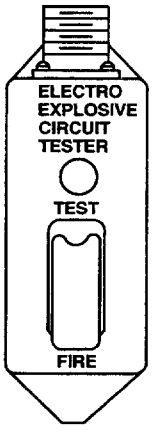
TO RAISE HOIST, ROTATE MANUAL OVER-RIDE KNOB CLOCKWISE.

CAUTION

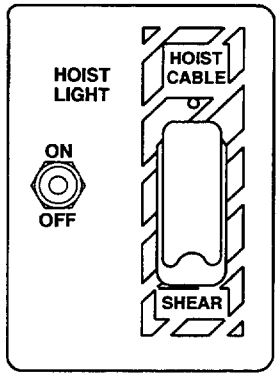
DO NOT FULLY EXTEND OR RETRACT CABLE DURING EMERGENCY OPERATING.
WHEN EMERGENCY OPERATION IS COMPLETED, RETURN MANUAL OVERRIDE KNOB TO OFF (DETENTED) POSITION.



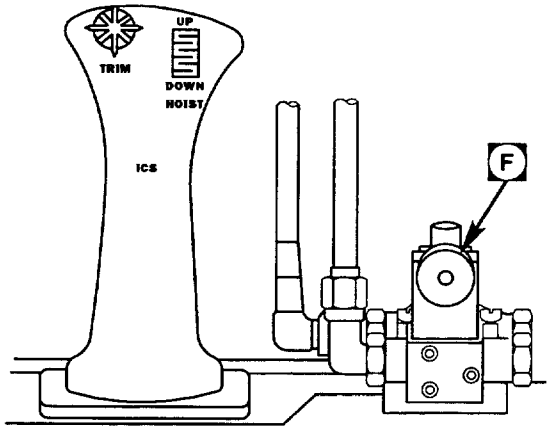
EMERGENCY CONTROL PANEL



CIRCUIT TESTER



CREWMAN'S HOIST CABLE SHEAR SWITCH PANEL



CREW HOIST HOVER TRIM CONTROLS

HM1330
SA

Figure 2-36. Rescue Hoist Controls

system to dispense a selectable mix of jammers, flares, and chaff. The set consists of a countermeasures dispenser panel, an arming control panel, a dispenser programmer, pilots' and crew initiate switches, two firing sequencers, and two external dispenser pods. The left weight-on-wheels scissors switch disables the system on the ground. The No. 1 primary dc bus circuit breaker panel in the cabin furnishes power and control through two circuit breakers marked PWR and CONT under the general heading CM DISP.

2.25.1 Countermeasures Dispenser Control Panel (CDCP). The control panel marked ALE-39 is on the cockpit console (FO-7). The salvo/power switch marked SALVO FLARE-ON-OFF is one of two switches used to arm the system. OFF removes power from the cockpit control, the programmer, and disables the arming relay. ON activates cockpit control, the programmer, and the arming relay. SALVO FLARE energizes a circuit which rapidly dispenses all countermeasures in case of emergency. To place the switch in SALVO FLARE the lever lock of the switch is pulled out and lifted up. Above the heading LOAD REMAIN are three subtractive counters and rotary selector switches marked CHF, FLR, and JMR. The counters indicate the available payloads of chaff, flares, and jammers remaining in the dispenser pods. Below the heading MODE are three release option windows and rotary pushbuttons marked CHF, FLR, and JMR. The pushbuttons select release options for chaff, flares, and jammers shown in the mode windows, which will be released from the dispenser pods. These MODE options are available:

O (Off)	-No payloads are released.
S (Single)	-A single payload is released.
P (Program)	-Programmed release of single payloads from a single dispenser selection as established on the programmer.
M (Multiple)	-For flares only. Parallel release of a payload from each of two sections of the dispenser.
G (Group)	-For flares only. Programmed parallel release of payloads from each dispenser section as established by the programmer.
R (RWR)	-A single payload is released in this installation. The radar warning receiver (RWR) feature is not used in the MH-53E installation.

2.25.2 Arming Status Panel. The arming panel marked DISP is on the cockpit console (FO-7). The ARMSAFE is a lever lock switch, normally in SAFE, which is pulled out and lifted up to ARM. It is the second of two switches used to arm the system. Two amber DIMPUSH indicator lamps go on when the system is armed. The indicator lamps show ARM for the respective left and right dispenser pod. Pressing the light switch will alternately turn it dim and bright. The LAMP TEST switch, when pressed, will test the ARM lamps.

2.25.2.1 Initiate Switch (Pilots')

WARNING

The initiate switches are momentary switches which must be released to enable the system to initiate a new operation.

A four-way toggle switch marked ECM for manual firing of the countermeasures is on each pilot's collective pitch stick grip (Figure 2-20 and FO-5). The switch, controlled with the pilot's thumb, has marked positions CHF-FLR-JMR-MIX for dispensing chaff, flares, jammers, or a mixture of cartridges depending on programmer setting.

2.25.3 Initiate Switch (Crew)

WARNING

The initiate switches are momentary switches which must be released to enable the system to initiate a new operation.

Two momentary contact press-type initiate switches marked CM DISP are in the cabin. One is at the hoist station and one is at the port ramp station. Each is lit when the system is armed, and has the same function as the pilot's initiate switch MIX position.

2.25.4 Programmer. The programmer (Figure 2-37) marked ALE-39 is installed above the left cabin circuit breaker panel. Programmed dispensing routines can be set in the indicator windows with 2 rows of 7 thumbwheel switches. QTY (quantity) and INTV (interval) can be set for CHAFF, JAMMER, and FLARE dispensing. The type LOAD can be set as C, F, or J for left and right pod payload sections (L10, L20, R10, R20). The programmer accepts encoded command signals from the CDCP,

decodes the commands, and provides the two sequencer switches in the dispenser pods stepping pulses for dispensing countermeasure payloads. Lifting the reset switch and moving it in the direction of the arrow for at least 5 seconds will clear all settings in the programmer and cancel the program.

2.25.5 External Dispenser Pods. A detachable pod is externally mounted on each side of the aft cabin ahead of the cargo ramp hinge points. Each pod contains an ALE-29 dispenser module, ALE-29 dispenser housing, and ALE-39 sequencer switch. Each module has 30 discharge tubes electrically partitioned into payload sections of 10 and 20. The pods face 5° above the horizontal plane and 10° aft of the helicopter beam. The sequencer switches transfer the initiator signal from the programmer to the dispenser to cause the desired payload to be discharged. A lever-operated SAFE-ARM safety switch and a safing pin insert are contained on each pod. A protective cover is provided for installation when the pod is installed but not in use. The pod is bracket-mounted for quick installation and removal. The sequencer electrically disconnects at the aircraft skin and a dust cap is to be installed when the pod is removed.

2.25.5.1 Countermeasures Override Switch. The switch, above the programmer, marked OFF and O RIDE is normally OFF. Placed in O RIDE allows bypass of the weight-on-wheels switch to enable arming the system on the ground for maintenance.

2.26 CABIN AND LOADING EQUIPMENT

The cabin area (Figure 2-38), from station 162.0 to station 522.0, is capable of carrying cargo, personnel, litters, and wheeled vehicles, and is equipped with two roller conveyors and a removable centerline skid rail, to aid loading and unloading of cargo. Both roller conveyors may be inverted into the cabin floor when not being used for cargo, and the reverse sides will provide skid strip surfaces of vehicular cargo, or troop transport operation. Guide rails prevent cargo pallets from riding off the roller conveyors. The guide rails must be removed before the roller conveyors are inverted for troop carrier operation.

The cabin floor is capable of sustaining static loads of 300 pounds per square foot (Figure 2-39). Tiedown fittings (Figure 2-40), rated at 5000 and 9700 pounds, are installed on the cabin floor to aid cargo tiedown, and have fittings that serve as troop seat and litter attachment

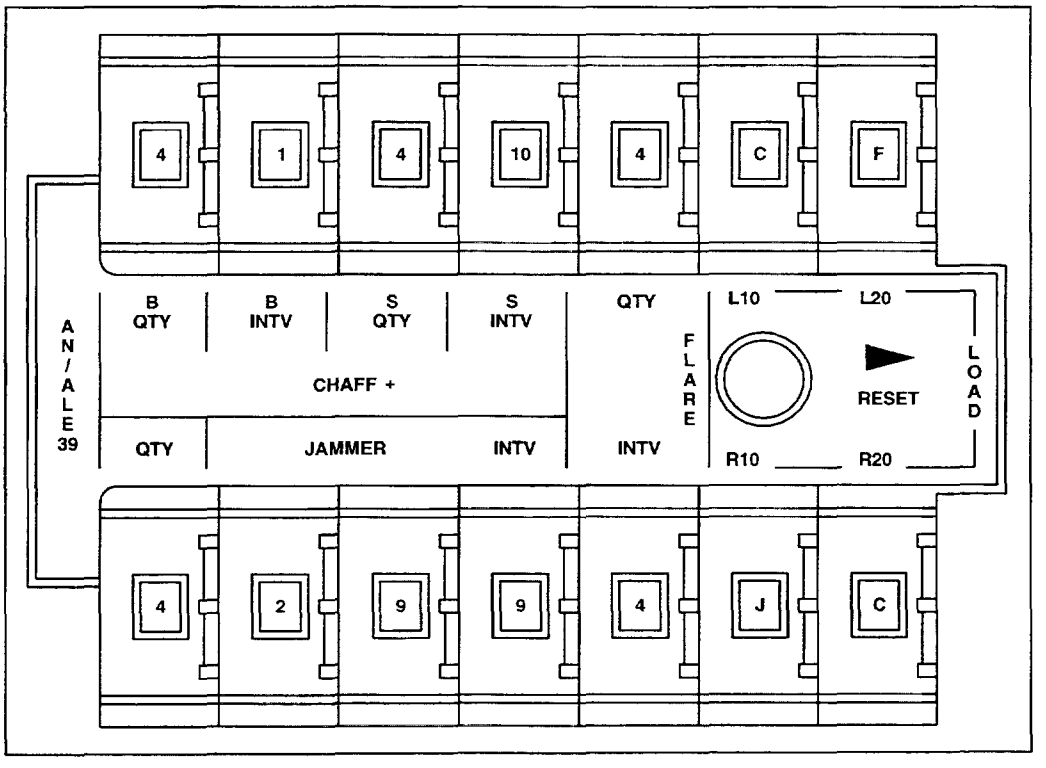


Figure 2-37. ALE-39 Programmer Control

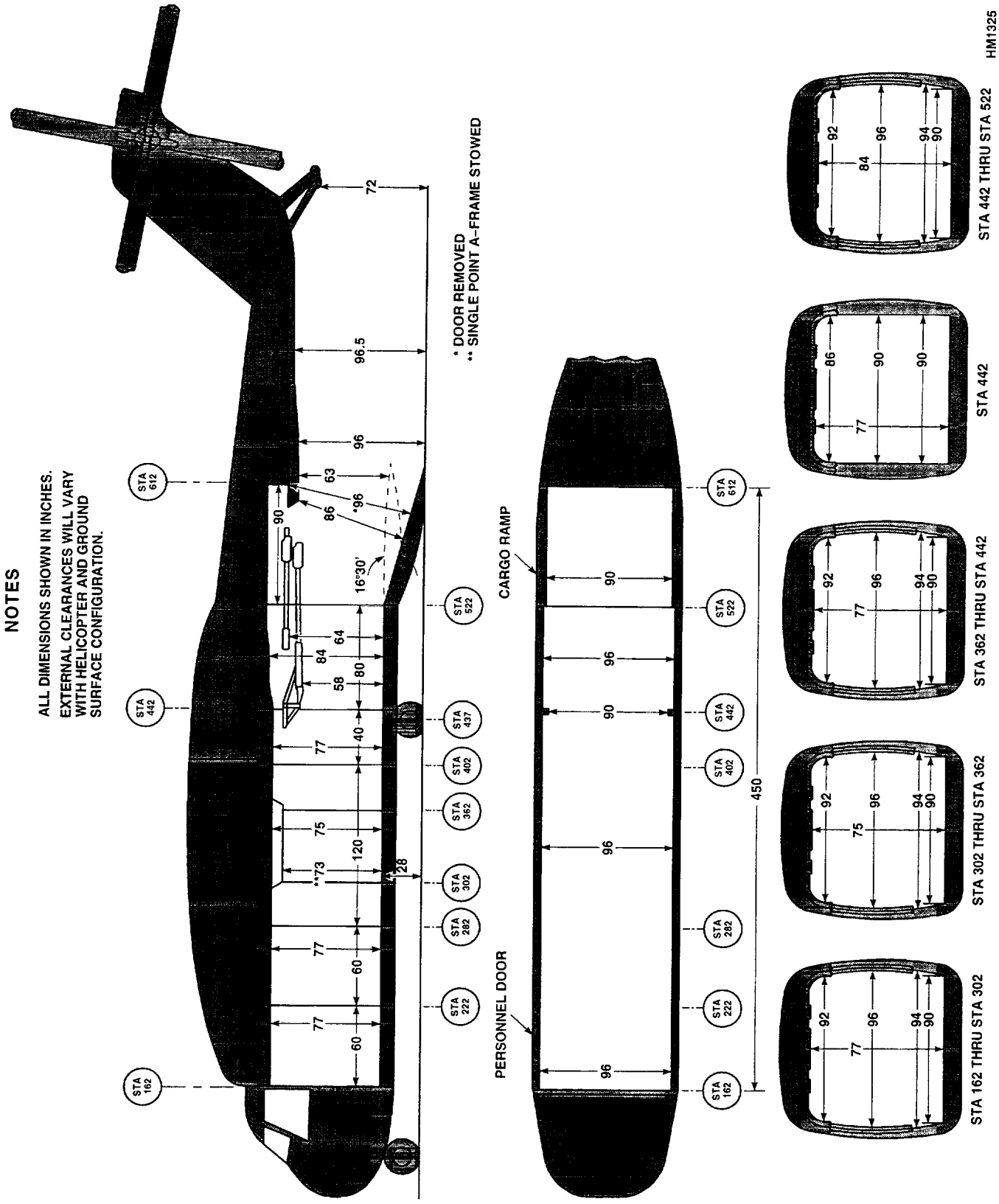


Figure 2-38. Cabin Dimensions

points. Additional tiedown fittings (Figure 2-40), rated at 10,000 and 20,000 pounds, are installed at the intersection of the cargo floor and cabin walls. Two rows of seat stud fittings (Figure 2-40) extend the length of the floor at 20-inch intervals for securing centerline seat installations. A centerline cargo winch system is provided for cargo handling operations. The cabin also contains a personnel door and a cargo ramp and door, both of which may be used for loading cargo and personnel. When loading the helicopter, refer to Figure 2-41, 2-42, and the Handbook of Weight and Balance Data, AN 01-1B-40, for center of gravity and weight limitations.

Figure 2-42 shows the approximate CG range of internal cargo loads that are permissible on the MH-53E in order to keep the CG range of the helicopter within its limits.

2.26.1 Litters. The cabin has provisions for the installation of 24 pole-type litters. The litters are arranged in tiers of four litters, each with three tiers on each side of the cabin. The litters are clamped by their outboard poles to the litter brackets on the sides of the cabin. The inboard poles of the litters are supported by straps that run from fittings in the ceiling to the cargo tiedown fittings in the floor.

2.26.2 Cargo Ramp and Door. A cargo ramp and door, installed in the aft end of the cabin, is used to aid the loading and unloading of cargo and personnel. A 90° stub ramp replaces the cargo ramp when configured for AMCM missions (See AIRBORNE MINE COUNTERMEASURES (AMCM) EQUIPMENT in this Chapter). The ramp operates simultaneously with the door so that when the ramp is lowered the door retracts into the cabin. When the ramp is closed, the door extends down to meet the ramp, and forms a complete closure. The tail skid circuit is routed through the down side of the ramp control switch so that the tail skid will automatically retract when the cargo ramp is lowered and the helicopter is on the ground. The ramp surface, about 6 feet, 6 inches long, and 7 feet, 6 inches wide, contains two roller conveyor assemblies and two flipper assemblies. The roller conveyors aid in the loading and loading of cargo. Both roller conveyors may be inverted into the ramp floor when not being used for cargo, and the reverse sides will provide skid-strip surfaces for vehicular, cargo, or troop transport operation. Flippers, which fold back when the ramp is closed, are at the end of each roller conveyor, to aid moving cargo onto the ramp. The cargo ramp and door are electrically-controlled and hydraulically-actuated by hydraulic pressure from the utility 1 hydraulic system. The ramp and door is normally-operated from control panels

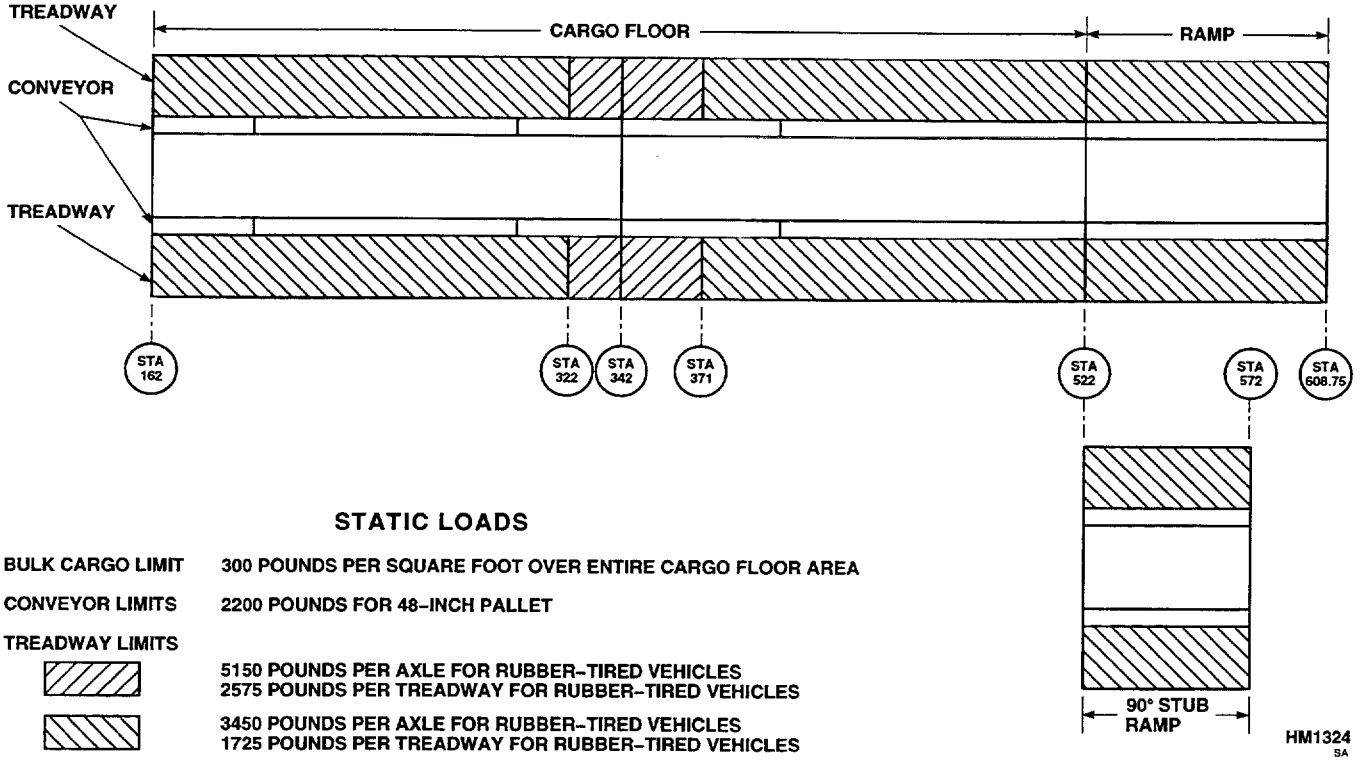


Figure 2-39. Floor Strength Limits

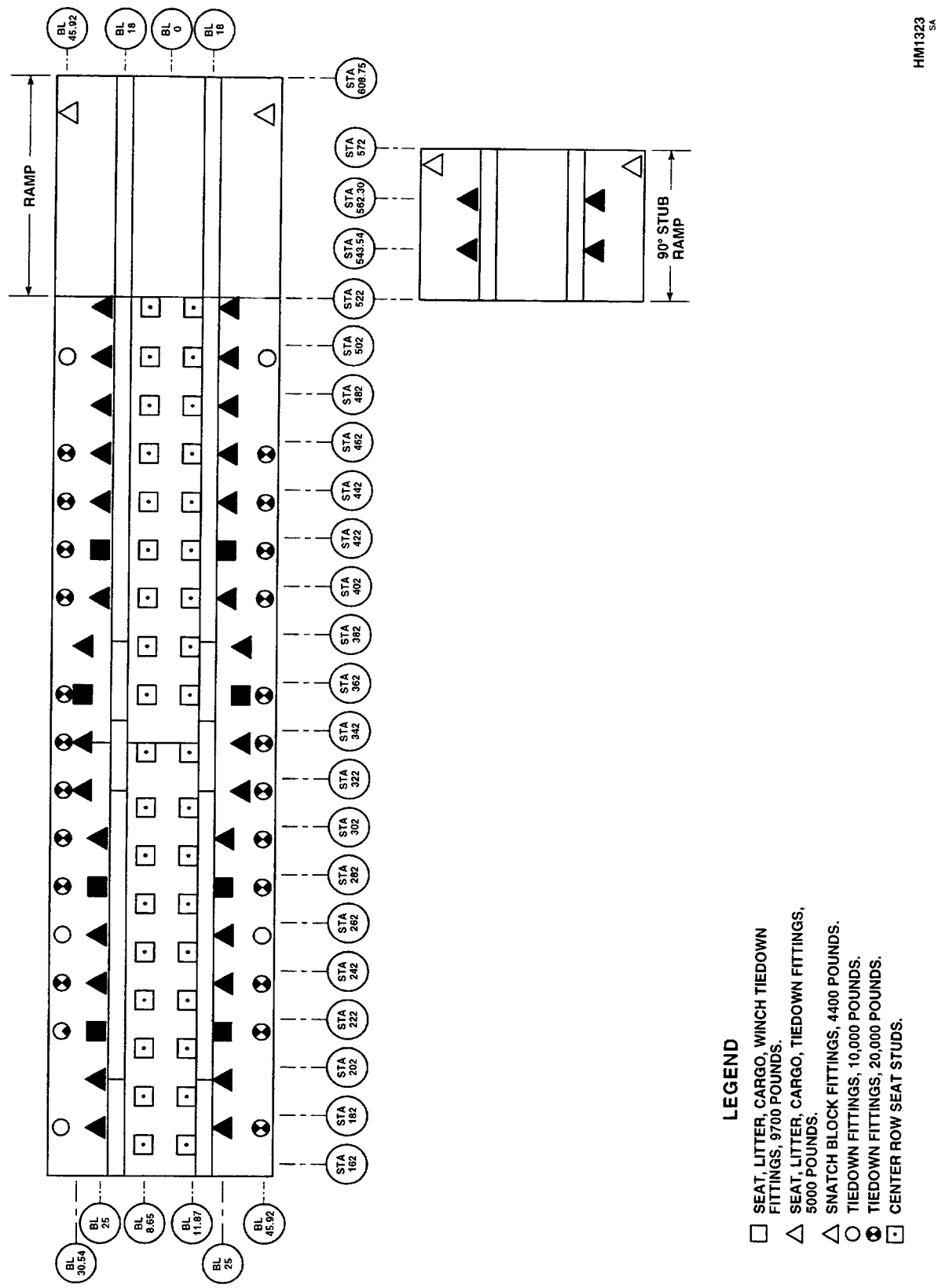


Figure 2-40. Location of Tiedown Fittings

CENTER OF GRAVITY ENVELOPE

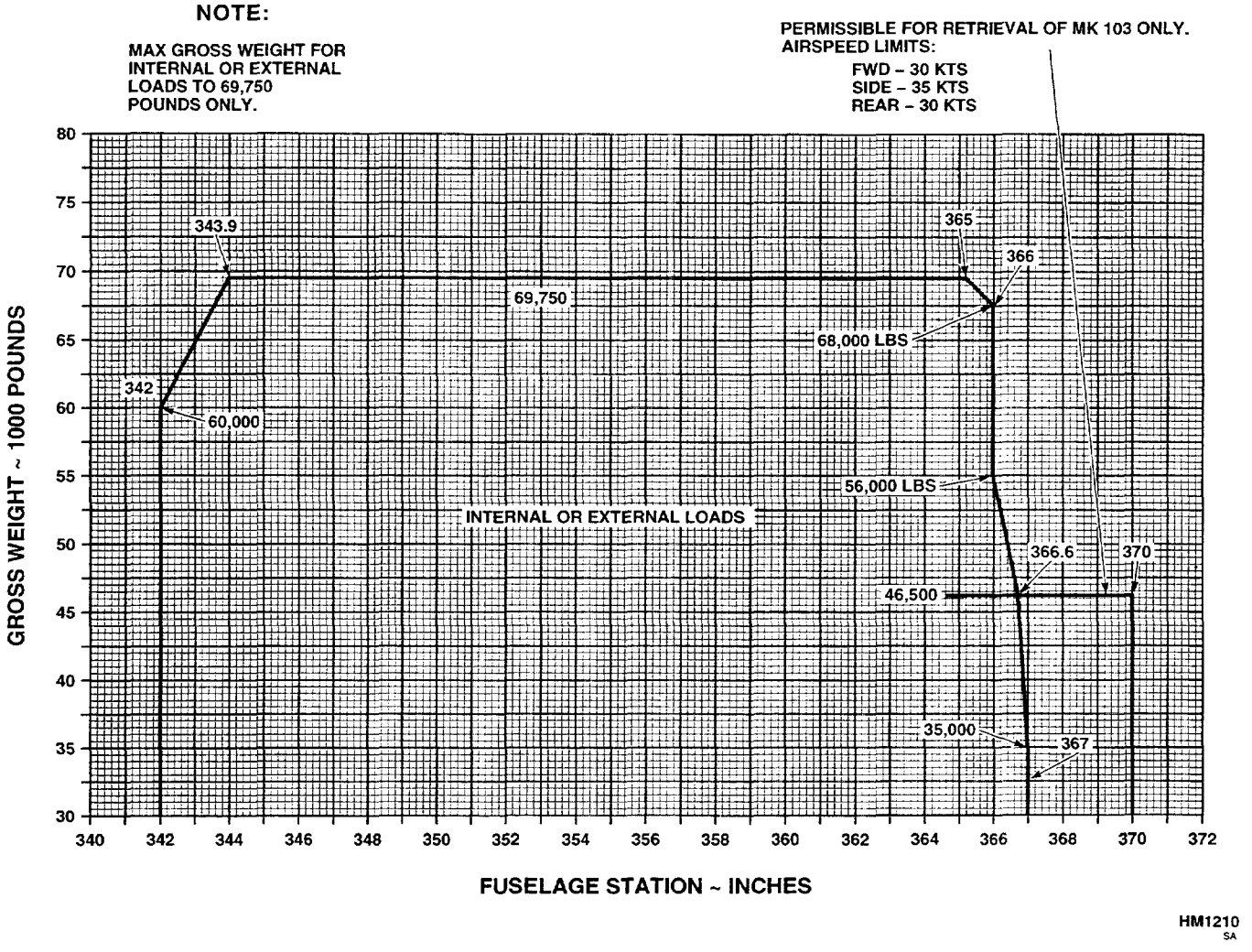


Figure 2-41. Longitudinal CG Limits vs. Gross Weight

in the cockpit or cabin. The ramp may be lowered manually, when hydraulic or electrical power is not available, by use of the uplock release and a mechanical override valve. The ramp uplocks are mechanically latched and released by hydraulic pressure. The ramp may be stopped at any intermediate position between closed and open to permit it to be used for loading. The ramp system incorporates a floating ramp capability, in the open position, in that relief valves are provided in the pressure lines of each actuating cylinder. This permits the helicopter to make taxi drops over rough terrain. If the ramp should strike the ground, the relief valves will cause the hydraulic pressure to bypass and allow the ramp to move toward the closed position until the force is removed. This feature lessens the possibility of ramp or actuating cylinder damage. The cargo ramp and door actuating system receives power from the No. 1 primary dc bus through circuit breakers, marked OPEN WARN and CONT, under the general heading RAMP. A light, marked RAMP OPEN, on the advisory panel (FO-6), will go on when the ramp is not fully up and locked. The RAMP OPEN light may be disabled when the ramp is rigged for AMCM operations. A light marked RAMP UNLOCKED, on the crew miscellaneous control panel (FO-43), will go on if the pilot MASTER switch is placed to PILOT and the copilot's OPERATE switch is placed to OPEN, or if the pilot's MASTER switch is at CREW and the crew ramp control handle is out of the neutral position.

ALLOWABLE CG OF CARGO–FUSELAGE STATIONS

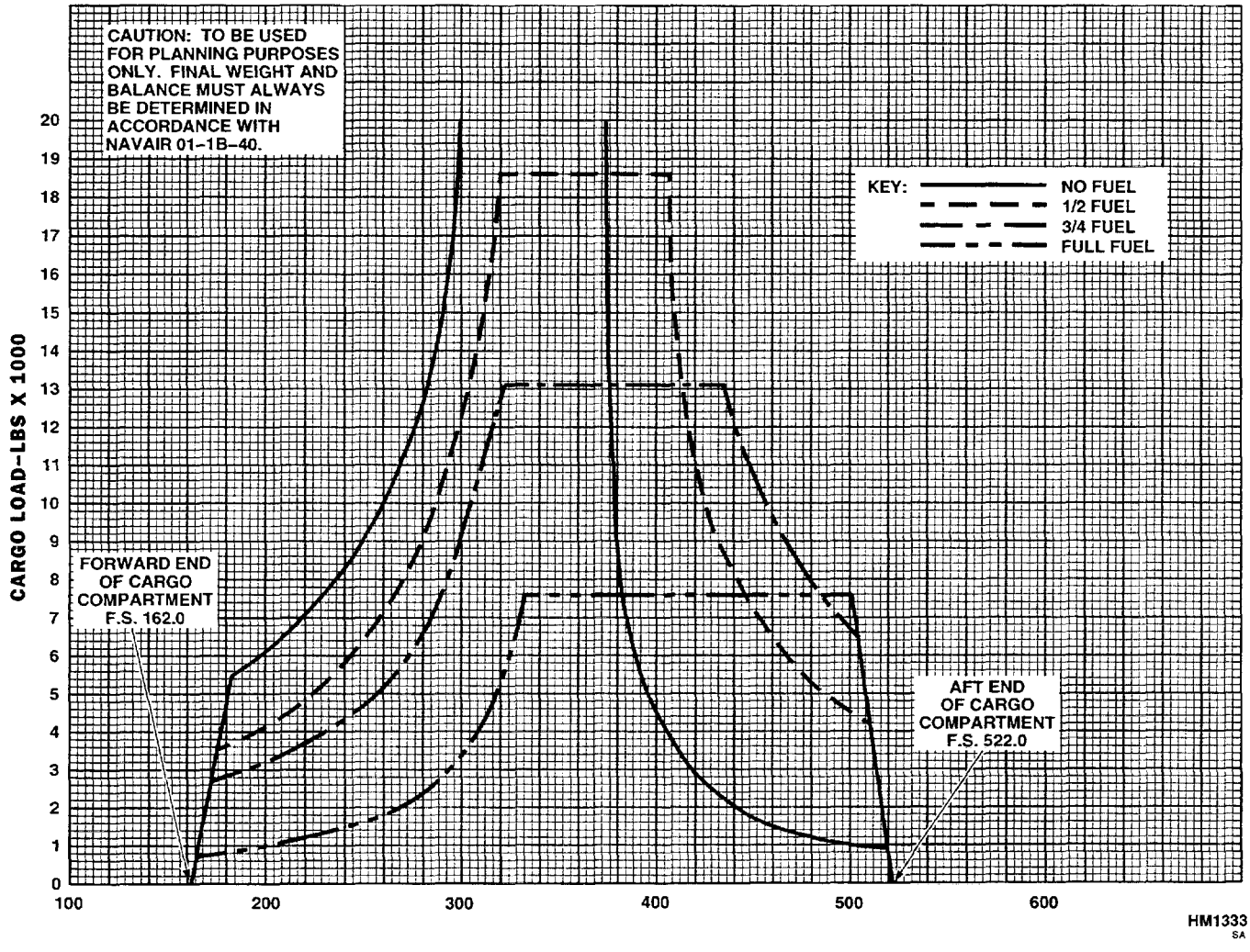


Figure 2-42. Cargo Center of Gravity Placement Chart

2.26.2.1 Ramp and Door Control Panel, Pilots. The CAR LDG panel, on the overhead control panel (FO-1) contains two operating controls under the heading RAMP CONTROL. The MASTER switch has positions CREW-OFF-PILOT. The OPERATE knob has positions OPEN-HOLD-CLOSE. The ramp can be operated only from the cockpit with the MASTER switch at PILOT, and from the cabin only with the switch at CREW. With the switch at PILOT, turning the OPERATE knob to OPEN moves the ramp down until placed at HOLD, or the ramp is full down. Hold will stop the ramp at any position. Turning the knob to CLOSE raises the ramp until placed at HOLD, or the ramp closes and the door is lowered to the closed position. The CARGO LOADING LTS switch has positions CREW-OFF-ON. ON turns the cargo lights on. CREW transfers cargo light control to the crew miscellaneous control panel.

WARNING

When transferring ramp control from pilot to crew, or from crew to pilot, be sure the pilot's ramp control knob is at HOLD and the crew ramp control handle is in neutral. If not in the respective positions, the ramp will immediately move to the position selected, and injury to personnel or damage to the helicopter may result.

CAUTION

Before lowering ramp, be sure that the area under it is clear of equipment, rocks, etc., that the ground is of equal load carrying capability to avoid twisting the ramp when heavy loads are applied, and that the flippers are up.

2.26.2.2 Miscellaneous Control Panel, Crew. The panel (FO-43) on the left aft cabin wall, is marked MISC. The panel contains a light marked RAMP UNLOCKED, that will go on whenever the door is not fully closed or the ramp is not fully up and locked; a LOADING LT dimming unit used to control the loading light's brightness; and a DAVIT MASTER switch used to turn on the davit control system.

2.26.2.3 Crew Ramp Control. The RAMP CONTROL handle (FO-43) on the left aft cabin wall, is a spring-loaded switch which is normally at a positive detent in the neutral (down) position. Moving the handle in the direction marked UP will close the ramp and door. Moving the handle toward DOWN will open the ramp and door. The rate of movement of the ramp and door varies with the amount of displacement of the handle to provide precise positioning of the ramp.

2.26.2.4 Cargo Door. The door may be operated independent of the ramp by placing the manually-operated ramp/door selector valve of the hydraulic actuator panel (Figure 2-43), on the right aft side of the cabin, to DOOR ONLY. The valve is normally left at NORMAL POSITION so the door will operate in conjunction with the ramp. The OPEN and CLOSE position of the pilot's OPERATE knob, or the crew ramp control handle, control door operation.

2.26.2.5 Ramp Uplock Release Levers

WARNING

Care should be taken, when manually releasing the door latches, to be sure the door does not slam and injure personnel.

The manual ramp uplock release levers, on each ramp uplock, can be used to manually release or engage the ramp uplocks, when hydraulic power is not available. Moving the handle forward releases the uplocks, and moving the handle aft engages the uplocks.

2.26.2.6 RAMP Control Servovalve. A servovalve on the hydraulic actuator panel (Figure 2-43), on the right aft side of the cabin, provides a manual control of the ramp. Turning the knob counterclockwise (DN) lowers the ramp, and turning the valve clockwise (UP) raises the ramp. To stop the ramp, return the knob to the center (detented) position. The valve will override the ramp control handle, and will control the ramp during electrical failure (UTILITY 1 hydraulic power on). A decal next to the control knob contains emergency operating instructions.

2.26.2.7 Ramp Manual Hydraulic Pump System. A manual control valve marked RAMP POSITION below the hydraulic actuator panel (Figure 2-43), on the right aft side of the cabin, with positions LOWER-OFF-RAISE, allows manual operation of the ramp during utility 1 hydraulic malfunction. Placing the valve to either marked position (LOWER-RAISE) will allow the ramp to be moved by actuating the hydraulic system handpump aft of the personnel door. The handpump selector valve is placed at position A (No. 2 accumulator) to manually raise or lower the ramp. The valve is placed in the vertical position (OFF) when not being used.

2.26.2.8 Door Locking Valve. The valve marked CARGO DOOR aft of the hydraulic actuator panel, is used to isolate hydraulic pressure from the door hydraulic cylinder. The valve has marked positions LOCKED UP-NORMAL. The NORMAL position is used except when locking the door. LOCKED UP will hold the door at any position it is in.

2.26.3 Cargo Winch. A variable speed hydraulically-driven, electrically-controlled cargo winch (Figure 2-44) is provided for cargo operations. The winch, if installed, is centerline-mounted on the cargo floor immediately behind the cockpit. It provides at least 80 feet of usable stainless steel cable. When cable is reeled out,

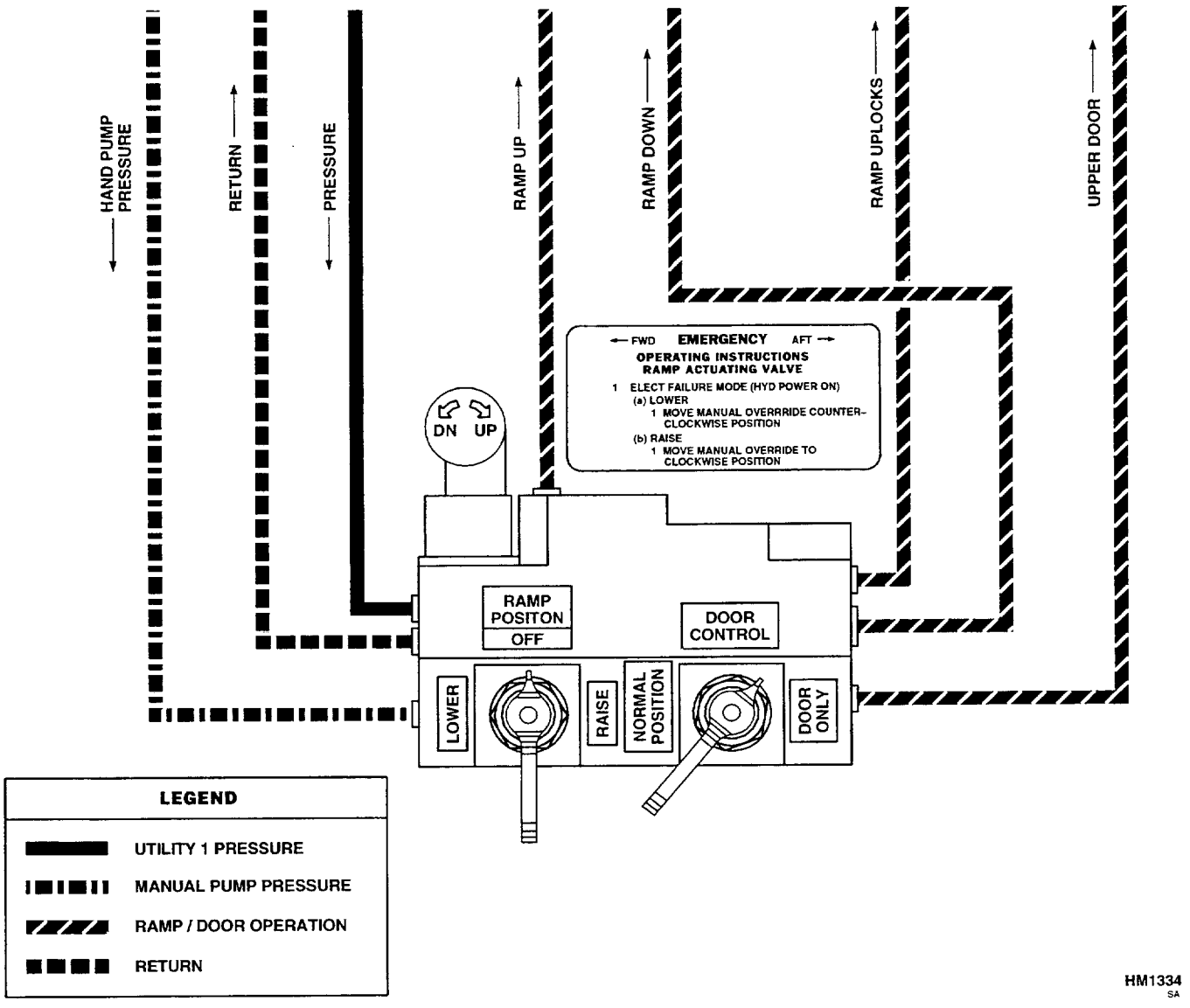


Figure 2-43. Hydraulic Actuator Panel Schematic

one man must pull on it (there is no freewheeling capability). A 4-foot painted length of cable reels off the winch just before an out-limit switch automatically stops the winch. A slowdown switch will slow cable reel-in to about 20 fpm when 4 to 6 feet of cable remains to be reeled in. Also, an in-limit switch stops the winch when about 6 inches of cable remains to the cable end fitting. Winch capacity is 5000 pounds at all speeds. The cargo winch hydraulic motor is powered by the 3000 psi UTILITY 1 system pump. Electrical control power comes from the No. 1 dc primary bus, and is protected by a CARGO WINCH circuit breaker on the left cabin circuit breaker panel. Operation of the winch is controlled through a pendant in the cargo compartment. A stowage case for removable cargo handling equipment is installed in the forward left corner of the cabin and replaces three troop position seats. The stowage case may be used for three seat positions, or it can be removed and the troop seats reinstalled. The forward most three-man troop seat assembly, on the helicopter centerline, can be used only when the winch assembly is removed from the winch support assembly. A step/cover protects the winch and provides a step to the cockpit in both winch assembly positions, and when the winch assembly is removed from the support assembly.

2.26.3.1 Cargo Winch Operation. The cargo winch is used for loading cargo through the cargo ramp

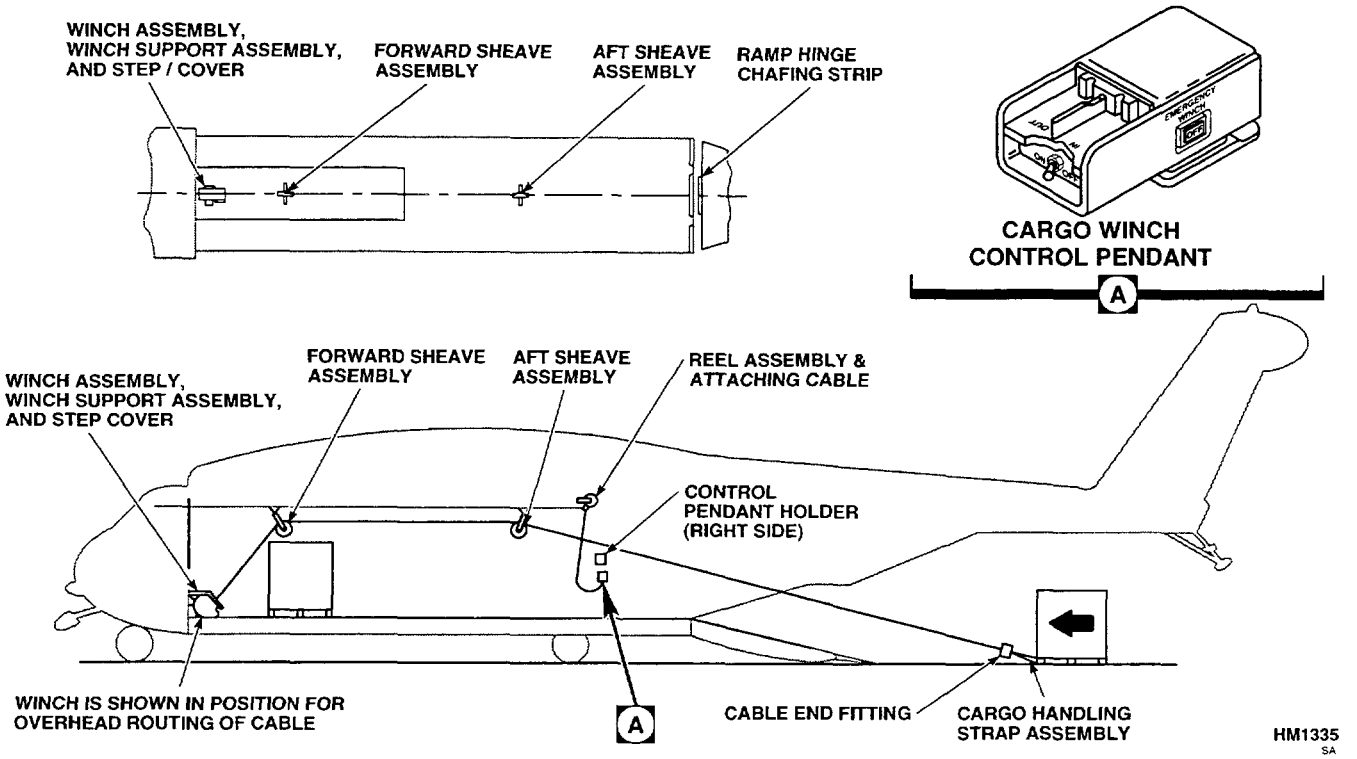


Figure 2-44. Cargo Winch Installation and Operation

door. A winch support assembly is bolted to the cargo compartment floor and holds the cargo winch assembly by two attaching plates. The support assembly contains four bearing points, which allow the winch assembly to be rotated on the attaching plates to either a horizontal position (for direct cable haul-in) or an angled position of 54° from the horizontal (for winch cable haul-in via the overhead sheave assemblies). The winch assembly is locked into either position by four release pins. The forward and aft overhead sheave assemblies consist of a snatch block assembly with a 6-inch diameter sheave, and a fitting assembly which attaches to the overhead cabin structure with two quick-release pins. One or several pieces of cargo may be loaded at one time. Winch operation will cause the cargo to be pulled into the cargo compartment. A chafing strip is installed over the ramp hinge to protect the cabin floor. Two nylon cargo handling strap assemblies are used to attach to the cable end fitting for moving cargo.

2.26.3.2 Control Pendant. The control pendant (Figure 2-44) and attaching cable, housed in a reel assembly, is mounted on the right side of the cargo compartment. The attaching cable, housed in a reel assembly on the aft cabin overhead, permits the crewman to operate the control pendant from various locations. When holding pressure is released from the reel assembly, the control pendant and attaching cable automatically retract. The assembly provides both winch and ICS functions for the winch operator. The pendant operates the cargo winch by an ON-OFF master power switch, and EMERGENCY WINCH OFF switch, and a winch control/speed/direction selector marked IN-OUT. The control/speed selector is spring-loaded to neutral and has variable speed/direction control that will provide a variable winch speed capability of 0 to 70 fpm in each direction. Pressing the emergency stop switch removes all power from the winch control/speed selector. When the master power switch is ON, it provides power to the winch control/speed selector. A "hot mike" ICS condition is produced when the control pendant is connected to the cable assembly. A holder on the right side of the cabin is for stowage of the control pendant.

2.27 EMERGENCY SYSTEMS

2.27.1 Fire Detection Systems. The engine, main transmission (419 engine) and APP/heater fire detector systems provide a warning in case of fire in any of these areas. Each system contains a control amplifier, infrared-type flame detectors, and warning lights. The control units monitor the frequency impedance of the flame detectors

that are installed in fire zone areas of the engine, main transmission (419 engine), and APP/heater compartments. The flame detectors sense infrared radiation, causing the appropriate warning lights to go on. As the flame in the fire zone drops below the warning point, the system will be restored to its original condition with all the warning lights off. Each detector provides a 90° scan. The APP/heater compartment contains two detectors, one mounted high on the firewall facing forward, and one mounted forward under the heater, facing aft. All fire detector systems receive power through five-amp circuit breakers on the emergency dc bus. These circuit breakers are marked: FIRE DET, under the general heading of the associated engine, MAIN XMSN FIRE DET for the main transmission compartment (419 engine), and FIRE CAB HTR APP for the cab heater and APP compartments. All circuit breakers are in the cockpit.

Note

Certain conditions of sunlight, especially during the early morning and late evening hours, may cause the engine fire warning lights to go on. The lights should go off when the helicopter changes its relative position to the sunlight.

2.27.1.1 Master-Fire Warning Lights. The MASTER CAUTION light and master FIRE warning lights are in front of the pilot and copilot under the glareshield. Both master lights will go on any time the photocell flame detectors of any system detect a fire. The MASTER CAUTION and master FIRE warning lights can be pushed in to reset after having been lit.

2.27.1.2 Engine Fire Warning Lights. Each engine emergency T-handle on the fuel selector quadrant (FO-1) contains a red fire warning light. The appropriate engine fire warning light will go on to indicate which engine compartment has developed a fire. The fire warning master lights will alert the pilot of a fire, and the engine fire warning light in the T-handle will designate which engine is affected.

2.27.1.3 APP and Cabin Heater Fire Warning Light. The APP emergency T-handle, on the APP control panel, contains a red fire warning light. The fire warning light will go on to indicate that a fire has developed in the APP and cabin heater compartment, only after APP speed has reached 92%. Before 92%, there is no fire warning detection for the APP and cabin heater compartment. The master fire warning lights will alert the pilot of a fire, and the APP and cabin heater compartment fire warning light will designate the fire to be in the APP and cabin heater compartment. However, the warning light will not show whether the fire is in the APP or the cabin heater.

2.27.1.4 Main Transmission Fire Warning Lights. The MAIN XMSN FIRE warning lights are in front of the pilot and copilot under the glareshield. They go on when the photocell flame detectors of the main transmission fire detect system indicate a fire in that area.

2.27.1.5 Fire Warning Test Control Panel (416 Engines). This panel (FO-1), on the overhead control panel, is used to test the engine and the APP and heater compartment fire detector systems. The control panel, marked FIRE WARN TEST, contains a tear-shaped rotating switch, with marked positions NORM-1-2-3, under the general markings APP-ENGS. The switch is spring-loaded to NORM. When the switch is turned to the 1 position, the master fire warning lights and the lights in the engine and APP emergency T-handles will go on, to indicate that the No. 1 detector circuit of each system is operating properly. Turning the switch to the 2 position will also cause the master fire warning lights and engine and APP emergency T-handles to light, to indicate the No. 2 detector circuit of each system is operating properly. When the switch is turned to the 3 position, the master fire warning lights and the lights in the engine emergency T-handles will light, to indicate the No. 3 detector circuit of each engine fire detector circuit is operating properly.

2.27.1.6 Fire Warning Test Control Panel (419 Engine). The FIRE WARNING TEST panel (FO-1), on the overhead control panel, is used to test the engine, main transmission and APP/heater compartment fire detector systems. It has a rotating switch with the following marked positions: NORM-1-2-3-4-5. The switch is spring-loaded to NORM. Positions 1, 2, and 3 are under the general heading of ALL ENGS, while 4 and 5 are under the heading labeled ENG #2. Positions 1 and 2 are also under the heading labeled APP, while 3 and 4 are under the heading of XMSN.

With the switch at position 1, all three ENG EMER OFF and the APP EMER OFF T-handles will light, indicating that the No. 1 detector circuit for each system is operating properly.

At position 2, all three ENG EMER OFF and the APP EMER OFF T-handles will light, indicating that the No. 2 detector circuit for each system is operating properly.

At position 3, all three ENG EMER OFF T-handles and the MAIN XMSN FIRE indicator will light, indicating that the No. 3 detector circuit for each engine system and the No. 1 detector circuit of the main transmission system are operating properly.

At position 4, the #2 ENG EMER OFF T-handle and the MAIN XMSN FIRE indicator will light, indicating that the No. 4 detector circuit for the No. 2 engine system and the No. 2 detector circuit of the main transmission system are operating properly.

At position 5, the #2 ENG EMER OFF T-handle will light, indicating that the No. 5 detector circuit for the No. 2 engine system is operating properly.

The master fire warning lights will be lit for all switch test positions, 1 thru 5.

2.27.2 No. 2 Engine Dual Thermal Detection System (AFC 483). The No. 2 engine dual thermal detection system gives an indication of No. 2 engine compartment overheating. The system has a control unit, dual sensing elements, a warning light on the caution/advisory panel, and a NO. 2 ENGINE OVERHEAT WARNING PANEL on the cockpit overhead control panel. The control unit monitors the temperature detected by the sensing elements. When the temperature exceeds preset limits, the control unit sends an output signal which makes the #2 ENGINE OVERHEAT caution light come on. When the temperature drops below the preset limits, the system is reset and the #2 ENGINE OVERHEAT caution light goes out.

The NO. 2 ENGINE OVERHEAT WARNING PANEL (FO-1) has a press-to-test button labeled TEST. The TEST button checks the No. 2 engine dual thermal detection system electrical continuity. If the system check is good, the #2 ENGINE OVERHEAT caution light comes on.

The emergency ac bus supplies power to the No. 2 engine dual thermal detection system through the NO. 2 ENG THERM DET circuit breaker. The emergency dc bus supplies power to the No. 2 engine dual thermal detection warning light through another NO. 2 ENG THERM DET circuit breaker. Both NO. 2 ENG THERM DET circuit breakers are on the cockpit overhead control panel.

2.27.3 Fire Extinguisher Systems. These systems consist of the engine fire extinguisher system and an APP cabin heater compartment fire extinguisher system. The fire extinguisher systems containers are charged with 4.5 pounds of Monobromotrifluoromethane ($CF3B_r$) plus approximately 600 psi of nitrogen to propel the extinguishing agent. Nitrogen pressure is displayed by a gage on each container and the acceptable pressure for the ambient temperature is shown on a decal affixed to the container. The containers are not serviced at the organizational level. Both systems also contain discharge nozzles, overboard discharge tubes, discharge indicators, and necessary controls.

A crash generated force of 10 Gs automatically discharges the fire extinguishers into the engine compartments. The automatic discharge is actuated by an omnidirectional inertial switch that is powered by a rechargeable battery and is on the line at all times. Power to operate the battery recharger is furnished by the No. 1 primary ac bus through a circuit breaker marked BATT CHARGE in the cabin.

2.27.3.1 Engine Compartment Fire Extinguisher System. The system includes three containers, in the accessory compartment forward of the accessory gear box. Each container is interconnected with a manifold that permits the extinguishing agent to be distributed to the compressor and power turbine sections of selected engine compartments. A safety outlet in each container is connected through a common line to a red thermal discharge indicator, on the left side of the fuselage. If the pressure in either container becomes too high, the appropriate safety valve will open, the thermal discharge indicator seal will be ejected, and the extinguishing agent will be discharged overboard. A pressure gage on each container aids a preflight pressure check. When the containers are properly charged, the pressure gages should indicate the value within the range shown on the decal next to the gages. Power for the engine fire extinguisher system is received from the emergency dc primary bus through circuit breakers in the cabin, marked FIRE EXT, under the general heading of the associated engine.

Note

If two bottles were discharged into one compartment, the remaining bottle can be discharged into either of the remaining compartments. The last bottle will be discharged by either the MAIN or RESERVE selection, depending on which two bottles have already been discharged, and which compartment has been selected. In this case, the most expeditious thing to do is to select MAIN and then RESERVE.

2.27.3.2 Engine Emergency T-Handles. The three engine emergency T-handles, on the engine control quadrant (FO-1), direct the flow of the fire extinguishing agent. The emergency T-handle light covers are marked NO. 1 ENG EMER OFF, NO. 2 ENG EMER OFF, and NO. 3 ENG EMER OFF respectively, to designate which

engine fire extinguisher system it controls. When any T-handle is pulled full aft, the handle will close the fuel selector lever for the selected engine. The fire extinguisher switch is then placed to MAIN OR RESERVE to discharge the fire extinguisher agent into the engine selected. If more than one emergency T-handle is moved full aft, the fire extinguishing agent will be directed to the engine compartment of the last emergency T-handle actuated.

2.27.3.3 Engine Fire Extinguisher Switch. This switch, marked FIRE EXT, is on the emergency control panel marked EMER, on the overhead control panel (FO-1). The switch has marked positions RESERVE, OFF and MAIN. The switch is left OFF, until an emergency T-handle has been actuated, then place to either MAIN or RESERVE. When the switch is placed to MAIN, the contents of the engine's associated container is discharged in the engine compartment of the engine selected with the respective emergency T-handle. When the switch is placed to RESERVE, the contents of another engine's container is discharged in the engine compartment of the engine selected.

2.27.3.4 APP and Cabin Heater Compartment Fire Extinguisher System. This system includes a container, in the accessory compartment forward of the accessory gear box. The container is mechanically discharged whenever the APP emergency T-handle, marked APP EMER OFF on the light cover, forward of the APP power control lever, is pulled full aft. When the APP emergency T-handle is actuated, the APP and cabin heater fire areas will simultaneously receive fire extinguishing agent and fuel will be cut off to both systems. A safety valve in the container is connected to a red thermal discharge indicator, on the left side of the fuselage. If pressure in the container should become excessive, the safety valve will open, the thermal discharge indicator seal will be ejected, and the extinguishing agent discharged overboard. If the APP emergency T-handle has been actuated to put out a cabin heater fire, no fire extinguisher agent will be available for subsequent APP operation. The APP and cabin heater compartment fire warning lights, in the APP emergency T-handle, do not differentiate between an APP or cabin heater fire.

2.27.3.5 Electronics Compartment Emergency Access Panel. Two access panels, located on the forward cabin bulkhead behind the copilot and pilot seats, provide access to either the port or starboard electronic compartment in case of fire.

2.28 EMERGENCY ENTRANCE/EGRESS SYSTEMS

2.28.1 Cockpit Windows. The windows (Figure 2-45, Detail A) are opened and closed with a handle attached to an actuating bar. The windows are opened by turning the handle up; then, using the handle as a lever, turning the actuating bar down until the latches release.

The window then pushed out to the open position, where the engage locks will hold it open. The windows are closed by releasing the engage locks and pulling the window partially closed. With the handle up, it is used as a lever to turn the actuating bar down to retract the latches. The window is then pulled in, fully closed; then the handle is turned down until its lock latch engages. Operating instructions are on each window sill. The windows may be opened on the ground, but should not be opened during flight. However, each window is equipped with a snap vent that may be extended for additional ventilation. The windows may be jettisoned to provide emergency exits by the manual emergency release handles, marked EMERGENCY EXIT PULL OUT AND TURN, at the bottom of each window inside the pilot's compartment. The windows can be jettisoned by turning the release handle and pushing out on the window. The windows can also be released from the outside by turning the handle, marked EXIT RELEASE-PRESS BUTTON-TURN.

2.28.2 Personnel Door. This door (Figure 2-45, Detail B), on the right side of the helicopter, is normally used as an entrance to the cabin and cockpit. The door is divided into an upper and lower section, each of which may be opened separately. The upper half may be opened from the outside by turning the handle, marked TO OPEN-PRESS BUTTON-TURN, on the bottom of the upper section. The upper section of the door is normally opened and closed by the handle, marked TO OPEN-TURN, on the inside of the door. The handle also locks the upper section of the door open if needed for in-flight operations. The upper section may be jettisoned from the inside by turning both handles and pulling in on the door. The lower door swings inward on vertical hinges against the forward cabin bulkhead. The outer handle is recessed in the door and extends out when a button on the handle is pressed. To open the door from the outside, turn the handle counterclockwise. To open the door from the inside, turn the handle clockwise.

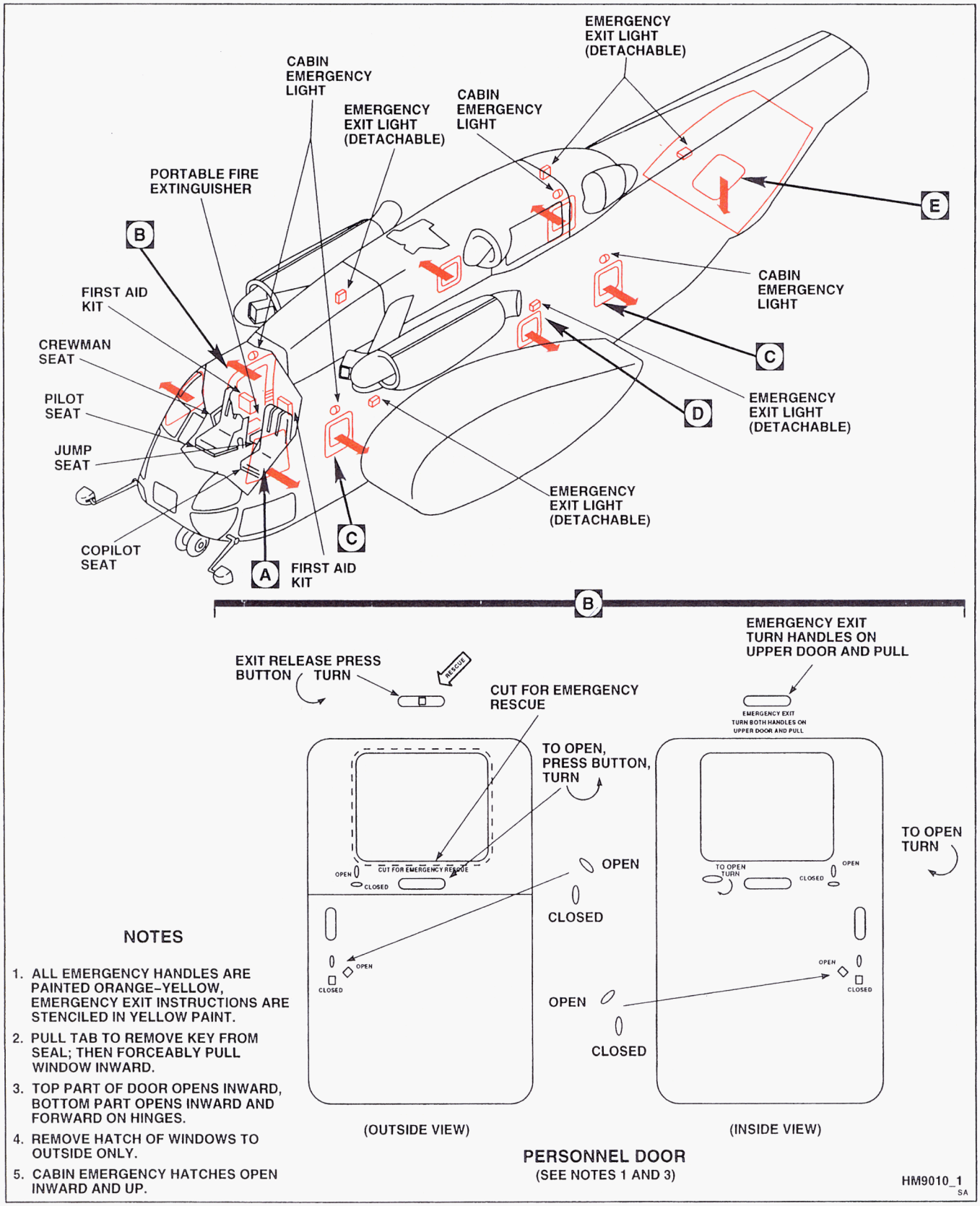


Figure 2-45. Emergency Equipment, Exits, and Entrances (Sheet 1 of 2)

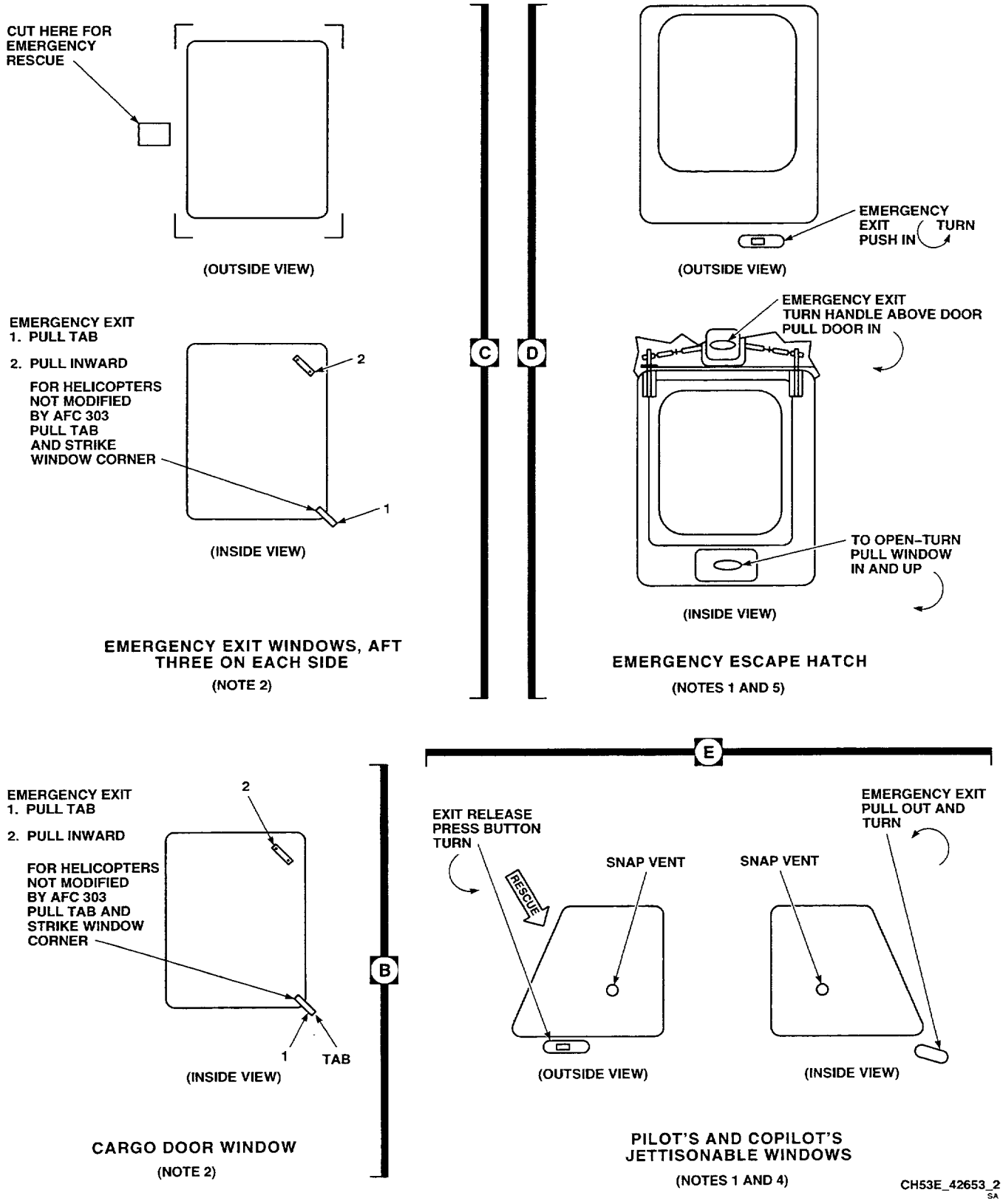


Figure 2-45. Emergency Equipment, Exits, and Entrances (Sheet 2 of 2)

WARNING

To avoid injury to personnel, decrease airspeed below 60 KIAS before opening or closing upper section of personnel door.

2.28.3 Cabin Emergency Escape Hatches. The hatches may be used as emergency exits. Two hatches are on the left side of the cabin and one is on the right side of the cabin (Figure 2-45, Detail C). Each hatch can be hinged open by turning the lower handle clockwise and swinging the hatch inboard and up. Each hatch can be removed for emergency exit by turning the upper handle clockwise and pulling the hatch inboard. Each hatch can be removed from the outside by turning the handle below the hatch counterclockwise and pushing the hatch in. The left forward hatch may be used as a gun port.

WARNING

To avoid injury to personnel, decrease airspeed below 60 KIAS before opening or closing forward left escape hatch.

2.28.4 Cabin Windows. Two cabin windows (Figure 2-45, Detail D), one on each side, may be pulled inward for additional emergency exits. Each window has EMERGENCY EXIT stenciled above the window. Each window has a pull tab, marked PULL TAB, by which the locking strip may be pulled out of the rubber seal surrounding the window panel. The window panel may then be pulled inward using the strap attached to the upper corner of the window panel.

Note

The single-point cargo hatch may be used as an exit, should an emergency situation warrant.

2.28.4.1 Cargo Door Window. The door has a window (Figure 2-45, Detail E) marked EMERGENCY EXIT, that may be pulled inward, as an additional emergency exit. The window has a pull tab, by which the locking strap may be pulled out of the rubber seal surrounding the window pane. The window panel may then be pulled inward using the strap attached to the upper right corner of the window pane.

2.29 EMERGENCY EQUIPMENT

2.29.1 Emergency Lights. These lights are both fixed and portable and are discussed in this section under LIGHTING EQUIPMENT.

2.29.2 First Aid Kits. One first aid kit is mounted on the bulkhead behind the copilot's seat. A second kit is mounted on the forward cabin bulkhead AFCS servo compartment door.

2.29.3 Portable Fire Extinguisher. A portable monobromotrifluoromethane ($CF3B_r$) fire extinguisher is mounted beneath the aircrewman's seat. The fire extinguisher is held in place by a bracket with a tightfitting quick-release lever.

2.30 AIRBORNE MINE COUNTERMEASURES (AMCM) EQUIPMENT

AMCM equipment consists of the various installations which selectively used in combination accomplish the helicopter's primary mission. The items used are the AMCM installations provided with the helicopter, streaming winches, various towed vehicles, and armament equipment. The following equipment used for AMCM is considered part of the helicopter installation.

2.30.1 AMCM Tow Control Panel. The MCM TOW control panel, on the center console (FO-7), contains controls for various tow mode functions: MCM tension/skew angle indicator selections, tow guillotine arming, tow and transfer hook selections, anticollision beacon selection, and audio/visual warning systems.

2.30.1.1 Load Cell Function Control. The knob with marked positions OFF (PULL)-AUTO-TOW-STR-WINCH, selects the tension mode to be indicated on the MCM tension/skew angle indicators. At OFF power is removed from the system. The switch must be lifted (PULL) to move into the OFF position. When at AUTO the tension indicator will automatically show the load cell tension (TOW, STREAMING, or WINCH) in use. If more than one load cell is under tension, the tension displayed is from the load cell under the most tension. TOW permits only tow tension to be indicated, STREAM permits only streaming roller tension to be indicated, and WINCH provides only winch tension to be indicated (the winch load tension function is inoperative).

2.30.1.2 Tension Mode Switch. The knob with marked positions TENSION-HI SET-LO SET-CAL (PULL), selects tension displays to be indicated on the MCM tension/skew angle indicators. When at TENSION, the

indicator will display the tension, hi set, lo set, and release level on the tension indicator. At HI SET the indicator will display the high tension selected, and at LO SET the indicator will display the low tension selected. Selected limit switch adjustments can also be made while in the HI SET and LO SET positions. The CAL position is used for calibration of the load cells only when the helicopter is on the ground and there is no tension on the load cells. The switch must be lifted (PULL) to move into the CAL position. Either PASS or FAIL will light on the tension skew indicator during calibration to indicate proper calibration or partial/complete failure of load cell calibration respectively.

2.30.1.3 Test Switch. The press button marked TEST is used for self-test functions on the ground and in the air. The correct test is automatically chosen based on the tension on the load cell(s) and weight-on-wheels switch. When pressed, all segments of the tension skew indicator, CABLE CONTACT AMCM advisory light, the TENSION/SKEW caution light, and the tension audio (if selected) should turn on. The self-test, when complete, will cause the word PASS to light on the tension skew indicator if the system is operating properly. The word FAIL will light and the DEGRADED legend will go on, to indicate a system malfunction.

Note

The DEGRADED legend is only cleared by a system self-test or system power reset.

2.30.1.4 Limit Switch. The LIMIT switch with marked positions INC-DECR, is a three position switch spring-loaded to the center position. Used with the tension mode control, the switch sets the high and low tension limits on the MCM tension/skew indicator. Set the mode control to either HI SET or LO SET and hold the limit switch momentarily to either INC (to increase) or DECR (to decrease) to move the respective tension scale segment to the desired position.

2.30.1.5 Tension Select Switch. The switch marked TENS SEL with marked positions CPLT-NORM-PLT selects the channel being used to provide information to the pilot and copilot MCM tension/skew angle indicators. At NORM, both indicators are using their own information channels. At CPLT or PLT, both indicators receive information from the copilot or pilot channel, as selected. The switch must be lifted from a detent to place it at CPLT or PLT. When placed a PLT or CPLT place test switch to TEST to initiate a self-test to restart the disconnected pilot or copilot channel.

CAUTION

Automatic release is disabled when the TENSION SELECT switch is in the PLT or CPLT position.

2.30.1.6 Scale Switch. The SCALE switch with marked positions 6000 - AUTO - 40000, selects the tension scale on the MCM tension/skew indicator. At AUTO the indicator will automatically select the appropriate scale to provide tow tension information. At 6000 and 40000, the indicator will show tow tension on the 6000 pound and 40,000 pound scale, respectively.

2.30.1.7 Tension Audio Switch. The switch marked TENS AUDIO has positions ON-OFF. At ON, the audio system is armed to provide tension audio warning when the altitude/attitude warning system is disabled. OFF disables the system.

2.30.1.8 Guillotine Switches. There are two guillotine arming switches marked PORT ARMED and STBD ARMED under the heading GUILLOTINE. When the PORT ARMED switch is at the PORT ARMED position and the port guillotine cutter is attached to the port streaming wire, the wire will be guillotined when the CABLE SHEAR, SWEEP TOW switch on the emergency control panel is activated. When the STBD ARMED switch is at the STBD ARMED position and the starboard guillotine cutter is attached to the starboard streaming wire, the wire will be guillotined when the CABLE SHEAR, SWEEP TOW switch on the emergency control panel is activated. The guillotine switches and the sweep tow switches are normally OFF. For test procedures, refer to Chapter 7, under POST APP START.

2.30.1.9 Tow Release Switch. The switch marked TOW REL, with positions ARMED-OFF, when placed at ARMED allows the tow hook to release (open) by pressing the cargo hook release switch on either cyclic grip. OFF disables the system.

2.30.1.10 Warning System Pushbutton. Under the heading WRN SYS the pushbutton marked LDG GEAR, when pressed, disables the landing gear and attitude warning systems and lights, to show WRN SYS OFF. When engaged, tension below the low limit setting (but above 200 pounds) will cause the low limit bug and TENSION × 1000 legend on the tension skew indicator to flash. Tension above the high limit setting will cause the high limit bug on the TENSION × 1000 legend to flash,

the TENSION/SKEW warning to turn on, and the tension audio warning should sound (if selected). Exceeding 60 knots will cause the light to go off and return the landing gear and attitude warning system to normal operation.

2.30.1.11 Warning System Switch. The WRN SYS switch has positions RESET-NORM. The switch is spring-loaded to the NORM (normal) position. Momentarily placed to RESET will cause the warning system pushbutton light to go off and return the landing gear and attitude warning system to normal operation.

2.30.1.12 Anticollision Beacon Switch. The ANTI-COLL BCN switch, with marked positions AMBER-RED, selects the forward anticollision light to be used as either an amber or a red light. When AMBER, the light will turn counterclockwise and light amber to indicate that AMCM operations are being conducted. When RED, the light operates normally.

2.30.1.13 Transfer Hook Switch. Inoperative.

2.30.2 Tension/Skew Angle Indicating System. Two liquid crystal display (LCD) MCM tension/skew indicators (FO-5) provide the pilot's with a digital presentation of tow tension and skew angle information. In the upper left corner of the indicator, a FAULT display lights to indicate system fault during self test. In the upper right corner of the indicator, a DEGRADED display lights when an operator-initiated system test detects a malfunction. Two segmented arched tension scales in the upper center of the indicator provide parallel displays. The upper scale is divided into segments from 0 to 40 × 1000 representing 1000 lbs each. The lower scale is divided into segments from 0 to 6 × 1000 representing 150 lbs each. Low, high, and automatic release limits for a selected scale are shown on the opposite scale. The limit for automatic tow release is displayed by three light segments, the center segment indicates the precise numeric limit. This limit is set by maintenance personnel and cannot be adjusted by the pilots.

CAUTION

Automatic release is disabled when the TENSION SELECT switch is in the PLT or CPLT position.

The upper scale has indices at 1000-lb increments from 0 to 40 with 0, 10, 20, 30, and 40 marked in figures. The lower scale has indices at 1000-lb increments from 0 to 6 with 0, 1, 2, 3, 4, 5, and 6 marked in figures. A TENSION × 1000 display flashes to indicate when either high or low tension is exceeded. When engaged, tension below the low limit setting (but above 200 pounds) will cause the TENSION × 1000 legend on the tension skew indicator flash. Tension above the high limit setting will cause the TENSION × 1000 legend to flash, the TENSION/SKEW warning to turn on, and the tension audio warning to sound (if selected). An alphanumeric digital readout provides actual tow tension in pounds (to the nearest 100 pounds) corresponding to the segmented scale display. A display of TOW STREAM WINCH lights to show the load cell function being monitored, as selected by the load cell function control switch on the AMCM control panel. The lower portion of the indicator provides a segmented scale showing skew angle from 12° left to 12° right. Below the scale indices at 1° increments are shown from 10 left to 10 right with 10, 0, and 10 marked in figures. A display of SKEW ANGLE flashes to indicate skew angles between 8 to 12°.

2.30.3 AMCM Advisory Lights Panel. Two AMCM advisory lights panels on the instrument panel (FO-5), provide the pilots with monitoring information capsules marked TOW HOOK OPEN, TOW BOOM, and CABLE CONTACT. When on, TOW HOOK OPEN indicates the tow hook is unlocked; TOW BOOM indicates the tow boom is not in the stowed position and the tow release switch is in the armed position; and CABLE CONTACT indicates the tow boom skew is in excess of 8° either side of the helicopter centerline. The TRANSFER HOOK ENGAGED advisory light is inoperative.

2.30.4 AMCM Control Pendants. Electrical control of the streaming winches is provided by two variable-speed control pendants (FO-43). When not in use, the pendants may be stowed on the left or right cabin walls. The pendants, with cord reel assemblies for housing and attaching cord, are mounted in the aft ceiling of the cabin compartment near the ramp opening. The pendants, one for each streaming winch, contain the controls for streaming winch operation. The attaching cord and cord reel assembly permits crewmen to operate the pendants from various locations. When holding pressure is released, the control pendant and attaching cord will be automatically retracted to the cord reel assembly. Each control pendant has a master power switch marked SWEEP-OFF-TOW SWEEP or TOW select the desired mode of operation and OFF removes control power to the winches. A reel-in, reel-out control paddle is marked IN-OUT. Increasing the displacement of the paddle from center increases the speed of the selected SWEEP or TOW function. The paddle is spring-loaded to the center position. An EMERGENCY WINCH OFF button, when pressed, removes power from the winch pendants. When this button is

pressed, it lights to indicate that electrical power has been removed from the winch pendants. An ICS button is used for communication between crewmembers, and a CALL button is used to break through to the pilots when they have selected ICS isolation (ISOL) in the cockpit.

2.30.5 Safety and Control Panel. A safety pendant and control panel (FO-43) on the left side of the cabin are incorporated in the winch electrical circuit to enable shut down of the utility 2 hydraulic system by a safety observer. The pendant has a covered switch marked AMCM WINCH EMER STOP. Pressing the switch will shut down the utility 2 system and will remove electrical power form the pendants. The pendant is attached to the control panel marked SAFETY OFFICER PENDANT. A light on the control panel will show OFF when the pendant switch is pressed.

2.30.6 Guillotine and Circuit Tester Panels

WARNING

When wire is to be cut, reduce tension and make sure that crewmen are clear of the area, to prevent injury from flying particles. The cutters contain explosive cartridges and shall be handled in accordance with the specified procedures.

A guillotine and circuit tester panel (FO-43), each equipped with a circuit tester box and cable cutter, is installed on either side of the cargo compartment walls forward of the rear escape hatches. The guillotines are stowed on the panels when not being used. The guillotines are interchangeable. The guillotines should not be installed unless directed by the pilot. The circuit tester box, marked ELECTRO EXPLOSIVE CIRCUIT TESTER, is used to test the system circuitry. The box contains a guarded switch, with marked positions TEST and FIRE, and a test light. The panel contains a light marked GUILLOTINE ARMED, to show when the shear circuit is armed. For test procedures, see Chapter 7, under POST APP START. To fire the guillotines, place the arming switches, on the MCM tow control panel, ON, depending on which wire is to be guillotined, and actuate the EMERGENCY CONTROL panel switch marked SWEEP TOW. The arming switches marked PORT ARMED and STBD ARMED arm the port and starboard guillotine respectively. The port guillotine is powered from the No. 1 primary dc bus and is protected by a circuit breaker marked PORT CABLE SHEAR. The starboard guillotine is powered from the No. 3 primary dc bus and is protected by a circuit breaker marked STBD CABLE SHEAR.

2.30.7 Tow Provisions. The tow system has a tow capacity of 30,000 pounds and is used with other AMCM installations to provide dynamic and static towing of sweep gear and vehicles. The system consists of the tow boom support and stowage system, tow boom, tow boom dampers, and tow hook assembly. Hydraulic power is provided by the utility 2 system through an AMCM hydraulic manifold panel on the right cabin wall. When not in use the tow boom is stowed in a cradle assembly attached to the cabin ceiling. Together the tow provision is configured for towing by use of the tow hook. The tow cable can be disengaged from the tow hook and lowered into the water for transfer operations. Support and roller assemblies at the ramp entrance aid extension and retraction of the cable. Rollers and an aperture guard are used to direct the cable and prevent damage to the helicopter.

2.30.7.1 Tow Boom Support and Stowage Systems. The tow boom support is attached to the cabin ceiling and provides the attaching point for the tow boom. It allows vertical and lateral movement of the boom and contains the skew angle sensor for measuring lateral movement. It provides attaching points for one end of the damper assemblies. The stowage system is actuated by a hydraulic stow actuator in the tow boom support which provides the force to move the tow boom into the secure stow position. The AMCM manifold contains a dual pressure reducer selector knob with marked positions 775 PSI - 1025 PSI. The knob is positioned with 775 PSI showing to provide utility 2 hydraulic pressure to the tow boom dampers for towing operations. The knob is positioned with 1025 PSI showing to provide hydraulic pressure to the tow boom dampers to center the tow boom, and pressure to the stow actuator for positioning the boom to secure stow. A three-position stow control valve on the AMCM manifold marked LOWER-OFF-RAISE controls utility 2 hydraulic pressure to the hydraulic stow actuator. LOWER removes hydraulic pressure from the stow actuator to an unloaded condition which will allow the boom to position to the horizontal (operational secure position). RAISE will cause the hydraulic stow actuator to drive the tow boom aft and upward to the secured stow position.

OFF removes hydraulic pressure from the stow actuator. The cradle assembly will support the tow boom in either stow position.

Note

To place the tow boom to secure stow the dual pressure reducer selector knob must be at 1025 PSI and the stow control valve at RAISE.

2.30.7.2 Tow Boom Dampers. Two oblique dampers govern vertical and lateral movement of the boom. Utility 2 hydraulic pressure to the dampers is controlled through the AMCM manifold and pressure accumulator with the dual pressure reducer selector knot at 775 PSI any position of the tow boom can be overridden by applying a break-out force, and the boom will relock in a new position when the force is removed. When the dual pressure reducer selector knob is at 1025 PSI, the tow boom is driven to the centered operational stow position.

2.30.7.3 Tow Boom and Hook. (See FO-47). The tow boom is a fixed length 4-inch-diameter tube constructed of composite tubing. The forward end of the tow boom is attached to the tow boom support and contains the load cell. The boom has 32° of movement in the pitching plane, and can yaw about the vertical axis to either side of the cabin. Yaw angles are measured by rotary transformers mounted on the vertical pivot of the support. The forward end of the boom is set in sleeve bearings to allow operating motion for a load cell which monitors tow loads. The damper assemblies and manifold are attached to fittings on the outer tube. The tow hook assembly is bolted to an adapter on the aft end of the tow boom. The AMCM system tow ball is inserted through the underside of the hook and seats in the jaws of a 4-inch spherical recess. The tow ball can be released electrically or manually. Normal electrical release is initiated by a linear actuator in the tow hook. Power is provided from the No. 1 primary dc bus and the No. 3 primary dc bus through circuit breakers marked TOW HOOK RELEASE. Manual release is provided by a hook release lever in the forward end of the tow boom which is attached to the release actuator by a cable through the center of the tow boom tube. A low load manual release handle on the forward end of the tow hook housing is provided to spread the jaws of the tow hook to release the tow hook ball when not under tension. The electrical release or manual hook release lever must be actuated before pushing the manual release handle aft to move the linear actuator and release the tow ball. A safety pin to prevent hook opening inserts through a marked hole on top the tow hook housing. The pin is stowed in a holder on the tow hook housing when not installed.

2.30.7.4 Cradle Assembly. The cradle assembly attached to the cabin ceiling above the forward ramp area is provided to support the tow boom when not in use. It consists of a saddle assembly, support strut, cable, and bungee cord, and locking handle. The saddle assembly, provides a roller and securing strap to hold the tow boom in the centered position. The support strut, cable, and bungee support the cradle from the cabin ceiling. In the operational-stow position, the tow boom is raised to parallel the cabin ceiling and is readily available for AMCM operations. In the secure stow position the boom is stowed against the ceiling. The locking handle secures the boom and cradle to the ceiling when in the secure stow position.

2.30.7.5 90° Stub Ramp. The 90° stub ramp replaces the normal ramp when the helicopter is configured for AMCM missions. The stub ramp surface, about 4 feet long, and 7 feet, 5 inches wide, contains two roller conveyor/skid-strip assemblies, and no provision for flipper assemblies. It contains integral provisions for AMCM equipment mounting and serves as an AMCM deployment platform. The stub ramp may be lowered to 90° below horizontal at helicopter speeds up to 60 knots. The stub ramp retraction hydraulic cylinders will break away, allowing the stub ramp to pivot upward when a landing is attempted with the stub ramp in any down position. Other 90° stub ramp operation is the same as the normal ramp.

2.30.7.6 90° Stub Ramp Mechanical Retraction System. The mechanical retraction system is used to raise the 90° stub ramp when hydraulic or electrical malfunction occurs to the normal ramp retraction system. The system is mounted on the right cabin wall, and consists of a ratchet winch-hoist, cable, and pulley. One end of the cable is attached to a 20,000 pound tiedown fitting and the other end is attached to a 4000-pound snatch block fitting on the ramp. A pulley with hook is attached to the cabin wall. When stowed, the system is retained to litter fittings by retaining pins and bungee cord. The winch can be powered by a crewman to lift the ramp from 90° down to the retracted position with the heaviest AMCM vehicle and cradle attached to the ramp. Normal hydraulic system pressure is bypassed and does not have to be overcome during mechanical ramp operation.

2.30.7.7 Aperture Guard. The aperture guard assembly, Figure 2-46, provides a tow window for AMCM tow cables. The window restricts motion of the tow cable to keep it from contacting the tail rotor, chafing the ramp,

or catching the side of the ramp or helicopter structure. The assembly is a tubular structure consisting of an upper roller, lower roller, and two side tubes. It is attached to the aft end of the 90° ramp and the aft fuselage of the helicopter, is of fixed length, and moves with the 90° ramp in all its selectable positions.

2.30.7.8 Heat Shield. A removable high-temperature resistant heat shield mounts on the left side of the fuselage to protect crewmen on the ramp from exhaust heat of the No. 2 engine. Fasteners provide for quick installation or removal. It will resist steady-state temperatures up to 121°C.

2.30.7.9 Davit. The davit is an electrically-activated, hydraulically-controlled pivoting A-frame mount for a pulley. It is on the aft cabin floor and is used to stream and recover the AQS-14 and ALQ-141 towed bodies. To allow full travel of the davit, the tow boom is stowed to the starboard side of the cabin with a side stowage cradle and securing strap.

CAUTION

Do not allow the davit to contact the ramp or towed body during operation.

2.30.7.10 Davit Controls. To operate the davit, electrical control is provided by the DAVIT MASTER switch marked ON-OFF on the crew miscellaneous control panel (FO-43). Movement of the davit is controlled by the handle on the DAVIT CONTROL panel (FO-43). It is a spring-loaded switch which is normally at a positive detent in the neutral (down) position. Moving the handle in the direction marked IN will tilt the davit toward the cabin. Moving the handle toward OUT will tilt the davit away from the cabin. The rate of movement of the davit varies with the amount of displacement of the handle. Electric power is through the No. 2 dc primary bus circuit breaker marked DAVIT CONT. Hydraulic pressure is from the utility 2 system.

A manual override knob is provided on the lower edge of the davit control panel to provide hydraulic control of the davit in case of electrical failure. Turning the knob toward the front of the helicopter will move the davit in, and turning the knob toward the rear of the helicopter will move the davit out.

A valve marked DAVIT MOTOR BYPASS is on the left side of the cabin (FO-43) to relieve davit hydraulic pressure and permit manual retrieval of the davit if required. The valve has two positions marked NORMAL-BYPASS. The valve should be in NORMAL except when manual retrieval is required. At BYPASS hydraulic pressure to the davit is removed and fluid can move unrestricted within the motor during manual retrieval.

Note

See Chapter 12 for emergency davit retrieval procedure.

2.31 MISCELLANEOUS EQUIPMENT

2.31.1 Cockpit

2.31.1.1 Ashtrays. An ashtray is installed on each side of the cockpit, between the windshield and the chin bubble.

2.31.1.2 Checklist. A takeoff and landing checklist is mounted on the instrument panel in front of the pilot.

2.31.1.3 Curtain. Antiglare curtains are installed over the entrance to the cockpit, and the lower two windows on each side of the cockpit. The antiglare curtains are to prevent unwanted light from entering the cockpit during night and instrument flight conditions.

2.31.1.4 Map Cases. A map case is installed on each side of the cockpit outboard of the pilots' seats.

2.31.1.5 Mirror. A rearview mirror is attached to the center windshield frame on the left side.

2.31.2 Armorplate. The pilots' seats are armor-plated and are shown in Figure 2-47.

2.31.3 Controllable Mirrors. The mirrors, one controlled by the pilot and the other by the copilot, are mounted on the left and right sides of the fuselage nose section. Each is rotated 15° downward to provide visibility under the sponsons. The mirrors are individually controlled by selector switches, marked CLTV BEEPER MODE SEL, with marked positions MIRROR-SPOTLIGHT, on the pilot's and copilot's overhead consoles; and the SPOT LIGHT TRAIN switches, on the pilot's and copilot's collective pitch lever grips. To adjust a mirror, place a selector switch to MIRROR and actuate the corresponding TRAIN switch. When a TRAIN switch is placed to UP or DN, the appropriate mirror can be adjusted to any position not greater than 30° to above and below horizontal. When the switch is placed to L or R, the mirror can be adjusted to any position not greater than 30° to left or right of the centerline. The slew rate in both planes is 12 seconds for

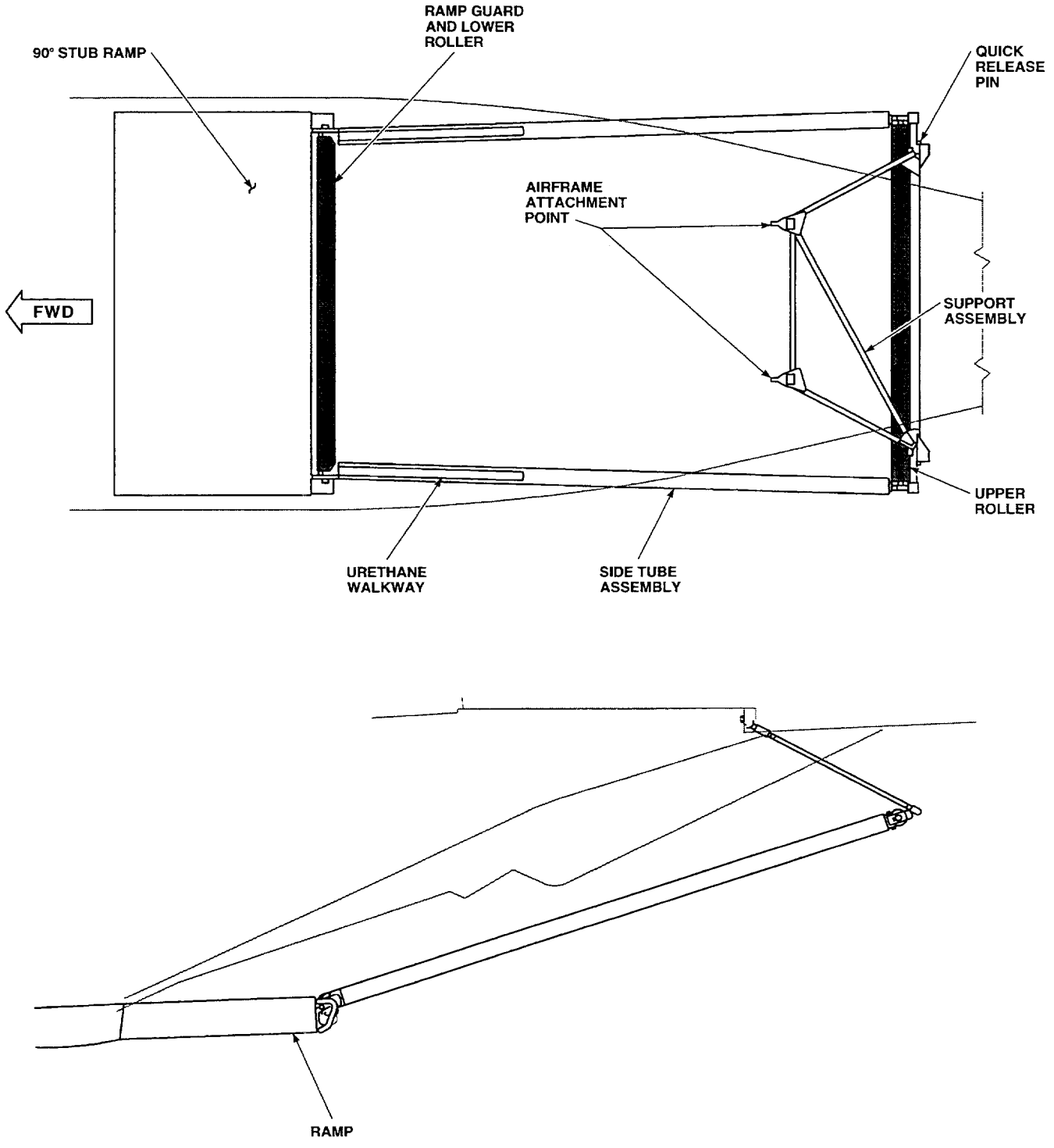


Figure 2-46. Aperture Guard

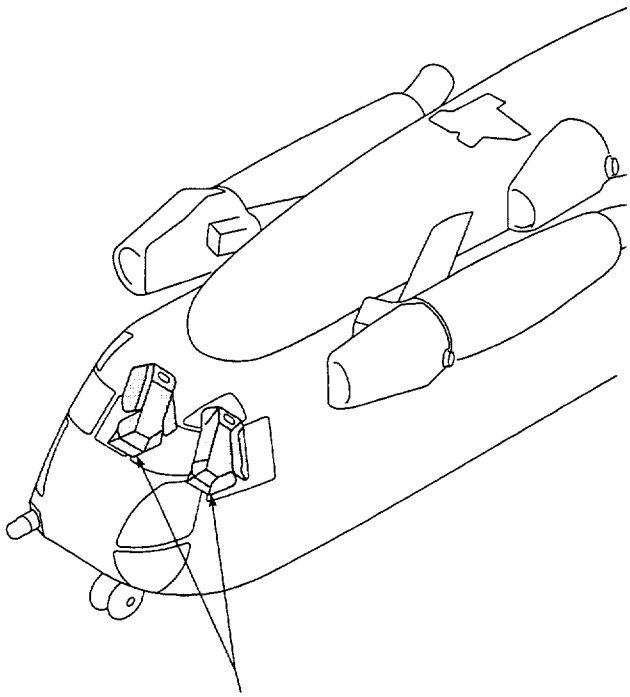


Figure 2-47. Armorplate Installation

60° travel. The controllable mirrors use the same power source and protective circuit breakers as the controllable spotlights. When the mirrors are installed, and their use is not anticipated, they may be stowed vertically by pulling down on a pin, in the bottom of the mount, and turning the mirror and support assembly upward.

2.31.4 Stowage Locker. A removable stowage locker is on the cargo floor on the right side of the cabin aft of the cabin door. It has a clasp to enable locking. The stowage box may be used for three seat positions. The stowage locker may also be alternately installed at the left rear cabin position.

2.31.5 Marine Location Markers. A stowage rack for five MK-25 and five MK-58 marine location markers is on the right forward cabin bulkhead. A separate stowage tube with twist-off cap is provided for each marker. The rack is held in position by litter fittings.

2.31.6 Safety Cable Assemblies. Two assemblies, about 14 feet long, are installed overhead in the cabin compartment ceiling. The cables, which are parallel to each other, are attached to overhead fittings that are above the tow boom attaching point and the cargo ramp door. The cables are attached to the fittings by pins at both ends of each cable. The cables are used as hand rails and attaching points for the tether from the crewman's safety harness. Each cable is fitted with a stop to prevent a crewman's safety harness latch from sliding beyond the ramp.

2.31.7 Liquid Oxygen (LOX) Vent. A LOX vent (Figure 2-48) is installed to be used when liquid oxygen is transported in a cabin-mounted tank. A fitting to the vent is on the cabin floor below the left forward cabin hatch. A brass alloy tube from the fitting vents through the bottom skin of the helicopter. A vent plug is installed in the vent fitting when the system is not in use. The plug is removed and a LOX connector is installed when the vent is to be used. The LOX connector is an item of government-furnished equipment which connects to a hose from the LOX tank.

WARNING

Inside surface of vent tube and connector must be kept free of oil and grease when transporting LOX. Oil and grease in the presence of oxygen can cause fire.

CAUTION

The vent plug is installed to maintain watertight integrity of the helicopter.

2.31.8 Mooring Rings. There are four mooring rings (Figure 3-5). One is aft and outboard of each sponson, and one is on each side of the fuselage aft of the electronics compartment. There is a water-tow point on the nose of the helicopter for bowline attachment.

2.31.9 Relief Tubes. One relief tube is mounted on the bulkhead behind the pilot's seat, and another is on the left side of the forward bulkhead in the cabin compartment.

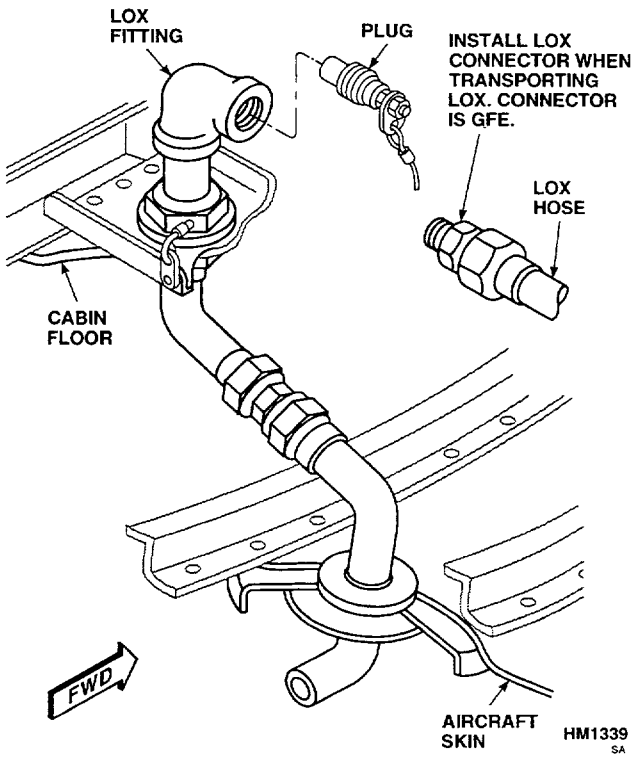


Figure 2-48. LOX Fitting and Vent

2.32 AN/AYQ-23(V) GROUND PROXIMITY WARNING SYSTEM (GPWS)

2.32.1 GPWS System Description. The AN/AYQ-23(V) GPWS consists of a GPWS processor and an air data computer (ADC). Together they use a combination of analog and digital input signals, provided by existing helicopter sensors, to calculate the helicopter's dynamic state and generate ground avoidance warnings. Appropriate aural warnings are issued through the aircrew ICS headsets for each of seven specific ground avoidance situations and a visual GPWS alert indicator lights on the pilot's advisory panel. The aural warnings are as follows:

PRIORITY 1 WARNING: Altitude Loss After Takeoff warning issued to prevent controlled flight into terrain (CFIT) shortly after takeoff and during initial climb out. This warning protects against altitude loss due to in-air descent, rising terrain, or a combination of the two. This warning is enabled after takeoff between 40 feet AGL to 250 feet AGL and/or during the first minute of flight after passing 40 feet AGL. During the Climb Out state, a non-predictive warning level is maintained below the helicopter and penetration of this level causes a GPWS warning.

Helicopter's AGL Altitude	Warning Altitude
40 to 50 feet AGL	20 feet AGL
51 to 80 feet AGL	Helicopter altitude minus 30 feet
81 to 250 feet AGL	50 feet AGL

If the follow-up warning altitude is penetrated, the following GPWS warning is issued:

Aural Warning	"PULL UP PULL UP"
Visual Warning	GPWS ALERT lamp on the caution/advisory panel illuminates and stays lit.
Rearm Condition	Helicopter climbs to 80 feet AGL. The alert lamp is turned off.

PRIORITY 2 WARNING: Predictive CFIT warning issued when the GPWS computes that the predicted altitude loss for the helicopter is greater than the helicopter's height above ground level. This warning is enabled at all times the helicopter is more than 20 feet above ground level after takeoff and just before landing. From the Takeoff and Landing state and less than 20 feet AGL, no CFIT warning will be given by the GPWS.

Aural Warning	"WHOOP WHOOP PULL UP PULL UP"
Visual Warning	GPWS ALERT lamp on the caution/advisory panel illuminates and stays lit.
Rearm Condition	Helicopter climbs to 50 feet AGL. The alert lamp is turned off.

PRIORITY 3 WARNING: Glide Slope warning issued whenever the helicopter descends below the glide slope limits. The glide slope alert is issued at 1000 to 150 feet when the helicopter is 1.3 dots below the glide slope; at 100 feet when the helicopter is 2 dots below the glide slope; and at 50 feet when the helicopter is 2.7 dots below the glide slope as read on the ILS indicator.

Aural Warning	"BELOW GLIDE SLOPE BELOW GLIDE SLOPE"
Visual Warning	GPWS ALERT lamp on the caution/advisory panel illuminates and stays lit.
Rearm Condition	Re-intercept the glide slope.

PRIORITY 4 WARNING: Excessive Bank Angle warning issued whenever the helicopter's bank angle exceeds 60 degrees. This warning is enabled whenever the helicopter is in the air.

Aural Warning	"BANK ANGLE BANK ANGLE"
Visual Warning	GPWS ALERT lamp on the caution/advisory panel illuminates and stays lit.
Rearm Condition	Helicopter bank angle returns to 60 degrees or less. The alert lamp is turned OFF.

PRIORITY 5 WARNING: Non-Predictive Selectable Altitude warning issued when the helicopter descends below the low altitude warning settings selected on the pilot and copilot radar altimeter height indicators. This warning is enabled in the Climb Out, Flight, and Landing states. There is a 3-second inhibit to prevent duplicate warnings from being issued from the same height indicator setting. Separate warnings are issued for the pilot and the copilot low altitude warning settings. The warnings issued when descent below the low altitude warning index occurs are:

Aural Warning	"ALTITUDE"
Visual Warning	None
Rearm Condition	Helicopter climbs above the two index settings.

PRIORITY 6 WARNING: Landing Gear Up warning issued whenever the landing gear up criteria defined in the NATOPS manual is violated. This warning is enabled when the helicopter is in the air and either of the following occurs:

1. Radar altimeter signal is valid, helicopter less than 150 feet AGL, IAS is less than 60 knots, and the landing gear is up.

2. Radar signal is invalid, IAS is less than 60 knots, and the landing gear is up.

If the landing gear up warning criteria is violated, the following GPWS warning is issued:

Aural Warning	"GEAR GEAR" warning repeated every 3 seconds.
Visual Warning	GPWS ALERT lamp on the caution/advisory panel illuminates and stays lit.
Rearm Condition	Gear is lowered, or radar altitude 150 feet AGL, or IAS 60 knots, or the Landing Gear Reset switch is pressed. The alert lamp is turned off.

PRIORITY 7 WARNING: Tail Strike warning issued whenever a potential tail strike is detected. This warning is enabled when the helicopter is in the air. If the tail strike warning criteria are violated, the following GPWS warning is issued:

Aural Warning	"TAIL" warning repeated every 3 seconds.
Visual Warning	GPWS ALERT lamp on the caution/advisory panel illuminates and stays lit.
Rearm Condition	Initial warning conditions no longer violated. The alert lamp is turned off.

Note

Lower priority will not occur until higher priority has been cleared.

GPWS Operating Procedures

1. Ensure helicopter essential ac power is on.

Note

If any avionics signals are missing, a GPWS FAULT may be heard upon initial power up.

2. Turn on the RAD ALT. Turn the control knob labeled PUSH TO TEST clockwise from OFF and ensure the test switch is in the flight mode.

3. Ensure GPWS circuit breakers are on.

Note

The following power up annunciations will be heard:
a. "WHOOP WHOOP PULL UP PULL UP"
b. "BANK ANGLE BANK ANGLE"
c. "GPWS READY" or "GPWS FAULT" or "GPWS INPUT FAULT"

Visual warning: None

4. If "GPWS READY" is heard, and the GPWS caution/advisory panel lamps are extinguished, the GPWS is operating normally and is operational.

The GPWS processor and the ADC are located in the left avionics compartment. Power is supplied to the system via circuit breakers in the pilot's No. 3 primary ac bus, GPWS (CB25 115V) and GPWS (CB38 26V); and No. 3 primary dc bus GPWS (CB66 28V). The system has Built-In Test (BIT) functions that are initiated (I-BIT) at system turn-on and periodically (P-BIT) thereafter. On the ground, BIT indications are aural through the aircrew ICS headsets and visual via the GPWS INOP indicator on the pilot's advisory panel. In air, BIT indications are visual only.

2.32.2 Air Data Computer. The Air Data Computer (ADC) receives inputs from various helicopter sensors. Any position or systematic error in these inputs is corrected in the ADC. These corrected signals are used to compute accurate air data. ADC outputs are used for altitude reporting and unsafe landing warning.

CHAPTER 3
Aircraft Servicing

3.1 FUELING

(See Figures 3-1 and 3-3.)

Fueling equipment will be operated only by qualified and authorized personnel. The aircrewman is responsible for refueling his assigned helicopter after each flight, and visually checking that the proper type fuel is used. Loose pyrotechnics, smoking, striking matches, working on helicopter, or the use of any device producing flame within 50 feet of the helicopter is strictly prohibited. The helicopter should not be parked near possible sources of ignition such as blasting, drilling, or welding operations. A minimum of 50 feet should be maintained from other aircraft or structures and 75 feet from any operating radar set. All radio switches and electrical equipment will be turned off and a check made to be sure that no electrical apparatus supplied by outside power (electrical cords, droplights, floodlights, etc.), are in or near the helicopter. Safety flashlights shall be used in place of helicopter lights for night fueling operations. During all fueling operations, fire extinguisher equipment will be readily available. Electrical power will have to be applied to the helicopter to obtain fuel quantity gage readings.

3.1.1 Pressure Fueling. Pressure refueling does not require electrical power for refueling the main fuel tanks (Figure 3-2). Always be sure that the helicopter is in a level attitude so that the maximum amount of fuel will enter the tanks. Make sure pressure from the fueling source is not over 55 psi, before beginning fueling. Before fueling, the helicopter and refueling unit grounding devices should be inspected by fueling personnel for proper ground. The system will automatically shut off when the tanks are full. Refer to Figure 3-2 for instructions regarding the pressure refueling precheck and appropriate warnings. Pressure refueling through the air refuel probe can be accomplished through extended or retracted probe, utilizing a ground refueling adapter (Figure 3-1, Detail BB).

3.1.1.1 Pressure Refueling with Rotors Engaged. These procedures describe hot refueling operations (rotor engaged, engines operating) from a Marine Tactical Airfield Fueling Dispensing System (TAFDS), aboard ship, from a fuel truck, or any other single-point pressure refueling system. Except in tactical situations, all personnel except the pilot, copilot, and necessary refueling personnel shall disembark from the helicopter and move at least 50 feet away. Necessary radio and electrical equipment may be on.

1. The aircrewman will refuel the helicopter, making sure that the proper type fuel is used, and that the helicopter and single-point nozzle are properly grounded.

2. The pilot is responsible for positioning the helicopter in the fueling area, clear of all obstructions.

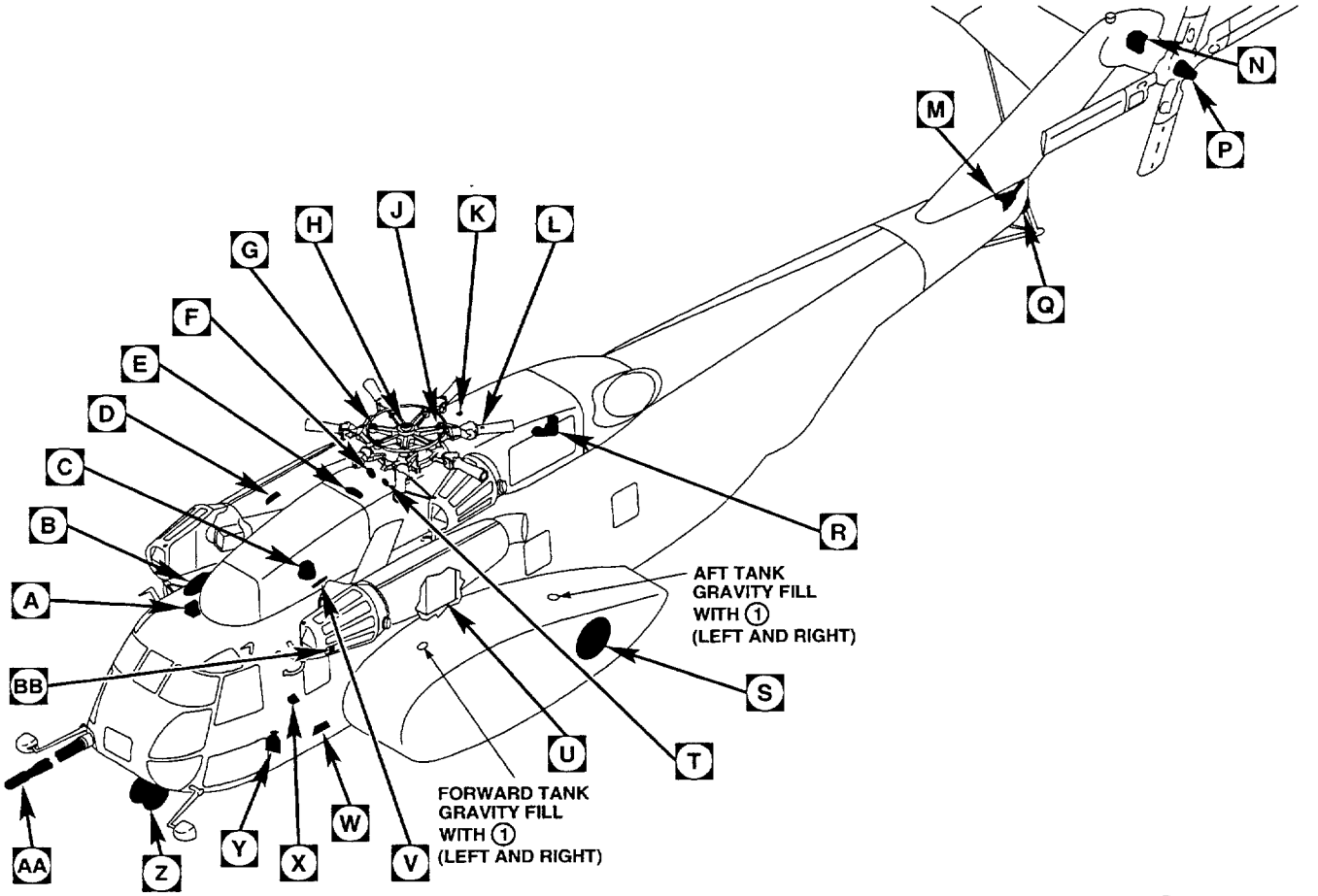
3.1.1.2 Pressure Partial Refueling. Normal pressure refueling procedures are used when a small quantity of fuel is required. If the tanks are not to be filled, the amount of fuel necessary will have to be determined by the fuel gage reading. This amount will then have to be read from the fuel counter on the refueling unit.

3.1.2 Gravity Fueling. The helicopter is gravity-fueled through filler caps on top of each sponson. Before fueling, grounding devices on the helicopter and drag chains on the fuel truck will be inspected by fueling personnel, to be sure of proper ground. Before using a fuel hose, the hose nozzle must be grounded to some metal part of the helicopter remote from the fuel tanks, to be sure that no static differential exists. Before moving the filler caps, attach the hose nozzle grounding attachment into the grounding jack above each sponson between the cabin windows. Remove the filler cap of one fuel tank at a time. Replace it immediately after filling the tank, and before removing the cap of the other tank. If dual fuel equipment with a full complement of personnel is available, more than one tank may be serviced simultaneously. Take care that the refueling nozzle is of the proper length and diameter, and be sure that the refueling hose does not damage the sponson.

3.2 OIL SERVICING

(See Figure 3-3.)

3.2.1 Engine Oil Servicing. The helicopter shall be in a level attitude before and during servicing. In flight, engine oil tanks shall be replenished only when directed to do so by the pilot. This permits the pilot to monitor each engine's oil consumption. On the ground, to prevent overservicing, if the engine has been idle or is cold, motor



LEGEND	
(1)	FUEL
(2)	LUBRICATING OIL TURBINE ENGINE OIL
(3)	LUBRICATING OIL
(4)	HYDRAULIC FLUID
(5)	NITROGEN
(6)	WATER OR WATER AND ETHYLENE GLYCOL

NOTE

INDICATOR MUST BE WITHIN LIMITS, FROM 0.5–INCH BELOW TOP OF BLADEFOLD JUNCTION BOX. DEPENDING UPON AMBIENT AIR TEMPERATURE. REFER TO FIGURE 3–1 (SHEET 4 OF 4).

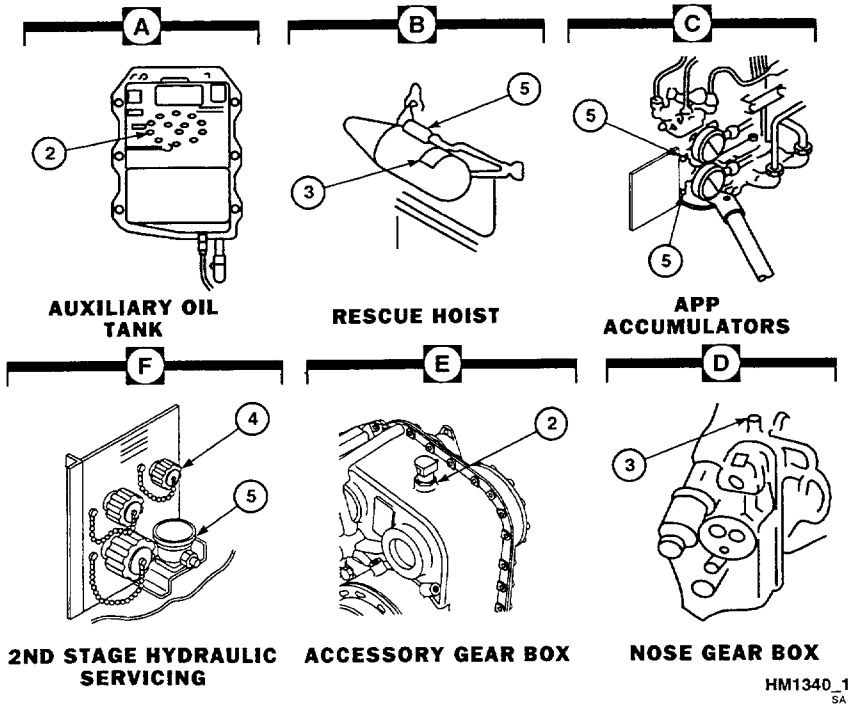


Figure 3-1. Servicing Diagram (Sheet 1 of 4)

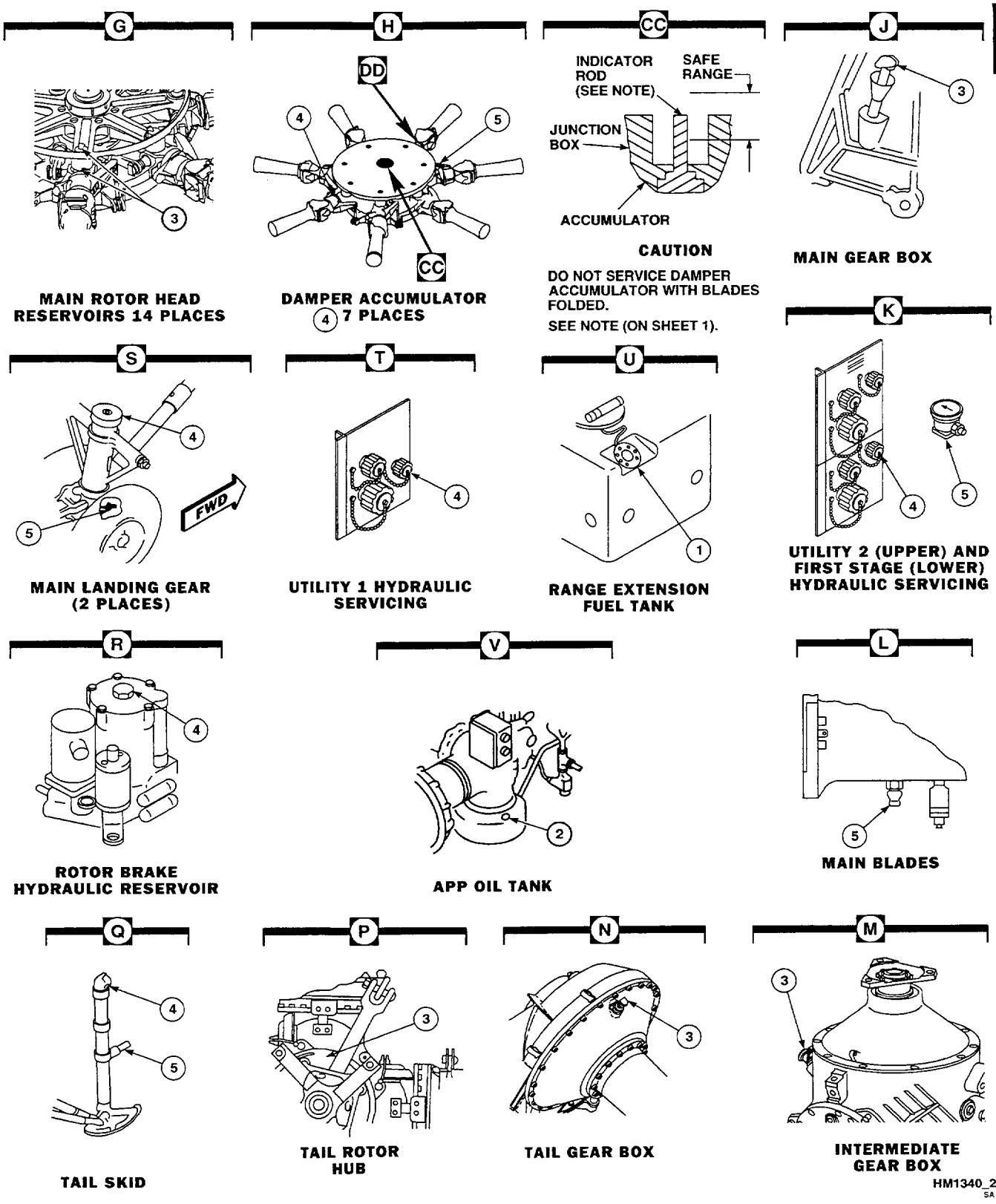
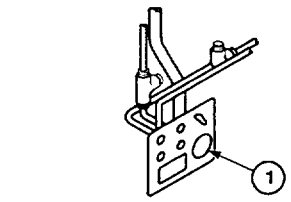
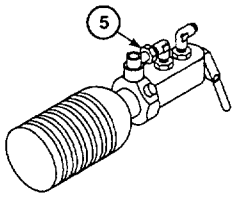


Figure 3-1. Servicing Diagram (Sheet 2 of 4)



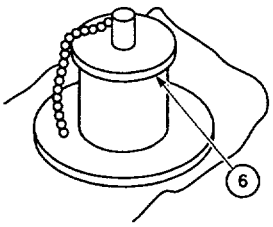
PRESSURE FUELING

W



EMERGENCY LANDING GEAR NITROGEN BOTTLE

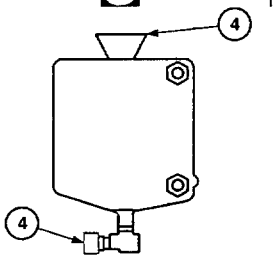
X



WINDSHIELD WASHER SERVICING

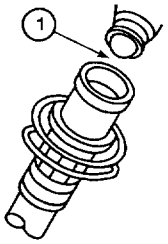
Y

AB



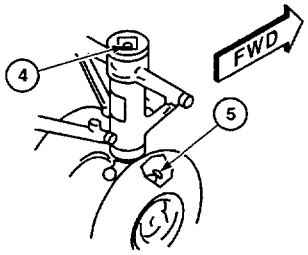
INFLIGHT HYDRAULIC REFILL

AA



GROUND PRESSURE FUELING

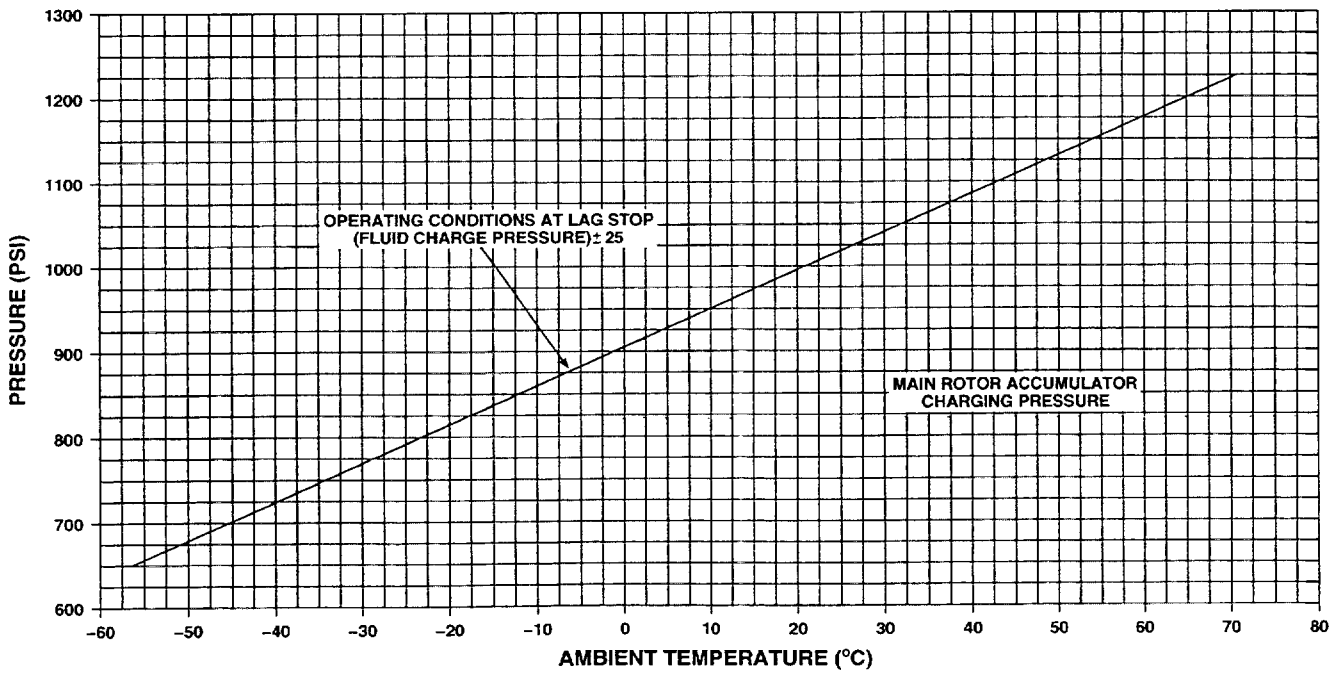
Z



NOSE LANDING GEAR

AD

DAMPER ACCUMULATOR PRESSURE



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SA

Figure 3-1. Servicing Diagram (Sheet 3 of 4)

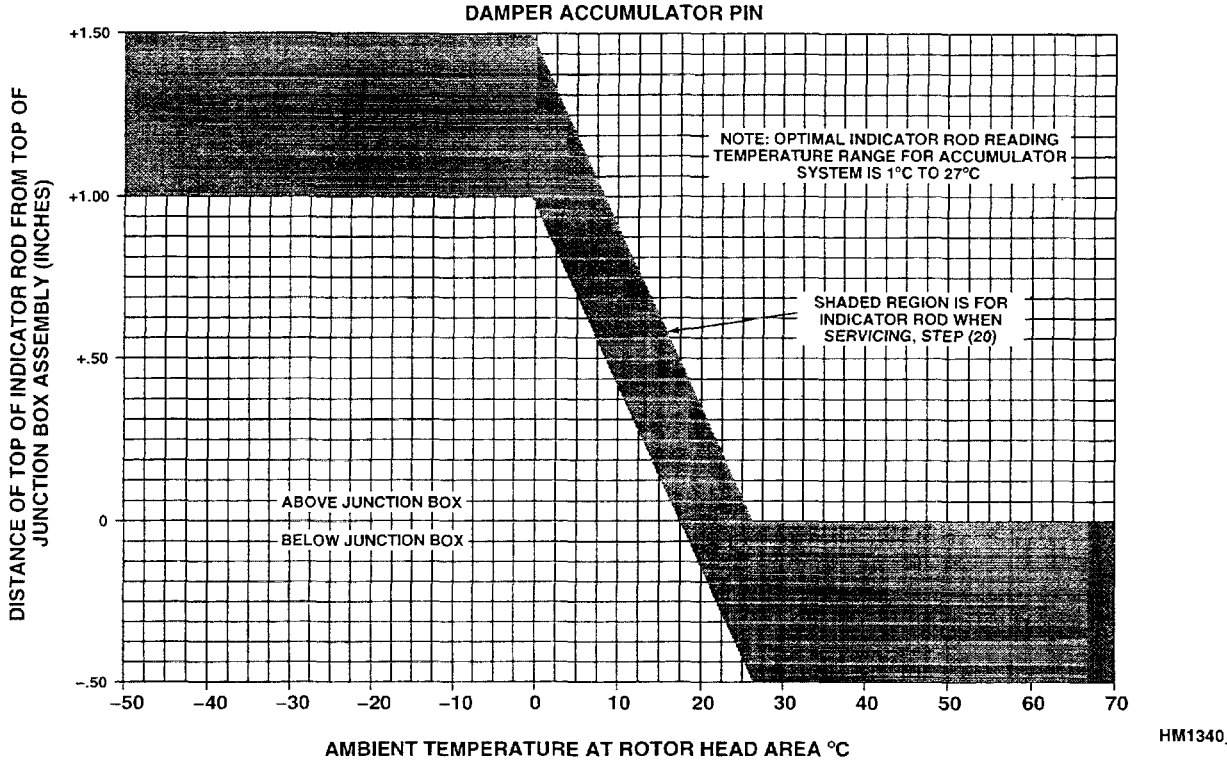


Figure 3-1. Servicing Diagram (Sheet 4 of 4)

the engine for 30 seconds. This scavenges oil out of the sump and returns it to the engine oil tank. Now check the ENG OIL QTY LOW caution lights to see if replenishment is necessary. The engine oil tanks shall be replenished only from the auxiliary oil system, by turning and holding the appropriate selector valve to open and operating the handpump. The engine oil tank is fully serviced when the appropriate TANK FULL light goes on. The filler necks on each engine oil tank shall not be used for servicing.

3.2.2 *Gear Box Oil Servicing.* The intermediate and tail rotor gear boxes each have a filler port (Figure 3-1, Details M and N) and a sight gage that contain inner and outer circles. The gear boxes are full when the oil level is within the inner circle. The oil should be replenished if the level is at the bottom of the outer circle. The main, accessory, and nose gear boxes each have a filler port (Figure 3-1, Details J, E, and D) and a dipstick. The gear boxes are full when the FULL mark is reached on the dipstick.

3.3 HYDRAULIC SERVICING

(See Figure 3-3.)

3.3.1 Ground Hydraulic Servicing. The utility and utility 2 hydraulic systems (Figure 3-1, Details U an K) and the first and second stage flight control hydrauli systems (Figure 3-1, Details K and F) are serviced in th same manner. Servicing is done at each system's groun service panel, or the hydraulic refill unit in the cabin, usin a hydraulic servicing unit. Attach the hose of the hydrauli servicing unit to the fill disconnect on the appropriat service panel and pump fluid until the indicator show green (safe).

Note

- The fill disconnect is the smaller of the three quick-disconnects on each panel.
- Make certain that the servicing unit hose is full of fluid before connecting it to the panel.
- For ground servicing, the reservoir indicator should be used to determine proper fluid level. The cockpit quantity indicator should be used for inflight monitoring of proper reservoir fluid level.

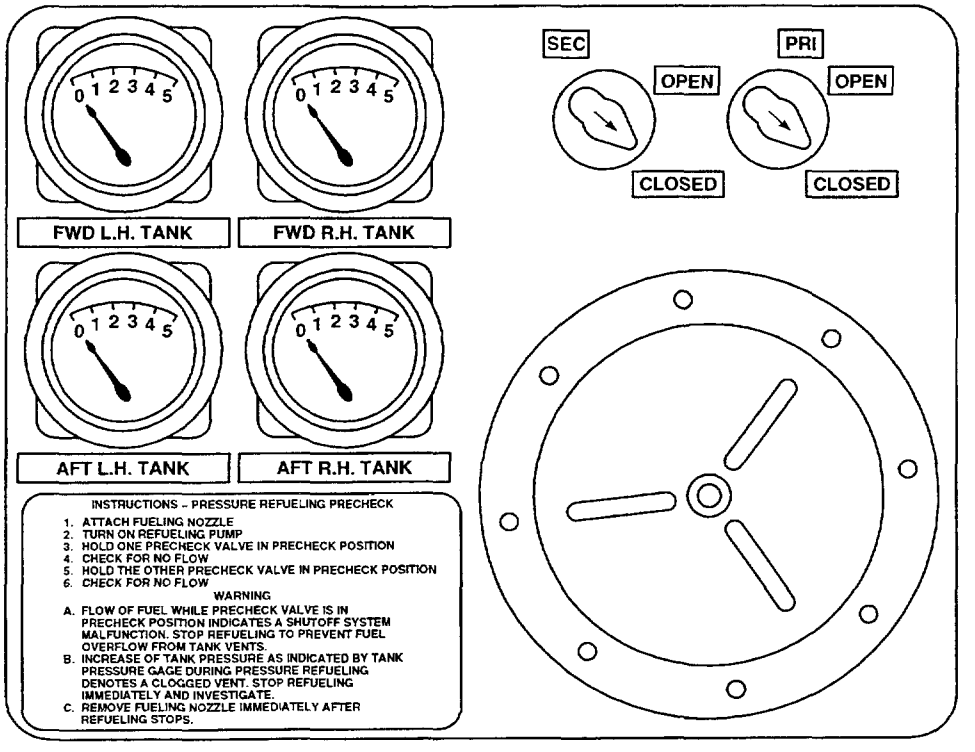


Figure 3-2. Pressure Refueling Panel

- A properly serviced system could indicate an overfilled or underfilled condition depending on ambient or system temperature (as, when temperature increases, fluid expands).

3.3.2 In-Flight Hydraulic Servicing. The utility 1, utility 2, and first and second stage flight control hydraulic systems can be serviced in flight from the hydraulic refill reservoir (Figure 3-1, Detail CC). With the refill system selector valve, select the hydraulic system to be serviced. While pressing the selector valve, replenish fluid with the handpump until the respective cockpit hydraulic quantity status gage indicates green.

3.4 WINDSHIELD WASHER SERVICING

(See Figure 3-3.)

The windshield washer system is serviced by filling the reservoir (Figure 3-1, Detail Z) behind the copilot's seat.

3.5 FIRE EXTINGUISHER SERVICING

(See Figure 3-3.)

The fire extinguisher containers are removed when they have been emptied for any reason, and are replaced with fully serviced units.

3.6 APP SERVICING

(See Figure 3-3.)

The APP has a filler port (Figure 3-1, Detail W) and a dipstick. The oil system level is indicated by a dipstick.

3.7 EXTERNAL ELECTRICAL POWER REQUIREMENTS

The helicopter requires 115/200 volt, three-phase, 400 Hz ac external power. The ac external power receptacle is on the right side of the helicopter, forward of the personnel door and below the pilot's window. The helicopter does not have a dc external power receptacle.

MH-53 FUEL PREFERENCE AND CROSS REFERENCE CHART

	NATO CODE NO.	FUEL[1] TYPE	U.S. MILITARY		ASTM COMMERCIAL	
			CODE	SPEC	CODE	SPEC
PRIMARY FUELS	F-44	High Flash Kerosene	JP-5	MIL-T-5624	None	
	F-40	Widecut	JP-4	MIL-T-5624	None	
	F-34	Kerosene	JP-8	MIL-T-83133	None	
ALTERNATE FUELS[3]	F-35	Kerosene	(JP-8)[2]	None	Jet A-1	ASTM D-1655
	None	Kerosene	None		Jet A	ASTM D-1655
	None	Widecut	(JP-4)[2]	None	Jet B	ASTM D-1655
	F-43	High Flash Kerosene	(JP-5)[2]	None	None	

NOTE

1. Although the T-64 engine has an adjustment on its fuel control to accommodate for the specific gravity of the particular fuel type being used, it is a very tolerant engine with respect to this fuel property. This adjustment is normally set and left in the JP-4 position regardless of the fuel type actually loaded aboard the aircraft.
2. A U.S. Military fuel which is essentially identical to the NATO and / or commercial fuel(s) listed except that the U.S. Military fuel contains additives. See Note 3 below.
3. Alternate fuels may be used without restrictions and without airframe or engine modifications. These fuels do not usually contain Fuel System Icing Inhibitor (FSII) or corrosion inhibiting additives. Although the MH-53E does not need FSII to prevent fuel system icing problems it does need this additive to prevent the growth of microorganisms within its fuel tanks. In addition, corrosion inhibiting additives improve the lubricating properties of the fuel thus reducing wear of fuel system components. For these reasons use of alternate fuels should be held to a minimum.

CAUTION

Any aircraft scheduled for immediate shipboard duty should be fueled with F-44 (JP-5) or F-43 only.

For additional information on aviation fuels consult the following:

1. NAVAIRINST 10300.2 (series). "Fuels, lubricants and associated products used by the North Atlantic Treaty Organization (NATO) Armed Forces." This instruction provides a listing of each NATO Nation's fuel specification(s) under the appropriate NATO Code Number(s).
2. NAVAIRINST 10341.1 (series). "Utilization of aircraft engine fuels." This instruction provides a list of the fuels approved for use in each Navy and Marine Corps aircraft.
3. NAVAIRINST 10340.3 (series). "Maintaining quality and limiting contamination of aircraft fuels." This instruction provides basic information on the physical and chemical properties of aviation fuels along with guidance on handling these products.

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Figure 3-3. Servicing Summary Table (Sheet 1 of 2)

ITEM	PRIMARY PRODUCT		ACCEPTABLE SUBSTITUTE	
	MIL. SPEC	NATO CODE	MIL. SPEC	NATO CODE
ENGINE	MIL-L-23699	O-156		
GEAR BOXES	DOD-L-85734		MIL-L-23699	O-156
MAIN ROTOR HEAD SLEEVE AND SPINDLES AND RESERVOIRS	MIL-L-21260 GRADE 50	C-642	MIL-L-21260 TYPE 1, GRADE 30	
TAIL ROTOR HUB RESERVOIRS	MIL-L-21260 GRADE 50	C-642	MIL-L-21260 TYPE 1, GRADE 30	
MAIN ROTOR HEAD DAMPERS	MIL-H-83282 (RED)		MIL-H-5606	H-515
HYDRAULICALLY - OPERATED COMPO- NENTS AND SYSTEMS	MIL-H-83282 (RED)		MIL-H-5606	H-515
WINDSHIELD WASHER SYSTEM	WATER AND ALCO- HOL, FED. SPEC TT-1-735			
FIRE EXTINGUISHER CONTAINERS (RE- PLACE), LANDING GEAR BLOWDOWN BOTTLE (3000 psi), APP ACCUMULATOR PRECHARGE (1600- ± 50 psi), BLADE DAMPER ACCUMULATOR PRECHARGE (910 psi at 60°F)	MIL-N-6011		MIL-N-6011 GRADE A, TYPE I or II	
1ST AND 2ND STAGE ACCUMULATOR PRE- CHARGE (1000 psi WITH ACCUMULATOR PISTON BOTTOMED)				
ENGINE, APP AND HEATER COMPARTMENT FIRE EXTINGUISHER SYSTEM (REPLACE)	CF3BR (MONOBROMO- TRIFLUORO- METHANE)			

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Figure 3-3. Servicing Summary Table (Sheet 2 of 2)

The following is a partial list of external power sources which provide 115/200 volt, three-phase, 400 Hz ac power.

USN	USAF	CANADIAN
NC-2A	B-10	CAN-C (same as USN NC-5)
NC-5	B-10A	
NC-6A	B-10B	
NC-7	MD-3	
NC-7A	MD-3A	
NC-7B	M32A-10	
NC-7C	M32A-13	
NC-8		
NC-10		
NC-10B		
NC-12		
NC-12A		

3.8 GROUND HANDLING PROCEDURES

Due to the top-heavy configuration of the helicopter, precautions must be observed during all helicopter movement to prevent possible damage. When feasible, the helicopter will be moved with a tractor using an approved tow bar. Towing equipment shall be operated only by qualified personnel, who will be responsible for checking the approved towing couplings before towing. Towing shall not begin until a qualified individual is in the cockpit and ready to operate the brakes. When towing a helicopter, three wingwalkers shall be used. A wingwalker shall be stationed on each side of the helicopter, and another near the tail rotor, for adequate clearance. In addition, towing shall be supervised by a director with a whistle. During night towing operations, wingwalkers shall carry a flashlight or luminous wand. All stop signals shall be given by a whistle or hand signal. Whistle signals should be supplemented by hand signals when possible. Wheel brakes shall be applied as soon as a stop signal is received from the director. See Figure 3-4 for turning radius.

CAUTION

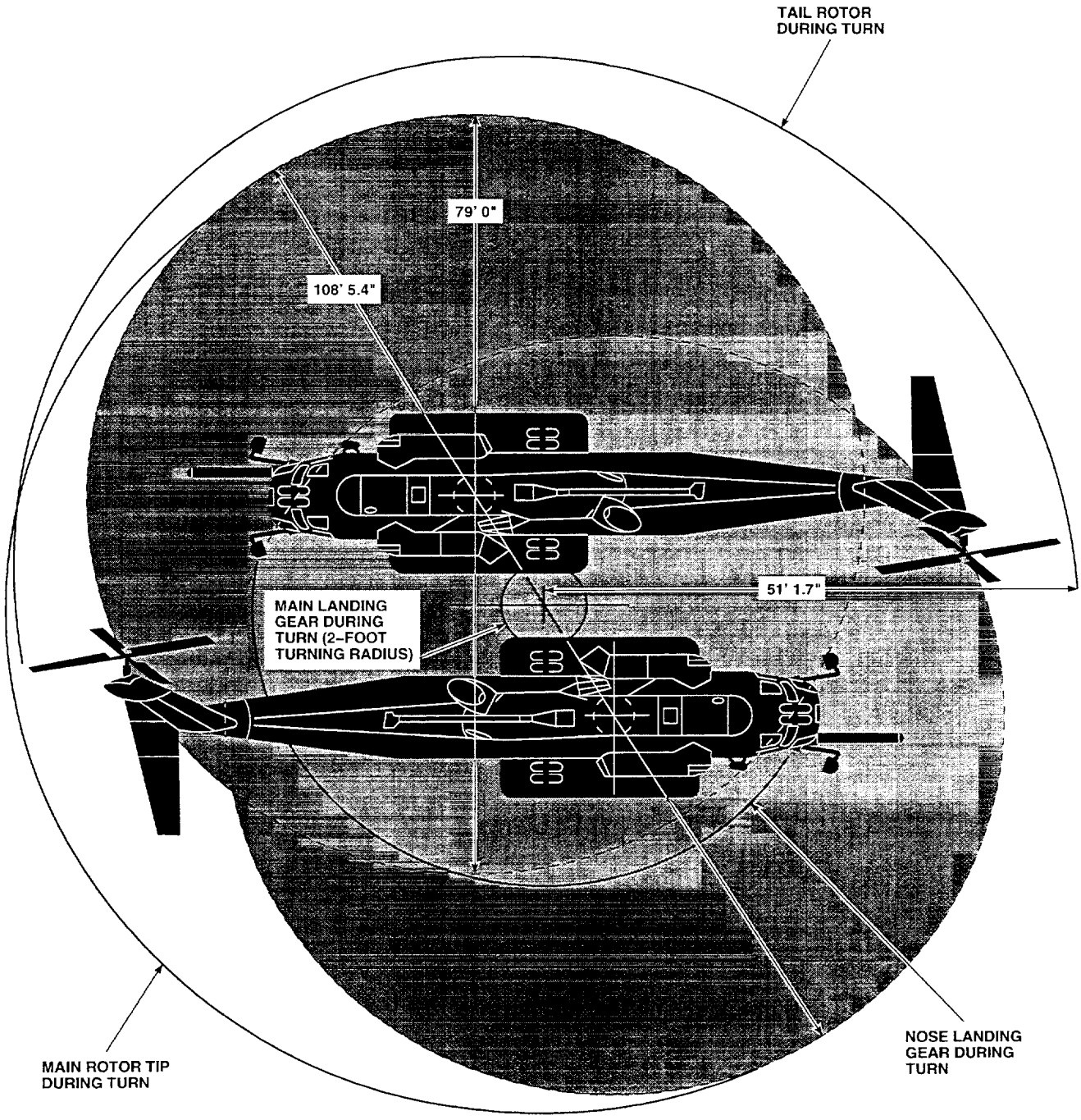
Towing speeds shall not be over 5 miles-per-hour, and sudden stops and starts will be avoided.

3.9 TIEDOWN PROCEDURES

Helicopters, when tied down as directed, can withstand winds up to 60 knots. If winds above 60 knots are forecast, it is recommended that the helicopter be placed in a hangar or safe weather area. The helicopter has tiedown rings on the aft outboard side of each sponson and below the pilot's and copilot's windows (Figure 3-5). Except during cold weather operations, because of freezing due to condensation, the helicopter will have the parking brake set when tied down for high wind considerations. See Figure 3-6 for tiedown techniques.

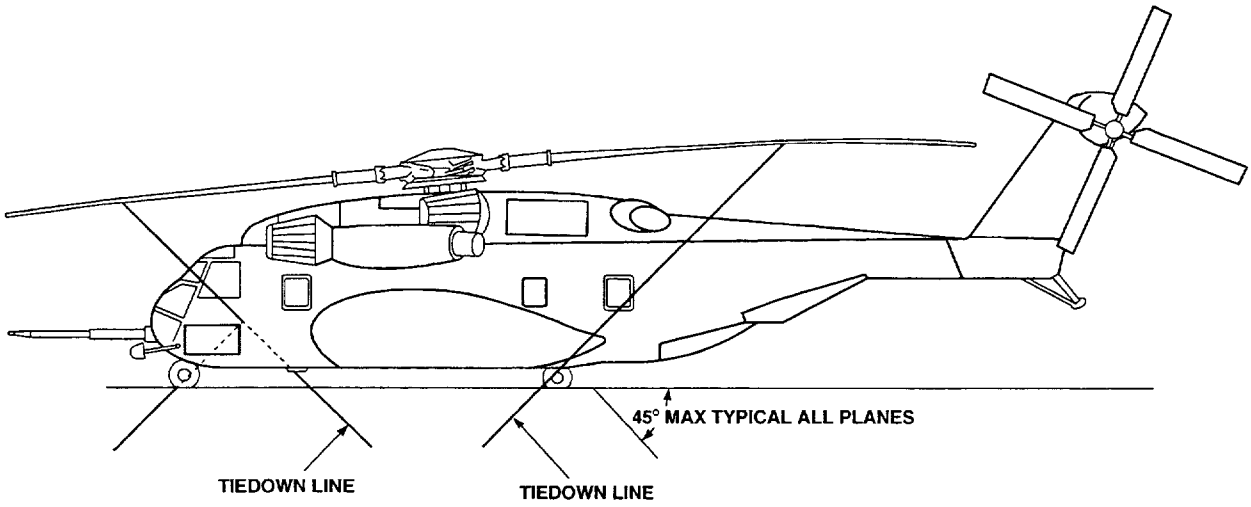
CAUTION

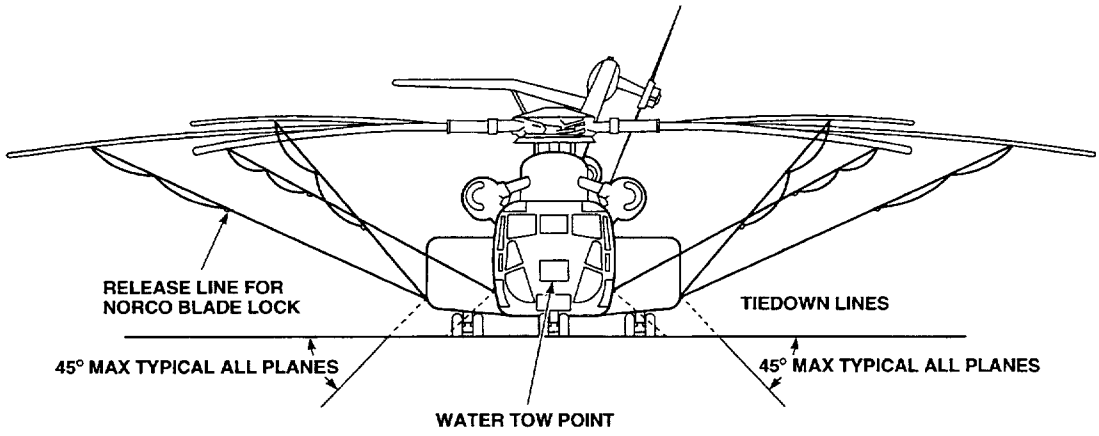
- To prevent overtightening due to moisture absorption, there should be enough slack in all tiedown ropes.
- The helicopter should be positioned with the nose into the wind during high wind conditions.
- During high wind conditions the pitch locks should be engaged.

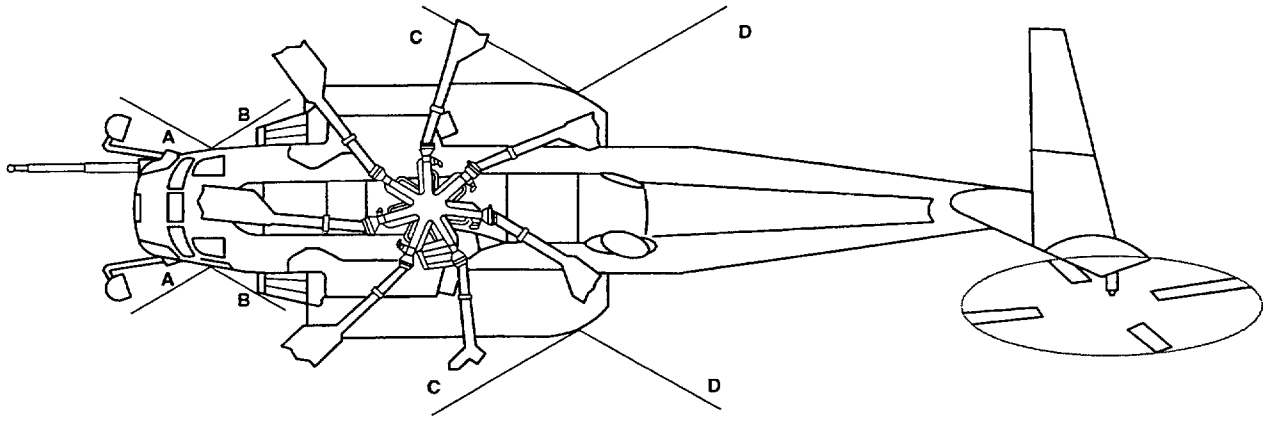


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Figure 3-4. Turning Radius Diagram







ANGLE A MUST BE APPROXIMATELY EQUAL TO ANGLE B
ANGLE C MUST BE APPROXIMATELY EQUAL TO ANGLE D

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Figure 3-5. Tiedown Arrangement Exterior

TECHNIQUE	WIND CONDITION		
	WINDS UNDER 45 KNOTS	WINDS BETWEEN 45 AND 60 KNOTS	WINDS ABOVE 60 KNOTS (SEE NOTE)
Helicopter parked into wind	X	X	X
All wheels chocked	X	X	X
Front and rear chocks secured to each other		X	X
Helicopter chained to the deck with at least 4 chains (where satisfactory deck tiedown points exist)		X	
Helicopter chained to the deck with at least 8 chains (where satisfactory deck tiedown points exist)			X
Main rotor blades spread and tied down	X		
Main rotor blades folded and secured, and pylon folded and secured		X	
Mechanical gust lock engaged	X	X	X
Fuel tanks filled to capacity		X	X
Protective covers installed	X	X	X
Parking brakes set	X	X	X
Deflate shock struts		X	X
Main rotor blades removed and pylon folded and secured			X

Note

If winds are forecast to be above 60 knots and no safe area is available, it is advisable, conditions permitting, to remove the main rotor blades to prevent damage to blades and rotor head.

Figure 3-6. Tiedown Technique vs. Wind Condition

CHAPTER 4
Aircraft Operating Limitations

4.1 MINIMUM CREW REQUIREMENTS

The minimum crew required to operate the helicopter under normal conditions is a pilot, copilot, and aircrewman. Additional crewmembers, as required, may be added at the discretion of the commanding officer.

4.2 SYSTEM OPERATING LIMITATIONS

Note

Should any system operating limit be exceeded, a Maintenance Action Form regarding the exceeded parameter and duration shall be completed.

4.2.1 Engine Operating Limitations. Engine operating limitations are illustrated in Figures 4-1 and 4-2 and are independent of one another. Whichever limit occurs first is the limit to be observed. Refer to the appropriate performance charts in Part XI to determine limitations under specific operating conditions. When the engine anti-icing system is being used, each engine will lose 3% of its power at maximum power. Power loss from use of the fuel purge system is negligible.

4.2.1.1 Engine Torque Shaft Limits. No steady state combination of torque and speed shall exceed 5500 horsepower (172% torque at 100% N_f) for more than two minutes (Figure 4-2).

4.2.1.2 Engine Operating Limits. For normal, military, and maximum operations, N_g is limited to 100% for the 416 engines and 100.8% for the 419 engine. The maximum allowable transient overspeed, 102.5% N_g, is limited to not more than 30 seconds of operation. N_g speeds in excess of 102.5% require maintenance action. The T_5 is limited to 773°C (416 engine), 792°C (416A engine), or 829°C (419 engine) for maximum operations of 10 minutes. 416 engines are limited to 713°C and 753°C for continuous and military operation, respectively. 419 engines are limited to 769°C and 810°C for continuous and military operation, respectively. If the time limit of a particular operating range is reached, the determination must be made based on operational requirements whether to remain in that range or to reduce T_5 to the next lower range.

CAUTION

Military and maximum T_5 temperatures are based on engine life. Exceeding these temperatures should be avoided consistent with operating requirements. T_5 should not, however, be reduced for short periods of time and then returned to higher temperatures.

Operations sometimes require higher engine T_5 levels for sustained periods, particularly at high gross weights and during AMCM operations when ambient temperature is high. If maximum or military limits are exceeded, record the maximum temperature and duration for use by maintenance.

CAUTION

In aircraft equipped with the 419 engine, maximum and military T_5 temperature limits shall not be exceeded.

Momentary overtemperatures to 900°C are allowed. During post engine shutdown, T_5 should not exceed 320°C. A momentary peak is a transient high-temperature condition of short duration, where the temperature peaks and falls off, either automatically or through corrective action. Any observed or suspected overtemperature shall be recorded, including maximum T_5 obtained and the time period over which the overtemperature occurred, for use by maintenance.

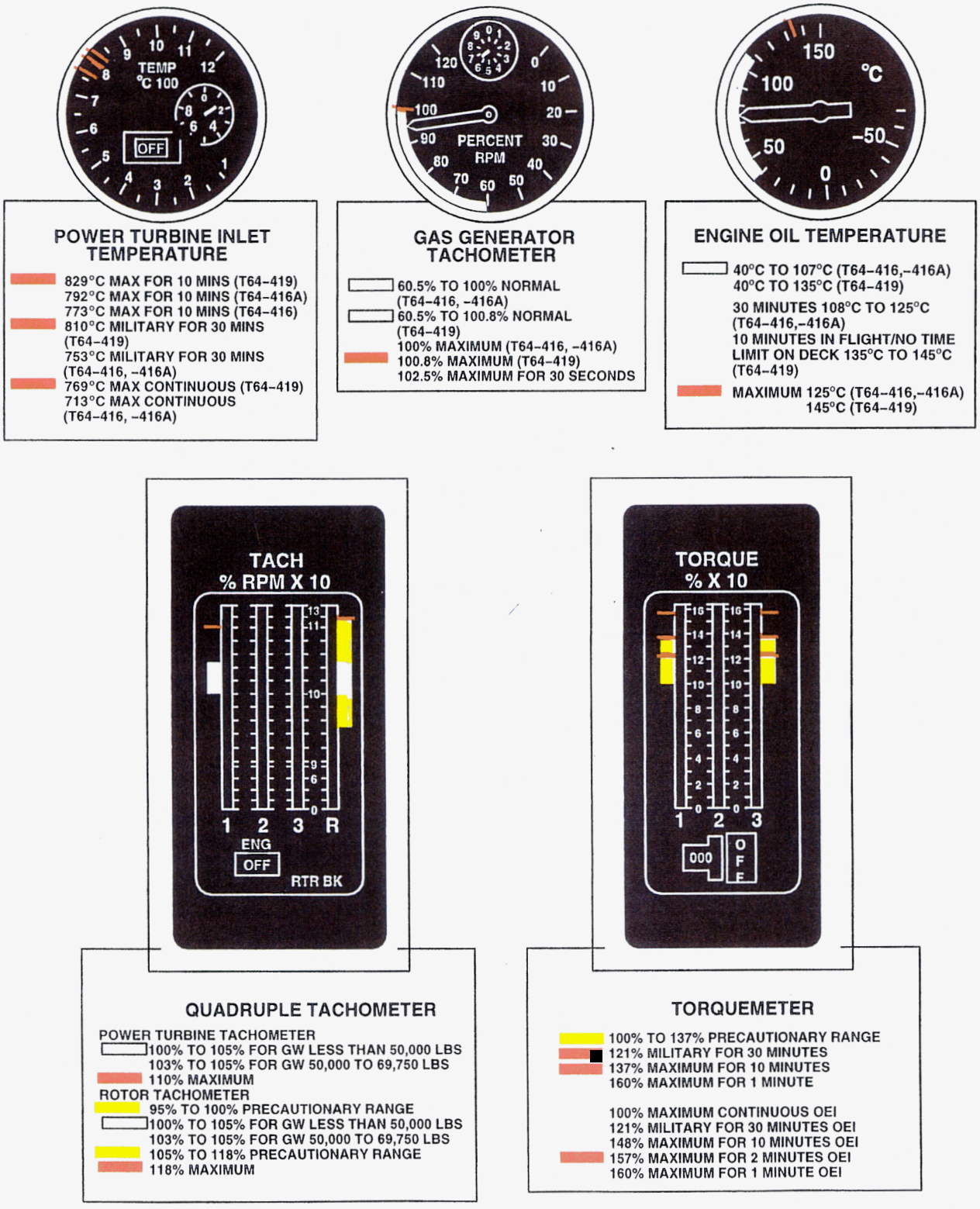
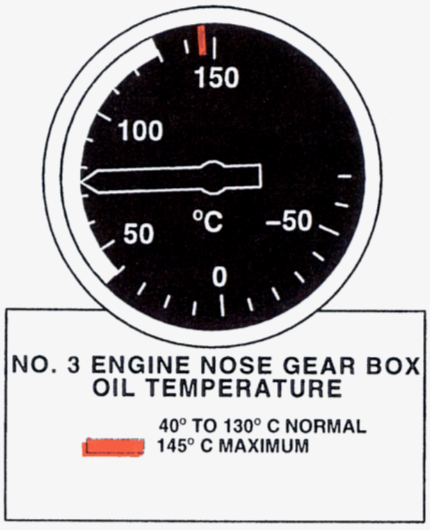
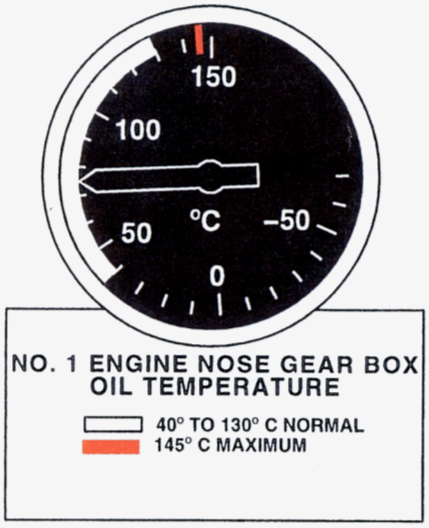


Figure 4-1. Instrument Range Markings (Sheet 1 of 3)



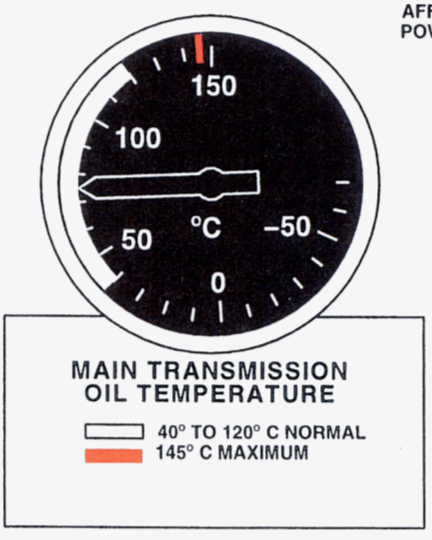


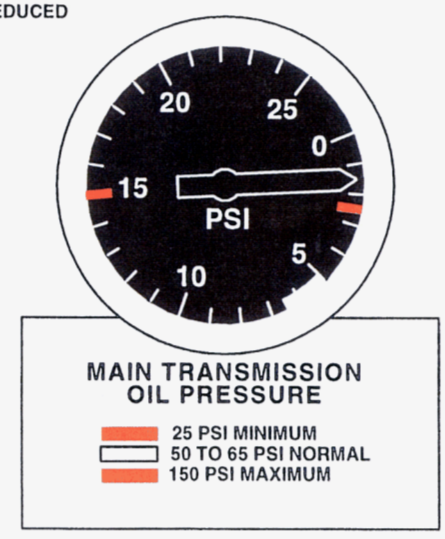
CAUTION

A NOSE GEAR BOX OIL TEMPERATURE EXCURSION BEYOND 130°C INDICATED TEMPERATURE, REGARDLESS OF DURATION, REQUIRES A NOSE GEAR BOX SERVICEABILITY INSPECTION PER APPLICABLE MAINTENANCE MANUALS. NGB OPERATIONS ABOVE THE INDICATED OIL TEMPERATURE OF 145°C ARE PROHIBITED.

NOTE

IF THE NORMAL NGB INDICATED OIL TEMPERATURE LIMIT OF 130°C IS EXCEEDED, REDUCE POWER ON AFFECTED ENGINE TO A LEVEL THAT PROVIDES A MINIMUM SAFE OPERATING MARGIN FOR PREVAILING CONDITIONS AND REQUIREMENTS. IF INDICATED NGB OIL TEMPERATURE DECREASES TO ITS NORMAL OPERATING RANGE, CONTINUE TO USE AFFECTED ENGINE AT THE REDUCED POWER LEVEL.





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Figure 4-1. Instrument Range Markings (Sheet 2 of 3)

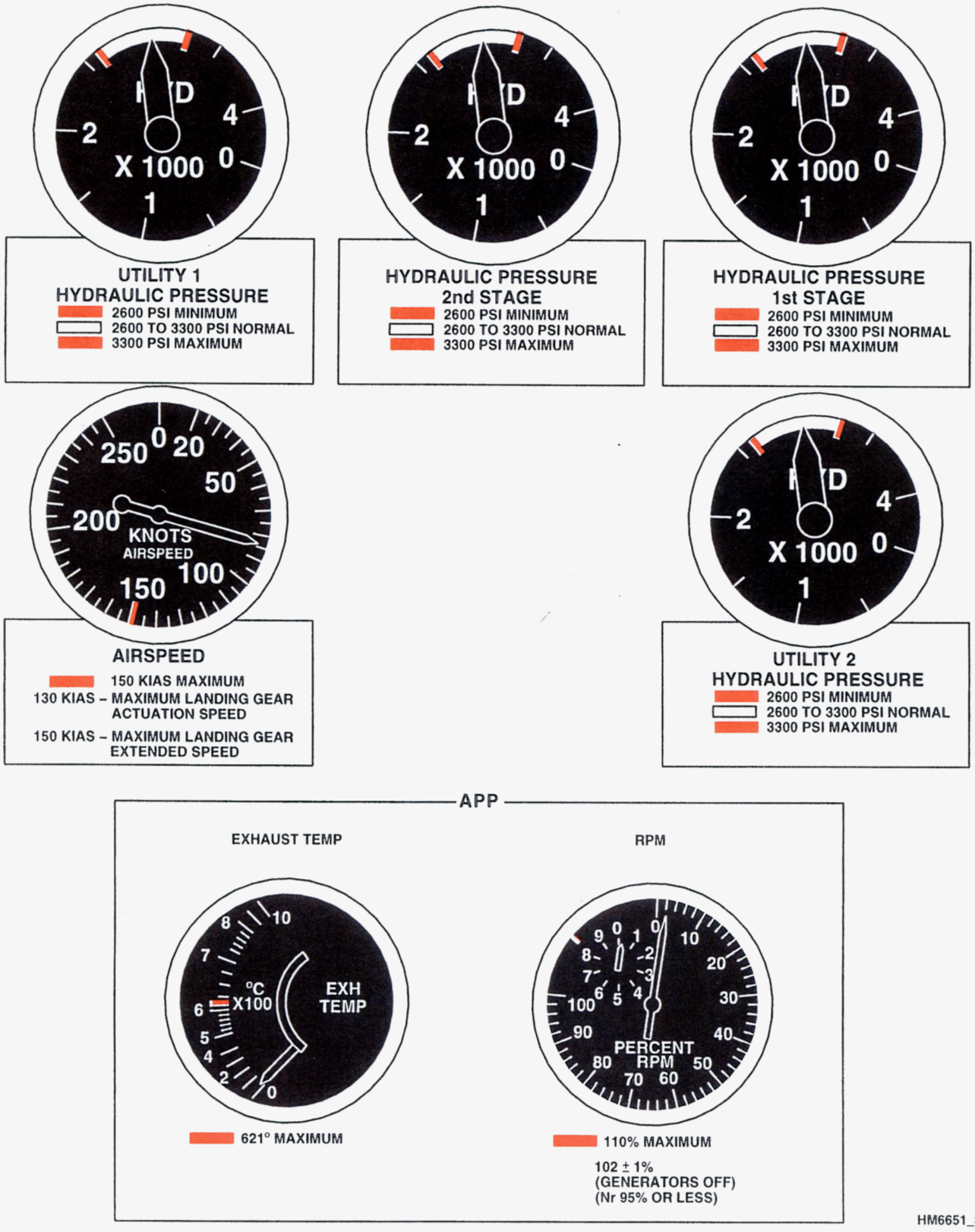


Figure 4-1. Instrument Range Markings (Sheet 3 of 3)

RATING	UI	DURATION	% Q/ENGINE	HP 100% N_r
THREE-ENGINE OPERATION				
TRANSIENT OVERTORQU	M	1 MINUTE	160*	15,360
MAXIMUM	D	10 MINUTES	137*	13,140
MILITARY	D	30 MINUTES	121*	11,570
MAXIMUM CONTINUOU		—	100*	9600
DUAL-ENGINE OPERATION				
TRANSIENT OVERTORQU	M	1 MINUTE	160*	10,240
CONTINGENCY POWER	M	2 MINUTES	157*++	10,000
MAXIMUM	D	10 MINUTES	137*+	8760
MILITARY	D	30 MINUTES	121*+	7712
MAXIMUM CONTINUOU		—	100*+	6400
SINGLE-ENGINE OPERATION				
TRANSIENT OVERTORQU	M	1 MINUTE	160*	5120
CONTINGENCY POWER	M	2 MINUTES	157*++	5000
MAXIMUM	D	10 MINUTES	137*+	4380
MILITARY	D	30 MINUTES	121*+	3856
MAXIMUM CONTINUOU		—	100*+	3200

Note

\+ Engine limit (-416/416A)

++ Engine limit (-419)

* Transmission limit

F4jure 4-2. Transmission/Engine Torque Limitations

4.2.1.2.1 One-Engine :rnoperative (OEI) Contingency Power. The 41ne engine has a one-engine inoperative (OEI) contingenc; o·ating of 5000 shp at 100% N_f (157% torque) on a 90°F ecy at sea level conditions for two minutes, followed by ɔune hour of operation at maximum continuous rated power. 419 engines may reach as high as 105% N_g and 925°C during OEI operations. This contingency power shall only be used in the event of an OEI situation.

CAUTION

Use of contingency power exceeds normal operating limits and requires the completion of a maintenance action form specifying the exceeded parameters and duration thereof.

Note

419 engines are adjusted to maximum topping to provide for contingency power in the event of an engine failure. Large or rapid collective inputs may cause transient excursions into the contingency power range during three-engine operation. Exceeding the transmission limits shown in Figure 4-2 will reduce component life and require maintenance action.

4.2.1.3 Engine Overspeeds. The 416 engines have a maximum allowable Gas Generator (N_g) overspeed of 100% to 102.5% for 30 seconds. The 419 engine has a maximum allowable N_g overspeed of 100.8% to 102.5% for 30 seconds. If this limitation is exceeded, the engine will require an overhaul. Any observed or suspected overspeed shall be recorded, including maximum N_g obtained and the time period over which the overspeed occurred, for use by maintenance personnel.

4.2.1.4 Power Turbine (N_f). If the maximum allowable N_f overspeed of 125% for 5 seconds is exceeded, the engine will require an overhaul. The engine will also require an overhaul any time 129% is exceeded for any time period.

4.2.2 Rotor and Transmission Limitations. Normal operating limitations of the rotor and transmission systems are shown in Figures 4-1 and 4-2. However, rotor system overspeed imposes a severe load on the rotor and transmission systems and should be noted on the appropriate forms.

When an overspeed condition occurs, this is required.

1. 118% to 129% N_r. Visual inspection of the main rotor hub, tail rotor hub, tail drive shafts, accessory drive shaft, and tail disconnect coupling jaw teeth. The nose to main gear box drive shaft will also require a visual inspection if the engine(s) has oversped.

2. In excess of 129% N_r. Remove main rotor hub, tail rotor hub, and tail disconnect coupling. Disassembly inspection of tail drive shafts and accessory drive shaft. The nose to main gear box drive shaft will require a disassembly inspection if the engine(s) have oversped. Visual inspection of all gear box chip detector plugs, strainers, and filters.

4.2.2.1 Rotor Speed (N_r) Gross Weight Limitations 100% to 105% N_r for gross weights less than 50,000 lbs.

103% to 105% N_r for gross weights 50,000 to 69,750 lbs.

4.2.2.2 Rotor Blade Limitations. When N_r is over 125%, the main and tail rotor blades shall be removed.

4.2.2.3 Rotor Engagement/Disengagement. Rotors should not be engaged or disengaged in winds of over 45 knots, from any direction.

4.2.2.4 Blade Fold/Unfold. Blades should not be folded or unfolded in winds over 45 knots, from any direction. When possible in winds over 20 knots, the aircraft should be positioned into the wind.

4.2.2.5 Pylon Fold/Unfold. The pylon fold sequence shall not be initiated in winds over 45 knots. When possible in winds over 20 knots, the aircraft should be faced into the wind to prevent airframe damage in the event loss of control of pylon occurs during fold/unfold process.

4.3 CABIN LIMITATIONS

The inboard cabin compartment floor is limited to static loads of 300 pounds per square foot. The outboard section of the floor is stressed to withstand greater loads at various positions. (see Figure 2-39).

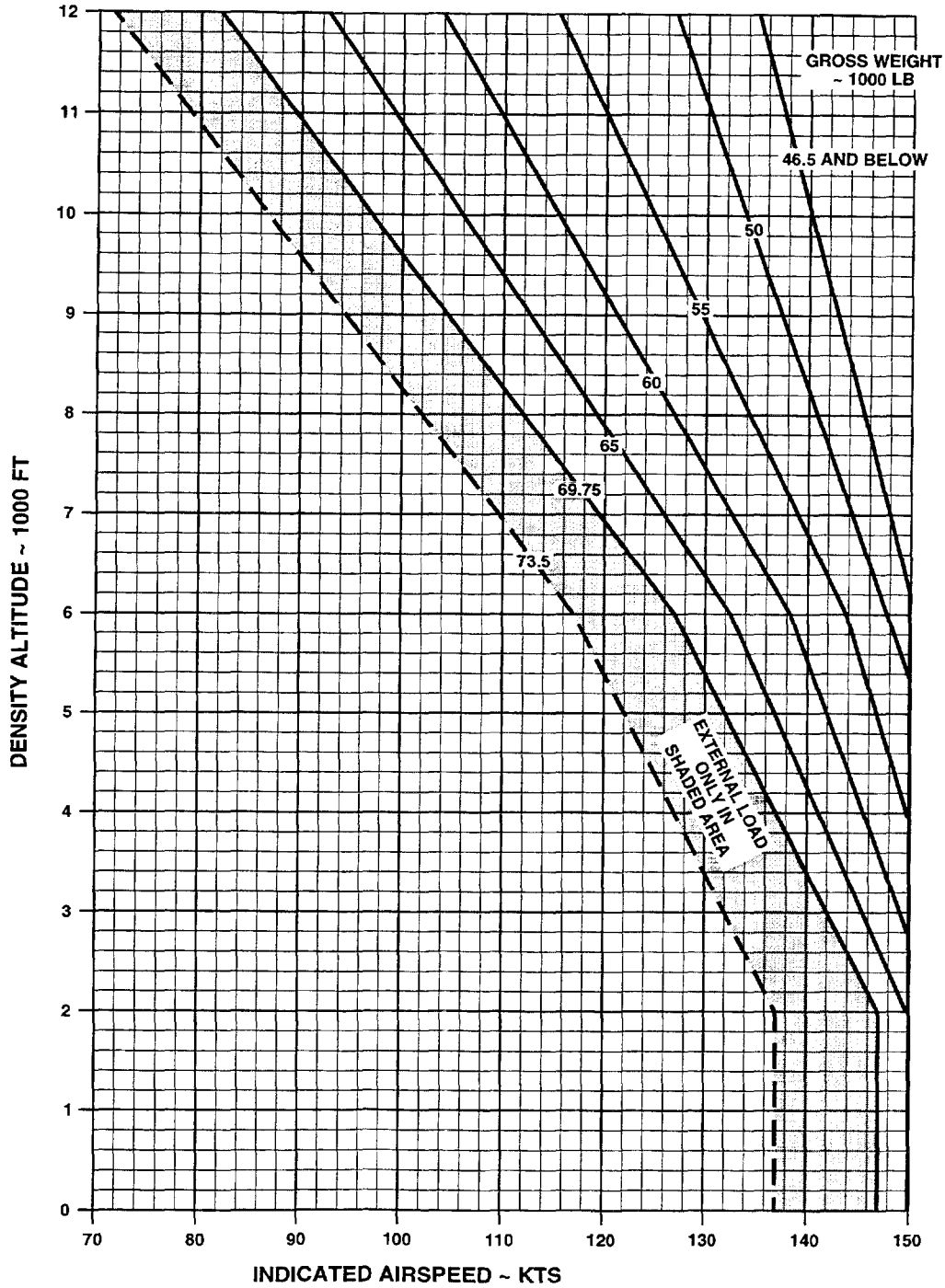
4.4 AERODYNAMIC LIMITATIONS

4.4.1 Airspeed Limitations. The maximum authorized forward flight speed is 150 KIAS or the maximum airspeed from Figure 4-3, whichever is less.

The maximum permissible airspeeds for normal flight regimes are as follows:

MAXIMUM ALLOWED AIRSPEED VS DENSITY ALTITUDE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST



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Figure 4-3 Airspeed vs. Density Altitude Limitations

Forward flight	See Figure 4-3
Sideward flight	35 knots
Rearward flight	30 knots
External loads	150 KIAS
Landing gear actuation	130 KIAS
Landing gear extended	150 KIAS
EAPS doors closed	150 KIAS
Maximum autorotation airspeed	120 KIAS except for emergency situations
90° stub ramp extended below level	60 KIAS

4.4.2 Maneuvering Flight Limitations

WARNING

- Rapid forward cyclic and reduced collective setting may cause blade/fuselage impact.
- Any of the following conditions may indicate an inoperative desensitizer:

  1. DSEN fail advisory light on the AFCS control panel is lit.
  2. AFCS is OFF.
  3. AFCS duplex failure.
  4. FAS shearpin is sheared.

- Loss of a control desensitizer will, under certain circumstances, allow the pilot to interact with the fuselage bending modes to create a PIO (pilot-induced oscillation) or PAO (pilot-assisted oscillation). This interaction can result in divergent helicopter oscillations. Delayed pilot response in eliminating these oscillations may result in helicopter damage and/or uncontrolled flight. If encountered, releasing the flight controls for several seconds may eliminate the condition.
- If desensitizer failure occurs, and does not clear after a MODE reset or resetting computer power, observe the following precautions:

  1. Avoid rapid control inputs.
  2. Minimize hover time.
  3. Do not pick up an external load. If flying with an external load, continue to the destination and gently set the load down. Do not attempt to re-lift the load.
  4. Do not commence AMCM operations. If engaged in AMCM operations initiate recovery procedures. If PIO/PAO is encountered, jettison/release AMCM gear and remove hands from controls.

- Aerobatics, such as loops, rolls, etc., are not permitted. Hovering turns over 360° in less than 15 seconds are prohibited.
- Maneuvering in uncoordinated flight and/or abrupt control inputs will result in higher dynamic system stresses and shall be avoided.
- Maneuvering flight which combines high airspeed, high altitude, and large sideslip angles may result in tail rotor blade flap stop contact which is accompanied by a rapid rise in tail rotor system loading. There may be no indication to the flight crew when this contact occurs. To minimize exposure to flap stop contact the following restrictions apply for airspeeds above 130 KIAS:

  1. Maximum ball deflection — ONE BALL WIDTH.
  2. Maximum roll rate — 15° ANGLE OF BANK PER SECOND.
  3. Maximum turbulence conditions — LIGHT.

Maximum angle of bank is 45°. Evasive maneuvering (EVM) training is prohibited. For operations where maximum maneuvering capability is required (low level, contour flights, etc.), limit airspeed to 130 KIAS.

4.4.3 Altitude Limitations. Helicopter operations are primarily limited by the ability to hover in and out of ground effect. Refer to the performance charts in Part XI to

determine the hovering ceiling for various flight conditions. Service ceilings for helicopters are normally the altitude that the helicopter can sustain the best rate-of-climb speed for specific conditions. Refer to the climb charts in Part XI to determine altitude limitations. Altitude limitations related to emergency operations can be obtained from the performance charts in Part XI when the emergency procedures outlined in this section are followed. Minimum autorotative altitudes and airspeeds are established to provide the altitude and airspeed combination that will permit the pilot to select the best available landing site and accomplish a safe autorotative landing.

4.4.4 Landing Limitations. Landings should be made so as not to subject the landing gear to a rate of descent greater than the design sink rate limitation of 672 feet-per-minute at 46,500 pounds gross weight and 360 feet-per-minute at 69,750 pounds gross weight. The tail skid air/oil shock strut will withstand inadvertent ground contact up to a sink rate of 672 feet-per-minute. Landing gear touchdown and takeoff speed shall not exceed 40 knots ground speed.

4.4.5 Acceleration Limitations. The helicopter is restricted from maneuvers which would exceed the actual demonstrated load factor capability of the aircraft. Since some structural limitations are a function of gross weight, load factor, and density altitude, the following apply:

1. Gross weights at or below 56,000 pounds	
* Density altitudes to 2000 feet	0.5 to 2.0 g
* Density altitude above 2000 feet	0.5 to 1.5 g
2. Gross weight 56,000 pounds to 69,750 pounds	0.5 to 1.5 g

4.5 WEIGHT AND BALANCE LIMITATIONS

The gross weight limit with or without external load is 69,750 pounds. The helicopter is restricted from maneuvers which would exceed the design load factors. The maximum takeoff or landing weight with internal cargo is 69,750 pounds. The structural limitations are based on a function of gross weight to G-load factor. Gross weight is further limited by the ability of the helicopter to hover in and out of ground effect for specific conditions. Refer to the performance charts in Part XI to determine the gross weight limitation related to power available, and other related factors. It is possible to go over the CG limits if the helicopter is not properly loaded. CG computations must account for CG shift which accompanies fuel burnoff, otherwise CG limits may be exceeded. See Figure 2-41 for longitudinal CG vs gross weight limits.

4.6 LATERAL CG LIMITS

The lateral CG limits are 8.5 inches right and 13.5 inches left, regardless of the configuration.

4.7 LONGITUDINAL CG LIMITS

See Figure 2-41.

4.8 RESCUE HOIST LIMITATIONS

The maximum load that may be raised or lowered with the rescue hoist is 600 pounds. Hoist recoveries are restricted to hover only.

4.9 EXTERNAL CARGO HOOK LIMITATIONS

The single-point suspension external cargo hook is limited to 25,000 pounds. Because the aircraft lacks a CG/Hook-Load indicator system, use of the two-point suspension system is prohibited except as specifically authorized by NAVAIRSYSCOM. The two-point suspension system cargo hooks are designed for maximum loads of 21,600 lbs each and a maximum combined capacity of 36,000 lbs.

WARNING

- One two-point suspension hook shall never be used independently of the other two-point suspension hook.
- One or both two-point suspension hooks shall never be used in conjunction with the single-point suspension hook.
- Two-point external cargo operations are prohibited in the MH-53E.

4.10 EMERGENCY WATER OPERATING LIMITATIONS

Emergency water limitations are based on the ability to stay afloat for at least 2 hours in 1 to 3 foot waves with a wind of 7 to 16 knots, a roll of 10°, a water taxi speed of 8 knots at 46,500 pounds, and the cargo ramp and door closed.

Flotation capability of the helicopter with the 90° stub ramp installed is degraded.

4.11 FUEL DUMPING LIMITATIONS

Fuel dumping is limited to 40 to 130 KIAS in level flight and in climbs. Fuel dumping in descents is limited to 90 to 130 KIAS. Fuel shall not be dumped if the rate of descent exceeds 1500 feet-per-minute.

4.12 ICING LIMITATIONS

See Figure 14-1.

4.13 IN-FLIGHT REFUELING LIMITATIONS

Figure 4-4 presents the safe in-flight refueling envelope. It is valid for NATOPS CG limits with the following restrictions:

1. Airspeed range: 105 to 120 KIAS.

2. AFCS must be functional (except altitude hold).

3. To reduce loads on dynamic components and improve aircraft handling qualities, use 103% to 105% N_r at gross weights above 50,000 lbs and/or density altitudes above 6000 ft.

4. CG positions aft of 362.0 inches:

   a. Must be avoided when possible and not used for initial aerial refueling training.

   b. Must be used only when operational requirements exist and by pilots having extensive in-flight refueling experience at CGs forward of 362.0 inches.

4.14 AMCM LIMITATIONS

Maximum steady state tow tension is 25,000 lbs with maximum surges to 30,000 lbs.

Maintain a minimum of 103% N_r during tow operations.

Downwind tow limitations are shown in Figure 4-5. Downwind conditions are defined as winds from 135° to 225° relative to the helicopter nose.

Tailwind tow limitations are shown in Figure 4-6.

Maximum skew angle is 10° left and right.

Due to high ambient noise levels in the aft cabin during AMCM flights, limit individual crewman exposure time at the crew work stations below to the following (within a 24-hour period):

Safety Observer	4.0 hrs
Starboard Ramp	1.5 hrs
Port Ramp	5.0 hrs
Starboard Handler	12.0 hrs
Port Handler	12.0 hrs

CAUTION

Failure of aircrewmen to wear properly fitted earplugs under approved headgear during AMCM operations will result in permanent hearing damage.

Note

AMCM crewman hearing conservation shall be monitored in accordance with OPNAVINST 6260.2.

The 90° stub ramp may be lowered to 90° below horizontal at airspeeds up to 60 knots.

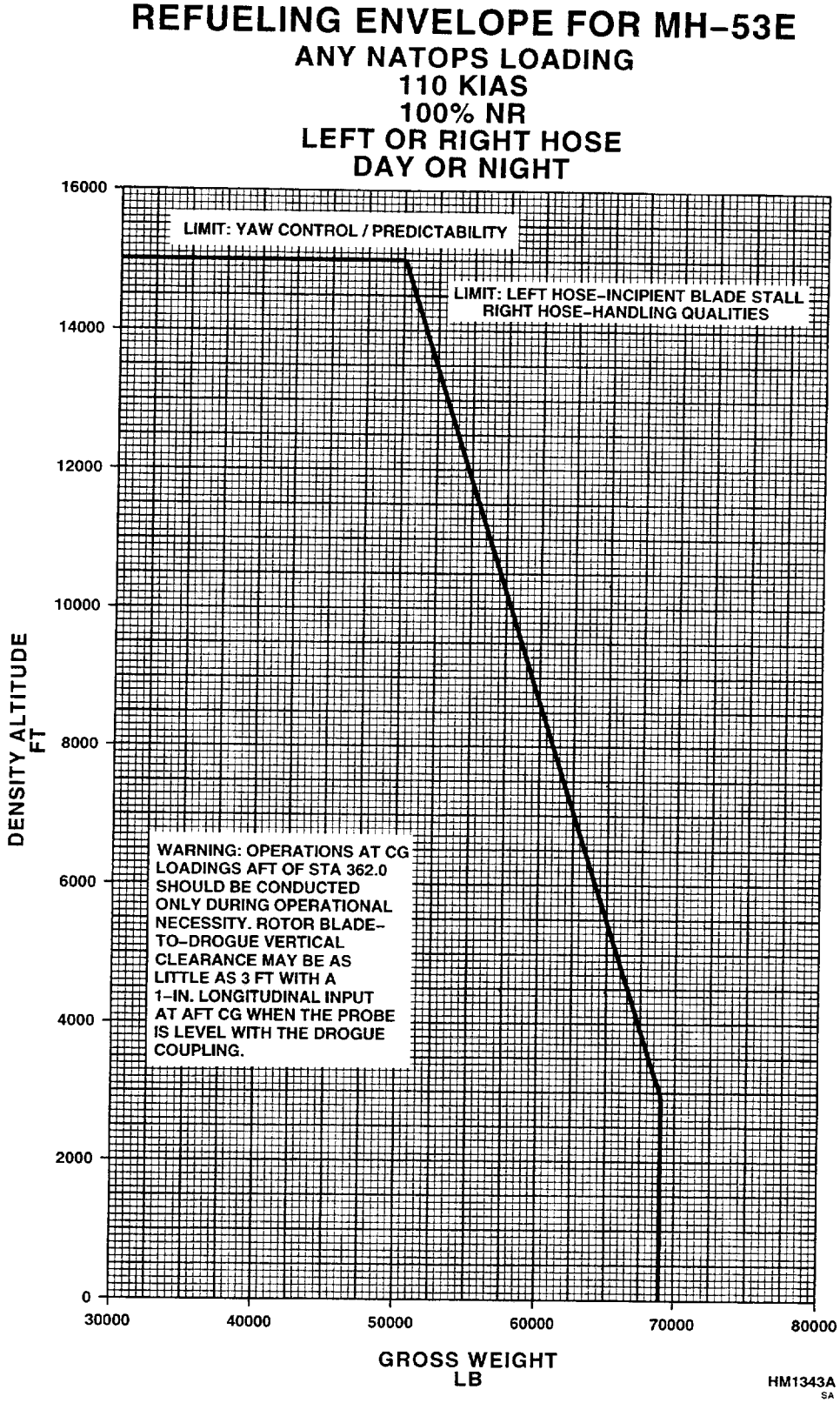
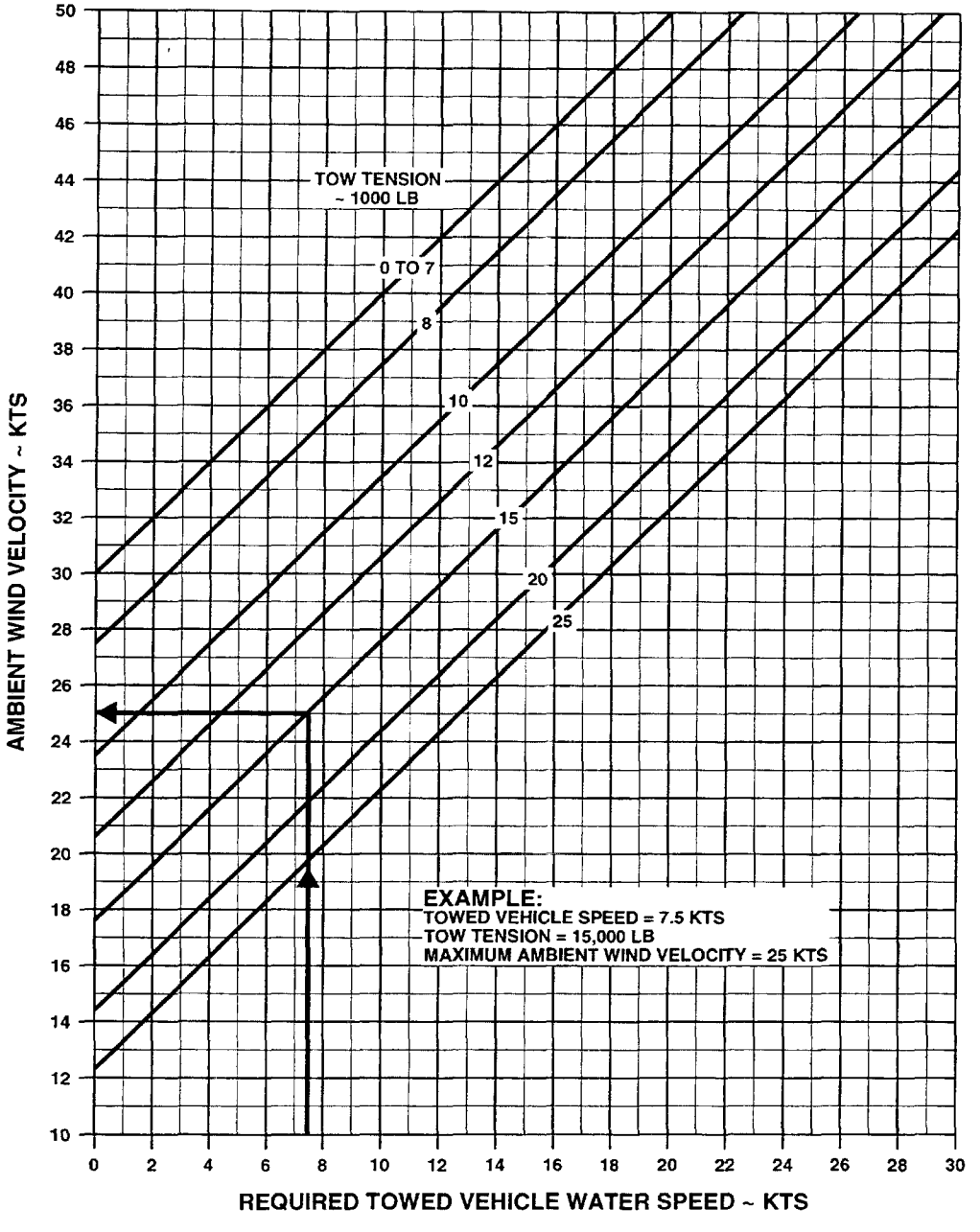


Figure 4-4. Aerial Refueling Envelope for the MH-53E with the C-130

DOWNWIND TOW LIMITATIONS

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST

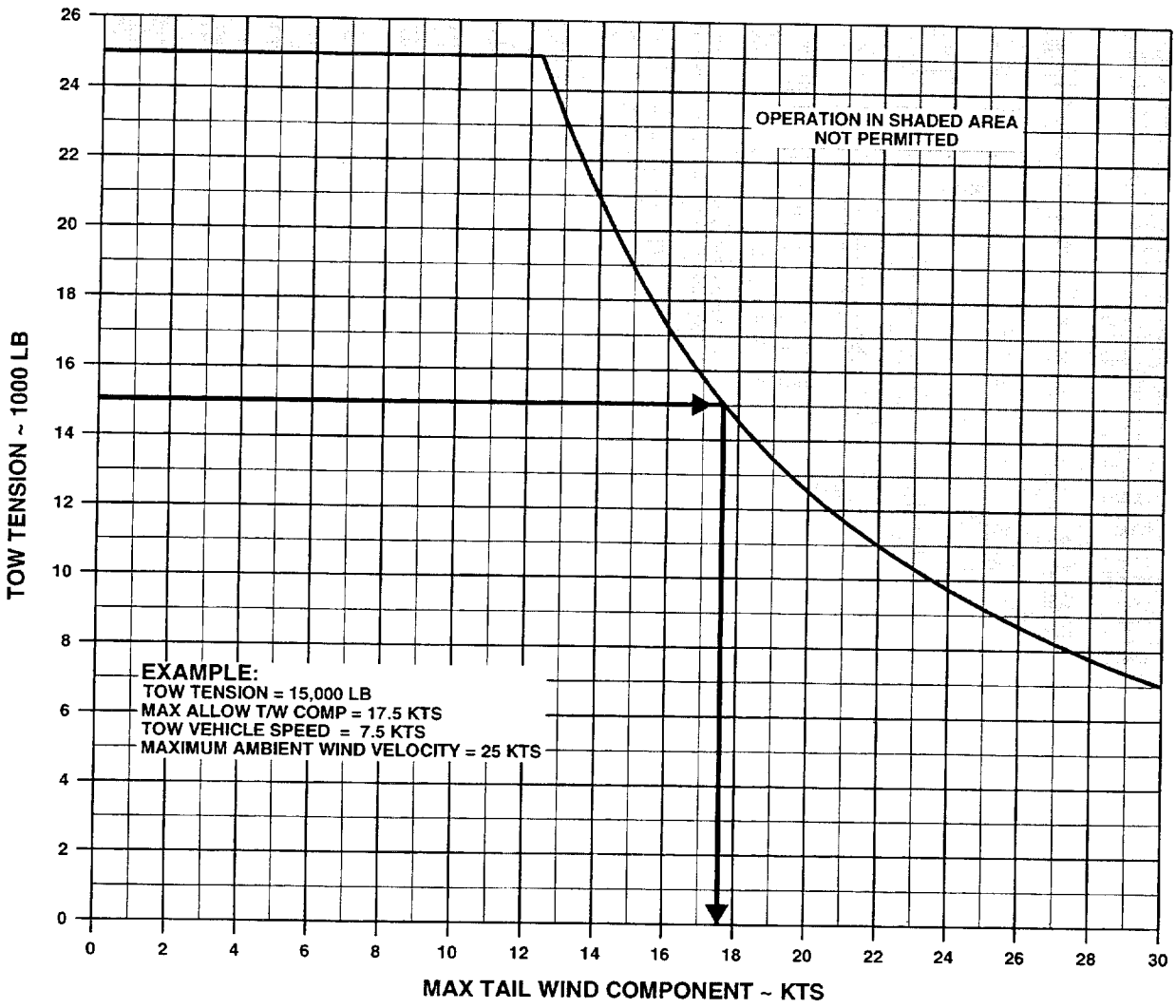


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Figure 4-5. Downwind Tow Limitations

TAIL WIND TOW LIMITATIONS

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST



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Figure 4-6. Tail Wind Tow Limitations

PART II

INDOCTRINATION

Chapter 5 Indoctrination

CHAPTER 5
Indoctrination Procedures

5.1 GROUND TRAINING SYLLABUS

A ground training program shall be established which shall ensure thorough training and a high degree of readiness for all flight personnel. The ground training syllabus required below is to be used as a guide. The syllabus is set forth in the CNO Approved MH-53E Training Syllabus.

5.1.1 Pilot Ground Training. Pilot ground training will include NAMTG pilot familiarization, helicopter performance and emergency procedures, helicopter loading and weight and balance, communication, publications, flight planning and navigation, flight safety and survival equipment, Fleet Mine Warfare training, and search and rescue.

5.1.2 AMCM Aircrewman Ground Training. AMCM aircrewman ground training will include plane captain qualification, publications, ground handling and servicing, helicopter loading, weapons loading (as required), maintenance and troubleshooting procedures, communication, blade and pylon fold/spread operations, safety and survival equipment, aircraft familiarization, Fleet Mine Warfare AMCM, search and rescue, and helicopter inspection and preservation/corrosion control.

5.1.3 Utility Aircrewman Ground Training. Utility aircrewman ground training will include plane captain qualification publications, ground handling and servicing, helicopter loading, weapons loading, maintenance and troubleshooting procedures, communications, auxiliary powerplant operation, safety and survival equipment, aircraft systems familiarization, external cargo operations, passenger transportation requirements, helicopter inspection and search and rescue.

5.2 FLIGHT SYLLABUS

5.2.1 Pilot Flight Training. A flight training syllabus shall be established by each command to accomplish maximum training for the mission and tasks assigned. The syllabus must be flexible and tailored to fit the situation and the varying nature of the tasks and commitments. The flight training syllabus will contain the following phases: familiarization, formation, instruments, navigation, night, shipboard, SAR procedures, external cargo operations, and AMCM operations. The syllabus is set forth in the CNO Approved MH-53E Training Syllabus.

5.2.2 AMCM Aircrewman Flight Training. A flight training syllabus shall be established by each command to accomplish maximum training for the mission and tasks assigned. The syllabus must be flexible and tailored to fit the situation and varying nature of the tasks and commitments. The flight syllabus will contain the following phases: familiarization, external cargo operations, confined area landings, SAR procedures, AMCM operations, and general flight duties.

5.2.3 Utility Aircrewman Flight Training. A flight training syllabus shall be established by each command to accomplish maximum training for the mission and tasks assigned. The syllabus must be flexible and tailored to fit the situation and varying nature of the tasks and commitments. The flight syllabus will contain the following phases: familiarization, external cargo operations, confined area landings, SAR procedures, and general flight duties.

5.3 PERSONAL FLYING EQUIPMENT

In the interest of safety and survival, flying equipment shall be worn by all personnel engaged in flights as set forth in OPNAVINST 3710.7.

5.3.1 Equipment.

1. Protective helmet.
2. Fire-resistant flight suit.
3. Flight safety boots.
4. Inflatable life preserver as required.
5. Survival knife and sheath.
6. Flashlight.
7. Flight gloves.
8. Identification tags.
9. Personal survival kit.
10. Parachutes as required.

11. Anti-exposure suit as required.

12. Signal device.

13. NATOPS Pilot's Pocket Checklist, A1-H53ME-NFM-500, and NATOPS Aircrew Pocket Checklist, A1-H53ME-NFM-900.

14. NWP-55-8-H53 (TACAID) for all AMCM flights.

15. Ear Plugs.

In addition to the crew requirements for life preservers, all passengers shall be provided with an approved-type life preserver on all flights conducted over water. All survival equipment shall be secured so that it is easily accessible and will not be lost during an emergency. Additional survival information is available in: Survival Training Guide (NAVAER 00-80T-56), Polar Guide (NAVAER 00-80T-32), Safety and Survival Equipment Manual (NAVAER 00-80T-52), and Survival on Land and Sea (NAVAER 00-80S-56).

5.4 FLIGHT CREW QUALIFICATIONS AND CURRENCY REQUIREMENTS

The flight crew qualifications and requirements as set forth in the following paragraphs are minimums and are not to be interpreted as limiting in anyway the establishment of higher requirements by proper authority.

5.4.1 Pilot Qualifications and Currency Requirements. A pilot must be qualified as a helicopter pilot under the provisions of OPNAVINST 3710.7 and complete a formal helicopter ground and flight training program before he can become qualified as a helicopter aircraft commander (HAC) or helicopter second pilot (H2P). A pilot who has qualified in one of the helicopter classifications shall have a certificate thereof signed by the qualifying authority. This certificate will state the model helicopter and modification thereto in which he is qualified, and shall be placed in his Aviator's Flight Log Book and Naval Aviator Naval Flight Officer Qualification Jacket. Commanding officers, or higher authority in the chain of command, are empowered to designate helicopter aircraft commanders and issue certification thereto. The immediate superior in command to the commanding officer, or higher authority, may assume the function. The authority assuming the function shall issue appropriate instructions.

5.4.2 Qualifications

5.4.2.1 Mission Commander. Multiple formation flight, i.e., two or more separate formations of aircraft, each of which is led by a separate flight leader, on a common helicopter support mission, shall be under the command of a designated mission commander. A mission commander should be designated when the helicopter support mission requires multiple sorties by a formation of four or more aircraft. The mission commander may be, but is not limited to being, one of the formation flight leaders. The status of each member of the flight or flights shall be understood prior to flight. The mission commander shall direct a coordinated plan of action and shall be responsible for both the effectiveness of the flight and for all phases of the assigned mission. Commanding officers shall establish policy to identify other helicopter support missions which require the assignment of mission commander. To be eligible for designation as a mission commander, the individual aviator shall be a qualified HAC in model.

Designation as mission commander is a function of command, and, as such, qualities of personal integrity, maturity, judgement and initiative, in addition to rank and flight experience, shall be considered by the commanding officer when designating mission commanders.

5.4.2.2 AMCM Mission Commander. The AMCM mission commander shall be an H-53E HAC who has displayed a high degree of AMCM proficiency, a minimum of 25 AMCM hours under tow, and completed an AMCM flight check in the MH-53E. AMCM Mission Commander designation and HAC designation can be done concurrently for individuals who were previously designated as an AMCM Mission Commander.

5.4.2.3 Helicopter Aircraft Commander. The helicopter aircraft commander shall have completed all the requirements for, and possess to an advanced degree, the knowledge, proficiency, and capabilities of a helicopter second pilot. He shall further meet the requirements as set forth in detail in OPNAVINST 3710.7. In addition, the HAC shall satisfactorily complete the unit's helicopter aircraft commander flight check.

5.4.2.4 Helicopter Second Pilot. A helicopter second pilot will be designated helicopter pilot and shall meet all of the requirements as set forth in OPNAVINST 3710.7. In addition, the second pilot shall satisfactorily complete the units helicopter second pilot flight check.

5.4.2.5 Pilot Under Instruction. A pilot under instruction is a designated aviator under instruction.

5.4.2.6 Qualified In Model. A designated aviator who has completed an open book exam, closed book exam, and a NATOPS flight check in an H-53 model aircraft.

5.4.2.7 Formation Leader. A formation of two or more naval aircraft shall be under the direction of a formation leader who is authorized to pilot naval aircraft. The formation leader may also be the mission commander when so designated. The status of each member of the formation shall be clearly briefed and understood before take off. The formation leader is responsible for the safe and orderly conduct of the formation.

Designation as formation leader is a function of command and, as such, commanding officers shall establish policy to control the number of aircraft an individual formation leader may command. Qualities of personal integrity, maturity, judgement and initiative, in addition to rank and experience, should be considered.

5.4.2.8 Functional Checkflight Pilot. A functional checkflight pilot is an aviator, designated in writing by the commanding officer, authorized to conduct functional checks of aircraft systems in flight as required by OPNAVINST 4790.2. To be eligible for designation as a functional checkflight pilot, the individual aviator shall be a qualified HAC in model. Prior to initial designation as functional checkflight pilot, the individual aviator shall satisfactorily complete the unit's written functional checkflight procedures examination and shall satisfactorily demonstrate the ability to perform functional checks of aircraft systems in flight.

5.4.3 Minimum Crew Requirements

1. The helicopter is designated a multi-piloted aircraft. The minimum crew required to fly the aircraft is a pilot, copilot, and an aircrewman.

2. Commanding officers are authorized to permit single pilot operations on flights when, in his opinion, conditions do not require two pilots. The minimum crew for single piloted operations is a helicopter aircraft commander (HAC), a qualified observer, and a crewman, one of the latter to be a qualified aircrewman.

3. A HAC shall command the aircraft and occupy one of the control positions on all flights except that commanding officers are authorized to permit training flights under VFR conditions, with two helicopter second pilots (H2Ps), one being designated as pilot in command.

4. All instructional flights shall be under the direct supervision of a HAC.

5. A pilot under instruction (PUI) may occupy one of the control positions on flights where passengers are carried, but he shall not perform takeoffs or landings where passengers embarked.

6. On operational missions to or from ships, the pilot at the controls shall be qualified and current to perform takeoffs and landings.

7. The pilot and copilot seats shall be occupied on all flights.

5.4.4 Currency Requirements

5.4.4.1 Annual Flying Requirements. To ensure that the skill of naval aviators is maintained at an acceptable standard of readiness for fleet operations, the annual flying requirements as set forth in OPNAVINST 3710.7 shall be adhered to by all active duty naval aviators. Pilot and aircrew day, night, and AMCM currency requirements shall be established and maintained at the local level.

5.4.4.2 Shipboard Qualifications

5.4.4.2.1 General. No minimum hour requirements are set prior to shipboard qualification. Initial day/night carrier qualifications should be made under VMC weather conditions to include a visible horizon.

5.4.4.2.2 Field Carrier Landing Practice. Five day and five night FCLPs shall be made within 30 days before initial shipboard qualification, or when renewing currency if currency has expired, or when regaining shipboard currency. For day shipboard qualifications only, day FCLPs are required. FCLPs will be conducted to simulate shipboard operations as closely as possible.

Briefing before FCLPs will include the information set forth in chapter 8 and shall include the following:

1. Patterns, altitudes, and airspeeds.

2. Helicopter director signals.

5.4.4.2.3 Shipboard Qualification Requirements

1. Day initial qualification - Not less than five landings and takeoffs.

2. Night initial qualification - Day qualified and not less than five night landings and takeoffs. At least two day landings and takeoffs must be made on the day of night qualifications.

5.4.4.2.4 Shipboard Currency

1. Day - 2 day or 2 night landings and takeoffs within 6 months.

2. Night - 2 night landings and takeoffs within 6 months.

5.4.4.2.5 Requirements to Regain Shipboard Currency

1. Day - Not less than two landings and takeoffs.

2. Night - Not less than two landings and takeoffs. At least two day shipboard landings and takeoffs must be made on the day of night qualifications.

5.4.4.3 Air Refueling Qualification. The following minimum initial qualification in the H-53E model aircraft shall be met by all pilots:

1. Day - At least one rendezvous and join-up with a total of three day plugs.

2. Night - Same requirement as day. Day initial qualifications shall be completed before night qualifications are attempted.

After initial qualification a pilot is considered current for deployment involving refueling operations if he has completed a minimum of 2 day and 2 night plugs in the last 180 days. Night currency is not required for day-only operations.

5.4.4.4 NATOPS Evaluation. On assignment to another unit, helicopter aircraft commanders and helicopter second pilots will not be required to receive a NATOPS evaluation if the log book entry indicates successful completion of the evaluation within the guidelines set forth in OPNAVINST 3710.7 or if he has a current NATOPS Evaluation Report Form, OPNAV 3510.8, on file.

5.4.4.5 Waivers. Unit commanders are authorized to waive in writing minimum flight assignment and/or training requirements where authorized by OPNAVINST 3710.7.

5.4.5 AMCM Aircrewman and Additional Crewmember Qualifications, Requirements, and Designations.

An appropriately qualified aircrewman shall be assigned aboard the helicopter for the performance of duties necessary for the successful completion of the mission. In the event an additional crewmember is required for mission accomplishment, he must meet all the requirements and qualifications as set forth below.

5.4.5.1 Qualifications

1. Shall be a volunteer for aircrew training.

2. Shall possess the qualities of personal integrity, maturity, judgement, and initiative which are vital to the satisfactory performance of assigned tasks.

3. Shall meet the physical and psychological requirements of the medical department.

4. Shall be a qualified swimmer in accordance with OPNAVINST 3710.7.

5.4.5.2 Requirements

5.4.5.2.1 AMCM Crewman. The AMCM crewman shall meet the following requirements.

1. Successfully completed a CNO approved FRS training syllabus.

2. Satisfactorily completed a NATOPS open and closed book exam.

3. Satisfactorily completed a NATOPS flight evaluation.

5.4.5.2.2 AMCM Second Crewman. The AMCM second crewman shall qualify within 18 months in applicable AMCM training flights. The requirements for the AMCM second crewman are as follows:

1. Satisfactorily complete requirements for MH-53E AMCM crewman.

2. Satisfactorily complete a unit approved aircrew ground training syllabus for second crewman.

3. Satisfactorily complete a unit approved AMCM flight training syllabus for second crewman.

4. Have 25 hours tow time.

5. Be a designated MH-53E plane captain.

6. Satisfactorily complete a NATOPS open book exam.

7. Satisfactorily complete a NATOPS closed book exam.

8. Satisfactorily complete a second crewman check ride on an AMCM mission designated by the command.

9. By designated in writing by the commanding officer.

5.4.5.2.3 AMCM First Crewman. The AMCM first crewman is an aircrewman assigned aboard the helicopter for duties necessary for the successful completion of the AMCM mission. The safety observer position for all AMCM missions shall be a designated AMCM first crewman. He shall coordinate cabin activities with the AMCM mission commander on any in-flight emergency. He is ultimately responsible for crewman performance, crewman coordination, and mission accomplishment. The requirements for AMCM first crewman are as follows:

1. The AMCM first crewman shall be an AMCM second crewman who has displayed a high degree of crew coordinating ability and AMCM proficiency.

2. Have 50 hours tow time.

3. Satisfactorily complete a NATOPS open book exam.

4. Satisfactorily complete a NATOPS closed book exam.

5. Satisfactorily complete an in-flight AMCM NATOPS evaluation as the safety observer on any AMCM mission flight.

6. Be designated in writing by the commanding officer.

5.4.5.2.4 Utility Aircrewman.

1. Complete the applicable unit training syllabus for designation.

2. Be designated in writing by the commanding officer.

5.4.5.3 Designation. Commanding officers shall designate helicopter aircrew members and ensure certification in his aircrew member qualification jacket and service record book.

5.4.5.4 NATOPS Evaluation. On assignment to another unit, an aircrewman will not be required to another unit, an aircrewman will not be required to receive a NATOPS evaluation if his service record indicates successful completion of the evaluation within the guidelines set forth in OPNAVINST 3710.7.

5.4.5.5 Aircrew Member Permanent Qualification Jacket. An aircrew member's permanent qualification jacket shall be established and maintained to reflect his previous designation completion of current qualifications and requirements.

5.4.5.6 Waivers. Unit commanders are authorized to waive, in writing, minimum flight and/or training requirements where authorized by OPNAVINST 3710.7.

5.4.6 AMCM Definitions.

5.4.6.1 Tow Time Definition. Since the mission of towing involves many separate evolutions from takeoff to landing, the following rules shall be followed when recording tow time.

5.4.6.2 Aircraft and Pilot Tow Time. Aircraft tow time and pilot tow time always be the same. It will be logged anytime there is tension on the helicopter, however slight, and regardless of the type of gear.

5.4.6.3 Operational Tow Time. Operational tow time shall be that tow time after which all streaming or transfer evolutions are completed and before any recovery or transfer evolutions are started.

5.4.6.4 Minefield Tow Time. Tow time in the minefield shall include any period or periods of time when the helicopter is logging operational tow time within the perimeters of a designated minefield.

PART III

NORMAL PROCEDURES

Chapter 6	Flight Preparation
Chapter 7	Shore-Based Procedures
Chapter 8	Shipboard Procedures
Chapter 9	Special Procedures
Chapter 10	Functional Checkflight Procedures

CHAPTER 6
Flight Preparation

6.1 MISSION PLANNING INTRODUCTION

Mission planning has two basic requirements. The first, that of preparation of planning documents for a future helicopter AMCM or support mission, is normally done from weather summaries and predictions in the desired area. All factors that contribute to successful mission accomplishment, such as weather, performance, terrain, tactical situations, etc., should be planned and documented before every flight. Additional information is normally contained in intelligence summaries and estimates. The second requirement is for pilots and operations personnel to calculate performance capabilities on a daily basis before every flight.

6.2 FACTORS AFFECTING HOVER PERFORMANCE

6.2.1 Density Altitude. Density altitude varies with atmospheric pressure, temperature, and humidity. As density altitude increases, the maximum gross weight at which hover or level flight can be maintained decreases.

6.2.2 Temperature. High outside air temperatures (OAT) have an adverse effect on the power output of gas turbine engines. An increase in OAT, at a constant pressure altitude, causes decreased engine performance.

6.2.3 Humidity. The effect of humidity is considered negligible in this helicopter.

6.2.4 Wind. Wind affects helicopter performance by producing translational lift. Therefore, less power is required to hover in a wind than under no wind conditions, or, using the same power, the helicopter can hover at a higher gross weight in winds. The relative wind generated by ships underway can be used to increase the hover performance of the helicopter, in the same way that running takeoffs are used ashore.

Note

At very low hovers the wind washes the ground effect from beneath the helicopter. Therefore, higher wind velocities are required at low AGL hovers than at higher AGL hovers before translational lift reduces the power needed. See the Torque Required to Hover Charts in Part XI.

6.2.5 Ground Effect. Ground effect will increase the lifting capability of the helicopter. A helicopter hovering close to the ground requires less power than a helicopter at the same gross weight hovering at a greater height.

6.2.6 AMCM Mission Planning. Under conditions of high helicopter gross weight and high density altitude, the helicopter may not have the ability to maintain AMCM tow altitude and rotor speed in the event of an engine failure. Flight operations for routine AMCM training, AMCM proficiency, and AMCM training exercises shall be conducted at reduced mission weights (fuel loading) such that in the event of an engine failure, a 40-foot hover can be maintained. Preflight mission planning to predict one engine inoperative (OEI) hover capability is discussed in Part XI, Chapter 20.

6.3 FACTORS AFFECTING RANGE AND ENDURANCE

6.3.1 Cruise Control. Fuel consumption may be minimized during cruise by proper selection of altitude, airspeed, rotor speed, and CG location.

6.3.2 Altitude. The decrease in OAT, associated with altitude increases, generally increases engine efficiency; however, the increased density altitude will decrease rotor efficiency. Overall helicopter/ engine performance, operational requirements, and weather should be considered when selecting a cruising altitude.

6.3.3 Minimum Altitude Navigation Flight. Minimum altitude navigation flights may be conducted for these reasons:

1. Special tactical requirements.

2. To train pilots in low level map reading navigation (without radio aids).

Note

Special care must be taken to avoid flying over populated areas, civilian airports, etc. Conformance with existing FAA Regulations and OPNAVINST is mandatory.

6.3.4 Weight and Balance. This helicopter is a class 2 helicopter for weight and balance purposes. The responsibility for safe loading of class 2 helicopters before requesting clearance is assigned to the operating activity. The requirement to attach a Form F to the flight clearance is waived when a current form is on file at the operating activity. Further information may be found in OPNAVINST 3710.7 and NAVAIR 01-1B-40. The aircraft commander is responsible for computing the CG location and gross weight of his assigned helicopter, and making sure that the maximum allowable limits are not exceeded.

6.3.4.1 Weight Definitions. See Figure 6-1.

6.3.4.2 Weight Empty. Weight empty is the weight of the helicopter structure plus powerplant, instruments, control system, hydraulic system, electrical system, communicating system, armament provisions (including gunfire protection), furnishings, anti-icing equipment, and auxiliary powerplant. It is a term used for design purposes, and usually does not affect service activities.

6.3.4.3 Basic Weight. The basic weight of a helicopter includes all fixed operating equipment and trapped fuel and oil, to which it is only necessary to add the variable or expendable load items for the various missions.

Note

The basic weight of a helicopter varies with structural modifications and changes in the fixed operating equipment. The term basic weight, when qualified with a word indicating the type of mission, such as basic weight for AMCM, may be used in conjunction with directives stating what the equipment shall be for these missions. For example, extra fuel tanks and various items of equipment installed for long range ferry flights which are not normally carried on AMCM missions shall be included in basic weight for ferry, but not in basic weight for combat.

6.3.4.4 Operating Weight. The operating weight of a helicopter is the basic weight plus those variable items which remain substantially constant for the type mission. The items include oil, crew, crew's baggage, emergency, and extra equipment that may be required.

Note

The operating weight of a transport helicopter is the weight of the helicopter including the crew and all equipment required for the mission, but not including fuel or payload.

6.3.4.5 Gross Weight. The gross weight is the total weight of a helicopter and its contents. The takeoff gross weight is the operating weight plus the variable and expendable load items which vary with the mission. These items include fuel, cargo, passengers, ammunition, and external auxiliary fuel tanks if to be jettisoned during flight. The landing gross weight is the takeoff gross weight minus the expended load items.

6.3.4.6 Footprint Weight. The distribution of weight on the landing gear (foot-print weight) is dependent on the CG loading of the helicopter.

At 46,500 pounds gross weight and a forward CG loading of 342.0 the nose gear load is 13,509 pounds or 117 psi and the footprint area is 116 square inches. Each main gear load is 16,495 pounds or 154 psi and the footprint area is 107 square inches.

At 46,500 pounds gross weight and an aft CG loading of 366.0 the nose gear load is 10,046 pounds or 117 psi and the footprint area is 86 square inches. Each main gear load is 18,202 pounds or 154 psi and the footprint area is 118 square inches.

At 69,750 pounds gross weight and a forward CG loading of 343.9 the nose gear load is 19,858 pounds or 117 psi and the footprint area is 170 square inches. Each main gear load is 24,946 pounds or 154 psi and the footprint area is 162 square inches.

At 69,750 pounds gross weight an aft CG loading of 359.0 the nose gear load is 16,638 pounds or 117 psi and the footprint area is 142 square inches. Each main gear load is 26,556 pounds or 154 psi and the footprint area is 173 square inches.

Note

Footprint weight versus the bearing capacity of decks, elevators, runways, taxiways, and parking areas should be considered.

6.3.5 Atmospheric - Power Conditions vs. Weight Limit. The relationship of lift capability to atmospheric conditions may impose a weight limit less than the maximum gross weight. Decreased helicopter performance caused by increased density altitude is reflected in the indicated torque required to hover in and out-of-ground effect figures in Part XI. While flight opera-

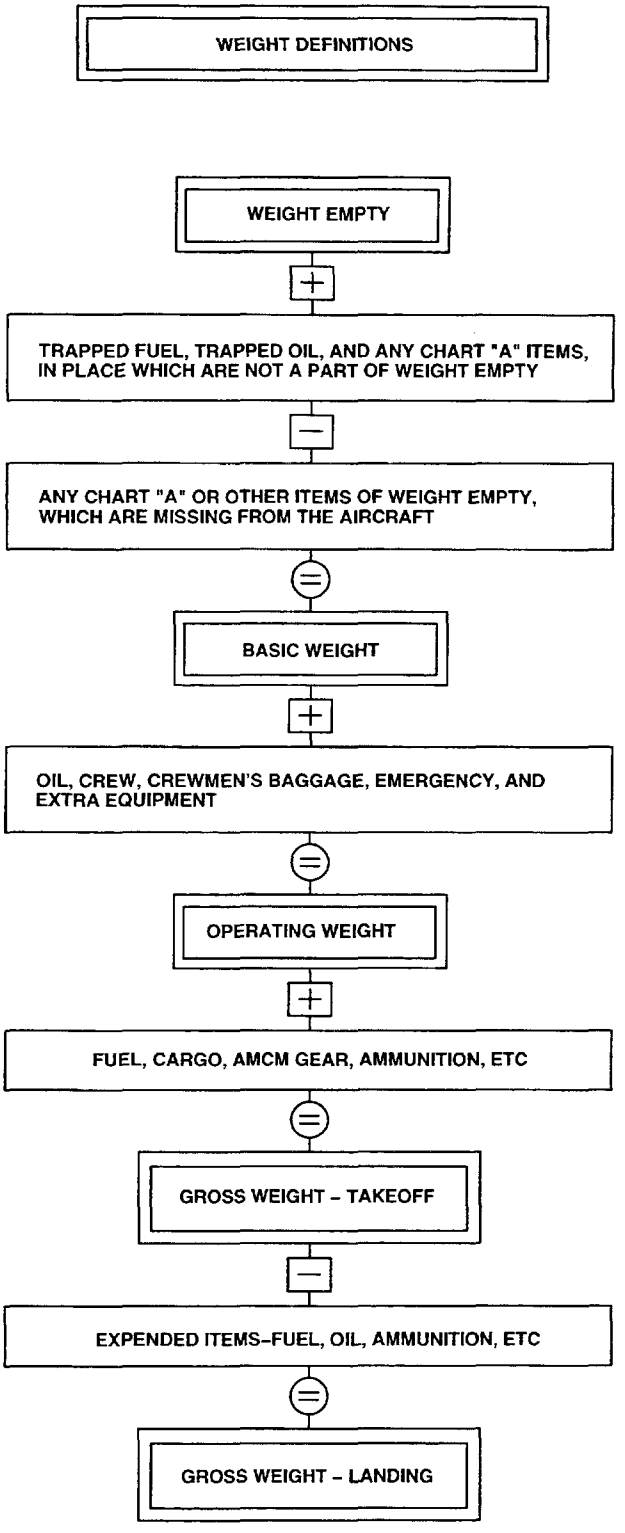


Figure 6-1. Weight Definition

tions based on the HIGE (hovering in-ground effect) limit will permit an increase in lift capability the HOGE (hovering out-of-ground effect) weight computations will be used for normal training operations. Exceptions to this will be when operational and service flights are made under favorable conditions which require carrying internal payloads at an altitude beyond the capability of the helicopter to HOGE. Roll-on landings and takeoffs will further increase payloads but require a smooth surface of sufficient length in an area free of obstacles. HOGE and HIGE altitudes should be computed for information before takeoff or landing in these circumstances. Flight operations, based on the atmospheric condition-power vs. weight limits found in the performance charts in Part XI, will ensure maximum usage and flexibility consistent with flight safety. When existing atmospheric conditions permit a weight lifting capability which is over the maximum gross weight (structural limit), the latter must be followed.

6.4 CARRIAGE OF CONVENTIONAL CARGO

Refer to NAVAIR A1-H53BE-CLG-000 (H-53 Cargo Loading Manual) for procedure to be followed for internal and external transport of selected cargo, including CG limits, floor loading and tiedown requirements.

6.5 CARRIAGE OF NUCLEAR CARGO

Refer to NAVAIR 01-230HMA-75 (H-53 Nuclear Cargo Loading Manual) for procedures to be followed for internal or external transport of nuclear cargo.

6.6 FERRY FLIGHTS

Ferry flights will be conducted in accordance with OPNAVINST 3710.7.

6.7 MISSION EQUIPMENT REQUIREMENTS

Refer to OPNAVINST 5442.4.

6.8 BRIEFING

An appropriate briefing guide will be used to conduct the required briefing. Each pilot will maintain a knee pad and record all flight numbers, call signs, and other data necessary to successfully assume the lead and complete the assigned mission.

6.8.1 General Mission Briefing Guide. The following applicable items should be briefed to all aircrew prior to each flight.

1. Flight/ Mission planning.

a. Basic mission profile.

b. Aircraft assignment.

(1) NAVFLIR/ manifest.

(2) Discrepancy book.

c. Pertinent times (manning, launch, stream, recovery, landing).

d. Weather.

(1) Local area.

(2) Forecast.

(3) Abort criteria.

e. Required flight gear and equipment:

(1) Personal (clothing, exposure suits, survival gear, ear plugs, dog tags, HEEDS bottle, etc.).

(2) Mission.

(a) First aid kits/ life rafts.

(b) Special equipment (SAR kit, VOD kit, external lift pendants, flares, etc.).

f. Preflight checks.

(1) Aircrew assistance on preflight.

(2) Hotseat procedures.

(3) Special loading requirements (cargo, troops, AMCM equipment, etc.).

2. General.

a. Aircrew coordination.

b. Operating areas.

c. Ramp operations.

d. Simulated emergencies.

e. ICS procedures (inflight, AMCM operations, hot-mike).

f. Mission abort criteria.

g. Hearing conservation precautions.

3. Taxi/ Takeoff/ Flight/ Landing.

a. Lookout assignments/ traffic reporting.

b. Seat belts/ crewman safety belt.

c. Cabin security checks.

4. Mission.

a. Familiarization/ tactics/ instruments.

(1) Flight maneuvers.

b. Functional Check Flight.

(1) FCF requirements.

c. Externals/ Logistics.

(1) Cargo/ personnel manifest.

(2) CG/ weight limitations.

(3) Internal cargo tiedown.

(4) Load hookup/ release/ grounding procedures.

(5) Emergency release/ jettison.

(6) Ground director/ LSE signals.

(7) Confined area operations.

d. SAR.

(1) Reference NWP 55–8 (SAR TACAID).

e. Formation.

(1) Flight maneuvers.

(2) Lookout doctrine.

(a) Lead changes.

(b) Inadvertent IMC.

(3) Visual signals.

(4) Emergencies.

f. Ship operations.

(1) Ship name/ type/ hull number.

(2) Mission scenario.

(3) Deck spotting.

(4) Flight deck procedures.

g. HIFR.

(1) Ship name/ type/ hull number.

(2) Deck spotting/ positions.

(3) Hookup/ refuel/ disconnect/ grounding.

(4) Hoist operations.

(5) Fuel leaks.

(6) Emergency breakaway.

h. HAR.

(1) Cabin configuration.

(2) Fuel leaks.

(3) Lookout assignments.

i. AMCM.

(1) Precise navigation system.

(2) MK-103.

(a) Configuration/ pendant length.

(b) Stream/ tow/ recovery.

(c) Tensions/ altitudes/ speeds.

(d) Air-to-air transfer.

(e) Grappling.

(3) MK-104/ MK-105/ MK-106/ SPU-1W.

(a) VERTREP of MOP.

(b) Stream/ tow/ recovery.

(c) Tensions/ altitudes/ speeds.

(d) MK-104 broach.

(e) Boom/ foils/ turbine/ exciter procedures.

(f) Air-to-air procedures.

(g) MK-105 refueling.

(h) MK-105 external operations.

(4) AQS-14/ ALQ-141.

(a) Stream/ tow/ recovery.

(b) Tensions/ altitudes/ speeds.

(c) Conning responsibilities.

(d) Device status reports.

(e) Broach/ bottom contact.

(5) 50 CAL procedures.

(a) Operating area.

(b) Stand-off range/ distance.

(c) Targets.

(d) Weapon safety/ malfunction.

5. Flight Crew Emergencies.

a. Forced landings/ ditching.

(1) Water landing.

(a) Controlled.

(b) Uncontrolled.

(c) Egress/ regroup.

(2) Unprepared sites.

(a) Controlled.

(b) Uncontrolled.

(c) Obstacle avoidance.

(d) Egress/ regroup.

b. Engine failure(s).

c. Flight control system malfunctions (including tail rotor).

d. Hydraulic malfunctions.

e. Fires.

(1) Reporting/ confirmation.

(2) Engine fire (on deck/ inflight).

(3) Cabin/ fuselage/ electrical (on deck/ inflight).

(4) Extinguisher use.

f. AMCM Emergencies.

(1) Utility 2 malfunctions/ failure.

(2) Streaming winch malfunctions/ failure.

(3) Runaway winch.

(4) Tension/ skew indication failure.

(5) Snagged gear.

(6) AQS-14/ ALQ-141 Emergencies; ramp/ davit.

(7) Fouled air to air transfer.

(8) Guillotines.

g. Injuries.

6. Postflight.

a. Hotpit/ hotseat/ water wash.

b. Post flight inspection.

c. Debrief.

6.8.2 Pilot/ Copilot Briefing Guide. The following items should be discussed by all pilots, as applicable, prior to each flight:

1. Flight/ Mission Planning.

a. Required equipment.

(1) NAVBAG/ fuel packet/ AMCM TACAID/ SAR TACAID.

b. Mission planning.

(1) Flight plan filing.

(2) Weather abort criteria.

(3) Mission planning form.

(4) AMCM/ OEI capability.

c. Seat assignments/ preflight responsibilities.

2. Start/ Taxi/ Takeoff/ Landing.

a. Checklists (ground/ inflight).

b. Copilot assistance.

(1) Backup scan (engine instruments/ flight instruments).

(2) IMC/ IFR approach.

c. Control switching.

d. Communications (IFR, VFR, AMCM).

e. Vertigo/ disorientation.

f. Lost communication.

3. Mission Profile.

a. Syllabus flight.

(1) Refer to syllabus training guide.

b. Familiarization/ tactics/ instruments.

(1) Flight maneuvers.

c. Externals/ logistics.

(1) Cargo/ passenger management.

(2) Special/ routine, loading.

d. AMCM.

(1) Copilot assistance.

(2) Stream/ tow/ recovery.

(3) Mission Data.

e. Formation.

(1) Flight leader and alternate.

(2) Inadvertent IMC.

(3) Lost communications.

f. Functional Check Flight.

(1) Copilot assistance.

(2) Profile.

g. Ship operations/ HIFR.

(1) Ship identification (hull number, deck edge height, obstructions, usable deck spots, etc.).

(2) Patterns/ altitudes.

(3) LSE signals.

(4) Waveoff.

(5) Bingo.

(6) Frequencies/ call signs/ PIM.

h. HAR.

(1) Operating altitudes/ airspeeds/ altimeter settings.

(2) Visual checkpoints/ positions.

(3) Rendezvous/ break up/ fuel transfer/ post-air refueling procedures.

(4) Lighting/ light signals.

(5) Hose marking.

(6) Probe malfunctions.

(7) Streaming fuel.

(8) Emergency breakaway.

(9) Inadvertent IMC.

4. Emergency Procedures.

a. Engine failure(s) (takeoff/ inflight/ AMCM/ landing).

b. Tail rotor malfunctions (takeoff/ inflight/ AMCM/ landing).

(1) Control.

(2) Drive.

c. AFCS.

(1) Mode failures.

(2) Computer malfunctions.

(3) Servo hardovers.

d. Electrical.

(1) Generators.

(2) Transformer/ rectifiers.

(3) Gyros.

e. Chip detector lights.

(1) Gearboxes.

(2) Engines.

f. Fire.

(1) Ground.

(2) Flight.

g. Hydraulics/ flight controls.

6.8.3 Aircrew Briefing Guide. This briefing guide will include the following items:

1. Station assignments.
    a. AMCM MK-103.
        (1) Safety observer.
        (2) Starboard rampman.
        (3) Port rampman.
        (4) Starboard handler.
        (5) Port handler.
        (6) Precise navigation operator.
    b. VOD (external/ internal).
    c. Utility.
    d. MK-104/ MK-105/ MOP.
        (1) Safety observer.
        (2) Rampman.
        (3) Handler/ MK-105 controller.
        (4) Precise navigation operator.
    e. AN/ AQS-14/ AN/ ALQ-141.
        (1) Safety observer.
        (2) Rampman.
        (3) Console operator.
        (4) Handler.
        (5) Precise navigation operator.
2. Pre-taxi.
    a. Pins/ chocks.
    b. Ramp and door.
    c. Crew alerted.
    d. Lookouts.
3. Flight.
    a. In flight security.
    b. Lookouts.
4. Emergency procedures.
    a. Fires ground/ air.
    b. Runaway winch.
    c. Winch failures.
    d. Guillotine.
    e. Bailout.
    f. Water landing.
    g. Snagged gear.
    h. Injuries.
    i. Davit.

6.8.4 Passenger Briefing Guide. This briefing guide will include the following items:

1. Helicopter side number.
2. Time of takeoff.
3. Time of arrival.
4. Safety regulations.
    a. Seat belts/ safety belts.
    b. Movement inside of helicopter.
    c. Smoking regulations.
5. Emergency procedures.
    a. Emergency exits.
    b. Fire on the ground.
    c. Fire in flight.
    d. Engine failure.
    e. Forced landing.
    f. Ditching.

g. Parachuting (as required).

6. Fitting and operating of life preserves, cranial helmets, and parachutes (as required).

7. Order of entering and leaving (as required).

6.9 DEBRIEFING

A proper debriefing conducted under tactical or training conditions is an important part of a flight. Under tactical conditions, debriefing is a primary source of information leading to the location of targets, distribution of troops, and many other important considerations. An outline should be followed for proper debriefing and should contain all the items for briefing, plus the following:

1. All unusual circumstances encountered.

2. Discrepancies arising which do not conform to an established doctrine.

3. Following an AMCM flight, the mission commander is required to debrief the crew on procedures and unusual circumstances encountered. This is to improve crew coordination and gain information which can be used for more effective procedures.

4. The mission commander on an AMCM flight is also responsible for completing an AMCM tactical brief form with the following information:

a. Mine detonation itinerary.

b. Total flight time.

c. Total tow time.

d. Total operational tow time.

e. Total time in field.

f. Total laps by track.

g. Total mines detonated.

h. Additional remarks (detailed information pertaining to AMCM equipment malfunction and unusual circumstances encountered).

A proper debriefing should contain constructive criticism and be conducted in such a manner that all concerned can participate and present their ideas on the conduct of the flight.

CHAPTER 7
Shore-Based Procedures

7.1 PREFLIGHT INSPECTION

The pilot shall not accept the helicopter for flight until assured that the helicopter is satisfactory for safe flight and mission accomplishment. The two major steps to be taken before acceptance of the helicopter are a careful examination of the helicopter's recent discrepancies and a thorough preflight inspection. For his information, the pilot shall review at least the last ten flights and all associated maintenance discrepancy forms in accordance with OPNAVINST 3710.7. Any additional discrepancies shall be brought to the attention of the pilot. The aircraft commander shall ensure that a standard Daily/Turnaround Inspection as set forth in A1-H53ME-MRC-200/A1-H53ME-MRC-100 has been conducted, and that the signature of the plane captain appears on the acceptance sheet. When satisfied with the acceptance sheet information, the aircraft commander shall sign for acceptance of the aircraft. The preflight inspection shall consist of an exterior inspection (which includes items on the exterior of the helicopter that contribute to safety of flight, reference Figure 7-1) and an interior inspection. The interior inspection shall include the presence of equipment, positioning of switches, and reading of indicators. In so far as possible, switches shall be positioned as required for engine starting. When the helicopter is flown by the same crew in regularly scheduled airline-type operations, or when assigned tactical or administrative missions requiring intermediate stops, it is not necessary to perform all preflight checks. Those items that are required to be done on a through-flight inspection will be preceded by an asterisk. The copilot and aircrewman will assist the pilot in doing a preflight inspection.

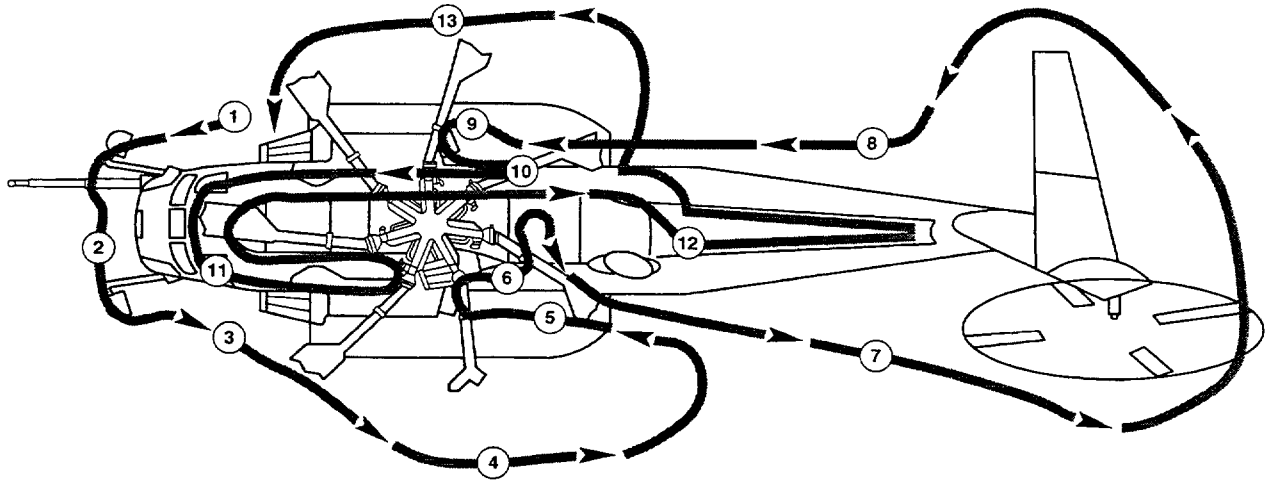
Note

All listed items shall be checked for condition, security, leakage when applicable, and specifically as indicated.

7.1.1 Before Exterior Inspection

1. Aircraft forms and flight publications — CHECKED.

2. Fuel samples — CHECKED.



HM1345
SA

Figure 7-1. Exterior Inspection Diagram

3. Chocks — IN PLACE.

4. Fire extinguisher — POSITIONED OUTSIDE HELICOPTER.

5. Weapons safety check — GUNS SAFETIED AND STOWED.

6. Passengers — BRIEFED.

Refer to Chapter 6.

7.1.2 Exterior Inspection. See Figure 7-1.

CAUTION

For overwater flights make sure all drain plugs are installed for maximum watertight integrity.

Note

Only those items marked * are required on through-flight inspection. Those items marked ** may be omitted with EAPS installed except before the first flight of the day, or if maintenance has been done.

1. Right Front Fuselage.

   a. Upper personnel door emergency release handle — SECURE.

   b. Personnel door — SECURE AND FREE OF DAMAGE.

   *c. Rescue hoist and light — SECURE, UNDAMAGED, AND FREE OF LEAKS.

   d. External power receptacle cover — CLOSED AND SECURE.

   e. Pilot's window emergency release handle — SECURE.

   f. External ICS cover — CLOSED.

   g. Electronics compartment.

      (1) Check control bellcranks and tubing secure and free.

      (2) Fuel probe solenoid secure.

      (3) Check avionics gear.

         (a) AHRS synchro transformers.

         (b) Radar beacon (Removed by AFC 501, Part 3).

         (c) RAD ALT test switch at FLT.

         (d) No. 2 AFCS computer.

         (e) GPWS relay panel.

      (4) Closed and secure.

WARNING

An unsecured compartment door support strut could jam the roll and/or directional bellcrank (even with the refuel probe installed). Extreme care must be taken to ensure that the support struts are tightly secured by the retaining clips.

   *h. Refueling probe — SECURITY, WIRING INTEGRITY, AND FREE OF LEAKS AND DAMAGE.

   i. Fuselage — FREE OF DAMAGE, DENTS, AND CRACKS.

   j. Probe light — CLEAN AND SECURE.

   k. Spotlight — CLEAN AND SECURE.

   l. Landing light — CLEAN AND SECURE.

   m. Antennas — CLEAN, SECURE, AND UNDAMAGED.

2. Front Fuselage.

   a. Nose access door.

      (1) Control pedals free and clear.

      (2) Check wiring secure.

      (3) Check avionics gear.

(a) Turn rate gyros.

(b) Air-to-air refueling relay panel.

(c) UHF-DF group.

(d) VOR/ILS.

(e) Navigation relay unit.

(4) Closed and secure.

*b. Nose gear — SAFETY PIN INSTALLED, DOWN AND LOCKED INDICATION, UNDAMAGED, CLEAN, PROPERLY INFLATED, FLUID INDICATING PIN FLUSH AND NOT EXTENDED, AND CO-ROTATING VISCOUS DAMPER SETSCREWS SECURE AND UNDAMAGED.

*c. Nosewheels and tires — UNDAMAGED, AND TIRES PROPERLY INFLATED AND FREE OF CUTS AND BLISTERS.

*d. Nose gear well — UNDAMAGED AND FREE OF HYDRAULIC LEAKS.

*e. Nose gear door — SECURE AND UNDAMAGED, DOOR EXTENSION ASSEMBLY FREE OF NICKS OR DAMAGE.

f. Landing gear down light — CLEAN AND SECURE.

g. All protective covers — REMOVED.

h. Windshields and glass — CLEAN AND UNDAMAGED.

i. ILS glide slope antenna — SECURE AND UNDAMAGED.

3. Left Front Fuselage.

a. Landing light — CLEAN AND SECURE.

b. Spotlight — CLEAN AND SECURE.

c. Anticollision light — CLEAN AND SECURE.

d. Antennas — CLEAN, SECURE, AND UNDAMAGED.

e. Electronics compartment.

(1) Check control bellcranks and tubing secure and free.

(2) Check avionics gear.

(a) Rate switching gyro for vertical gyro.

(b) Vertical gyro power failure detector.

(c) Landing gear warning amplifier.

(d) LF/ADF.

(e) IFF/transponder.

(f) HF/COMM.

(g) IFF/transponder test set.

(h) No. 1 AFCS computer.

(i) TACAN.

(j) Vertical gyro (1080Y).

(k) Air data transducer (Removed by AFC 501, Part 3).

(l) Dimming controls.

(m) GPWS processor (after AFC 501, Part 3).

(n) Air data computer (after AFC 501, Part 3).

(3) Closed and secure.

f. Copilot's window emergency release handle — SECURE.

g. Escape hatch emergency release handle — SECURE.

h. Engine water wash door — SECURE.

i. Fueling panel — SECURE AND CHECK POSITION OF PRECHECK VALVES.

j. Fire extinguisher discharge plugs — INTACT.

k. Sponson position light — CLEAN AND UNDAMAGED.

*l. Fuselage — FREE OF DAMAGE, DENTS, AND CRACKS.

4. Left Side Fuselage.

a. Forward fuel cell drain valve, diverter strap cover/fastener — SECURE
(On aircraft modified by AFC 443.)

b. Aft fuel cell drain valve, diverter strap cover/fastener — SECURE.
(On aircraft modified by AFC 443.)

c. Landing gear well — GEAR PIN INSTALLED, DOWN AND LOCKED INDICATION, UNDAMAGED AND FREE OF LEAKS, AND FLUID INDICATING PIN FLUSH AND NOT EXTENDED.

d. Landing gear strut — UNDAMAGED, CLEAN, AND PROPERLY INFLATED.

*e. Wheels, brake disc, brake lines, and housing — UNDAMAGED.

f. Scissors switch — SECURE.

*g. Tires — PROPERLY INFLATED, AND FREE OF CUTS AND BLISTERS.

*h. Grounding drag wire — SECURE AND CHECK GROUND CONTACT.

i. Check fuel dump line and mounting clamps — SECURE.

*j. Sponson and fuselage — FREE OF DAMAGE, DENTS, AND CRACKS.

5. Left Side Fuselage (Upper Sponson).

a. No. 1 engine tail pipe EGR nozzle — SECURE, FREE OF DAMAGE AND OBSTRUCTIONS.

b. Engine — SECURE, FREE OF LEAKS, AND NO HOT SPOTS OR BULGES.

**c. EAPS — CLEAN AND FREE OF FOD (DURING COLD WEATHER REFER TO COLD WEATHER OPERATIONS SECTION).

d. EAPS rear support — FREE OF CRACKS.

**e. Nose gear box — LEAKAGE, SECURITY OF CHIP DETECTOR.

**f. Engine intake — FREE OF FOD.

g. Engine nacelle — SECURE.

h. Engine fuel filter — FILTER BUTTON IN.

i. Engine fire detection sensors — CLEAN AND UNDAMAGED.

j. Engine isolators — SECURE AND WITHIN LIMITS.

k. Engine cowling — FOR DAMAGE AND OBSTRUCTIONS.

l. Main fuel tank filler caps — SECURE.

6. No. 2 Engine Platform — OPEN.

**a. Intake — CLEAR.

b. EAPS — SECURE, CLEAN, AND FREE OF FOD.

c. Main rotor head, left side aft.

*(1) Dampers — UNDAMAGED AND RETAINER IN PLACE, FREE OF LEAKS.

*(2) Pitch rods — CHECK PLAY, BOLT HEADS DIRECTION OF ROTATION.

(3) Droop stops — IN.

(4) Flap restrainers — CLEAN AND FREE.

*(5) Sleeve and spindles — RESERVOIRS SERVICED AND FREE OF LEAKS.

*(6) Vertical hinge pin — RESERVOIRS SERVICED AND FREE OF LEAKS.

(7) Beanie ring — SECURE.

(8) Pitch locks — NOTE ENGAGED OR DISENGAGED.

(9) Blade lockpins — SEATED.

(10) Spar pressure indicators — COVERS REMOVED. ALL INDICATORS WHITE.

WARNING

- The spar pressure indicator contains Strontium 90, a beta ray radiation source. Procedures outlined here shall be followed to avoid exposure beyond limits allowed by the Nuclear Regulatory Commission. Keep eyes at least 24 inches from any indicator which does not have a test/shipping cover secured in place. The cover shall be secured in place when any black color shows on the indicator, or before testing, or if it is necessary to work with eyes less than 24 inches from the indicator.

- Black indicates an unsafe spar/indicator condition and the rotor shall not be turned up.

CAUTION

- Do not use IBIS indicator as a hand-hold. Any bending or side load put on indicator or installed protective cover will seriously damage indicator. Before each indicator is tested, turn main rotor so indicator is easy to read.

- When resetting indicator, press, do not strike or use excessive force on protective cover, as it may make indicator inoperative.

Note

Under the special condition where the helicopter is kept in a warm hangar and it is rolled out into cold ambient conditions, the spar pressure indicators may erroneously trip due to differential warming of the gas in the indicator's bellows and the gas in the spar. In this case it is permissible to reset the pressure indicator(s) one time only.

(a) Place the test/shipping cover over the pressure indicator and lock the retaining chain to the lockwire at the indicator's base. Allow 0.5-inch space above the indicator to allow reset button to pop out.

(b) Press and hold test button. Do not place hand on indicator's body, as heat of hand may change internal reference pressure and cause erroneous readings.

(c) Reset button must pop out and a full-black (unsafe) indication appear within 60 seconds. When the button is released, the full black indication will remain.

WARNING

When the test button is pressed, a full black indication should be displayed. If not, the helicopter shall not be flown. At temperatures below -31°C, a full black indication may not be obtained.

Note

If checking indicator below -6°C, the indicator may not operate normally.

(d) Press test/shipping cover firmly against reset button until shaft is fully retracted and color bands return to white. Reset button must latch in this position.

WARNING

Do not remove test/shipping cover if reset button does not latch or any black color shows.

(e) Remove test/shipping cover.

(11) Swashplate and scissors — SECURE, UNDAMAGED, AND NO FOD.

(12) Main rotor blades — UNDAMAGED.

(13) Damper accumulator gage — CHARGED.

d. Formation lights — CLEAN AND UNDAMAGED.

e. No. 2 engine.

(1) Engine — SECURE, FREE OF LEAKS, AND NO HOT SPOTS OR BULGES.

(2) Engine fuel filter — FILTER BUTTON IN.

(3) Engine fire detector sensors — CLEAN AND UNDAMAGED.

(4) Engine isolators — SECURE AND WITHIN LIMITS.

(5) Engine cowling — FREE OF DAMAGE AND OBSTRUCTION.

(6) Tail pipe — FREE OF DAMAGE AND OBSTRUCTION.

7. Left Rear Fuselage.

a. COMM 1 antenna — SECURE AND UNDAMAGED.

b. Hover light — CLEAN AND UNDAMAGED.

*c. Pylon and aft fuselage — UNDAMAGED.

d. ALE dispenser pod — SECURE AND SAFETIED.

e. Ramp and door — SECURE AND UNDAMAGED.

f. VOR/ILS localizer antenna — SECURE AND UNDAMAGED.

g. Pylon lockpin and flags — IN.

h. Tail skid — SECURE AND UNDAMAGED.

*i. Tail rotor and intermediate gear box oil levels — SERVICED.

j. Tail rotor blades — UNDAMAGED.

k. Tail rotor pitch change links — SECURE, LOCKWIRED, AND BOLTS ALIGNED.

*l. Tail rotor hub — UNDAMAGED AND FREE OF LEAKS.

m. Tail rotor hub reservoir — SERVICED.

n. Tail rotor positioner — RETRACTED.

o. Pylon position light — CLEAN AND UNDAMAGED.

*p. If the tail rotor pylon is folded — ENSURE THE MAIN ROTOR HEAD IS POSITIONED TO PLACE A MAIN ROTOR BLADE AT THE 5:30 to 6:00 POSITION OF THE AIRCRAFT.

CAUTION

If pylon was spread manually, tail rotor positioner may be extended. With positioner extended, movement of main rotor will damage positioner actuator.

8. Right Rear Fuselage.

a. Stabilizer — SECURE AND UNDAMAGED.

b. Inspection panels — SECURE.

c. Pylon hinges — SECURE AND UNDAMAGED.

d. Pylon and fuselage skin — UNDAMAGED.

e. VOR/ILS Localizer antenna — SECURE AND UNDAMAGED.

f. ALE dispenser pod — SECURE AND SAFETIED.

g. HF antenna — SECURE AND UNDAMAGED.

9. Right Side (Upper Sponson).

a. No. 3 engine tail pipe EGR nozzle — FREE OF DAMAGE AND OBSTRUCTIONS.

b. No. 3 engine — SECURE, FREE OF LEAKS, AND NO HOT SPOTS OR BULGES.

**c. EAPS — CLEAN AND FREE OF FOD (DURING COLD WEATHER REFER TO COLD WEATHER OPERATIONS SECTION).

**d. Nose gear box — NO LEAKAGE AND SECURITY OF CHIP DETECTOR.

*e. Engine intake — FREE OF FOD.

f. Engine fuel filter — FILTER BUTTON IN.

g. Engine fire detector sensors — CLEAN AND UNDAMAGED.

h. Engine isolators — SECURE WITHIN LIMITS.

*i. Engine cowling — NO DAMAGE OR OBSTRUCTIONS.

*j. Main fuel tank filler caps — SECURE.

10. Right Side Upper Fuselage.

a. Rotor brake and manifold — SERVICED AND SECURE.

b. Main transmission oil cooler (and No. 2 engine oil cooler on 416/416A engine installations) — CLEAN, SECURE, AND FREE OF LEAKS.

c. Utility 2 heat exchanger inlet duct — FREE OF OBSTRUCTIONS.

*d. First stage hydraulic reservoir — PROPER SERVICE AND FREE OF LEAKS.

e. First stage filter — TWO FILTER BUTTONS IN AND FREE OF LEAKS.

f. IBIS detector — CLEAN AND SECURE.

g. Tail rotor drive shaft — SECURE AND NO FOD.

h. Rotor brake assembly — SECURE AND FREE OF LEAKS.

i. Gust lock — AS DESIRED.

j. Main gear box filter buttons (2) — IN.

k. Main transmission fire detector sensors (419 engine only) — CLEAN AND UNDAMAGED.

l. Access panels — SECURE.

m. Control rods — UNDAMAGED, COTTER-KEYED, AND ROD END PLAY.

n. All bellcranks — SECURITY AND PLAY.

*o. Main transmission — UNDAMAGED, NO LEAKAGE, AND MOUNT BOLTS.

p. Main transmission oil level — CHECKED.

q. Utility 2 filter buttons (3) — IN.

*r. Forward and lateral primary servos — FREE OF LEAKS, LOCKWIRED, AND SECURE.

s. Servo centering springs — SHEARPIN SECURE AND DOES NOT PIVOT.

t. No. 3 engine input shaft and Thomas coupling — UNDAMAGED.

u. Flight control mixing unit — UNDAMAGED AND COTTER-KEYED, YAW BREAKAWAY ROD SHEARPIN.

*v. Transmission deck — FREE OF LEAKS AND SPILLAGE.

w. Accessory gear box oil level — CHECKED.

x. Swashplate and scissors — SECURE, UNDAMAGED, AND NO FOD.

y. Main rotor head, right side.

*(1) Dampers — UNDAMAGED, RETAINER IN PLACE, AND FREE OF LEAKS.

*(2) Pitch rods — CHECK PLAY AND BOLT HEADS DIRECTION OF ROTATION.

(3) Droop stops — IN.

(4) Flap restrainers — CLEAN AND FREE.

*(5) Sleeve and spindles — RESERVOIRS SERVICED AND FREE OF LEAKS.

*(6) Vertical hinge pin — RESERVOIRS SERVICED AND FREE OF LEAKS.

(7) Beanie ring — SECURE.

(8) Pitch locks — NOTE ENGAGED OR DISENGAGED.

(9) Blade lockpins — SEATED.

(10) Spar pressure indicators — COVERS REMOVED. ALL INDICATORS WHITE. See 6.c. (10) for WARNINGS and NOTES.

(11) Swashplate and scissors — SECURE, UNDAMAGED, AND NO FOD.

(12) Main rotor blades — UNDAMAGED.

(13) Spar pressure radiation detector — SECURE AND WINDOW CLEAN.

z. Formation lights — CLEAN AND UNDAMAGED.

aa. No. 3 engine.

(1) Input drive shaft and cowling — SECURE.

(2) Oil cooler fan belts — SECURE AND NOT FRAYED, TENSION.

(3) Blower fan — UNDAMAGED.

**(4) Nose gear box oil level — SERVICED.

**(5) Intake — CLEAR.

(6) Nose gear box cowling and EAPS — SECURE AND UNDAMAGED.

ab. Accessory gear box section.

(1) Flight control mixing unit — SECURE AND NO FOD.

(2) Deck — FREE OF SPILLAGE AND FOD.

(3) Second stage reservoir — PROPERLY SERVICED AND FREE OF LEAKS.

(4) All hydraulic lines — SECURE.

(5) Second stage filter — TWO FILTER BUTTONS IN AND FREE OF LEAKS.

(6) Second stage heat exchanger inlet duct — FREE OF OBSTRUCTION.

(7) Generators and pumps — SECURE AND FREE OF LEAKS.

(8) Clutch assembly — FREE OF LEAKS.

(9) Engine and APP fire bottles — PROPER PRESSURE.

(10) Engine start hydraulic system filter — TWO FILTER BUTTONS IN AND FREE OF LEAKS.

ac. Main rotor head (top front).

*(1) Damper hydraulic accumulator pin indicator — PROPERLY SERVICED. (Must be checked with blades spread.)

(2) Beanie ring — SECURE.

(3) Dampers — UNDAMAGED, RETAINER IN PLACE, AND NO LEAKS.

(4) Main rotor blades — UNDAMAGED.

(5) Sliding doghouse — CLOSED AND SECURE.

ad. APP compartment.

(1) All lines and hoses — FREE OF LEAKS.

(2) APP air inlet duct — CLEAR.

(3) Exhaust pipe — SECURE.

(4) Combustion section — NO HOT SPOTS OR BULGES.

(5) Forward supports and aft struts — SECURE.

(6) APP fuel pump, starter motor, and fuel control — FREE OF LEAKS AND SECURE.

(7) APP oil level — CHECKED.

(8) APP bleed-air reservoir — SECURE.

(9) APP compartment — CLOSED AND SECURE.

CAUTION

Operation of the APP with the folding cover open can result in heat damage to the main rotor blades. If folding cover must be open, position main rotor blades away from APP exhaust.

(10) APP and heater exhaust — CLEAR OF OBSTRUCTIONS.

ae. UHF antenna — SECURE AND UNDAMAGED.

11. Upper Left Side.

a. No. 1 engine.

(1) Nose gear box cowling and EAPS — SECURE AND UNDAMAGED.

(2) Intake — CLEAR.

(3) Nose gear box oil level — SERVICED.

(4) Blower fan — UNDAMAGED.

(5) Oil cooler fan belts — SECURE AND NOT FRAYED, TENSION.

(6) Input drive shaft and cowling — SECURE.

b. Utility 1 filter — TWO FILTER BUTTONS IN AND FREE OF LEAKS.

c. Utility module landing gear emergency extension valve indicator pin — IN.

d. Utility 1 and 2 hydraulic reservoirs — PROPERLY SERVICED AND FREE OF LEAKS.

e. Utility 1 heat exchanger inlet duct — FREE OF OBSTRUCTION.

f. Main rotor head, left side.

*(1) Dampers — UNDAMAGED, RETAINER IN PLACE, AND FREE OF LEAKS.

*(2) Pitch rods — CHECK PLAY AND BOLT HEAD DIRECTION OF ROTATION.

(3) Droop stops — IN.

(4) Flap restrainers — CLEAN AND FREE. RESERVOIRS SERVICED AND FREE OF LEAKS.

*(5) Sleeve and spindles — RESERVOIRS SERVICED AND FREE OF LEAKS.

*(6) Vertical hinge pin — RESERVOIRS SERVICED AND FREE OF LEAKS.

(7) Beanie ring — SECURE.

(8) Pitch locks — NOTE ENGAGED OR DISENGAGED.

(9) Blade lockpins — SEATED.

(10) Spar pressure indicators — COVERS REMOVED. ALL INDICATORS WHITE. See 6.c. (10) for WARNINGS and NOTES.

(11) Swashplate and scissors — SECURE, UNDAMAGED, AND NO FOD.

(12) Main rotor blades — UNDAMAGED.

*g. Main transmission — UNDAMAGED, NO LEAKS, AND MOUNT BOLTS.

*h. Aft primary servo — FREE OF LEAKS, LOCKWIRED AND SECURE.

i. Servo centering spring — SHEARPIN SECURE AND DOES NOT PIVOT.

j. Control rods — UNDAMAGED, COTTERKEYED, AND ROD END PLAY.

k. All bellcranks — SECURITY AND PLAY.

l. Main transmission — UNDAMAGED, NO LEAKS, AND MOUNT BOLTS.

*m. Transmission deck — FREE OF SPILLAGE.

n. No. 2 engine EAPS — SECURE AND UNDAMAGED.

o. Access and servicing panels — SECURE AND UNDAMAGED.

12. Upper Rear Transition Section and Pylon.

a. Fuselage, tail rotor drive shaft cowlings, and pylon — FREE OF DENTS, CRACKS, WRINKLES, AND SECURE.

b. Formation lights — CLEAN AND UNDAMAGED.

c. Antennas — SECURE.

d. Pylon lockpin and flag — IN AND SEATED.

e. Tail rotor — PITCH LINKS LOCKWIRED, FREE OF LEAKS, AND BOLTS LINED UP.

f. Stabilizer and strut — FREE OF DISTORTION, CRACKS, STRESS, AND NO POPPED RIVETS.

13. Right Side Fuselage.

a. Check fuel dump line and mounting clamps — SECURE.

b. Landing gear well — GEAR PIN INSTALLED, DOWN AND LOCKED INDICATION, UNDAMAGED AND FREE OF LEAKS, AND FLUID INDICATING PIN FLUSH AND NOT EXTENDED.

c. Landing gear strut — UNDAMAGED, CLEAN, AND PROPERLY INFLATED.

*d. Wheels, brake disc, brake lines, and housing — UNDAMAGED.

e. Scissors switch — SECURE.

*f. Tires — FREE OF CUTS, BLISTERS, AND PROPERLY INFLATED.

g. Sponson position light — SECURE.

h. Aft fuel cell drain valve, diverter strap cover/fastener — SECURE.
(On aircraft modified by AFC 443.)

i. Forward fuel cell drain valve, diverter strap cover/fastener — SECURE.
(On aircraft modified by AFC 443.)

*j. Sponson and fuselage — FREE OF DAMAGE, DENTS, AND CRACKS, AND ALL BILGE COMPARTMENT DRAIN PLUGS INSTALLED.

k. Precise navigation antenna (if installed) — SECURE AND UNDAMAGED.

7.1.3 Post Exterior Inspection

1. Covers, plugs, and all tiedowns — REMOVED.

2. All access panels — SECURE.

3. EAPS — SECURE.

4. Blades — CONDITION.

5. Tools — ACCOUNTED FOR.

7.1.4 Interior Inspection

7.1.4.1 Items for Basic Configuration

1. First crewman's exposure suit blower — OFF.

2. Portable fire extinguisher — SECURE AND CHECK SEAL.

3. Circuit breaker panels — CHECK.

4. AFCS servo compartment — SECURITY, FOD, LEAKS, FAS SHEAR PIN INTEGRITY, SERVO VALVE ADJUSTMENT SLIPPAGE MARKS.

WARNING

Do not fly helicopter if slippage marks are missing or show any indication of adjustment screw movement.

5. First aid kit — COMPLETE AND SECURE.

6. Jump seat — STOW.

7. Cargo winch — SECURE AND FREE OF LEAKS.

8. Speech security system (KY-58).

9. ALE-39 programmer — PROGRAMMED.

10. Countermeasures override switch — OFF.

11. Wiggins fitting — COVERED, UNDAMAGED, AND NO LEAKS.

12. HIFR filter canister — NO LEAKS.

13. Emergency escape hatches — SECURE AND ACCESSIBLE.

14. Emergency lights — SECURE AND ACCESSIBLE.

15. Landing gear emergency blowdown bottle — SECURE AND CHARGED (2500 to 3000 psi).

16. Hydraulic refill tank and pump — SECURE, NO LEAKS, AND QUANTITY.

17. LOX Fitting — PLUG INSTALLED.

18. Cargo hook doors — AS REQUIRED.

19. Gust lock — AS DESIRED.

20. Doppler well — INTEGRITY AND SECURITY.

21. Crewman's ramp control handle — CENTERED.

22. Davit control:

    a. Handle — CENTER.

    b. Manual override — CENTER.

    c. Switch — OFF.

23. Ramp door — UNRESTRICTED.

24. Aft transition section — INSPECT.

25. Cargo ramp release levers and ramp door override valve — AS DESIRED.

26. Rotor brake manual override handle — AS DESIRED.

27. Raft — SECURE, NO TEARS, CLEAN, INSPECTION DATE.

28. Fuel handpump — SECURE AND NO LEAKS.

29. Auxiliary oil tank — SECURE, QUANTITY, NO LEAKS.

30. Hoist shear circuit test switch position — FIRE/COVER CLOSED.

31. Hoist cable shear switch — OFF AND SHEAR-WIRED.

32. Hoist light switch — OFF.

33. APP/pylon fold handpump — SECURE, NO LEAKS, AND HANDLE STOWED.

34. APP accumulator selector handle — AS DESIRED.

35. Hover control — SECURE.

36. Both APP accumulator pressure gages — 3000 PSI MINIMUM.

7.1.4.2 Items for Specific Mission Configurations

1. Range extension tanks, control panel, and harness — SERVICED, SECURE, NO DAMAGE OR LEAKS, AND FUEL SELECTOR IN MAIN TANK POSITION.

2. Precise navigation pallet — SECURE.

3. Precise navigation antenna control panel — INSTALLED AND SECURE.

4. Cargo — SECURE.

5. Seat pallets — SECURE.

6. Single-point cargo hook.

    a. A-frame, tube, links — WEAR, CORROSION, CRACKS, AND SECURE AT ATTACHMENT POINTS.

    b. Pendant cover — BREAKS, CHAFING, DETERIORATION.

    c. Pip pins — WEAR AND CORROSION.

    d. Electrical connection at hook and explosive separator — SECURE.

    e. Winch and lifting line — WEAR AND CORROSION.

    f. Mechanical release — TURN MANUAL RELEASE KNOB CLOCKWISE AND PULL ON LOAD BEAM. USING INSPECTION PORT, VERIFY THE SPRING LOADED RELEASE MECHANISM RETURNS TO SAFE AND

LATCHED POSITION. ENSURE MANUAL RELEASE KNOB RETURNS TO SPRING LOADED POSITION.

g. Note the I. D. plate for serial numbers modified with suffix A.

7. Tow boom — STOWED AND SECURE.

8. Streaming winch guillotines — INSTALLED AND SWITCH IN FIRE POSITION.

9. AMCM equipment — INSTALLED, SECURED, AND COMPLETE.

10. Safety cables — ATTACHED TO PANEL AND STOPS IN PLACE.

11. Towed vehicle refuel switches — OFF.

12. Flare stowage rack — SECURE.

13. Stowage box — SECURE AND LATCHED.

7.2 PRESTART

7.2.1 Consoles

*1. Seat belts and harness — ADJUSTED.

2. VLEA control dial — SET.
(Helicopters modified by crash-attenuating seats.)

*3. Seat cushion and exposure suit blower switch — OFF.

4. Cockpit window emergency release handles — SECURE/SHEARWIRED.

5. ICS and radio control panels — SET.

6. Gear handle and downlock release — DOWN, SET.

7. Emergency gear handle — SHEARWIRED.

8. Emergency cargo release handle — DOWN.

*9. Parking brake — SET.

*10. COMM and NAV set — OFF.

11. MCM tow panel — OFF.

*12. Emergency control panel switches — OFF AND COVERED.

13. ALE control panels — SAFE AND OFF.

*14. Servo switches — CENTER.

7.2.2 Copilot's Overhead Panel

1. Switches — AS DESIRED AND COMM 1 ANTENNA IN AUTO/RETRACT.

7.2.3 Pilot's Overhead Panel

1. Switches — AS DESIRED.

2. Pitch locks — AS REQUIRED.

a. Blades spread — DISENGAGED.

b. Blades folded — ENGAGED.

7.2.4 Overhead Control Panel

*1. Engine speed controls — SHUTOFF.

*2. Emergency start panel — NORM, NORM, AND OFF.

*3. Engine fire T-handles — FORWARD.

*4. Fuel select levers — CROSSFEED, 2-1-2.

5. AHRS — SLAVED.

6. Radar beacon — OFF.

7. FAS switch — COVERED.

8. Utility 2 pump — OFF.

*9. Emergency circuit breaker panel — CHECK.

10. Hoist control panel switches — OFF.

11. Cargo loading panel switches — OFF/HOLD.

12. Windshield wiper/washer — OFF.

13. Cabin heater and vent blower — OFF.

14. Cargo hook control panel switches — OFF.

15. EAPS switches — AS DESIRED.

*16. High-pressure rotor brake switch — EMER.

17. Rotor head light — OFF.

*18. Generators — OFF.

19. Engine overspeed test switches — OFF.

*20. Anti-ice panel switches — OFF.

*21. Fire guard — POSTED.

*22. Main rotor head position — MAIN ROTOR BLADE AT 5:30 to 6:00 POSITION (PYLON FOLDED).

*23. APP-CHECK AND START.

CAUTION

Restarting of APP before 2-minute wait may cause a hot start.

a. Emergency T-handle — FWD.

b. Automatic shutdown circuit breakers — SET.

c. Circuit breaker control switch — ON.

d. APP control lever — START.

Hold lever in start position until clutch engagement. Light off should occur at about 20% rpm. Clutch starts to engage at 92% rpm. Complete engagement should occur at 100% rpm.

Note

- Before reaching 92% rpm, the only automatic shutdown protection available is high exhaust temperature. After 92% rpm, overspeed and low oil pressure will also be available.
- Following APP start, engine start hydraulic system may chatter. This chatter may be eliminated by placing emergency start switch to EMER, and actuating engine starter, after generators are on.
- With certain airflow directions and velocities across the airframe the APP may not start. Consideration should be given to changing the helicopter position.

e. APP ON advisory light — ON.

f. APP rpm — CHECK.

CAUTION

Any time an APP start is not completed, abort the start by placing the APP control lever to SHUTOFF and placing the circuit breaker control switch to OFF. An APP start shall be aborted whenever (1) acceleration hangs up for more than 4 seconds, (2) there is no RPM indication, (3) exhaust temperature reaches or exceeds 621°C, or (4) the APP clutch fails to engage, as indicated by the No. 1 rectifier, No. 2 rectifier, No. 1 generator and No. 3 generator capsules on the caution/advisory panel not going on within 4 seconds after APP reaches 100% rpm. Wait 2 minutes before attempting another start.

7.3 POST APP START

*1. No. 1 and No. 3 generators — ON.

Note

- If the generator switches are left on when the APP and/or main rotor head is shut down, relay chatter may occur when external power is applied. Relay chatter can be stopped by placing the generator switch OFF.
- After the generators are turned on, the BIM caution light may be on for as long as 2 minutes while the IBIS system is warming up.

*2. ICS — CHECK.

*3. Hydraulic pressure/quantity — CHECK.

*4. Caution advisory panel — CHECK AND TEST.

CAUTION

If pitch locks are engaged, be sure 2 STAGE PRESS is normal but 2 STG M/R SERVO BYPAS caution light is on.

Note

- Check that UTILITY 1 OIL HOT, ACC GB OIL PRESS, and ACC GB OIL HOT caution lights are extinguished, or shut down the generators and APP.
- Be sure all warning, master caution, caution, advisory, chip locator, blade/pylon, and AFCS control panel lights go on.

*5. Interior/exterior lights — AS REQUIRED.

*6. Emergency exit light — ARM.

*7. Parking brake — RESET.

8. Fire warning — TEST.

On aircraft equipped with 416 engines, turn rotary switch through 1, 2, and 3 positions, observing that master fire warning lights go on for each position, engine emergency T-handle lights go on for all three positions, and APP emergency T-handle light goes on for positions 1 and 2.

On aircraft equipped with the 419 engine, turn rotary switch through 1, 2, 3, 4, and 5 positions, observing that master fire warning lights go on for each position; all engine emergency T-handle lights go on for positions 1, 2, and 3; No. 2 engine emergency T-handle light goes on for positions 4 and 5; APP emergency T-handle light goes on for positions 1 and 2; and MAIN XMSN FIRE lights go on for positions 3 and 4.

9. NO. 2 ENGINE OVERHEAT WARNING panel TEST switch — PRESS. Note that #2 ENGINE OVERHEAT caution light comes on.

*10. COMM/NAV radios, IFF, CMPTR power ON.

*11. Doppler, RAD ALTS — ON.

*12. RAD ALT setting — AS DESIRED.

13. Miscellaneous panel switches — SET.

14. Blades/Pylon spread — AS REQUIRED.

a. Area — CLEAR.

b. PITCH LOCK switch — AS REQUIRED.

(1) Blades spread — PITCH LOCK SWITCH DISENGAGED.

(2) Blades folded — PITCH LOCK SWITCH ENGAGED.

PITCH LOCK ADVANCED and PITCH LOCKS ENGAGED lights on. 2 STG M/R SERVO BYPAS caution light goes on. Second stage hydraulic pressure remains normal.

c. Master power switch — POWER.

d. ROTOR BRAKE ON advisory light — ON.

e. Struts — REMOVED.

f. Pylon fold/spread switch — SPREAD.

(1) Pylon starts to spread. PYLON UNSAFE FOR FLIGHT goes off when pylon fully spreads and tail rotor actuator and pylon flags fully retract.

(2) Crewman visually check all 3 pylon flags — RETRACTED.

g. Pylon fold/spread switch — OFF.

h. Blade fold/spread switch — SPREAD.

Blades start to spread and BLADES FOLDED light goes off. When blades fully spread and locked for flight BLADES SPREAD light goes on.

i. Blade fold/spread switch — OFF.

j. Pitch lock switch — DISENGAGED 5 SECONDS AFTER PITCH LOCK ADVANCED LIGHT EXTINGUISHES.

PITCH LOCKS ENGAGED light goes off after any pitch lock disengages. PITCH LOCK ADVANCED light goes off after all pitch locks

are retracted. In addition, the 2 STG M/R SERVO BYPAS caution light goes off.

k. Master power switch — OFF.

BLADE PYLON FOLD caution light and SAFETY VALVE OPEN light go off. FLIGHT READY light goes on.

l. Pitch locks — VISUALLY CHECK ALL DISENGAGED.

CAUTION

Pilot shall not move flight controls until pitch locks visually checked disengaged.

*15. ROTOR BRAKE ON advisory light — ON.

16. Gust lock — DISENGAGED. (Note ROTOR LOCKED caution light off).

*17. Area — CLEAR TO POSITION FOR ENGINE START.

CAUTION

Prior to positioning the main rotor head for engine start, be sure that the pitch lock switch on the blade/pylon fold panel is in the disengaged position.

*18. ROTOR POSITIONER switch — ENG START POSN.

ENG START HEAD POS advisory light should go on. Check ROTOR BRAKE ON advisory light goes on, indicating rotor brake pressure has built back up. Release switch, ENG START HEAD POS advisory light goes off.

CAUTION

Any time the safety valve open light on the blade fold panel is on and the pitch lock switch is placed to engage, the pitch locks will attempt to engage regardless of head position. Ensure the pitch lock switch is in the disengage position before:

Note

If rotor positioner switch is held to ENG START position for more than 5 seconds after head is in START position, the blade fold SAFETY VALVE OPEN light may remain on. To extinguish, cycle MASTER POWER switch.

1. Positioning the rotor head for start.

2. Opening the safety valve for blade or pylon fold.

*19. BLADES SPREAD/FLIGHT READY lights — ON.

20. IBIS BIT — COMPLETE.

21. Bearing monitor system (BMS) test (AFC 491) — COMPLETE.

Note

BMP startup BIT (SBIT) is activated when power is initially applied to the system. The panel startup BIT will cause the display to indicate flashing testing for about 1 minute. When SBIT is complete, ALL OK appears in the alphanumeric display. If a bearing/system fault exists, the fault and fault location is displayed.

Aircrew Checks:

a. BMS lamp/LED test:

(1) BMP display — ALL OK.

(2) CABIN PANEL LIGHTS control panel:

(a) Rotate LH knob counter-clockwise — CHECK LIGHTS DIM.

(b) Rotate LH knob clockwise — CHECK LIGHTS BRIGHT.

(3) Press and hold BRT/DIM button — BRIGHT OBSERVED.

(4) Press and release NEXT button — LMP TEST DISPLAYED.

(5) Press and hold SELECT button — 01030100 DISPLAYED. ALL LIGHTS ILLUMINATE. OBSERVE NO DARK AREAS IN CHECKERBOARD PATTERN.

(6) Release SELECT button — 8 LIGHTS GO OUT/ALL OK. LAMP TEST COMPLETE.

b. BMS self-test:

Note

BMS self-test lasts approximately 1.5 minutes.

(1) BMP display — ALL OK.

(2) Press and release NEXT button — SYSTEST DISPLAYED.

(3) Press and release SELECT button — 01030100 DISPLAYED. DISPLAY FLASHES TESTING. BEARING VIB LIMIT, BEARING TEMP DETECT, AND BEARING TEMP LIMIT CAUTION LIGHTS ILLUMINATE.

(4) Press PREV button — RESET DISPLAYED.

(5) Press PREV button — SYSTEST DISPLAYED.

(6) Press PREV button — ALL OK DISPLAYED. TEST COMPLETE.

7.3.1 Instrument Panel

1. Fuel quantity gages — TEST AND QUANTITY.
2. REFUEL PWR pushbutton — OFF.
3. PURGE pushbutton — OFF.
4. Refuel PROBE switch — STOW.
5. Clocks — SET.

*6. Barometric altimeter — SET.

*7. Attitude director indicators (ADIs) — SET.

8. Airspeed indicator — CHECK.

*9. Compass — SLAVED AND ALIGNED.

10. VSI — CHECK.
11. Landing gear position indicators — CHECK.
12. Landing gear handle warning light — TEST.
13. Instrument Flight Checklist — AS REQUIRED.

7.3.2 Console

1. Spot master switch — AS DESIRED.
2. Second stage servo interlock — CHECK.

Place flight control servo switch to 2 STG OFF, 2 STG PRESS M/R caution light should not go on and second stage hydraulic pressure should remain at 2600 to 3300 psi. Return servo switch to centered position.

*3. Flight controls — ADJUST AND CHECK.

a. All AFCS servos off. Slowly move the cyclic, collective, and pedals through full range of control movement. No restriction should occur. Mechanical coupling among all flight controls may be apparent. While moving the flight controls, have aircrewman observe movement of main and tail rotor blades.

b. AFCS SERVO 1 on. With the collective at minimum pitch, slowly move the cyclic and pedals through full range of control movement. Repeat with the collective at maximum pitch. No restriction should occur and there should be no coupled response between the cyclic and collective. Any coupled response between the cyclic and collective could indicate an engaged pitch lock.

CAUTION

If any restriction in control movements or mechanical coupling between the collective and cyclic is noted, do not engage rotor.

Note

Rapid movement of controls may cause second stage pressure to drop below 2000 psi and light 2 STG PRESS M/R caution light.

4. AFCS servos — ENGAGE, RELEASE, AND TRANSFER.

CAUTION

Center the cyclic before engagement or disengagement of AFCS servos. Failure to do so may cause the FAS shear pin to fail.

a. Set pushbuttons so none are on. Center cyclic and pedals, and place collective in midposition.

b. Press SERVO 1 pushbutton. SERVO 1 light should go on and SERVO 2 UNARMED light should go on.

c. Press SERVO 1 pushbutton again. SERVO 1 light and SERVO 2 UNARMED light should go off.

d. Press SERVO 2 pushbutton. The SERVO 2 light should go on.

e. Press SERVO 2 pushbutton again. SERVO 2 light should go off.

f. Press SERVO 1 pushbutton. SERVO 1 light and SERVO 2 UNARMED light should go on.

g. Press SERVO 2 pushbutton. SERVO 2 UNARMED light should go off.

h. Transfer SERVOS from SERVO 1 to SERVO 2 and back to SERVO 1 by pressing SERVO 1 pushbutton.

*5. AFCS — CHECK.

a. SERVO * 1 on and SERVO 2 armed (UNARMED light off).

b. Press and light AFCS pushbutton. No FAIL ADVISORY lights should go on.

c. Press and light TRIM pushbutton. No FAIL ADVISORY lights should go on.

d. Press SERVO 1 off. SERVO 2 goes on automatically, AFCS and TRIM pushbuttons stay lit.

e. Press SERVO 2 off. AFCS and TRIM pushbutton lights go off.

f. In sequence, press SERVO 1, SERVO 2, AFCS, and TRIM. SERVO 1, AFCS, and TRIM pushbuttons light. SERVO 2 is armed (UNARMED light off).

g. Press and light AUTO BANK pushbutton. No FAIL ADVISORY lights should go on.

h. Press AFCS pushbutton off. Note AFCS and AUTO BANK lights go off.

i. Press MODE RESET pushbutton momentarily. Note that AFCS pushbutton relights.

6. Barometric/radar altitude hold — CHECK.

a. BAR ALT pushbutton — PRESS. BAR ALT light should go on and there should be no FAIL ADVISORY lights on.

b. CLTV TRIM REL button — PRESS.

BAR ALT light should flash while pressed. Release button. Copilot repeat check.

c. BAR ALT pushbutton — PRESS.

BAR ALT lights should go off.

d. RDR ALT pushbutton — PRESS.

RDR ALT light should go on and there should be no FAIL ADVISORY lights on.

e. ALT SET knob — INCREASE.

Collective should rise slightly. Return ALT SET knob to null position.

f. CLTV TRIM REL button — PRESS.

RDR ALT light should go off. Engage RDR ALT again and disconnect with copilot's CLTV TRIM REL button.

g. RDR ALT pushbutton — PRESS.

RDR ALT light goes on.

h. Radar altimeter PUSH-TO-TEST control knob — PRESS.

Altimeter — PRESS TO TEST.

(Repeat using alternate RAD ALT channel).

7. Trim systems — CHECK (SERVO 1 ON; SERVO 2 ARMED; CMPTR PWR, AFCS, AND TRIM ON).

a. Cyclic trim release button — PRESS.

Move cyclic in lateral and fore-and-aft directions.

b. Cyclic trim release button — RELEASE.

Move cyclic in lateral directions from trimmed position and note that resistance increases with increased displacement and cyclic returns to the trim position. Move cyclic in longitudinal direction; force should not increase beyond 1/2-inch displacement. Longitudinal cyclic may not return to trim from end stops. In this case, lightly assist cyclic to within 2 inches of trim, at which point it should return.

Note

In the fore and aft axis if the cyclic does not return to the trim position, the FAS shearpin may be sheared.

c. Cyclic beeper trim — ACTUATE TRIM BEEP BUTTON FORE, AFT, LEFT, AND RIGHT, CHECKING CYCLIC MOVEMENT IS SMOOTH AND IN SAME DIRECTION.

d. Collective trim release button — RELEASE.

Move collective up and down from holding position and note that resistance increases with increased displacement and collective returns to trim position.

e. Cyclic and pedals — CENTERED.

f. Collective — DOWN.

g. Pedal trim — CHECK.

Move pedals without pressing collective pedal trim release switch or pedal switches. Pedals should return to trim position.

h. Heading trim — CHECK.

Turn HDG TRIM knob clockwise and note that right pedal advances; press pedal switch and note that pedal motion stops. Repeat, turning HDG TRIM knob counterclockwise.

8. Single and two-point cargo hooks — AS REQUIRED.

See EXTERNAL TRANSPORT OF CARGO AND AIRCRAFT in Chapter 9.

9. Rescue hoist function check and guillotine test — AS REQUIRED.

See RESCUE HOIST OPERATION in Chapter 9.

7.4 STARTING ENGINES/ENGAGING ROTORS

The engine exhaust danger areas are shown in Figure 7-2. The pilot in command will make sure that preflight inspections have been completed and that all crewmembers are present and at their stations. Designated checks shall be made with participating crewmembers at their respective stations and shall extend through the post engine start check. A qualified pilot or person designated by the commanding officer shall be in the pilot's seat any time the engines are started. Starting personnel shall receive and acknowledge crewman and fire guards all clear signals before starting engines. To make the No. 2 engine accessible for fire fighting during engine start, engines 2, 1, and 3 are started in that order; however, no special sequence is required for technical reasons.

WARNING

Failure to chock both main landing gear while the aircraft is operating at 100% N_r on the ground may result in an inadvertent ground spin.

CAUTION

- Before engine start, the pilot in the right seat shall check that the head has positioned correctly by observing that there is a blade at the 12:30 position (Figure 7-3).

- Locked-rotor starts are mandatory during shipboard operations or in high or gusty wind conditions.

- If APP flames out before engine reaches starter dropout speed, abort start. Immediately return APP control lever to SHUT OFF to avoid potential post shutdown APP fire.

- Engines should not be started with a tailwind component. No. 2 engine shall not be started with aircraft relative winds 180 to 270 degrees. Starting engines with a tailwind component may result in heat damage and possible fire.

*1. Area — CLEAR AND FIRE GUARD POSTED.

*2. Harness — LOCKED.

ALTERNATE (UNLOCKED) START

Alternate start procedures are used when an unlocked rotor start is desired. This may be determined by the ability of the rotor brake to hold sustained forces of torque during start. When new rotor brake pucks have been installed, for instance, rotor brake effectiveness may be reduced and this procedure should be considered.

With the alternate (unlocked) start, boxed items replace steps 3 through 22.

When using the alternate (unlocked) start procedures, go directly to the boxed items.

*3. Flight controls — START POSITION.

a. Collective down.

b. Pedals centered.

c. Cyclic shaft vertical.

*4. No. 2 engine starter button — PRESS.

Note that ENG STARTER ON advisory light goes on.

*5. No. 2 engine speed control lever — GRD IDLE (minimum 20% N_g).

CAUTION

- If fuel flow exceeds 175 pph before light-off at GRD IDLE, a hot start may occur if the start is not aborted.

- If engine light-off does not occur within 10 seconds after fuel flow indication, abort the start by pulling down on the engine speed control lever and returning it to the shutoff position. To purge the engine of fuel, motor engine with the starter for at least 1 minute and until no further fuel spray is noted from the tail pipe. Wait an additional minute to drain excess fuel from the engine.

- Due to the probability of damaging the start system, the gas generator speed shall be zero before engaging the starter.

- If T_5 reaches 650°C before ground idle, abort the start immediately as a hot start is indicated. To purge the engine of fuel, motor engine with the starter for at least 1 minute and until no further fuel spray is noted from the tail pipe. Wait an additional minute to drain excess fuel from the engine.

- A hung start is indicated by failure of the gas generator to accelerate to proper idle speed, accompanied by high T_5 indications. If T_5 reaches 650°C and/or start time exceeds 60 seconds, abort the start. Failure to do so may create a fire hazard caused by hot exhaust gas backflow into the aft engine compartment.

- A cold hangup will be indicated by failure of the gas generator to accelerate to proper idle speed, accompanied by a low T_5 indication.

- During engine purge operations, excess fuel may be sprayed into the power turbine and tail pipe section and drip onto the exterior surfaces of the helicopter. To prevent a serious fire, ground personnel shall wipe tail pipe, EGR nozzle, and fuselage area dry of fuel before attempting starts.

*6. No 2 engine instruments — CHECK

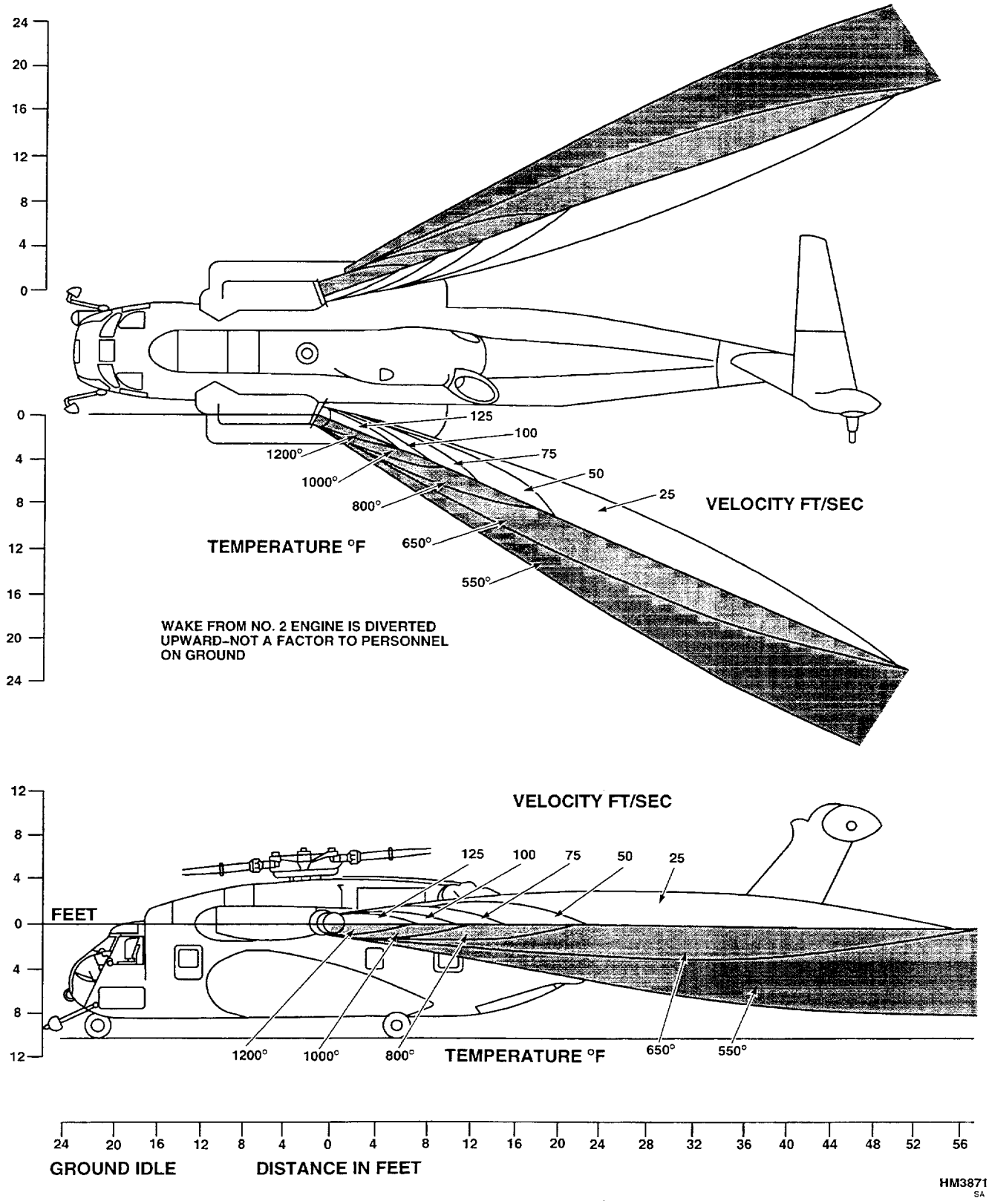


Figure 7-2. Danger Areas

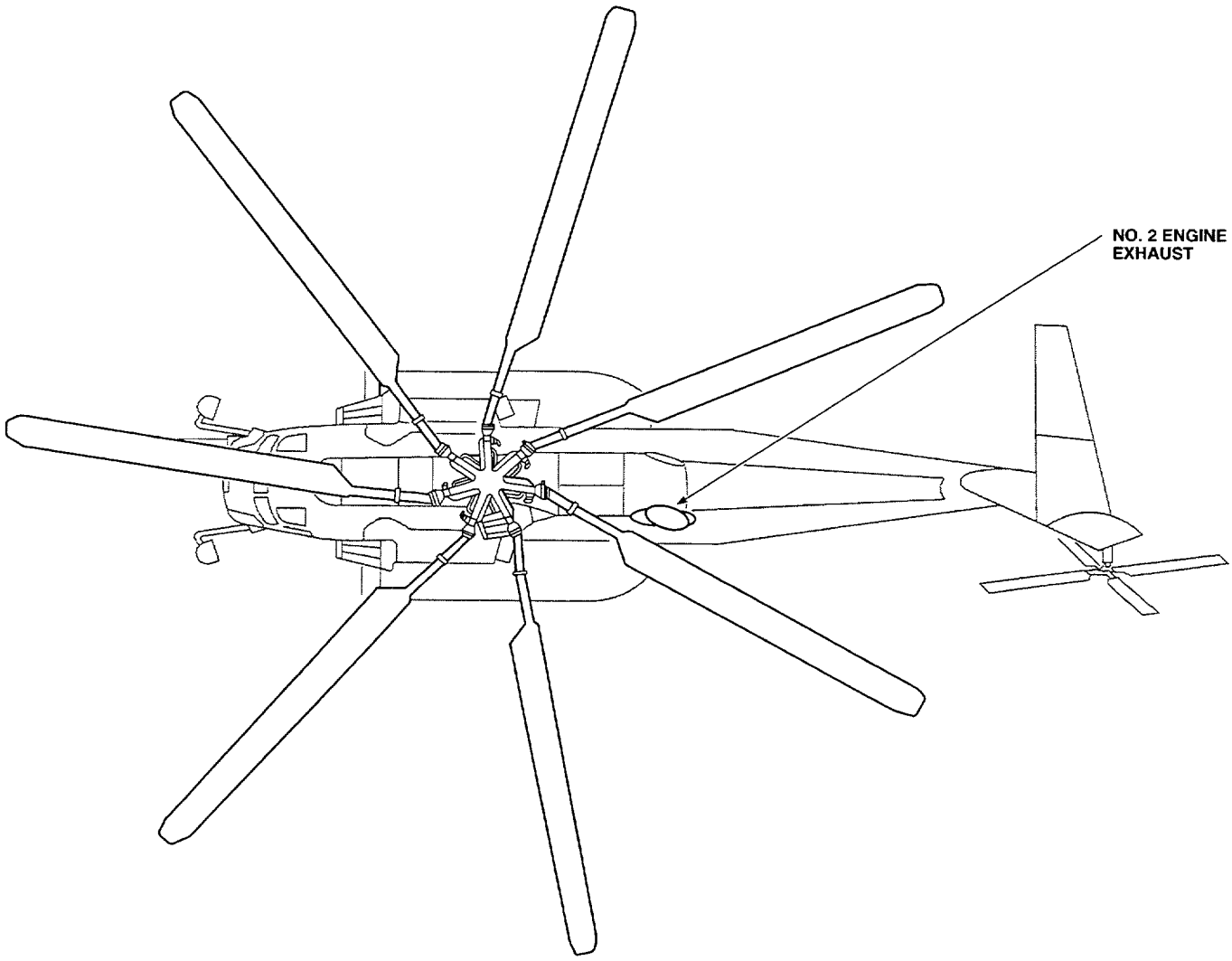


Figure 7-3. Engine Start - Blade Position

a. #2 ENG FUEL BOOST and #2 ENG OIL PRESS LOW and HIGH caution lights off.

CAUTION

Engine oil high pressure light may stay on for as long as 3 minutes, until oil has warmed. Should engine oil high light stay on for over 3 minutes, secure engine. Do not go over ground idle until oil pressure is within normal operating limits. (Caution lights off.)

b. T_5 — WITHIN LIMITS.

c. Fuel flow — ABOUT 200 to 350 LBS/HR.

d. N_g ABOUT 60.5% to 70%. (Ground idle is variable with OAT.)

CAUTION

Should APP flame out before rotor engagement, there will be no hydraulic or electrical power available. Additionally, if rotor brake slips after an APP flame out or inadvertent shutdown, there will be no positive indications of complete rotor brake release and a rotor brake fire hazard exists. Immediately return APP control lever to SHUT-OFF and shutdown engines.

Note

If engine should shut down, or abnormal T_5, N_g, or fuel flow indications are noted fuel lines may have lost their prime.

*7. Starter dropout — CHECK.

The starter should drop out by the time the engine reaches ground idle. Normally the starter should automatically drop out at about 51% to 58% N_g if the starter does not drop out, manually disengage it by pulling down on the engine speed control lever.

*8. No. 1 engine — START AND GROUND IDLE.

Procedure for starting No. 1 engine is same as for No. 2 engine.

*9. No. 1 engine instruments — CHECK.

*10. No. 3 engine — START AND GROUND IDLE.

Procedure for starting No. 3 engine is same as for No. 2 engine.

*11. No. 3 engine instruments — CHECK.

*12. Fuel selector levers — CROSSFEED, 3-3-1.

*13. Area — CLEAR.

*14. Crew — ALERTED.

*15. Flight controls — NEUTRAL.

CAUTION

- High velocity or gusty winds can cause excessive blade flapping. When engaging rotor in high or gusty winds, monitor tip path and engage rotor rapidly and smoothly.

- On all rotor engagements, check that BLADES SPREAD and FLIGHT READY lights go off with MGB OIL PRESS caution light at about 14 psi. If all lights on blade/pylon fold panel do not go off, secure rotor engagement and investigate.

*16. High-pressure rotor brake — RELEASE.

Hold for about 5 seconds and make sure that ROTOR BRAKE ON advisory and ROTOR BRAKE PRESS caution lights are off. Make sure that the 1 STG M/R SERVO BYPAS caution light is off when 1 STG PRESS M/R T/R caution light is off.

CAUTION

Before releasing the rotor brake by pulling the manual override release handle, make sure the high-pressure rotor brake switch is off.

17. First stage hydraulic pressure quantity CHECK.

CAUTION

Shut down engines immediately if either nose gear box oil pressure light remains illuminated after the rotor has stabilized at ground idle.

*18. Control response — CHECK.

Note

- Do not turn any stage off until all servo bypass lights are off.

- Keep thumb on servo switch and be prepared to return switch to center (on) position if controls respond abnormally during any portion of check.

- There are no interlocks to prevent turning off pressure to either hydraulic stage when a servo in the other stage is in bypass. Sufficient force can be generated by a bypassed stage to drive a servo to its extreme if pressure is unavailable to the non-bypassed stage.

With rotor at ground idle, turn off first stage servo, move cyclic a small amount laterally and longitudinally and check for tip path response. Move collective a small amount and check for tip path response. Move pedals a small amount and be sure you see and feel response. Repeat check with second stage servo turned off.

Note

- Appropriate flight control servo failure caution lights will go on as various flight control systems are depressurized, and will go off when the system is again pressurized.

- When doing interlock check, and/or securing individual servo stages, blinking of first or second stage servo pressure caution lights is not a cause for servo removal.

- Do not advance N_r beyond 100% until the APP is secured.

19. On-line engine wash — AS REQUIRED.

Note

When gusty wind conditions and/or high sea states are encountered on startup and engine washing is required, use of the Alternate Engine Wash on Startup procedure should be considered. For wind engagement limitations, refer to the applicable NATOPS publication (CV NATOPS, LHD/LHA/LPH NATOPS, etc.).

*20. Rotor — 100% N_r.

a. Collective — DETENT.

b. Cyclic — CENTERED.

CAUTION

Do not rely on the stick position indicator for an accurate indication of tip path plane position.

c. Advance SCL — DROOP STOPS OUT.

WARNING

Rapid cyclic control movements, particularly forward, may cause main rotor blades to strike the fuselage.

d. Collective — FULL DOWN.

e. SCL — ADVANCE 100% N_r.

21. Q-14 CONSOLE OFF.

*22. No. 2 generator — ON.

*23. APP — SHUTDOWN.

(App circuit breaker control switch should remain on).

24. Utility 2 — AS REQUIRED.

CAUTION

With the utility 2 system on prior to 100% N_r, APP maximum operating thresholds can be exceeded when combined AGB loads (rapid control inputs, engine starter engagement, cargo winch use, etc.) are encountered. Use of the utility 2 system prior to 100% N_r shall be minimized and combined AGB loads avoided.

25. PURGE pushbutton — AS DESIRED.

ALTERNATE (UNLOCKED) START:

1. Flight controls — START POSITION.
   a. Collective down.
   b. Pedals centered.
   c. Cyclic shaft vertical.
2. Starter safety interlocks — CHECK.
   a. ROTOR BRAKE ON advisory light — ON.
   b. Emergency starter switch — NORM.
   c. No. 3 engine start button — PRESS.
   d. No. 3 engine start sequence — ABORT.
3. Emergency start switch — EMER START.
4. High-pressure rotor brake — RELEASE.
   a. ROTOR BRAKE ON advisory light — OFF.
   b. ROTOR BRAKE PRESS caution light — OFF.
5. Harness — LOCKED.
6. Crew — ALERTED.
7. No. 2 engine — START.
8. First stage hydraulic pressure/quantity — CHECK.
9. Control response — CHECK.
10. No. 2 engine — 100% N_f.
11. No. 1 engine — START.
12. No. 3 engine — START.
13. Engine instruments — CHECK.
14. No. 1 & 3 engines — 100% N_f.
15. Emergency start switch — NORM.
16. Fuel selector levers — 3-3-1.
17. No. 2 generator — ON.
18. APP — SHUTDOWN.
19. Purge — AS DESIRED.

ALTERNATE ENGINE WASH ON STARTUP CHECKLIST:

1. No. 1 and No. 2 engine — GRD IDLE.

Note

Maintain rotor speed at 100% N_r with the No. 3 engine and alert maintenance personnel that the No. 1 and No. 2 engines are ready for wash procedure.

2. No. 1 and No. 2 engines — WASH AS REQUIRED.
3. No. 1 and No. 2 engines — 100% N_f
4. No. 3 engine — GRD IDLE.
5. No. 3 engine — WASH AS REQUIRED.
6. No. 3 engine — 100% N_f

7.5 PRE-TAXI/HOT SEAT

Note

Upon hotseating aircraft, only asterisked items are required.

1. Engine overspeed — CHECK.

Match engine torque at 100% N_r. Collective full down. Momentarily actuate each overspeed switch. Look for decrease in N_g, N_f, T_5, fuel flow, and torque when each overspeed switch is moved to TEST.

2. Flat pitch — CHECK.
   a. Engine speed control levers — FULL FORWARD.
   b. Check N_r at 104% to 107%.

      Engines' N_g, T_5, and torque approximately matched.

   c. Return speed control levers to desired N_r, torques matched.

*3. Anti-ice — CHECK OPERATION AND USE AS NECESSARY.

*4. Fuel selector levers — DIRECT.

*5. Instruments — CHECK.

*6. Caution/advisory panel — CHECK.

*7. BAR ALT — SET AND CHECK.

*8. Communications, NAVAIDS, RAD ALTS, and IFF — SET AND TEST.

9. Instrument flight checklist — COMPLETE AS REQUIRED.

*10. Bearing monitor system (BMS) test (AFC 491) — COMPLETE AS REQUIRED.

11. AMCM mission checks — AS REQUIRED.

a. Load cell function switch — AUTO, TOW, OR STRM (AS REQUIRED).

Select desired load cell. Tow boom load cell — TOW. Streaming roller load cell — STRM. Either tow boom or streaming winch load cell (whichever is being used) — AUTO. WINCH position is not used.

b. Tension select switch — NORMAL.

CAUTION

Automatic release function is disabled when the tension select switch is in the PLT or CPLT position.

c. Tension mode switch — TENSION.

d. Tension audio warning — ON.

e. Altitude/attitude warning — DISENGAGE (PUSHBUTTON ILLUMINATED).

f. Self-test — COMPLETE.

Press TEST button to initiate self-test of tension skew indicators. During the self-test all segments of the tension skew indicators should light for approximately 4 seconds, the CABLE CONTACT AMCM advisory light and TENSION/SKEW caution light and the Master Caution lights should illuminate, and the tension audio warning sound should be heard while the TEST button is pushed. The indicator will then blank out except for the word TEST which indicates that a test is in progress. TEST will remain until completion of the test (up to one minute). At the completion of the self-test, the indicator will display PASS and then display normally, or error codes which indicate a malfunction in the system. If more than one error code exists, they will appear automatically every 10 seconds in order of decreasing priority, or they can be advanced by pushing the LIMIT switch to INC. A DEGRADED legend will appear when at least one nontransient currently detected malfunction is indicated. The DEGRADED legend will remain on until another self-test is performed and is successful, or the system power is turned off and on. The final error code will be replaced by a normal display on the TSI. When error codes appear, record them as they display and notify maintenance personnel. (Do not press MODE RESET during test or self-test will be interrupted.)

Note

This self-test can be initiated in any phase of flight. When initiated in flight, tension readout on both tension skew indicators is removed for 4 seconds. A PASS resulting from a self-test indicates that no errors have been detected and the system is operational. A FAIL indicates the system is not operational.

g. Self calibration — CHECK.

(1) Set tension mode switch to CAL position to initiate the calibration of all load cells. When the CAL position is selected the word CAL will display in the TSIs as long as the calibration is in progress (up to one minute). When complete, note that CAL is replaced by a PASS or FAIL displayed on the LBS scale to indicate test results. A PASS indicates a successful calibration and will remain on until the mode switch is moved to another position. A FAIL indicates that at least one malfunction has been detected. If FAIL displays consult maintenance personnel.

Note

- The calibration self-test can only be initiated when the weight of the helicopter is on the wheels.
- Do not press the self-test button while CAL is displayed or the calibration will be interrupted.

h. Auto release — CHECK.

Check setting of auto release on both tension skew indicators. The release level may only be displayed when the helicopter is on the ground. To display the release level the following sequence of events must be followed exactly:

(1) Tension mode switch — CAL.

(2) Hold LIMIT switch — INC POSITION AND PRESS TEST BUTTON SIMULTANEOUSLY.

(3) TEST and LIMIT buttons — RELEASE.

The indicators will display and high and low limit, and automatic release level bugs as well as a digital numerical display of the auto release level.

Note

Changing the auto release tension setting cannot be done by pilots. Removal of the tow control panel and adjustment is required by maintenance personnel.

i. Tension limit setting — LO SET/HI SET.

(1) Set mode switch to LO SET position and use LIMIT SET switch in either INC or DECR positions respectively to increase or decrease low tension limit setting on both tension/skew indicators.

(2) Set mode switch to HI SET position and use LIMIT SET switch as described in step 1 to set high tension limit setting on both TSIs.

j. Load cell function switch — AUTO, TOW, OR STRM (AS REQUIRED).

k. Tension select switch — NORMAL.

l. Tension audio switch — AS DESIRED.

m. Altitude/attitude warning — AS DESIRED.

n. AMCM guillotine system — TEST (IF REQUIRED).

(1) Starboard guillotine — TEST.

(a) Starboard electro explosive circuit tester switch (aft right cabin panel) — TEST POSITION.

(b) Safety observer — VERIFY TEST POSITION.

(c) Starboard arming guillotine switch — STBD ARMED POSITION.

(d) Starboard guillotine armed light (aft right cabin panel) — ON.

(e) CABLE SHEAR SWEEP TOW switch (pilot's emergency control panel) — ACTUATE.

(f) Electro explosive circuit tester light (aft right cabin panel) — ON.

(g) CABLE SHEAR SWEEP TOW switch (pilot's emergency control panel) — OFF, TEST LIGHT OFF.

(h) Copilot verified OFF position.

(i) Starboard arming guillotine switch — OFF.

(j) Starboard guillotine arm light (aft right cabin panel) — OFF.

(k) Safety observer — VERIFY FIRE POSITION.

(2) Port guillotine — TEST.

(a) Port electro explosive circuit tester switch (aft left cabin panel) — TEST POSITION.

(b) Safety observer — VERIFY TEST POSITION.

(c) Port arming guillotine switch — PORT ARMED POSITION.

(d) Port guillotine armed light (aft left cabin panel) — ON.

(e) CABLE SHEAR SWEEP TOW switch (pilot's emergency control panel) — ACTUATE.

(f) Electro explosive circuit tester light (aft left cabin panel) — ON.

(g) CABLE SHEAR SWEEP TOW switch (pilot's emergency control panel) — OFF, TEST LIGHT OFF.

(h) Copilot verified OFF position.

(i) Port arming guillotine switch — OFF.

(j) Port guillotine arm light (aft left cabin panel) — OFF.

Note

If the guillotine explosive cartridges are not installed, the ARMED lights will not illuminate.

(k) Safety observer — VERIFY FIRE POSITION.

o. Tow release — CHECK.

CAUTION

Attempting to electrically actuate the tow hook release with the safety pin installed in the tow hook may result in failure of the tow hook release linear actuator.

(1) Place TOW RELEASE switch to ARMED position. Ensure tow hook is closed with crewman prepared to reclose tow hook.

(2) Pilot press tow hook release button on cyclic and release. Note TOW HOOK OPEN AMCM advisory light illuminates for approximately 30 seconds as the tow hook opens. Ensure crewman can activate the tow hook release lever.

(3) Repeat step (2) using copilot's tow hook release button.

(4) Crewman opens tow hook using manual release handle and again note TOW HOOK OPEN AMCM advisory light illuminates as tow hook opens.

(5) Ensure tow hook returns to closed position.

p. Skew — CHECK.

(1) Have the crewman push tow boom to starboard and port extremes. Ensure skew indication on tension skew indicators is accurate and CABLE CONTACT AMCM advisory light, TENSION/SKEW caution light, and Master Caution lights illuminate when skew exceeds 8 degrees.

Note

- TENSION/SKEW caution capsule will extinguish when the tow boom exceeds 12 degrees skew.
- Full travel (12 degrees) tow boom skew checks may be restricted in certain AMCM configurations due to interference with equipment (e.g., Mk-103, AN/AQS-14, AN/AQS-141).

12. EAPS — AS REQUIRED.

*13. Pins and chocks — REMOVED.

*14. Ramp and doors — CLOSED.

*15. Crew and passengers — ALERTED.

*16. Ground personnel — CLEAR.

*17. Fuel probe extension — TEST AS REQUIRED.

See HELICOPTER AIR REFUELING PROCEDURES in Chapter 9.

*18. VLEA control dial — SET (helicopters modified with crash-attenuating seats).

7.6 TAXI

WARNING

Failure to ensure the nose wheel is aligned fore and aft, and the pedals are centered when taxiing to a stop may result in an inadvertent ground spin.

CAUTION

- During ground taxiing, right pedal inputs will cause the tip path plane to dip due to yaw to pitch coupling.
- Because of rotor turbulence, use caution when taxiing near light planes and other aircraft. Take particular care during air taxiing due to increased rotor downwash and it's effect on loose equipment and debris near helicopter.
- Taxiing with nose landing gear strut extended may cause damage to nose landing gear, due to restricted swivel range.
- Using a tight radius of turn at a high gross weight increases the potential for rolling the main landing gear tires off their rim. Cyclic should be displaced in direction of turn, for an even distribution of weight on main landing gear.

Note

Do not force the parking brake handle when releasing the parking brakes. This action may damage the parking brake actuating cable and cableway, causing the parking brakes to remain on when the advisory light is off.

Requirements for taxiing will vary according to conditions in operating area. Only approved standard taxi signals will be used and no one will be permitted to taxi a helicopter except those authorized to fly it. Enough ground control personnel must be available for the safe taxiing of helicopters, when in vicinity of obstructions or other aircraft. Except for mandatory emergency stop signal, taxi director's signals are of an advisory nature only. The pilot is responsible for the safe and orderly taxi of his helicopter. Use extreme caution when taxiing at night. To initiate a taxi movement, use collective as necessary to move at a safe rate of speed, and use rudder pedals to control direction. Keep cyclic and brake action at a minimum. Place cyclic in direction of turn.

*1 Wheel brakes — CHECK.

2. Heading indicators and turn needles — CHECK.

3. Standby magnetic compass — CHECK.

7.7 PRE-TAKEOFF

1. Fuel quantity — CHECK.

2. Fuel selector levers — DIRECT.

3. Compass — SET.

*4. Cockpit windows — CLOSED AND SECURE.

5. Crew and passengers — ALERTED.

6. HEEDS bottles — OPEN.

*7. Panel takeoff checklist:

   a. APP — OFF.

   b. Engine instruments — CHECK.

   c. AFCS — ON.

   d. RPM — SET.

   e. Brakes — AS REQUIRED.

   f. Harness — AS DESIRED.

   g. Caution/advisory panel — CHECK.

8. Panel takeoff checklist — COMPLETE.

7.8 FLIGHT

CAUTION

Caution is required during air taxi maneuvers and downwind hover to preclude possible engine power fluctuations due to exhaust gas ingestion.

7.8.1 Takeoff. The governing factors for determining the type of takeoff to be made are gross weight, density altitude, and size and condition of the takeoff area. Vertical climbs are possible; however, at high gross weights, the ability of the helicopter to climb vertically exceeds the ability to make a safe landing if one engine fails. The minimum height and airspeed for safe landing after engine failure should be used as a guide in determining takeoff climb speeds. The best airspeed to be used for obstacle clearance should be determined from the performance charts. The objectives during takeoff are to clear obstacles at a safe altitude and airspeed, and then to establish a rate-of-climb airspeed. The following paragraphs describe the types of takeoff to be made under various conditions.

7.8.1.1 Operational Power Check. A pilot may perform an operational power check to determine maximum engine power available, based on existing atmospheric conditions. The following operational power check procedures provide the pilot with a means of verifying his power available when operating under maximum power required conditions (within 10% of maximum power available). The check is not intended to permit the pilot to set topping. If topping on a particular engine is not set correctly, and is unacceptable for the mission's requirements, do not attempt to reset topping.

7.8.1.2 Operational Power Check Procedure

WARNING

While performing an operational power check, do not retard the speed control levers of the other engines below MIN GOV. If the engine being checked should fail while the other speed control levers are below MIN GOV, excessive loss of rotor speed will result.

CAUTION

Exceeding 100% N_g (416 engines) or 100.8% (419 engine) will reduce the fatigue life of the compressor rotor. Repeated occurrences may result in compressor rotor failure.

Note

Make sure an aircrewman visually clears the PNAC's side of the aircraft during check.

1. While in forward flight, 80 to 100 kts, at 103% N_r, EAPS doors open; cabin heater, APP, engine anti-ice, BAR ALT HOLD, and fuel purge OFF; adjust the collective/speed control lever of the engine to be verified to achieve the maximum power available (for the ambient conditions) without exceeding any of the following parameters:

   a. N_g: 100% (416 engines) or 100.8% (419 engines).

   b. T_5: 773°C (416 engines), 792°C (416A engines), or 829°C (419 engines).

2. Stop increasing the speed control lever/collective setting when the first limitation is reached and note the torque equals or exceeds maximum power available (416 engine is degraded 7% and 419 engine is rated at specification power.) computed for that day. Repeat this procedure to verify the remaining engines.

7.8.1.3 Normal Takeoff. A normal takeoff (Figure 7-4) is made by increasing collective to raise the helicopter vertically. As the helicopter lifts off, maintain heading with the rudder pedals and maintain attitude with the cyclic. Increase collective pitch until helicopter is about 10 feet off surface. Check engine and transmission instruments, and flight controls before continuing flight.

7.8.1.4 Maximum Performance Takeoff. The primary objective of a maximum performance takeoff is to clear an obstacle within a minimum of horizontal distance. Apply power smoothly and increase collective pitch to raise the helicopter to a low hovering altitude of about 2 to 3 feet, where maximum power shall be smoothly applied to continue the takeoff. For light gross weight takeoffs, climb vertically while maintaining hover attitude,

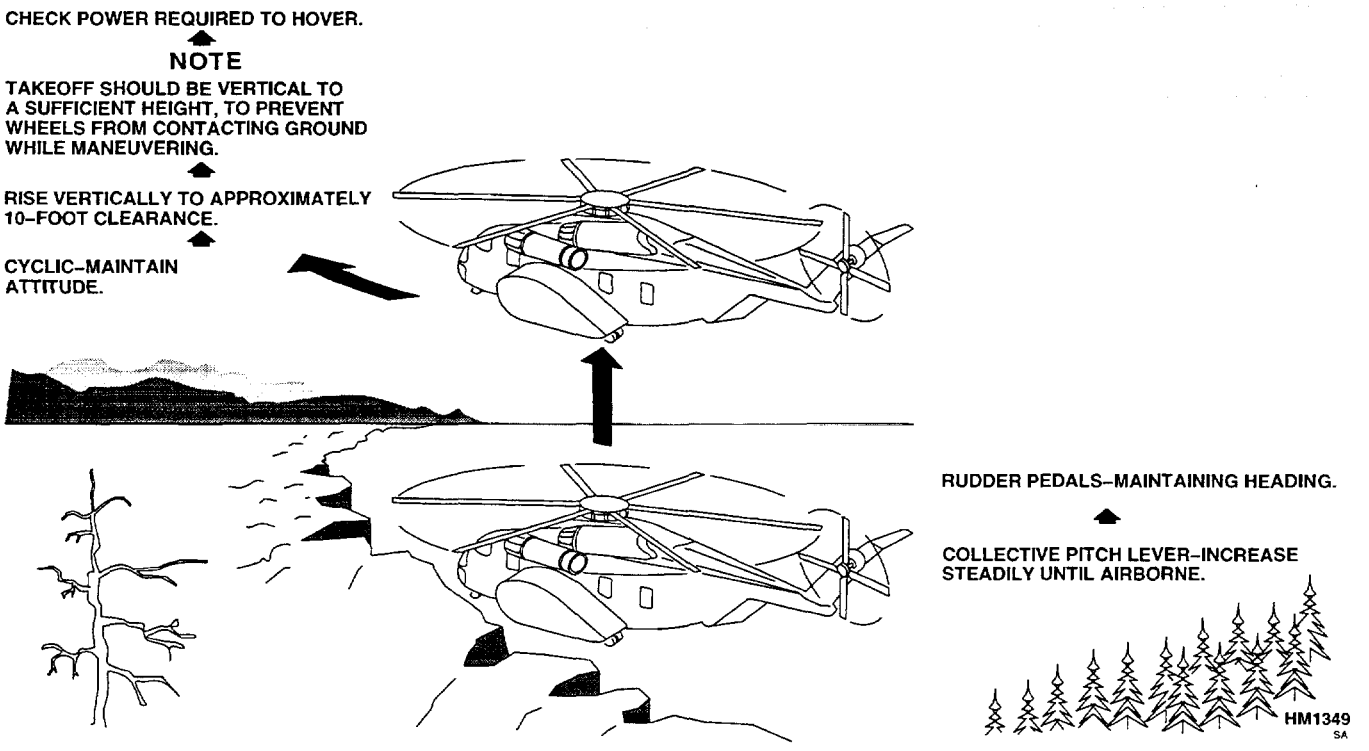


Figure 7-4. Normal Takeoff (Land)

until sufficient altitude is reached to clear any obstacles. Then apply forward cyclic to accelerate to best rate-of-climb speed. When conditions of gross weight and/or density altitude prohibit a vertical climb, the minimum horizontal distance to clear an obstacle can best be obtained by hovering at 2 to 3 feet and simultaneously applying forward cyclic with the collective necessary to obtain maximum power. From this point, accelerate and climb until the obstacle is cleared. After the obstacle is cleared, adjust cyclic and collective to obtain the airspeed that will produce the best rate-of-climb.

7.8.1.5 Heavy Lift Takeoff. An Operational Power check for the operating conditions should be performed before heavy lift operations.

WARNING

- When operating near maximum power available, monitor instruments to ensure engine temperature (T_5), torque (Q), and speed (N_g) limits are not exceeded.
- If engine power is limited, droop N_r as required, but do not allow N_r to droop below 100%, as tail rotor authority may be degraded.
- N_r droop indicates exceeding power available or possible collective bias adjustment. N_r should not be drooped as main and tail rotor efficiency is degraded.

For heavy lift takeoffs (gross weights in excess of 60,000 pounds), head into the wind and set engine speed control levers to 105% N_r. Apply power as required until an engine maximum limitation is reached.

7.8.1.6 Running Takeoff. Running takeoffs are used under certain conditions of high gross weight and/or high density altitude where there may not be enough power developed by the engines and/or lift developed by the main rotor blades for a vertical takeoff. Under these conditions it is necessary to obtain translational lift through forward motion on the ground before becoming airborne. Do not attempt running takeoffs over rough or

rocky terrain, due to the possibility of damage to the helicopter. Make running takeoffs into the wind when practical, then increase collective pitch and apply forward cyclic as necessary to start the ground run and obtain takeoff speed. Use rudder pedals to maintain directional control during the ground run. When desired takeoff speed is reached, move cyclic aft while simultaneously increasing collective to maximum power. When the helicopter becomes airborne before reaching best climb speed, maintain level flight until best climb airspeed is obtained.

7.8.1.7 Crosswind Takeoff. Crosswind takeoffs are the same as takeoffs into the wind, with the exception of lateral cyclic required to correct for drift. Greater care must be taken in maintaining directional control.

7.8.2 Transition To Forward Flight. As the helicopter transitions from hovering to forward flight, the loss of ground effect and/or the change in direction of the main rotor thrust vector will result in a loss of lift which tends to cause the helicopter to settle. As airspeed increases above approximately 15 knots, translational lift will become effective and tend to cause the helicopter to climb. Transition to forward flight is best made by smoothly moving the cyclic forward to increase airspeed, meanwhile making coordinated adjustments to the collective control and rudder pedals to maintain altitude and directional control. As the desired climb speed is approached, rotate the helicopter and adjust collective pitch to establish the desired rate-of-climb and climb airspeed.

Note

When transitioning through approximately 60 KIAS, the EAPS caution light may flicker. This is a normal occurrence and does not require any pilot or maintenance action.

7.8.3 Climb Procedures. The procedures for establishing a climb will vary if the climb was initiated from transition to forward flight, a running type takeoff, or from a selected altitude. Regardless of the type of climb desired, refer to the climb charts in Part XI to obtain the factors that will produce the best rate-of-climb speed.

7.8.3.1 Initial Climb to Altitude. This will normally start after the helicopter has transitioned to forward flight and the desired climb speed is approached. Then adjust the collective and cyclic to obtain the climb attitude that will produce the best climb speed for the specific gross weight, pressure altitude, and OAT conditions. Maintain directional control with the rudder pedals.

7.8.3.2 Cruise Climb. This is normally made to climb from an established to a selected altitude. This type of climb may be varied by sacrificing rate-of-climb for airspeed, or airspeed for rate-of-climb, depending on the time and horizontal distance desired before reaching the newly selected altitude. After determining the desired rate-of-climb and associated airspeed, adjust the collective and cyclic to obtain the climb attitude that will produce the results for specific gross weight, pressure altitude, and OAT conditions. Maintain directional control with the rudder pedals.

7.8.3.3 Maximum Performance Climb. The climb is usually made to gain altitude in the least amount of time, or when gross weight and density altitude prohibit a normal climb with associated power. When a maximum performance climb is initiated after a maximum performance takeoff, adjust the collective to maintain maximum power while simultaneously applying forward cyclic to accelerate to the airspeed that will produce the best rate-of-climb. Other maximum performance climbs are made by adjusting collective to obtain maximum power while simultaneously adjusting cyclic to obtain the climb attitude that will produce the maximum rate-of-climb and associated climb speed permitted by the gross weight, density altitude, and OAT conditions. Directional control is maintained on all maximum performance climbs with the rudder pedals.

7.8.4 Post-Takeoff. Conduct normal cruise at a safe altitude and as dictated by weather, terrain and obstacles, mission of the flight, and safety of the helicopter and crew. For specific speeds, power settings, and fuel consumption rates, refer to the cruise charts in Part XI.

1. Landing gear — AS REQUIRED.
2. Radios navaids/IFF — CHECKED.
3. ALE control panels — AS REQUIRED.
4. Cabin security — CHECKED.
5. Single-point performance check/operational power check/computer-based engine performance check — AS REQUIRED.

Note

When the NAVAIR-generated, computer-based engine performance programs are available and have been authorized, for use, by the cognizant type commander, N_f/N_r can vary between 100% to 103%. The T_5 value can range from 720 to 760°C. Selected PA must remain constant during the entire performance check.

6. Fuel transfer — AS REQUIRED.

7. Fuel dump — ONLY WHEN REQUIRED.

7.8.5 Two-Engine Cruise. During some operations it may be desirable to completely secure one engine. Reference should be made to the performance charts in Part XI to determine where slight fuel economies may be realized. The decision to conduct two-engine cruise operations shall be guided by command policy and then only when operating at an altitude which, when all factors of aircraft performance are considered, in case of an engine failure a normal start could be accomplished on the secured, good engine. See ENGINE SHUTDOWN IN FLIGHT and ENGINE RESTART IN FLIGHT procedures in Part V to shut down and restart an engine in flight.

WARNING

For elective dual-engine cruise, shut down the No. 1 or No. 3 engine. If the No. 2 engine is shut down and subsequently restarted, reduce airspeed to less than 85 KIAS during the shutdown and start sequence to reduce the possibility of a fire hazard caused by hot exhaust gas backflow into the aft engine compartment.

7.8.6 Single-Point Performance Check. A single-point performance check is done to determine if an engine is producing minimum acceptable torque upon reaching its military power parameters at the existing OAT and pressure altitude. If the indicated torque is less than the value indicated for the specific conditions, enter discrepancy and pertinent facts for appropriate maintenance action. To obtain accurate performance data, all of the subsequent steps must be complied with.

1. Determine pressure altitude at which check will be done. Set and maintain a base of 29.92 in window on barometric altimeter.

2. Maintain level flight and constant speed, within a speed range of 80 to 100 KIAS.

3. Open EAPS doors.

Note

- During single-point performance checks, cabin heater, APP, engine anti-icing system, and fuel purge system must be off.
- Ensure an aircrewman visually clears the PNAC's side of the aircraft during the check.
- Pre-post mission performance checks should be taken from the same seat/gage.

4. While in forward flight, establish and maintain a constant altitude at an applicable pressure altitude specified in Figure 7-5.

WARNING

While performing a single-point performance engine power check, do not retard the speed control levers of the other engines below MIN GOV. If the engine being checked should fail while the other speed control levers are below MIN GOV, excessive loss of rotor speed will result.

5. While maintaining 100% N_f/N_r, manipulate all SCLs as required to load the engine being checked until 750 °C T_5 or 100% N_g (whichever occurs first) is reached. Allow the engine to stabilize for approximately 2 minutes and record OAT and torque.

6. Use Figure 7-5 to determine if torque value is acceptable. Sheet 1 of 3 is for the 416 engine, Sheet 2 of 3 is for the 416A engine, and sheet 3 of 3 is for the 419 engine.

7.8.6.1 Doppler Approach Checklist

1. Doppler mode — AS APPROPRIATE.

2. RAD ALT mode — AS APPROPRIATE.

3. RAD ALT/BAR ALT — CROSS CHECK.

4. ADI mode — AS DESIRED.

T64-416 SINGLE POINT PERFORMANCE CHECK WITHOUT EAPS OR WITH EAPS DOORS OPEN
80 TO 100 KIAS, N_f = 100%, T_5 OF 750°C PERCENT MINIMUM ACCEPTABLE TORQUE

OAT °C	PRESSURE ALTITUDE (FEET)																			OAT °C
	SL	500	1000	1500	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	
50	77	76	75	73	72	69	67	64	62	60						50
48	80	78	77	76	74	71	69	66	64	62						48
46	82	80	79	77	76	73	71	68	65	63	61					46
44	84	82	81	80	78	75	73	70	67	65	62	60				44
42	86	84	83	81	80	77	75	72	69	66	64	61				42
40	88	87	85	83	82	79	76	73	71	68	65	63	61			40
38	90	89	87	85	84	81	78	75	72	70	67	64	62	60		38
36	92	91	89	87	86	83	80	77	74	71	69	66	63	61		36
34	94	93	91	89	88	85	82	79	76	73	70	67	65	62	60	34
32	97	95	93	91	90	87	84	80	77	74	72	69	66	64	61	32
30	98	97	95	93	91	88	85	82	79	76	73	70	68	65	63	30
28	101	99	97	95	94	90	87	84	81	78	75	72	69	67	64	28
26	103	101	99	97	94	92	89	86	82	79	76	73	71	68	65	26
24	105	103	101	99	96	94	91	87	84	81	78	75	72	69	67	24
22	107	105	103	101	98	96	93	89	86	83	80	77	74	71	68	22
20	110	108	106	104	100	98	95	91	88	85	81	78	75	72	70	20
18	112	110	108	106	102	100	97	93	89	86	83	80	77	74	71	18
16	114	112	110	108	104	102	99	95	91	88	85	81	78	75	73	16
14	116	114	112	110	106	104	101	97	93	90	86	83	80	77	74	14
12	118	116	114	112	108	106	102	98	95	91	88	84	81	78	75	12
10	120	118	116	114	110	108	104	100	96	93	89	86	83	79	76	10
8	122	120	118	116	112	109	106	102	98	94	91	87	84	81	78	8
6	124	122	119	117	114	111	107	103	99	95	92	89	85	82	79	6
4	126	123	121	119	115	113	109	104	101	97	93	90	86	83	80	4
2	127	125	123	120	117	114	110	106	102	98	94	91	87	84	81	2
0	129	127	124	122	118	116	112	107	103	99	96	92	89	85	82	0
-2	131	128	126	124	120	117	113	109	105	101	97	93	90	86	83	-2
-4	132	130	128	125	121	119	115	110	106	102	98	95	91	88	84	-4
-6	134	132	129	127	123	120	116	111	107	103	99	96	92	89	85	-6
-8	136	134	131	129	125	122	118	113	109	105	101	97	94	90	87	-8
-10		135	133	131	126	124	120	115	111	106	102	99	95	91	88	-10
-12			135	133	128	126	121	117	112	108	104	100	96	93	89	-12
-14	CLIMB		137	135	130	127	123	118	114	110	106	102	98	94	90	-14
-16	TO A			137	132	129	125	120	116	111	107	103	99	95	92	-16
-18	HIGHER				134	131	127	122	117	113	108	105	101	97	93	-18
-20	ALTITUDE				136	133	129	124	119	115	110	107	102	98	95	-20

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Figure 7-5. Single-Point Performance Check (Sheet 1 of 3)

T64-416A SINGLE POINT PERFORMANCE CHECK WITHOUT EAPS OR WITH EAPS DOORS OPEN
80 TO 100 KIAS, N_f = 100%, T_5 OF 750°C PERCENT MINIMUM ACCEPTABLE TORQUE

PRESSURE ALTITUDE (FEET)																
OAT °C	SL	500	1000	1500	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	OAT °C
50	73	72	70	69	68	66	63	61								50
48	76	74	73	72	70	68	66	63	61							48
46	78	76	75	74	72	70	68	65	62	60						46
44	80	79	77	76	74	72	69	67	64	62						44
42	82	81	79	78	77	74	71	68	66	64	61					42
40	84	83	81	80	78	76	73	70	68	65	63	60				40
38	87	85	84	82	81	78	75	72	69	67	64	62	60			38
36	89	87	85	84	82	79	77	74	71	68	66	63	61			36
34	90	89	87	86	84	81	78	75	72	70	67	65	62	60		34
32	93	91	89	88	86	83	80	77	74	71	69	66	64	61		32
30	94	93	91	89	88	84	82	79	76	73	70	67	65	62	60	30
28	96	94	93	91	89	86	83	80	77	74	71	69	66	64	61	28
26	99	97	95	93	92	88	85	82	79	76	73	70	68	65	63	26
24	100	98	97	95	93	90	87	83	80	77	74	72	69	66	64	24
22	102	100	99	97	95	92	89	85	82	79	76	73	70	68	65	22
20	105	103	101	99	97	94	91	87	84	81	78	75	72	69	67	20
18	107	105	103	101	99	96	92	89	85	82	79	76	73	70	68	18
16	109	107	105	103	101	98	94	91	87	84	81	78	75	72	69	16
14	111	109	107	105	103	99	96	92	89	86	82	79	76	73	70	14
12	113	111	109	107	105	101	98	94	90	87	84	81	78	75	72	12
10	115	113	111	109	107	103	100	96	92	89	85	82	79	76	73	10
8	117	115	113	111	109	105	101	97	94	90	87	84	80	77	74	8
6	119	117	115	113	111	107	103	99	95	92	88	85	82	79	76	6
4	121	119	117	115	112	108	105	101	97	93	90	86	83	80	77	4
2	123	121	118	116	114	110	106	102	98	95	91	88	84	81	78	2
0	125	122	120	118	116	112	108	104	100	96	93	89	86	82	79	0
-2	126	124	122	120	118	113	110	105	101	98	94	90	87	84	80	-2
-4	128	126	123	121	119	115	111	107	103	99	95	92	88	85	81	-4
-6	130	127	125	123	121	116	113	108	104	100	96	93	89	86	83	-6
-8	132	129	127	125	122	118	114	110	105	102	98	94	91	87	84	-8
-10	133	131	129	126	124	120	116	111	107	103	99	95	92	88	85	-10
-12	135	133	130	128	126	121	117	112	109	104	100	97	93	89	86	-12
-14	137	134	132	130	127	123	119	114	110	106	102	98	94	91	87	-14
-16		137	134	132	129	125	121	116	111	107	103	99	96	92	88	-16
-18			136	133	131	126	122	117	112	109	105	101	97	93	90	-18
-20			137	135	133	130	124	119	114	110	106	102	98	94	91	-20

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Figure 7-5. Single-Point Performance Check (Sheet 2 of 3)

T64-419 SINGLE POINT PERFORMANCE CHECK WITHOUT EAPS OR WITH EAPS DOORS OPEN
80 TO 100 KIAS, N_r = 100%, T_5 OF 750°C PERCENT MINIMUM ACCEPTABLE TORQUE (#1, #3 ENG / #2 ENG)

PRESSURE ALTITUDE (FEET)																
OAT °C	SL	500	1000	1500	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	OAT °C
50	69 / 71	68 / 70	66 / 68	65 / 67	64 / 66	62 / 64	59 / 61									50
48	71 / 73	70 / 72	69 / 71	67 / 69	66 / 68	64 / 66	61 / 63	59 / 61								48
46	74 / 76	72 / 74	71 / 73	70 / 72	68 / 70	66 / 68	63 / 65	61 / 63	59 / 61	60 / 60						46
44	76 / 78	75 / 77	73 / 75	72 / 74	71 / 73	68 / 70	65 / 67	63 / 65	61 / 63	61 / 61						44
42	78 / 80	77 / 79	76 / 78	74 / 76	73 / 75	70 / 72	68 / 69	65 / 67	63 / 65	62 / 62	59 / 60					42
40	81 / 83	79 / 81	78 / 80	77 / 79	75 / 77	72 / 74	70 / 71	67 / 69	65 / 67	63 / 64	61 / 62	59 / 60				40
38	83 / 85	82 / 84	80 / 82	79 / 81	78 / 79	75 / 76	72 / 74	69 / 71	67 / 69	65 / 66	62 / 64	60 / 61				38
36	86 /88	84 / 86	83 / 85	81 / 83	80 / 82	77 / 78	74 / 75	71 / 73	69 / 71	67 / 68	64 / 66	62 / 63	59 / 61			36
34	88 / 90	87 / 88	85 / 87	84 / 85	82 / 84	79 / 80	76 / 78	74 / 75	71 / 73	69 / 70	66 / 67	64 / 65	61 / 62	59 / 60		34
32	91 / 92	89 / 91	88 / 89	86 / 87	84 / 86	81 / 82	78 / 80	76 / 77	73 / 75	70 / 72	68 / 69	65 / 67	63 / 64	60 / 61		32
30	93 / 95	92 / 93	90 / 92	88 / 89	87 / 88	84 / 84	80 / 82	78 / 79	75 / 77	72 / 74	70 / 71	67 / 68	65 / 66	62 / 63	59 / 60	30
28	96 / 98	94 / 96	93 / 94	91 / 92	89 / 91	86 / 87	83 / 84	80 / 81	77 / 79	75 / 76	72 / 73	69 / 70	67 / 68	64 / 65	61 / 62	28
26	99 / 100	97 / 99	96 / 97	94 / 95	92 / 94	89 / 90	85 / 87	83 / 84	80 / 81	77 / 78	74 / 75	71 / 72	69 / 70	66 / 67	63 / 64	26
24	102 / 103	100 / 101	98 / 100	96 / 97	95 / 96	91 / 92	88 / 89	85 / 86	82 / 83	79 / 80	76 / 77	73 / 74	71 / 71	68 / 69	65 / 66	24
22	105 / 106	103 / 104	100 / 102	99 / 100	98 / 99	94 / 95	91 / 92	88 / 88	85 / 85	82 / 82	79 / 79	76 / 76	73 / 73	70 / 70	67 / 67	22
20	108 / 109	106 / 107	104 / 105	102 / 103	100 / 101	97 / 98	93 / 94	90 / 90	87 / 88	84 / 85	81 / 82	78 / 78	75 / 75	72 / 72	69 / 69	20
18	109 / 110	107 / 108	106 / 106	104 / 104	102 / 103	98 / 99	94 / 95	91 / 91	88 / 89	85 / 86	82 / 83	79 / 80	76 / 76	73 / 73	70 / 70	18
16	111 / 112	109 / 110	107 / 107	105 / 105	103 / 104	99 / 100	96 / 97	93 / 93	89 / 90	86 / 87	83 / 84	80 / 81	77 / 78	74 / 74	71 / 71	16
14	112 / 113	110 / 111	109 / 109	107 / 107	105 / 106	101 / 102	97 / 98	94 / 94	91 / 91	88 / 88	84 / 85	81 / 82	78 / 79	75 / 75	72 / 72	14
12	114 / 115	112 / 112	110 / 110	108 / 108	106 / 107	102 / 103	98 / 99	95 / 96	92 / 93	89 / 89	85 / 86	82 / 83	79 / 80	76 / 76	73 / 73	12
10	116 / 117	114 / 114	112 / 112	110 / 110	108 / 109	104 / 105	100 / 101	96 / 97	93 / 94	90 / 91	87 / 87	83 / 84	80 / 81	77 / 77	74 / 74	10
8	117 / 118	115 / 115	113 / 113	111 / 112	109 / 110	105 / 106	101 / 102	98 / 99	95 / 95	91 / 92	88 / 89	84 / 85	81 / 82	78 / 78	75 / 75	8
6	119 / 120	117 / 117	115 / 115	113 / 113	111 / 112	107 / 108	103 / 103	99 / 100	96 / 97	92 / 93	89 / 90	86 / 86	82 / 83	79 / 80	76 / 76	6
4	120 / 121	118 / 119	116 / 117	114 / 115	112 / 113	108 / 109	104 / 105	100 / 101	97 / 98	94 / 94	90 / 91	87 / 88	83 / 84	80 / 81	77 / 77	4
2	122 / 123	120 / 121	118 / 119	116 / 117	114 / 115	109 / 110	105 / 106	102 / 103	98 / 99	95 / 96	91 / 92	88 / 89	84 / 85	81 / 82	78 / 78	2
0	124 / 125	121 / 123	119 / 120	117 / 118	115 / 116	111 / 112	107 / 108	103 / 104	100 / 101	96 / 97	93 / 94	89 / 90	86 / 86	82 / 83	79 / 79	0
-2	125 / 126	123 / 124	121 / 122	119 / 120	117 / 118	112 / 113	108 / 109	105 / 106	101 / 102	97 / 98	94 / 95	90 / 91	87 / 88	83 / 84	80 / 80	-2
-4	126 / 128	125 / 126	123 / 124	120 / 122	118 / 119	114 / 115	110 / 110	106 / 107	102 / 103	99 / 100	95 / 96	92 / 92	88 / 89	84 / 85	81 / 81	-4
-6	128 / 130	126 / 127	124 /125	122 / 123	120 / 121	115 / 116	111 / 112	107 / 108	104 / 105	100 / 101	96 / 97	93 / 94	89 / 90	85 / 86	82 / 83	-6
-8	130 / 132	128 / 129	126 / 127	124 / 125	121 / 123	117 / 118	112 / 113	109 / 110	105 / 106	101 / 102	98 / 99	94 / 95	90 / 91	87 / 87	83 / 84	-8
-10	132 / 133	129 / 131	127 / 129	125 / 126	123 / 124	118 / 120	114 / 115	110 / 111	106 / 107	103 / 104	99 / 100	95 / 96	91 / 92	88 / 89	84 / 85	-10
-12	133 / 135	131 / 132	129 / 130	127 / 128	125 / 126	120 / 121	115 / 117	112 / 113	108 / 109	104 / 105	100 / 101	96 / 97	93 / 94	89 / 90	85 / 86	-12
-14	135 / 137	133 / 134	130 / 132	128 / 130	126 / 127	122 / 123	117 / 118	113 / 114	109 / 110	105 / 106	102 / 103	98 / 99	94 / 95	90 / 91	86 / 87	-14
-16	137 / 138	135 / 136	133 / 134	130 / 131	128 / 129	123 / 124	118 / 120	115 / 116	111 / 112	107 / 108	103 / 104	99 / 100	95 / 96	91 / 92	87 / 88	-16
-18			134 / 135	132 / 133	129 / 131	125 / 126	120 / 121	116 / 117	112 / 113	108 / 109	104 / 105	100 / 101	96 / 97	92 / 93	88 / 89	-18
-20			136 / 137	134 / 135	131 / 132	126 / 128	122 / 122	118 / 119	114 / 115	109 / 111	106 / 107	102 / 102	98 / 98	94 / 94	90 / 90	-20
	NOTE: FIRST TORQUE VALUE IS FOR THE NO. 1 AND NO. 3 ENGINES. SECOND TORQUE VALUE IS FOR THE NO. 2 ENGINE.															

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Figure 7-5. Single-Point Performance Check (Sheet 3 of 3)

5. RAD ALT warning bug — SET.

6. Doppler return — CHECK.

7. RAD ALT hold — SET TO HOVER ALTITUDE.

8. AFCS — CONFIRM ON/AUTO BANK OFF.

9. LAT/LONG velocity controls — SET.

10. APP/HVR coupler — ENGAGE.

Note

If the water surface is smooth, the Doppler may go into the memory mode, deceleration and drift will have to be controlled manually. As the rotor wash disturbs the surface, the Doppler may receive a return and mode reset may enable the Doppler to effect the remainder of the approach and successfully engage a stabilized hover.

7.8.7 Fuel Dumping. Fuel dumping may be required to reduce weight for mission requirements, in case of single- or dual-engine operation, or to adjust fuel loading in case of fuel system malfunction. Dump fuel as follows:

1. Minimum altitude — 6000 FEET AGL.

In emergency situations, or where conditions dictate dumping at lower altitudes, avoid populated areas.

2. Determine desired fuel to remain after dumping.

3. Fuel dump switches — AS REQUIRED.

4. Fuel quantity — MONITOR.

5. Fuel dump switches — SECURE.

When desired fuel level is reached and fuel dump is not secured, fuel will dump down to the level that turns the fuel low level caution lights on, at which time fuel dump shuts off automatically.

CAUTION

After securing fuel dump switches, allow 2 minutes for fuel dump lines to drain. Securing fuel dump immediately before overflying a ship or landing area will result in fuel draining onto that ship or area, creating a personnel hazard and a fire hazard if static electricity is discharged on touchdown.

7.8.8 Descent Procedures. The factors governing the type of descent to be made are the conditions existing at the time. The conditions that vary the type of descent to be made are gross weight, density altitude, condition of landing site and terrain, and the amount of time desired in which to accomplish the descent. The autorotative descent can be used whenever a rapid descent is desired.

7.8.8.1 Descent to Landing. The descent to landing is the most common type of descent made. Descents from cruising to traffic pattern altitudes are made by lowering the collective to obtain the power that will produce the desired rate-of-descent while simultaneously using the cyclic and rudder pedals to maintain attitude and directional heading. The following should be done before beginning the descent:

1. Crew and passengers — ALERTED.

2. Safety belt and shoulder harness — SECURED.

7.8.8.2 Cruise Descent. Descents from an established to newly selected altitude are made by lowering the collective to obtain the power that will produce the desired rate-of-descent while simultaneously using the cyclic and rudder pedals to maintain attitude and heading. Descents that are made to establish lower cruising altitudes may be varied, depending on the time and horizontal distance desired before attaining the newly selected altitude.

7.8.8.3 Autorotative Descent. The autorotative descent is used whenever a rapid descent is desired. An autorotative descent is made by lowering the collective to minimum and entering autorotation, then using collective to control N_r. Refer to Figure 12-3 for minimum sink rate and maximum glide distance. To recover, raise the collective at about 200 feet above the selected altitude to slow the rate of descent; then ease the cyclic forward to maintain altitude and establish a cruise airspeed. If a higher rate of descent is desired, increase airspeed.

7.8.9 Pre-Landing. See Figure 7-6. The density altitude, landing gross weight, and center-of-gravity of the helicopter are important factors to be considered when determining the feasibility of a helicopter landing. Refer to WEIGHT AND BALANCE, AND ACCELERATION LIMITATIONS in Chapter 4 and the performance charts in Part XI to be sure that the maximum gross weight for landing or center-of-gravity limits are not exceeded.

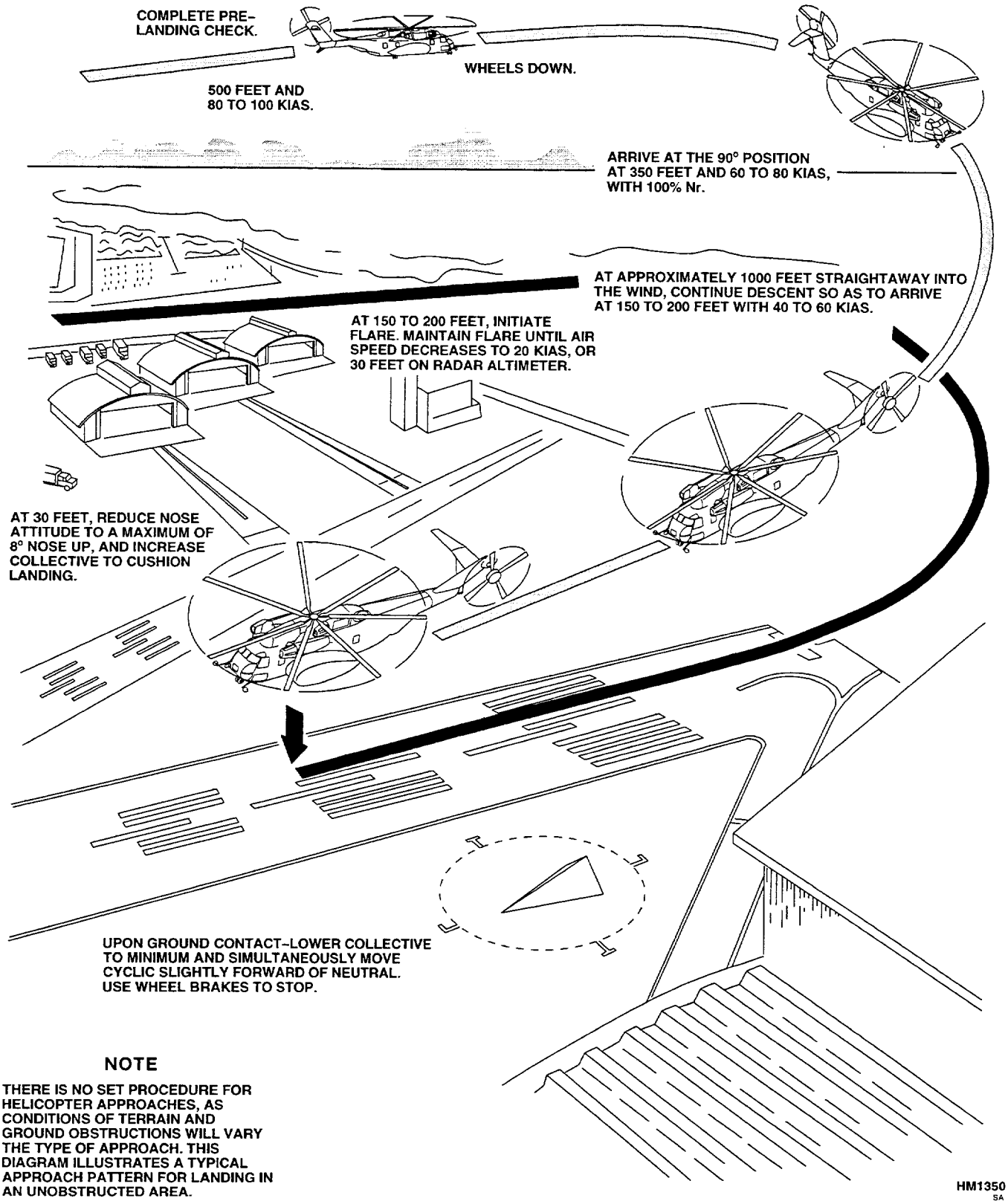


Figure 7-6. Normal Approach and Landing Pattern (Land)

1. Crew and passengers — ALERTED.
2. EAPS — AS REQUIRED.
3. Panel landing checklist:
   a. RPM — AS REQUIRED.
   b. Gear — DOWN.
   c. Brakes — ON OR OFF AS REQUIRED.
   d. Harness — SECURE.
   e. COMM 1 — AUTO OR RETRACT.
   f. Ramp — UP/TAIL SKID DOWN.
   g. Cabin heater — OFF.
   h. Windshield anti-ice — AS REQUIRED.
   i. ALE control panels — SAFE/OFF.
4. Landing checklist — COMPLETE.

7.8.10 Landing. The versatility of the helicopter permits safe operation from unfamiliar and unprepared operating sites such as open fields, mountain knolls, ridges, desert, snow, and ice areas. Although the helicopter is capable of operating from closely confined areas, the final analysis of the situation and the decision to land must be made by the pilot. Before operating the helicopter from unprepared areas, the pilot must make on the spot evaluations and plan his approach, landing, and subsequent takeoff accordingly.

On the spot evaluations may be made by making passes into the wind over the intended landing site at various altitudes and airspeeds. A refined flying technique that includes all phases of flight contributing to desert, mountain, and rough terrain landings is included under mountain and rough terrain flying in Part VI. The procedures outlined herein will produce the results stated in the landing distance-ground roll chart in Part XI.

CAUTION

- Do not use tail skid as a normal landing point.
- Due to normally nose-high attitude during hovering, use caution during landings and hovering maneuvers to avoid striking ground with tail rotor blades (Figures 7-7 and 7-8).
- Landing with tail skid in retracted position may allow tail rotor to contact ground.
- Hydraulic power boost will not be available to wheel brakes until helicopter has settled on oleo struts enough to allow isolation valve to open.
- Excessive nose high attitude with low fuel state can cause flameout.

7.8.10.1 Normal Landing. Before commencing a normal landing, complete prelanding checklist. The landing is approached from an abeam position of 500 feet altitude, AGL, and an airspeed of 80 to 100 KIAS so as to arrive at the 90 degree position at 350 feet altitude AGL, and 60 to 80 KIAS with 100% N_r. Continue the descent to a final approach into the wind with an approximate 1000 foot straightaway at 150 to 200 feet altitude AGL, and an airspeed of 40 to 60 KIAS. Initiate a flare at 150 to 200 feet altitude. Maintain this until the airspeed decreases to 20 KIAS or 30 feet on the radar altimeter. At 30 feet, reduce the nose attitude to a maximum of 8° nose-up and increase collective pitch to cushion the landing. Maintain heading and attitude by use of the rudder pedals and cyclic. After ground contact, steadily reduce collective pitch and simultaneously move cyclic to the neutral position. When transition to a hover is not possible and running landings are not feasible, normal approach procedures may be used for a no-hover landing at a ground speed less than 5 knots.

7.8.10.2 High Gross Weight Landings

WARNING

If engine power is limited (engine topped), droop N_r as required, but do not droop below 100%.

During aircraft landings at high gross weights, ensure that engine speed selector levers are full forward. If engine power is limited, or maximum torque is achieved, consideration should be given to the execution of a wave-off prior to the onset of vortex ring state or settling with power.

The tail rotor blades or tail skid may be struck with the following combinations of nose-up attitude and altitude. This chart is based on zero setting of vertical gyro and accurate radar altimeter.

RADAR ALTITUDE IN FEET	DEGREES OF NOSE-UP ATTITUDE	TAIL SKID	MAIN GEAR STRUTS	GROUND CONTACT
45	51	-	-	Tail rotor
40	46	-	-	Tail rotor
35	40.5	-	-	Tail rotor
30	35	-	-	Tail rotor
28	33	Down	Extended	Tail rotor and skid
25	29.5	Down	Extended	Skid
11.5	17	Up	Extended	Tail rotor and skid
7	13	Up	Extended	Skid
6	10	Down	Extended	Skid
6	10	Up	Compressed	Closed ramp
4.5	8.5	Down	Compressed	Skid

Figure 7-7. Tail Rotor/Skid Ground Contact Chart

7.8.10.3 Running Landing. Running landings are usually made from a shallow approach when the helicopter cannot be hovered due to a high gross weight or altitude. Adjust collective pitch as necessary to maintain the desired approach angle (about 8°), and dissipate speed gradually throughout the approach so the landing can be made while maintaining translational lift. Before attempting a running landing, the surface should be checked from low altitude to determine the feasibility of landing. A running landing should not be attempted on rough terrain. Establish a straight track over the ground and a shallow approach with a slow rate-of-descent. Use rudder pedals to maintain heading in direction of track and cyclic to control drift. Eliminate all side drift before touchdown. As the helicopter approaches the ground, increase collective pitch slightly to reduce rate-of-descent and airspeed to a minimum value (not over 40 knots ground speed) compatible with gross weight and altitude conditions. As the wheels contact the ground, move cyclic to the neutral position and slowly decrease collective pitch to minimum. Stop the helicopter with the wheel brakes. To prevent fire, avoid overbraking, especially at high gross weights.

7.8.10.4 Crosswind Landing. Crosswind landings are the same as into the wind vertical landings except the cyclic must be displaced into the wind. It is important to have no sideward drift during crosswind landings.

7.8.10.5 Practice Single- or Dual-Engine Approaches and Landings

CAUTION

Practice single-engine takeoffs are prohibited. While simulating dual engine failures, the speed control levers shall not be retarded below MIN GOV.

For training, and to maintain pilot proficiency, it is desirable to practice emergency procedures by simulating engine failure(s).

Practice single- or dual-engine approaches may be made to simulate engine failures in which altitude cannot be maintained and an immediate landing is desirable.

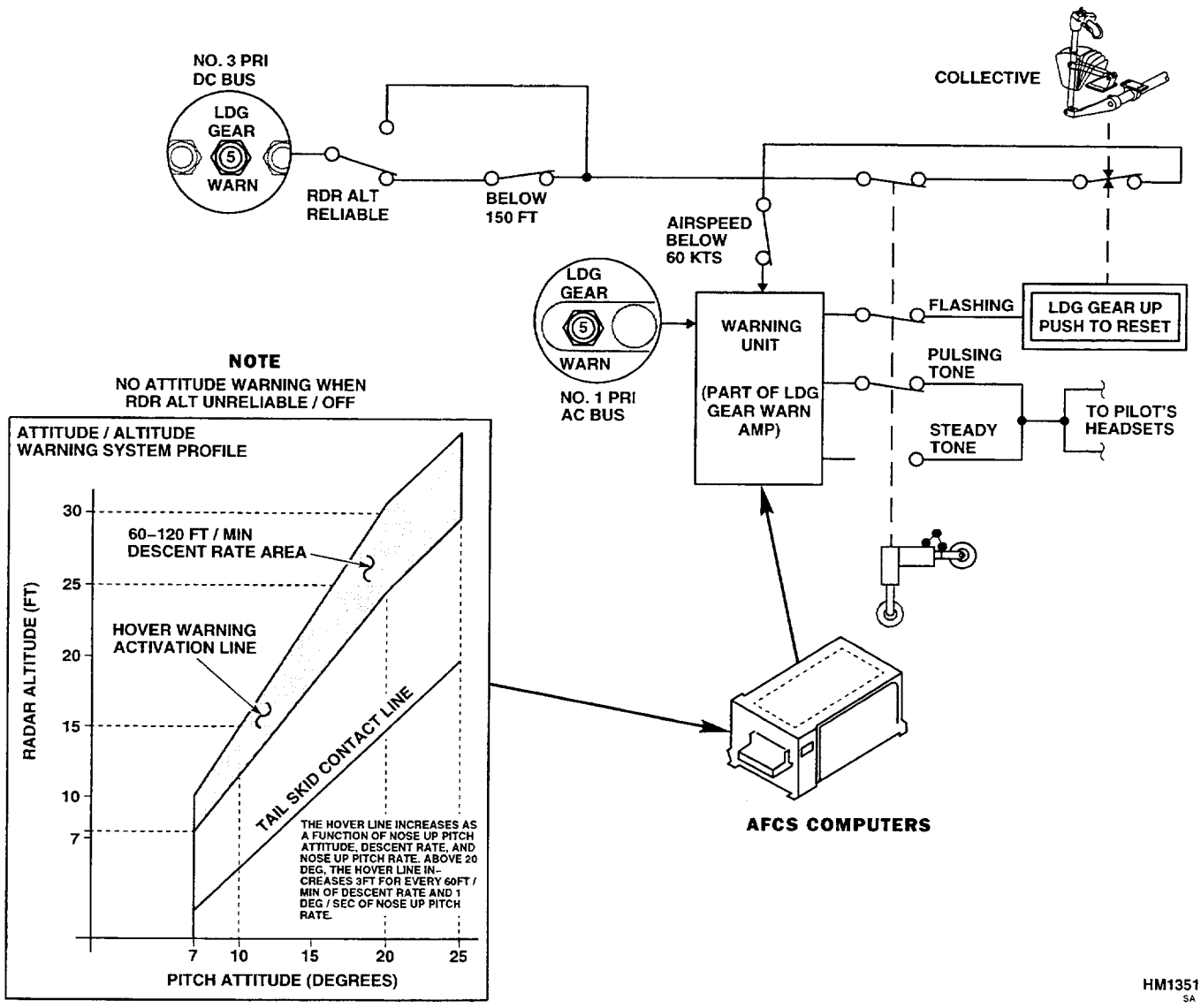


Figure 7-8. Landing Gear/Attitude Warning System

These approaches can be made at other than approved landing areas or airfields; however, recovery shall be made at not less than 200 feet above the terrain and not less than 40 KIAS. Practice single- or dual-engine landings should be made into the wind and shall be performed at approved landing areas or airfields, preferably a hard, flat, smooth surface clear of approach and roll-out obstructions and that have a crash crew available.

Practice single- or dual-engine failure and recovery as follows:

1. One or two speed control levers — RETARD TO MIN GOV.
2. Collective — AS REQUIRED TO MAINTAIN N_r.
3. Engine instruments — ANALYZE.
4. Speed control levers — AS DESIRED.
5. Execute approach and/or landing depending on location/terrain.

7.8.10.6 Slope Landing. When hovering over a slope, ground effect is less than when hovering over level ground. The percentage of ground effect lost will vary with the degree of slope. Before landing on slopes, the parking brake should be applied. Ground contact should be made

using a vertical descent. Sideward motion of the nose gear should be avoided. Landings on slopes up to approximately 4° differ very little from normal, level landings, and any direction of landing may be accomplished. On slopes greater than 4°, a cross-slope landing with the right side upslope is recommended whenever possible. The normal left side low hover attitude makes this type landing easier to accomplish than in other directions. If a right side upslope landing is not possible, the following order of preference in landing is recommended: Nose upslope, left side upslope, and nose downslope. Nose downslope landings should be avoided due to danger of ground contact by the tail skid and/or tail rotor. Takeoffs and landings should be made with smooth positive control movements to permit stopping or aborting the maneuver at any time. The helicopter will have a tendency to slide downslope slightly during landings; however, rapid or excessive control movement should not be used to avoid dynamic rollover. Proper cyclic trim position for takeoff will be retained if the trim is not adjusted after landing. See ROLLOVER CHARACTERISTICS in Part IV.

WARNING

A combination of excessive cyclic and low collective settings or rapid or excessive control movement should not be used to avoid dynamic rollover. During slope operations with the AFCS engaged, cyclic control inputs will be induced by the AFCS due to fuselage attitude changes. These inputs will be in a direction to hold the helicopter on the slope but will reduce rotor-to-fuselage and rotor-to-ground clearance.

If a large cyclic control movement or rapid reduction or collective is applied, excessive rotor blade flapping may occur. If the cyclic control is near the fore or aft position and the collective is lowered rapidly, the rotor blade may flex or dip enough for the blades to contact the helicopter.

Note

For slope landings, utility hydraulic pressure can be made available to the wheel brake power boost system by placing hoist control switch to PILOT, to open isolation valve.

7.8.10.7 Cross-Slope. After the upslope gear is on the ground, use smooth control inputs to maintain a near-level attitude. Reduce collective to place the nose gear on the ground and further reduce collective to lower the downslope gear to the ground. As the collective is reduced, additional lateral cyclic control may be used to help control the rate of roll; however, avoid overcontrolling that could result in rotor blade contact with obstructions on the upslope side of the helicopter. After the helicopter is firmly on the ground, decrease the collective to full down.

WARNING

When the thrust of the rotor system is approximately equal to the weight of the helicopter and one main landing gear is on the ground, the helicopter may roll over on its side if the bank angle (roll angle) reaches 15° with the right gear upslope or 13° with the left gear upslope. Reduce collective to stop the roll and correct the bank angle to a wings-level attitude.

To take off from a cross-slope, slowly increase collective to bring the helicopter to a level attitude before breaking clear of the ground. The helicopter will normally roll towards the downslope side just as the last tire breaks ground. A large upslope lateral cyclic input should not be used as they may reduce rotor-to-ground clearance on the upslope side.

When cross-slope landings and takeoffs are made, the "one-wheel-on-the-ground" maneuver is unavoidable because the upslope wheel touches down first and lifts off last. If the helicopter starts to roll toward the upslope side (5° to 8° bank angle), reduce the collective pitch to correct this condition. Return to a wings-level attitude before continuing the takeoff or landing.

CAUTION

Do not increase collective pitch suddenly to get airborne in attempting to recover from the banked condition. The angle of roll will increase and accelerate before the wheel will lift off the ground. The angle of roll may increase beyond the critical roll angle and/or roll rates may become excessive causing dynamic rollover resulting in the helicopter rolling over on its side. Use smooth moderate collective movements when recovering from a banked attitude with one wheel on the ground. Rapid reduction of collective may cause fuselage - rotor contact or a high rate of roll in the opposite direction. See Dynamic Rollover in Part IV.

7.8.10.8 Nose Upslope. Use a normal vertical rate of descent until the nose gear contacts the ground. As the nose gear touches, slow the rate of descent slightly and use a small (approximately 1 inch) forward cyclic input to hold the nose gear firmly on the ground as the strut compresses. Then lower the main gear at normal rate of descent by reducing collective to the full down position. When the slope is near the limit of 8°, there will be more of a tendency for the helicopter to roll down hill as the main gear descends; however, the roll is normally negligible. Use extreme care in applying additional forward cyclic, as it could result in rotor-blade-to-fuselage contact as the collective is lowered. Monitor rotor blade to ground clearance. After the initial forward cyclic input to get the nose gear firmly on the ground, only very small input (1/4 to 1/8-inch) are required the pitch and roll attitude.

Takeoff is made by increasing collective to establish a level attitude as the nose gear breaks clear of the ground. The cyclic control is used only to stabilize the attitude and not to lift the main gear off the ground.

7.8.10.9 Nose Downslope. The ramp door should be opened to permit a crewmember to observe and report tail skid and rotary rudder clearance. While descending vertically and as the main gear touches down, hold the cyclic essentially fixed, using only small stabilizing inputs, to prevent rotating the tail into the ground. Then decrease the collective to lower the nose gear to the ground. There is very little tendency for the helicopter to slide or to roll if brakes are applied prior to landing.

CAUTION

Slope angles of 5°, with nose-down slope, may cause the tail skid to strike the ground on landing or on rotating for takeoff. This condition is aggravated by tail winds.

Takeoff is made by increasing collective to establish a level attitude. As the main gear breaks ground, there is a tendency for the helicopter to move forward. Extreme caution must be used if this movement must be stopped, since any aft cyclic input may rotate the tail into the ground. If possible, it is best to let the helicopter move forward with little or no aft cyclic input until well clear of the ground. If this is not possible, a crisp and positive vertical rate of climb should be used from just before main gear lift-off until well clear of the ground.

7.8.11 Precision Obstacle Approach. A normal approach will be flown until reaching the final inbound course to the landing site. At this time transition to 45 to 50 KIAS and allow for adequate obstacle clearance. Intercept the glide slope (about 20° to 30°) and reduce power to begin the descent. While descending, do not go over 700 feet-per-minute rate of descent and maintain translational lift until reaching ground effect. Should rate of descent become excessive, or glide slope become excessively steep, execute a waveoff. The approach shall be flown to a hover or no hover landing as desired.

7.8.12 Operation From Confined Area Landing (CAL) Sites. Confined area landings present varied problems and definite procedures cannot be established in all cases. However, certain factors will be standard for all CAL landings.

1. Before any CAL landing, the parking brakes should normally be unlocked unless the site dictates otherwise.

2. When approaching power and telephone lines, it is advisable to fly over the poles or tower rather than over the wire.

3. During routine practice and whenever possible; at least two helicopters should participate so that mutual assistance may be rendered in case of an emergency.

7.8.12.1 Selection of Landing Sites

1. Only designated landing sites will be used for CAL landing practice. A clearing pass will be made before landing on all sites not occupied by competent landing zone control personnel.

2. Refer to 14.5.3 for Landing Site Evaluation considerations.

3. LANDING APPROACH.

The approach shall be a precise maneuver and should not be either so low that the pilot loses sight of the landing point or so high that a very low power setting with a high rate-of-descent is necessary. Approach speed will depend on weight, altitude, and wind conditions. Maintain translational lift as long as possible while avoiding excessive flares and large changes of power. Do not continue in a poor approach. Wave off before a dangerous condition arises.

7.8.12.2 Night Lighting of Confined and Unprepared Areas. Operations require landing in confined unprepared landing zones with or without the use of aircraft lighting systems. Prevailing topographical and/or meteorological conditions may reduce the effectiveness of these aircraft lighting systems, necessitating the use of LZ marker lights. LZ marker lights are required whenever ambient light conditions are such that artificial cues must be provided to enable pilots to maintain depth perception, judge altitude and interpret closure rate. LZ light positioning is a key factor in decreasing the potential for pilot disorientation through fixation or the autokinesis effect. Spacing of lights should be such that at least two lights are visible from each pilot position during the final landing phase to include a normal hover altitude over the intended point of landing. It is desirable that three lights be visible.

WARNING

To decrease the possibility of pilot disorientation, a minimum of two lights shall be observed by the pilot at the controls throughout the final landing phase.

1. Before their deployment, landing zone control parties will be thoroughly briefed on the proper light pattern to be used and in the operation of the angle of approach light to be sure that adequate terrain clearance is obtained on the glide slope to maintain a minimum approach angle consistent with safety.

2. The positioning of landing sites and points in the landing zone will be in the most suitable areas compatible with wind directions and terrain conditions.

3. The helicopter's rotor wash may generate IMC conditions. Initiate a waveoff before a dangerous condition arises.

4. The Helicopter Portable Lighting Set with the GAIL (Guide Angle Indicator Light) should be fully utilized, when available. (See Figure 7-9.)

5. Refer to the Assault Support Helicopter Tactical Manual (NWP 55-9-ASH) under Landing Zone Lighting.

7.8.13 Practice Autorotative Approach. Practice full autorotations to touchdown will not be conducted. Practice power recovery autorotations will always be made into the wind and will be made at approved landing areas or airfields. Always plan an autorotation to an area that will permit a safe landing in an actual emergency, preferably a hard, flat, smooth surface clear of approach and takeoff obstructions. Under conditions of high gross weights, the transition to flare to slow forward speed and stop rate-of-descent becomes very critical. Special precautions must be taken to ensure the security of internal weights. Practice autorotations should be made only during day and dusk conditions. Deviations from straight-in autorotations should be practiced to ensure full utilization of the helicopter capabilities and additional pilot training. Practice autorotations will begin at an altitude that will permit a power off-approach to the desired landing spot and will be terminated at 50 feet AGL. The desired altitude to start practice autorotations is at a minimum of 1,000 feet over the terrain. Main rotor rpm should be set at 100 to 103%. After completion of the cockpit landing checklist and at a selected cruising speed, smoothly lower the collective. Maintain N_r below 110%, and airspeed as determined from Figure 12-3. Entry airspeed for the cyclic flare maneuver should be the airspeed (based on gross weight) for maximum glide distance providing for flare effectiveness. At about 300 ft AGL or as determined by Figure 25-1, execute a smooth, progressive flare by adjusting nose-up pitch attitude as necessary (about 20 to 30°) to reduce ground speed and rate-of-descent. Allow N_r to increase throughout the flare and adjust collective as necessary to prevent N_r from exceeding 110%. Nose-up pitch attitude will be dependent upon aircraft gross weight and ambient conditions. At 100 to 150 feet AGL, lower the nose to the landing attitude (8° maximum nose-up) and raise collective to arrest the helicopter's rate-of-descent. This power recovery should be smoothly executed and should terminate in a waveoff with the helicopter having come no lower than 50 feet AGL. Airspeed at recovery will generally be 0-50 KIAS based on flare effectiveness and landing site options.

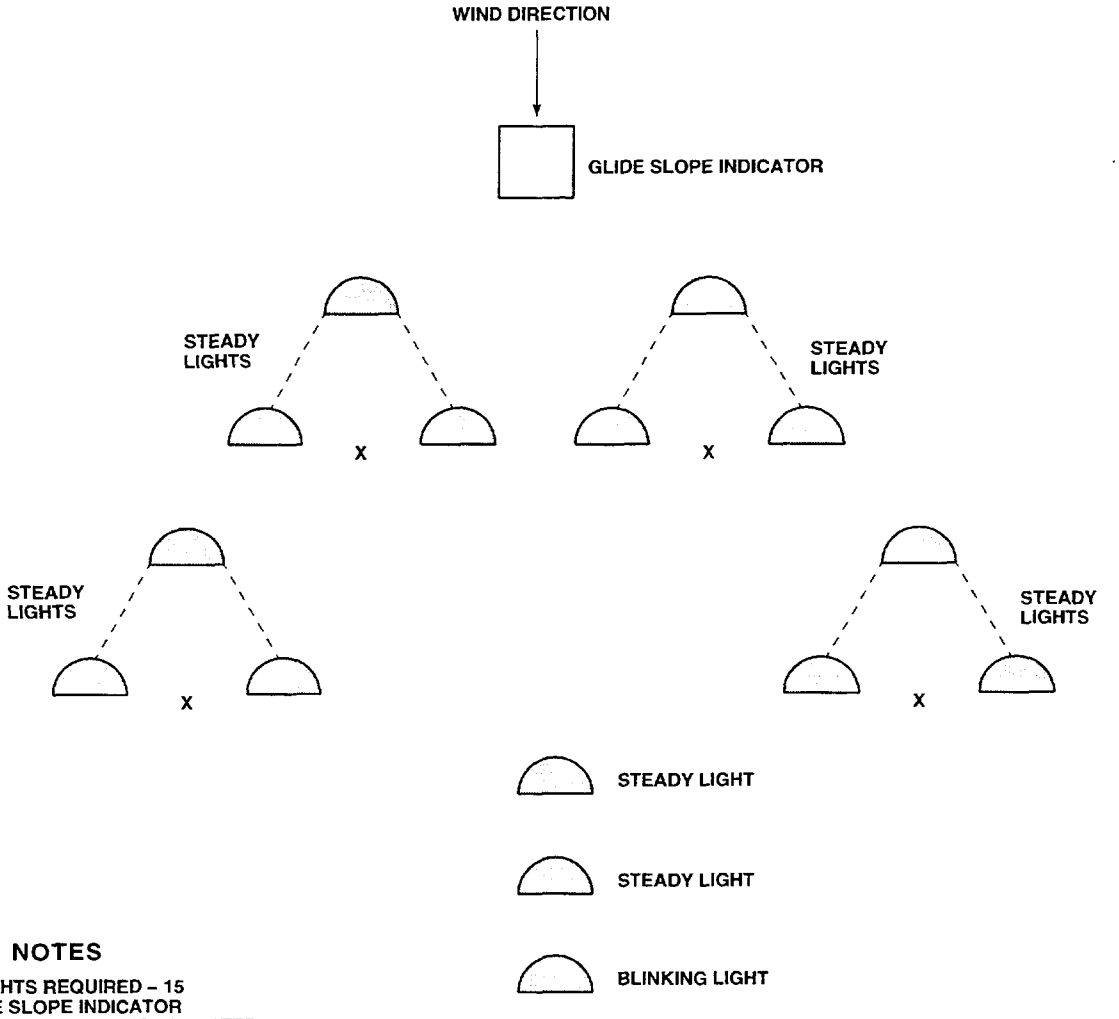


Figure 7-9. Confined and Unprepared Area Lighting Pattern

Note

- Flare effectiveness at airspeeds for minimum rate-of-descent will be marginal in arresting rate of descent.
- Maximum glide distance airspeed provides improved flare effectiveness.
- Practice autorotations should not be attempted in conditions of high gross weight and critical center of gravity loadings.
- Simulated emergencies over other than approved landing sites may be executed wherein an autorotative state is entered; however, recovery will be made at not less than 200 feet above the terrain, and not less than 40 knots. These simulated emergencies are primarily for the purpose of developing sound judgement in the selection of the best available landing site in an emergency situation.

7.8.14 AFCS Off/AFCS Servos Off Practice Maneuvers. AFCS servo off practice flight is permitted in the MH-53E. However, the following minimum guidelines and restrictions apply:

1. AFCS/AFCS SERVOS OFF FLIGHT/HOVER shall be briefed prior to flight. Briefing shall include procedures, acknowledgment, and mode of flight for disengaging/reengaging AFCS/AFCS servos. Engagement/disengagement of AFCS servos shall be made with minimum pilot input to the controls.

2. The AFCS servos shall be engaged/disengaged with the helicopter on the deck with flight controls neutral, or in level flight at or above 200 feet AGL.

3. Verbal acknowledgment by the pilot on the controls is required prior to AFCS/AFCS servo engagement/disengagement.

WARNING

There is a decrease in required collective force of 20 pounds down to 4 pounds when the AFCS servos are reengaged. If the pilot is moving the collective at the moment an AFCS servo is reengaged while airborne, an overshoot or overcorrection with the collective will occur. This overcontrolling motion can result in a violent vertical movement in the helicopter that could progress into a pilot-assisted oscillation situation.

4. External load/AMCM operations with an inoperative/secured AFCS is prohibited.

5. Avoid AFCS OFF/AFCS servos off flight in turbulent conditions.

7.8.15 Waveoff. Accomplish a waveoff (Figure 7-10) by increasing collective pitch to obtain enough power to attain a safe forward speed and establish a climb. Reduce power after obtaining climbing speed and clearing all obstacles.

7.9 PRESSURE REFUELING WITH ROTOR HEAD ENGAGED

CAUTION

When pressure fueling the aircraft to maximum fuel loads, ensure that all main fuel tanks remain selected after high level shutoff is achieved, fuel flow light out. Securing main fuel fill switches, with refuel master power ON, during pressure fueling will allow precheck fuel to enter the tank, which may overfill. In addition, overpressurization may damage the fuel tanks.

Pilot:

1. Landing gear pins — AS REQUIRED.

2. Radar altimeters/Doppler — OFF.

3. Radios and electrical equipment — MINIMUM REQUIRED.

4. Passengers — DEBARKED.

5. Refuel master power switch — ON.

6. Fuel samples — AS REQUIRED.

7. Ramp — LEVEL.

8. Refuel switches — REFUEL.

9. Shutoff test — CHECK.

10. Refuel switches — CLOSE.

11. Refuel master power switch — OFF.

12. Purge as desired.

13. Doppler, RAD ALTS — AS REQUIRED.

14. Radios and electrical equipment — AS REQUIRED.

Crew:

CAUTION

Observe fueling precautionary procedures.

1. Ramp — LEVEL.

2. Passengers — DEBARKED.

3. Landing gear pins — AS DESIRED.

4. Wheel chocks — IN.

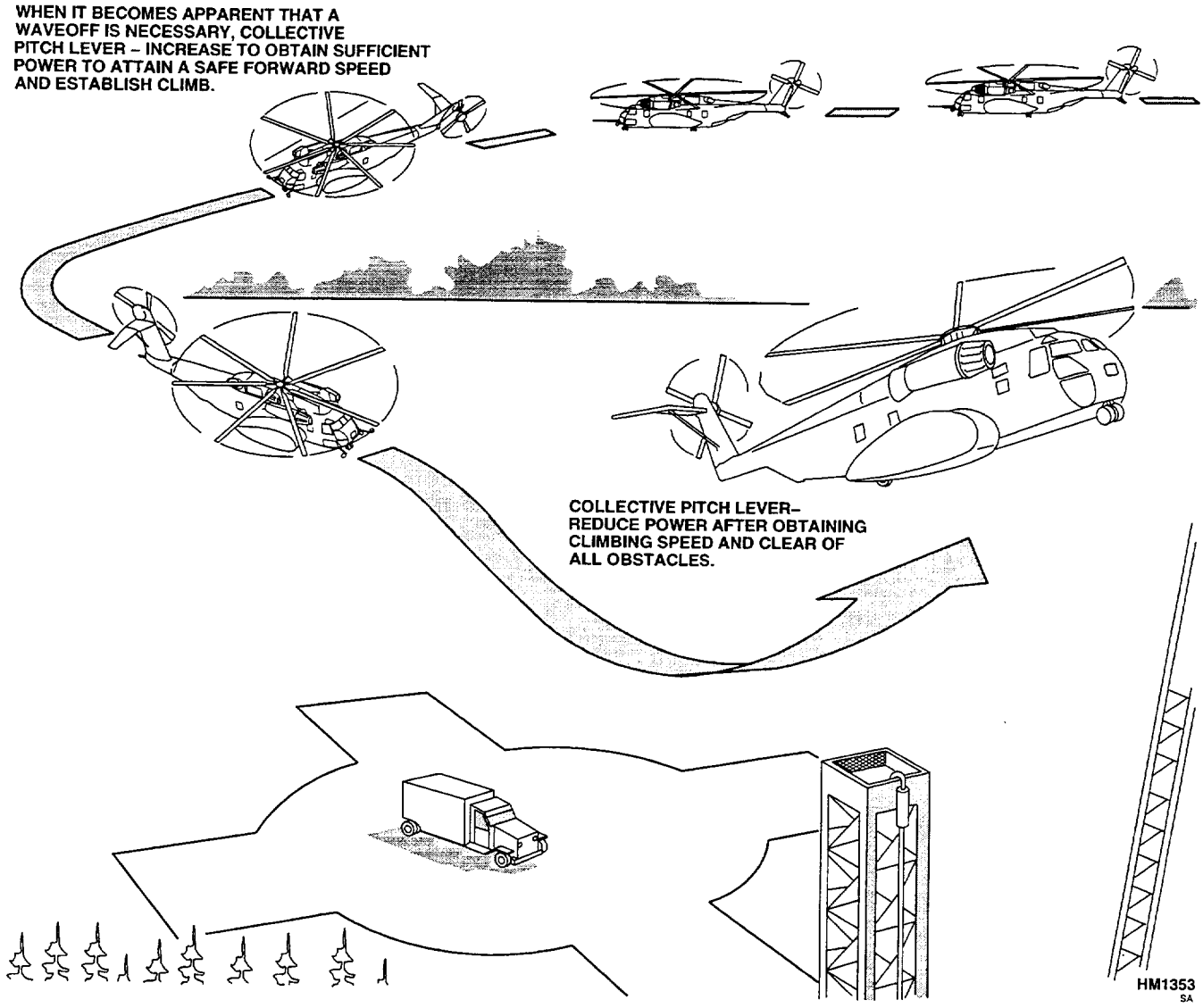


Figure 7-10. Wave-off Diagram (Land)

5. Open pressure refueling access door and remove refueling cap.

6. Ground refueling hose to helicopter before connecting hose.

7. Make sure refueling unit is set for a line pressure of 35 to 55 psi.

8. Be sure manual precheck valves are CLOSED.

WARNING

With precheck valve open, any fuel flow indicates an inoperative shutoff valve. Increased tank pressure during refueling denotes clogged vent lines. Tank pressure must not be over 1.5 psi. In either case, stop refueling operations immediately.

9. Shut down refueling unit on PILOT'S DIRECTION.

10. Disconnect refueling nozzle, disconnect all ground wires, and secure access door.

11. Chocks — REMOVED.

12. Landing gear pins — AS REQUIRED.

13. Ramp — AS DESIRED.

14. Notify pilot — WHEN READY.

7.10 SHUTDOWN

*1. Parking brake — SET.

*2. Landing lights — OFF.

*3. Landing gear pins and chocks — INSTALLED.

*4. N_r — 100%.

*5. AMCM tow panel — OFF.

*6. UTILITY 2 — OFF.

*7. APP — START.

Note

During MRH shutdown with an inoperable APP, loss of generators will result in an immediate loss of all electrical instruments, internal fire detection/extinguishing ability, warning systems, ICS, and AFCS. First stage hydraulics will be available until the rotor system is nearly stopped, however system authority will decay as N_r decays.

*8. No. 2 generator — OFF.

*9. Flight controls — POSITION FOR SHUTDOWN, CONTROLS NEUTRAL, AND COLLECTIVE FULL DOWN.

CAUTION

If the longitudinal bias actuator fails, the actuator may stop in any position; therefore, the pilot shall not rely on the position of the cyclic on rotor shutdown, but must observe the position of the tip path plane and move the cyclic as necessary to prevent damage to the droop stops as rotor speed decays.

Note

To provide engine cooling before engine shutdown, one of the following conditions must occur before moving the speed control levers to SHUT-OFF. (However, in an emergency, the engines may be shut down immediately.) (a) One minute of taxiing. (b) One minute of operation at or above the minimum governing range and with minimum collective pitch. (c) One minute at GRD IDLE.

*10. Alternate on-line engine wash — AS REQUIRED.

Note

When gusty wind conditions and/or high sea states are encountered on shutdown and engine washing is required, use of the Alternate On-Line Engine Wash on Shutdown procedures should be considered. For rotor disengagement wind limitations, refer to applicable NATOPS publication (CV NATOPS, LHD/LHA/LPH NATOPS, etc.).

ALTERNATE ON-LINE ENGINE WASH ON SHUTDOWN:

1. While maintaining 100% N_r with the No. 3 engine, No. 1 and No. 2 engines — GRD IDLE.

Note

Alert maintenance personnel that the No. 1 and No. 2 engines are ready for wash procedure.

2. No. 1 and No. 2 engine wash — AS REQUIRED.
3. No. 1 and No. 2 engines — 100% N_f.
4. No. 3 engine — GRD IDLE.
5. No. 3 engine wash — AS REQUIRED.
6. Set engines:
   a. No. 3 engine — 100% N_f.
   b. No. 1 and No. 2 engines — GRD IDLE.

Note

Maintain No. 3 engine at 100% N_f for 15 minutes to clear wash residue.

11. Normal on-line engine wash — AS REQUIRED.
    a. Three engines — GROUND IDLE.
    b. Collective — GRADUALLY RAISE TO DETENT POSITION AND NEUTRALIZE TIP PATH PLANE WITH CYCLIC.
    c. Droop stops — IN.
    d. No. 1, No. 2, and No. 3 engine wash — AS REQUIRED.

*12. Any two engines — GROUND IDLE, SHUT OFF.

*13. Third engine — GROUND IDLE.

*14. Collective — GRADUALLY RAISE TO DETENT POSITION AND NEUTRALIZE TIP PATH PLANE WITH CYCLIC.

CAUTION

Do not rely on the stick position indicator for an accurate indication of tip path plane position.

*15. Droop stops — IN.

Note

If, during rotor shutdown, one or more droop stops fail to go in, increase N_r above 75%. Recheck tip path plane at neutral position and reattempt rotor shutdown. If droop stop does not go in, check that rotor area is clear of personnel, and then proceed with normal shutdown procedure while maintaining cyclic in a neutral position. If a droop stop comes out, or is out after rotor brake has been applied, continue shutdown procedure.

*16. Third engine — SHUT OFF.

Note

If an engine post-shutdown fire should occur as indicated by a continuous or rising power turbine inlet temperature T_5 above 320°C, engage starter and motor engine until fire is put out.

*17. Low-pressure rotor brake — ON AT 25% N_r (ROTOR BRAKE LIGHT OUT) AND HOLD AT ON 5 SECONDS.

This starts the rotor brake hydraulic pump and the ROTOR BRAKE PRESS caution light goes on after 10 psi is reached. After 350 psi is reached, the pump automatically stops for 60 seconds and then automatically restarts. The ROTOR BRAKE ON advisory light goes on after 975 psi is reached.

For shipboard or high gusting wind conditions, a high energy rotor brake application is made with all engines shut off, N_r 50% to 25% (rotor brake light on), high-pressure rotor brake switch at EMER.

An emergency brake application can be made at any N_r with all engines shut off and high-pressure rotor brake switch at EMER.

WARNING

A fire hazard exists during emergency brake application due to the heat generated and the presence of debris and oil in the rotor brake area.

CAUTION

If the APP is inoperative and external power is not available, shut down engines and allow rotor to coast to a stop. If an immediate shutdown is necessary without an APP or external power, place the high-pressure rotor brake switch to EMER and shut down all engines immediately. With all engines shut down, the rotor brake will stop the rotor within 30 seconds after high-pressure brake application.

Note

The RTR BK light on the N_f/N_r tachometers goes on when N_r decays to 50 ±4% N_r and remains on until N_r decays below 25 ±4%.

*18. High-pressure rotor brake switch — EMER.

*19. Engine fuel selectors — SHUTOFF.

CAUTION

Before fold sequence, make sure flap and droop restrainers are in. Restrainers not in may allow a blade to fold at an improper angle and damage the blade or airframe.

Note

Be sure tail rotor anti-flap restrainers are engaged to prevent tail rotor component damage due to gusting winds.

20. Blade/pylon fold — AS REQUIRED.

a. Area — CLEAR.

b. High-pressure rotor brake — EMER.

c. Gust lock — UNLOCKED.

d. Master power switch — POWER.

CAUTION

When the safety valve open light on the blade fold panel is on and the pitch lock switch is placed to engage, the pitch locks will attempt to engage regardless of head position. Ensure the pitch lock switch is in the disengaged position before:

(1) Positioning the rotor head for start.

(2) Opening the safety valve for blade or pylon fold.

SAFETY VALVE OPEN light goes on. FLIGHT READY light goes off. BLADE PYLON FOLD caution light goes on.

e. Blade fold position switch — BLADE FOLD POSN. ROTOR BRAKE ON advisory light goes off during positioning. HEAD IN FOLD POSITION light and ROTOR BRAKE ON advisory light go on after head positions.

f. Pitch locks — ENGAGE.

(1) Rudder pedals neutral.

(2) Collective seated in detent.

Note

Raise collective above detent, then slowly lower to detent as indicated by first lighting of stick position indicator.

(3) Position cyclic to light the center position arrows.

(4) Pitch lock switch — PITCH LOCK.

Note

Stick position indication may change as pitch locks engage.

PITCH LOCK ADVANCED light goes on as locks start to advance. In addition, 2 STG M/R SERVO BYPAS caution light goes on. The second stage hydraulic pressure gage indicates normal. The

stick position indicator may deviate from center indication as pitch locks engage. The PITCH LOCKS ENGAGED light goes on when all six pitch locks are extended and engaged.

CAUTION

- Do not move cyclic from center position after pitch locks are engaged.
- With the pitch locks engaged, do not push the blade fold control valve's manual override (on the rotor head) to fold until the rotor head has been positioned for blade fold.

g. Blade fold/spread switch — FOLD.

BLADES FOLDED light goes on when blades fully folded.

CAUTION

Center the cyclic before engagement or disengagement of the AFCS servos. Failure to do so may cause the FAS shear pin to fail.

h. AFCS servos — OFF.

CAUTION

The tail rotor shall be manually secured prior to pylon fold.

i. Pylon fold/spread switch — FOLD.

PYLON UNSAFE FOR FLIGHT light goes on.

j. Tail rotor actuator — EXTENDS.

k. Blade fold position, blade fold/spread, and pylon fold/spread switches — OFF.

l. Master power switch — OFF.

21. If pylon not folded

a. Trim and AFCS pushbutton — OFF.

b. AFCS SERVO 2 — UNARMED.

c. AFCS SERVO 1 — ON.

22. Gust lock — AS DESIRED.

*23. All radio/electrical switches — OFF.

*24. Emergency exit light — OFF.

Note

Turn off emergency exit lights before the last operating generator is shut down. Otherwise, lights will automatically go on whenever dc buses are deenergized, and then cannot be turned off until dc buses are again energized.

*25. Computer bite code — CHECK.

*26. CMPTR POWER — OFF.

*27. Exterior/interior lights — OFF.

*28. No. 1 and No. 3 generators — OFF.

*29. APP — SHUTDOWN.

*30. Side circular window vents — CLOSED.

7.10.1 Postflight Inspection. The crew should do a postflight inspection immediately after completing the assigned mission. This shall consist of a visual inspection of the landing gear, fuselage, rotor and transmission system, and engines. The pilot should enter, on the maintenance discrepancy sheet, all discrepancies noted in flight and during postflight. To aid in discrepancy analysis, specific information related to the discrepancy noted in flight, such as position of controls, instrument readings, etc., should be included with the report. Qualified maintenance personnel should be available for consultation. The pilot will make sure that all discrepancies have been completely and comprehensively conveyed, both orally and in writing.

7.11 BLADE/PYLON FOLD/SPREAD SEQUENCING

Refer to FO-44.

7.12 MANUAL PYLON FOLD/SPREAD SYSTEM

The system uses hydraulic pressure developed by the handpump (Figure 7-11) mounted forward on the right side of the cabin, to fold and spread the pylon. A red flag on the bottom of the tail cone is visible when the tail rotor drive shaft is uncoupled. Two red flags on the left side of the tail cone are visible when the locking pins are not seated. The flags move in direct proportion to lockpin travel.

7.12.1 Manual Pylon Fold/Spread Operation

WARNING

The tail rotor shall be secured loosely to the tail skid before pylon fold/spread and while folded, as wind will spin the tail rotor when the tail rotor drive shaft is uncoupled.

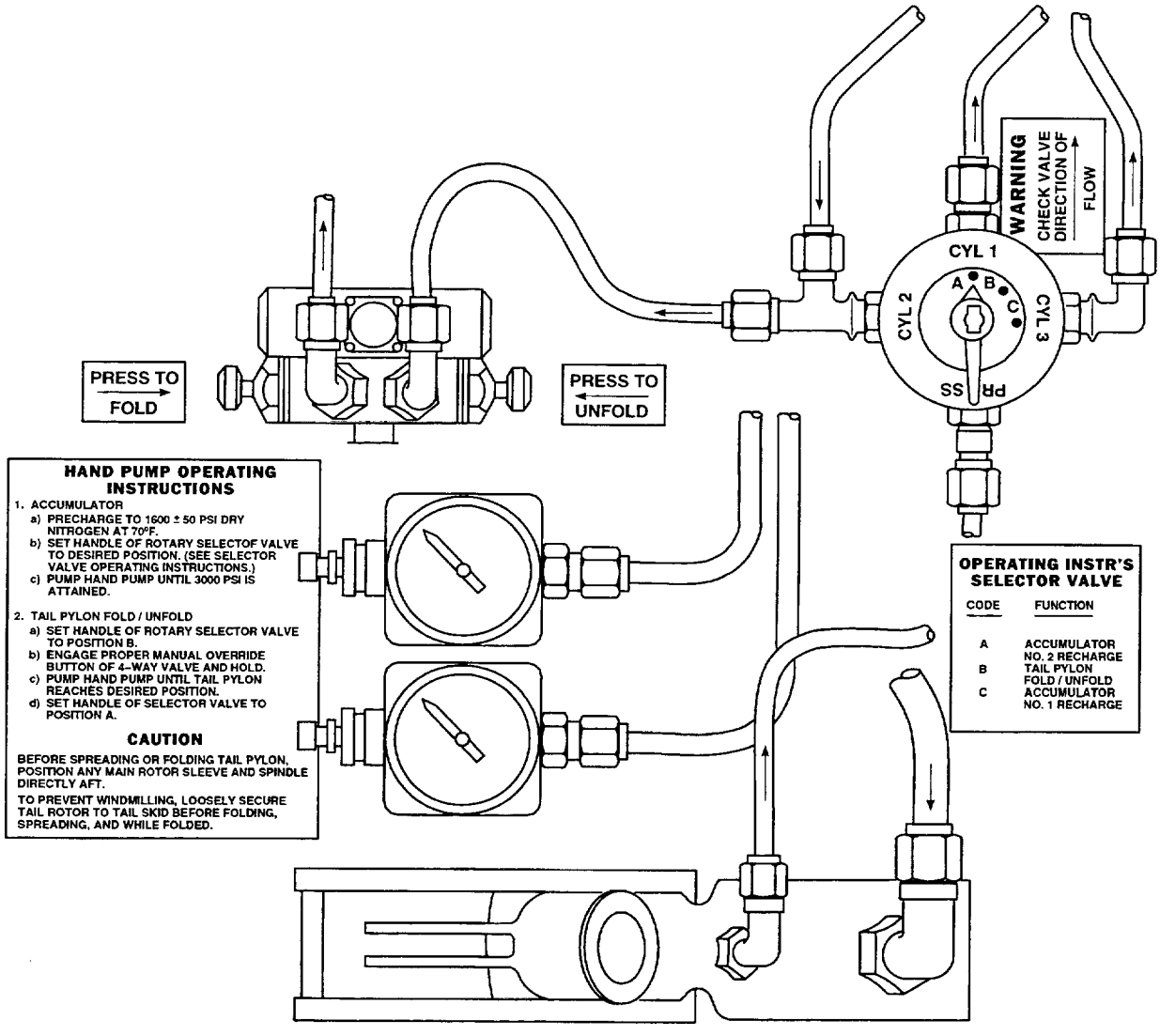


Figure 7-11. Hydraulic Handpump

7.12.1.1 To Fold

1. Tail rotor — SECURED.

2. Position any main rotor blade in the 5:30 to 6:00 position.

3. Gust lock — ON.

4. Observer stationed to monitor main rotor blade and pylon clearance during fold cycle.

5. Handpump selector valve — POSITION B.

6. PRESS TO FOLD valve button — HOLD PRESSED.

7. Handpump — PUMP.

8. Pylon folded, and pump selector valve — POSITION A.

7.12.1.2 To Spread

CAUTION

If pylon is spread manually, tail rotor positioner may be extended. With positioner extended, movement of main rotor will damage positioner actuator.

1. Tail rotor — SECURED.

2. Position any main rotor blade in the 5:30 to 6:00 position.

3. Area/strut — CLEAR/REMOVED.

4. Gust lock — ON.

5. Observer stationed to monitor main rotor blade and pylon clearance during spread cycle.

6. Handpump selector valve — POSITION B.

7. PRESS TO UNFOLD valve button — HOLD PRESSED.

8. Handpump — PUMP.

9. Three external flags — RETRACTED COMPLETELY.

10. Handpump selector valve — POSITION A.

11. Tail rotor — UNSECURED.

CHAPTER 8
Shipboard Procedures

8.1 COMMAND RESPONSIBILITY

Command relationships and general procedures to be followed are contained in NWP 42, APP-2/Supplement (HOSTAC) and CV, LHA, LPH, and LHD NATOPS Manuals.

8.2 FLIGHT SCHEDULING

The squadron training and operational requirements must be coordinated with the needs of the ship through the ship's air operations officer. The squadron's flight schedule is derived from the ship's air plan. This is a complete daily schedule of flights and mission to be performed. The air plan is promulgated by the operations department and becomes an order of the commanding officer of the ship.

8.3 HANGAR AND FLIGHT DECK PROCEDURES

General flight and hangar deck procedures can be found in the applicable NATOPS manuals and NWP series.

8.3.1 Precautions in Movement of Helicopters.

CAUTION

- The APP should be started before moving the helicopter on the flight deck, to be sure of adequate braking action.
- Tow tractors are not capable of handling the weight of the helicopter on slippery or pitching decks.

Precautions must be observed in all movement to prevent the possibility of damage to the relatively light structural members and rotor blades. Normal movement of helicopters on the hangar and flight deck will be made by using a tractor equipped with a tow bar. In all cases of deck movement, a qualified individual will be in the cockpit to be sure the helicopter will be moved at a slow and safe speed.

8.3.2 Starting APP and Engines. The auxiliary powerplant (APP) and the engines will not be started on the hangar deck unless operational necessity dictates, and prior approval is received from the ship's air department.

WARNING

Flight deck personnel shall be familiar with the APP and engine exhaust profiles (Figure 7-2).

8.3.3 Flight Deck Procedures.

1. Flight deck handling procedures and aircraft handling signals are contained in the applicable NATOPS manuals.

2. Starting the auxiliary powerplant (APP), the engines, rotor turn-up, and taxiing will be done only upon direction of personnel from the ship's air department.

3. Movement of helicopters will be under positive control of directors.

4. The maximum safe relative wind conditions for unfolding or folding the rotor blades or rotor engagement is 45 knots from any quadrant.

8.3.4 Manning Helicopters. Upon receipt of the word to "man aircraft", flight crews will expedite movement to the helicopter and complete the preflight inspection. The helicopter will then be manned in accordance with existing conditions of readiness.

WARNING

Extreme caution shall be taken by pilots and crew during preflight inspection of the rotor head, pylon, and while walking along the upper fuselage walkways. Due to possible slippery footing conditions, ship's motion, and the lack of good handholds, personnel injury may result.

8.3.5 Starting Engines. Preparation for starting the auxiliary powerplant and engines shall be made by the helicopter crew immediately after they enter the helicopter. Upon signal from the Landing Signalman Enlisted (LSE), the auxiliary powerplant and the engines will be started and the checklist completed as far as possible in accordance with existing prestart and starting checklists. A visual signal will be passed to the LSE as soon as the pilot determines that he is ready to engage rotors.

8.3.6 Starting Rotors. Rotors will be engaged only upon the signal from the LSE. The mandatory requirements for engagement of the rotors are:

1. Rotor blade tiedown removed.

2. Flight deck area clear of unnecessary personnel and loose gear.

3. Deck tiedowns secure and chocks in place.

WARNING

If it is necessary to engage the rotor while the helicopter is tied down, it is mandatory that the tiedown chains be attached with slack, thus relieving any tension in the chains attached above the oleos. Engagement of the rotor while the helicopter is tied down tightly will result in ground resonance.

After the rotor engagement is completed, the pilot will continue with the cockpit checklist. When completed and ready for takeoff, he shall indicate an (up status) signal to the LSE. The checklist should be made as rapidly as possible, consistent with safety. However, one pilot shall keep the LSE in sight and be prepared to receive signals at any time. When directed and following an up status signal from the pilot, the tiedowns shall be removed. In case of a down status signal from the pilot, chocks and tiedowns will be left on. Upon getting a disengage signal from the LSE, the pilot will proceed with a normal shutdown, and fold the rotor and pylon if directed. If the pilot deems it necessary to shut down immediately, he will do so and advise the ship.

8.4 LAUNCH AND RECOVERY OPERATIONS

See appropriate Ship/NATOPS Manual.

WARNING

During shipboard operations in the presence of radar or HF transmissions the following may occur:

1. BIM caution light illumination.

2. Increased ICS background noise.

3. Erratic quadruple tachometer indications.

4. Erratic triple torquemeter indications.

5. Erratic radar altitude indications.

6. AFCS inputs (1/2-inch maximum stick movement) accompanied by failure advisory lights/AFCS degraded light.

8.4.1 Relative Wind for Launch and Recovery.

1. Launch and recovery should be made into the relative wind, never exceeding a 35 knot crosswind component.

CAUTION

Takeoff and landing in high relative winds may increase the hazardous effects of turbulence from rotor downwash to personnel and unsecured equipment. (Refer to Figures 11-3 through 11-6.)

2. Operations in the island wash area should be held to a minimum.

3. See LHA, LPH, and LHD NATOPS for launch and recovery wind limits.

8.4.2 Shipboard Pattern Limitations. During takeoffs, nose down pitch should be limited to 5° maximum. The pilot not at the controls should monitor flight parameters until 300 feet and 80 KIAS are attained, to ensure achieving a positive rate of climb and an increase in airspeed. Departures should be made on the ship's BRC or straight ahead as appropriate. Consideration should be given to using the BAR ALT feature during shipboard

patterns to maintain desired altitude. On approach, the aircraft should not descend below 200 feet prior to the 90° position. All landings should be made by the pilot nearest the island or hangar.

WARNING

It is mandatory to obey a waveoff or hold signal from the LSE.

8.5 EMERGENCY PROCEDURES

Refer to Part V and appropriate Ship/NATOPS Manual.

8.6 NIGHT OPERATIONS

See Appropriate Ship/NATOPS Manual.

Night operations are always the most critical for both pilots and flight deck crews. The tempo of operations must be reduced in both volume and speed when compared to day operations. Slow and careful handling of helicopters by pilots and flight deck crews is mandatory. Particular attention must be given to be sure that all personnel involved in night operations are well briefed in their duties and procedures by the appropriate ship and squadron authority. Preflight and postflight inspections will be done in the same manner as for day operations.

During shipboard operations, instrument takeoffs shall be utilized any time weather is less than 500 feet ceiling and 1 mile visibility or during night flight operations when there is no visible horizon. When flight deck conditions permit, takeoffs should be made utilizing remaining flight deck during transition to forward flight, thereby taking advantage of ground effect during initial acceleration. At night, the additional power required between HIGE and HOGE can deceive the pilots into a false impression of having added enough power for a normal climb when in fact no climb has been initiated. During night ITOs both pilots must closely monitor initial rate of climb utilizing both radar altimeter and vertical speed indicator (VSI). Descent or lack of climb during takeoff requires immediate corrective action. Heading and radio frequency changes should not be initiated prior to 300 feet and 80 KIAS.

WARNING

Pilots must anticipate approximately a 15% increase in power required upon transition from HIGE to HOGE during shipboard takeoffs.

CAUTION

Shipboard takeoffs at near maximum gross weight for conditions may not allow initial instrument climbs of 500 feet per minute.

8.7 AVIATION FACILITY SHIP

The certification or waiver status of each aviation ship should be examined before operations such as landings, VERTREP, and HIFR are commenced. Certification of a facility for operations guarantees adequate clearance, deck strength, firefighting, lights, markings, communications, etc., according to the level and class of operation as designated by CNO. However, Fleet Commanders in Chief have waiver authority to provide for required helicopter operations when a facility is not certified. Pilots operating from these ships should be aware that personnel training and operational familiarity is normally less than that found aboard an LHA or LPH. Thus, the pilots and crew will have to be more alert. Launching procedures are the same as for shipboard operations. However, due to the configuration of these ships, limited deck space, gun mounts, cranes, and antennas, the helicopter director will launch the helicopter to either port or starboard. The pilot must be sure he is being launched into the relative wind. Recovery procedures will be the same as for shipboard operations. The pilot should not land until assured by the copilot and aircrewman that the area is clear for landing and that the main gear is over the flight deck. The areas certified for landings are of adequate size, providing the forward wheels are within the 24-foot diameter circle (preferably on the 4-foot dot) and the helicopter is aligned with the lineup line. Clearances during VERTREP over certified facilities are provided when the helicopter is aligned over, 15 feet above, and parallel the dashed VERTREP lineup lines. Clearance is also provided when similarly aligned over the top of a series of

Ts found on some ships with large VERTREP areas. VERTREP may also be safely conducted aft of the Ts or either another reversed series of Ts or the edge of the VERTREP area.

Note

- Specific data can be found in the HOSTAC.

- Non-aviation ship's deck edge power may not be compatible with the helicopter's electrical system. Use of the APP will be needed for ground electrical power checks.

CHAPTER 9
Special Procedures

9.1 FORMATION FLYING

It is essential that the fundamentals of formation flying be practiced. The procedures and positions contained herein provide a foundation for formation flying which will meet most combat and non-combat mission requirements. The signal for a change in a formation may be made by the radio, on a squadron common frequency, or by appropriate aircraft signals outlined in Figure 9-1. However, no changes in formation will take place until all helicopters in the formation understand and acknowledge the signals given.

9.1.1 Elements of a Formation. The elements of a formation are a section consisting of two aircraft and a division consisting of three or four helicopters (two sections). Two or more divisions form a flight. The disposition of members within a formation, i.e., heavy right, heavy left, etc., will be at the discretion of the flight leader.

9.1.2 Basic Formations. The three basic formations are parade, tactical, and other. Parade is used primarily when there is a requirement for aircraft to fly a fixed bearing in close proximity and when maximum maneuverability is not essential. It is most frequently employed during arrival at or departure from ships and airfields or during flight demonstrations. Power is varied to maintain position. When maneuverability is a prime consideration for formations engaged in combat tactics, tactical formation are used. Through the use of a tactical formation the leader is able to maintain formation integrity and still be free to maneuver with few restrictions. The tactical formations outlined herein afford this flexibility. Radius of turn rather than power is varied to maintain position.

9.1.3 Parade Formations

9.1.3.1 Types. The four basic types of parade formation are echelon, fingertip (Figure 9-2), diamond (Figure 9-3), and column.

9.1.3.2 Positions. The parade position for echelon, fingertip, and diamond is on a 45° bearing with 10 feet of step-up and one and one-half rotor diameter diagonal clearance. This position provides adequate longitudinal and lateral clearance between helicopters. In fingertip and diamond, the section leader will fly the same position on the leader as the number two man. The column position is on a 0° bearing with 10 feet of step-up and two rotor diameters longitudinal clearance.

9.1.4 Parade Turns

9.1.4.1 Echelon and Fingertip. Wingmen will rotate about the leader's longitudinal axis during all turns.

SIGNAL	MEANING	RESPONSE
Series of zooms by lead aircraft	Join up; join up on me (Given from cruise, column, or scout lines)	Repeat signal to pass to subsequent aircraft and to acknowledge, then execute
Wing dip	Given from column following join-up signal to indicate section join-up on side of dip (heavy side)	Execute
Lead plane swishes tail	All helicopters in this formation form step-up column in tactical order behind leader	Execute. Leader steps down slightly to aid formation of column
Leader's rotating beacon on	No. 2 helicopter has lead	No. 2 helicopters turns beacon off (if on) and assumes lead

Figure 9-1. Supplementary Signals for Helicopters

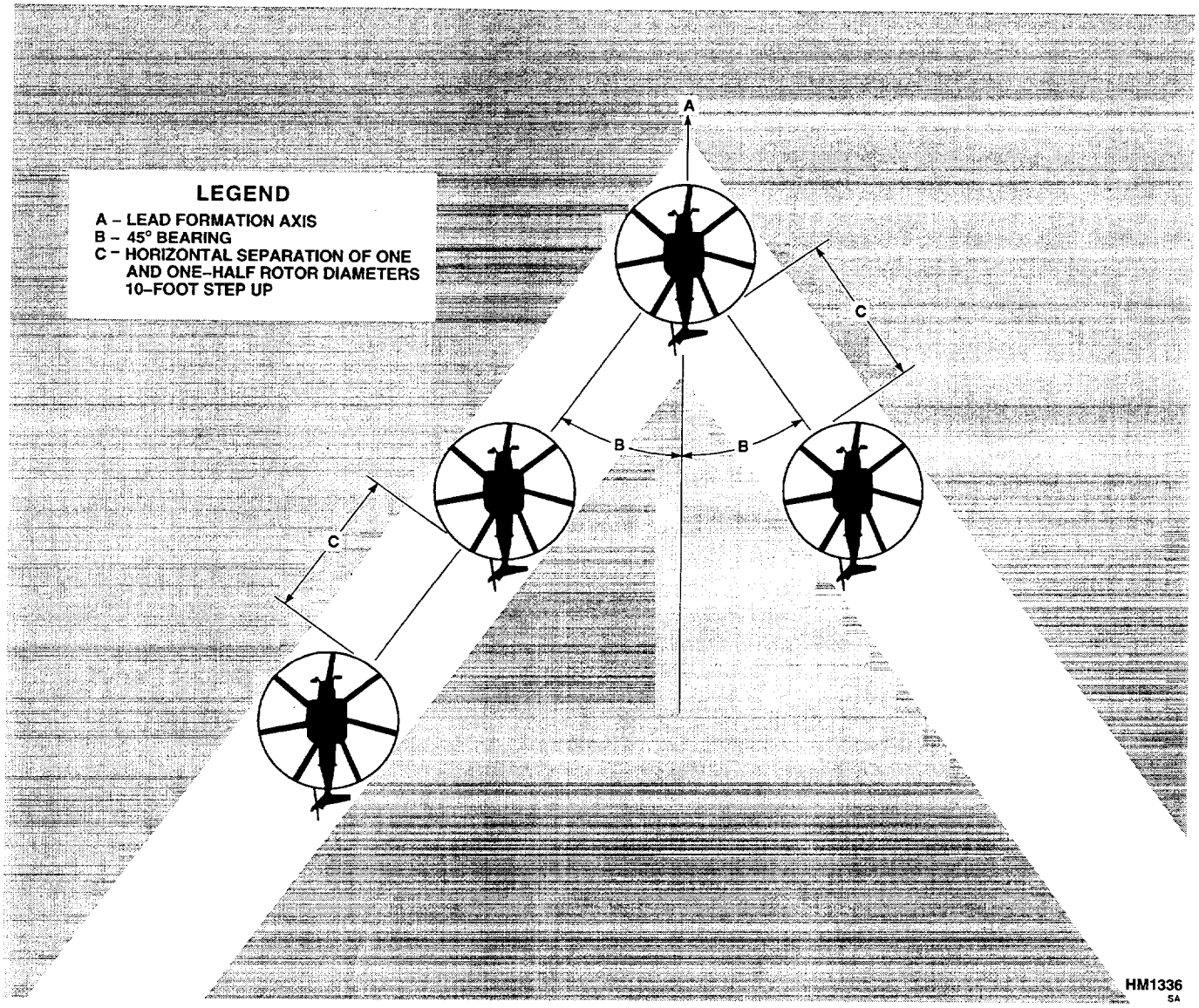


Figure 9-2. Four-plane Division Parade (Fingertip)

9.1.4.2 Diamond and Column. Wingmen will maintain a fixed position and roll about the leader's longitudinal axis on all turns.

9.1.5 Tactical Formations. Refer to NWP 55-9-ASH.

9.1.6 Other Formations

9.1.6.1 Cruise. The cruise position (Figure 9-4) is on a 45° bearing with 10 feet of step-up and a minimum of two rotor diameters separation. This position will provide adequate longitudinal and lateral clearance between helicopter for maximum maneuverability. The wingman will primarily use radius of turn rather than power adjustments to maintain position and is free to maneuver between the 45° left and 45° right bearings. If another helicopter or section is in the formation, dash three will allow room for dash two to maneuver freely between dash three and the leader.

9.1.6.2 Tail Chase. The tail chase formation is flown in a loose column and all wingmen will utilize basic cruise turn principles to maintain longitudinal clearance between helicopter. The formation is most commonly used in conjunction with the basic cruise formation when the leader is required to maneuver extensively through climbs, dives, and turns for the purpose of defensive evasive maneuvering, approaches to confined LZs, etc. When the

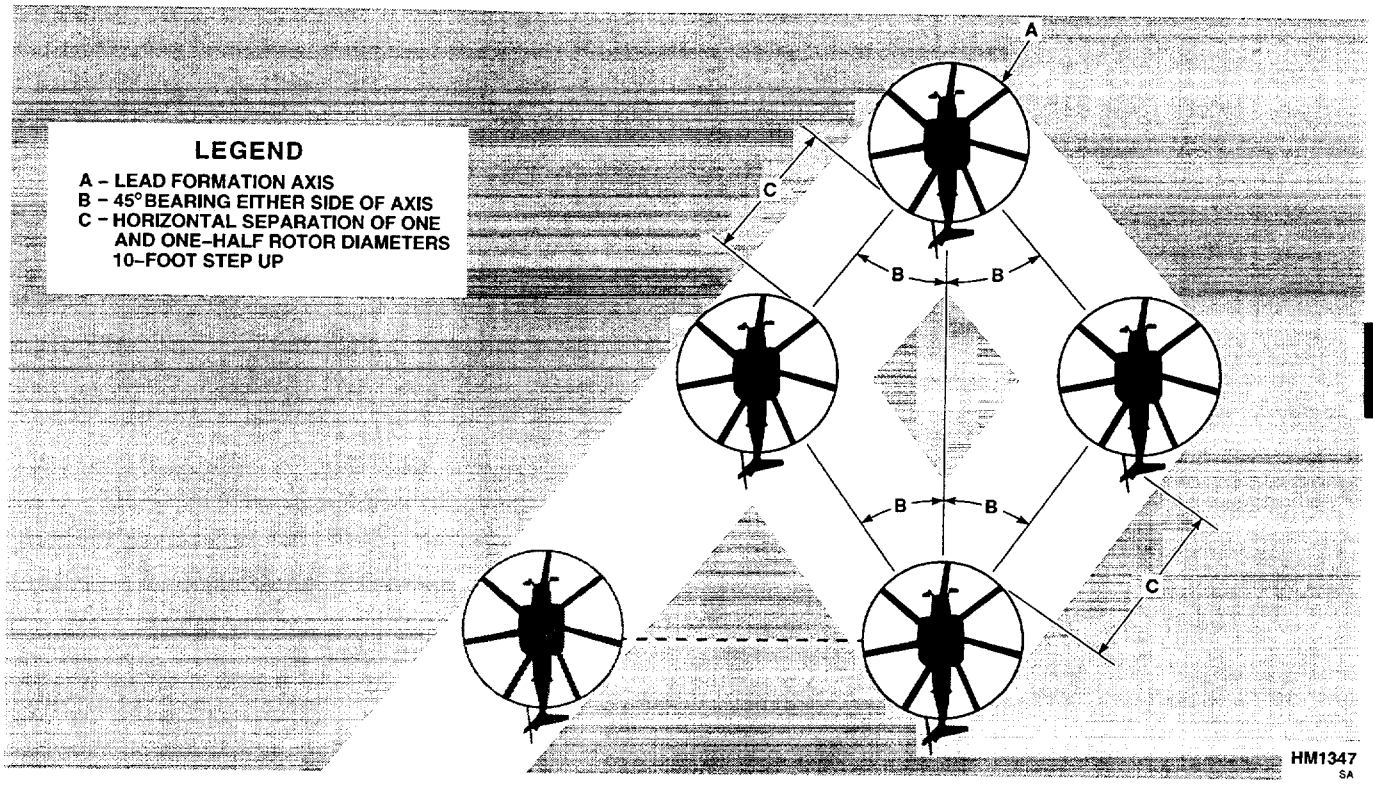


Figure 9-3. Diamond Parade

need for the tail chase ceases, the leader should return the formation to normal cruise formation.

9.1.6.3 Scouting Line. During flights that require increased lookout capability and where a high degree of maneuverability is not required, the leader may desire to move his wingmen forward and out from the normal cruise position. The degree of maneuverability required will dictate the bearing and distance between helicopter in the formation. The more forward the bearing, the greater lookout support and ease of maintaining position and the less maneuverable the flight. This type of formation is generally employed on routine flights over extended distances.

9.1.7 Crossovers. Crossovers will be made by individual wingmen or sections when directed by the leader. The leader must make sure that all helicopters in formation are aware of an impending change in formation. The following procedures will be followed:

1. When a wingman is required to cross over, he will move to the corresponding position on the opposite side while maintaining longitudinal blade tip clearance. The section leader will slide out on bearing, allowing room for number two when applicable.

2. When the section is required to cross over, it shall be made by the section moving across to the appropriate position on the opposite side. The section leader's wingman will not effect his crossover on the section leader until the section leader is in his new position.

9.1.8 Lead Changes. All lead changes should be accomplished with positive two-way radio communications. In the event of lost communications or when EMCON conditions preclude the use of radio communications, prebriefed visual signals shall be utilized. All changes of the lead position in a formation shall be acknowledged in such a manner as to preclude the possibility of misunderstanding by any member of the formation. Lead changes shall be executed from level flight and from echelon formation. Pilots at the controls should be occupying seats on complementary sides of the formation. Visual contact must be established and maintained between the original formation leader and the new formation leader before a lead change is effected.

A lead change shall be done in the following manner:

1. Lead — "Prepare to take the lead."

2. Wing — "Roger, moving into position."

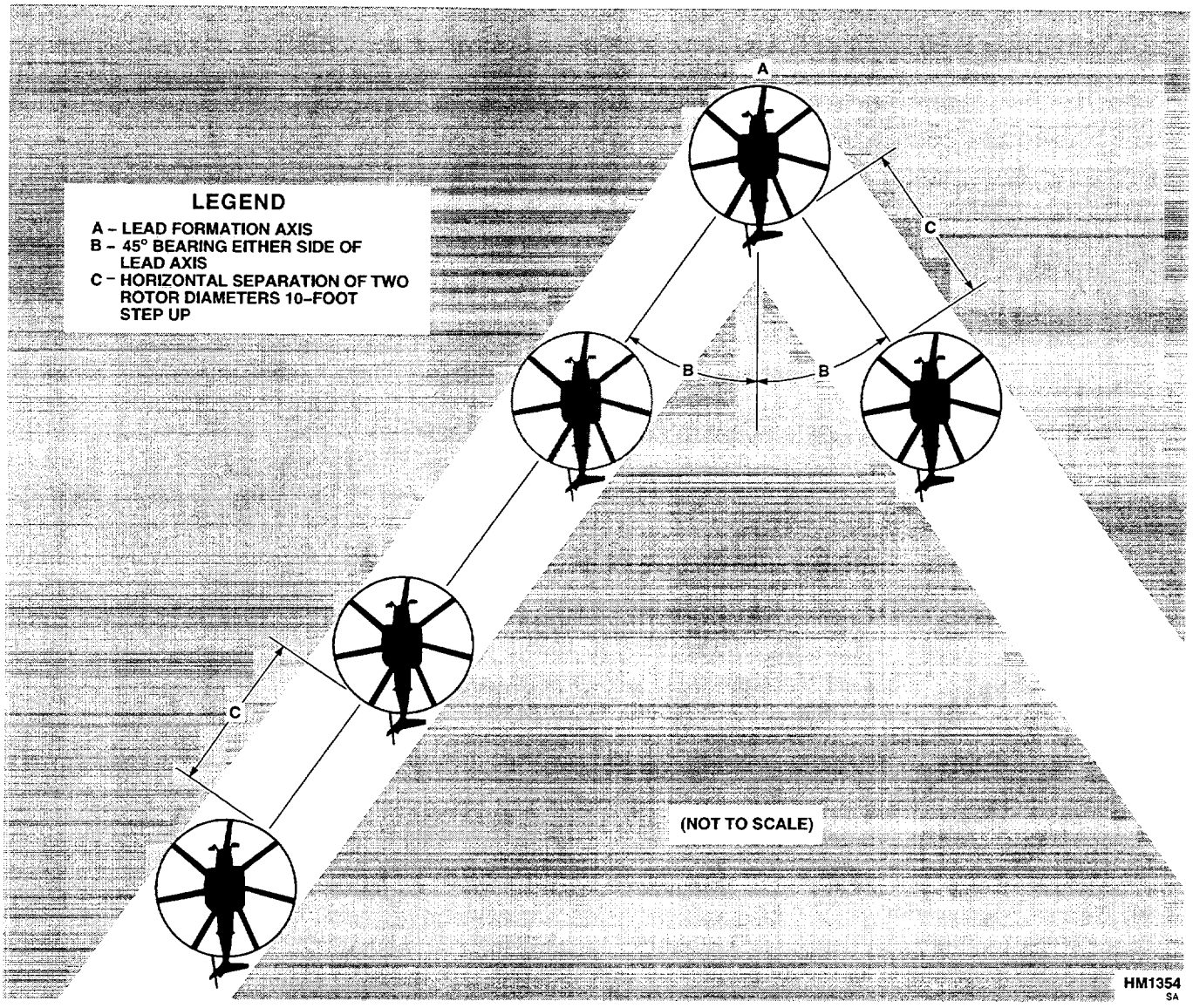


Figure 9-4. Four-plane Division Cruise

a. Wing increases lateral separation and moves abeam of leader.

3. Wing — "In position to assume the lead."

4. Lead — "Roger, you have the lead."

5. Wing — "Roger, I have the lead."

a. Original leader is now the wingman, responsible for separation. He moves back to the wing position. Normal formation flight maneuvering may now be resumed.

The responsibility of the new leader is to maintain a constant heading, altitude, and airspeed throughout the lead change. The original formation leader (new wingman) has the responsibility to maintain a minimum of one and a half rotor diameters with 10 feet of stepdown until in position of the 45° bearing at which time he will increase to a 10 foot step-up. The new formation leader is obligated to continue straight and lever flight until the original formation leader transmits, "In position." Normal formation flight maneuvering may then be resumed.

9.1.9 Rendezvous. The two types of basic rendezvous are the running rendezvous and the carrier type

rendezvous. A combination of the principles of these two are generally employed to join aircraft after takeoff.

9.1.9.1 Running Rendezvous. The leader will depart maintaining a prebriefed airspeed that will allow wingmen to use an airspeed differential and/or radius of turn that will allow them to overtake the leader and join as briefed.

9.1.9.2 Carrier Type Rendezvous. Basically, this is a join-up executed while the division leader makes a 180° level turn using a 10° angle of bank and 120 knots airspeed, or as prebriefed. Joining helicopters will assume a rendezvous bearing on the division leader using the cutoff vector to effect the join-up. The final phase of the rendezvous will be on a 45° rendezvous bearing. Join-ups will be made to the inside of the turn. After relative motion is stopped, effect a crossover when required. When practicing carrier-type rendezvous, breakups will be executed from an echelon. The leader will break and maintain altitude and a 30° bank throughout his turn. Each succeeding wingman breaks at a prebriefed interval with 30° of bank, adjusting his bank to be in an extended column position when the leader completes his turn.

9.1.10 Formation Takeoff and Landing. Formation takeoffs and landings are frequently used during normal missions and should be practiced. Power available, size of zone, obstacles to flight, wind direction and velocity, enemy fire, terrain features, rotor turbulence, and other considerations will determine the positions to be assumed by members of a formation.

9.1.11 Wake Turbulence. Every aircraft/ helicopter generates wake turbulence while in flight. Wake turbulence is generated in the form of two counter-rotating cylindrical vortices trailing behind the aircraft. The strength of the vortex is governed by the weight, speed, G-loading/ disc loading, and wing shape of the generating aircraft. The usual hazard is an induced rolling moment which can exceed the roll capability of the encountering aircraft. Characteristics which can help the pilot visualize the wake location and take avoidance precautions are:

1. Vortices are generated about the wing tip/ rotor tip from the moment the aircraft leaves the ground.

2. The vortex flow field is normally two wing spans/ rotor diameters in width, and one wing span/ rotor diameter in depth.

3. Flight tests have shown that the vortices sink at a rate of 400 to 500 feet-per-minute, with a leveling off about 900 feet below the flight path.

4. When the vortices sink close to the ground (within about 200 feet), they tend to move laterally outward over the ground at a speed of about 5 knots.

WARNING

Wake vortices must be avoided while maneuvering at low altitude. An encounter with wake vortices while maneuvering at low altitude may result in conditions from which recovery may be impossible.

9.2 INTERNAL TRANSPORT OF CARGO/ PASSENGERS

Mixed loads of bulky cargo and passengers are not recommended if access to cabin doors and escape hatches would be restricted during an emergency. Care should be taken when computing the weight and balance to be sure that CG limitations are not exceeded. All cargo will be properly secured before takeoff. Passenger comfort should be stressed and abrupt changes in power or attitude should be avoided whenever possible.

Refer to NAVAIR A1-H53BE-CLG-000 (H-53 Cargo Loading Manual) for procedure to be followed for internal transport of selected cargo, passengers, including CG limits, floor loading, and tiedown requirements.

WARNING

The internal transport of fueled collapsible fuel bladders is prohibited.

9.3 PARATROOP DELIVERY OPERATIONS

Successful paratroop delivery operations require close coordination between the pilots and aircrewman. Specific duties and responsibilities related to each are indicated herein.

9.3.1 Pilots' Procedures

	RAM-AIR (SQUARE PARACHUTE) STATIC LINE SYSTEM (Static line deployed)	ROUND PARACHUTE STATIC LINE SYSTEM (Static line deployed)	FREE-FALL PARACHUTE SYSTEM (No static line deployed)
1. Airspeed	100 KIAS	80 to 100 KIAS	80 to 120 KIAS
2. Cargo Ramp	5° Below Level	10° to 15° Below Level	10° to 15° Below Level
3. Tail Skid	Retracted	Retracted	Retracted
4. Jump Altitude	3000 ft. AGL Min.	Below 90 KIAS: 1500 ft. AGL Min. At or above 90 KIAS: 1250 ft. AGL Min.	In accordance with minimum requirements for parachute and automatic opening device used

Note

Static lines, when used, may be rigged in a number of acceptable configurations. They should normally be attached in the left side of the helicopter (right side looking aft) to a point no higher than two feet above the cargo compartment floor and rigged so the aft end of the static line extends between 9 and 19 feet beyond the ramp edge when the ramp is lowered 5° to 15° below level. This configuration assures that parachute pack opening and canopy release will occur clear of the helicopter, and that static lines and parachute deployment bags will trail in a stable pattern, well clear of the tail rotor and succeeding jumpers.

9.3.2 Aircrewman's Procedures. Anchor cables, when used, may be rigged in a number of acceptable configurations. However, they should normally be attached on the port side of the helicopter to a point no higher than 2 feet above the cargo compartment floor and rigged so that the aft end of the static line extends between 9 and 19 feet beyond the ramp edge when the ramp is lowered 5° to 15° below level, depending on the length of the ramp used. This configuration ensures that pack opening and canopy release will be safely clear of the helicopter and that static lines and deployment bags will trail in a stable pattern well clear of the tail rotor and succeeding jumpers. In addition to all normal responsibilities the aircrewman shall:

1. Act as communication link between pilot in command and jumpmaster, if ICS communication between pilot in command and jumpmaster breaks down.

2. Make sure that all personnel follow necessary safety precautions enroute and during paratroop delivery operations.

If using ram-air (square parachute) static line system (static line deployed):

3. Open cargo ramp door and position cargo ramp 5° below level.

4. Ensure a 10-foot static line extension is used and the static line stop is at station 482.

WARNING

Failure to adhere to the static line extension and static line stop requirements may allow parachute deployment bags to become entangled with the tail rotor.

If using a round static line parachute system (static line deployed):

3. Open cargo ramp door and position cargo ramp 10° to 15° below level.

4. Ensure a 5-foot static line extension is used and the static line stop is at station 502.

WARNING

Failure to adhere to the static line extension and static line stop requirements may allow parachute deployment bags to become entangled with the tail rotor.

If using a free-fall parachute system (no static line deployed):

3. Open cargo ramp door and position cargo ramp 10° to 15° below level.

4. N/A

5. Make sure that all paratroopers leave the helicopter from the right side (left side looking aft) of the cargo ramp.

6. Notify pilot in command of status of paratroopers as they leave helicopter

7. Make a positive statement to pilot, reporting as follows:

   a. Number of passengers aboard.

   b. All passengers; safety belts fastened.

   c. Cabin occupants and/or internal cargo ready for taxi/ takeoff.

8. Make sure that all troop life preservers are removed and returned when overwater flight is completed.

9. Signal passengers when clear to leave.

9.4 COUNTERMEASURES DISPENSING SET OPERATION

The AN/ALE-39, when armed, is designed to operate in a fully automatic mode upon manual initiation by a pilot or crewman. Desired programmer and countermeasures dispenser control panel (CDCP) preliminary settings should be made before flight.

To dispense countermeasures:

WARNING

The initiate switches are momentary switches which must be released to enable the system to initiate a new operation.

1. Power switch — ON.

2. ARM-SAFE switch — ARM (AMBER LIGHTS ON).

3. Initiate switch (pilot's) — CHF, JMR, FLR, or MIX.
or
Initiate switch (crew) — CM DISP.

To turn system off:

1. ARM-SAFE switch — SAFE.

2. Power switch — OFF.

To jettison countermeasures:

1. ARM-SAFE switch — SALVO FLARE.

2. Initiate switch (pilots') — MIX.
or
Initiate switch (crew) — CM DISP.

9.5 ARMAMENT EQUIPMENT

The helicopter is provisioned for the installation of gun mounts that will accommodate either an XM-218 (.50 caliber) or M-60 (7.62 mm) weapon. The gun mount provisions are located so that one weapon may be fired through the escape hatch, on the left forward side of the cabin, and the other through the upper half of the personnel door, on the right forward side of the cabin. See Figure 9-5 for the fields of fire appropriate to each type of weapon. As each weapon has a different field of fire, it must be installed with an associated pintle. The armament equipment consists of gun mounts, machineguns, pintle assemblies, ammunition trays, and bag assemblies. Pip pins are provided to aid quick installation and removal of the gun mounts from mounting brackets. An ICS station is provided for the left gunner while the right gunner uses the ICS at the aircrewman's station. Refer to NAVAIR 01-230-HM-75-17, Conventional Weapons Checklist, CH-53 Crew Served Guns for preflight procedures.

9.5.1 Machinegun Procedures

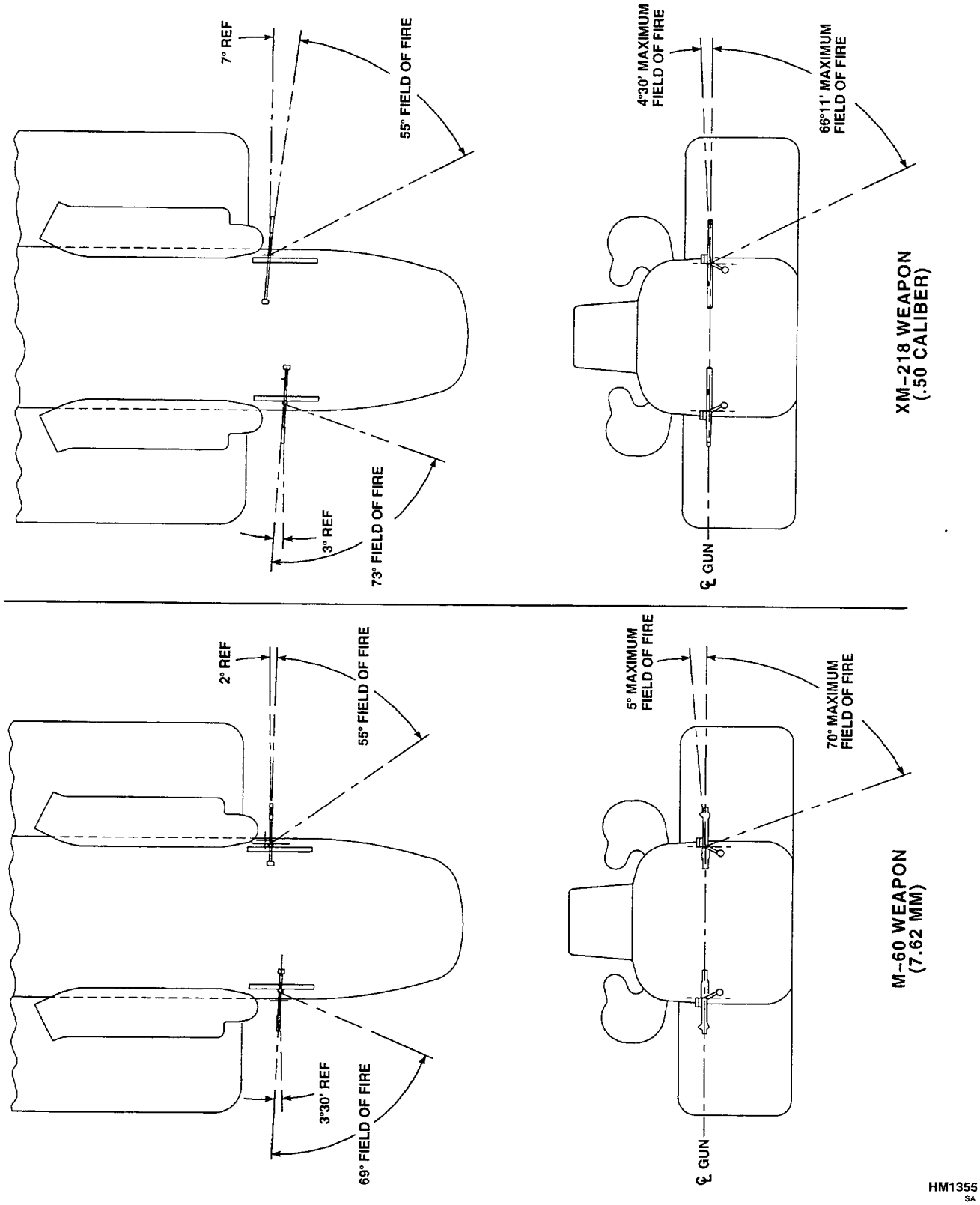


Figure 9-5. Armament Field of Fire

WARNING

Although stops are provided, extreme care must be taken to prevent firing weapons into the tanks, rotor blades, or airframe. At no time shall the elevation of the weapon be above the horizontal. Weapons shall not be fired while taxiing or during maneuvering flight. Use of weapons under conditions other than hovering or wings level forward flight may result in bullet to blade contact.

9.5.1.1 Weapons Delivery Pattern. During operational missions, mine destruction is best accomplished from a hover. All known intelligence should be utilized to determine a safe standoff range and gun depression angle. For training missions, the safe single-engine envelope should be maintained by increasing airspeed and/or altitude. This pattern should be flown between 500 and 600 feet of altitude at airspeeds of 20 to 50 knots in a right or left orbit. For training missions, standoff slant range is at least 300 yards at an angle of 40° to 60°. Before firing, the pilot shall make sure that no personnel, surface vessels, or aircraft are within 2 miles of the target.

9.5.1.2 ICS Voice Procedures. The following sequence of ICS voice procedures shall be used on all air-to-surface training missions.

1. Approaching the target area, pilot advises "Tallyho, two o'clock, five hundred yards (relative bearing and range), standby to fire."

2. Crew acknowledges "Roger" and the gunner then locks the ammunition into the feed position (no round in the chamber) and reports "Crew standby".

3. Pilot acknowledges "Roger". By this time the aircraft should be established in the ordinance delivery pattern and the pilot informs the crew to "Load".

4. Crew acknowledges "Roger load" and the gunner puts a round in the chamber and reports "Ready to fire".

5. Pilot rechecks the pattern and area clearance and gives permission to "Commence firing".

6. Crew acknowledges "Roger fire" and commences firing (one or two second bursts are recommended). At any time when any danger to aircrew personnel, surface vessels, or the aircraft arises, an immediate "Cease fire" shall be executed. The "Cease fire" may be passed by any member of the crew, and must be obeyed. The crew shall also report "weapon empty" and after reloading, "Reloaded ready to fire". Upon completion, the pilot shall order "Cease fire".

7. Crew acknowledges "Roger cease fire".

8. Pilot, if considerable transit time is involved or the aircraft is required to enter an area where there is any possibility of striking a non-hostile target, or the mission is completed, the pilot shall order "Cease fire, go cold".

9. Crew acknowledges "Roger cease fire, going cold". The crew shall then clear the weapon twice and visually check that the weapon is clear. The gunner shall then report "Weapon checks clear".

10. Pilot, upon completion of the landing checklist, tells the crew to "Report gun clear, ready for landing".

11. Crew shall re-clear and visually check the weapon, and the gunner shall then report "Gun cold, ready for landing".

12. Pilot, when giving clear report to the tower prior to landing, shall state "Gear down and locked, guns cold".

CAUTION

To preclude inadvertent damage to the tail rotor or aircraft fuselage, brass shall not be dropped overboard.

9.6 PYROTECHNIC HAND LAUNCHING

This section contains information and procedures for storage and handling, inspection/ preparation, launch and disposition requirements for hand launching of pyrotechnics authorized for this aircraft. To obtain additional functional and physical descriptive data not contained within, consult NAVAIR 11-15-7 (OP 2213).

9.6.1 Handling and Storage. Loose pyrotechnics may be damaged, caused to ignite inadvertently, or may cause physical damage to the aircraft. Rough handling must be avoided because the devices are easily activated. Adequate airborne storage and securing must be provided. Devices should be stowed vertically, fuze end up, in

bulletproof boxes if available; otherwise they should be stowed in suitable containers and strapped/ tied down aboard the aircraft.

9.6.2 Disposition. The manner of disposition for pyrotechnics depends on the condition of the device and urgency of the situation.

1. If during inspection the device is found to be dented, bent, cracked, or in any way damaged so as to raise a question as to it's serviceability, segregate the damaged device and dispose of in accordance with NAVAIR 11-15-7.

2. If the operational condition of the device is considered hazardous/ unsafe for on-board storage or activation is imminent, dispose of as follows:

   a. If over water, jettison immediately.

   b. If over populated area and device condition permits, inform pilot of situation and need to divert to unpopulated area for disposal.

9.6.3 MK-45/LUU-2 Aircraft Parachute Flares. These devices are intended for use in any condition calling for air launched illumination of 1.6 million candlepower for the LUU-2A/B flare and 2 million candlepower for the MK-45 and LUU-2B/B flares and with burn times of 3.5 minutes for the MK-45, 4 minutes for the LUU-2B/B, and 5 minutes for the LUU-2A/B flares.

9.6.3.1 Preflight Procedures. Prior to flight, perform the following:

Note

To assist in severing entangled flare lanyards or prematurely deployed parachutes, a pair of diagonal wire cutters and a knife should be carried by launching personnel.

1. Ensure flares loaded aboard the helicopter are without drogue trays.

Note

If only drogue tray configured flares are available, remove drogue trays and configure flare in accordance with NAVAIR 11-15-7.

2. MK-45/LUU-2A/B/LUU-2B/B: Inspect flares for dents, cracks or other damage and dispose of damaged flares in accordance with instructions in disposition section.

3. MK-45: Remove plastic shipping cap from fuze end of flare. Inspect to ensure that yellow dial pointer is at "Safe," safety clip is in place and snaphook is not attached to split ring. Replace plastic cap.

4. LUU-2A/B/LUU-2B/B: Ensure timer knob is set to safe and attach the short lanyard to timer knob. Ensure lock gate positively engages and holds the lanyard loop. Position loose end of lanyard under protruding lip at the top of the timer mechanism.

5. MK-45/LUU-2A/B/LUU-2B/B: Secure flares onboard in accordance with Handling and Storage Section instructions.

6. MK-45/LUU-2A/B/LUU-2B/B: Ensure that static line (FSN 1370-962-1798) is onboard and attached to cargo tie down ring (or suitable substitute) so that opposite end of static line will extend 6 to 12 inches over aft cargo ramp when it is in a level position.

9.6.3.2 Airborne Hand Launching Procedures. To launch the flares perform the following:

1. MK-45: Remove plastic shipping cap, verify flare safe condition and carefully uncoil the lanyard from fuze cavity. Ensure lanyard coil is attached to flare attachment loop.

2. MK-45: Snap black plastic lanyard retainer over rim of flare case with slot toward fuze center and slide retainer around rim of fuze body until it is adjacent to yellow-tagged key ring. Remove slack from cable by pulling lanyard through retainer until lanyard loop is against retainer.

3. MK-45/LUU-2A/B/LUU-2B/B: Set the fuze (MK-45) of timer (LUU-2A/B/LUU-2B/B) in accordance with instructions on side of flare case or as provided in the accompanying instruction sheet. Use table on instruction sheet in flare container to determine desired fuze/ timer setting.

4. MK-45/LUU-2A/B/LUU-2B/B: To launch flare, attach the loop at the free end of the lanyard to the static line then for the MK-45 only, very carefully attach swivel snap hook on lanyard to yellow-tagged split ring being sure not to unseat the safety clip. Point fuze (MK-45) or timer (LUU-2A/B/LUU-2B/B) end of flare

inboard and launch flare outward and downward. The lanyard with safety clip and fuze toggle/ timer knob still attached should be pulled back into the aircraft immediately after launching the flare to prevent flailing from slip-stream or rotor wash.

5. In the event the flare is not launched, return the fuze to safe by taking the following steps:

   a. MK-45: Check to be certain that the safety clip is securely in place.

   b. MK-45: Carefully detach the swivel snap hook from the yellow-tagged split ring.

   c. MK-45: Turn the dial indicator counterclockwise to safe.

   d. LUU-2A/B/LUU-2B/B: Turn the timer knob clockwise to safe.

9.6.4 MK-25/MK-58 Marine Location Marker (MLM). These markers are designed primarily to be launched from aircraft to provide day or night reference points such as in marking the course of enemy submarines in antisubmarine warfare operations or in search and rescue missions. They are suitable, however, for any type of sea-surface reference point marking that calls for smoke and flame for a period of 10 to 20 minutes with the MK-25, and 45 to 55 minutes for the MK-58.

9.6.4.1 Hand Launching Procedures. The following procedures must be followed during hand launching operations of the MK-25 and MK-58 MLMs.

1. Remove marker from shipping container and inspect for damage of any kind. Dented, corroded or otherwise damaged markers should be segregated for disposition accordingly.

2. With the MK-58 MLM, remove end cover of marker using a domestic type can opener so as to expose the pull ring.

Note

To eliminate injury-causing sharp edges, the domestic can opener is preferred to the twist key attached to the bottom of the can.

3. With the MK-25 MLM, rotate cover (ridged arming plate in base end of marker) clockwise to armed position as indicated by notch in base rim.

4. As the last step before launching:

   a. Push base plugs into the battery cavity at the base of the MK-25 marker.

   b. Pull the MK-58 marker pull ring.

5. Immediately launch marker from the aircraft.

6. If the MK-25 Marker is to be returned to storage, inspect the base plugs for integrity. If the base plug integrity is in question or in the event the plugs have been pushed in prematurely, install a MK-34 Marine Marker Adapter Kit to the base of the MK-25 Marker in accordance with NAVAIR 11-15-7.

7. If the MK-58 Marker is to be returned to storage, care should be taken in all subsequent handling and storage operations to protect the tape over the battery cavity hole, and the marker should be stored to be the first in line for use.

9.7 HOISTING OPERATIONS

WARNING

- Hoist operations shall not be attempted with a damaged hoist cable. Before all hoist operations, the cable shall be inspected for proper rigging.

- At high gross weights, rotor downwash may generate sustained winds of 60 mph with peak velocities of 95 mph. Hoist operations at gross weights above 60,000 pounds should be avoided.

- Ground/ ship crews shall be briefed on the static electricity potential and downwash effects of the helicopter, and safety considerations. (See DOWNWASH in Chapter 11.)

- Exercise caution when establishing a hover over personnel. Factors such as gross weight, relative winds, hover height, and personnel flotation devices during wet hoists should be taken into consideration.

- All helicopters generate static electricity which may ignite aviation or other fuels or injure personnel. Always ground the hoist cable before permitting personnel on the surface to touch the cable and ensure the area is free of fuel spills.

- Personnel shall not be lowered from the aircraft by the hoist unless the cable can be grounded prior to the personnel touching the deck.

- Practice live hoists should be performed over the water or at no more than 10 feet above a hard surface.

- Live practice hoists utilizing the rescue hoist in manual mode is prohibited.

For all hoist operations, a crewman is required. The crewman will keep the pilot advised of both the status of the hoisting operation and the helicopter position over the object being hoisted. The crewman shall use standard calls to direct the pilot. During many hoist operations, the pilot will find he has very little if any visual reference points, and will have to rely on directions from the crewman or copilot to maintain a steady hover. The pilot should maintain a steady hover over the spot until the load is in the cabin and all personnel are strapped in. The hoist is used as a means of lifting or lowering cargo or personnel from a hover. There three general types of hoist operations:

1. Pickups from water.

2. Pickups from boats or ships where a helicopter cannot land.

3. Pickups from wooded or obstructed areas.

9.7.1 Aircrewman Hoisting Qualifications

1. Initial qualification shall be four live hoists or simulated rescue operations.

2. Currency shall be maintained in accordance with local instructions.

9.7.2 Lowering Personnel. When lowering personnel, pay out the cable and have them sit down in the hatchway with feet hanging over the side. They should be secured with a gunner's belt until just prior to the hoist transfer. Take up any cable slack. When the helicopter is steady over the spot, raise the personnel up and out with the hoist, then lower at a constant and steady rate.

WARNING

Failure to secure personnel being hoisted with a gunner's belt until the aircraft is in a steady hover and they are attached to the hoist hook could result in serious injury or fall.

9.7.3 Pickup From Open Water. When making an approach for a pickup over open water, the pilot must keep the pickup in sight as long as possible. A right-hand orbit is preferable. Use marine locator markers if available. They should be deployed upwind and at the 2 o'clock position from the pickup point. The last part of the approach should be slow and deliberate to avoid overrunning the target and at a sufficient altitude to minimize downwash.

9.7.4 Hover Transfers to Air Capable Ships. When possible, the helicopter should land to transfer material and personnel. Transfers involving smaller ships not having landing platforms should be conducted by hovering over the VERTREP area if available. When transferring material on ships equipped with a VERTREP area, a LSE should be utilized. When hoisting cargo or personnel, the weight of the load shall not exceed the gross weight limitations of the hoist.

Prior to initiating an approach to a ship for a hover transfer, the best approach path and hover area should be determined. Consider the following:

1. Ship's certification and characteristics

2. Crew abilities

3. Wind/ sea state/ weather

4. Transfer requirements

5. Disposition of other ships in company.

The ship must be certified for transfer in accordance with OPNAVINST 3120. (series) and the configuration of the ship, specifically any obstructions, noted. The abilities of the crew, including current qualifications and present status of training, must be considered. Also the difficulty of the transfer will depend on the wind and sea conditions, other significant weather and it's affect on visibility, and

the stability of the platform to be serviced. The hoisting station to be employed and the nature of the material to be transferred should be considered as well as the disposition of other ships in company.

WARNING

Although no hover altitude can be dictated, sufficient altitude shall be maintained to allow the helicopter a safe transition/ wave-off path clear of the hover area and obstructions in case of a helicopter system malfunction.

9.7.5 Pickup From Wooded or Obstructed Areas. Pickups from wooded or obstructed areas require a stable hover, without drift, to keep the hoist cable from snagging in trees or obstructions. The hoist cable should be sheared if this occurs.

9.7.6 Pickup Using Stokes Litter. When hoisting stokes litters, ensure that the litter is turned so that the patient's head is pointing forward to facilitate bringing the litter into the aircraft.

9.7.7 Lost Communication Procedures During Hoisting Operations

Note

The possibility of a complete ICS failure is remote. Lost ICS is usually isolated to a particular station, cord, or helmet. Therefore, prior to hoisting, the hoist operator should have an alternate ICS cord/ station available.

1. In the event of lost communications between the hoist operator and the PAC, the hoist operator shall immediately attempt to regain communications. If communications are not immediately regained, the hoist operator will tap the PNAC on the shoulder and indicate lost communications by pointing to his mike and giving a thumbs-down.

2. If the PNAC has two-way communications with the hoist operator, it may be advantageous to pass the flight controls and continue hoisting. However, if the hoist operator cannot communicate with either pilot, then he shall direct the aircraft using the hand signals described in Figure 9-6. The PNAC will then relay these hand signals to the PAC using ICS.

Note

The pilot in the left seat has a better view of the aircrewman's hand signals. To facilitate communications by hand signals, controls should be transferred to the right seat.

3. If communications are hampered between the PNAC and the PAC, then the PNAC will relay the hand signals from the hoist operator to the PAC by applying pressure to the PAC's shoulder in relation to desired direction of movement.

CAUTION

Once the hoist is clear, no further hoist operation shall be initiated without ICS.

9.7.8 Hoist Functional Check and Cable Shear Test

1. Hoist master switch — PILOT.

2. Hoist control switch — DOWN. Check cable downward movement.

WARNING

- Heavy-duty gloves shall be worn when guiding the cable during hoisting operations.
- Extreme caution must be used when operating the hoist. Severe injury to fingers is possible in close proximity to the hoist/ cable/ hook.

3. Hoist control switch — OFF.

4. Hoist control switch — UP. Check cable upward movement.

5. Hoist control switch — OFF.

6. Hoist master switch — CREW.

7. Hoist station ICS — CHECK.

8. Hoist crewman activate cable down and up with hoist grip thumbswitch. Prior to full cable retraction,

VOICE COMMANDS	HAND SIGNALS	LOST COMMUNICATION SIGNAL	MEANING
WAVE OFF **	VIGOROUS CROSSING OF HANDS	VIGOROUS CROSSING OF HANDS	Self-explanatory, ABORT approach.
HOLD **	DOUBLE CLENCHED FISTS	DOUBLE CLENCHED FISTS	Immediately STOP all movement.
FORWARD *	PALM FORWARD	FORWARD PRESSURE ON SHOULDER OF FLYING PILOT	Move forward.
BACK *	PALM BACK	BACK PRESSURE ON SHOULDER OF FLYING PILOT	Move back.
LEFT *	PALM LEFT	LEFT PRESSURE ON SHOULDER OF FLYING PILOT	Move left.
RIGHT *	PALM RIGHT	RIGHT PRESSURE ON SHOULDER OF FLYING PILOT	Move right.
UP *	PALM UP	UPWARD PRESSURE ON SHOULDER OF FLYING PILOT	Move up.
DOWN *	PALM DOWN	DOWNWARD PRESSURE ON SHOULDER OF FLYING PILOT	Move down.
STEADY	SINGLE CLENCHED FIST	NO PRESSURE ON SHOULDER OF FLYING PILOT	Maintain present position.
CLEARED TO GO	CIRCULAR MOTION OF HAND WITH INDEX FINGER POINTING UP	THREE TAPS ON SHOULDER	Cleared to go.
EASY	NONE	NONE	Slow rate of movement, precedes basic command.
STOP	NONE	NONE	Self-explanatory, precedes basic command.
HOIST GOING DOWN	CLENCHED FIST, THUMB POINTED DOWN	CLENCHED FIST, THUMB POINTED DOWN	Hoist going down.
HOIST GOING UP	CLENCHED FIST, THUMB POINTED UP	CLENCHED FIST, THUMB POINTED UP	Hoist going up.
SALT SPRAY	NONE	NONE	Rotor wash picking up salt spray. Give estimate of amount.
** COMPLIANCE WITH THIS CALL IS MANDATORY			
* GIVE DISTANCE IN FEET (UP 10, RIGHT 5, ETC.)			

Figure 9-6. Standard Terms, Hand/Lost Communication Signals and Meanings

stop the hoist, depress the upper limit switch, and rotate thumbswitch upward. Cable should not move. Release upper limit switch and fully retract cable.

Note

The thumbswitch is spring-loaded to the stop position.

9. Hoist crewman activate cable down and up with hoist manual override.

WARNING

Use extreme caution when operating the hoist in the emergency mode. The limit switches are bypassed and will not stop the hoist at either extreme.

10. Electro-explosive circuit tester switch — TEST.

CAUTION

ELECTRO-EXPLOSIVE CIRCUIT TESTER switch must be at TEST before checking shear circuit.

11. Hoist cable shear switch (crewman's hoist cable shear switch panel) — SHEAR.

12. Electro-explosive circuit tester test light — ON.

13. Hoist cable shear switch (crewman's hoist cable shear switch panel) — OFF, COVER CLOSED.

14. Pilot's hoist cable shear switch (emergency control panel) — ON.

15. Electro-explosive circuit tester test light — ON.

16. Pilot's hoist cable shear switch — OFF, COVER CLOSED.

17. Electro-explosive circuit tester switch — FIRE, COVER CLOSED.

18. Hoist master switch — OFF.

9.7.9 Pilot Operation

1. Hoist master switch — PILOT.

2. Personnel door — OPEN.

WARNING

- The crewman's safety belt shall be used with the personnel door opened.
- To avoid injury to personnel, airspeed shall be below 60 KIAS before opening, removing, or closing personnel door.

3. Hoist control switch — DOWN.

When informed by crewman hoist hook is lowered and grounded:

4. Hoist control switch — OFF.

When informed by crewman cargo/ personnel is ready to be hoisted:

5. Hoist control switch — UP.

When informed by crewman cargo/ personnel is up and in cabin:

6. Hoist control switch — OFF.

7. Personnel door — CLOSED.

8. Hoist master switch — OFF.

9.7.10 Crewman Operation

9.7.10.1 Normal Hoist Operation

1. Hoist master switch — CREW.

2. Personnel door — OPEN.

3. Hoist grip thumbswitch — DOWN. Inform pilot when cable is down and grounded and when the cargo/ person is ready to be hoisted.

4. Hoist grip thumbswitch — UP.

WARNING

When lifting heavy loads, the hoist shall be slowed down before stopping. Rapid stopping or reversing of the hoist may cause loss of control. If control is lost while lifting, control may be recovered by moving the hoist manual override knob to the maximum raise rate position.

5. Personnel door — CLOSED.

6. Hoist master switch — OFF.

9.7.10.2 Manual Hoist Operation. The hoist manual override is used in the event of an electrical failure of the hoist control system.

1. To lower hoist, rotate manual override knob on hoist control valve counterclockwise.

2. To stop hoist, return override knob to center (detented) position.

3. To raise hoist, rotate manual override knob clockwise.

9.8 SEARCH AND RESCUE PROCEDURES

9.8.1 Introduction The MH-53E should be utilized as a contingency Search and Rescue asset. It's large fuel capacity makes it an excellent search platform and it is well suited for on-scene-commander operations. Due to it's increased rotor downwash however, it is not intended to act as a primary Search and Rescue asset in regions where other SAR assets are available. Each SAR mission presents a different set of circumstances, and specific procedures cannot be given to cover all situations. The aircraft commander must assess each situation and evaluate weather, turbulence, sea state, terrain, condition of the survivor, and aircraft performance capabilities. Often there is no communication with the survivor or ground rescue party to assist the pilot in evaluating the situation and the pilot must rely on his experience and good judgment. In the face of pressure to complete a rescue, mature judgment is needed to avoid placing the aircraft and crew in an unnecessarily dangerous position.

The nature of the mission and the low-altitude overwater environment dictate that all maneuvers be accomplished as expeditiously and precisely as possible. Continuous, in-depth training is of the utmost importance in maintaining an adequate level of pilot proficiency, crewman ability, and overall crew coordination.

When emergencies occur, the lives and safety of personnel are often jeopardized unless immediate assistance is available. If the designated search and rescue helicopter is not available and/or additional assistance is required, any helicopter may be directed to perform SAR duties.

Most searches entail the rescue of personnel or the location and recovery of military hardware. Therefore, every effort must be made to complete the search as rapidly and as efficiently as possible. Accurate navigation is mandatory and precise headings, turns, altitudes, and airspeeds must be maintained. The search area must be thoroughly scanned and reactions to sightings must be timely and accurate.

Note

The term rescue implies a pickup. For SAR mission information. refer to NWP 3-50.1 (Navy SAR Manual), JP 3-50 (National SAR Manual), NWP 55-8-SAR (SAR TACAID), and NWP 3.04-1M (Shipboard Helicopter Operating Procedures).

9.8.2 Capabilities

1. Over land — The MH-53E helicopter is capable of day/ night overland search and rescue missions in visual conditions.

2. Overwater

   a. Day visual conditions — The MH-53E helicopter is capable of day search and rescue missions.

   b. Low visibility or night rescue missions — The MH-53E helicopter with an operable Doppler radar navigation set is capable of low-visibility or night overwater search and rescue missions.

9.8.3 Crew Qualification. Because of the high level of crew coordination required and the inherent dangers of rescue operations, flight crews need to maintain proficiency in aspects of the SAR mission.

Pilots and aircrewmen shall obtain initial qualifications and maintain currency in accordance with local instructions.

9.8.4 SAR Equipment. A complete SAR kit must be readily available to crewmembers. It should be recognized that, because of the limitations imposed by space available and maximum gross weight for the aircraft, a SAR kit must be tailored to the environment in which the crew anticipates SAR operations. When assigned SAR in support of amphibious operations involving overwater transport of combat-loaded troops, the internal fuel tank should not be installed. Helicopters designated as contingency SAR vehicles should carry the equipment specified below:

1. BGU/8N curtain with the following:
   a. Two crewman safety belts (gunner belts)
   b. One pair heavy-duty gloves
   c. One cable grip (Chicago grip)
   d. Three chemical light straps
   e. Six 4-inch chemlights
   f. Six 6-inch chemlights
   g. One quick splice
   h. One pair litter hoisting slings
   i. One hand-held cable cutter or pneumatic webbing cutter
   j. Three cranial helmets with goggles
   k. Three LPP-I or LPU-30 life preservers
   l. Two wool blankets
   m. One rescue strop (horse collar)
2. One level "A" medical kit
3. One level "B" medical kit (for commands with SAR medical technicians NEC 8401 only)
4. One trail line assembly
5. Five Mk 58 marine location markers
6. Five Mk 25 marine location markers
7. Three electric sea marker lights
8. One Stokes or MEDEVAC litter with flotation
9. One Aldis lamp (optional)
10. PRC- 125 rescue swimmer radio (optional)
11. Forest penetrator/ rescue seat (optional)
12. Rescue net (optional)
13. The following equipment shall be worn by the rescue swimmer when deployed:
    a. Approved swimmer's harness
    b. LPU-28 (SAR-1 flotation)
    c. Mask, fins, and snorkel
    d. Wetsuit top or one-piece shorty
    e. Full wetsuit including hood, gloves, and booties when water temperature and conditions warrant.

9.8.4.1 Aircraft Required Systems

1. The following aircraft systems are required to safely perform SAR missions and should be considered prior to any attempted rescue:
   a. Hoist
   b. Radar altimeter
   c. ICS
   d. VHF/UHF radio
   e. Radar altimeter hold (Optional for day/VFR)
   f. Approach/ hover coupler (Optional for day/VFR)
   g. Doppler (Optional for day/VFR)

9.8.5 Lookout Doctrine. Good lookout doctrine is mandatory for successful search and rescue operations. Because the pilots must involve themselves with the actual operation of the helicopter, especially at night when

actual instrument flight is required, the efficiency of pilot lookout doctrine is degraded and the importance of the aircrewman as lookout becomes paramount. The aircrewman should be assigned specific lookout stations and must be briefed as to the nature of the objects for which the search is being conducted.

9.8.6 Arrival On Scene. Control of the rescue is assumed by the first helicopter to arrive at the scene and remains with this helicopter until it is relieved by proper authorities. This involves control of aircraft in the immediate area so as to avoid congestion and to prevent hindrance of the rescue as well as the direction of the actual rescue operation. Other aircraft should be used as radio relays as necessary.

9.8.7 Search Procedures. The aircraft commander will supervise and coordinate all activities of the crewmembers. The copilot should plot the search pattern, record sighting information, monitor the altimeter, and accomplish other duties as requested by the HAC. Search Procedures shall be performed in accordance with the NWP 3-50.1 (Navy SAR manual), and the NWP 55-8-SAR (SAR TACAID).

9.8.8 Scanning Techniques. Precise scanning is one of the most important aspects of a search. The helicopter crewmembers in the cabin will be the primary scanners. Sighting characteristics and detection possibilities of the objectives must be included in the briefing.

1. When over water, the most probable objectives of the search will be lifeboats, rafts, debris, oil slicks, and personnel.

2. Over land, scanners should look for smoke, broken or scarred trees, shiny metal, fresh-looking burnt-out areas, parachutes, and signals.

3. With three available crewmembers to scan, positions should be rotated every 30 minutes (left side, right side, rest).

4. A routine scanning pattern should be used when searching. The eyes should move and pause for each 3 or 4 degrees of lateral/ vertical distances at a rate which will cover 10 degrees per second. The scanner's eye movement should be away from the helicopter to the effective visibility and then back toward it to a point as near under the helicopter as can be comfortably seen. Scanners must avoid turning away from the scanning pattern, closing their eyes, looking around the helicopter, or focusing short of the surface being scanned.

9.8.9 Sighting Procedures. When a sighting is made, the crewmember will notify the rest of the crew over the ICS and indicate the position of the sighting by using the clock system and distance. Immediately upon making a sighting, a smoke signal or sea marker will be dropped to mark the appropriate location of the sighting. The pilot should immediately turn in the direction of the target. If possible, the observer will continue to call out the target position and distance to orient the pilot. If the sighting is confirmed, these procedures apply:

1. Keep the target in sight at all times. Mark with dye marker/ smoke floats.

2. Turn transponder to appropriate code.

3. Report sighting to rescue center, on-scene commander, air/ ground station or operation agency as appropriate.

9.8.10 Swimmer Deployment and Survivor Assistance. When available, the swimmer shall enter the water and assist the survivor on all rescues except when the pilot determines that circumstances will unnecessarily expose the swimmer to danger. Conditions existing at the scene of the rescue (i.e., water temperature, sea state, condition of the survivor, proximity of other units, etc.) will indicate procedures to be followed, and the final decision shall rest with the pilot in command.

9.8.10.1 SAR Terms and Signals. SAR missions require clear, concise communications between crewmembers. Standard terms and their meanings are listed in Figure 9-7.

9.8.10.2 Day/VFR Rescue Over Water

1. Prior to any rescue, a "go-no go" point should be determined and briefed. This point is defined as the minimum altitude/ airspeed from which a safe recovery can be made from a single-engine failure determined from the appropriate charts, commensurate with pilot proficiency at recovering from an engine failure out of ground effect. Nonflying pilot shall make a voice call at the prebriefed "go-no go" point.

2. The first crewmember to sight the survivor will inform the pilot of the survivor's position. After the pilot has the survivor in sight, he will commence a wind line approach to the survivor. When the pilot directs, "Talk me in," the crewman will commence verbal instructions to position the aircraft over survivor using standard terms. Pilot and hoist station radio mixer switches should be secured at this time.

SITUATION	SPEAKER	REPORT
1. Survivor sighted	Person making observation	"I have the survivor at _____ o'clock _____ yards."
2. Approaching survivor	Copilot	"Approaching survivor, arm three Marine Locator Markers."
3. Marine Locator Markers armed	Crewman	"Three Marine Locator Markers armed and ready."
4. Aircraft over survivor	Copilot	"Aircraft over survivor, standby to drop Marine Locator Markers."
5. Once clear of survivor	Copilot	"Markers, drop, drop, drop."
6. All Marine Locator Markers clear of aircraft	Crewman	"Marine Locator Markers away."
7. All Marine Locator Markers clear of aircraft	Copilot	"Come (left/right) heading _____ degrees."
8. Crewman sees light off of the Marine Locator Markers	Crewman	"I have light off on (0, 1, 2, 3) Marine Locator Markers."
9. Aircraft on final, 300 feet and 80 knots	Copilot	"Standby for automatic approach."
10. Aircraft on final, 300 feet and 80 knots	Pilot	"Engage automatic approach."
11. Copilot selects automatic approach to a hover by pushing the APPR/HVR pushbutton on the APPR/HVR COUPLER CONTROL PANEL	Copilot	"Automatic approach selected, beginning descent."
12. Approach begins	Copilot	"Under 60 knots, rig hoist station for pickup."
13. Crewman requests hoist power	Crewman	"Request hoist power aft."
14. Copilot places hoist master switch to CREW	Copilot	"You have hoist power aft."
15. GO - NO GO point	Copilot	"GO/NO GO"
16. Personnel door opened, hoist rigged	Crewman	"Personnel door opened and hoist station ready for pickup."
17. Aircraft trimmed in a hover	Pilot	"Aircraft trimmed in a stable hover. Standby for control aft."
18. Copilot pushes CREW HVR pushbutton	Copilot	"Crew hover selected, you have control aft."
19. Crewman pushes ENGA pushbutton	Crewman	"Roger, I have control aft moving to the survivor."
20. Crewman moves the helicopter in any direction	Crewman	"Moving (left, right, aft, forward)."
21. Aircraft hovering at 100 feet above the survivor	Crewman	"Ready to deploy swimmer, you have control forward."

Figure 9-7. Standard Terminology used in Low-Visibility/Night Coupled Approach/Departure and Rescue (Sheet 1 of 3)

SITUATION	SPEAKER	REPORT
22. Copilot disengages crew hover by pushing CREW HVR pushbutton	Copilot	"CREW HVR disengaged."
23. Pilot assumes control and maintains a steady hover using hover coupler	Pilot	"I have control forward, ready swimmer."
24. Swimmer positioned in doorway and attached to hoist	Crewman	"Swimmer ready."
25. Stable hover maintained	Pilot	"Lower swimmer."
26. Swimmer on hoist and going down	Crewman	"Swimmer going down."
27. Swimmer halfway between aircraft and water	Crewman	"Swimmer halfway down."
28. Swimmer in water	Crewman	"Swimmer in water."
29. Swimmer detaches and signals all right	Crewman	"Swimmer detached, ready for control aft."
30. Copilot pushes CREW HVR pushbutton	Copilot	"Crew hover selected, you have control aft."
31. Crewman pushes ENGA pushbutton	Crewman	"Roger, I have control aft."
32. Crewman maintains visual contact with swimmer and maneuvers away from the survivor	Crewman	"Moving (left, right, aft, forward)."
33. Pilot/ crewman observes signal from swimmer, ready for pickup	Person making observation	"I have a pickup signal."
34. Crewman moves aircraft over survivor	Crewman	"Moving (left, right, forward, aft)."
35. Swimmer and survivor hooked up	Crewman	"Swimmer and survivor hooked up, prepare for weight coming on aircraft."
36. Swimmer and survivor clear of water	Crewman	"Swimmer and survivor clear of water, you have control forward."
37. Copilot disengages crew hover by pushing CREW HVR pushbutton	Copilot	"Crew hover disengaged."
38. Pilot assumes control	Pilot	"Roger, I have control forward."
39. Swimmer and survivor halfway between water and aircraft	Crewman	"Swimmer and Survivor halfway up."
40. Swimmer and survivor approaching the door	Crewman	"Swimmer and survivor approaching aircraft."
41. When swimmer and survivor are in cabin and strapped in	Crewman	"Swimmer and survivor aboard."
42. Door closed, hoist cable retracted	Crewman	"Door secured, hoist up, secure hoist power, ready for forward flight."

Figure 9-7. Standard Terminology used in Low-Visibility/Night Coupled Approach/Departure and Rescue (Sheet 2 of 3)

SITUATION	SPEAKER	REPORT
43. Copilot secures hoist power by placing the hoist master switch to OFF	Copilot	"Hoist power secured."
44. Ready for departure from hover, pilot will either press the DEPART SELECT on the cyclic or direct the copilot to press the depart pushbutton on the APPR/ HOVER COUPLER panel	Pilot	"Departing or Select departure."
45. If required, Copilot depresses DEPART pushbutton.	Copilot	"Departing."
46. When aircraft reaches 500 feet and 100 KIAS depart mode will disengage and BAR ALT will engage.	Copilot	"BAR ALT engaged, departure mode disengaged."
47. Crewman reports on condition of Survivor(s)	Crewman	"Survivor(s) is/are _____."

Figure 9-7. Standard Terminology used in Low-Visibility/Night Coupled Approach/Departure and Rescue (Sheet 3 of 3)

WARNING

If parachute remains in area of survivor, maintain a minimum of 150 feet separation between parachute canopy and rotor downwash.

3. When the decision is made to deploy the rescue swimmer, the following procedures apply:

a. Pilot commands, "Below 60 knots, man rescue stations." Crewman will open personnel door, rig hoist, and position swimmer in door with gunner's belt on.

b. Crewman reports, "Rescue stations manned and ready."

WARNING

The crewman shall monitor salt spray and report it's severity to the pilot. Extended operation in a high salt environment may cause compressor stall.

c. Pilot commands, "Stand by to deploy swimmer." Crewman grasps back of swimmer's harness and places other hand on chest of swimmer, then swimmer disconnects gunner's belt.

d. Crewman reports, "Swimmer ready."

e. Pilot commands (at jump point), "I have _____ knots and _____ feet, jump, jump, jump."

f. On third "jump," crewman checks area clear of debris, releases swimmer harness, and taps swimmer three times on shoulder. Swimmer jumps.

WARNING

It is extremely difficult to accurately judge height above water. The swimmer, therefore, shall not jump into the water until the pilot positively gives the "jump" signal to the crewman.

g. After swimmer exits aircraft, crewman reports. "Swimmer away."

h. Crewman observes "I am all right" signal from the swimmer and reports, "Swimmer OK." Crewman then directs pilot to hoisting altitude, left and aft to maintain visual contact with the survivor and swimmer.

WARNING

In the event of loss of visual contact with swimmer and/or survivor, the pilot shall cycle the search/ hover lights. The swimmer and/or survivor shall then ignite the day/ night end of a Mk 124 flare to aid in reestablishing visual contact.

4. The crewmember first observing "ready for pickup signal" reports observation and the crewman then directs the aircraft over the survivor and calls for "Steady hover."

5. Crewman attaches rescue sling to double rescue hook and lowers hoist to water, discharging the static electricity.

CAUTION

Do not deploy rescue sling until helicopter airspeed has decreased to 30 KIAS to preclude damage to sling or the helicopter.

6. Crewman reports, "Swimmer approaching hoist hook" and "Survivor hooked/ swimmer hooked up" when appropriate.

WARNING

- Prior to lifting, ensure no slack is in cable. Use of hoist at high speed rates can cause injury. Ensure the survival rescue sling chest strap is secured or that the survivor is briefed on rescue sling safety procedures.
- Prior to commencing hoisting, ensure that cable is clear of survivor, that survivor's hands are clear of rescue hook area, and that survivor signals are "thumbs-up."

7. Crewman makes the following reports during the hoisting evolution:

a. "Weight coming on aircraft."

b. "Clear of water."

c. "Survivor and swimmer halfway up."

WARNING

If cable oscillation occurs, crewman shall notify the pilot and stabilize the cable.

d. "Approaching aircraft."

e. "Survivor and swimmer aboard."

Note

If the next survivor is not in the immediate vicinity, hoist swimmer and fly or air taxi to the next pickup point. Swimmer will be hoisted with last survivor in cases of multiple rescue situations.

8. With door closed and hoist stowed, the crewman reports, "Ready for forward flight."

9. The pilot transitions to forward flight.

10. Crewman reports survivor's condition/ injuries to pilot.

9.8.10.3 Low-Visibility/Night Rescue Over Water. On MH-53E helicopters, the Approach/ Hover/ Depart Coupler and radar altimeter are coupled to the automatic flight control system, enabling the aircraft to make low-visibility/ night overwater approaches to a coupled hover. This maneuver requires precise instrument flight technique and excellent crew coordination. The low-visibility/ night pattern and approach permits the helicopter crew to effect a rescue in minimal time with a proper margin of flight safety.

WARNING

Task saturation followed by loss of situation awareness can occur at any time during the demanding overwater SAR evolution. RADALT hold shall be used for all low-visibility/ night SAR operations to help reduce pilot workload and increase aircrew coordination.

During the preflight brief, a "go-no go" point will be determined. This point is defined as 100 feet and the minimum dual-engine airspeed as determined from the appropriate dual-engine charts. The minimum dual-engine airspeed will be determined at the highest gross weight at which a Doppler approach will be commenced.

To accomplish a low-visibility/ night approach and rescue with the hover coupler system, the following procedures apply:

Note

If circumstances permit, crews should check the performance of the hover coupler and cockpit instruments in a hover over a lighted pad or in close proximity to the ship prior to using the hover coupler system in a low-visibility/ night approach.

1. Perform the following Preapproach Checklist:

   a. Radar altimeter — ON and SET (low-altitude warning bug set to 5 feet below desired hover altitude).

   b. Radar altimeter mode selector switch — SEA.

   c. Select desired radar altimeter channel.

   d. Doppler mode selector switch — SEA.

   e. AFCS — ON.

   f. Trim — ON.

Note

Use of heading hold allows the pilot to make a coupled approach without use of the rudder pedals. Heading hold input may be overridden by depressing rudder pedals. When heading hold is overridden, increased pilot attention is required during the approach/ hover phase.

   g. Radar altimeter hold ALT SET knob — SET TO 100 FEET.

   h. Hover coupler LAT/LONG VEL control knobs — SET TO ZERO.

   i. COMM 1 antenna switch — RETRACT.

   j. Pilot radio mixer switches — OFF.

   k. Crewman radio mixer switches — OFF.

   l. Smokes — ARMED AND READY.

2. Once the survivor is located, the pilot shall fly the aircraft on instruments. The copilot shall perform all copilot duties to include timing, monitoring instruments, radios, NAVAIDs, planning the approach, and moving necessary switches.

3. Upon arriving over the survivor, mark the position with at least three marine markers.

WARNING

Use caution not to strike the survivor with the markers. In areas where fuel or other flammables may be on the surface, electric sea marker lights shall be used instead of smoke flares. Avoid dropping smoke flares upwind of the survivor as fumes are caustic and may be harmful.

Note

Marking the survivor's position in the water quickly and accurately is an extremely critical phase of any low-visibility/ night rescue, and crew coordination is of paramount importance. Since these types of rescues are predicated on environmental conditions, it is likely that the helicopter will be very close to, if not directly over, the survivor when sighted.

4. The pilot shall execute the approach and maneuver the aircraft in accordance with procedures outlined

in the NWP 3-50.1 (Navy SAR Manual) and NWP 55-8 SAR (SAR TACAID) manuals to position the aircraft for the coupled approach.

Note

The copilot shall call for all turns and descents. During the turn, the copilot shall reacquire visual contact with the marine markers and advise the pilot when to roll out of the turn in order to establish a course in line with the markers.

5. Once established on final, approach/ hover coupler — ENGAGE.

6. When airspeed is less than 60 KIAS, the crewman opens the lower personnel door.

7. When instructed, the swimmer attaches himself to hoist and positions himself in doorway.

8. When established in a stable hover, the copilot shall engage crew hover and pass control of the aircraft to the crewman.

9. The crewman shall position the helicopter over the survivor with the crew hover "joystick" and take up tension in the rescue hoist cable.

Note

A lighting device shall be attached to the hook.

10. The crewman passes control of the aircraft back to the pilot, and the copilot secures crew hover.

11. The crewman lowers the swimmer to the water.

12. When the swimmer detaches from the hoist cable, the crewman informs the pilot.

13. The pilot passes control of the aircraft to the crewman and the copilot engages crew hover.

14. The crewman positions the aircraft where rotor wash does not interfere with the swimmer and survivor.

15. When the swimmer signals "Ready for pickup," the crewman positions the aircraft over the survivor and swimmer.

16. The swimmer attaches himself and the survivor to the hoist cable, and gives "Ready for hoist" signal.

17. The crewman hoists the swimmer and survivor to the aircraft.

18. When the crewman has the survivor and the rescue swimmer clear of the water, he passes control of the aircraft back to the pilot and the copilot secures crew hover.

19. The crewman assists the swimmer in bringing the survivor aboard.

20. Once the survivor and swimmer are aboard, the crewman secures the aft station and stows the hoist and lower personnel door.

21. Pilot commences departure procedures utilizing depart function of Doppler as desired.

WARNING

Both pilots shall monitor attitude, airspeed, and altitude during climbout.

22. Once climbout complete, verify hover coupler is off.

23. BAR ALT hold — ENGAGE.

24. Perform the following Postapproach Checklist:

a. Radar altimeters — RESET AS REQUIRED.

b. Doppler — RESET AS REQUIRED.

c. COMM 1 antenna — AS REQUIRED.

d. Pilot radio mixer switches — AS REQUIRED.

e. Crewman radio mixer switches — AS REQUIRED.

9.8.11 Night Manual (Alternate) Doppler Approach. The following procedure is authorized only for helicopters equipped with an operational Doppler and radar altimeter under visual conditions. It must be remembered that if the Doppler and radar altimeter are not coupled to the flight control system, all corrections in drift, groundspeed, and altitude must be manually made by the

pilot. To accomplish the manual Doppler approach and rescue, the following procedures should be followed.

WARNING

Task saturation followed by loss of situation awareness can occur at any time during the demanding overwater SAR evolution. RADALT hold shall be used for all low-visibility/ night SAR operations to help reduce pilot workload and increase aircrew coordination.

1. Complete the following Preapproach checklist:

   a. Radar altimeter — ON (low-altitude warning bug set to 5 feet below desired hover altitude).

   b. Radar altimeter mode switch — SEA.

   c. Radar altimeter hold ALT SET knob — SET TO 100 FEET.

   d. Doppler mode switch — SEA.

   e. AFCS — ON.

   f. TRIM — ON.

   g. COMM 1 antenna — RETRACT.

   h. Pilot radio mixer switches — OFF.

   i. Crewman radio mixer switches — OFF.

   j. Smokes — ARMED AND READY.

2. Once the survivor is located, the pilot shall fly the aircraft on instruments. The copilot shall perform all copilot duties to include timing, monitoring instruments, radios, NAVAIDs, planning the approach, and moving necessary switches.

3. Upon arriving over the survivor, mark the position with at least three marine markers.

WARNING

Use caution not to strike the survivor with the markers. In areas where fuel or other flammables may be on the surface, electric sea marker lights shall be used instead of smoke flares. Avoid dropping smoke flares upwind of the survivor as fumes are caustic and may be harmful.

Note

Marking the survivor's position in the water quickly and accurately is an extremely critical phase of any low-visibility/ night rescue, and crew coordination is of paramount importance. Since these types of rescues are predicated on environmental conditions, it is likely that the helicopter will be very close to, if not directly over, the survivor when sighted.

4. The pilot shall execute the approach and maneuver the aircraft in accordance with procedures outlined in the NWP 3-50.1 (Navy SAR Manual) and NWP 55-8 SAR (SAR TACAID) manuals to position the aircraft for the coupled approach.

Note

The copilot shall call for all turns and descents. During the turn, the copilot shall reacquire visual contact with the marine markers and advise the pilot when to roll out of the turn in order to establish a course in line with the markers.

5. When airspeed is less than 60 KIAS, the crewman opens the lower personnel door.

6. The crewman commences giving verbal directions to the pilot utilizing standard terminology outlined in Figure 9-6 in order to bring the aircraft into a stable hover over the survivor.

7. When established in a stable hover, the copilot shall engage radar altimeter hold.

8. When instructed, the swimmer attaches himself to the hoist and positions himself in doorway.

Note

A lighting device shall be attached to the hook.

9. Once positioned over the survivor, the crewman lowers the swimmer to the water.

10. When the swimmer detaches from the hoist cable, the crewman informs the pilot.

11. The pilot positions the aircraft where rotor wash does not interfere with the swimmer and survivor utilizing verbal directions from the crewman.

12. When the swimmer signals "Ready for pickup," the pilot positions the aircraft over the survivor and swimmer utilizing verbal directions from the crewman.

13. The swimmer attaches himself and the survivor to the hoist cable, and gives "Ready for hoist" signal.

14. The crewman hoists the swimmer and survivor to the aircraft.

15. The crewman assists the swimmer in bringing the survivor aboard.

16. Once the survivor and swimmer are aboard, the crewman secures the aft station and stows the hoist and lower personnel door.

17. Pilot commences climbout procedures.

WARNING

Both pilots shall monitor attitude, airspeed, and altitude during climbout.

18. Perform the following Postapproach Checklist:

a. Radar altimeter hold — OFF.

b. Doppler — RESET AS REQUIRED.

c. Radar altimeters — RESET AS REQUIRED.

d. COMM 1 antenna — AS REQUIRED.

e. Pilot radio mixer switches — AS REQUIRED.

f. Crewman radio mixer switches — AS REQUIRED.

9.9 CARGO WINCH OPERATION

1. Connect control pendant and short cord to cable reel assembly.

2. Control pendant MASTER PWR switch — ON.

3. Cargo loading area — CLEAR.

4. Control speed/ direction selector — IN-OUT.

CAUTION

- When control speed/ direction selector is in neutral position, cargo load may creep.
- Tension must be applied to the cable during rewind to prevent damage to the cable and winch when winding on the reel. Be sure slack is out of cable before attempting to draw a heavy load into helicopter.

Note

An emergency winch OFF button is provided on the side of the control pendant which will remove power from the control speed/ direction selector when pressed.

9.10 HELICOPTER IN-FLIGHT REFUELING (HIFR) PROCEDURES

9.10.1 General. HIFR is done to extend the on-station time and should be initiated with enough fuel remaining to Bingo to the nearest land base or carrier if it is not possible to inflight refuel. Daylight VFR refuel operations can be made in the same manner as normal utility transfers to mail or cargo. Night inflight refueling is a more demanding operation and can be scheduled as operational necessity requires. Hot refueling (refueling on the ground while rotors are turning) is preferable to night HIFR. Additional information is available in the NWP-42.

WARNING

- Prior to conducting of (HIFR etc.) operations, ground/ deck crews should be briefed on the downwash potential of the helicopter and safety considerations. See DOWNWASH in Chapter 11.

- Deck crews should be briefed before HIFR on the static electricity potential of the helicopter. Deck crews shall use a CH/ MH-53E approved grounding rod to maintain helicopter grounding while attaching or releasing HIFR saddle.

9.10.2 Helicopter Grounding

1. Before planned HIFR operations the rescue hoist should be checked for proper grounding by applying a light download (25 to 35 pounds) on the hook and checking for electrical continuity from the helicopter to the hoist hook.

2. The ship's HIFR hose and HIFR assembly provide a continuous grounding path between the helicopter and the ship. When the HIFR assembly and hose are being raised or lowered, the grounding path is through the hoist hook to the saddle. When possible, obtain verbal assurance from the ship that a ship's system ground check was made prior to HIFR operations.

3. Certain lack of grounding continuity problems may cause the helicopter to discharge static electricity as the grounding jack is touched by a crewman or as the jack is touched to the helicopter. The grounding jack must always be connected before plugging the refueling hose into the aircraft receptacle (Wiggins fitting) and disconnected after the hose is unplugged from the aircraft receptacle to be sure that any static electricity arcing that might take place is not from the fueling adapter.

4. Use of insulated (lineman's) gloves by crewman when contacting the HIFR saddle, is required.

5. If static electricity arcing takes place during step 4, or any other indication of poor grounding is manifested (shocks, etc.), HIFR should be conducted only if essential.

9.10.3 HIFR Rigs. All HIFR capable ships are equipped with one of two different rigs (Figures 9-8 and 9-9).

9.10.3.1 Wiggins/North Island (NI) HIFR Rig. This rig has a ship's hose (>100 feet in length) and a HIFR assembly which is a 10-foot section of 1 1/2-inch hose outfitted with a saddle for hoisting the HIFR assembly and hose to the aircraft. Both ends of the HIFR assembly are equipped with female closed circuit refueling (CCR) fittings (also referred to as Wiggins fittings). A manual emergency disconnect lanyard (emergency release T-handle) is located near the Wiggins fitting on the HIFR assembly which connects to the male Wiggins fitting in the helicopter. The second Wiggins fitting connects the HIFR assembly to the ship's hose. This rig incorporates a manual breakaway which requires a helicopter crew member to pull a lanyard to effect breakaway (Figure 9-8).

9.10.3.2 NATO Compatible High Capacity (NHC) HIFR. This new rig features a 110-foot long 2-inch lightweight hose, unisex couplings, automatic emergency breakaway and facilitates the use of either a CCR nozzle or a D-1 nozzle (SPR) for HIFR operations. The NHC has two major assemblies - the 100-foot HIFR hose and the 10-foot HIFR assembly. During routine HIFR operations the H-53 aircraft will receive the CCR nozzle attached to the HIFR assembly. This nozzle has a built-in 45 psi pressure regulator and an on/off flow control handle which allows the crewman to turn fuel flow on and off. Emergency breakaway is initiated when 450 ±50 lbs of straight tensile pull is exerted on the automatic breakaway coupling. The mount for the hoist cable has been designed for self alignment between the winch and deck tiedown to assure a straight pull (Figure 9-9).

Note

Emergency breakaway occurs automatically as the helicopter moves away from the ship. No action by aircrew is necessary.

Most U. S. helos are configured with a CCR type connection for HIFR refueling while all other NATO countries with HIFR capability, use an SPR connection. Therefore, if a U. S. helicopter is HIFR'd by a non-U. S. ship, it will be given a SPR nozzle and must carry an adapter to convert it to a CCR type connection.

9.10.4 Normal Operation. Day and night HIFR fueling hookups shall be conducted over the fantail of the surface vessel, with the helicopter hovering into the relative wind. The wind should be 330° to 355° relative to the ship's heading at a velocity of 15 to 20 knots. Density

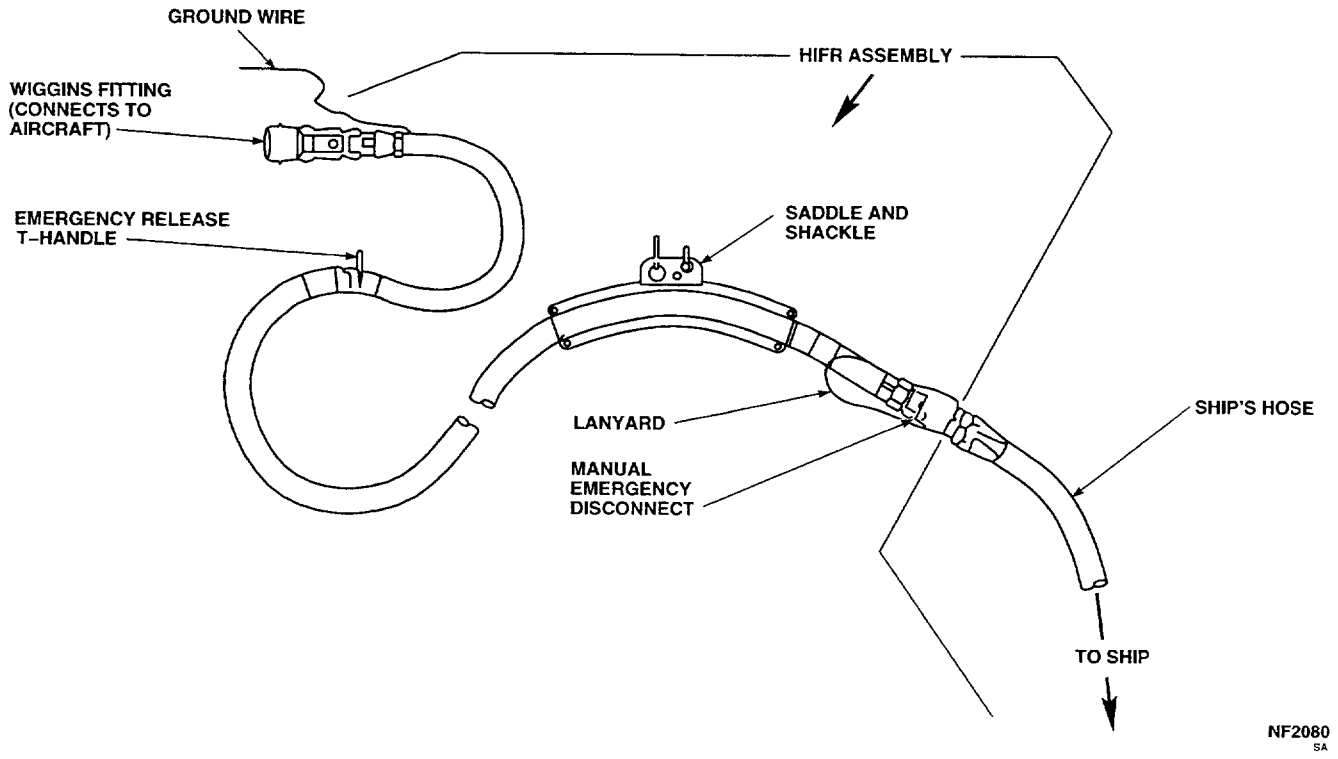


Figure 9-8. Wiggins North Island (NI) HIFR Rig

altitude and true wind velocity will dictate whether a higher relative wind velocity will be required to hover. During high true wind conditions, the most stable hover with the least amount of turbulence is normally encountered when the ship is at a speed slightly above that required to maintain steerageway. The ship's speed may be adjusted to minimize the pitching, rolling, and fishtailing of the transferring ship in high seas.

9.10.5 Communications. Signals to start and stop pumping shall be exchanged between helicopter crewman and the ship's director, with the radios as the backup means of communication. In addition to the normal hover positioning reports (refer to search and rescue standard terms in this section), the terminology and visual signals in Figure 9-10 shall be used.

To request HIFR, the pilots shall contact the refueling ship and request HIFR and the amount of fuel in pounds required.

9.10.6 Procedures

1. Approach.

Approach to the ship should be made from the stern at an altitude of 150 feet and 90 knots. At a point one-half mile astern the ship, a transition should be started so as to arrive in a 15- to 20-foot hover over the flight deck with the same relative movement as the ship. When established in a hover, secure the personnel door in the open position. Aircrewman shall wear a crewman's safety belt whenever the personnel door is open.

CAUTION

- The salt spray circulated by the downwash can create visibility problems for the pilot, especially if the windshields become covered. Further, when the sun shines through the salt covered windshield the visibility is reduced.
- When the relative wind is off the bow of the ship, significant turbulence can be experienced from the wind blowing through the top of the ship's superstructure.

2. Lower rescue hoist hook.

When in position over the ship, lower the rescue hoist hook to the deck. Aircrewman reports: "Hoist going down". Crewman on ship will allow hook to contact deck

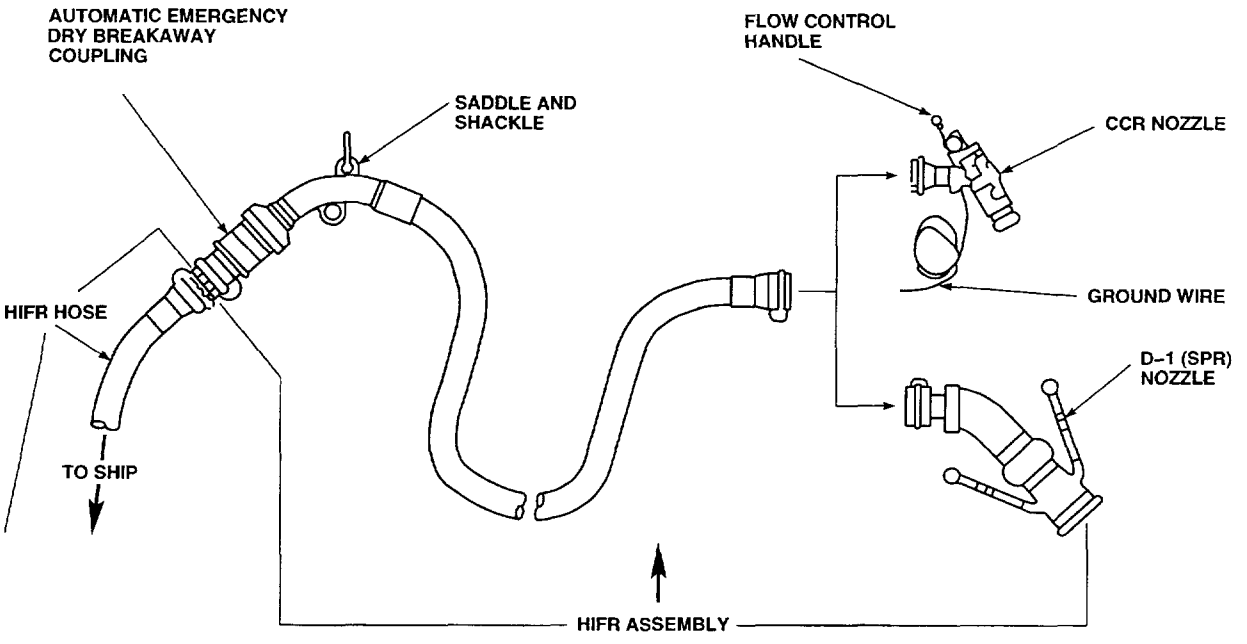


Figure 9-9. NATO High Capacity (NHC) HIFR Rig

thereby discharging static electricity. The aircrewman shall observe and ensure that the hoist is grounded before it is touched by deck crew personnel. This can be accomplished by having the deck crew touch the hook to a cable or chain grounding device. The device has one end grounded to the ship so that when the other end touches the rescue hoist hook (or cable) it completes an electrical circuit that will discharge the continuing static electricity buildup in the cable. The grounding device must remain in contact with the hoist hook (or cable) until the saddle hose is connected to the hoist. Aircrewman reports, "Hoist is on the deck" while observing deck crew attaching the hose saddle.

CAUTION

Under no circumstances shall a fuel sample be taken from the petcock on the HIFR assembly inside the helicopter. A fuel spill may result.

Note

- A fuel sample will be made available by the deck crew for inspection before commencing HIFR operations. A fuel sample bag with the fuel sample inside can be attached to the rescue hoist and inspected by the aircrew before attaching the saddle hose assembly to the rescue hoist hook.

- A one-cell light should be connected to the hoist hook during night operations to give visual references to hook position at all times.

3. Raise hose to helicopter.

When deck crew gives "thumbs up," the aircrewman will raise the hoist to retrieve the hose. Aircrewman reports: "Hose coming up." Stop hose just below the hoist seat position. Aircrewman reports: "Hose is in the cabin, cleared to move left."

CAUTION

- Constant attention and crew coordination is required in order to keep the HIFR hose from becoming taut.

HIFR COMMUNICATIONS

From	To	When	Report/ Visual Signal	Response
CREW	PILOT	Hoist is going down.	HOIST GOING DOWN.	ROGER
CREW	PILOT	Hoist in on the deck.	HOIST IS ON THE DECK.	ROGER
CREW	PILOT	Hose connected to hoist hook.	HOSE COMING UP.	ROGER
CREW	PILOT	Hose is in the cabin.	Hose is in the cabin. CLEARED TO MOVE LEFT.	ROGER, MOVING LEFT
CREW	PILOT	Ready to receive fuel (hose connected).	HOSE CONNECTED.	ROGER, COMMENCE PUMPING
CREW	SHIP	Directed to commence pumping.	CREWMEMBER MAKES CIRCULAR MOTION WITH HAND.	
PILOT	CREW	Desired quantity of fuel has been received.	STOP PUMPING.	ROGER, STOP PUMPING
CREW	SHIP	Stop fueling.	CREWMEMBER MAKES CUTTING MOTION ACROSS THROAT.	
CREW	PILOT	Fueling has stopped.	FUELING STOPPED, HOSE DISCONNECTED CLEAR TO MOVE RIGHT.	ROGER MOVING RIGHT
CREW	PILOT	Ready to lower hose.	HOSE GOING DOWN.	ROGER
CREW	PILOT	Hose on deck.	HOSE IS ON THE DECK.	ROGER
CREW	PILOT	Hose disconnected from hoist hook and hoist is being raised.	HOIST HOOK CLEAR.	

Figure 9-10. HIFR Communications (Sheet 1 of 2)

- The NI HIFR assembly can be installed backwards. The aircrewman must ensure the emergency release T-handle is located near the Wiggins fitting which he attaches to the aircraft's fitting. Opposite connection is possible and will force the helicopter to shear the hoist to effect an emergency breakaway.

Note

Position the helicopter on the port side clear of the deck. The amount of hose available and the need to keep clear of the ship will determine the HIFR position.

4. Attach restraining strap to HIFR saddle to relieve lateral tension on hoist.

5. Connect grounding wire.

6. Connect CCR nozzle (NHC rig) or Wiggins fitting (NI rig) to the aircraft receptacle.

Open access panel to aircraft receptacle and remove dust cover. Pull back on bail (collar) on the CCR nozzle or Wiggins fitting and fit nozzle onto aircraft receptacle. Aircrewman reports: "Hose connected."

Note

If there is pressure in the line, it will not be possible to connect the fuel hose to the helicopter.

When using the NHC rig, crewman shall check to determine hose is pressurized and then place flow control handle in the OPEN position.



NOTE

THE VISUAL SIGNALS WILL BE THE SAME AT NIGHT EXCEPT RED AND GREEN LENS FLASHLIGHT SHALL BE USED

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Figure 9-10. HIFR Communications (Sheet 2 of 2)

When using NI rig, crewman shall place one hand on the emergency release T-handle and keep it there until fueling is complete and the NI Wiggins nozzle has been disconnected from the aircraft receptacle.

CAUTION

Constant attention and crew coordination is required to keep HIFR hose from becoming taut.

7. Raise hoist to near seat position.

CAUTION

The HIFR saddle must be raised as near as possible to the hoist seat position to permit proper and safe operation of the emergency breakaway on either rig.

8. Commence pumping.

When directed by pilot, signal ship to start pumping. Signal is a circular motion with the hand. Pilot directs: "Commence pumping." Crewman responds: "Roger, commence pumping."

WARNING

The copilot must monitor the fuel quantity indicators during the pumping phase to avoid overfilling and possibly rupturing the fuel tanks in the event the high-level shutoff valves fail.

Note

A slow pumping rate of less than 100 pounds-per-minute total for all tanks may indicate a clogged fuel filter in the helicopter's receiving system. Reducing the helicopter's altitude over the deck of the ship may aid in increasing the pumping rate.

9. Cease pumping.

Note

Crewman has ability to stop fueling with flow control handle on the NHC rig's CCR nozzle. In addition, this CCR nozzle will automatically stop flow and the red pin behind the flow control handle will extend under the following conditions:

1. Pressure has exceeded 45 psi.
2. Tanks are full.

When directed by pilot, signal ship to stop pumping. Stop signal is a cutting motion across the throat. Pilot directs: "Stop pumping." Crewman responds: "Roger, stop pumping."

10. Disconnect CCR nozzle (NHC rig) or Wiggins fitting (NI rig).

When pumping has stopped and hose is depressurized, place CCR nozzle (NHC rig) flow control handle in the OFF position. Pull back on bail (collar) to release nozzle or Wiggins fitting from the aircraft's receptacle. Aircrewman reports: "Fueling stopped, hose clear, ready to move right." Replace dust cover on aircraft's receptacle and close access panel. Release restraining strap from HIFR saddle.

Note

Pilot will reestablish position over deck. Crewman will assist through verbal control.

11. Disconnect ground wire.
12. Lower hose to deck.

After helicopter is repositioned over ship's fantail, lower hose to deck. Aircrewman reports: "Hose going down." "Hose is on the deck." Aircrewman should attempt to reduce tension on the hoist cable.

WARNING

With a pitching deck, it is possible to have too much slack in the cable. A slack cable can cause personal injury or entangle with obstacles on the deck.

13. Retrieve rescue hook.

Observe deck crew disconnect hose from hoist hook. When "thumbs up" received from deck crew, raise hoist. Aircrewman reports: "Hoist hook clear." Secure hoist and close lower half of personnel door. Aircrewman reports: "Cabin Section secure."

Note

- At the pilot's discretion and when hoist is reported clear of ship deck, the pilot will move left and depart area.
- All visual signals from the helicopter will be the same at night except a red lens flashlight shall be used. (See Figure 9-10.)

9.10.7 Night/Low Visibility HIFR Approach. The recommended approach pattern (Figure 9-11) is a 90° to 270° turn pattern which will enable the pilot to arrive at a gate position, either using the ship's radar for positive control, the ship's TACAN if installed, or a dead reckoning visual flight path. After the course and speed of the surface vessel have been determined, either visually or by radio, the helicopter will descend to 300 feet and 90 KIAS. The helicopter will then fly over the refueling ship on a heading 180° relative to the ship's heading. When over the ship's stern, this procedure should be done:

Note

The pilot in the left seat should fly the helicopter and the pilot in the right seat should perform all copilot responsibilities until just before the helicopter arrives at the ship's fantail. Then, the pilot in the right seat should assume control and make a visual transition to a hover over the fantail.

1. Commence a standard rate turn to the left. Passing through 90° of turn reverse direction and execute a 270° standard rate turn to the right.

2. As the reversal course is approached, and upon completion of the 270° turn, the copilot should attempt to establish visual reference with the refueling ship's wake. As visual reference is established, the copilot should advise the pilot as to corrections to course in order to establish level flight over the ship's wake and on the ship's heading.

3. Descend to 150 feet and about 90 knots ground speed before reaching a point 1/2-mile astern of the ship.

4. The copilot will direct the pilot as necessary to keep the helicopter over the ship's wake until good visual reference is established with the ship.

5. When a green deck signal is received from the ship, the helicopter descends to HIFR altitude, the pilot in the left seat will secure the forward rotating anticollision light (about 100 yards astern of the ship).

WARNING

- Do not rely on BAR ALT hold during low altitude operations.
- With RDR ALT hold turned on, any interruption of power to the radar altimeter can cause up to 30 feet of altitude loss before the AFCS detects the malfunction and switches to the BAR ALT retention mode.

Note

Be prepared to collective jumps when the radar altimeter acquires or loses the height of the ship's fantail, if the RDR ALT mode is used.

6. Upon completion of the refueling evolution, make a 20° turn to the left and after receiving a "ready for forward flight," report from the crew chief slide clear of the ship to port and climb to departure altitude.

9.10.8 Emergency Breakaway Procedures. During HIFR when an emergency condition is observed, or when the command "Breakaway" is received, one of the following emergency breakaway procedures should be followed depending on the type of HIFR rig being used.

Note

If emergency breakaway is necessary with either rig, the HIFR assembly, which includes the saddle and a 10-foot section of hose, will remain attached to the helicopter.

9.10.8.1 NI HIFR Rig. The crewman with his hand on the emergency release T-handle must pull the device thus releasing the HIFR hose and letting it fall back to the ship. The pilot then flies away from the ship.

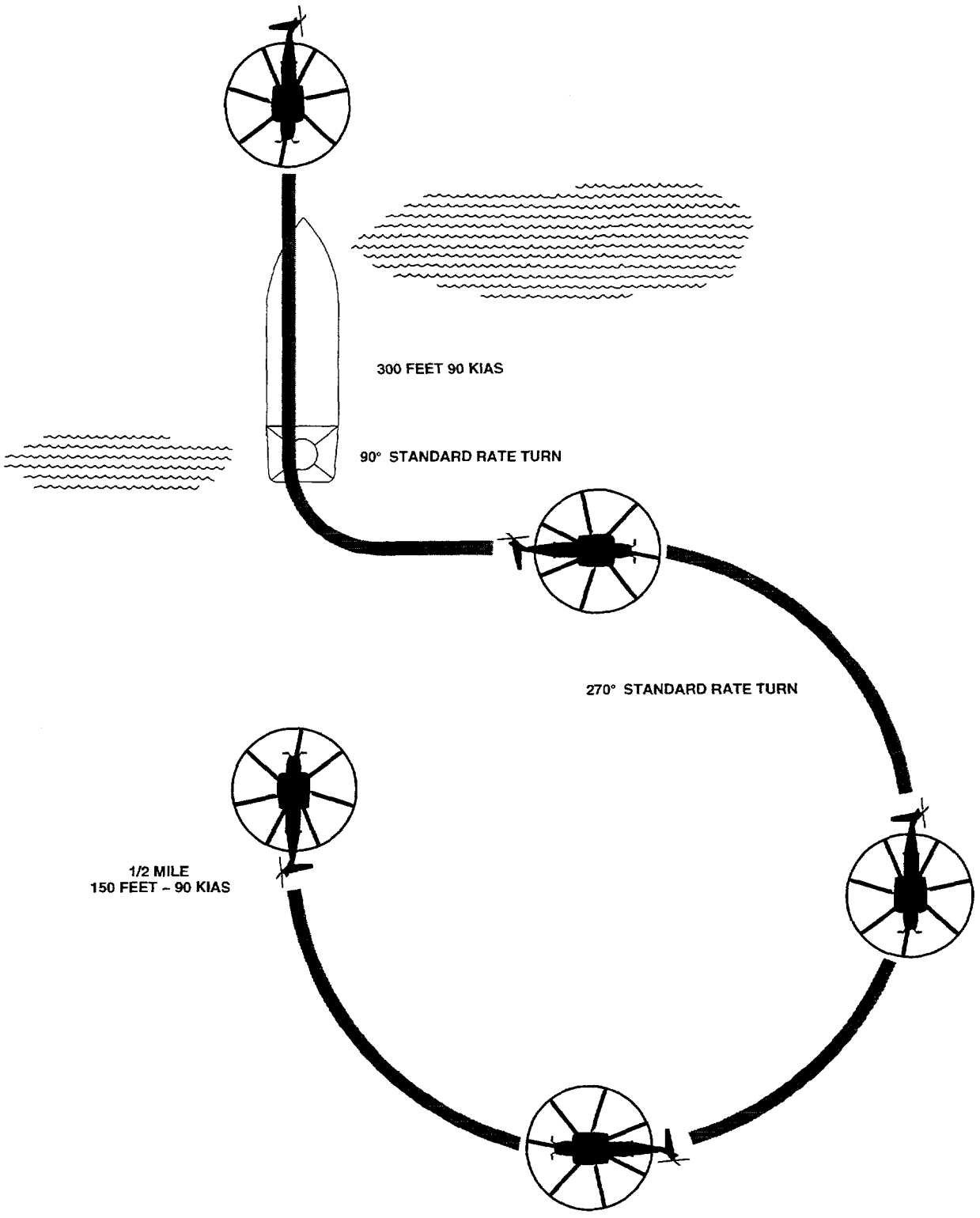


Figure 9-11. Night/Low Visibility HIFR Approach

Note

The NI rig has a manual emergency breakaway which requires aircrew action to disconnect.

1. When directed or when deemed necessary, the crewman shall pull the emergency breaking lanyard (T-handle) on the HIFR hose. The command "Breakaway" will be repeated 3 times, that is: "Breakaway, Breakaway, Breakaway" by the initiating station over the ICS. The report and action should occur simultaneously.

2. Report when hose is clear of the helicopter.

When the fueling hose separates and drops away from the helicopter, the aircrewman reports: "Hose Clear."

9.10.8.2 NHC HIFR Rig. This rig incorporates an automatic emergency breakaway. No crewman action is necessary to disconnect system. Once the NHC rig has been attached, the pilot can effect emergency breakaway at anytime by flying from the ship and climbing. See paragraph 9.10.3.2 for details on this automatic system.

CAUTION

All slack hose between aircraft and deck tiedown point near HIFR hose will be pulled taunt upon fly away. Injury may result if deck crew becomes tangled in the HIFR hose.

Once emergency condition has passed, return the HIFR assembly to the ship and resume HIFR operations.

When position is reestablished over the deck, disconnect fuel hose from aircraft receptacle and lower HIFR assembly to the deck. Deck crew will reconnect fuel hose to the saddle assembly or remove saddle assembly from hoist depending on pilot decision to continue or secure HIFR.

CAUTION

If HIFR operations are to be continued, make sure that the hose has been thoroughly flushed before pumping is resumed. It is probable that sea water entered the line when the hose fell into the water on breakaway.

Note

With a helicopter emergency, it may not be possible to return the saddle assembly.

If either rig fails to disconnect when an emergency breakaway is attempted, it will be necessary for the crewman to quickly disengage the nozzle and grounding wire from the aircraft and cut the hoist cable.

WARNING

If the hoist cable is cut with either HIFR rig connected to the aircraft fitting, the possibility exists that the HIFR rig or aircraft fitting could rupture, causing pressurized fuel to leak into the cabin.

9.10.9 Clogged HIFR Filter

1. Stop fueling.

When a pump rate of less than 100 pounds-per-minute is observed by pilot, he will command, "Stop pumping." Upon this command, aircrewman will report, "Roger, stop fueling" and signal ship with "Cease fueling" hand signal (cutting motion across his throat).

2. Disconnect nozzle from Wiggins fitting. After pressure has been removed from hose, pull back on bail wire or collar to release lock. While holding collar back, pull straight out on nozzle. Return saddle assembly to ship before starting troubleshooting.

3. Remove filter cover.

Before removing cover, drain filter from both drain valves. Locate T-bar in center of filter cover which is next to Wiggins fitting. Turn T-bar counterclockwise until cover can be removed. Lay cover aside.

4. Remove old fuses/ install new fuses.

Remove five old fuses. Check bottom of filter for FOD. Insert five new fuses. If fuses are in plastic bags, make sure bags are removed before installing.

5. Replace filter cover.

Replace filter cover and turn T-bar until cover is secure. Cover need be handtightened only.

6. Retrieve saddle assembly and reconnect.

Reconnect nozzle to Wiggins fitting. Check security of connection.

7. Inform pilots.

After nozzle is connected, report: "Hose connected." Pilots will report: "Roger, commence pumping." Crewman will signal ship with "commence pumping" hand signal. (Circular motion with his hand.)

8. Check for leaks.

Inspect filter and receptacle area for leaks.

WARNING

If leaks are present, fueling will be secured until corrective action can be taken.

9.11 HELICOPTER AIR REFUELING PROCEDURES

Helicopter air refueling is divided into four stages of operation; rendezvous (intercept/ escort), join-up contact/ fuel transfer, and post air refueling. The tanker accomplishes all required maneuvering during rendezvous to preclude degradation of receiver capability. Rendezvous procedures provide the tanker a means of transitioning from escort/ intercept conditions to a position 1/2 nautical mile in trail to the lead position, establishing refueling configuration (hoses extended, flaps 70%, airspeed below 120 KIAS), and establishing an observation position at the air refueling control point (ARCP). A complete description of air refueling procedures is in the NATOPS Air Refueling Manual. Air refueling emergency procedures are discussed in Part V.

9.11.1 Fuel Probe Extension Test

1. REFUEL PWR pushbutton — ON.

2. PROBE switch — EXTEND.

WARNING

During extension of the refueling probe, be sure no personnel or vehicles are directly in front of the refueling probe. There is enough bleed-air pressure to propel the probe from the helicopter if the external lock actuator fails.

Note

- If probe does not extend completely, stop and recycle by first pressing REFUEL PWR pushbutton OFF, recycling PROBE switch, and then pressing the REFUEL PWR pushbutton ON. Allow 1 minute between stowing and reextending probe for system bleed.

- Total time to extend air refueling probe should not be over 1 minute, and total time to retract probe should not be over 2 minutes, with No. 1 and No. 3 engines above GRD IDLE.

3. PROBE READY light — READY.

4. PROBE switch — STOW.

5. PROBE READY light — OUT.

6. REFUEL PWR pushbutton — OFF.

9.11.2 Altimeter Settings. The altimeter setting used will be the nearest station altimeter unless the standard altimeter setting 29.92 inches Hg is authorized.

9.11.3 Visibility. Minimum visibility for a VMC rendezvous is 5 nautical miles. Minimum visibility for radar rendezvous is 1 nautical mile. Lost contact procedures are discussed in Part V.

Flight through clouds after contact is not recommended. Special weather services are required to support operations involving air refueling, and certain weather support procedures shall be used. It is paramount to the success of these operations that a single coordinated forecast be provided to the Refueling Area Commander (RAC) having overall control (making go/no-go decisions). It is also imperative that a close weather watch be maintained throughout the operation to aid in making recalls, diversions, etc., if unexpected weather conditions critical to the operation occur.

9.11.4 Rendezvous Procedures. During the initial stage of rendezvous standard intercept procedures are employed to place the tanker on an intercept course with the receiver. The receiver and tanker monitor rendezvous

frequencies and attempt to establish radio contact at least 30 minutes before air refueling control time (ARCT). Before starting join-up procedure, a minimum separation of 1000 feet between tanker and receiver should be maintained before visual or radio contact has been established.

Before rendezvous, the participating crews will confirm any changes to the permission briefing. Additionally, the following information is determined/ reconfirmed by the tanker pilot if not previously addressed in an in-flight briefing:

1. Refueling altitude.
2. Altimeter setting.
3. Time of bingo fuel.

After initial radio contact has been established between the tanker and the receiver, the tanker assumes control of the rendezvous. The tanker pilot requests the receiver to (1) climb or descend to join-up altitude, which is 200 feet above the refueling altitude, (2) transmit a specific IFF code, and (3) transmit for a DF steer if needed. Positive radar identification is made by having the receiver turn the IFF to STBY. The tanker notifies the receiver when radar contact is established. DF procedures continue until visual contact is established. The receiver is provided with range information every 10 nautical miles. When the IFF signal is received after radio contact has been established, the receiver is instructed to STBY for 10 seconds and return to NORM. When he complies, this indicates receipt of instructions. The receiver will complete the PRECONTACT checklist.

9.11.4.1 Precontact

1. Crew briefing — COMPLETED.
   a. Review type rendezvous, number tankers, refueling altitude, airspeed, and any other information pertinent to the refueling operation.
   b. All normal and emergency equipment required during refueling operations will be available.

WARNING

Smoking is not allowed during and immediately after fuel transfer.

2. Fuel — CHECKED.
3. Altimeter setting — SET (STATE SETTING).
4. Refueling panel — SET.
   a. REFUEL PWR pushbutton — ON.
   b. Tank selector switches — AS REQUIRED.
5. PROBE switch — EXTEND.

CAUTION

Takeoffs and landings should not be made unless the probe is fully retracted and locked.

Note

If probe does not extend completely, stop and recycle by first pressing REFUEL PWR pushbutton OFF, placing PROBE switch to STOW, recycling PROBE switch, and then pressing the REFUEL PWR pushbutton ON. Allow 1 minute between stowing and reextending probe for system bleed.

6. PROBE READY light — READY.
7. Fill pushbuttons — AS REQUIRED.

9.11.4.2 Random Rendezvous. Random rendezvous is used during VMC as a method to aid rendezvous without losing visual contact with the receiver. The tanker pilot positions his aircraft to maintain visual contact and:

1. Reaches rendezvous altitude at least 5 nautical miles from the receiver.
2. Confirms receiver is a join-up altitude.
3. Descends to refueling altitude and maneuver to 1/2 nautical mile in trail; then proceed with the Join-up procedures.

Note

This procedure is designed to expedite rendezvous, to maintain visual contact once established, and to allow the tanker pilot to maneuver the tanker as required to accomplish a successful rendezvous.

9.11.5 Join-up. Rendezvous procedures position the tanker for join-up. Join-up from all types of rendezvous is the same. The tanker must maintain a positive rate of closure to avoid delaying refueling operations; however, caution must be exercised to avoid overruning the receiver. The tanker is at an altitude 200 feet below the altitude of the receiver and plans his approach to pass on the right side of the helicopter.

At close range (1/2 nautical mile), tanker advises receiver "1/2 nautical mile in trail" and reduces airspeed to 155 KIAS and lowers flaps to 70%. (Receiver will have completed the JOIN-UP checklist.)

9.11.5.1 Join-Up Checklist

1. Windows, doors, and hatches — SECURE.
2. EAPS — CLOSED.
3. Heater/ vent blower — OFF.
4. AN/ALE-39 — OFF/SAFE.
5. Join-up altitude — ESTABLISHED (200 FEET ABOVE REFUELING ALTITUDE).
6. Refueling airspeed — ESTABLISHED (110 KIAS RECOMMENDED).
7. Air refueling lights — AS REQUIRED.

WARNING

Intensity of refueling probe light or searchlight is adjusted to pilot's desire. Bright lights reflecting on probe or drogue may induce vertigo.

8. Join-up checklist — COMPLETED.

CAUTION

Main rotor-to-probe clearance can be as little as 4.0 feet during 1.0 inch longitudinal cyclic pulses. Avoid abrupt longitudinal cyclic inputs.

Note

If aerial refueling is attempted following flight in icing conditions, offcenter contacts with drogue basket are made to remove ice from probe. This will properly seat the drogue. Visual verification of an ice-free probe is accomplished by the scanner in the tanker. Wet refueling is not started until probe is free of ice.

As the nose of the tanker passes the receiver's 3-o' clock position, the receiver goes to STBY on IFF and reports "tally-ho". The tanker advises the receiver "tanker assumes formation lead" and establishes refueling airspeed of 110 KIAS. The receiver calls when in the left observation position, which is a loose formation position on the left side of the tanker. The left side refueling position is the primary position for air refueling.

WARNING

Receiver crews should not attempt probe-to-drogue contact while in a turn at night. The possibility of spatial disorientation exists when the pilot must divide his attention between the drogue and coordinating a turn while having less visual reference at night. Once in contact, turns are permitted, as the pilot's reference is solidly on the tanker.

9.11.5.2 Airspeeds and Altitudes. The optimum airspeeds and altitudes for both tankers and receivers must be compromised when arriving at a common altitude which is safely within the performance capabilities of each. It is important to remember that the VNE for the paradrogue assembly is 120 KIAS.

9.11.5.3 Air Refueling System Description. If all tanker refueling systems are functioning properly, the tanker normally has two hoses extended (the tanker pilot

may elect to extend only one hose on air refueling training missions that do not require the use of both hoses).

The hose on Marine and Air Force C-130s extends 81 feet from the pod fairing (actual hose length including remaining wrap on the drum within the pod is 93 feet) and each 10 feet of the hose length is marked by a white band. On Marine Corps C-130 F/Rs there is a 60-foot refueling range. The paradrogue has to be pushed in at least 5 feet in order for fuel to be transferred. On Air Force C-130s and Marine Corps KC-130Ts, there is a 20-foot refueling range from the 56-foot to the 76-foot mark, and it is further defined by 5-foot bandings at each end of the range.

The heavy reception coupling at the end of the hose is kept aerodynamically stable by the circular canopy of the paradrogue assembly. The paradrogue assembly is attached to the reception coupling by interconnecting spokes. Aerodynamic load inflates the canopy to an outside diameter of 46 inches and provides an inside or target diameter of 27 inches. Pod and hose illumination lights are mounted on the forward outboard edge of the tanker's horizontal stabilizers for night use, if greater illumination is desired to improve the receiver pilot's visual references.

WARNING

Use of pod and hose illumination lights may cause receiver windshield glare, or induce vertigo.

At the aft end of the refueling pod are three lights. The red light, when on, indicates: hydraulic pressure off. Engaging the hose when this light is on is considered an emergency procedure. The yellow light, when on, indicates: tanker ready. The green light, when on, indicates: fuel flowing. Normally, as the receiver approaches the tanker, the yellow tanker ready light is on.

The interior of the reception coupling attached to the end of the hose is cone-shaped to guide the entrance of the mating probe. The coupling has a locking mechanism which consists of three spring-loaded pistons connected to rollers extending through the interior of the reception coupling. When the probe enters the reception coupling, these rollers are forced back against the spring tension as they ride up the shallow angle of the sloping front surface of the probe head. After coupling is completed, the rollers drop down the steeply angled rear surface of the probe head. It requires approximately 140 foot-pounds of force to push the rollers back during the coupling action; thus a closure rate of approximately 2 - 5 KTS is necessary.

When refueling is in progress, the probe and drogue engagement is further ensured by the fuel pressure in the hose which is transmitted to the rear of the spring-loaded pistons in the reception coupling. This pressure locks the rollers behind the head of the probe. If coupling is done at less than the required closure rate, with insufficient force to cause the probe to enter completely into the reception coupling, the described locking action cannot take place.

In order to have a proper probe-to-coupling locking action, a positive closure rate should be maintained until after initial contact. If the locking action does not occur and the receiver adjusts his position relative to the tanker rearward, the hose and probe will separate and the hose will remain in the position at the time of separation. This is referred to as a: soft contact. Incomplete locking action could result in fuel spraying from the coupling. If, however, proper coupling is done and the locking action is completed by fuel pressure, pull on the hose when the receiver moves back will be sensed by the tanker response system. The hose will extend at the same rate as the receiver moves to the rear. Fuel can be transferred with incomplete coupling only while the receiver pushes inward. On Marine Corps C-130F/Rs, during refueling, the receiver should maintain a position on the hose that allows for a safe clearance between the trailing edge of the C-130 wing and the tip path plane of the helicopter. On Air Force C-130s and Marine Corps KC-130Ts, during refueling, the receiver should maintain a position on the hose midway between the two 5-foot white bands indicating the refueling range.

9.11.5.4 Air Refueling System Operation. Before clearing the receiver to refuel, the tanker crew will have checked out the operation of all components of the refueling system. The final step in this checkout procedure is to actuate the reset switch on the auxiliary fuel panel. Actuation of the switch establishes a reference pressure within the tanker hydraulic system which is representative of the aerodynamic drag on the hose and drogue. Thus, if this drag is increased the hose would extend. The yellow tanker ready light goes on 5 seconds after the reset switch has been actuated, indicating this reference pressure. When the receiver aircraft engages the drogue and moves forward, it assumes a portion of the aerodynamic drag of the hose and drogue. The tanker hydraulic system, acting on the basis of the lock-in reference pressure, senses this loss of drag and retracts the hose. The system continues to retract the hose as long as the receiver closes on the tanker, preventing any slack hose from developing. As the

receiver recedes from the tanker, the tanker hydraulic system extends the hose since the drag is increased beyond the original reference pressure. Thus, the receiver can close on or recede from the tanker aircraft, and the hose will retract or extend accordingly. When the receiver recedes to the original 81-foot hose extension, the hose stops extending and a disconnect is effected.

The tanker system may be set to start pumping fuel automatically when the hose is pushed 5 feet in from the full trail position. As the hose is pushed in past the 76-foot position, the yellow tanker ready light goes off and the green fuel flowing light goes on. Fuel will continue to flow as long as the receiver maintains the hose extension between 76 and 20 feet on Marine Corps C-130s and 76 and 56 feet on Air Force C-130s. Exceeding either of these range limits causes the fuel flowing light to go off and fuel flow to be shut off. The yellow tanker ready light also goes on whenever either of these limits is exceeded. While the receiver is in the refueling range, fuel continues to flow until the scheduled amount of fuel has been transferred, or until the receiver is full, and intermittently thereafter as receiver fuel supply is constantly diminished by the operating engines of the receiver aircraft. Fuel flow during refueling may be controlled manually by the tanker flight engineer; however, little difference will be noted by the receiver pilot.

9.11.6 Contact/Fuel Transfer. After completion of the join-up checklist and when the tanker is ready for air refueling, the tanker pilot clears the receiver for wet/dry contact on the left/ right drogue and clears the receiver the stabilized position. The receiver acknowledges this clearance and checks that the yellow (tanker ready) light on the refueling pod is on. The receiver maneuvers into the stabilized position, lines up the probe with the tanker's hose and drogue and calls "stabilized". The tanker acknowledges the receiver and clears the receiver to plug. A good stabilized position is when the end of the probe is no more than 5 - 10 feet from the basket. In turbulent air, a 5-foot stabilized position is desired.

WARNING

Under no circumstances should the pilot stare at the drogue, as this will result in poor aircraft control, and leads to spatial disorientation.

CAUTION

- If tanker hose-reel response is improperly adjusted, an inadvertent disconnect may occur. A lateral disconnect while in the refueling position may result in probe damage, loss of probe nozzle, and subsequent fuel siphoning. Prior to commencing aerial refueling, the first aircraft should evaluate hose-reel response both in and out before moving to the refuel position.

- Excessively hard contact between probe and drogue can damage the refueling nozzle.

- Wing/ prop turbulence can cause controlled settling. If settling occurs while connected to the drogue, disconnect immediately. Failure to disconnect may result in damage to the probe and possible rotor blade-to-drogue contact.

- Air refueling with an after center of gravity with this helicopter gives the minimum amount tip path plane to probe and drogue clearance. Air refueling with an aft center of gravity should be attempted only if mission requirements do dictate.

When hose slack and whip occur, and are observed by the tanker scanner or reported by receiver pilot, the receiver will be instructed to return to the observation position.

When the receiver is clear and the tanker response set switch is actuated, the hose in question will be observed to travel to full trail and the tanker ready light will go on. When cleared, the receiver may reengage. If hose response is improper, the receiver will be directed to a spare hose, if available.

Note

A small amount of fuel spray from the nozzle and receptacle during fuel transfer does not require fuel transfer to be terminated. The tanker and/or receiver pilot should be notified if this condition exists. The air refueling operation will be continued or discontinued at the discretion of the receiver pilot.

After contact is established, the receiver pilot need only focus attention on the tanker and fly a normal position. A good refueling position is with the refueling probe approximately half the distance between the refueling pod and the wingtip dump tube. The pilot may need to move left or right due to turbulence. When refueling from the left hose, the probe should not be further outboard than the dump tube, nor further inboard than the refueling pod. When refueling from the right hose, the probe should be no further outboard than the dump tube and no further than half the distance between the refueling pod and the dump tube. Good step-up is with the trailing edge of the C-130 wing at eye level. This refueling position is intended to minimize potential for inadvertent lateral disconnects while maintaining adequate tanker to receiver clearance.

WARNING

Refueling directly behind the refueling pod is not recommended. An advertent hose guillotine while in this position could cause the hose to contact the main rotor blades.

When initiating refueling operations, the following procedure is done immediately at the start of fuel flow.

1. Observe FUEL FLOW light on and desired tank selector lights on.

2. FUEL SHUTOFF TEST pushbutton — PRESS AND HOLD. Observe that fuel flow stops and flow indicator lights go off.

Note

If high-level shutoff is inoperative, closely monitor fuel gage and manually secure fuel transfer when desired fuel level is reached.

3. FUEL SHUTOFF TEST pushbutton — RELEASE. Observe that fuel flow resumes and flow indicator lights go on.

Since the receiver pilot must devote his full attention to flying formation, the receiver copilot or aircrewmember will monitor the fuel flow lights and all engine instruments. The receiver copilot informs the pilot when fuel flow ceases/ fuel transfer is complete. The copilot reports to the pilot all premature fuel flow stoppage. The receiver copilot must be cognizant of maintaining coordinated flight during fuel transfer. The receiver copilot monitors the turn and slip indicator and informs the pilot when flight is uncoordinated.

9.11.6.1 Multiple Dry Contacts (Training). During training flights, when a series of dry contacts and disconnects are scheduled, the following procedures may be used.

The receiver requests dry contacts by stating, "Request multiple dry contacts on the left (or right) drogue". The tanker approves multiple dry contacts by stating, "Cleared for multiple dry contacts on the left (or right) drogue, cleared stabilized". Once the receiver is in the stabilized position the pilot calls "stabilized". The tanker acknowledges the receiver and clears him to plug.

This series of maneuvers, contacts and disconnects, may be continued at the discretion of the receiver pilot until the clearance for multiple dry contacts is cancelled or the helicopter moves to the observation position.

9.11.6.2 Disconnect. To effect a normal disconnect, the receiver pilot reduces power slightly and reduces airspeed by applying aft cyclic while maintaining the normal disconnect position (about 5 - 10 feet above the contact position). This causes the tanker to gradually pull away from the receiver and the refueling hose to extend. A normal disconnect will occur when the refueling hose reaches its maximum extension. Breakaway Procedures are discussed in Part V.

WARNING

- The receiver pilot will not descend below disconnect position during this operation, to assure maximum rotor blade to drogue separation during and after disconnect.

- If the receiver cannot disconnect from the tanker, refer to Section V, EMERGENCY AIR REFUELING PROCEDURES.

CAUTION

Offcenter disconnects can damage the refueling nozzle.

Since fuel pressure will be off at full hose extension, the locking action described earlier will be released. Considerably more force will still be required to disengage than was required to engage, because the locking rollers of the reception coupling must now travel up the steeply inclined rear surface of the probe head. About 420 pounds of force is required to break a properly completed coupling. After disconnect, the tanker will maintain level flight and refueling airspeed until the receiver is confirmed clear.

9.11.6.3 Crossover. If a crossover is required and clearance has been received from the tanker, the receiver pilot moves to an observation position outside of the tanker wing tip, 100 feet aft of the horizontal stabilizer, and increases altitude to not less than 50 feet above the tanker's vertical stabilizer. A crossover is then made by altering the receiver's heading. During the crossover, the receiver should be flown to a position outboard of the opposite wing tip aft of the horizontal stabilizer before descending into the opposite observation position. This procedure eliminates the possibility of the receiver passing through the area of extreme turbulence directly behind and slightly to the right of the tanker.

If a crossover is required at night, the tanker turns on its top rotating beacon to clearly define the top of the vertical stabilizer before the receiver commences the crossover.

WARNING

Blade stall and uncontrolled settling may be encountered if the area of extreme turbulence is entered. During demonstrations of wake turbulence for pilots receiving initial air refueling qualifications, the instructor should use caution not to enter the area of extreme turbulence.

The tanker may use asymmetrical power to reduce turbulence when the right refueling position is used. If asymmetrical power is desired, ask the tanker pilot for asymmetrical power.

9.11.7 Post Air Refueling. Upon clearing the tanker, the receiver calls "Receiver clear." The receiver copilot copies the post air refueling data as required and completes the Post Air Refueling Checklist.

1. PROBE switch — STOW.

CAUTION

Do not retract the refueling probe if there is more than 4000 pounds of fuel in the number 3 fuel tank. Damage to the fuel cell or overboard fuel transfer may result.

2. PROBE READY light — OUT.
3. REFUEL PWR pushbutton — OFF.
4. AN/ALE-39 — ON/ ARMED AS REQUIRED.
5. Refueling lights — OFF.
6. Tank selector switches — AS REQUIRED.
7. PURGE pushbutton — AS REQUIRED.
8. EAPS — AS REQUIRED.

WARNING

EAPS will remain closed until after shutdown after flight in icing conditions.

9. IFF — AS REQUIRED.
10. Post air refueling checklist — COMPLETED.

9.12 CARGO RAMP AND DOOR PROCEDURES

The procedures outlined here describe the normal operating procedures for ground operation. The system is operated in the same manner in flight, except the APP will not have to be operating.

To Lower Cargo Ramp:

WARNING

- Before requesting ramp power from pilot visually check that ramp and ramp area are clear of personnel before operating ramp.

- To preclude inadvertent actuation of the ramp, ensure cockpit OPERATE knob is in HOLD prior to selecting ramp MASTER switch to PILOT or CREW.

1. APP — ON.
2. Cockpit OPERATE knob — HOLD.
3. Ramp MASTER switch — PILOT OR CREW.
4. Flippers — UP.
5. Area — CLEAR.
6. Cockpit OPERATE knob — OPEN; THEN HOLD.
or
Cabin RAMP CONTROL handle — DOWN; THEN NEUTRAL.
7. RAMP OPEN and UNLOCKED lights — ON.

CAUTION

Before lowering ramp, be sure that area under ramp is clear of equipment, rocks, stumps, etc., and that ground is of equal load-carrying ability, to avoid twisting ramp when heavy loads are applied.

8. Flippers — ADJUSTED AND EXTENDED.

CAUTION

To prevent damage to cargo ramp hydraulic system, ramp control switch shall be left at OPEN when the ramp is used for cargo loading.

To Raise Cargo Ramp:

1. APP — ON.
2. Cockpit OPERATE knob — HOLD.
3. Flippers — UP.
4. Ramp MASTER switch — PILOT OR CREW.
5. Cockpit OPERATE knob — CLOSE.
or
Cabin RAMP CONTROL handle — UP.
6. Ramp OPEN and UNLOCKED lights — OFF.
7. Cockpit OPERATE knob — HOLD.
and
Cabin RAMP CONTROL knob — NEUTRAL.
8. Ramp MASTER switch — OFF.

9.12.1 Manual Ramp Operation. To open cargo ramp and door:

1. Flippers — UP.
2. RAMP POSITION selector valve — LOWER.
3. APP/ pylon selector valve — POSITION A.
4. Pump hydraulic handpump until ramp at desired position.
5. RAMP POSITION valve — OFF.

To close cargo ramp and door:

1. Flippers — UP.
2. RAMP POSITION selector valve — RAISE.
3. APP/ pylon selector valve — POSITION A.
4. Pump hydraulic handpump until ramp at desired position.
5. RAMP POSITION valve — OFF.

Note

To operate ramp door only, position manually-operated valve to DOOR ONLY.

9.13 EXTERNAL TRANSPORT OF CARGO AND AIRCRAFT

Refer to appropriate FMFRP 5-31 manuals for basic operation/ equipment and single- or dual-point hook procedures.

WARNING

- Adequate clearance between the hovering helicopter and ground personnel should be maintained at all times during hookups. The aircrewman observer as well as the plane director advises the pilot of the relative position of the helicopter and the necessary corrective action to maintain it directly over the load through use of the standard ICS signals. Do not start liftoff until ground personnel are clear of helicopter and load.

- For all external cargo operations, the ground hookup crews will be briefed on the static electricity potential of the helicopter and proper grounding procedures. An approved ground rod will be used at all times. When available, insulating (lineman's) gloves will be worn.

- Insulated type loads (wheeled vehicles, pallets, etc.) that are dropped off after lift should be grounded before initial ground crew contact to avoid possible shock.

- Before the conduct of external cargo operations, ground/ deck crews will be briefed on the downwash potential of the helicopter and safety considerations. See DOWNWASH in Chapter 11.

- During external cargo operations, flight crewman shall avoid reaching through the cargo hook hatch to assist in attaching loads. Doing so may cause the crewman to become part of the path for static electricity discharge.

- Drooping of N_r as collective is increased in attempting to lift a load is an indication of exceeding power available. The external lift should be aborted as further increase in collective/ drooping of N_r further reduces the aircraft's lift capacity in a hover.

- This mission should not be conducted in turbulent air. Unstable loads will increase the probability of catastrophic loss of helicopter control.

- Loss of a control desensitizer will, under certain circumstances, allow the pilot to interact with the fuselage bending modes to create a PIO (pilot-induced oscillation) or PAO (pilot-assisted oscillation). This interaction can result in divergent helicopter oscillations. Delayed pilot response in eliminating these oscillations may result in helicopter damage and/or uncontrolled flight. If encountered, releasing the flight controls (HAND REMOVED FROM COLLECTIVE) for several seconds should eliminate the condition. During external cargo or AMCM operations, if PIO/PAO is encountered and cannot be controlled, immediately jettison the load or jettison/ release the tow.

- If a desensitizer failure occurs, and does not clear after a MODE RESET or recycling computer power, the following precautions must be observed:

1. Minimize hover time.
2. Avoid rapid control inputs.
3. Do not pick up an external load. If flying with an external load, continue to the destination and gently set the load down. Do not attempt to re-lift the load.

- Any of the following conditions may indicate an inoperative desensitizer:

1. DSEN fail advisory light on AFCS control panel is lit.
2. AFCS is off.
3. AFCS duplex failure.
4. 4. FAS shearpin is sheared.

- One two-point suspension hook shall never be used independently of the other two-point suspension hook, except when conducting a functional checkflight test of the two-point suspension system.

- One or both two-point suspension hooks shall never be used in conjunction with the single-point suspension hook.

9.13.1 External Transport of Cargo. External cargo may be carried beneath the helicopter suspended from a single-point or two-point suspension system. The single-point system uses one cargo hook, and the dual-point system uses two hooks. This type of airlift normally requires a plane director and rigger at the pickup and delivery zones. In addition, an aircrewman observer will be stationed in the cabin for the necessary duties associated with the mission. Flight over personnel, buildings or equipment should be avoided. For heavy lift takeoffs and landings, set rotor speed to about 105% N_r. Apply power as required, until either topping or maximum torque is achieved. Before conducting external transport operations, helicopter performance capabilities must be verified by referring to Indicated Torque Required to Hover-In-Ground Effect charts, in Part XI and performing an operational power check.

WARNING

If collective bounce is encountered in any regime of flight with any loading configuration, the safest and quickest method of elimination is for the pilot to immediately remove his hand completely from the collective grip. Delayed pilot response in eliminating these oscillations may result in helicopter damage and/or uncontrolled flight. During external cargo operations, if collective bounce is encountered and cannot be controlled, jettison the load.

Note

- Initial tensioning of the cargo sling legs, and load liftoff, should be done with the cargo hook(s) directly over the apex of the sling legs.

- Liftoff should be made by applying power smoothly and slowly. Rely on directions from the plane director to assure a vertical liftoff to prevent the load from being dragged over the surface.

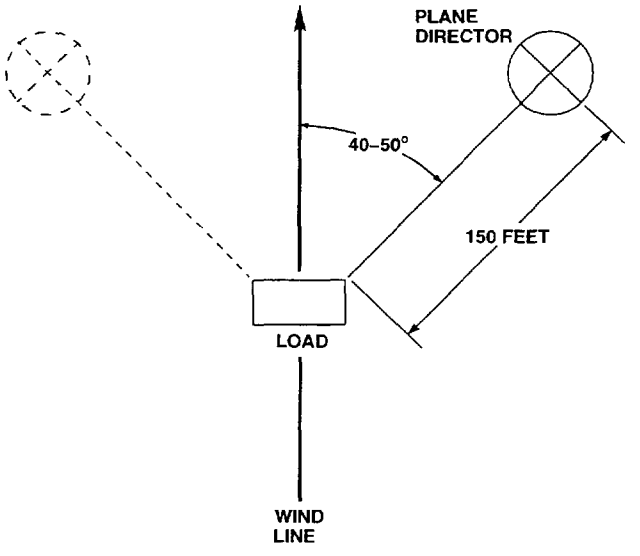
- Normal small oscillations (2 to 3 feet) of heavy external cargo loads (over 20,000 pounds) cause very positive aircraft reactions which may cause crew concern. For non-aerodynamic loads, these oscillations may be expected to be self damping. In turns, above 60 knots, the coordinated turn feature of the AFCS may allow unbalanced flight to develop (as much as one ball out). The above reactions provide very strong sensory cues to the pilot but will be quickly accepted as normal and are likely to only become a critical factor during flight in IMC (instrument meteorological conditions) with heavy external loads. Under these conditions, pilot effort to fly the helicopter reacting to sensory cues may aggravate load oscillations and result in severe disorientation.

If ambient conditions dictate a weight reduction, exercise careful judgement when stripping the helicopter so that the CG is not significantly affected. (Refer to Weight Reduction List in this chapter.)

A rigger should be available to disconnect the cargo or retrieved aircraft at the delivery point when the cargo is resting on the surface or when all wheels of the retrieved aircraft are on the surface. Approaches for a pickup (Figures 9-12 and 9-13) should be made so as to arrive in an airtaxi condition short of the pickup point and into the wind. See Figure 9-14 for appropriate hand signals. The pilot can best control the approach until he can no longer see the load; at this time, the plane director should supply the necessary information to aid the pilot in positioning the helicopter over the load. When positioned over the load, the aircrewman will supply more detailed information so the pilot can maneuver the helicopter to where the cargo rigger can make the hookup.

The aircrewman stations himself in a position to observe the load, cargo sling, and pendant when conducting external cargo operations. While the load is airborne, he informs the pilot of any unusual load movement, indications of improper load security, or other conditions affecting load safety.

The pilot informs the crew of the intended mode of release, before the approach at the cargo release site. The approach to the delivery point should be slightly high to prevent dragging the load on the surface. The helicopter is hovered when the cargo is about 6 to 8 feet above the surface. A vertical descent is then made until the load is resting on the surface. The load will be released upon signal from the aircrewman. Although care should be exercised when lowering all equipment to the ground,

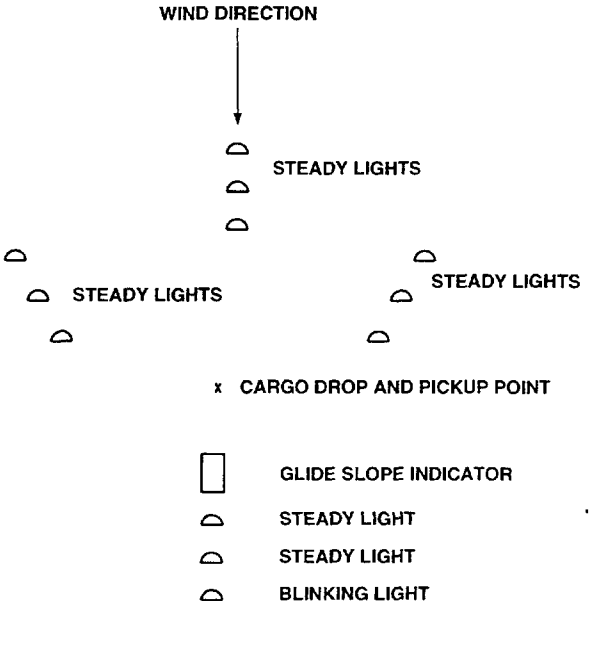


NOTE

THE PLANE DIRECTOR WILL POSITION HIMSELF ON THE SIDE OF THE AIRCRAFT FROM WHICH THE PILOT CONTROLLING IS SEATED.

HM1358 SA

Figure 9-12. External Cargo Pickup Procedure



NOTES

1. TOTAL LIGHTS REQUIRED – 12.
2. ONE GLIDE SLOPE INDICATOR.

HM4125 SA

Figure 9-13. External Cargo Lighting Pattern

those items which are designed to sustain shock loads (in general, sprung and wheeled vehicles) need not be treated so delicately as huts, shelters, containers, and other non-wheeled items which, in addition to their inherent inability to withstand shock loads, are liable to contain electronic and other delicate equipment. After the equipment has been lowered to the ground, the helicopter should descend slowly until spreader bars (if fitted) or sling hardware components are either resting on top of the equipment, or have otherwise been rendered incapable of inflicting damage to the equipment by falling on it.

9.13.2 Two-point Suspension Rigging. Suspension of external cargo from the two-point system uses an inverted Y as indicated in Figure 9-15. The inverted Y is achieved with single leg pendants suspended from each two-point cargo hook. As the helicopter approaches a load, the pendants allow slings which are secured to the load to be attached to releaseable hooks on the pendants by ground crewmen.

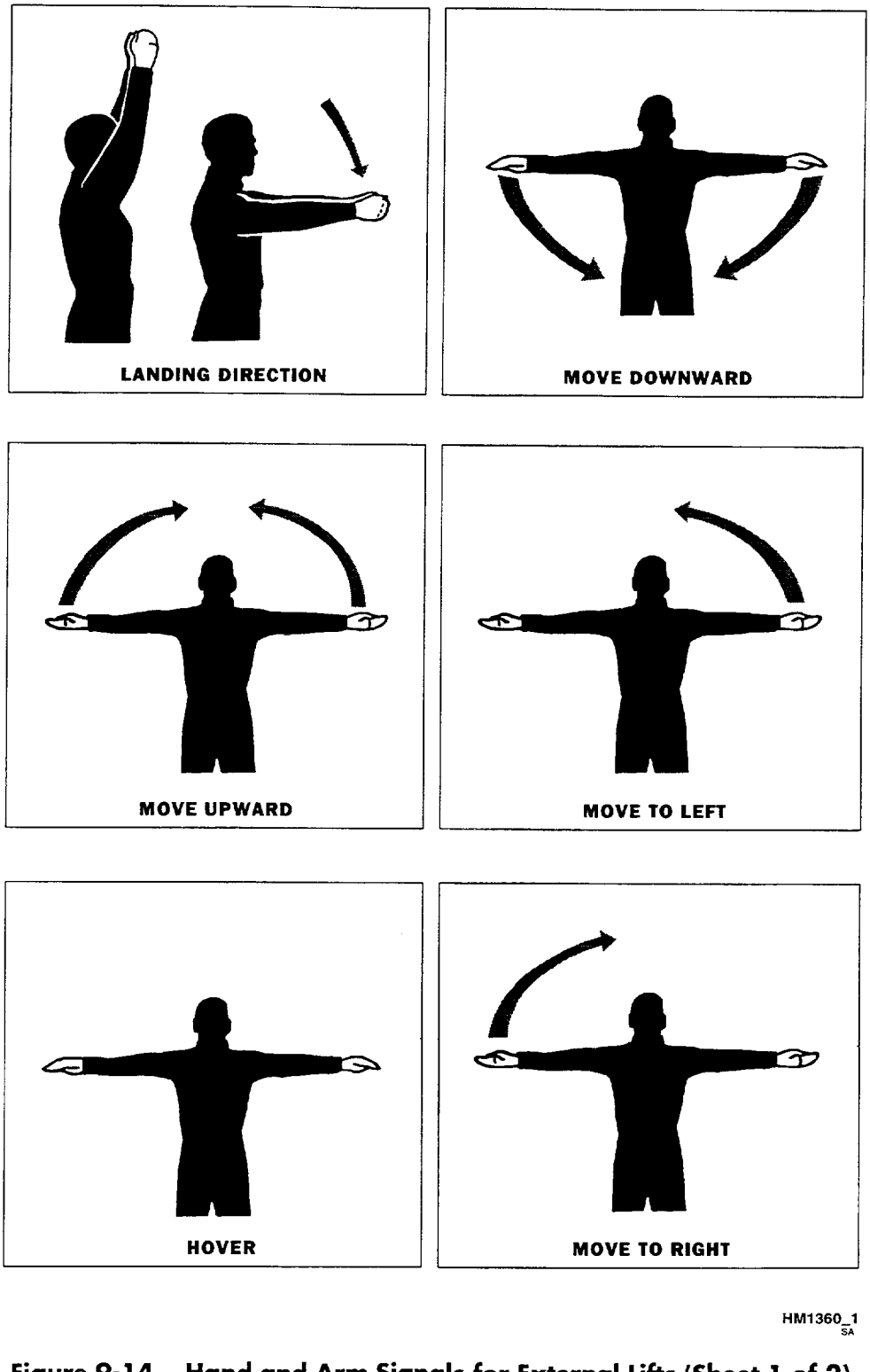
CAUTION

Be sure load distribution does not exceed 60% on either pendant.

9.13.2.1 Two-Point External Cargo Pendants. The two-point external cargo pendants (Figure 9-16) have a 21,600-pound capacity. They are used in sets, with one pendant for each two-point cargo hook. The pendant swivel hook extends about 7-1/2 feet below the cargo hook. The pendant hook can be opened by the aircrewman with a release handle from the cargo compartment, or by a ground crewman with a twist knob on the side of the hook. Either mechanical release will release loads of 465 ±135 pounds on the hook. With loads of over 600 pounds the pendant hook will not open. A security strap is provided to retain the pendant if the cargo hook opens inadvertently. The strap is attached by a snap to any

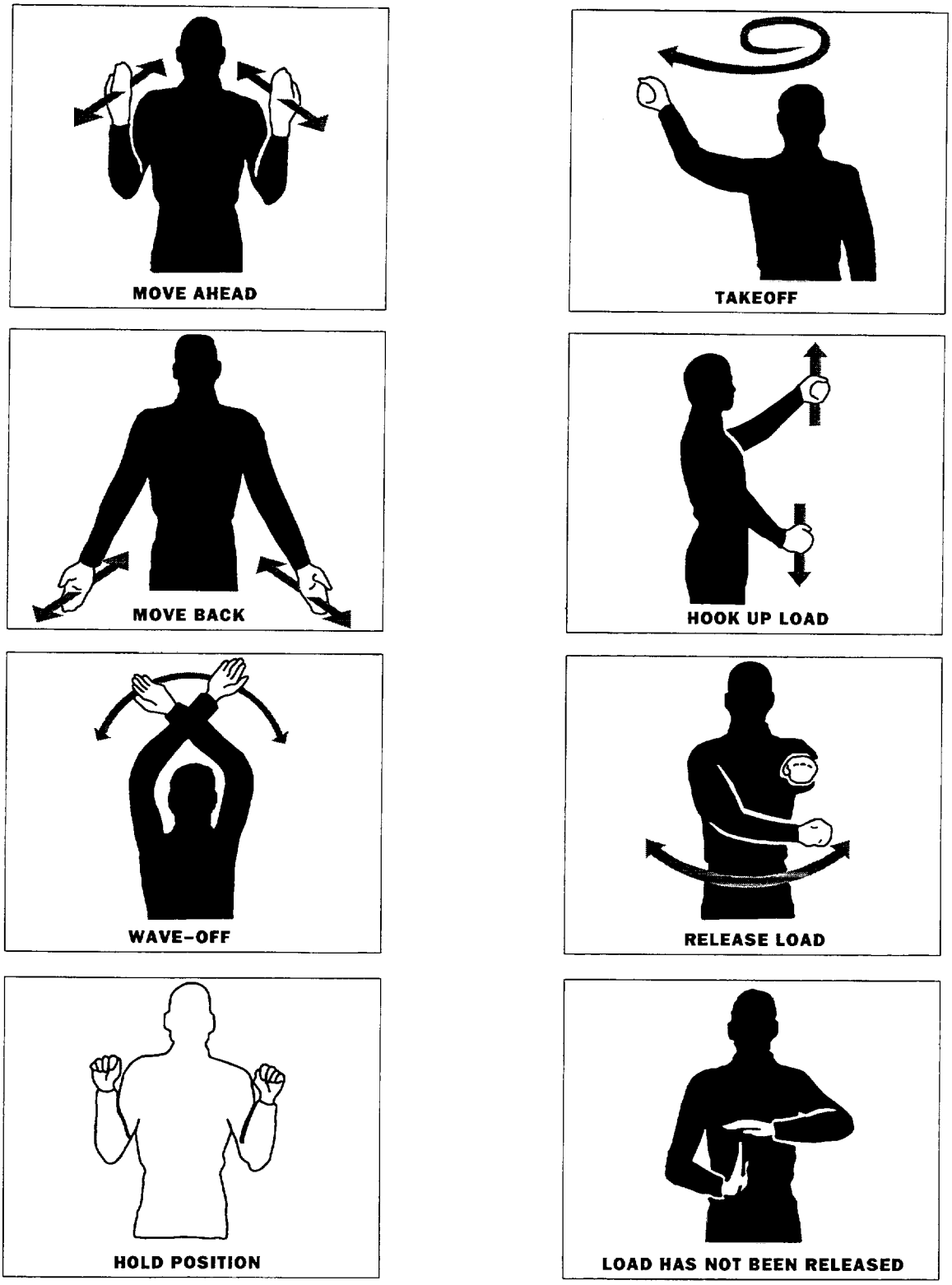
THESE SIGNALS HAVE BEEN EXCERPTED FROM **NWP-41** FOR THE CONVENIENCE OF THE USER. FOR COMPLETE SIGNALS OR IF ANY DISCREPENCY EXISTS, **NWP-41** SHALL GOVERN.

THE SIGNALS IN BLACK ARE AUTHORIZED FOR USE IN U.S. NAVY OPERATIONS AND WHEN OPERATING WITH NATO FORCES. **HOLD POSITION** (U.S. NAVY USE ONLY).



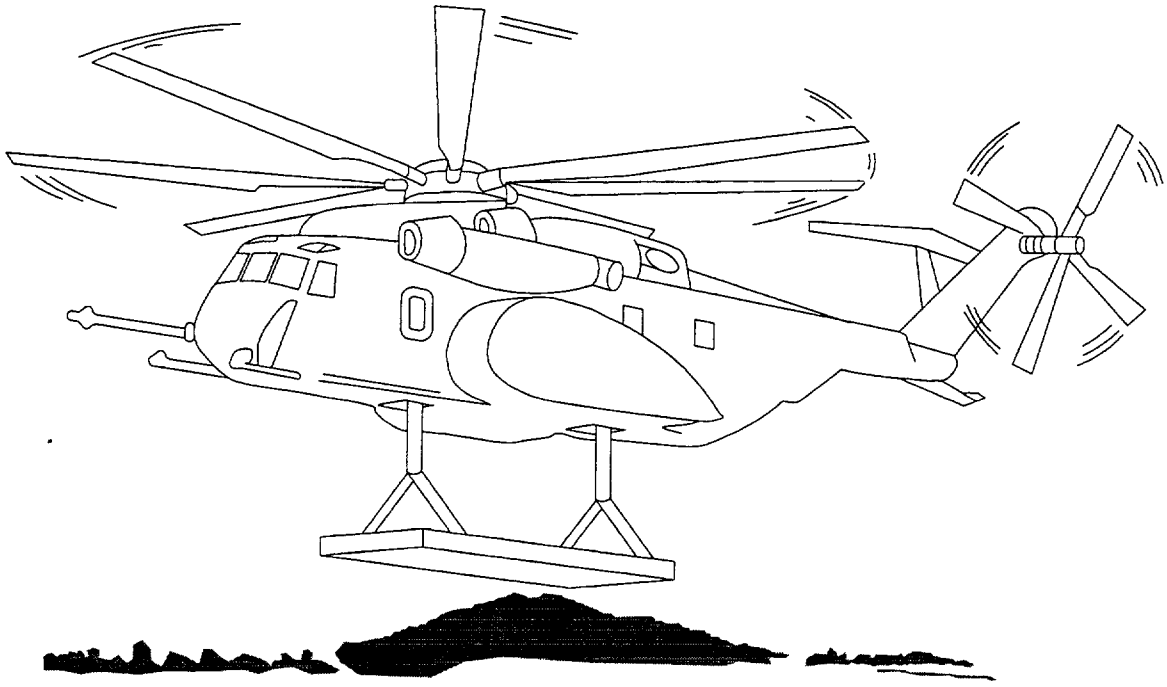
HM1360_1
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Figure 9-14. Hand and Arm Signals for External Lifts (Sheet 1 of 2)



HM1360_2
SA

Figure 9-14. Hand and Arm Signals for External Lifts (Sheet 2 of 2)



HM1361
SA

Figure 9-15. Two-point Suspension Inverted Y Rigging

cargo floor tiedown fitting. The security strap will break away with a load of 950 ±450 pounds.

WARNING

Emergency release of the load will cause the security straps to break away, possibly striking an aircrewman.

9.13.3 Single-Point Suspension Operation

9.13.3.1 Single-Point Cargo Hook Guillotine/ System Check. After attaching or reattaching the single-point cargo hook, the following checks shall be made.

1. PWR SEL switch (CARGO HOOK panel) — SINGLE PT.
2. CONTROL switch — ALL.
3. MODE switch — NORM.
4. Check the manual release knob for proper operation, freedom of movement, and ensure it has returned to the fully closed position.

Note

Hook must be in a near vertical/ upright position when checking the manual release system.

If cargo hook is not modified with suffix A, perform the following prior to each lift:

a. Inspect using hook's window part and placard.

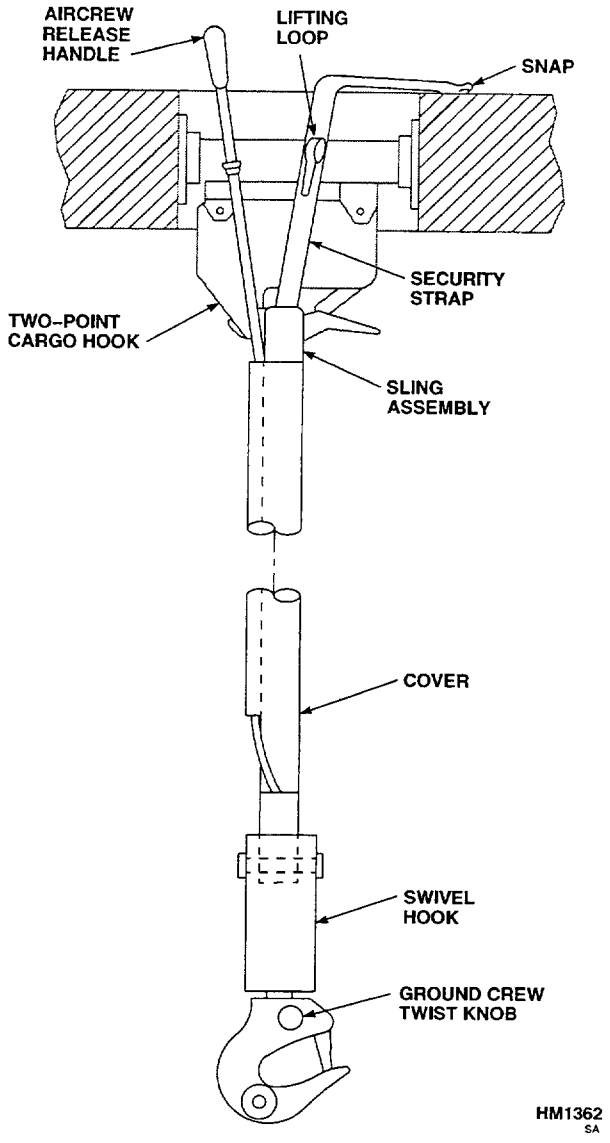


Figure 9-16. Two-Point External Cargo Pendants

b. Visually confirm hook mechanism — CLOSED.

CAUTION

Failing to confirm visually the hook's locking status via the inspection window part (on hooks not modified by serial numbers identified with suffix A) prior to each lift, may result in uncommanded load releases.

5. Pilot's, copilot's, and aircrewman's electrical releases by activating and observing SINGLE PT HOOK OPEN advisory light flicker as long as CARGO REL button is pressed — CHECK.

WARNING

Intermittent malfunctioning of the aircrewman's portable pendant may result in inadvertent load release. If intermittent malfunctioning is indicated, remove/ replace the aircrewman's portable pendant.

6. SINGLE PT HOOK OPEN advisory light — OFF.

7. Hook inspection port — POSITIVE LATCH INDICATION.

Note

Hook must be in a near vertical/ upright position when checking the manual release system.

8. Crewman rotate hook manual release knob. Observe single-point hook open advisory light flicker while knob is rotated — CHECK.

9. Manual release knob should be free of binding and should return to locked position — CHECK.

10. SINGLE PT HOOK OPEN advisory light — OFF.

11. Hook inspection port — POSITIVE LATCH INDICATION.

12. SINGLE PT switch — HOLD AT TEST.

13. SINGLE-POINT CABLE SHEAR switch (EMERGENCY CONTROL panel) — HOLD AT SHEAR.

14. JETT TEST light — ON.

15. HOOK SHEAR switch — OFF, COVERED.

16. SINGLE PT switch — OFF.

17. PWR SEL switch — OFF.

WARNING

Emergency release of the load will cause the winch cable to break away, possibly striking an aircrewman.

9.13.3.2 To Attach Cargo (Single-Point Suspension)

1. PWR SEL switch — SINGLE PT.

2. CONTROL switch — AS DESIRED.

3. MODE switch — NORM.

4. Hook inspection part — POSITIVE LATCH INDICATION.

5. SINGLE PT switch — ARM.

6. Lower cargo hook from stowed position.

7. Hover over load.

8. Descend so that rigger on ground can discharge static electricity with wand and can attach cargo sling into cargo hook.

CAUTION

Contact between the wand and the cargo hook must be maintained throughout cargo hookup. If contact is broken, crewman may receive severe shock.

9. SINGLE PT HOOK OPEN advisory light — OFF.

10. When aircrewman advises hookup completed, lift off vertically until load is clear of deck, monitoring plane director.

11. Depart when cleared by plane director.

9.13.3.3 To Automatically Release Load (Single-Point Suspension)

CAUTION

To prevent inadvertent load release, the minimum weight for the single-point external cargo hook automatic release mode is 4000 pounds.

1. PWR SEL switch — SINGLE PT.

2. MODE switch — AUTO-RELEASE. Check auto release on advisory light illuminated prior to touchdown.

CAUTION

If auto release on advisory light does not illuminate, secure auto release and do not attempt to use the system.

3. Descend slowly with no forward speed or drift. Cargo hook will release on ground contact and SINGLE PT HOOK OPEN advisory light will go on.

Note

When load is resting on the ground, the weight of the cargo sling may be enough to keep the cargo hook from opening automatically. In this case, decrease altitude to reduce cargo sling weight on the cargo hook.

9.13.3.4 To Release The Load Electrically (Single-Point Suspension)

CAUTION

To prevent accidental release of the load when releasing with the crewman's pendant, do not lift the pendant's switch cover until ready to release load.

1. Descent slowly with no forward speed or drift until cargo rests on surface.

WARNING

Be sure that all load tension is removed from the helicopter pendant before release of cargo. Release of cargo with high tension loads on the pendant may cause the cargo hook to recoil at the aircrewman or strike the airframe.

2. Descend slowly until spreader bars or apex are resting on top of the equipment or move to one side to prevent damage to the load by any metal parts of the sling.

3. PWR SEL switch — SINGLE PT.

4. CONTROL switch — COCKPIT OR ALL. (COCKPIT for pilot release, ALL for aircrewman release.)

5. MODE switch — NORM.

6. CARGO REL button — PRESS.

7. SINGLE PT HOOK OPEN advisory light — ON.

8. PWR SEL switch — OFF.

9. Aircrewman stow cargo hook.

9.13.3.5 To Mechanically Release Load (Single-Point Suspension)

1. Descend slowly with no forward speed or drift until cargo rests on surface.

2. Descend slowly until spreader bars or apex are resting on top of the equipment.

3. Ground crew actuate mechanical release on side of cargo hook.

4. Aircrewman slow cargo hook.

9.13.4 Two-point Suspension Operation

9.13.4.1 Preflight (Two-Point Suspension)

Note

- The FWD or AFT HOOK OPEN advisory lights go on briefly when the appropriate hook releases. The advisory light goes off when the appropriate hook relatches.
- Mechanical release should be smooth and free of binding.
- Crewman must manually verify each hook's load beam pivots smoothly once before testing.
- All visible parts should be secure and free of damage.

1. MODE switch — LOAD/UNLOAD.

2. CONTROL switch — ALL.

3. PWR SEL switch — TWO PT. FLT MODE UNSAFE light and 2 PT FLT UNARMED caution light goes on.

4. TWO PT TEST - 2 switch — HOLD AT A.

5. Pilot's cyclic CARGO REL button — PRESS. FWD and AFT HOOK OPEN advisory lights go on, indicating forward hook solenoid is energized.

6. Repeat check with copilot's CARGO REL button and crewman's pendant switch.

7. MODE switch — FLIGHT. FWD and AFT HOOK OPEN advisory lights go on. 2 PT FLT UNARMED caution light goes off, indicating one set of no-load switches energized the forward hook solenoid.

8. MODE switch — LOAD/UNLOAD. 2 PT FLT UNARMED caution light goes on.

9. TWO PT TEST - 2 switch — HOLD AT B.

10. Pilot's cyclic CARGO REL button — PRESS. FWD and AFT HOOK OPEN advisory lights go on, indicating aft hook solenoid is energized.

11. Repeat check with copilot's CARGO REL button and crewman's pendant switch.

12. MODE switch — FLIGHT. FWD and AFT HOOK OPEN advisory lights go on. 2 PT FLT UNARMED caution light goes off, indicating one set of no-load switches energized the aft hook solenoid.

13. MODE switch — LOAD/UNLOAD. 2 PT FLT UNARMED caution light goes on.

14. TWO PT TEST - 2 switch — RELEASE TO NORM.

15. TWO PT TEST - 1 switch — HOLD AT C.

16. MODE switch — FLIGHT. FWD and AFT HOOK OPEN advisory light go on. 2 PT FLT UNARMED caution light goes off, indicating second set of no-load switches energized emergency release solenoids.

17. MODE switch — LOAD/UNLOAD. 2 PT FLT UNARMED caution light goes on.

18. TWO PT TEST - 1 switch — RELEASE TO NORM.

19. EMERGENCY CARGO HOOK RELEASE T-handle — PULL ABOUT 1/2 INCH. FWD and AFT HOOK OPEN advisory lights go on, indicating the T-handle's microswitch is energizing the emergency release solenoids.

20. PWR SEL switch — OFF. FLIGHT MODE UNSAFE light and 2 PT FLT UNARMED caution light goes off.

21. EMERGENCY CARGO HOOK RELEASE T-handle — PULL. Crewman checks hook's load beam free to open.

CAUTION

Be sure the two-point EMERGENCY CARGO HOOK RELEASE handle is re-seated after system operational check. Failure to reseat the handle will result in inadvertent pendant and sling release.

9.13.4.2 Pre-Takeoff (Two-Point Suspension)

1. Park beside or hover over load.

2. MODE switch — LOAD/UNLOAD.

3. PWR SEL switch — TWO PT. FLT MODE UNSAFE light goes on. 2 PT FLT UNARMED caution light goes on.

4. FWD and AFT HOOK OPEN advisory lights — OFF.

5. CONTROL switch — AS REQUIRED. Plane director will signal when load is hooked up and ground personnel are clear.

6. Hover with load airborne.

7. FLT MODE UNSAFE light — OFF.

8. MODE switch — FLIGHT (as soon as load is airborne and FLT MODE UNSAFE light is off).

CAUTION

Load will be released if the MODE switch is placed to FLIGHT before the load is airborne or the FLT MODE UNSAFE light is on.

9. 2 PT FLT UNARMED caution light — OFF.

10. Normal takeoff.

WARNING

- Select FLIGHT with the MODE switch throughout the flight, because the no-load sensing microswitches in the hooks operate only in this mode. Therefore, in this mode, failure of a cargo sling in one closed hook will cause both hooks to open automatically and prevent the helicopters CG limits from being exceeded.

- The PWR SEL switch shall be kept at TWO PT throughout flight since it furnishes electrical power for system operation.

- The jump seat should not be occupied during two-point external cargo lifts. The jump seat occupant may inadvertently activate the cargo release handle.

9.13.4.3 Load Release (Two-Point Suspension)

CAUTION

To prevent accidental release of the load when releasing with the aircrewman's pendant, do not lift the pendant's switch cover until ready to release load.

1. Normal approach to a hover.
2. Air taxi to load release point.
3. MODE switch — LOAD/UNLOAD.
4. Lower load to ground.
5. Release the load manually using the aircrew release handle on each pendant.

CAUTION

If forward flight is to be resumed with unloaded pendants attached to the aircraft cargo hooks, the control panel mode switch must be kept in the LOAD/UNLOAD position.

6. Depart off-loading hover after aircrewman and plane director have indicated cargo released and ground riggers are clear.

9.13.5 External Cargo Crew Signals. In order for pilots to receive standard working signals from aircrewman, these signals will be used:

SIGNAL	MEANING
At delivery point Up (number of feet).	Helicopter is too low.
Steady	Over pickup/ delivery point. Hold steady hover.
Down (number of feet)	Come down.
Right-left-forward-back (number of feet)	Left, right, forward, back of intended pickup/ delivery point.
Load on deck	Cargo on deck not released from cargo hook.
Load is released	Cargo sling's apex ring clear of cargo hook.
Load is hooked up UP (number of feet to put tension on load)	Cargo attached. Lift straight up to put tension on load.
Clear to depart	Cargo clear of the deck, obstructions, and ground personnel area clear.

9.13.6 Weight Reduction List. The following list indicates some of the items that may be removed to reduce the basic weight of the helicopter by the amount indicated.

Item	Weight lbs
Cargo hook, single-point	
Hook	114
Pendant	51
A-frame	56
Forward support	18
Explosive separator/ universal fitting	27
	266
Cargo hook, two-point	
Hooks (2)	117
Solenoid assembly	15
Support assembly (2)	69
Load sensor (4)	20
Hardware	20
	231
Cargo handling equipment	
Winch	153
Winch support	13
Winch pendant	2
Sheave fittings (2)	13
Sheave blocks (2)	40
Cargo straps (2.5 lbs each)	
Tiedown chains (6.3 lbs each)	
Stowage box	41
Guide rails	123
Ramp flippers	51
Centerline skid pad	16
Cargo conveyors	136
	588
Heater assembly (less ducts)	111
Aircrewman's seat	12
Jump seat	3
Seats, troop (without AFC 497)	
Support tubes (37)	34
Seat belts (37)	37
Sidewall seats (37)	84
Centerline seats (18)	135
Centerline seat belts (18)	19
Hardware	9
	318
Seats, troop (AFC 497) (seats, belts, tubes)	187

Item	Weight lbs
Tow boom	327
Cargo ramp	256
90° stub ramp	196
Overhead door (complete)	59
AN/ALE-29 pod (each)	49
M-60D	28
XM-218	82
Gun mount support fittings	10
Rescue hoist	80
EAPS No. 1 and No. 3 (total)	224
Windshield washer fluid	13
Refueling probe (including trapped fuel)	307

9.13.7 External Transport of Aircraft. To conduct external transport operations, an aircraft recovery kit must be used that contains all the necessary lifting equipment required for the mission. If ambient conditions dictate a weight reduction in the aircraft being retrieved, exercise careful judgment when stripping the retrieved aircraft so that the CG is not significantly affected.

9.13.7.1 Checklist For External Transport of Aircraft.

1. Standard mission brief.
2. Tactical or administrative lift.
3. Type aircraft to be recovered.
4. Items removed by damage (if any).
5. Items removed intentionally (if any).
6. Final net weight of downed aircraft (estimated).
7. CG of downed aircraft (lift by Bay City type crane, if applicable).
8. Area of downed aircraft.
9. Altitude of downed aircraft.
10. Computed power available.
11. Reduction of own aircraft weight (see weight reduction list).
12. Payload possible.
13. Recommended airspeed and elapsed time enroute (to and from).
14. Fuel on board computation.
15. Hook up crew brief/ procedures (actual or remote).
16. Retrieval equipment to be used (sling, cable, grab links, belly bands, swivel chute, rope, band saws, tools, etc.).
17. Proper rigging of downed aircraft.
18. Engine topping checks (outbound).
19. Oscillation dampening techniques (inbound).
20. Release downed aircraft — responsibilities (both enroute and delivery at destination)

CHAPTER 10
Functional Checkflight Procedures

10.1 FUNCTIONAL CHECKFLIGHT AUTHORITY

Functional checkflights are made to determine if the airframe, engines, accessories, and items of equipment are functioning in accordance with predetermined requirements, while subjected to the intended operating environment. These flights should normally be conducted within autorotative distance of a landing field, when feasible, and during daylight hours, under VFR conditions. However, if necessary to accomplish the assigned mission, the unit commander may authorize functional checkflights under conditions other than the above, if in his opinion the flight can be conducted with an acceptable margin of safety under the existing conditions. This authority may not be delegated. Those portions of the flight which are considered critical should be conducted in the vicinity of a suitable landing area. At the discretion of commanding officers, functional flights may be made in combination with operational flights, provided the operational portion is not conducted until the flight inspection requirements have been satisfied by a designated functional check pilot.

10.2 FUNCTIONAL CHECKFLIGHTS

The appropriate checkflight shall be made after the completion of the maintenance procedures where the operational performance of the system cannot be evaluated on the ground. The appropriate checkflight checklist shall be used. This section contains detailed checkflight procedures, sequenced in the order in which they should be done. The boxed letters to the right of the PROFILE have been established for each checkflight condition and prefixes applicable check items in this section and the NATOPS Functional Checkflight Checklist, A1-H53ME-NFM-700. Checkflight personnel will familiarize themselves with these procedures before the flight. Daily and turnaround inspections are required before the checkflight.

Note

These procedures are intended for use by designated functional checkflight pilots only, and are not to be used as troubleshooting procedures by squadron pilots.

10.2.1 Conditions Requiring Functional Checkflights. The specific conditions or actions listed below relate to a general function profile. The extent and type maintenance performed may warrant the deletion of certain profile steps at the discretion of the commanding officer, the maintenance officer, or designated representative. Satisfactory completion is required prior to the release of the helicopter for operational use.

A. Items done during normal checklist procedures are prefixed A in the PROFILE and shall be done on all flights.

B. The complete functional checkflight shall be made upon acceptance of the helicopter from the manufacturer or another command, SDLM, and when required after phase maintenance. All checklist items required are prefixed B in the PROFILE.

C. The AFCS (only) checkflight shall be made when AFCS components are adjusted, repaired, or replaced (to include replacement of AFCS servo valve, stick trim shutoff valve, trim servo valve, and FAS actuator). Minimum checklist items required are prefixed C in the PROFILE.

D. The flight control rigging (only) checkflight shall be made when the helicopter is completely rerigged, or when any of the following components have been adjusted, replaced, or reconnected after having been disconnected/removed to aid maintenance: main rotor head, main gear box, tail gear box, tail rotor head, primary servo, sleeve and spindle assembly, swashplate, pitch control rod, main/tail rotor blades, tail rotor servo, tail rotor pitch links, flight control rods, and longitudinal bias actuator. In the case of rerigging or quick rig, a flight control rigging check flight is required only if control rods, or pitch change rods are adjusted. Minimum checklist items required are prefixed D in the PROFILE.

E. The engine control rigging (only) checklist shall be accomplished when an engine is replaced or engine rigging has been done. Checks are only required on an engine(s) which has had maintenance performed on it. Adjustment of ground idle N_g, N_f flat pitch, or collective bias requires only that the specific parameter adjusted be within limits. Minimum checklist items required are prefixed E in the PROFILE.

Note

- Do all normal procedures (such as APP start, engine start, rotor engagement, etc.), in accordance with normal NATOPS procedures, except where specific deviation is directed by the checkflight procedures.

- Functional checks assume rotor blades and pylon are spread unless otherwise noted.

PROFILE

10.3 FUNCTIONAL CHECKFLIGHT CHECKLIST

10.3.1 Preflight

A

10.3.1.1 Exterior Inspection. Do normal preflight exterior inspection, paying particular attention to those components repaired, reworked, or replaced.

A

10.3.1.2 Interior Inspection. Do normal preflight interior inspection, paying particular attention to those areas where maintenance has been done.

1. Personnel Door — Check for proper operation.
2. Cockpit Windows — Check for proper operation.
3. Instrument Range Markings — Check.

B E

10.3.1.3 Topping Adjustment. Be sure military trim adjustment is at the maximum limit by turning the military trim adjustment (remote topping trim adjustment) counterclockwise 1/4 turn and then carefully turn clockwise until clicks stop or resistance is felt. Limiting maximum N_g consequently limits maximum T_5. This direct N_g and T_5 relationship will vary as OAT changes. Maximum transmission torque is limited to the values shown in Figure 4-2. Fuel flow limit will increase in relationship to the N_g limit as altitude is increased; however, the N_g limit is fixed and does not vary from engine to engine or with altitude. The fuel flow is approximate and will vary from engine to engine.

There is a provision in the fuel control which limits the gas generator speed below 102.5% (416 engines). This prevents N_g overspeed regardless of the fuel flow (topping) adjustment.

CAUTION

419 engines are capable of one-engine inoperative (OEI) contingency power which, at maximum topping adjustment position described above, will allow the engine to reach 105% N_g and 925°C T_5. Use of this contingency power may require engine removal and maintenance.

Note

- N_g is not affected by OAT.
- N_g is limited to Engine Overspeed limits shown in Chapter 4.
- Military trim adjustment (remote topping trim adjustment) directly adjusts N_g which indirectly changes T_5.

10.3.2 Prestart

A B E

10.3.2.1 Speed Control Lever Rigging. Move speed levers through full travel. Motion should be smooth. Check latching at GRD IDLE. At some position above GRD IDLE check that there is deadband play in each direction. A light spring force should tend to return lever to center of play from each direction. Return engine speed control levers to shutoff position.

PROFILE

A B E

10.3.2.2 Fuel Selector Levers and T-handle Rigging. Check operation of each fuel selector lever for a detent in all positions. Move all engine fuel selector levers to DIRECT. Move all T-handles aft. As handles move aft, they should mechanically engage fuel selector levers and move them to SHUT OFF. Return T-handles to full forward position. Set fuel selector levers 2-1-2.

A

10.3.2.3 APP Start

1. Clutch engagement — Clutch engages at 100% N_g.

Note

APP should automatically shut down if exhaust temperature is over 621°C, and high exhaust temperature circuit breaker should pop.

2. Time from start to 100% N_g — 8 to 11 seconds.

3. Operating speed — 102 ±1% is normal with generators off.

B

4. APP Fire Detection — Check with APP running and generators off.

10.3.3 Post APP Start

A

10.3.3.1 Hydraulic Pressure Reading

1. Second Stage Hydraulic Pressure — 2600 to 3300 psi.

2. Utility 1 Hydraulic Pressure — 2600 to 3300 psi.

3. Utility 2 Hydraulic Pressure — 0.

   a. Utility 2 Switch — ON.

   b. Utility 2 Hydraulic Pressure — 2600 to 3300 psi.

   c. Utility 2 Switch — AS REQUIRED.

10.3.3.2 Doppler. Set the Doppler select knob to TEST, note that the drift angle indicator reads at the 7:30 position and the ground speed reads 27 Kts. Return the knob to LAND or SEA, as applicable.

A

10.3.3.3 Interior/Exterior Lights. Check all cockpit, cabin, and exterior helicopter lighting systems for proper operation.

A

10.3.3.4 Parking Brake. Set parking brake by applying pressure to either set of pedals and pulling up on parking brake handle. Hold handle up while releasing pedal pressure. Parking brake handle should remain up, and PARKING BRAKE ON advisory light should illuminate. Apply pedal pressure to either set of pedals, handle should drop, and parking brake light should go out. Reset brake.

CAUTION

If parking brakes fail to release with pedal pressure, do not apply downward force to parking brake handle, as parking brake cable damage may occur.

B **10.3.3.5 EAPS.** EAPS control switches to OPEN and have crewman note that doors open. Plac control switch to CLOSED and have crewman note that doors close, and EAPS DOOR CLOSE advisory light goes on. Place switch to AUTOMATIC. Doors should remain closed.

B **10.3.3.6 Blade and Pylon Fold Interlocks**

CAUTION

- Do not move flight controls while blade or pylon are folded or prior to visual check of all pitch locks disengaged. Damage to the flight control system may result.
- Any time the safety valve open light on the blade fold panel is on and the pitch lock switch is placed to engage, the pitch locks will attempt to engage regardless of head position. Ensure the pitch lock switch is in the disengage position before:
  1. Positioning the rotor head for start.
  2. Opening the safety valve for blade or pylon fold.

Note

Make sure main rotor head is not in blade fold position before these interlock checks.

1. Set initial conditions as follows:
   a. Blades and pylon — SPREAD.
   b. Gust Lock — LOCKED.
   c. High-pressure rotor brake — EMER.
   d. Speed control levers — SHUT OFF.
   e. Droop stops — IN.
   f. Flap restrainers — IN.
   g. BLADES SPREAD light on and FLIGHT READY light off.
   h. ROTOR LOCKED, ROTOR BRAKE PRESS, MGB OIL PRESS, and BLADE PYLON FOLI caution lights on.
   i. ROTOR BRAKE ON and ISOLATION VALVE OPEN advisory lights on.

PROFILE

B 2. Controls — SET FOR FOLD.

a. Rudder pedals neutral.

b. Collective in detent.

c. Beep cyclic to light center position arrows.

d. PITCH LOCK switch — PITCH LOCK.

d. Pitch locks do not engage because master power switch is off.

e. PITCH LOCK switch - DISENGAGED.

B 3. Master power switch — POWER. SAFETY VALVE OPEN light on.

a. PITCH LOCK switch — PITCH LOCK. PITCH LOCK ADVANCED light goes on as pitch locks start to advance. In addition, 2 STG M/R SERVO BYPAS caution light goes on. The second stage hydraulic pressure gage indicates normal. The PITCH LOCKS ENGAGED light goes on when all six pitch locks are extended and engaged.

B 4. High-pressure rotor brake — RELEASE. Brake does not release because master power switch is at POWER. ROTOR LOCKED and ROTOR BRAKE PRESS caution lights and ROTOR BRAKE ON advisory light stay on.

B 5. High-pressure rotor brake — EMER.

B 6. Blade fold position switch — FOLD POSN; THEN OFF. Head does not start to position because gust lock locked.

B 7. Pylon fold/spread switch — FOLD; THEN OFF. Head does not start to position because gust lock locked.

B 8. ROTOR POSITIONER check:

a. MASTER POWER switch — OFF.

b. ROTOR POSITIONER switch — ENG START POSN, then OFF. Head does not start to position because gust lock is locked.

c. MASTER POWER switch — POWER.

B 9. Gust lock — UNLOCKED. ROTOR LOCKED caution light goes off.

B 10. Move No. 1 engine speed control lever forward out of SHUT OFF.

B 11. Blade fold position switch — FOLD POSN; THEN OFF. Head does not start to position.

B 12. Pylon fold/spread switch — FOLD; THEN OFF. Head does not start to position.

B 13. No. 1 engine speed control lever — SHUT OFF.

B 14. Repeat steps 10. through 13. for No. 2 and No. 3 engine speed control levers.

PROFILE	
B	15. Blade fold/spread switch — FOLD; THEN OFF. Blades do not start to fold because head not positioned.
B	16. Blade fold position switch — FOLD POSN. ROTOR BRAKE ON advisory light goes off and head positions, in the shortest direction, for blade fold. When the head is in the fold position, the HEAD IN FOLD POSITION light and the ROTOR BRAKE ON advisory lights go on.
B	17. Pylon fold/spread switch — FOLD; THEN OFF. Head does not start to position for pylon fold nor does the pylon start to fold because the blade fold position switch is at FOLD POSN.
B	18. Blade fold/spread switch — FOLD. BLADES SPREAD light goes off and BLADES FOLDED light goes on when blades are fully folded.
	Note Physically restrain tail rotor blade during pylon FOLD sequence.
B	19. AFCS servos — OFF.
B	20. Pylon fold/spread switch — FOLD. PYLON UNSAFE FOR FLIGHT light goes on, tail rotor actuator extends, and pylon folds.
B	21. Blade fold/spread switch — SPREAD, THEN OFF. Blades do not spread because pylon is folded.
B	22. Pylon fold/spread switch — SPREAD. The PYLON UNSAFE FOR FLIGHT light goes off when the pylon is fully spread.
B	23. AFCS servos — ON.
B	24. Pylon fold/spread switch — OFF.
B	25. PITCH LOCK switch — DISENGAGED. Pitch locks do not disengage and the PITCH LOCKS ENGAGED and PITCH LOCK ADVANCED lights stay on because the blades are not spread.
B	26. PITCH LOCK switch — PITCH LOCK.
B	27. Blade fold/spread switch — SPREAD. BLADES FOLDED light goes off and the BLADES SPREAD light goes on when the blades are fully spread.
B	28. Blade fold/spread switch — OFF.
A B	29. PITCH LOCK switch — DISENGAGED. The PITCH LOCKS ENGAGED light goes off when the pitch locks start to retract, and the PITCH LOCK ADVANCED light goes off when all pitch locks are retracted. At this time the 2 STG M/R SERVO BYPAS caution light goes off.
B	30. Pitch locks — VISUALLY CHECKED ALL DISENGAGED.
B	31. Master power — OFF. SAFETY VALVE OPEN light off. FLIGHT READY light on. BLADE PYLON FOLD caution light off.
B	32. Move No. 1 engine speed control lever forward out of SHUT OFF.

PROFILE

33. ROTOR POSITIONER switch — ENG START POSN, THEN OFF. Head does not start to position because speed control lever out of SHUTOFF.

34. Repeat steps 32. and 33. for No. 2 and No. 3 engine speed control levers.

A B **10.3.3.7 Altimeters.** Check ±75 feet of field elevation.

10.3.3.8 ADI Transfer

A 1. Check that indices are lined up when trim knobs are set on dots.

B 2. Press CMPTR PWR pushbutton off. Pull circuit breaker marked AHRS on emergency ac bus circuit breaker panel. Pilot's ADI will become inoperative and ATT flag should appear. Place pilot's VG XFR switch to ALT. Pilot's ADI should become operative (ATT flag should disappear) and copilot's should continue to operate. Reset circuit breaker and place VG XFR switch to NORM.

B 3. Pull circuit breaker marked ADI/GYRO CO-PILOT on the emergency ac bus circuit breaker panel. Copilot's ADI will become inoperative and the ATT flag should appear. Place copilot's VG XFR switch to ALT. Copilot's ADI should become operative (ATT flag should disappear) and pilot's should continue to operate. Reset circuit breakers and place VG XFR switch to NORM. Both ADIs should be operative.

B 4. Press CMPTR PWR pushbutton on.

A B D **10.3.3.9 Second Stage Servo Interlock.** Second Stage Servo Interlock — Attempt to turn off the second stage servo by using the pilot's and then copilot's SERVO OFF switch. The second stage servo should remain on. Return both SERVO OFF switches to center position.

A B D **10.3.3.10 Flight Controls**

1. Freedom of Controls — Check that both AFCS servos are off. Move all flight controls to their extreme. Motion should be smooth and free of binds after initial AFCS servo breakout forces are overcome. Longitudinal and lateral breakout forces should be estimated with the collective in the midposition. Deviations from the design control forces will lead to AFCS degradation, and malfunctions will make the helicopter more susceptible to pilot-induced oscillations. Design flight control breakout forces are:

a. With AFCS SERVO OFF:

(1) Longitudinal Cyclic — 5 ±1-1/2 pounds.

(2) Lateral Cyclic — 3 ±1-1/2 pounds.

(3) Collective — 20 pounds maximum.

(4) Pedals — 30 pounds maximum.

b. With AFCS SERVO, and TRIM ON:

(1) Longitudinal Cyclic — 1 7/8 ±3/8 pounds.

(2) Lateral Cyclic — 1 3/4 ±1/4 pounds.

(3) Collective — 9 pounds maximum.

(4) Pedals — 16 pounds maximum.

c. With AFCS SERVO ON:

(1) Longitudinal Cyclic — 5/8 ±1/8 pound.

(2) Lateral Cyclic — 3/4 ±1/4 pound.

(3) Collective — 3 1/2 ±1/2 pounds.

(4) Pedals — 8 pounds maximum.

Note

Collective must be trimmed at about 75% of full up pitch and pedals must be centered while cyclic forces are measured.

2. AFCS Servo Control Response.

a. All AFCS servos off — Slowly move the cyclic, collective, and pedals through full range of control movement. No restriction should occur. Mechanical coupling among all flight controls may be apparent. While moving the flight controls, have aircrewman observe movement of main and tail rotor blades.

b. AFCS SERVO 1 on — With the collective at minimum pitch, slowly move the cyclic and pedals through full range of control movement. Repeat with the collective at maximum pitch. No restriction should occur and there should be no coupled response between the cyclic and collective. Any coupled response between the cyclic and the collective could indicate an engaged pitch lock.

CAUTION

If any restriction in control movement or mechanical coupling between the collective and cyclic is noted, do not engage rotor.

c. Repeat procedure with SERVO 2 pushbutton engaged.

d. Secure AFCS servos.

10.3.3.11 AFCS Ground Checks

A 1. AFCS Servo — ENGAGE, RELEASE, AND TRANSFER.

CAUTION

Center the cyclic before engagement or disengagement of the AFCS servos. Failure to do so may cause FAS shear pin to fail.

a. Set pushbuttons off. Center cyclic and pedals, and place collective in mid position.

b. Press SERVO 1 pushbutton. SERVO 1 light should go on and SERVO 2 UNARMED light should go on.

c. Press SERVO 1 pushbutton again. SERVO 1 light and SERVO 2 UNARMED light should go off.

d. Press SERVO 2 pushbutton. The SERVO 2 light should go on.

e. Press SERVO 2 pushbutton again. SERVO 2 light should go off.

f. Press SERVO 1 pushbutton. SERVO 1 light and SERVO 2 UNARMED light should go on.

g. Press SERVO 2 pushbutton. SERVO 2 UNARMED light should go off.

h. Transfer SERVOS from SERVO 1 to SERVO 2 and back to SERVO 1 by pressing SERVO 1 pushbutton.

B C

2. AFCS Servo — SERVO HARDOVER CHECK.

a. Set initial conditions for hardover check by accomplishing the following:

(1) SERVO 1 engaged, SERVO 2 armed, rotor brake and computer power both on, AFCS and TRIM pushbuttons both off.

(2) Have crewman clear AFCS computer BITE code display in electrical bay by setting the computer GND INIT/CODE ADV switch to CODE ADV position repeatedly, as necessary.

(3) Have crewman initiate first phase of computer self test by setting GND INIT/CODE ADV switch to GND INIT position for 1-2 seconds. (First phase is completed when BITE code display reads BBB. Time required is up to five to six minutes.)

(4) Have crewman initiate second phase of computer self test by again setting GND INIT/CODE ADV switch to CODE ADV position. (Second phase is complete when BITE code display reads CCC and BAR ALT light on the control console AFCS panel flashes. Time required is about 15 seconds.) The computers are now properly set up for the AFCS servo hardover check.

b. With SERVO 1 turned on, lightly hold controls (with one or two fingers) in the following position:

(1) Cyclic — FULL LEFT AND FULL AFT.

(2) Collective — FULL DOWN.

(3) Pedals — FULL FORWARD LEFT PEDAL.

c. Depress AFCS pushbutton to turn on AFCS. If the controls are held lightly, no appreciable motion of the controls should be noted. (Small cyclic movements in pitch will occur when the AFCS pushbutton is depressed due to control limiter/cyclic interface.) A heavy grip on the controls may result in a slight control jump when the AFCS is turned on. Activation of the AFCS switch while the computer is in the TEST mode set in Step a. causes a maximum SAS electrical input in a direction opposite to the control position held in Step b. The pilot should be able to override this SAS hardover with no additional effort.

PROFILE

d. Turn AFCS off. Reposition and lightly hold the controls (with one or two fingers) as follows:

(1) Cyclic — FULL RIGHT AND FULL FORWARD.

(2) Collective — FULL UP.

(3) Pedals — FULL FORWARD RIGHT PEDAL.

e. Turn on TRIM. If the controls are held lightly, no appreciable motion of the controls should be noted in any axis. A heavy grip on the controls may result in a slight control jump when the TRIM is turned on. Activation of the TRIM switch while the computer is in the TEST mode set in Step a. causes a maximum SAS electrical input in a direction opposite to the control position held in Step 1. The pilot should be able to override this SAS hardover with no additional effort.

f. Turn off TRIM. Ensure flight controls are in the neutral position, engage AFCS SERVO 2 and repeat Steps b., c., d., and e.

WARNING

With properly adjusted servo valves, the controls will not move when hardovers are introduced. With misadjusted servo valves, the controls will move to full control throw depending on the severity of the misadjustment. Pilot override of a misadjusted servo is possible, but will require in excess of 50 pounds of control force in the appropriate axis. Any indication of servo valve misadjustment must be corrected prior to rotor engagement.

g. Depress and release CMPTR POWER switch on the center console AFCS control panel. (This removes the computer from the hardover check mode.)

B C

2. AFCS — CHECK.

a. Note CMPTR POWER pushbutton off and AFCS caution light on.

b. Press and light CMPTR POWER pushbutton and note AFCS caution light goes off.

c. SERVO 1 on and SERVO 2 armed (light off).

d. Press and light AFCS pushbutton, no FAIL ADVISORY lights should go on.

e. Press and light TRIM pushbutton, no FAIL ADVISORY lights should go on.

f. Press SERVO 1 off, SERVO 2 goes on automatically, AFCS and TRIM pushbuttons stay lit.

g. Press SERVO 2 off, AFCS and TRIM pushbutton lights go off.

h. In sequence press SERVO 1, SERVO 2, AFCS, and TRIM. The SERVO 1, AFCS, and TRIM pushbuttons light. SERVO 2 is armed (light off).

i. Press and light AUTO BANK pushbutton, no FAIL ADVISORY lights should go on.

j. Press AFCS pushbutton off. Note AFCS and AUTO BANK lights go off.

PROFILE

k. Press MODE RESET pushbutton momentarily, note AFCS pushbutton relights.

B C

3. Barometric/radar altitude hold — CHECK.

a. BAR ALT pushbutton — PRESS. BAR ALT light should go on and there should be no FAIL ADVISORY lights on.

b. RDR ALT pushbutton — PRESS. RDR ALT light should not go on.

c. CLTV TRIM REL button — PRESS. BAR ALT light should flash while pressed (both pilots).

d. BAR ALT pushbutton — PRESS. BAR ALT should disengage.

e. ALT SET knob — SET TO ZERO.

f. RDR ALT pushbutton — Press. RDR ALT light should go on and there should be no FAIL ADVISORY lights on.

g. ALT SET knob — INCREASE. Collective should rise slightly. Return ALT SET knob to zero position.

h. CLTV TRIM REL button — PRESS. RDR ALT light should go off. Engage RDR ALT again and disconnect with copilot's CLTV TRIM REL button.

i. RDR ALT pushbutton — PRESS. RDR ALT light goes on. Press RDR ALT press to test button. RAD ALT should not self-test.

j. Turn off both radar altimeters and note that RDR ALT pushbutton lights goes off, BAR ALT pushbutton light goes on, and ALT fail advisory light goes on. Press MODE RESET pushbutton and note ALT fail advisory light goes off.

k. Press BAR ALT pushbutton, light goes off.

l. Turn on radar altimeters. Check press to test 100 FT ±15.

m. Repeat procedure using alternate RAD ALT channel.

B C

4. Trim systems — CHECK.

a. Cyclic Beeper Trim — Check SERVO 1, AFCS, and TRIM ON. Operate pilot's cyclic STICK TRIM beep button, fore, aft, left, and right. Check that cyclic movement is instantaneous, smooth, and in proper direction. Repeat with copilot's cyclic STICK TRIM beep button and SERVO 2. Beep cyclic from full forward to full aft, from full aft to full forward, full right to full left, and full left to full right.

b. Cyclic, Collective, and Pedal Trim — With TRIM off, move controls through their extremes to see that there is smooth full control that is free of binds. With TRIM on, actuate pilot's cyclic and collective trim releases and pedal switches. Then move controls through their extremes to see that there is smooth full control that is free of binds. Pushing rudder pedals rapidly or to their forward extreme position during pedal trim check may cause a heading mode failure. Center cyclic and pull collective full up with collective trim release pressed. Release collective trim; collective should stay in new position. Push collective full down and release. It should return to the full up position. Press collective trim release and

PROFILE

return collective to full down position. Without pressing the cyclic trim release, move the cyclic fore, aft, left, and right. The cyclic should return to the original trimmed position in each case.

WARNING

With a 1/2-inch cyclic (roll input), collective, or pedal displacement against trim, the restoration force should feel constant with no tendency toward increasing. An increase in trim force with time while holding a constant inputted displacement indicates that the TRIM and Position Sensor plugs may have been incorrectly connected. A reversal of these connectors in MH-53E aircraft will also result in a shutdown of the AFCS DESEN mode with the appropriate BITE codes.

Note

The forward and aft control limiter in the mixing unit will be felt when the cyclic is 1 inch from the cyclic stops.

Press cyclic TRIM REL release and move cyclic to a new position. Release button. Cyclic should assume new position. Individually push rudder pedals 2 to 3 inches forward by pushing against foot rests, taking care not to engage pedal switches, and remove feet from pedals. When pedals are released, they should return to trimmed position. Repeat using copilot's controls.

c. Heading trim — Turn HDG TRIM knob clockwise and note that right pedal advances; press pedal switch and note that pedal motion stops. Repeat, turning HDG TRIM knob counterclockwise. Before test, allow 3 minutes after AFCS computer power is applied or recycled.

A B

10.3.3.12 Single-Point Suspension Ground Check

1. Mechanical Release — Place PWR SEL switch to SINGLE PT. Aircrewman turns manual release knob on the side of the hook. The hook opens (with assistance if required) and the SINGLE PT HOOK OPEN advisory light goes on. The manual release knob should be free of binding and should return to the locked position when released. Check the hook inspection port to verify that the hook has fully latched. SINGLE PT HOOK OPEN advisory light should go out.

Note

Hook must be in a near vertical/upright position when checking the manual release system.

2. Electrical Release — Place PWR SEL switch to SINGLE PT. Place MODE switch to NORM. Place CONTROL switch to COCKPIT. Pilot presses CARGO REL button, the cargo hook opens (with assistance if required), and the SINGLE PT HOOK OPEN advisory light goes on. Repeat check with copilot's CARGO REL button and the hook opens the same way as for the pilot's station. The hook should automatically return to the fully latched position, as verified by the SINGLE PT HOOK OPEN advisory light extinguishing and a latched indication in the hook inspection port. Repeat the check with the aircrewman's pendant switch and the hook does not open. Place the CONTROL switch to ALL. Repeat the check for each station and the hook opens for the pilot, copilot, and aircrewman.

PROFILE

3. Auto Release — Place PWR SEL switch to SINGLE PT. Place MODE switch to AUTO RLSE. AUTO RLSE ON advisory light goes on. Return MODE switch to NORM.

4. Guillotine Test — Be sure personnel are not beneath A-frame during this test.

   a. PWR SEL switch (cargo hook panel) — SINGLE PT.

   b. SINGLE PT switch — HOLD AT TEST.

   c. HOOK shear switch (emergency control panel) — HOLD AT SHEAR.

   d. JETT TEST light — ON.

   e. HOOK shear switch — OFF, COVERED.

   f. SINGLE PT switch — OFF.

   g. PWR SEL switch — OFF.

A B

10.3.3.13 Two-Point Suspension Ground Check

Note

- The FWD or AFT HOOK OPEN advisory lights go on briefly when the appropriate hook unlocks. The advisory light goes off when the appropriate hook relocks.
- Mechanical release should be smooth and free of binding.
- Aircrewman must manually verify each hook's load beam pivots smoothly once before testing.
- All visible parts should be secure and free of damage.

1. MODE switch — LOAD/UNLOAD.

2. CONTROL switch — ALL.

3. PWR SEL switch — TWO PT. FLT MODE UNSAFE light and 2 PT FLT UNARMED caution light goes on.

4. TWO PT TEST-2 switch — HOLD AT A.

5. Pilot's cyclic CARGO REL button — PRESS. FWD and AFT HOOK OPEN advisory lights go on, indicating forward hook solenoid is energized.

6. Repeat check with copilot's CARGO REL button and aircrewman's pendant switch.

7. MODE switch — FLIGHT. FWD and AFT HOOK OPEN advisory lights go on. 2 PT FLT UNARMED caution light goes off indicating one set of no-load switches energized the forward solenoid.

8. MODE switch — LOAD/UNLOAD. 2 PT FLT UNARMED caution light goes on.

9. TWO PT TEST-2 switch — HOLD AT B.

PROFILE

10. Pilot's cyclic CARGO REL button - PRESS. FWD and AFT HOOK OPEN advisory lights go on, indicating aft hook solenoid is energized.

11. Repeat check with copilot's CARGO REL button and aircrewman's pendant switch.

12. MODE switch — FLIGHT. FWD and AFT HOOK OPEN advisory lights go on. 2 PT FLT UNARMED caution light goes off, indicating one set of no-load switches energized the aft solenoid.

13. MODE switch — LOAD/UNLOAD. 2 PT FLT UNARMED caution light goes on.

14. TWO PT TEST-2 switch — RELEASE TO NORM.

15. TWO PT TEST-1 switch — HOLD AT C.

16. MODE switch — FLIGHT. FWD and AFT HOOK OPEN advisory lights go on. 2 PT FLT UNARMED caution light goes off, indicating second set of no-load switches energized emergency release solenoids.

17. MODE switch — LOAD/UNLOAD. 2 PT FLT UNARMED caution light goes on.

18. TWO PT TEST-1 switch — RELEASE TO NORM.

19. EMERGENCY CARGO HOOK RELEASE T-handle — PULL ABOUT 1/2 INCH. FWD and AFT HOOK OPEN advisory lights go on, indicating the T-handle's microswitch is energizing the emergency release solenoids.

20. PWR SEL switch — OFF. FLIGHT MODE UNSAFE light and 2 PT FLT UNARMED caution light goes off.

21. EMERGENCY CARGO HOOK RELEASE T-handle — PULL. Aircrewman checks hook's load beam free to open.

A B

10.3.3.14 Rescue Hoist

1. Make sure ground checks have been completed including running out of entire cable to check the two down-limit and two up-limit switches. Place master control switch to PILOT. Cycle hoist up and down using up-down thumbswitch. Check for proper phasing and operation at about 50 feet-per-minute. Place master control switch OFF. Neither pilot's nor crewman's controls should be operative.

2. Place master control switch to CREW. Pilot's control should be inoperative. Cycle hoist up and down using crewman's hoist control grip thumb switch. Check for proper phasing and operation at about 4 to 10 feet from full out, or 2 to 10 feet from full in positions. Check operation of hoist spotlight.

3. Electroexplosive circuit test — Place hoist master switch to CREW. Place electroexplosive circuit tester switch panel to TEST. Place hoist cable shear switch, on hoist operator's control panel, to SHEAR. Note test light is on. Place shear switch OFF, cover closed, and place pilot's hoist shear switch to SHEAR. Check test light is on. Place pilot's hoist shear switch OFF. Close cover. Electroexplosive circuit tester switch to FIRE, cover closed. Hoist master switch OFF.

PROFILE

B

10.3.3.15 Cargo Winch

1. Place cargo pendant power switch ON and assure hot mike functions. Run entire cable out to ensure 4-foot extension limit is marked and that out-limit switch functions. Retract cable to make sure slowdown switch slows reel in to about 20 fpm with 4 to 6 feet of cable remaining and that the in-limit switch functions. While reeling cable, assure pendant EMERGENCY OFF switch stops the winch. Assure that the variable speed control IN-OUT switch functions in both directions and is spring-loaded to neutral when released. Place power switch OFF and make sure mike returns to manual key ICS, and that the control/speed selector does not function.

2. Make sure control pendant cable reel automatic retract functions.

B

10.3.3.16 Cargo Ramp and Overhead Door/Tail Skid Place ramp control master switch OFF, and ramp operate switch to HOLD. Place operate switch to OPEN. Ramp should remain closed. Repeat with crew ramp control switch. Place master switch to PILOT, and operate switch to OPEN. Door and ramp should begin to move and RAMP OPEN advisory light and crew's RAMP UNLOCKED light should go on. Stop ramp at level by placing switch to HOLD. With ramp at level position door position should be up and locked. Place operate switch to OPEN. During opening cycle, place operate switch to HOLD. The RAMP UNLOCKED light should remain on and ramp and door should stop. Fully open ramp. Place operate switch to CLOSE. Ramp should close before door starts to move. When ramp and door are fully closed, RAMP OPEN advisory light should go off. Place operate switch to HOLD and check that RAMP UNLOCKED light is off. Place DOOR CONTROL valve in cabin to DOOR ONLY. Place operate switch to OPEN. Overhead should open and ramp should remain closed. Place operate switch to CLOSE. Door should close. Place ramp master switch to CREW and repeat entire procedure. If ramp operation appears slow, check by going from full closed to full open and note time. Time to open should be 8 to 11 seconds and time to close should be 6 to 9 seconds. During ramp checks note that tail skid starts to retract at about same time that RAMP OPEN advisory light goes on, and extends when light goes off.

10.3.4 Starting Engines/Rotors

10.3.4.1 Engine Controls

B E

1. Ignition — Place No. 1 engine anti-ice switch ON and listen for clicking of ignitors. Repeat for No. 2 and 3 ignitions. Clicking of ignitors may be difficult to hear and may be checked at engine ignitor boxes.

CAUTION

When engine starter is engaged, high exhaust temperature and low oil pressure automatic shutdown modes of APP are bypassed. Observe that APP speed does not drop more than 1% and exhaust temperature remains below 621°C.

B E

2. Max N_g with Starter and APP/Engine Starter Bypass Check — Ensure fuel selector levers of No. 1, 2, and 3 engines to No. 2, 1, and 2 tanks and hold No. 1 speed lever at SHUT OFF. Press and then release starter button. Starter should energize and remain energized. Starter-driven engine speed should stabilize at 26% to 32%. Pull out on speed lever. Starter should deenergize. Note operation of ENG STARTER ON advisory capsule. Repeat above procedure with No. 2 and 3 engines. Record percent N_g. While doing one of the max N_g motoring checks and a start motor is engaged, individually pull and reset the APP HIGH EXH TEMP and LOW OIL PRESS circuit breakers to check bypass of these APP auto shutdown modes during engine start cycle. APP should continue to operate normally when either circuit breaker is out.

PROFILE

3. Starter and Abort Microswitches — Check that rotor head is in engine start position and that fuel selector levers are at SHUT OFF. Hold No. 1 engine speed control lever slightly ahead of SHUT OFF and press starter button. Starter should not energize. Repeat with No. 2 and 3 engines.

CAUTION

Any time the safety valve open light on the blade fold panel is on and the pitch lock switch is placed to engage, the pitch locks will attempt to engage regardless of head position. Make sure the pitch lock switch is in the disengage position before:

1. Positioning the rotor head for start.

2. Opening the safety valve for blade or pylon fold.

B E

4. Engine Starter and Abort Interlocks:

a. Check for initial conditions:
Speed levers — SHUTOFF.
Blades/Pylon — SPREAD, FLIGHT READY.
Rotor brake — ON, ROTOR BRAKE PRESS caution and ROTOR BRAKE ON advisory lights on.
Head position — Place in other than engine start position.
Gust lock — DISENGAGED.

b. Head in start position — Attempt to start each engine. None should motorize. Place emergency start switch to EMER and attempt starts. Starters should energize. Abort starts. Place emergency start switch to NORM, and rotor positioner switch to ENG START POSN. Check for blade at 12:30 position.

c. Gust lock — Place gust lock handle to LOCKED position. Check for lighting of ROTOR LOCKED and BLADE PYLON FOLD caution lights. Attempt to start each engine. None should motorize. Disengage gust lock.

d. Rotor Brake — Release rotor brake and attempt to start each engine. Engine starters should not energize. Place rotor brake switch to EMER.

e. Safety valve — Place blade fold control master power switch to POWER. Note that SAFETY VALVE OPEN light goes on. Attempt to start each engine. Engine starters should not energize.

f. Pitch Locks — Neutralize rudder pedals, place collective in detent, move cyclic to center lights on stick position indicator and place pitch lock switch to PITCH LOCK. After PITCH LOCKS ENGAGED light goes on, place master power switch to OFF, check SAFETY VALVE OPEN light off, and attempt to start each engine. Engine starters should not energize. Place master power switch to POWER, pitch lock switch to DISENGAGE, master power to OFF after PITCH LOCKS ADVANCED light goes off and check BLADES SPREAD and FLIGHT READY lights on. Visually check that pitch locks are disengaged.

B E

5. Engine Speed Trim — Be sure fuel selector levers are at SHUT OFF. Beep engine speed levers from SHUT OFF to GRD IDLE. Pull speed levers out of GRD IDLE and beep them full forward. Note that speed levers advance to full forward position. Beep all speed levers aft and note that speed levers stop no more than 1/2 inch forward of MIN GOV. Return speed levers to SHUT OFF and

PROFILE

repeat procedure using copilot's speed trim switches. During copilot's speed trim check, engage pilot's trim switches to be sure pilot's speed trim switches override copilot's speed trim switches.

B

10.3.4.2 Start

B E

1. Rotor Brake and Interlocks — Place speed control levers to SHUT OFF and high-pressure rotor brake to EMER. Note ROTOR BRAKE PRESS caution and ROTOR BRAKE ON advisory lights go on.

   a. Place high-pressure rotor brake switch to RELEASE and note BRAKE PRESS caution and ROTOR BRAKE ON advisory light goes off.

   b. Place high-pressure rotor brake switch to EMER and note ROTOR BRAKE PRESS caution and ROTOR BRAKE ON advisory light goes on.

   c. Place high-pressure rotor brake switch OFF and note ROTOR BRAKE PRESS caution and ROTOR BRAKE ON advisory lights stay on.

   d. Release rotor brake by pulling rotor brake manual release handle, in cabin, and note ROTOR BRAKE PRESS caution and ROTOR BRAKE ON advisory lights go off.

   e. Reset rotor brake manual release handle.

   f. Hold low-pressure rotor brake switch at NORM for 5 seconds and note that the ROTOR BRAKE PRESS caution light illuminates, and after a time delay of approximately 1 minute, the ROTOR BRAKE ON advisory light illuminates. Release low-pressure rotor brake by setting high-pressure rotor brake switch to RELEASE.

   g. Set No. 1 engine speed control lever full forward and note that neither high-pressure or low-pressure rotor brake can be set.

   h. Place high pressure rotor brake switch to EMER.

   i. Slowly return No. 1 engine speed control lever to GRD IDLE. Rotor brake should not engage before GRD IDLE.

   j. Release high-pressure rotor brake.

   k. Return No. 1 speed control lever to SHUT OFF.

   l. Repeat check for No. 2 and No. 3 engine speed control levers.

B E

2. Max T_5 During Start — Record T_5.

B E

3. Starter Dropout — N_g should be between 51% and 58%. The pilot's only indication of start and ignition dropout, other than ENG STARTER ON advisory light, is the lack of starter motor noise. If starter dropout does not occur after engine stabilizes at ground idle, pull speed control lever out to disengage starter.

B E

4. Start Time — Time in seconds from starter engagement until N_g reaches ground idle (60.5% N_g) at sea level should be less than 60 seconds for all ambient temperatures above -15°C.

B E

5. Ground Idle Readings — After engine has stabilized.

PROFILE

Note

Engine oil temperature should be more than 40°C.

a. OAT — Record outside air temperature.

b. N_g for No. 1, 2, and 3 engines. N_g should fall between these figures on initial ground idle:

T_2 -°C	N_g Min - Max
-30	60.5 - 63
-20	61.0 - 63.5
-10	61.5 - 64.5
0	62.5 - 65.5
+10	63.5 - 66.5
+20	64.5 - 68
+30	65.5 - 69
+40	66.5 - 70

Note

Due to hysteresis in engine control system, a difference of 4% is allowable between the N_g noted after start, and N_g noted when speed levers are returned to GRD IDLE.

c. W_f — Should be 200 to 350 lbs/hr.

d. Ground idle adjustments are made at engine fuel control next to topping adjustment cable. 46 clicks equal about 1-1/4 turn, which equals about 1% N_g change (clockwise increases).

10.3.4.3 Engage Rotors

Note

There are no interlocks to prevent turning off pressure to either hydraulic stage when a servo in the other stage is in bypass. Sufficient force can be generated by a bypassed stage to drive the servo to its extreme if pressure is unavailable to the non-bypassed stage.

A B D

1. Flight Controls Phasing & Response Check — With AFCS, TRIM, and SERVO 1 pushbuttons engaged, flight controls at neutral, and rotors windmilling at GRD IDLE: check that first stage servo pressure is normal and that 1 STG PRESS M/R T/R caution light is off.

Note

Do not turn off servo stage if any servo bypass caution light is on.

Place pilot's flight control SERVO OFF switch to 2 STG. 2 STG M/R SERVO BYPASS, 2 STG PRESS M/R, 2 STG T/R SERVO BYPASS, and UTILITY T/R PRESS caution lights should go on. Although a slight displacement is permissible, there should not be large or cycling fluctuations in the tip path

plane when switching servo positions. Second stage servo pressure gage should indicate zero and there should be no jump in the flight controls. Improper primary servo timing or excessive air in the servo system may result in fluctuations or control jump. The pilot should observe the main rotor tip path, while first the cyclic then the collective is cautiously actuated a slight amount, the check for proper control phasing and correct response. The yaw system should be checked similarly. Absence of a small amount of fuselage movement, or movement in the wrong direction to pedal inputs is an indication of a tail rotor control system malfunction. Move the pilot's flight control servo off switch from 2 STG to 1 STG position: The second stage servo pressure gage should indicate normal and the three second stage caution lights and the UTILITY T/R PRESS caution light should go off. The first stage servo pressure gage should indicate zero and the 1 STG M/R SERVO BYPASS and the 1 STG PRESS M/R T/R and 1 STG T/R SERVO BYPASS caution lights should go on as soon as the second stage servo pressure has increased to 2000 psi and there should be no jump in the flight controls. The flight control hydraulic systems are equipped with snubbers to dampen pressure gage indications.

It will appear that the systems are being switched over at about 1000 psi. This is a normal condition, as the systems are actually switching over at 2000 psi. Return the pilot's SERVO OFF switch to the centered position. Engage SERVO 2 and recheck collective, cyclic, and pedal inputs for correct response and control phasing as described above. Turn off second stage, and then first stage servo, using the copilot's switch. Check for proper pressure and light indications. Check that both SERVO OFF switches are centered, then return to AFCS servo 1.

WARNING

Do not attempt flight if hydraulic pressure fails to transfer.

Note

While doing the interlock check and/or securing individual servo stages, blinking first stage or second stage servo pressure caution light may occur.

2. N_r — 100%.

3. No. 2 generator — ON.

A

10.3.4.4 APP Shutdown

B

1. Auto Shutdown Checks — Check following APP functions: Place APP emergency start switch to EMERG. Individually select and pull HIGH EXH TEMP and LOW OIL PRESS circuit breakers on APP overhead control panel. APP should continue to operate. Next pull overspeed circuit breaker and note that APP flames out and % RPM decelerates. Note time. Flameout to zero speed should be 45 ±10 seconds. Reposition start/run handle to shut off. Reset circuit breakers and return APP emergency start switch to NORM.

10.3.5 Pre-Taxi

10.3.5.1 Flat Pitch Checks. The following procedure checks maximum N_f at flat pitch, MIN GOV microswitches, torquemeter calibration, and engine overspeed governor. Monitor N_g, T_5, and W_f during these checks:

A B E

1. Torques matched at 100% N_r.

PROFILE

A B E

2. Engine Overspeed — CHECK. Individually position No. 1, 2, and 3 overspeed switches in TEST momentarily. Note that N_g, W_f, and T_5 decreases.

3. Maximum N_f/N_r governing and torque calibration check — Move No. 1 engine speed control lever full forward. Set No. 2 and 3 engines at ground idle. No. 1 engine N_f/N_r should read 102.5% ±0.5%. Check No. 2 and 3 low side torque at 1% to 2%. Repeat for No. 2 and No. 3 engine. N_f adjustments are made on the back of the fuel control. 10 clicks equals about 1% N_f change (clockwise increases).

Note

- The pilot's N_r tachometer strip should be used for all N_f checks and settings due to errors and inconsistencies of N_f strip indications and possible copilot strip difference. If the torque system is properly calibrated and each engine flat pitch is set consistently, engine torque should be nearly matched.
- Largest rotor speed difference among engines shall not be more than 0.5%.

4. Position all engine speed control levers full forward. Check N_r at 104% to 107%. Torque should be approximately matched (±5%); if not, recheck step 3 above/verify torque calibration as required.

5. Adjust speed control levers to set matched torques at 100% N_f/N_r. Speed control levers should align within 1 inch.

B E

10.3.5.2 Acceleration Check

1. With all speed levers full forward, return No. 1 engine speed lever to GRD IDLE. Let N_g stabilize.

2. Check engine acceleration by advancing speed lever to full forward within 1 second or less. Time from instant lever is moved until engine reaches 80% N_g should not be over 10 seconds.

CAUTION

Do not let accelerating engine engage transmission with excessive force. Retard speed control lever to idle immediately after N_g reaches 80%.

3. Engine must not flame out or stall throughout acceleration or deceleration sequence. Repeat steps 1. and 2. for engine No. 2 and No. 3.

B D E

10.3.5.3 Vibrations. If during rotor engagement or during engine acceleration checks, a ground roll/shuffle/or 1-per-revolution vibration is evident, do these checks:

1. Initial Conditions:

   a. 100% N_r, low collective.

   b. Parking brake — ON.

   c. Chocks in place.

PROFILE

2. Struts — If when lifting into a hover during hover checks, shuffle goes away, definitely suspect struts.

3. Tires — Check for proper inflation.

4. Shimmy Damper — Check for play on preflight. If beyond tolerance, it could be a source of ground shuffle.

5. If aircraft requires track and balance, perform IAW MIMS A1-H53ME-150-000, WP 004 00.

6. Damper — Damper system operations is checked during rotor speed changes. If, during engine run-up a bad damper is suspected, do this:

a. Bring all speed levers to 95% N_f/N_r. Advance them full forward in 1 second. Initially there will be one to two oscillations and then helicopter will smooth out. If oscillations continue, suspect a bad lag valve on at least one damper.

b. Bring all speed levers to 105% N_f/N_r. Retard them to 95% N_r/N_f in 1 second. Initially, there will be one to two oscillations and then helicopter will smooth out. If oscillations continue, suspect a bad lead valve on at least one damper.

c. On helicopter shutdown, check weep hole on each damper for excessive leakage.

7. Tail rotor drive vibration analysis spectrum vibration analysis shall be completed after any tail rotor drive shaft component (i.e., drive shaft, gear box or bearing) has been adjusted, disconnected, or replaced.

B **10.3.5.4 Generator Dropout and Pickup.** Turn off AFCS, TRIM and CMPTR POWER. Ensure AFCS SERVO 1 is ON and AFCS SERVO 2 is UNARMED. Reduce N_r slowly until GEN caution lights go on. Note N_r and increase speed until capsule goes off. Dropout and pickup should occur between 91% to 96% N_r. Turn on CMPTR POWER, AFCS and TRIM.

10.3.5.5 Electrical Power Supply

1. Generators — Check No. 1 monitor ac bus connector. Turn either pilot's anti-exposure suit blower switch on and note cooling air discharge from hose. Turn off No. 1 generator, note #1 GEN caution light goes on and cooling air no longer discharges. Turn No. 1 generator on, caution light goes off and air discharges. Repeat check with No. 2 and No. 3 generators. Turn off blower switch after check.

2. Rectifiers — Check No. 1 monitor dc bus connector. Copilot turn on spotlight and beep spotlight beam until visible on ground through chin bubble. Pull No. 1 primary ac bus circuit breaker marked CONVERTER NO. 1. #1 RECT caution light should go on and copilot's spotlight should go off. Reset CONVERTER NO. 1 circuit breaker, #1 RECT caution light should go off and copilot's spotlight should go on. Repeat check opening CONVERTER NO. 2 circuit breaker on No. 3 primary ac bus. Stow spotlight after completing check.

3. Single Generator Operation — Turn No. 1 and No. 2 generators off and check for the #1 GEN, #2 GEN, and #1 RECT caution lights. Turn the No. 2 generator on and the No. 3 generator off and check for the #1 GEN and #3 GEN caution lights. Turn the No. 1 generator on and the No. 2 generator off and check for the #2 GEN, #3 GEN, #2 RECT, BIM, and altitude caution lights. In this case, both RDR ALTS do not operate. Turn the No. 2 and No. 3 generators on and check that all generator, rectifier, BIM, and altitude caution lights go off.

PROFILE

B

10.3.5.6 Engine Anti-ice. Turn the engine anti-ice systems on. The IGV ANTI-ICE ON advisory lights should go on. If nose gear box fairing is below 32°C, or the engine inlet removable section is below 37°C, respective ENG ANTI-ICE caution light should go on. Note that T_5 increases. If system is producing enough heat, caution capsules should go off within 3 minutes. The capsules may remain on if outside air temperature is extremely cold. Turn off anti-ice.

10.3.6 Taxi

A B

10.3.6.1 Brakes. Each pilot checks left and right brake pedal.

B C

10.3.6.2 Turn Rate Transfer (While Taxiing). Pull the CO-PLT ADI GYRO circuit breaker on emergency dc bus circuit breaker panel. Copilot's turn needle will be inoperative. Press copilot's turn rate switch to light ALT. There should be a slight jump in the rate needle, indicating a switch over. Turn rate should become operative. Press switch to light NORM, and reset circuit breaker. Repeat procedure using PILOT ADI GYRO circuit breaker on emergency dc bus breaker panel. Press pilot's turn rate switch to light ALT. There should be a slight jump in turn rate needle, indicating a switch over. Press switch to light NORM, and reset circuit breaker.

A B D

10.3.6.3 Control Response (Taxiing)

B D

1. While taxiing, check operation of tail rotor controls by making slight taxiing turns to right and left without using wheel brake.

2. While taxiing, move the cockpit flight controls slowly through each axis. Ensure helicopter rotor tip path in phase with the axis that the pilot has imputed.

Note

Erratic electrical input or miswired AFCS servo can result in moderate rotor tip oscillations.

3. 100% N_r Servo Check. At 100% N_r recheck primary servos by turning off first stage. Check for tip path plane response.

   a. Move pedals a slight amount both left and right to check for proper operation of tail rotor servo.

   b. Repeat checks for second stage. (Pause 15 to 20 seconds in center position prior to selecting 2 STG).

Note

When switching either system on or when switching from one servo system to the other, a slight displacement is permissible. However, there should not be larger or cycling fluctuations in the tip path plane. Maximum acceptable tip path fluctuation is 4 inches.

10.3.7 Flight

10.3.7.1 Hover

B D

1. Controllability — Make sure that AFCS SERVO 1 is ON, AFCS SERVO 2 is ARMED, and the AFCS and TRIM pushbuttons are ON. Slowly lift to a low altitude hover to be sure of proper operation of the system and that there are no pronounced vibrations. Observe all engine and transmission instruments for proper operating range. Check tail rotor control by making left and

right turns on the spot of at least 10°. Fly short distances forward, backward, and sideward to check cyclic and collective. Observe tip path plane for proper blade track. Note any vibrations. From a stabilized hover into the wind, make a 360° turn to the left and then right. During hovering turns, note smooth operation of HSIs.

B D

2. Lateral Flight Yaw Control (As Required) — Check pedal stops and rigging.

   a. With AFCS and TRIM on, enter right sideward flight, into the wind, at 30 knots airspeed. At this speed, the helicopter should maintain heading and there should be a margin of left pedal remaining to yaw the helicopter to the left.

   b. With AFCS and TRIM on, enter left sideward flight, into the wind. At 30 knots airspeed, the helicopter should maintain heading and there should be a margin of right pedal remaining to yaw the helicopter to the right.

Note

- This check should be made at 50 feet, with helicopter going into wind sideward.
- To obtain 35 knots airspeed, subtract wind component to get around speed. If question exists as to control margin remaining, use a pace vehicle to get an accurate groundspeed run.
- With a properly rigged yaw system and the helicopter hovering motionless into the wind, the left pedal position will be about 1 inch forward of the right pedal position.

B C

3. Hover

   a. Power Change — Make rapid ±20% torque changes with feet off pedals. Helicopter transient heading error should not be over 5°, either side of original heading.

   b. Push/Pull and Release — AFCS and TRIM on. With helicopter trimmed for a hands-off hover into the wind, push the cyclic forward about 1/2 inch against the stick trim for 1 second, and then release. Helicopter should return to original attitude with no more than one overshoot. Repeat aft, left, and right.

   c. Hover Stability — Trim helicopter for hands-off hover into the wind. Helicopter should maintain attitude to within ±1°, and heading within ±3°. Additional tolerance must be added under gusty wind conditions. Repeat with SERVO 2 engaged.

   d. RDR ALT Hover — With RAD ALT CHAN 1 selected and RAD ALT 1 ON (RAD ALT 2 OFF) set ALT SET knob to a known altitude that will be referenced during this check. Establish a hover at that known altitude and engage RAD ALT. Helicopter should hover at that altitude within ±7 feet or 5%, whichever is greater, as indicated on radar altimeter. Disengage RAD ALT HOLD, then select RAD ALT CHAN 2, and repeat step d.

WARNING

If a radar altimeter is manually shut off for any reason, do not attempt to turn the system back on if the radar altitude hold mode of the AFCS is engaged. Secure RAD ALT hold before troubleshooting any radar altimeter malfunctions. Failure to do so will result in an uncommanded climb or descent.

PROFILE

B E

4. Collective Bias. Reduce speed control levers to lower N_r below 100%. Set 100% N_r by increasing speed control levers (to prevent hysteresis) until torques are matched. Increase collective from a 25 foot hover, smoothly pulling 100% torque. When stabilized in climb the N_r should read 100 ±2% with a maximum torque split of 8%. If not, land helicopter and make a correction with the collective bias in cabin overhead. After collective bias has been set, the N_r can vary between 100 ±2% with an 8% maximum torque split. See Figure 10-1 for N_r adjustment.

B D

5. Hover Track and Balance — Hover. After replacement of one or more main rotor blade(s) and/or replacement/adjustment of MRB pitch change rod(s)/rod end bearings, a hover track and balance is required. Proceed as follows.

a. Set N_r to 100%.

b. With track and balance equipment installed, establish OGE hover and record readings IAW MIMS A1-H53ME-150-000, WP 004 00.

B

6. Generator Underfrequency — While hovering, reduce N_r to 91% for at least 5 seconds. Generators should not drop out. Reestablish 100% N_r.

B

7. Landing Gear/COMM 1 Antenna/Ramp and Overhead Door/Tail Skid — Check COMM 1 antenna in AUTO. Raise landing gear. Time required from handle movement to up indication should be 15 seconds or less. Note that red light in handle is on anytime gear is in transit. Handle light will go off about 2 seconds after gear is up and locked. Note that tail skid retracts with the landing gear and that COMM 1 antenna extends. Place ramp control master switch to PILOT. ISOLATION VALVE OPEN advisory light should go on. Place operate switch to OPEN. Ramp should open and door should go up and lock. With 90° stub ramp installed check movement of ramp to the 90° down position. RAMP OPEN advisory light and crew's ramp UNLOCKED light should go on. Close ramp and place ramp control master switch OFF. ISOLATION VALVE OPEN advisory light should go off. Lower landing gear. Confirm COMM 1 antenna retraction and tail skid extension. With AFC 455, Part 4, the VHF-FM whip antenna is removed and replaced with a 9-inch tunable blade antenna.

10.3.7.2 Forward Flight

B C

1. Rapid Takeoff — With feet off pedals, make a rapid takeoff from a hover increase torque 20% over hover torque, but do not go over 110%. Transient heading should not be over ±5°.

B

2. Flight Instruments.

a. Airspeed — Check that pilot's and copilot's indicators agree within 5 knots.

b. Altimeters — Check that pilot's and copilot's altimeters agree within ±75 feet.

c. Vertical Velocity — Check for proper operation.

B D

3. Autorotation.

a. Auto Turn Check — Set altimeter to 29.92 and lower landing gear if over land. Climb to altitude where N_r is to be recorded, and cruise until OAT has stabilized. Compute density altitude (Figure 20-3); then refer to Figure 10-2 to determine rpm for conditions. Climb an additional 700 to 1000 feet for start of autorotation. Level off, establish 95 KIAS, balanced flight, and select a heading that provides an approach to a suitable landing area if a problem occurs on recovery. Slowly reduce collective to full low pitch, holding 95 KIAS. At some combinations of gross weight and density altitude, it will be necessary

PROFILE

to retard the speed control levers slightly to separate N_f from N_r. After noting N_r, return speed levers to a position that will maintain 100% N_r during the recovery. Make no control inputs at least 100 feet before rpm check altitude. Record rpm. N_r should be within ±2.5% of the rpm obtained from Figure 10-2. If correct rpm is not achieved, adjust all pitch control rods between the rotating swashplate and the blades. Lengthen rods to lower rpm. Shorten rods to increase rpm. One full turn changes RPM approximately 3%.

B C D

b. BAR ALT Autorotation — Enter a 95-knot autorotation with collective on bottom stop and let N_r stabilize. While holding collective down, engage BAR ALT, and descend another 200 feet. The N_r should remain the same. Disengage BAR ALT. If a tip path plane jump is experienced, terminate the flight and have collective rigging checked as the primary or secondary stops may be misadjusted.

B D

c. Yaw Control Check — Autorotate and yaw helicopter left and right. Adequate tail rotor control should be available. Check tail rotor rigging if control is not available.

B D

4. Control Rigging — With the helicopter trimmed for straight and level flight (needle and ball centered) at 150 KIAS and approximately 2000 feet density altitude, the controls should be in the following approximate positions:

a. Longitudinal Stick — Approximately 3 inches from forward stop.

b. Lateral Stick — Approximately centered in control range.

c. Collective Stick — Approximately 2 inches from up stop.

d. Pedals — Approximately centered.

B D

5. Vibrations and Inflight Track and Balance.

a. Vibrations — Set N_r to 100%. Fly helicopter to Vmax and note any abnormal vibrations. Make 30° bank turns, climbs, and descents at 130 knots. Inherent vibrations in any helicopter are those created by mechanical functions of engines and transmission systems, dynamic action of main and tail rotors, and aerodynamic effects on fuselage. Often two or more frequencies are superimposed to create a third frequency called a beat. Generally, vibrations are divided into three categories:

(1) Low frequency.

(2) Medium frequency.

(3) High frequency.

Refer to VIBRATIONS in Chapter 11.

b. Inflight main rotor blade track and balance — Vibration analysis equipment is available which allows for quantification and correction of objectionable helicopter vibrations. This equipment shall be used to make sure that helicopter vibrations are within acceptable limits. After replacement of one or more main rotor blade(s) and/or replacement/adjustment of MRB pitch change rods:

(1) Set N_r to 100.

PROFILE

(2) With track and balance equipment installed, fly helicopter at required regimes of tracking equipment and record readings in accordance with appropriate MIMS.

Note

Following successful completion of main rotor track and balance, re-verify auto RPM as discussed previously in this section.

B 6. Fuel Transfer Systems. Make sure of capability to transfer fuel.

B 7. Fuel Dump — While maintaining an altitude of at least 6000 feet, actuate each fuel dump switch individually to dump a small amount of fuel and have crew chief visually monitor fuel dump discharge tubes. Refer to Fuel Dumping in Chapter 2 and FUEL DUMPING limitations in Chapter 4.

B E 8. Four-point Engine Performance Check — The four-point engine performance check determines that each engine is producing minimum acceptable power for the existing ambient conditions of OAT and pressure altitude.

a. Establish forward flight with EAPS doors open at 90 to 120 KIAS.

Note

The four-point plot must be done with the EAPS doors open because pressure loss across the EAPS is inconsistent.

b. Cabin heater, APP, engine anti-ice, BAR ALT hold, fuel transfer, and purge system — OFF.

c. Set barometric altimeter to 29.92 and select a target pressure altitude.

d. While maintaining 100% N_r, adjust engine speed control levers/collective pitch to obtain one of the following values: 773 °C T_5 for the 416 or 792°C T_5 for the 416A at 100% N_g or 137% Q, or 829°C T_5 for the 419 at 100.8% N_g. Hold target pressure altitude and maintain airspeed within the prescribed range during this data collection.

e. Allow engine speed to stabilize at this point for 1 minute (1 minute is the minimum acceptable stabilization period once inputs of any sort have ceased), then record: 1) OAT; 2) KIAS; 3) PA; 4) Q @ 100% N_r; 5) N_g; 6) T_5; and 7) W_f.

Note

- Target pressure altitude must be maintained within ±100 ft.
- N_r must be maintained at 100% ±1%.
- The upper T_5, N_g, or torque limit, whichever is reached first, is checked to make sure that the remote topping adjustment is properly set. If it is improperly set, the engine's ability to reach maximum power will be mechanically limited.
- There is a provision in the fuel control which limits the N_g speed at or below 102.5%, even when the remote topping adjustment is properly set.

- At pressure altitudes below 1000 feet and ambient temperatures less than 5°C, the target values in step d. may not be reached due to fuel flow limiting. If this happens, increase altitude and repeat the check.

- At pressure altitudes above 1000 feet, note the following three conditions: 1) When ambient temperatures are below -5°C, expect to reach 100% N_g before reaching 773°C T_5 for the 416, 792°C T_5 for the 416A, or 829°C T_5 for the 419. 2) With ambient temperatures between -5°C and +5°C, the engine transitions from N_g control to T_5 control and either limit may be reached first. 3) At ambient temperatures above 5°C, expect to reach the T_5 limit first.

- If 100% N_g or 137% Q is reached before reaching target T_5, performance data shall be recorded at 100% N_g or 137% Q. When this happens, the data point shall be plotted using observed T_5.

f. Select the next three recorded points at target T_5's which are 20 to 30°C below each previously recorded point. This provides an adequate data point spread.

g. Repeat steps d., e., and f. for the remaining two engines as required.

Note

- Before recording any engine parameters, 1 minute shall be allowed for internal engine T_5 temperature stabilization.

- Inaccuracies or failures of the following systems will lead to errors in the four-point performance check:
  1) Engine torque system calibration
  2) T_5 system calibration
  3) Thermocouple bank resistances
  4) OAT gage accuracy (1°C equals 29 SHP error.)
  5) Anti-ice not operational

B

9. Heater — Check that HEAT rheostat is OFF and VENT switch is OFF. Blower should not be running. Place VENT switch ON and check for airflow at vents. Place switch OFF. Blower should stop. Turn HEAT rheostat to middle position. Both vent fan and combustion air blower should start and heater should light-off within 45 seconds. Automatic shutdown should occur after 45 seconds if there is no light-off. Check all ducts and outlets for warm airflow. Turn HEAT rheostat to HI. An increase in temperature should occur within a few minutes. Turn HEAT rheostat to OFF; blower could continue to operate until heater cools and then shut off automatically.

10. AFCS.

B C

a. Collective Drop — Be sure SERVO 1, AFCS, and TRIM are engaged. While in forward flight at 130 knots, with feet off rudder pedals, lower collective to flat pitch within 6 to 8 seconds. Transient heading error should not be over ±10°.

B C

b. Flight Stability — Trim helicopter for straight and level flight at 130 knots. When trimmed, engage BAR ALT. Fly hands-off for about 2 minutes. Helicopter should maintain attitude within 3° in pitch, roll and yaw, during calm air conditions. Engage altitude should be maintained at ±40 feet.

PROFILE

B C

c. Push/Pull and Release — Transfer to SERVO 2, AFCS, and TRIM engaged, trim helicopter for straight and level flight at 130 knots. When trimmed, engage BAR ALT. Push cyclic forward 1 inch for 1 second and release. Helicopter should return to original attitude with no more than one overshoot and to 130 ±5 knots. Repeat test, pulling cyclic 1 inch aft for 1 second. Repeat check with left and right cyclic input. Repeat check with SERVO 1 on.

B C

d. BAR ALT Beep Trim/Longitudinal Trim Check — With SERVO 1 on, AFCS, TRIM, and BAR ALT engaged, trim helicopter for straight and level flight at 130 knots. Beep cyclic aft to attain airspeed of 110 knots. Helicopter should maintain altitude within 40 feet and new airspeed without excessive oscillation or overshoots. Look for smoothness in cyclic travel and total control of beeper. Retrim by beeping to 130 knots and check previous tolerance.

B C

e. Auto Bank — With SERVO 1 on, AFCS, TRIM, and BAR ALT engaged; trim helicopter for straight and level flight at 130 knots and engage AUTO BANK. Apply lateral cyclic force to roll slowly into a 20° left bank without use of beep trim or trim release. The pedals may move to maintain a coordinated turn. Stop roll rate and release cyclic. The helicopter should maintain a 20° left bank. Ball in turn and bank indicator should hold to within ±1/2 ball width.

Note

- Pitch/roll/yaw oscillations of ±1° may be present in turns above 60 KIAS with BAR ALT or RAD ALT HOLD engaged.
- If the ±1/2 ball width criteria is not met, complete an accelerometer null check by flying wings level, balanced flight, 120 KIAS, and have aircrewman set null. Successful completion of null check is indicated by AFCS pushbutton light flickering and TRIM button going off. Pilot must reset TRIM pushbutton.

After 180° of turn with the ball trimmed to the center of the race, slowly roll back to within 2° of wings level, arrest the roll and yaw rates and release the cyclic. The helicopter should return to a zero bank angle. Repeat check in 20° right bank.

B C

f. Trimmed Turn — With AUTO BANK disengaged and SERVO 1 on, AFCS and TRIM engaged, trim helicopter for straight and level flight at 130 knots. Beep cyclic to obtain 20° of bank. Fly hands-off through at least 180° of turn. Helicopter should remain in trimmed flight and there should be no undesirable pitching or rolling. Pedals may move to maintain a coordinated turn. Ball in the turn-and-bank indicator should hold to within ±1/2 ball width of center. After 180° of turn, leave feet on pedals and roll out and repeat above in opposite direction.

B C

g. FAS Check: BAR ALT hold — OFF. Starting from trim at 120 KIAS and without moving the collective, roll into a stabilized 45° bank. Apply slight aft cyclic pressure. Check that the force on the cyclic increases. Repeat check in the other direction.

Note

Turning off barometric altimeter hold will prevent collective from increasing when this maneuver is attempted. At high density altitudes or higher gross weights, rotor blade stall may result.

PROFILE

B C

h. Pedal Check — At 120 KIAS with ball within ±1/2 ball width of center, kick ball out of center no more than 1-1/2 ball width. Forces should not exceed 24 pounds. Press pedal release switch on collective and forces should disappear. Release the pedal release switch and allow pedals to move, note helicopter returns to coordinated trimmed flight.

B C

11. Approach/Hover Coupler Check.

a. Approach Mode

(1) LONG VEL and LAT VEL controls — 0.

(2) RAD ALT control — 100.

(3) AFCS trim — ON.

(4) Doppler — LAND/SEA.

(5) RAD ALT — LAND/SEA.

(6) BAR ALT — OFF.

(7) ADI — SELECT DOPPLER.

(8) Trim the helicopter for 100 KIAS and 500 feet altitude, heading into wind, roll attitude less than 5°.

(9) APPR coupler — ON. Airspeed hold, heading hold, roll attitude hold, and 400 feet-per-minute rate-of-descent will be commanded.

(10) At about 450 feet, rate of descent should decrease to 200 feet-per-minute.

(11) At about 400 feet, a 1 knot-per-second ground speed deceleration will be commanded.

(12) At 60 KIAS, transition is made from attitude hold to Doppler mode, eliminating lateral drift.

(13) Helicopter should approach 100 feet at about 10 knots longitudinal ground speed.

(14) RAD ALT hold will engage at about 10 knots ground speed and HVR coupler will automatically engage when ground speed is below 2 knots.

Note

If the water surface is smooth, the Doppler may go into the memory mode, deceleration and drift will have to be controlled manually. As the rotor wash disturbs the surface the Doppler may receive a return and mode reset may enable the Doppler to effect the remainder of the approach and successfully engage a stabilized hover.

b. Hover Coupler — CHECK.

(1) AFCS and TRIM — CHECK ON.

PROFILE

(2) RAD ALT control — 100.

(3) LONG VEL and LAT VEL controls — 0.

(4) HVR coupler switch — PRESS ON.

Note

If longitudinal drift is more than 5 knots, HOVER coupler will not engage. If RAD ALT was not previously engaged, it will engage automatically when the helicopter is within 2 feet of RAD ALT control setting.

(5) Helicopter altitude should revert to RAD ALT setting automatically, at which time the RAD ALT will engage.

(6) Helicopter should hover within ±7 feet of RAD ALT setting, with a longitudinal or lateral ground speed not over ±2 knots with the LONG VEL and LAT VEL controls set at 0.

Note

Excessive longitudinal, lateral, or vertical drift may be indicative of improperly nulled accelerometers. Improperly nulled accelerometers may cause degraded AFCS tow heading hold performance.

(7) Start a 10-knot lateral drift to right against trim and release cyclic.

(8) Helicopter should return to a stable hover and not exceed limits in step (6) above.

(9) Repeat steps (7) and (8) for left lateral direction.

(10) Repeat steps (7) and (8) for longitudinal drift in forward and aft directions.

(11) RAD ALT control — 200.

(12) Helicopter should climb to 200 feet ±5% with only one overshoot. Rate-of-climb should not exceed 1000 fpm.

Note

During check of step (12), engine torque should stay below 121% with no more than one transient greater than 121%.

(13) RAD ALT control — 100.

(14) Helicopter should return to 100 ±7 feet with only one overshoot and torque limits as shown in NOTE above. Rate-of-descent should not exceed 200 fpm.

(15) LONG VEL control set to establish a 10-knot drift and return to 0. Helicopter should return to and maintain previously established hover.

(16) Repeat step (15) for LONG VEL in opposite direction.

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(17) LAT VEL control set to establish a 10-knot drift and return to 0. Helicopter should return to and maintain previously established hover.

(18) Repeat step (17) for LAT VEL in opposite direction.

(19) Repeat steps (15) and (17), using cyclic beeper instead of LONG/LAT VEL controls. Once 10-knot drift is established, press cyclic TRIM REL and release. Helicopter should return to a stable hover.

(20) Move HDG TRIM dial 36° to L (half turn).

(21) Helicopter heading change 36° to left at 1 1/2° per-second rate.

(22) Repeat steps (20) and (21) for right direction.

(23) Once helicopter is in a stable hover into the wind, press cyclic TRIM REL and release.

c. Crew Hover — CHECK.

(1) CREW HVR switch — PRESS ON; COUPLER PANEL HOVER TRIM LIGHT ON.

(2) Hoist CREW HVR panel switch — PRESS ON; CREW HOVER PANEL LIGHT SHOULD GO ON.

(3) Crew hover TRIM switch — PRESS FOR FORWARD DRIFT.

Note

The crewman's control authority is limited to 10 knots of ground speed in longitudinal and lateral directions in either axis. The hover TRIM switch output is pressure sensitive. Increase pressure in pounds commands increase in ground speed.

(4) Release switch pressure. Helicopter should return to stable hover.

(5) Repeat steps (3) and (4) for rearward, left, and right drifts.

(6) CREW HVR switch — PRESS OFF.

(7) HOVER TRIM light on crew hover panel should go out.

d. Departure Mode.

(1) HVR coupler — CHECK ON.

(2) Cyclic DEPART switch — PRESS. DEPART light on flight control panel should go on.

(3) Helicopter should climb at 480 feet-per-minute and accelerate at 2 knots-per-second.

(4) Below 60 KIAS, the helicopter should fly at the lateral velocity set on the LAT VEL set pot on the AFCS control panel.

(5) Above 60 KIAS, the helicopter should transition to roll attitude hold, and fly to 500 feet altitude for BAR ALT HOLD and 100 KIAS airspeed hold trimmed.

(6) Descend to 200 feet and engage APPR coupler.

(7) Radar altitude hold should automatically engage and helicopter should decelerate at 1 knot-per-second.

(8) As helicopter decelerates below 40 knots ground speed, RAD ALT hold disengages and 200 feet-per-minute rate-of-descent will be commanded. The remaining portion of approach is the same as steps a. (13) through a. (14).

(9) Press DEPART switch on coupler control panel; DEPART light should go on.

(10) The helicopter should enter a 480 feet-per-minute rate-of-climb and 2 knots-per-second acceleration.

(11) Before reaching 500 feet altitude and 100 KIAS, press collective ALT REL and cyclic TRIM REL switches. The AFCS should stabilize the helicopter at the altitude and airspeed at point of TRIM REL switch release.

(12) APPR coupler switch — PRESS.

(13) When established on automatic approach profile, PRESS cyclic DEPART switch.

(14) Helicopter should make smooth transition to 480 feet-per-minute rate-of-climb and 2 knots-per-second acceleration.

B 12. Communication Sets.

a. HF — Check clear sidetone and reception audible at all stations. Check SQL sensitivity control.

b. FM/VHF/UHF — Using COMM 1, at about 10 line-of-sight miles from station, check clear sidetone and reception audible at all stations. Transmit and use both T/R and T/R&G with MODE selector control. Background noise should be squelched in both positions. Set mode selector switch to MAN, tune in station frequency, and establish communications. Repeat procedure with COMM 2.

B 13. Navigation Sets.

a. VHF/UHF-DF — Fly over known geographical landmark at altitude of about 1500 feet with line-of-sight clearance. Using COMM 1 set a known tower frequency on the radio control panel (between 100 and 400 MHz). Contact tower and request homing signal. Turn mode switch on COMM 1 panel to DF. Fly helicopter directly over landmark on heading toward tower. The #1 pointers point in general direction of tower during 360° turn. Repeat procedure using COMM 2.

b. LF/ADF — Fly directly over geographical landmark on known bearing toward selected tower. Select ADF under HSI BRG 1 on mode selector panel. The #1 pointer of the HSIs should indicate known bearing ±5°. Repeat on headings of ±45° of nose and tail bearings. With CW and ANT selected, a beat note should be heard in headset. Select VOICE and check ADF receiver operation with mode selector switch in ANT position; check for audible reception on middle and high bands.

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c. TACAN — Fly over a landmark on a known bearing to the NAVAID. Select BRG 2 TACN and CRS SEL TACN under HSI and TACN under ADI on the mode selector panel. The No. 2 HSI pointers and ADI vertical command bars should indicate the known bearing within ±2°, and the range indicators should read the known distance ±0.5 miles. Turn course selector knob until the HSI course deviation bars are centered and the TO/FROM indicators reads TO. The COURSE selected window should read known bearing ±2.5°, and No. 2 HSI pointers should point straight up ±2° and the ADIs vertical command bars should be centered. Maintain heading toward NAV-AID. Turn course selector knob until the HSIs course deviation bars are on second dot and note course selected. Turn knob in other direction to place HSIs course deviation bars on second dot and note course selected. There should be a 10 ±3° difference between courses selected. Continue turning course selector knob until the reciprocal of the known bearing is selected. The TO/FROM indicator should read FROM. Select A/A T/R with the function selector knob and a channel, 63 channels apart, from a cooperating aircraft. Mileage should be ±0.5 miles of known distance to the other aircraft. If the cooperating aircraft is equipped with a bearing transmitter, check known bearing and distance to the cooperating aircraft in the same manner as when checking bearing and distance to a surface station.

d. VOR — Fly over a landmark on a known bearing to the NAVAID. Select BRG 2 VOR under HSI and VOR under ADI on the mode selector panel. The No. 2 HSI pointers and ADI vertical command bars should indicate the known bearing within ±2°. Turn the course selector knob until the HSIs course deviation bars are centered and the TO/FROM indicators read TO. The COURSE selected window should read the known bearing ±2.5°, and the No. 2 HSI pointers should point straight up ±2° and the ADIs vertical command bars should be centered. Maintain heading toward NAVAID. Turn course selector knob until the HSIs course deviation bars are on second dot and note course selected. Turn knob in other direction to place HSIs course deviation bars on second dot and note course selected. There should be a 10 ±3° difference between the courses selected. Continue turning course selector knob until the reciprocal of the known bearing is selected. The TO/FROM indicator should now read FROM.

e. ILS — Tune in a suitable ILS NAVAID. Intercept the localizer and fly inbound at a published altitude. When the glide slope signals are received, the glide slope warning flags on the ADIs and HSIs retract. ADIs vertical and horizontal command bars, and the HSI course deviation bars center when the helicopter intercepts the glide slope. Continue flying inbound making deviations to be sure the course and glide slope indicators center when lined up on the localizer and glide slope.

f. IFF/SIF — Contact local approach and request IFF/SIF check. Check all functions.

g. RADAR BEACON (Removed by AFC 501, Part 3) — With radar beacon on and warmed up, check for proper operation.

h. Doppler — Select LAND or SEA for appropriate terrain being overflown and look for proper GSDA drift angle and ground speed information.

i. Omega — Initialize system and verify initialization. Enter one known enroute waypoint. Fly to known waypoint to confirm Omega navigation indications.

B

14. EAPS/Landing Gear Warning — Before doing this check, be sure that radar altimeter is on and operative. Above 150 feet, slow helicopter to about 50 knots, with landing gear up. Note that EAPS DOOR CLOSED advisory light goes on between 100 and 60 knots. Descend through 150 feet and note that LDG GEAR UP warning light flashes and a pulse tone is heard in the headset at 150 ±10 feet. In a hover, press the LDG GEAR UP warning light. Note light goes off and tone

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stops. Lower the collective and the light and tone return. Below 150 feet, accelerate helicopter until LDG GEAR UP warning light goes off and intermittent tone is no longer heard in headset. Airspeed should be 60 ±5 knots. Above 150 feet, slow helicopter to about 50 knots, with landing gear up. Turn the radar altimeter off and note the LDG GEAR UP warning light flashes and a pulse tone is heard in the headset.

B 15. Rescue/Utility Hoist.

a. Place master switch to crew, and have crewman attach a 600-pound weight. Ascend to a higher hover, reeling out enough cable so weight remains on ground. Have crewman operate hoist, raising and lowering weight 15 or 20 feet, but make sure enough cable remains out to keep weight below helicopter. Hover helicopter at a minimum of 400 feet. Have crewman lower weight at maximum speed to full length of cable (240 feet) and raise weight to up-limit stops, checking the following. Smooth operation from about 0 to 50 feet-per-minute, during first 5 to 7 feet of cable extension. Smooth operation from about 0 to 200 feet-per-minute, during 7 to 235 feet of cable extension. Smooth operation during last 5 to 7 feet of cable extension before full down-limit is reached. At full down-limit, there should be at least three full cable wraps around drum. Raise weight through same sequence.

WARNING

A crewmember's safety belt shall be used when operating the hoist from the cabin compartment with the personnel door open.

b. Check emergency operation by pulling the No. 2 primary dc bus RESCUE HOIST PWR circuit breaker and setting pilot's MASTER ramp control switch to CREW or PILOT, to open the isolation valve. Turn the manual override knob or lower weight and note that rate-of-descent is controllable. Stop weight's descent and then raise weight and check that rate-of-ascent is controllable. Do not fully extend or retract cable during manual override operation, as up- and down-limit switches are inoperative. Reset circuit breaker and raise weight enough for a safe landing.

B 16. Single-point Suspension Check.

a. Hover over load.

b. Lower cargo hook from stowed position.

c. PWR SEL switch — SINGLE PT.

d. CONTROL switch — COCKPIT.

e. MODE switch — NORM.

f. Pilot checks electrical release by activating and observing SINGLE PT HOOK OPEN advisory light flicker as long as the CARGO REL button is pressed.

g. Descend so that rigger on ground can discharge static electricity with wand and can attach cargo sling into cargo hook.

h. SINGLE PT HOOK OPEN advisory light — OFF.

i. When aircrewman advises hookup is completed, lift off vertically until load is 2 feet off ground, monitoring plane director.

j. Descend slowly until load is resting on ground.

k. CARGO REL button — PRESS. SINGLE PT HOOK OPEN advisory light - ON.

l. CARGO REL button — RELEASE. SINGLE PT HOOK OPEN advisory light - OFF.

m. Rigger reattaches cargo sling into hook.

n. When aircrewman advises hookup is completed, lift off vertically until load is 2 feet off ground, monitoring plane director.

o. MODE switch — AUTO-RLSE.

CAUTION

To prevent inadvertent load release, the minimum weight for the single-point external cargo hook automatic release mode is 4000 pounds.

p. Descend slowly until load contacts surface.

q. The SINGLE PT HOOK Open advisory light goes on and the load is released automatically.

r. POWER SEL switch — OFF.

s. Aircrewman stow cargo hook.

B 17. Two-point Suspension.
Information to be provided.

10.3.7.3 Prelanding Hover

B 1. Instrument Readings — Check all instrument readings for proper indication.

10.3.8 Shutdown

Probe Extension and Retraction — Make sure that area directly in front of probe is clear of personnel and equipment.

1. Extension — Press REFUEL PWR switch ON and place probe switch to extend. Probe extension should appear smooth. During extension amber probe-in-transition light will light. When probe is locked, probe READY light will light. Transition light will be ON, when probe is extending. Probe extension time should not be over 1 minute. Allow 1 minute before retracting probe.

2. Retraction — Place probe switch to STOW. Probe retraction should be smooth. When probe begins to retract, probe READY light will go off and amber probe-in-transition light will go on. When probe is fully retracted, amber probe-in-transition light will go off. Probe retraction should not take over 2 minutes. Press REFUEL PWR switch off.

PROFILE

WARNING

During extension of the refueling probe, be sure no personnel or vehicles are directly in front of the refueling probe. There is enough bleed-air pressure to propel the probe from the helicopter if the external lock actuator fails.

10.3.8.2 Engine Fuel Selector Lever Shutdown. The following procedure checks the ability to shut down the engine with the fuel selector lever.

Note

After fuel selector lever shutdown, check fuel filter button normal.

B E 1. Torques matched at 100% N_f.

B E 2. Place No. 1 engine speed control lever to GRD IDLE. Place No. 1 engine fuel selector lever to SHUT OFF. When flameout occurs, as indicated by fuel flow reading zero, immediately move speed control lever to SHUTOFF and return engine fuel selector to DIRECT until after coastdown.

3. Restart No. 1 engine. When stable at ground idle, slowly advance to 100% N_f.

4. Repeat step 2. for No. 2 and No. 3 engines.

A B **10.3.8.3 Rotor Brake.** Shut down rotor system using applicable NATOPS procedures. Note rotor brake functions normally.

A B **10.3.8.4 Emergency Lights.** Test; then OFF.

B **10.3.8.5 APP Circuit Breaker Control Switch Shutdown.** Check operation of shutdown circuit by placing circuit breaker control switch OFF. APP should flame out and decelerate to zero in 45 ±10 seconds. Place control lever to SHUTOFF.

ROTOR SPEED	#1 TORQUE	CORRECTIVE ACTION TO INPUT LEVER ADJUSTING SCREWS (SEE NOTE)
Remains at 100%	Equals #3	None
Remains at 100%	Less than #3	Turn #1 CCW. #3 CW Same Amount
Remains at 100%	Greater than #3	Turn #1 CW. #3 CCW Same Amount
Exceeds 100%	Equals #3	Turn both #1 & #3 CW Same Amount
Exceeds 100%	Less than #3	Turn #3 CW
Exceeds 100%	Greater than #3	Turn #1 CW
Decreases below 100%	Equals #3	Turn both #1 & #3 CCW Same Amount
Decreases below 100%	Less than #3	Turn #1 CCW
Decreases below 100%	Greater than #3	Turn #3 CCW Full Turn

ROTOR SPEED	#1 AND #3 TORQUE	CORRECTIVE ACTION TO INPUT LEVER ADJUSTING SCREWS (SEE NOTE)
Remains at 100%	Equals #2	None
Remains at 100%	Less than #2	1/2 Turn CCW on #1 & #3 for each 1 Turn CW on #2
Remains at 100%	Greater than #2	1/2 Turn CW on #1 & #3 for each 1 Turn CCW on #2
Exceeds 100%	Equals #2	Turn #1, #2, #3 CW Same Amount
Exceeds 100%	Less than #2	Turn #2 CW
Exceeds 100%	Greater than #2	Turn #1 & #3 CW
Decreases below 100%	Equals #2	Turn #1, #2, #3 CCW Same Amount
Decreases below 100%	Less than #2	Turn #1 & #3 CCW
Decreases below 100%	Greater than #2	Turn #2 CCW Full Turn

NOTE

- CW adjustments decrease torque / Nf / Nr and CCW adjustments increase. CW / CCW pertains to the direction of the knurled adjusting nut, as viewed from below on the No. 1 and No. 3 engine bias blocks, and as viewed from above the No. 2 engine bias block.
- If adjusted one engine at a time, one turn will change the torque split by approximately 2%. Adjusting two engines at a time will change the torque split approximately 4% per turn. Once all engines are married, one turn each will cause Nf / Nr to change approximately 1%.

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Figure 10-1. Torque Split Beyond Allowable Limits

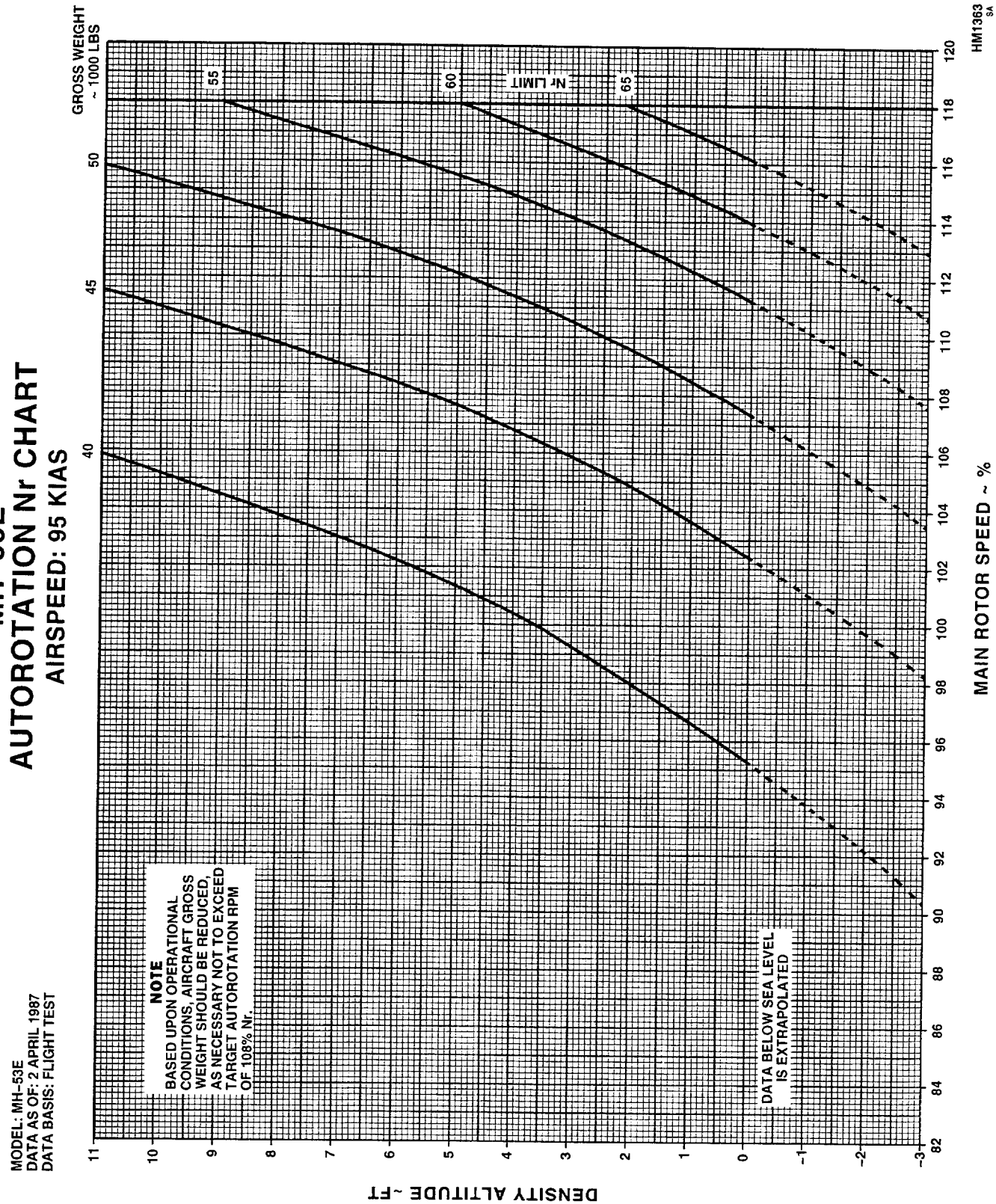


Figure 10-2. Autorotation RPM

PART IV

FLIGHT TECHNIQUES AND CHARACTERISTICS

Chapter 11 Flight Techniques and Characteristics

CHAPTER 11
Flight Techniques and Characteristics

11.1 INTRODUCTION

The unlimited freedom of movement at low speed and normal fuselage attitude, the ability to take off and land vertically, and the ability to hover over one spot comprise the advantageous flight characteristic of the helicopter. The normal speed range extends from a rearward speed of 30 knots to a forward speed of 150 KIAS, which includes sideward flight up to 35 knots. The helicopter is equipped with an automatic flight control system (AFCS) for stabilization.

11.2 SETTLING WITH POWER

Settling with power is a phenomenon which occurs when the power required to maintain level hovering or forward flight exceeds the power available. This may occur at high density altitude, high gross weights, or when operating with degraded engine performance. Careful preflight analysis of performance capabilities in Part XI, and in-flight awareness of ambient conditions, helicopter gross weight, and engine operational power performance will aid in avoiding settling with power. To recover from this condition:

1. Speed Control Levers — FULL FORWARD.
2. Maintain N_r.
3. Increase forward airspeed.
4. Reduce weight by releasing external loads or dumping fuel.

11.3 POWER SETTLING

Power settling is the incapability to stop a rate-of-descent when the helicopter begins to settle into a vortex ring state. A vortex ring state occurs when the velocity of the downwash from the rotor is approximately equal to the rate of descent of the helicopter causing the air to recirculate up, around, and back down through the rotor disc. The decreased rotor efficiency that results will cause a loss of lift, increased roughness, and poor control response. Settling may not be recognized as power settling, and a recovery may not be effected until considerable altitude has been lost. Recovery is best made by increasing forward speed and decreasing collective pitch. Increased collective pitch may further worsen the condition. Power settling is most likely to occur during conditions of high gross weight, high density altitude, low airspeed, downwind landing, and descending powered flight.

CAUTION

Flight conditions causing power settling should be avoided at low altitudes because of the loss of altitude necessary for recovery.

11.4 GROUND EFFECT

Ground effect is experienced when hovering at less than approximately 80 feet. When hovering close to a large surface, the surface restrains the rotor downwash permitting an increased hovering capability. This is done by reducing the induced velocity required to produce a given amount of thrust, which correspondingly decreases the amount of power required to hover. The decreased power requirements, when operating in ground effect, enables underpowered or heavily-loaded helicopters to hover, then obtain translational lift.

11.5 TRANSLATIONAL LIFT

Translation lift is the additional lift developed as the helicopter accelerates into forward flight. It is obtained by introducing the rotor to airspeed, thus changing the relationship between power required and power available. As airspeed increases, power required will correspondingly decrease until airspeeds are attained where an increase in drag will require an increase in power.

11.6 GROUND RESONANCE

Ground resonance is a self-excited vibration caused by unfavorable dynamic coupling between lead-lag motions of the rotor blades on their hinges and motions at the main rotor head in the plane of the rotor.

Ground resonance vibration in the fuselage would be at a sub-harmonic frequency of about 2/3 per main rotor revolution.

Analysis, testing, and experience with this aircraft have not revealed any normal flight or ground conditions, or likely malservice or failure modes which are subject to ground resonance.

Ground resonance could conceivably be caused by an unlikely combination of multiple failures involving landing gear stiffness, or damping, or blade lead-lag dampers. In such a case, amplitude buildup would probably be initiated by cyclic motions or a hard one-wheel landing.

If there is reason to believe ground resonance is occurring, recover by becoming airborne. Subsequent attempts at landing should be smoothly executed. When landing is accomplished, or if lift off was not possible, shut rotor down rapidly, by reducing collective pitch, placing the high-pressure rotor brake switch to EMER, moving speed levers to SHUT-OFF, and applying wheel brakes.

WARNING

If it is necessary to engage the rotor while the helicopter is tied down, it is mandatory that the tiedown chains be loose, relieving any tension in the chains attached above the oleos. Engagement of the rotor while the helicopter is tied down tightly will result in ground resonance.

11.7 ROLLOVER CHARACTERISTICS

11.7.1 Definition of Terms. Static rollover angle, critical rollover angle, and dynamic rollover define the rollover characteristics of any helicopter. Static rollover angle is the angle at which the helicopter will tip over on its side if it is parked on a very steep embankment. The minimum angle is about 29°. It occurs when the helicopter is tilted about an axis passing through the nose gear and either main gear ground contact points. Critical rollover angle is the maximum angle of slope that can be negotiated in a cross-hill landing or takeoff. At this angle, full lateral cyclic input is required to trim the wheels level with the slope without sliding. With the left wheel uphill and brakes on, this angle is about 13°. Dynamic rollover is an insidious dynamic condition that can occur during takeoff or landing with one wheel on the ground. It can result in almost certain destruction of the helicopter. It is not definable by a single number, nor is it simply a function of slope angle or lateral control authority. These will aggravate it, but the main contributor to dynamic rollover is buildup of angular velocity of the helicopter's center of gravity about the wheel touching the ground. When the resulting angular momentum of the helicopter about that wheel is greater than can be countered with full opposite lateral cyclic, the helicopter will roll over. This can occur within 2 seconds. The insidious aspect of dynamic rollover is that the roll rates which precipitate it are within the range the pilot would normally allow in flight. A detailed explanation of dynamic rollover follows, in conjunction with a discussion of slope landing, in order to develop a single set of logical control responses.

11.7.2 Slope Landing and Takeoff. There are three major forces involved in slope landings and takeoffs (Figure 11-1). These are: helicopter weight, rotor lift, and ground reaction (normal and friction forces). In general, the helicopter is controlled by using collective pitch to balance weight with rotor lift and by tilting rotor lift (into the slope) with lateral cyclic, which adds to wheel friction and prevents sliding.

Slope landings should be made by descending slowly and placing the upslope wheel on the ground first. Then, coordinately lower the collective and move the cyclic into the slope until the downslope wheel is also on the ground. The controls should always be positioned to keep the helicopter from drifting. Continue coordinated movement of collective and lateral cyclic until all of the helicopter weight is resting firmly on the ground. If lateral cyclic control contacts its stop, or if rotor-to-ground clearance becomes marginal before the downslope wheel is firmly on the ground, return to a hover by slowly raising collective and centering cyclic. Select another landing site with a shallower slope. After the slope landing is completed, be sure that the helicopter will not slide downhill, then center lateral cyclic. In a cross-slope landing with one wheel on the slope, collective provides a significant

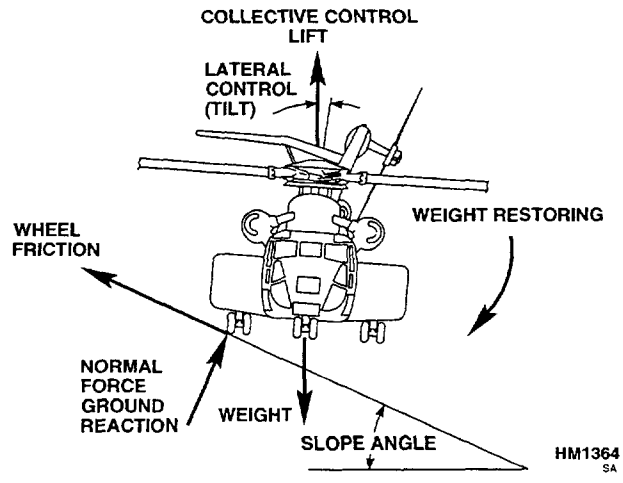


Figure 11-1. Slope Landing and Takeoff

contribution to roll control. Lateral cyclic still provides a hub moment, but control power (roll acceleration per inch of cyclic) about the wheel is substantially reduced. In this landing condition, the roll center is transferred from the center of gravity to the touchdown wheel, which results in a higher roll inertia. The roll inertia about the ground-contact wheel can be five times greater than the roll inertia about the center of gravity. Therefore, the corresponding control power is about 1/5 of the fully-airborne value. Thus, lateral control will feel sluggish.

Cross-slope landings (or takeoffs) should not be attempted on slopes steeper than the critical rollover angle (13°). As explained previously, lateral cyclic is on its stop and the downhill wheel is just touching the ground at this angle.

Cross-slope takeoffs should be made by first moving cyclic into the slope to prevent drift. Coordinately raise collective and adjust lateral cyclic to raise the downhill wheel first until the helicopter becomes level and lifts off the ground. Avoid large lateral cyclic displacements when the helicopter becomes airborne, because the roll center will now shift back to the center-of-gravity and lateral control power will increase five-fold to its flight value. If the helicopter rolls past level (into the slope) during the takeoff, lower collective rapidly but smoothly to avoid dynamic rollover. Set the helicopter back down on the slope and check for a blocked or hung-up wheel.

11.7.3 Dynamic Rollover. Dynamic rollover is the result of the helicopter developing too much angular momentum about a wheel in contact with the ground. It can occur during takeoff and landing on slopes, on corrugated steel matting or macadam, or during a deck launch with one gear still chained. The helicopter can roll over from a level attitude if a high sideward velocity (drift) occurs at touchdown and the wheel is prevented from sliding. This is illustrated in Figure 11-2. In this condition the upsetting rolling moment is caused by the momentum of the helicopter acting about the wheel ground-contact point. Thus, the wheel restraint converts the linear translation (drift) into an angular motion (roll rate) or angular momentum. The roll rate can be very large, depending on the sink and drift speeds, and the degree of wheel restraint. The resulting roll rate may be checked with opposite lateral cyclic, but lateral control will be sluggish (as described above) and will be limited by control range (stops). As in slope landing, and in all cases, smooth reduction of collective is the most effective corrective action the pilot can take to prevent dynamic rollover. If lateral cyclic cannot be displaced far enough to tilt the rotor lift line-of-action outside the wheel tread, then rotor lift adds to the upsetting moment (Figure 11-2). Since rotor lift opposes the only restoring force, helicopter weight, lift should be reduced. Thus, collective should be lowered if it appears that lateral control is ineffective, even though it has not yet contacted the stop. Since the AFCS is limited in authority (±10%) and subject to the same reduction in control power, its effectiveness in countering dynamic rollover is severely limited. For this reason, the pilot must observe the following procedures with caution:

11.7.4 Dynamic Rollover Avoidance Procedures

1. Do all landing, takeoff, and ground maneuvers smoothly, and maintain low roll rates.

2. Avoid rapid takeoffs.

3. Maintain wheels-level during takeoff and landing.

4. On sloping terrain, always lift the downhill wheel first during liftoff.

5. Keep the helicopter trimmed laterally during ground contact. Do not permit it to drift.

6. If lateral control feels sluggish, reduce collective and check for obstructions.

7. To correct roll rate, reduce collective smoothly. Avoid fast collective-drop to prevent blade strike or fuselage bounce.

8. Check cross-winds and lateral center-of-gravity offsets.

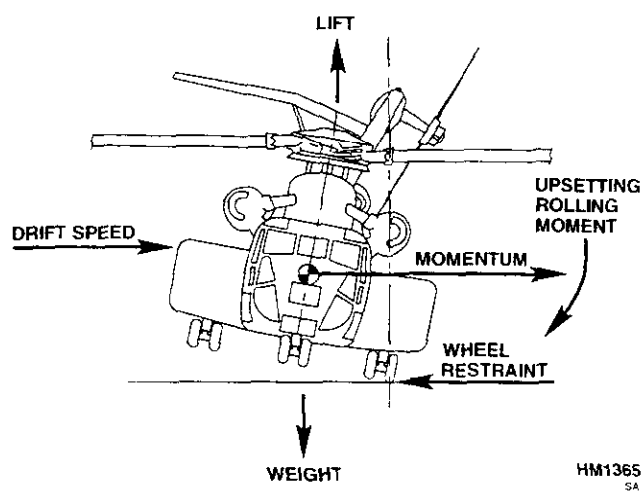


Figure 11-2. Dynamic Rollover Diagram

WARNING

When taking off or landing on a sloping or rough surface, the helicopter can be subjected to conditions which, with the slightest inattention by the pilot to developing roll rates, can result in almost certain destruction by dynamic rollover. Keep the helicopter under control at all times. When landing or taking off with one wheel touching the ground, use smooth collective motion to maintain low roll rates. Do not allow the helicopter to drift during ground maneuvers.

11.8 AIRSPEED INFORMATION

The following airspeeds are recommended for normal flights without external loads:

MANEUVER	AIRSPEED
Climb	100 KIAS
Slow Cruise	115 KIAS
Normal Cruise	135 KIAS
Descent	As required
Instrument Final	115 KIAS
Copter (only) Approach	90 KIAS

Note

Precision approach radar blind speeds may occur during final radar approaches. If so, increase or decrease airspeed within the cruise range.

11.9 DOWNWASH

Downwash is the term applied to the accelerated mass of air under a hovering helicopter. Downwash generated by the helicopter, under certain conditions, may create a hazard for personnel required to work underneath the helicopter during hover operations (HIFR, external cargo operations, hoisting, etc.). Downwash velocity will vary with hover altitude, aircraft gross weight, distance from the aircraft, and height AGL of the velocity measurement. See Figures 11-3 thru 11-5. Downwash characteristics (pattern, peak gust velocities, etc.) will vary due to all of the above considerations in addition to wind direction and velocity. Directly underneath the helicopter is an area of relative calm (Figure 11-6). Ambient winds will have striking effects on downwash characteristics by reducing effects upwind and increasing effects downwind. This will certainly be a factor in shipboard operations. Ambient winds will cause downwash effects to be experienced in the normally calm area under the helicopter. Personnel movement under the helicopter at lower gross weights is comparable to the CH/RH53D at a similar disc loading value. All downwash is characterized by great differences between average sustained velocities and peak velocities. Personnel must continually compensate for the changing forces. Control inputs cause large fluctuations in downwash which come as random gusts. This unpredictable nature and higher downwash velocities require a more cautions approach to CH/MH-53E operations. Ability to function under the helicopter also varies with the size, weight and strength of the individual. The following is a general guideline for ground crew operations at various aircraft gross weights when attempting to move above about at the point of the greatest downwash velocity.

1. Less than 50,000 pounds — Cautions, unrestricted operation of well-briefed personnel with optimum traction for footing.

2. 50,000 pounds — Limit that most personnel may be expected to tolerate without great difficulty.

3. 50,000 pounds to 56,000 pounds — Some personnel will begin to experience marginal or complete instability.

4. 56,000 pounds — All personnel will experience at least momentary loss of stability.

5. Above 60,000 pounds — Movement of personnel should not be attempted.

Note

- For zero wind, maximum average velocities occur at 49 feet from the rotor center (1.25 rotor radii). Maximum peak velocities occur from 59 feet to 69 feet from the rotor center (1.5 to 1.75 rotor radii).

- Personnel working underneath a hovering helicopter should have full body impact protection from projectiles (sand, etc.), goggles, and protective helmet with sound attenuation features.

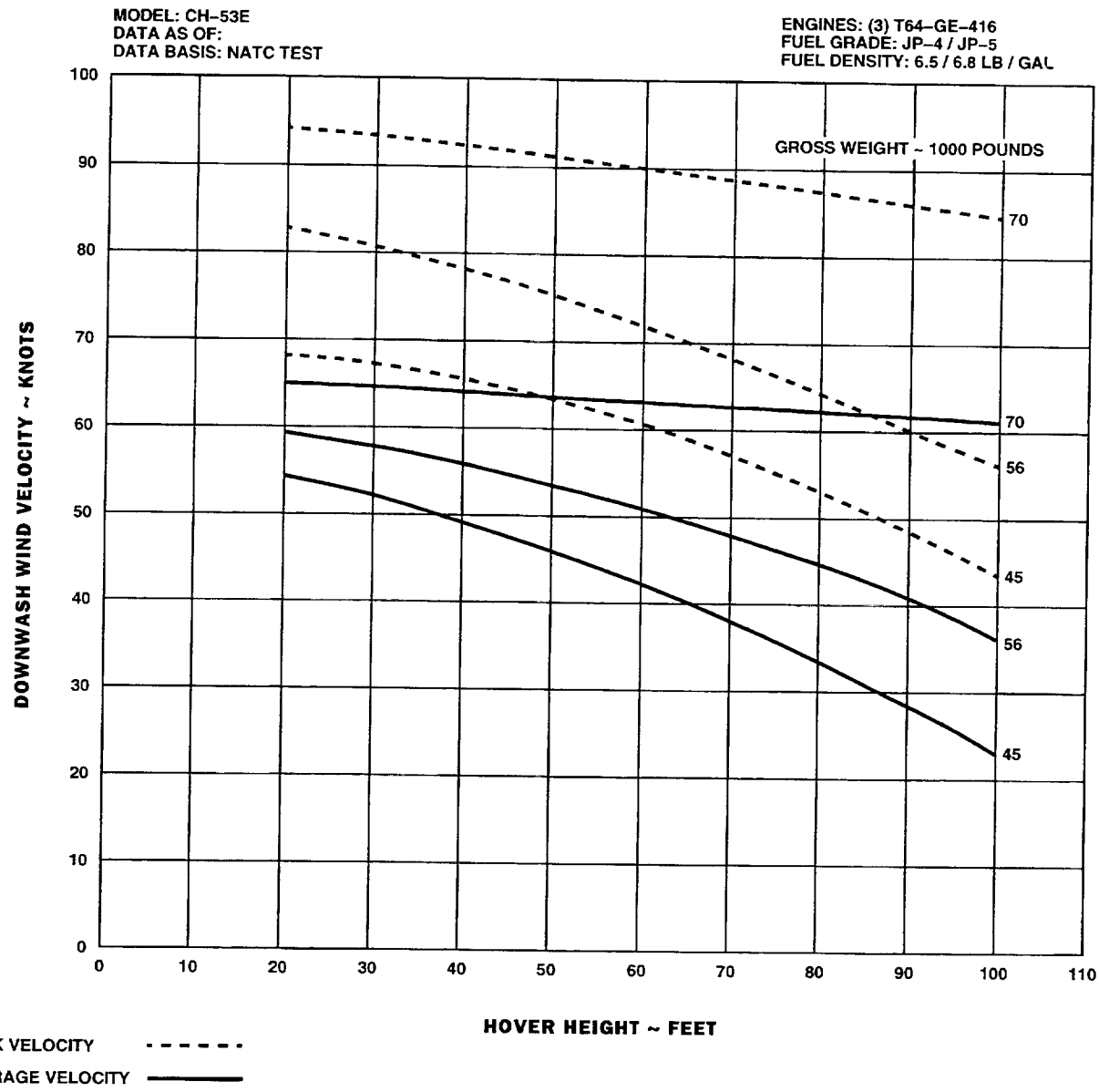
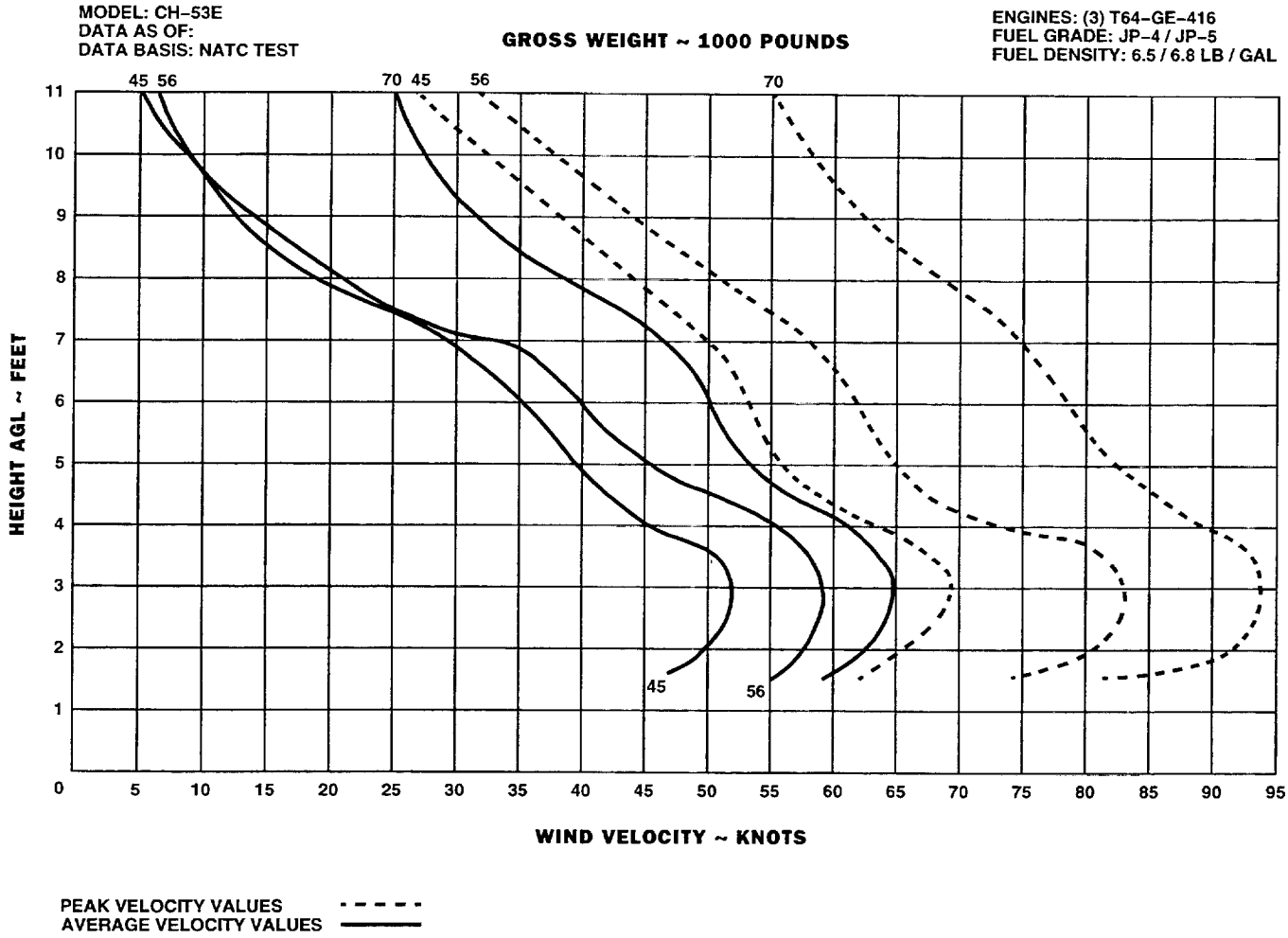
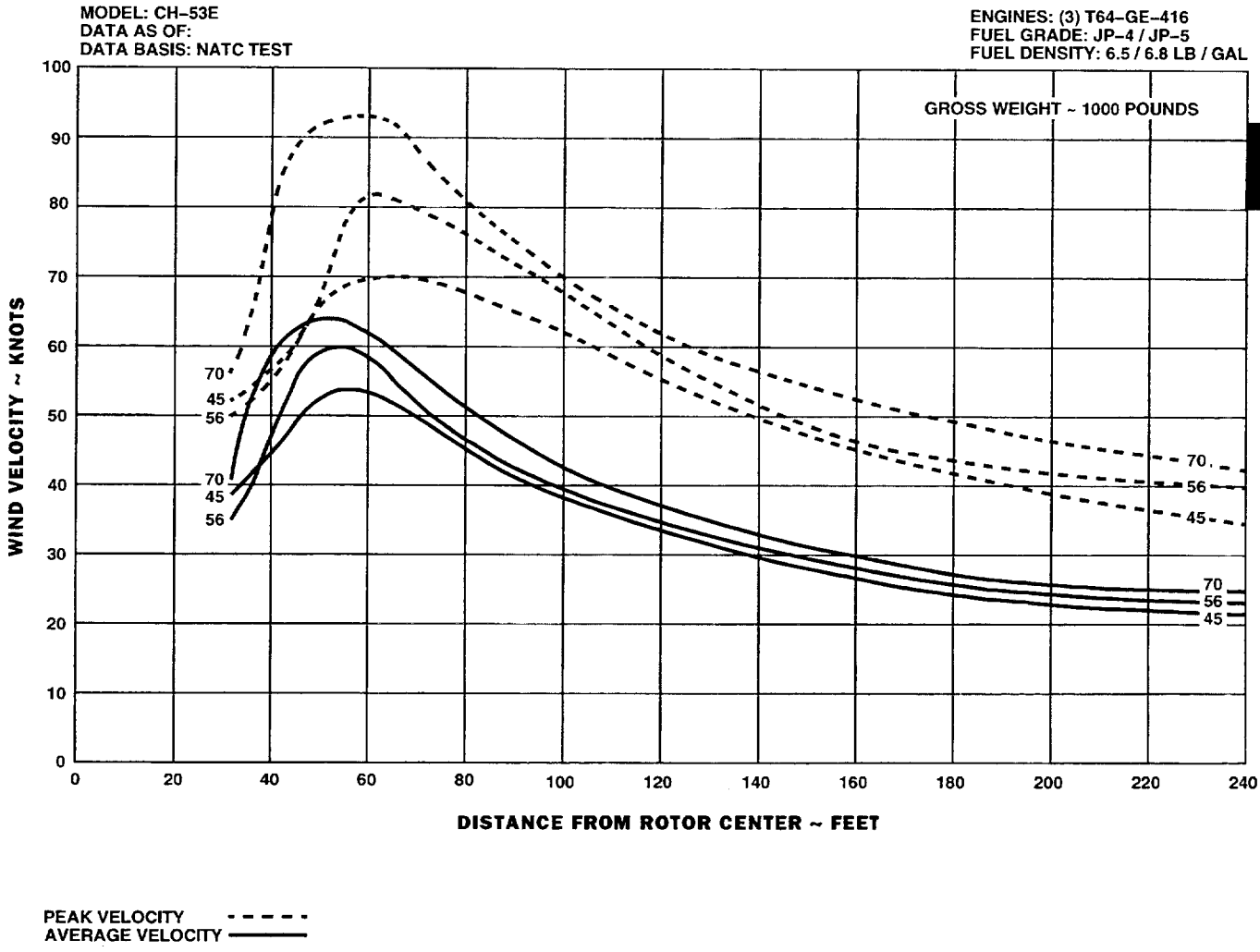


Figure 11-3. Maximum Downwash Wind Velocity as a Functional of Wheel Hover Height AGL



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Figure 11-4. Maximum Velocity - Height Profiles of Helicopter Downwash Wind Velocity Measured During a 20-Foot Hover



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Figure 11-5. Helicopter Downwash Wind Velocity as a Function of Distance from the Rotor Center - Data Measured at a Height of Three Feet

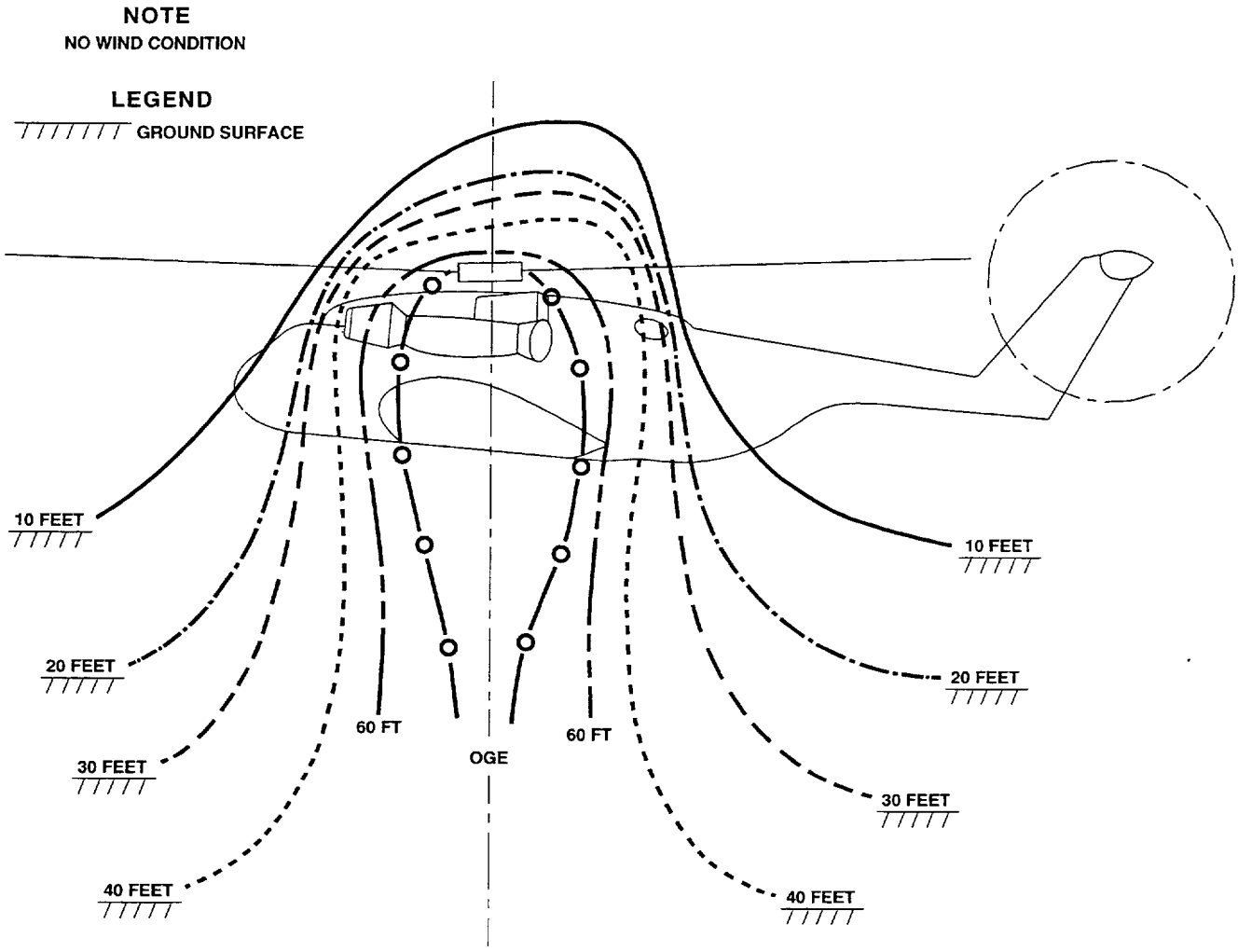


Figure 11-6. Zones of Relative Calm for Various Wheel Heights

- During external load operations, the pilot should hover without picking up the load until the hookup crew is well clear of the area.

- Recommended action for ground crewmen who are inadvertently engulfed in high velocity downwash is to drop to the ground in a sitting or prone position.

11.10 BLADE STALL

The retreating main rotor blades (the blades moving aft) have a tendency to stall which limits helicopter operating conditions and could cause structural damage. The tendency to stall is a result of reduced retreating blade relative air velocity (rotational speed minus forward speed) and the requirement to retain rotor rolling moment balance on the helicopter. The rolling moment balance requirement is met by increasing angle of attack on the retreating blade and decreasing it on the advancing

blade, through a combination of cyclic pitch and blade flapping velocity. For normal flight conditions this angle of attack variation is able to provide rolling moment balance even though the relative air velocity is smaller on the retreating blade. As flight conditions grow more severe, aerodynamic stalling of blade sections will begin to occur on the retreating blades, limiting the amount of lift that can be obtained. Blade stall is most likely to occur when operating at high values of airspeed, gross weight, density altitude, and power, and especially with low rotor rpm. Maneuvers, acceleration, or turbulent air, all of which increase G-load factors, will induce blade stall by reducing the airspeed at which it will occur. The roughness which accompanies it is not pronounced in this model helicopter and is not hazardous.

11.10.1 Method of Decreasing Blade Stall. Blade stall may be decreased as follows:

1. Gradually decrease collective pitch.
2. Gradually decrease the severity of the maneuver.
3. Gradually decrease airspeed.
4. Increase N_r. (When possible.)

11.10.2 Incipient Blade Stall Chart. This chart (Figure 20-7) gives the pilot and copilot a rapid means of finding the indicated airspeed at which blade stall occurs for various altitudes, rpm, gross weights, and angles of bank.

11.11 COORDINATION OF FLIGHT CONTROLS

Helicopter control is attained through the conventional use of the cyclic, collective, and rudder pedals. Flight control coordination is further enhanced by a mixing unit that integrates collective with pitch, yaw, and roll to provide essentially a vertical response with collective inputs. In addition to the conventional yaw-to-roll coupling provided in the mixing unit, yaw is also coupled to pitch, to compensate for the effect of the canted tail rotor. Turn coordination is automatically coupled into the yaw axis above 60 KIAS when entering into a bank turn. Longitudinal forces derived from the FAS actuator are appropriately shaped to provide a cyclic force proportional to the G forces developed in the maneuver.

11.12 LEVEL FLIGHT AND MANEUVERING CHARACTERISTICS

Level flight characteristics are very good at all speed conditions and operational altitudes. Fuselage attitude is dependent on the aircraft's center-of-gravity and airspeed. This is shown in Figure 11-7. The airspeeds in Figure 11-7 are steady airspeeds, not accelerating airspeeds. With accelerating airspeed, such as transition from a hover to forward flight, the aircraft attitude would tend to nose-down instead of nose-up as shown for the low steady airspeeds shown in Figure 11-7. Rearward and sideward flight can be accomplished without difficulty. Rearward flight can be flown up to 30 knots and sideward flight up to 35 knots. With the AFCS engaged, the helicopter is stable about all axes. Heading hold is provided at all airspeeds. Attitude hold is provided from 0 to 60 knots. Airspeed hold is provided above 60 knots. The inherent high control power makes the helicopter highly maneuverable at all airspeeds. Because of this, longitudinal cyclic forces have been introduced, through the AFCS FAS system, to help prevent the pilot from overstressing the airframe and dynamic system. During maneuvering flight above 60 knots, the pilot can expect to feel longitudinal forces commensurate with the G level imposed on the helicopter.

11.13 STRUCTURAL ASPECTS OF MANEUVERING FLIGHT

Maneuvering flight produces stresses in both the airframe and dynamic systems which are greater than level flight stresses at comparable conditions of airspeed and altitude. Exceeding design limit load factor can cause immediate airframe damage. Damage would typically be indicated by popped rivets, wrinkled fuselage skin or deformed fuselage frames. Exceeding the design load factors can also result in a shortening of dynamic system component lives. In general, increasing collective pitch during maneuvering flight results in increased dynamic system stresses and conversely decreasing collective pitch, all other factors equal, usually results in lower stresses. High bank angle and high pitch or roll rate maneuvers also usually result in elevated dynamic system stress levels. For the same flight condition (including flight under tow), 105% rotor speed will result in lower dynamic system stresses than the use of 100% rotor speed. Maneuvering at high altitude usually results in higher system stresses because the main rotor blades operate closer to the stall point. Maneuvering in uncoordinated flight tends to increase tail rotor system stresses approximately proportional to the amount of sideslip developed.

11.14 FLIGHT WITH EXTERNAL LOADS

It is very important for the pilot to know the riding characteristics of certain loads and the associated flight control applications. All maneuvers made with external cargo loads should be gradual and well coordinated. Care must be taken when flying with external loads that

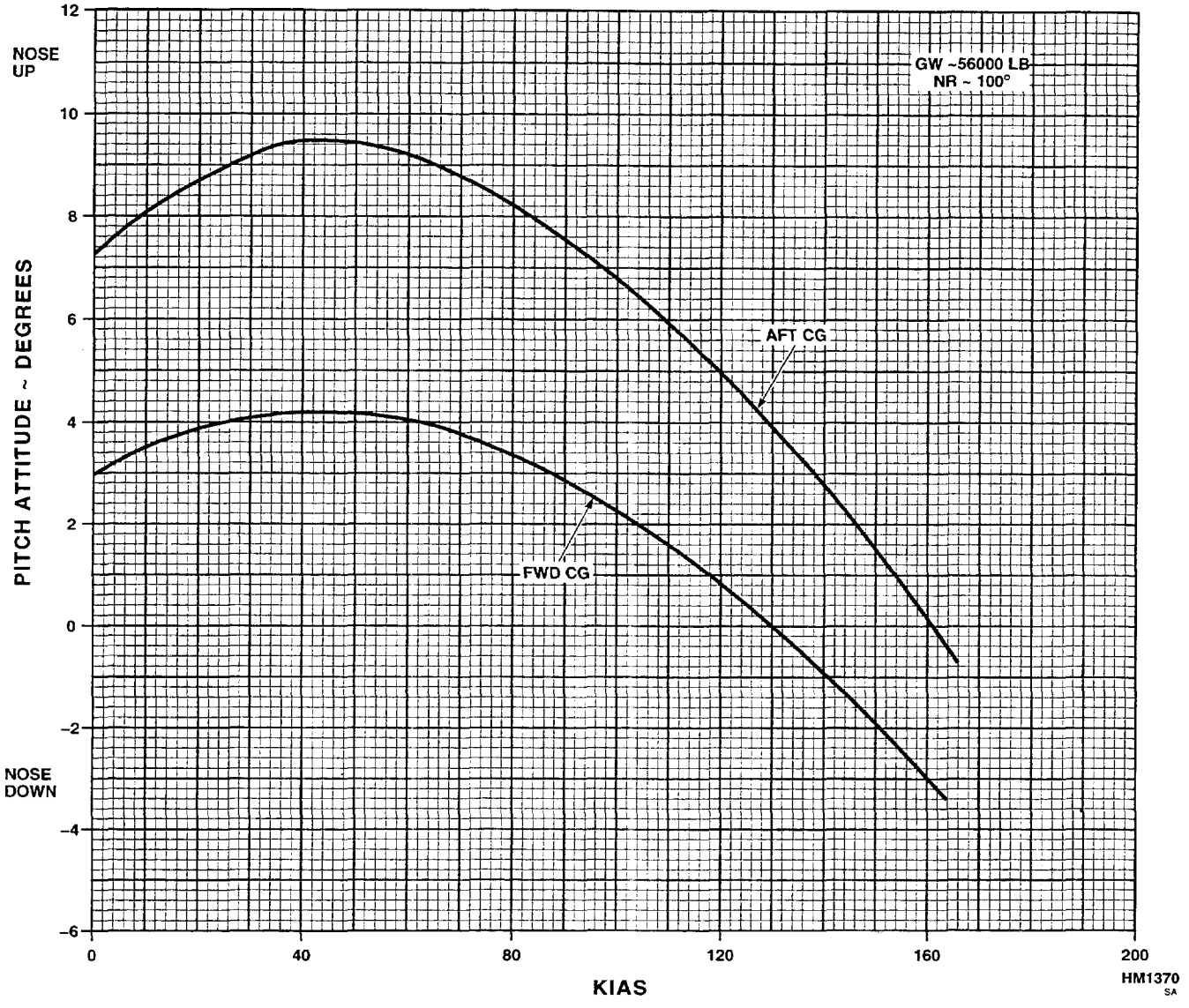


Figure 11-7. Pitch Attitude vs. Airspeeds

have aerodynamic characteristics (i.e., light aircraft, wings, tail sections, sheet metal, plywood, etc.). The aerodynamic lift of these loads may amplify any oscillation and cause the load to contact the helicopter. Hovering and turns while hovering present no unusual problems. However, some helicopter oscillation may be noticed with low density bulky cargo when in level flight. This oscillation can be lessened with smooth control movements. When making turns at higher airspeeds, more than the normal opposite lateral cyclic displacement is necessary to prevent excessive rolling motion into the direction of turn. This tendency increases with airspeed and requires a slightly larger turning radius than would be required at the same gross weight with an internal cargo load. More than normal amounts of cyclic displacement are necessary to overcome the external cargo inertia when initiating or stopping sideward flight. However, slow steady sideward flight presents no problems. Experience has shown that for any type of external cargo load, there is an airspeed best suited for that particular load, from very low speeds to cruise speeds. There is no single rule for flying external loads, since the combination of weight, dimension, and shape all have a direct bearing on the action of the load during flight. In general, more power will be required to hover with large flat loads that create a large vertical drag, than compact loads of the same weight. External cargo can be satisfactorily flown if control movements are smoothly applied and airspeed is slowly increased to

determine both the riding characteristics of the load and the best airspeed for it to be flown. If high airspeeds or turbulence should cause the load to oscillate, this can be reduced by decreasing airspeed and using the flight controls smoothly.

11.15 COLLECTIVE BOUNCE

Abrupt control inputs at high gross weight or with external loads may result in vertical oscillations known as "collective bounce". An abrupt collective control input will produce a vertical jump in the airframe. Another abrupt movement of the pilot's arm in reaction to this initial jump in the airframe will again move the collective involuntarily so that another bounce will be transmitted to the airframe. This sequence can repeat itself with increasing amplitude and is aggravated if the pilot continues to hold the collective whether or not the trim is engaged. When transporting external loads, the helicopter reaction can be transmitted to the load through the springing action of the pendant. Abrupt flight maneuvers, gusting winds, turbulence, and shifting or failure of external load slings can initiate similar vertical oscillations in the airframe. Smooth, coordinated control inputs with the collective trim release switch temporarily pressed should prevent entry into pilot-induced or pilot-assisted oscillations (PIO/PAO).

WARNING

Delayed pilot response in eliminating these oscillations may result in helicopter damage and/or uncontrolled flight. If encountered, IMMEDIATELY REMOVING THE PILOT'S HAND FROM THE COLLECTIVE GRIP FOR SEVERAL SECONDS SHOULD ELIMINATE THE CONDITION. If the helicopter is in a hover and the oscillation persists, set the external load on the ground and release it. If transitioning to or from a hover, increasing airspeed may eliminate the bounce. During external cargo operations, if collective bounce is encountered and cannot be controlled, release the collective and jettison the load.

11.16 OPERATION IN SALT SPRAY ENVIRONMENT

If hovering is necessary in a salt spray environment, a significant engine performance degradation should be anticipated due to a salt deposit buildup in the engine compressor section. The best indication of this power loss is the relationship between T_5 and torque where increases in T_5 at a constant torque setting signify engine performance degradation. To minimize salt ingestion, utilize the highest hover altitude consistent with the mission and avoid abrupt control movements. In case of a significant increase in T_5, (40°C or approaching maximum T_5 limits, whichever comes first), subsequent engine operation in clean air at higher altitudes may dissipate some of the salt buildup. Flight through rain may also reduce salt buildup. After operating in a salt spray environment, make an applicable entry on the maintenance action forms (MAF), requiring a fresh water wash/gas path cleaner application in accordance with current instructions.

11.17 VIBRATION

The inherent vibration in any helicopter is created by the mechanical functions of the engines and transmission systems, aerodynamic and dynamic action of the main rotor and tail rotor blades, and aerodynamic impingement on the fuselage. The predominant vibration felt in the occupied areas of the helicopter is generally at N_p of the main rotor, where N equals the number of blades and $_p$ equals per revolution. This is for a helicopter which has been "tuned" to track and balance the rotors. Sometimes two or more frequencies are superimposed to create a third frequency called a beat. Generally, vibrations are divided into three categories: (1) low, (2) medium, and (3) high frequencies. Through experience the pilot can judge which vibrations are normal and react especially to vibration changes which indicate adjustments are required. It is most helpful to identify the frequency range of the vibration to expedite troubleshooting.

1. Low-frequency vibrations.

   a. One-per-revolution (2.98 cycles per second) at 100% N_r.

      A one-per-revolution vibration originates from the main rotor system and is caused by an imbalance or out-of-track condition. The rotor could be somewhat out-of-track without causing an objectionable one-per-revolution (1P) vibration.

      Note that the fuselage natural bending frequencies are close to the main rotor one-per-revolution vibration frequency. Transient short-term excitation of these frequencies may be confused with 1P. These vibrations can be induced by large amplitude (1-inch or greater) rapid control reversals or stirs (see 1.e.).

b. Ground roll.

This a one-per-revolution vibration felt about the roll axis. It occurs with the rotor turning at 100% N_r. If it is present at 100% N_r on the ground, but disappears when the helicopter is lifted into a hover, check the servicing of the main landing gear tires and struts, or main rotor balance.

c. Vertical bounce on the deck.

This vibration may appear to the pilot as a mild vertical oscillation at a one-per-revolution frequency, and occurs while stopped or taxiing at 100% N_r. It can easily be eliminated by a slight change in either the cyclic or collective position.

d. Tail shake.

Tail shake is a random oscillation of relatively small amplitude and is felt in the cockpit as lateral motion. It is most likely to occur at 100 to 140 KIAS level flight and at slightly lower speeds during descent. This vibration is caused by the empennage being placed in the turbulent airflow behind the main rotor head pylon. The frequency of occurrence is random and is slightly greater than once-per-revolution. This model helicopter is generally insensitive to tail shake.

e. Pilot Induced/Assisted Oscillations (PIO/PAO).

Oscillations caused by or sustained by pilot actuation of cyclic, collective, or rudder pedals can be eliminated by releasing the appropriate flight control for several seconds. If doubt exists which axis the oscillation is in, the pilot should release the controls. The trim system will then dampen the collective and cyclic, stopping the oscillation within several seconds. The fuselage bending mode is felt as a 3.25 Hz vertical oscillation or bounce. Fuselage to external load coupled bending is felt as a vertical oscillation of 2.5 to 4.0 Hz, dependent upon external load weight. These oscillations might be confused with 1P (See 1.a. under VIBRATION). These PIO and PAO vibrations are conditions in which the natural movement of the pilot's body, in reaction to aircraft oscillations, causes the flight controls to react dynamically in such a way as to amplify the motion.

WARNING

Delayed pilot response in eliminating these oscillations may result in helicopter damage and/or uncontrolled flight. If encountered, releasing the flight controls (HAND REMOVED FROM COLLECTIVE) for several seconds should eliminate the condition. During external cargo or AMCM operations, if PIO/PAO is encountered and cannot be controlled, immediately jettison the load or jettison/release the tow.

Dual collective, cyclic, and pedal desensitizers have been added to the AFCS to reduce the probability of encountering this phenomenon by decoupling the pilot from the airframe to varying degrees across the susceptible frequency band during rapid control reversals.

Any of the following conditions may indicate an inoperative desensitizer:

(1) DSEN fail-advisory light on the AFCS control panel is lit.

(2) AFCS is off.

(3) AFCS duplex failure.

(4) FAS shearpin is sheared (loss of longitudinal cyclic trim, but no visual indication).

WARNING

If a desensitizer failure occurs, and does not clear after a mode reset or recycling computer power, the following precautions must be observed:

1. Minimize hover time.
2. Avoid rapid control inputs.
3. Do not pick up an external load. If flying with an external load, continue to the destination and gently set the load down. Do not attempt to relift the load.
4. Do not commence AMCM operations. If engaged in AMCM operations initiate recovery procedures. If PIO/PAO is experienced, jettison/release AMCM gear and remove hands from controls.

2. Medium-frequency vibrations.

   a. Seven-per-revolution (20.9 cycles-per-seconds at 100% N_r).

      These vibrations are most perceptible at a forward CG loading, high speed, and during a steep approach. The manner in which a load is distributed within the cabin may also have an effect on the magnitude of the seven-per-revolution vibrations.

   b. Tail rotor one-per-revolution (11.7 cycles-per-second at 100% N_r).

      The frequency (11.7 cycles-per-second) of tail rotor one-per-revolution is about one-half of the seven-per-revolution of the main rotor. If this frequency roughness of the helicopter increases, check the tail rotor balance and track.

3. 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 needles will appear to be fuzzy. High-frequency vibrations will normally come from the engine, main gear box input section, or tail rotor drive system, and are often equally apparent in a ground run as in flight. The most important cues to high frequency vibration are the associated sounds.

a. Main gear box vibrations.

   The main gear box has many possible sources of high frequency vibrations, such as the various gear box mounted accessories, the accessory gear train, the APP drive shaft, and APP clutch, oil cooler blower, vent fan blower, input drive shafts from the engines, bevel gear, and freewheeling units. These vibrations are generally heard rather than felt in the airframe. Combinations of these vibrations, in extreme cases, could result in the pilot sensing low or medium beat frequency vibrations or modulation of sounds. 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 by instrumentation.

b. Engine vibrations.

   To the pilot, excess engine vibrations will greatly increase noise levels. A tingling or buzzing of the airframe near the engine mounts may be sensed in the cabin by the crewman and indicate engine or engine mount problems. If the noise level of one engine seems too high compared with the other engines at the same power condition, and if the excessive noise varies with N_g or N_f changes and is possibly accompanied by a tingling vibration in the engine speed lever, then there may be a bad engine bearing or rubbing compressor blades may be indicated. Listen carefully to the engine during normal shutdown and look for discoloration (hot spots).

WARNING

An engine that is suspected of excessive vibrations should be considered as sufficient cause for termination of routine flight operations.

11.18 NO. 2 ENGINE COMPARTMENT BACKFLOW

With the main rotor at 100% N_r, a negative pressure differential exists between the No. 2 engine cowling forward cooling scoops and the engine tail pipe. The negative pressure attempts to push the hot exhaust gases backwards into the aft engine compartment. During normal or unlocked engine starts, as well as forward flight with all three engine torques matched, the venturi effect created by the engine exhaust flow across the ejector gap creates a net positive pressure and positive airflow which ensures that hot exhaust gases are evacuated out of the engine compartment and through the tail pipe.

Operating the No. 2 engine at ground idle above 85 KIAS may result in a backflow of hot exhaust gas into the aft portion of the engine compartment area. During engine starts in any flight condition, some backflow will occur, however temperature levels quickly drop as the engine reaches ground idle speed, and drop further as the engine is accelerated to a matched torque condition. The most serious backflow condition occurs during a No. 2 engine stall at all ground and flight conditions. In the stalled condition, N_g may decay below ground idle levels and the T_5 will rapidly increase. The engine cannot develop sufficient positive pressure due to the low N_g speed. This allows the hot exhaust gas to backflow into the engine compartment. If this condition persists, thermal damage could occur, leading to a fire in the aft portion of the engine compartment area.

WARNING

An engine fire in the aft portion of the compartment may not be detected by the fire detecting system. In a backflow condition, the fire extinguishing agent may not reach the aft portion of the engine compartment to extinguish the fire.

CAUTION

No. 2 engine backflow is most prevalent under the following conditions:

1. No. 2 engine in a stalled condition.
2. No. 2 engine at ground idle at airspeeds greater than 85 KIAS.
3. Engine starts with the rotor at 100% N_r and port winds greater than 15 knots.

PART V

EMERGENCY PROCEDURES

Chapter 12 Emergency Procedures

CHAPTER 12
Emergency Procedures

12.1 MEMORY ITEMS

Checklist items indicated with an * shall be completed without reference to the checklist.

12.2 INTRODUCTION

The terms IMMEDIATELY, POSSIBLE, and PRACTICAL, as used in this manual, refer to the degree of urgency with which a landing must be made.

1. Land Immediately — Self-explanatory.

2. Land as Soon as possible — Means land at the first site at which a safe landing can be made.

3. Land as Soon as Practical — Means extended flight is not recommended. The landing site and duration of flight is at the discretion of the pilot-in-command.

Any helicopter experiencing trouble in flight shall immediately notify the flight leader by radio or by visual signals, as the situation dictates. If the nature of the emergency warrants an immediate return to base, a radio call shall be made to enable the base to prepare for an emergency landing. In any case, the following information shall be transmitted:

*1. Side number of the helicopter.

*2. Position.

*3. Difficulty.

*4. Intentions.

*5. Fuel state.

If the helicopter with the emergency does not have radio communications, all possible information is relayed visually to the wingman who makes the necessary radio transmission.

Weight Reduction — Any emergency situation discussed in this section assumes that jettisoning of external cargo is an acceptable step in any procedures.

Note

The term PICKLE means: Jettison external loads, AMCM equipment, or fuel, as applicable.

12.3 PRECAUTIONARY LANDINGS

A precautionary landing is described as a landing when further flight is possible but inadvisable. Such landings will be governed by the following:

*1. When an indication is received by the warning lights or instruments that continued flight would jeopardize the safety of the helicopter or crew.

*2. When control function is questionable or instruments fail that are essential for continued flight.

*3. Any condition of uncertainty or distress.

Further flight will not be attempted until the trouble has been determined and/or corrected, as appropriate. It must be emphasized that most precautionary landing instance require an inspection by qualified maintenance personnel before further flight is attempted.

12.3.1 Emergency Shutdown. If conditions exist where the aircraft must be secured due to emergency, proceed as follows:

*1. High pressure rotor brake switch EMERGENCY.

*2. All engine speed control levers — SHUTOFF.

*3. APP — AS REQUIRED.

*4. Fuel selection levers — SHUTOFF.

12.4 SINGLE- OR DUAL-ENGINE FAILURE

WARNING

- Pilot response to single- or dual-engine failure is dictated by gross weight, ambient conditions, relative wind, and height above the surface. These factors will determine whether an immediate landing or a flyaway recovery should be attempted. Based on the pilot's knowledge of aircraft single- or dual-engine power available and power required, the pilot should decide which procedure he intends to follow before the emergency occurs. Indecision following the single- or dual-engine failure may prevent the success of either procedure.

- If the altitude hold feature of AFCS is engaged, it will increase collective pitch in an attempt to hold altitude. The collective must be positively controlled by the pilot to prevent excessive loss of rotor speed.

- Refer to Height-Velocity Diagram, Dual-Engine Failure and Height-Velocity Diagram, Single-Engine Failure in Section XI.

CAUTION

- Refer to the 419 Engine Contingency Power (2 Minute Limit) chart, the Ability to Maintain Level Flight charts and the Torque Required for Towing charts in Section XI during flight planning to determine engine-out contingency capabilities.

- Nose-high attitudes shall be avoided near the surface or the tail rotor blades may strike the ground or water. Tail rotor contact may occur with nose attitude above 5° when on the water. The altitude, airspeed, and gross weight at which a single- or dual-engine failure occurs will dictate the action to be followed to effect a safe landing. Refer to the height-velocity diagram-one- or two-engine failure. During mission planning, the engine torque available can be determined from the maximum and military power-available charts. The minimum and maximum indicated airspeed at which level flight can be maintained is determined from the Ability to Maintain Level Flight Chart. The maximum gross weight at which a hover or level flight can be maintained decreases as density altitude increases. Therefore, mission planning should include a thorough analysis of the performance data in Part XI.

Note

- If altitude cannot be maintained or a safe single- or dual-engine landing is not feasible, decrease gross weight by jettisoning external cargo, dumping fuel, or releasing towed vehicle, if required. Stop jettisoning before landing.

- Careful monitoring of main fuel tank quantities is required on flights where fuel transfer from range extension fuel tanks is being conducted, and fuel is not being depleted from all main tanks. Main fuel tank expansion volume can diminish and ultimately result in overboard vent spillage, due to constant flow of fuel through helicopter fuel system precheck lines.

- A roll on landing will normally decrease power required. Minimize drift and yaw on landing.

- Determine which engine has failed by reference to engine torquemeters, T_5 indicators, N_f or N_g tachometers, and proceed as instructed in ENGINE SHUTDOWN IN FLIGHT in this section. If a restart is advisable, refer to ENGINE RESTART DURING FIGHT in this section.

- On aircraft equipped with the 419 engine, the fuel control will automatically increase N_g, T_5, and torque into the contingency range if a rotor droop is encountered. Rapid or large collective movements may cause transient excursions into contingency power, even if remaining dual- or single-engine power is sufficient for level flight.

- The ENGINE OVERTORQUE caution light will go on and the overtorque aural tone will activate any time the output of one or more engines exceeds 137% torque. Additionally, the ENGINE OVERTORQUE caution light will remain on anytime the output of one or more engines exceeds 156% torque.

*1. Collective — MAINTAIN N_r AT OR ABOVE 90%.

WARNING

Premature collective reduction may set up an excessive descent rate that the remaining power available cannot arrest, depending on ambient conditions, relative winds, and gross weight. Maintain collective position while remaining engine(s) accelerate to pick up the load. Allow N_r to droop to ≥90% N_r if necessary before reducing collective position.

*2. Airspeed — AS REQUIRED FOR SINGLE/DUAL ENGINE CAPABILITY.

*3. Pickle — AS DESIRED.

*4. Speed control levers — AS REQUIRED (SHUT OFF AFFECTED ENGINE, CONDITIONS PERMITTING).

5. Land as soon as practical.

12.4.1 Single- or Dual-Engine Landing. Safe emergency single- or dual-engine landings (Figure 12-1) can be made provided they are initiated within reasonable airspeed and altitude combinations. Refer to the Ability to Maintain Level Flight chart in Part XI. When possible, a landing site should be selected that provides a smooth hard surface, and be approached at a safe single- or dual-engine airspeed.

1. Prelanding and landing checklist — COMPLETED.

2. Arrive at 90° position at about 350 feet, 60 to 80 KIAS, with maximum N_r.

3. At about 1000 feet straightaway into the wind, continue descent so as to arrive at 150 to 200 feet with 40 to 60 KIAS.

4. At 150 to 200 feet, initiate a nose-up flare. Maintain flare until about 30 feet is noted on radar altimeter. Apply collective to avoid a high rate-of-descent.

Note

Single- or dual-engine landings to confined areas or unprepared terrain may require a slight modification of final approach flare and airspeed to clear obstacles and/or lessen ground roll at touchdown.

5. At 30 feet, reduce nose attitude to a maximum of 8° nose-up and increase collective to cushion landing.

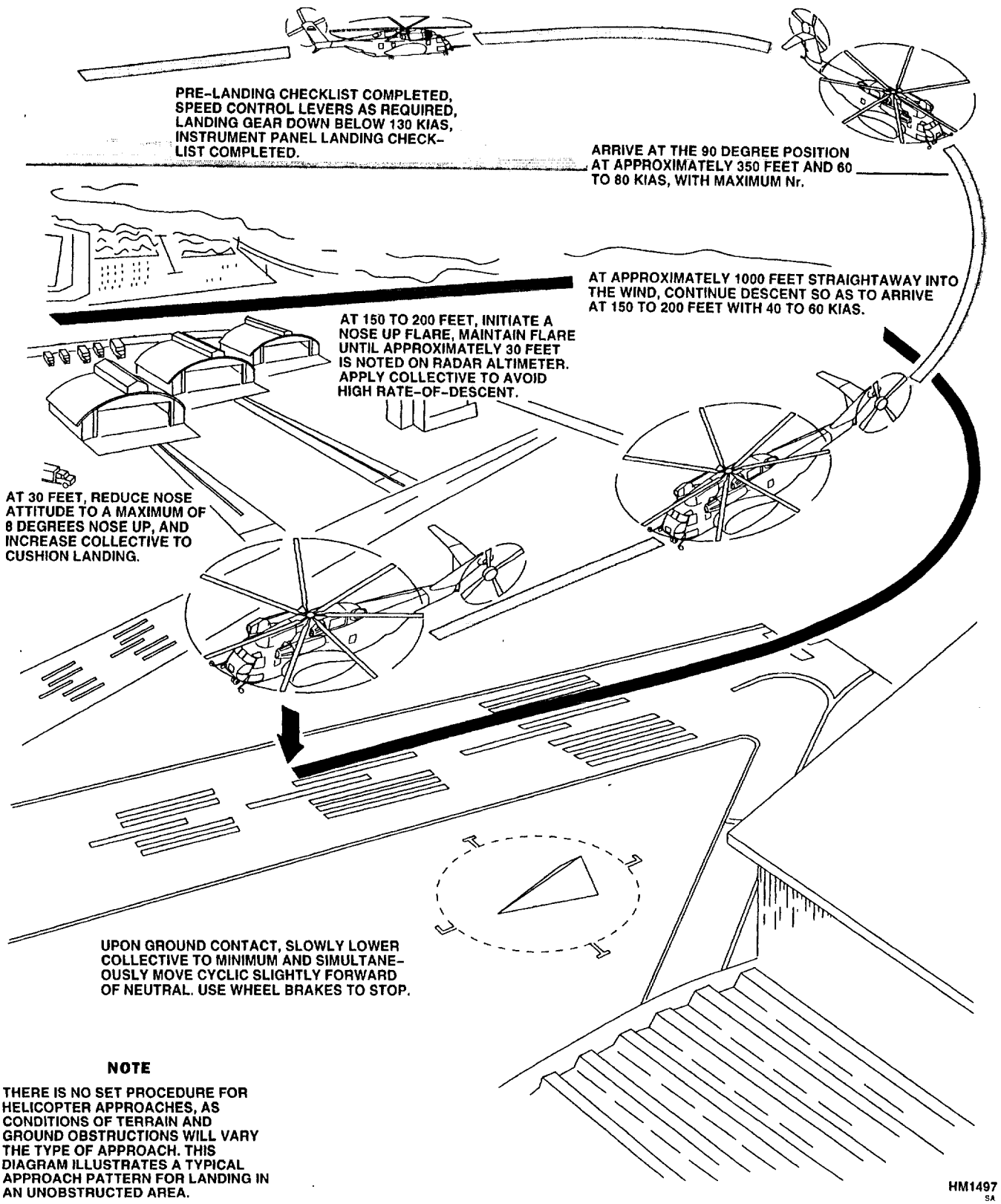
6. Upon ground contact, slowly lower collective pitch lever to minimum and simultaneously move cyclic slightly forward of neutral position.

7. Apply wheel brakes to minimize ground roll.

12.4.2 Single- or Dual-Engine Wave-Off. Any time the pilot feels that an approach is not within the desired parameters, a wave-off shall be executed. If the helicopter is in a nose high attitude and low airspeed, level the nose and use just enough collective to stop the rate of descent. As this is completed, best forward single- or dual-engine airspeed should be regained. Before beginning any approach, whether to a confined area or to a designated landing pad, a determination must be made as to the best route of exit, if a wave-off must be made.

12.4.3 Single- or Dual-Engine Takeoff. Emergency single- or dual-engine takeoffs are allowed. However, in all cases, the takeoff gross weight shall be reduced to be sure of single- or dual-engine hover capability is appropriate. Takeoff without single- or dual-engine hover capability is not recommended.

The gross weight, density altitude, and wind conditions are the factors to be considered when determining whether a safe single- or dual-engine takeoff can be accomplished and safe single- or dual-engine airspeed can be maintained. Refer to the Climb-Single- and Dual-Engine charts and the Ability to Maintain Flight - Single- and Dual-Engine charts in Part XI. A single- or dual-engine takeoff is made in the same manner as a three-engine takeoff, except the engine speed control lever(s) is advanced full forward and retained until a safe single- or dual-engine airspeed is reached. Power is then adjusted to stay within safe single- or dual-engine airspeed envelope.



NOTE

THERE IS NO SET PROCEDURE FOR HELICOPTER APPROACHES, AS CONDITIONS OF TERRAIN AND GROUND OBSTRUCTIONS WILL VARY THE TYPE OF APPROACH. THIS DIAGRAM ILLUSTRATES A TYPICAL APPROACH PATTERN FOR LANDING IN AN UNOBSTRUCTED AREA.

Figure 12-1. Single- or Dual-Engine Landing (Typical)

12.4.4 Single- or Dual-engine Failure During AMCM Operations. Recovery from a single- or dual-engine failure during AMCM operations may be possible under certain conditions of ambient temperature, relative wind, and gross weight, by establishing a lower hover or executing a fly away. If a water landing is inevitable, retain the tow and enter at the lowest groundspeed and rate of descent possible. The pilot should be cognizant of these conditions as well as power available required for single- or dual-engine flight.

WARNING

Preflight criteria for dual engine hover in ground effect (HIGE) capability should have been established based on mission, ambient conditions, gross weight, etc. Consideration should be given to immediately establishing a low HIGE or immediately releasing the tow and executing a fly away.

*1. Collective — MAINTAIN N_r AT OR ABOVE 90%/DISENGAGE RADAR ALTITUDE HOLD.

WARNING

Premature collective reduction may set up an excessive descent rate that the remaining power available cannot arrest, depending on ambient conditions, relative winds, and gross weight. Maintain collective position while remaining engine(s) accelerate to pick up the load. Allow N_r to droop to ≤90% N_r if necessary before reducing collective position.

*2. Tension — REDUCE TO MINIMIZE GROUNDSPEED.

*3. Speed control lever(s) — AS DESIRED.

4. Cyclic — ESTABLISH WATER ENTRY ATTITUDE (0° to 5° NOSE UP).

5. Collective — INCREASE AS NECESSARY TO CUSHION LANDING OR MAINTAIN LOW HOVER.

WARNING

Nose up attitude greater than 5° may allow tail rotor to contact water prior to water entry. Premature releasing of the tow may result in the helicopter contacting the water at a speed in excess of the safe water landing speed.

6. Tow — RELEASE.

Note

Tow hook release operation requires a minimum of 150 pounds tension. The electrical tow hook release actuation, once activated will release the tow in 0.6 seconds.

7. If streaming or recovering gear:

   a. Crewman installs guillotines, stands clear, reports guillotine installed.

   b. Arming switches — ARMED.

   c. Cable shear switch — ACTUATE.

8. Crewmen report — GEAR AWAY, CLEAR OF HELICOPTER.

9. Continue with SINGLE-ENGINE RESTART, SINGLE- OR DUAL-ENGINE WATER TAKEOFF, or WATER TAXIING procedures in this section, as appropriate.

Crewman:

1. Raise ramp and clear aft area.

2. If streaming and recovering gear:

   a. Install guillotine on pilot command and stand clear; report — GUILLOTINES INSTALLED AND READY FOR FIRING.

b. Report — GEAR AWAY, CLEAR OF HELICOPTER.

12.4.5 Single- or Dual-Engine Fly Away

WARNING

- Preflight criteria for dual engine hover in ground effect (HIGE) capability should have been established based on mission, ambient conditions, gross weight, etc. Consideration should be given to immediately establishing a low HIGE or immediately releasing the tow and executing a fly away.
- Engine power degradation due to salt spray ingestion will significantly reduce power available and must be considered prior to attempting a fly away.

*1. Collective — MAINTAIN N_r AT OR ABOVE 90%/DISENGAGE RADAR ALTITUDE HOLD.

WARNING

Premature collective reduction may set up an excessive descent rate that the remaining power available cannot arrest, depending on ambient conditions, relative winds, and gross weight. Maintain collective position while remaining engine(s) accelerate to pick up the load. Allow N_r to droop to ≥90% N_r if necessary before reducing collective position.

*2. Tow — RELEASE.

CAUTION

The TOW HOOK OPEN light does not provide positive indication that the tow hook is open. The light indicates that the tow hook is not fully closed and locked. Positive confirmation of tow release must be made prior to attempting to fly away from an engine failure.

Note

Tow hook release operation requires a minimum of 150 pounds tension. The electrical tow hook release actuation, once activated, will release the tow in 0.6 seconds.

*3. Airspeed — INCREASE. ESTABLISH APPROXIMATELY 10° NOSE DOWN TO ACCELERATE AS HELICOPTER SETTLES TOWARD WATER.

*4. Speed control lever — AS DESIRED.

*5. Airspeed — WHEN IN TRANSLATIONAL LIFT AND GROUND EFFECT, ACCELERATE TO BEST SINGLE/DUAL ENGINE AIRSPEED, CLIMB USING CYCLIC AND AIRSPEED.

6. Altitude — WHEN ALTITUDE PERMITS, (100 to 150 FEET AGL), ADJUST COLLECTIVE TO OBTAIN 95% to 100% N_r.

Continue with applicable procedures under single- or dual-engine failure during flight in this section.

12.5 THREE-ENGINE FAILURE

Should all engines fail, a safe autorotative landing probably can be made except when flying at low altitude-airspeed combinations. Refer to Height-Velocity Diagram - Three-Engine Failure chart in Part XI. The altitude-airspeed combination for a safe autorotative landing is dependent upon many variables such as density altitude, gross weight, proximity of a suitable landing area, and wind direction and velocity. Main rotor rpm will decay as soon as all engines fail, and the helicopter will yaw and roll to the left due to a loss in power and corresponding reduction in torque. Heading can be maintained by pressing the right rudder pedal to decrease the tail rotor thrust. Except when all engines fail in close proximity to the ground, it is mandatory that autorotation be established by immediately lowering the collective pitch to minimum. If collective pitch is not reduced enough to effect a safe recover, control will be lost due to a decay in N_r.

WARNING

After three-engine failure, corrective action has to be completed immediately or control will be lost due to N_r decay. Although the corrective action has to be done quickly, it must also be done smoothly to avoid rotor blade to fuselage contact.

Note

- Flare effectiveness at airspeeds for minimum rate-of-descent will be marginal in arresting rate-of-descent.
- Maximum glide distance airspeed provides improved flare effectiveness.

12.5.1 Autorotative Landing. Autorotative RPM will vary with different ambient temperature, airspeed, pressure altitude, G-load factors, and gross weights. Optimum rotor speed (N_r), in the descent, is 100% to 103%. For autorotative descent, select an autorotative glide airspeed as required. See Figures 12-2 and 12-3. Perform landing checklist, with landing gear as desired (gear up for water landings). The recommended entry airspeed for the cyclic flare should be no less than the minimum rate-of-descent airspeed as determined by Figure 12-3. At or above 150 ft AGL, or as determined by Figure 25-1, initiate a smooth progressive flare by adjusting nose-up pitch attitude as necessary to reduce ground speed and rate-of-descent. At an altitude of approximately 50 to 75 feet AGL, lower the nose to the landing attitude (8° nose-up maximum) and raise the collective to cushion the landing.

WARNING

- Allowing airspeed to decrease below 40 KIAS will cause a rapid increase in rate-of-descent.
- N_r will decay rapidly when collective is applied to recover. Allowing N_r to decay prematurely may result in insufficient lift for recovery.

12.5.1.1 Autorotation Charts. The autorotation charts (Figure 12-3) are derived from the nominal flight conditions of standard day at both sea level and 5000 ft. They provide optimum airspeed for either maximum glide distance (glide ratio) or minimum rate-of-descent regarding differences in gross weight. The glide ratio section shows the distance traveled in nautical miles per 1000 ft of altitude loss under zero wind conditions. The rate-of-descent section shows the vertical descent rate in hundreds of feet per minute. Optimum values for each section are depicted by dashed lines. Maximum glide distance or minimum rate-of-descent is achieved by adjusting the cyclic and collective to control and maintain 103% N_r at the airspeed shown where these dashed lines intersect an appropriate gross weight arc.

For example, to determine maximum glide distance (glide ratio), choose an appropriate gross weight arc on the right side of the upper section (50,000 lbs). Follow this contour to where the dashed line intersects. From this point, drop straight down to read the airspeed required for maximum glide distance (100 KIAS). From the same point of intersection, trace left to read a maximum glide ratio of 0.48 nm per 1000 ft altitude loss. The rate-of-descent for these conditions can be determined by tracing left from the point of intersection of the previously defined airspeed line and an appropriate gross weight arc in the lower section (3600 ft per minute).

Airspeed for minimum rate-of-descent can be determined in a similar manner with resultant glide ratio information.

12.5.2 Three-Engine Failure While Hovering at Low Altitude (0 to 50 Feet). If all engines should fail while hovering at low altitude, settling will be rapid, and immediate application of right rudder pedal will be necessary to maintain heading. The landing can be cushioned by increasing collective pitch as the helicopter settles to the ground. Do not reduce collective pitch, as a reduction in pitch will cause the helicopter to settle more rapidly. The helicopter should be held in a hover attitude until contact is made with ground, where the cyclic should be moved to the neutral position and the collective pitch lever slowly lowered to minimum. After contact with the ground is made, apply wheel brakes, start the APP, and apply the rotor brake.

12.5.3 Three-Engine Failure (Hover and Takeoff)

*1. Collective — REDUCE (IF ALTITUDE PERMITS, TO MAINTAIN N_r).

*2. Airspeed — AS REQUIRED.

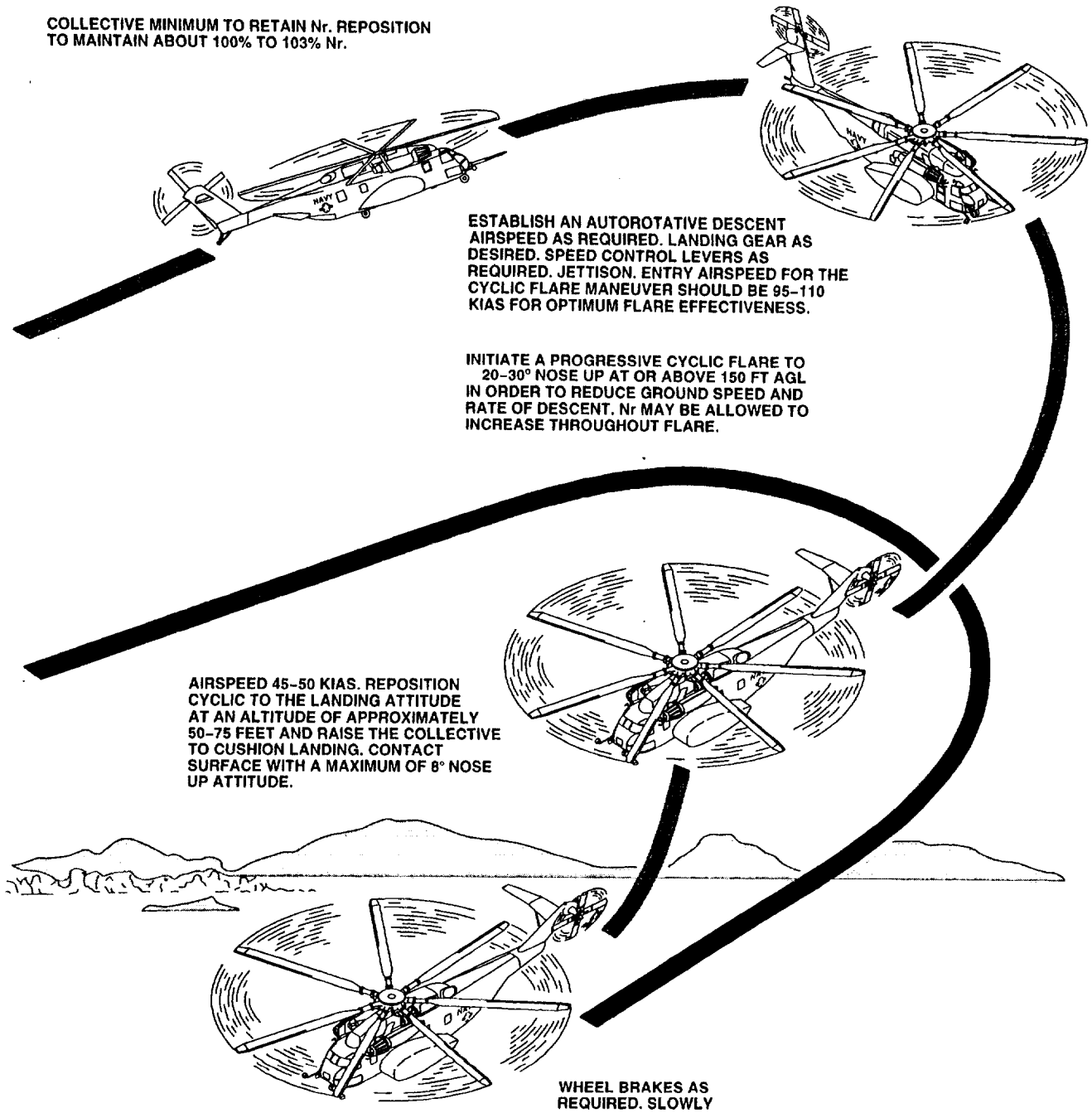


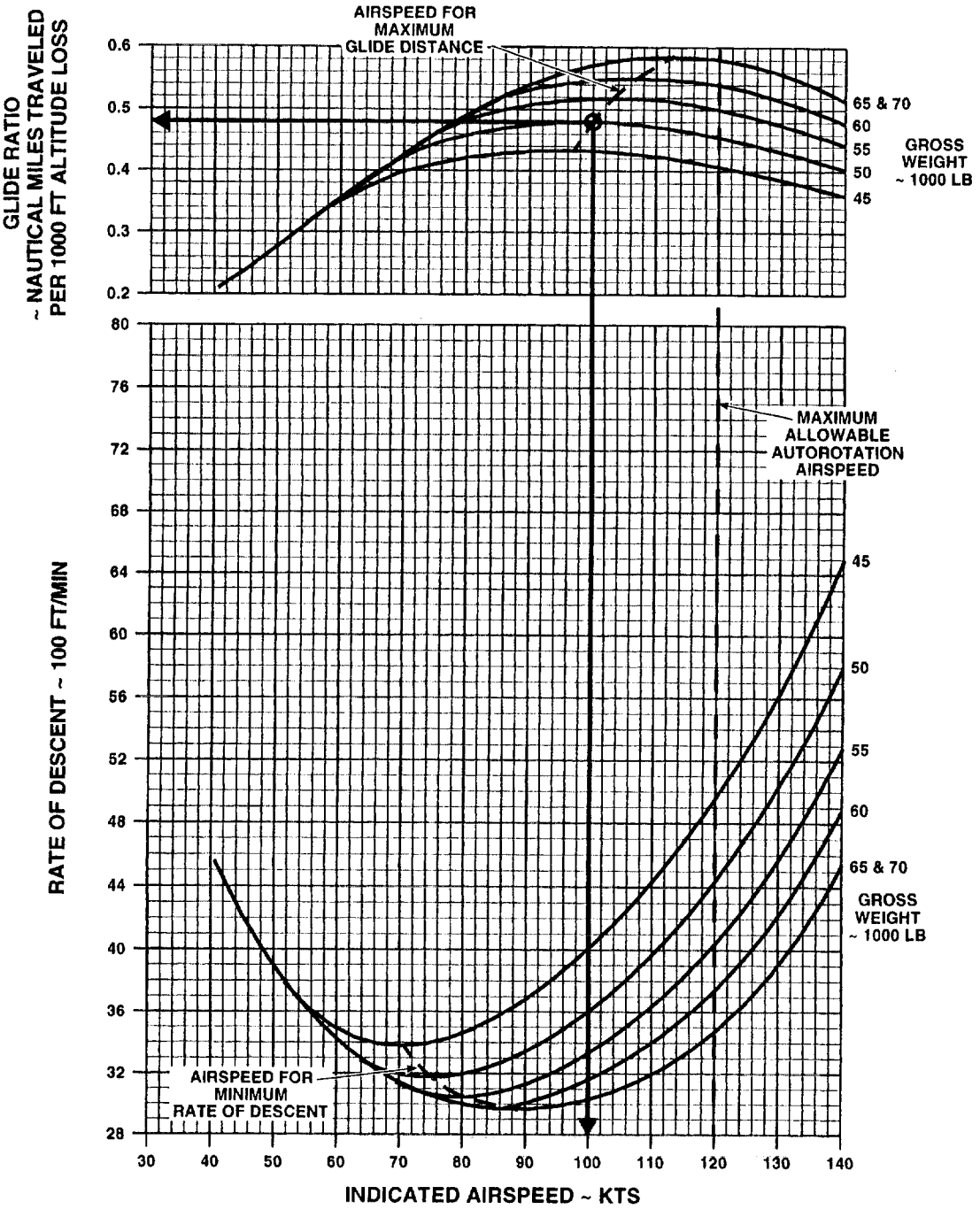
Figure 12-2. Autorotative Landing (Typical)

AUTOROTATION

103% Nr SEA LEVEL STD DAY

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST

NOTE: REDUCE RATE OF DESCENT BY 250 FT/MIN AND INCREASE GLIDE RATIO BY 0.035 NM/1000 FT WHEN OPERATING AT 100% NR



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SAF

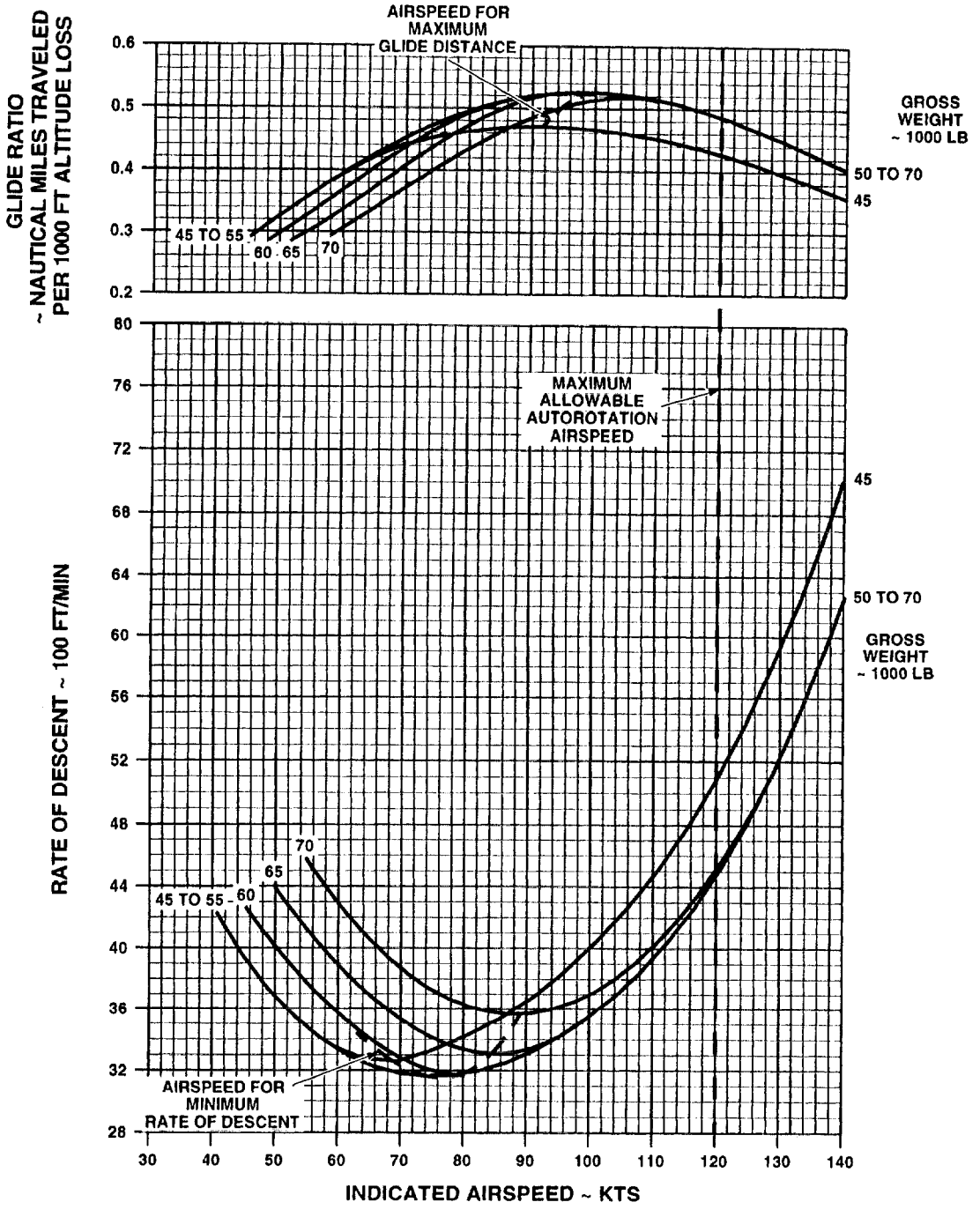
Figure 12-3. Autorotation Chart (Sheet 1 of 2)

AUTOROTATION

103% Nr 5000 FT STD TEMP

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST

NOTE: REDUCE RATE OF DESCENT BY 400 FT/MIN AND INCREASE GLIDE RATIO BY 0.04 NM/1000 FT WHEN OPERATING AT 100% NR



HM6110_2A
SAF

Figure 12-3. Autorotation Chart (Sheet 2 of 2)

*3. Pickle — AS DESIRED.

*4. Speed control lever — AS REQUIRED.

*5. Collective — INCREASE (CUSHION LANDING).

12.5.4 Three-Engine Failure (Cruise)

*1. Collective — REDUCE (TO MAINTAIN N_r AT 100% to 103%).

*2. Airspeed — AS REQUIRED (MAXIMUM GLIDE DISTANCE AIRSPEED PROVIDES IMPROVED FLARE EFFECTIVENESS).

*3. Pickle — AS DESIRED.

*4. Speed control levers — AS REQUIRED.

*5. Execute autorotative landing (Figure 12-2).

12.5.5 Three-Engine Failure at High Power and Low Speed. Reduce collective pitch to minimum and simultaneously apply forward cyclic to regain airspeed to establish a glide at a minimum airspeed of 80 KIAS. This action normally requires several hundred feet of altitude if the recovery is initiated at zero airspeed. Land as outlined in Three-Engine Failure (Autorotative Landing), in this section.

12.5.6 Three-Engine Failure at High Power and High Speed. If a constant airspeed is maintained while normal recovery procedures are being used, a loss of several hundred feet of altitude will be realized. This altitude loss may be reduced by applying aft cyclic and adjusting collective pitch as necessary to maintain sufficient N_r. The rate that aft cyclic is applied and the duration of the corresponding nose-high attitude determines the rate of deceleration and/or loss of altitude. Judicious use of collective pitch during the flare to keep N_r from building up also reduces the rate-of-descent. Land as outlined in Three-Engine Failure (Autorotative Landing), in this chapter.

12.5.7 Three-Engine Failure at High Speed and Low Altitude. If three-engine failure is encountered at high speed and low altitude, immediately but smoothly apply aft cyclic to hold the helicopter off the surface and adjust collective pitch to maintain N_r. Land as outlined in Three-Engine Failure (Hover/Take-off), in this chapter.

12.6 WATER OPERATIONS

The helicopter is configured with watertight hull and sponsons to permit emergency water landings with the ability to stay afloat for about 2 hours in 1- to 3-foot waves with a wind of 7 to 16 knots. If the helicopter becomes capable of further flight, a normal water takeoff may be made. If a takeoff is prevented due to excessive gross weights, but allowable at lower gross weights, consideration should be given to lightening the helicopter by removing cargo and nonessential equipment. If the helicopter cannot be flown from the water, it may be possible to taxi to a shoreline or salvage area. When operating on or near the surface of saltwater, the turbine compressor blades will acquire salt encrustation, which could eventually cause compressor stall. The rate of salt water ingestion increases with power; therefore, hovering close to the water or operations with increased collective while on the surface should be held to an absolute minimum. The stability of the helicopter on the water must be maintained by the pilot at all times when the engines and rotors are operating. Increased collective will have a leveling effect on choppy seas, and will reduce the rate of water inflow, but will also increase the spray effect, which will correspondingly increase the amount of salt ingested into the engines. A static helicopter can right itself from a roll of 10°, but high wave and wind conditions could cause excessive rolling and subsequent capsizing. Care must be taken not to increase lateral unbalance, since this will reduce the stability of a static helicopter on the water. In higher sea states, the helicopter will ride more comfortably with the bow angled about 30° to the existing sea. It is desirable to keep the rotor system operating unless it is determined that the helicopter is to be abandoned. If the decision is made to abandon the helicopter, the APP should be continued in operation until after the engines are shut down and the rotors have stopped. As rotor brake application will cause the helicopter to turn in the water, it is desirable to let the rotors coast down, unless rotor decay without brake application would be more hazardous. If time permits, secure all power and shut off all fuel before abandoning the helicopter (Figure 12-13). As collective is reduced and as N_r slows during shutdown, the rate of inflow water into the cabin area will greatly increase, limiting time available for safe egress from the helicopter.

12.6.1 Aircrew Prewater Landing Checklist. Crew will do this when advised a water landing is imminent:

1. Cabin occupants — NOTIFIED AND SEAT BELTS FASTENED.

2. Cargo — JETTISON OR SECURE AS REQUIRED.

3. Watertight integrity — CHECK.

All doors, hatches, and ramp closed and secure.

4. Emergency equipment — READIED.

5. Seat belt fastened.

6. Notify pilot that cabin occupants are prepared for water landing.

12.6.2 Three-Engine Water Landing

CAUTION

Nose-up attitudes greater than 5° may cause the tail rotor blades to strike the water.

A water landing with all engines operating should be approached in the same manner as a vertical landing ashore, except the landing gear should be retracted. If the landing gear cannot be retracted, care must be taken to minimize the forward contact speed. Care should be taken to establish a hover before descent with all sideward and rearward motion stopped. Any visual reference to objects in the water will aid in maintaining position during the descent. As the helicopter comes to rest on the water, the collective should be lowered smoothly while simultaneously moving the cyclic to the neutral position. At this point, the forward inclination of the rotor mast will cause the helicopter to have a tendency to move forward in the water.

12.6.3 Single-or Dual-Engine Water Landing. A single- or dual-engine landing on the water differs only slightly from that on a hard surface. However, it is necessary that touchdown speed be somewhat slower, especially over rough water, and that the rate-of-descent be held to a minimum. When possible, the pilot should pick out an object such as a buoy, boat, or shoreline in the path of the intended landing, to provide a ready reference. The use of instruments, especially the radar altimeter, and visual reference to rotor downwash will assist the pilot in maintaining a reference.

1. Crew — ALERTED.

2. Landing checklist — GEAR UP.

3. Cyclic — MODERATE FLARE AT 150 TO 200 FEET.

4. Collective — INCREASE TO CONTROL RATE-OF-DESCENT.

5. At 30 feet, assume landing attitude and smoothly apply maximum collective to cushion landing.

6. Contact water as slowly as possible.

CAUTION

Nose-up attitudes greater than 5° may cause the tail rotor blades to strike the water.

12.6.4 Water Autorotative Landings. Autorotative landings on water differ from land, in that touchdown speed must be held to a minimum. The helicopter should enter the water with a near vertical descent if possible. Refer to Three-Engine Failure (Autorotative Landing), in this section.

1. Autorotate as described under Three-Engine Failure.

2. Enter water tail rotor first.

3. Maintain fuselage attitude with cyclic until rotors contact water.

12.6.5 Water Taxi

CAUTION

- Extreme caution must be taken when taxiing downwind in winds of over 25 knots.
- For maximum watertight integrity, all doors, hatches, and the cargo ramp must be closed during all water operations.

Water taxiing procedures are basically the same as those outlined for taxi operations ashore. Forward speed is attained by applying slight forward cyclic while simultaneously slightly increasing collective. Additional forward speed may be obtained by increasing either cyclic or collective; however, increased collective will increase the amount of salt ingested by the engines. The helicopter can be taxied in calm water at a speed of about 8 knots. In higher sea states it may be necessary to reduce taxi speeds and maintain some increased collective, to mini-

mize the wave impact. The wave impact may be further minimized by taxiing from 30° - 90° to the waves. The helicopter should be kept level at all times, and turns should be made by moving the cyclic in the direction of the turn and simultaneously using the rudder pedals. If excessive taxi speeds or wave action should cause the helicopter to tuck, the collective should be immediately lowered to minimum and forward movement stopped. Sideward and rearward taxiing may be done with cyclic and collective, but are not recommended.

12.6.6 Three-Engine Water Takeoff

WARNING

If damage to the tail rotor is suspected, do not take off. Tail rotor damage may be accompanied by heavy medium-frequency vibrations. See VIBRATIONS in Part IV. Rapidly increasing severity of vibrations may indicate impending tail rotor failure. Consideration should be given to shutting down rotor system.

The procedures for a three-engine takeoff from water is the same as those outlined for a normal three-engine takeoff from land. However, excessive spray will be encountered as the collective is increased, and use of the windshield wiper system is recommended. The helicopter should be lifted vertically until clear of the surface before transitioning into forward flight. Premature application of forward cyclic as the collective is being increased may result in a severe tuck if the helicopter is not clear of the water surface. Standard climbout procedures should be used, to attain a safe single-engine operating speed as soon as possible.

12.6.7 Single- or Dual-Engine Water Takeoff. A single- or dual-engine water takeoff may be made if conditions permit a near vertical lift-off. Normally, all takeoffs will be made into the wind, but high sea states may make it desirable to take off slightly off the windline, in order to lessen wave impact. Takeoffs will become increasingly difficult with calm winds and higher gross weights. Consideration should be given to reducing helicopter gross weight by dumping fuel and jettisoning equipment and internal cargo. The speed control lever(s) should be advanced full forward. This power should be maintained as forward speed is increased. Forward speed should not exceed the maximum taxi speed of about 8 knots. Consideration must also be given to the possibility of power loss as a result of salt ingestion. Once clear of the surface, the helicopter should be accelerated forward to gain airspeed, before establishing a safe climb airspeed and altitude.

WARNING

When increasing collective to lift off the water surface, any flooding water which may be onboard will flow out of the helicopter, possibly affecting CG and stability.

12.7 ENGINE SHUTDOWN IN FLIGHT

*1. Speed control lever — SHUT OFF.

WARNING

If an operating engine and a failed or secured engine have the same tank selected, the operating engine may flame out, if the failed or secured engine's fuel selector lever was not placed to SHUT OFF.

*2. Fuel selector lever — SHUT OFF.

CAUTION

If an engine postshutdown fire should occur as indicated by a continuous T_5 above 320°C, motor engine with starter, to extinguish fire.

3. Adjust power on operating engines.

4. EAPS door — CLOSED

WARNING

If the No. 2 engine is shut down and/or subsequently restarted, reduce airspeed to less than 85 KIAS during the shutdown and start sequence to reduce the possibility of a fire hazard caused by hot exhaust gas backflow into the aft engine compartment.

12.8 ENGINE RESTART DURING FLIGHT

WARNING

No. 2 engine in-flight restart should be determined by critical power requirements. If the No. 2 engine is restarted, reduce airspeed to less than 85 KIAS during the start sequence to reduce the possibility of a fire hazard caused by hot exhaust gas backflow into the aft engine compartment.

CAUTION

A failed engine should not be restarted in flight unless it can be determined that it is reasonably safe to do so. Before restarting engine in flight, allow 30 seconds of gas generator windmilling with engine speed control lever at SHUT OFF, to purge engine of fumes and fuel.

Note

With AFC 483, a #2 ENGINE OVERHEAT caution light lets the pilots know when the No. 2 engine compartment temperature is above critical limits.

1. Emergency start switch — EMER.
2. EAPS — CLOSED.
3. Engine speed control lever — SHUT OFF.
4. Fuel selector lever — AS REQUIRED.

CAUTION

Due to probability of damaging the starting system, if time permits, the gas generator speed should be zero before engaging the starter.

5. Starter button — PRESS.
6. Speed control lever — GRD IDLE AT 20% N_g.
7. Engine instruments — CHECKED.

While engine is accelerating, check N_g tachometer, T_5 indicator, and engine fuel flow, as during normal start.

8. Speed control lever — 100% N_f.

Match engine torques.

9. EAPS — AS REQUIRED.

12.9 POWER FAILURE

(Figures 12-4 through 12-10).

Note

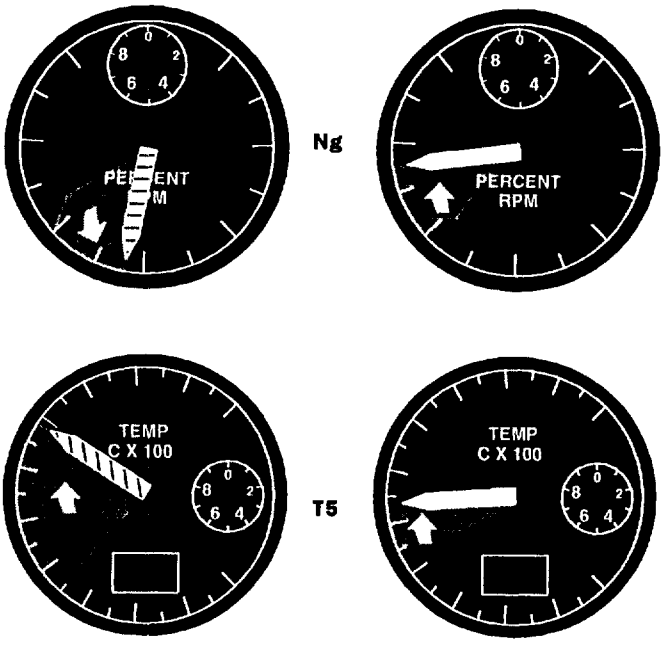
- The shaded indicators on the gages for Figures 12-4 through 12-10 show the indicators for the affected engine. The indicators that are not shaded show the indicators for normal engines.
- In case of single-, dual-, or three-engine failure, consider starting the APP so that electrical power will be available to the AFCS, rotor brake, fire extinguisher, and lighting systems, if N_r should be dropped below 91% to 96% on touchdown.

The altitude and airspeed at which engine failure occurs will dictate the action to be taken for a safe landing. It should be noted that the engine instruments often provide indications of fuel control system failure before actual engine failure. Air starts can often be made, but should not be attempted if there is evidence of mechanical failure within the engine.

COMPRESSOR STALL	
SYMPTOMS	**CORRECTIVE ACTION**
See Gages Affected engine(s): T_5 increase — all other parameters decrease. If affected engine is producing any usable torque, its N_f will remain matched with the normal N_fN_r. If torque drops to zero, N_f will likely split off and decay. Normal Engine(s): All engine parameters increase except for N_fN_r. If the normal engines' power available is not sufficient for the affected engine's power loss, (i.e., the total torque requirement cannot be met), N_fN_r may droop/decay excessively depending on the degree of power deficit. Also, if the normal engines have sufficient power available to compensate for the affected engine's power loss, (i.e., the total torque requirement can be met), it is normal for N_fN_r to droop about 1% to 2% as the normal engines are forced to assume the additional load. **NOTE** Compressor stall is normally accompanied by unusual engine sounds/slight yaw kick. Illumination of ENGINE FUEL BOOST and FUEL FILTER caution lights is possible due to decay of N_g.	*1. Collective — MAINTAIN N_r AT OR ABOVE 90%. *2. Airspeed — AS REQUIRED FOR SINGLE/DUAL ENGINE CAPABILITY. *3. Pickle — AS DESIRED. *4. Speed control levers — AS REQUIRED (IF COMPRESSOR STALL OF NO. 2 ENG IS INDICATED, SECURE SCL AS SOON AS POSSIBLE AND CONTINUE WITH ENG SHUTDOWN IN-FLIGHT PROCEDURES. IF NO. 1 OR NO. 3 ENG, AFFECTED SCL BELOW MIN GOV). *5. If T_5 continues to rise, position speed control of affected engine to SHUT off, secure engine as instructed under ENGINE SHUT DOWN IN FLIGHT in this chapter. **WARNING** With a compressor stall in the No. 2 engine, any delay in shutdown of the engine can result in hot exhaust gas backflow into the engine compartment, creating a fire hazard. If a No. 2 engine stall is suspected, reduce airspeed to less than 85 KIAS to reduce backflow and shut down the engine. *6. If T_5 decreases and stall clears, slowly advance speed control lever to reestablish matched torques. *7. If stall recurs, secure affected engine as instructed under ENGINE SHUTDOWN IN FLIGHT in this chapter.

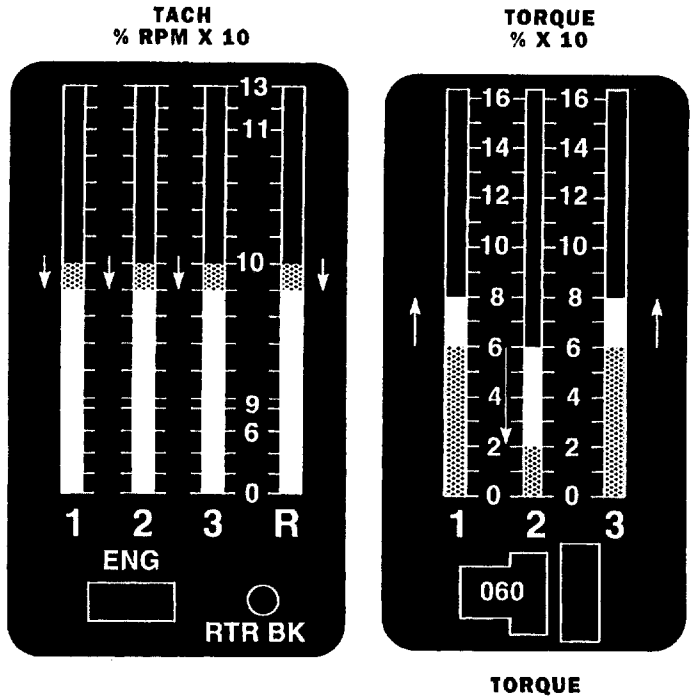
Figure 12-4. Compressor Stall (Sheet 1 of 2)

COMPRESSOR STALL



NOTE

GAGES REFLECT AN EXAMPLE OF ENGINE-TO-ENGINE-TO-ROTOR SYSTEM RELATIONSHIPS UPON OUTSET OF THE EMERGENCY IN ONLY ONE OF MANY POSSIBLE REGIMES. ACTUAL ENGINE / ROTOR SYSTEM RESPONSE WILL VARY DEPENDENT UPON NORMAL ENGINES POWER AVAILABLE, AND THE AFFECTED ENGINES (REDUCED) POWER AVAILABLE, AND TOTAL TORQUE LOAD AT THE TIME. THE LOCATION OF INDICATORS ON Ng / T5 GAGES IS NOT IMPORTANT. HOWEVER, THEIR DIRECTION AND AMOUNT OF CHANGE IS IMPORTANT.



NOTE

IN THIS EXAMPLE, THE NORMAL ENIGINES HAVE SUFFICENT POWER AVAILABLE TO COMPENSATE FOR THE AFFECTED ENGINE'S POWER LOSS.

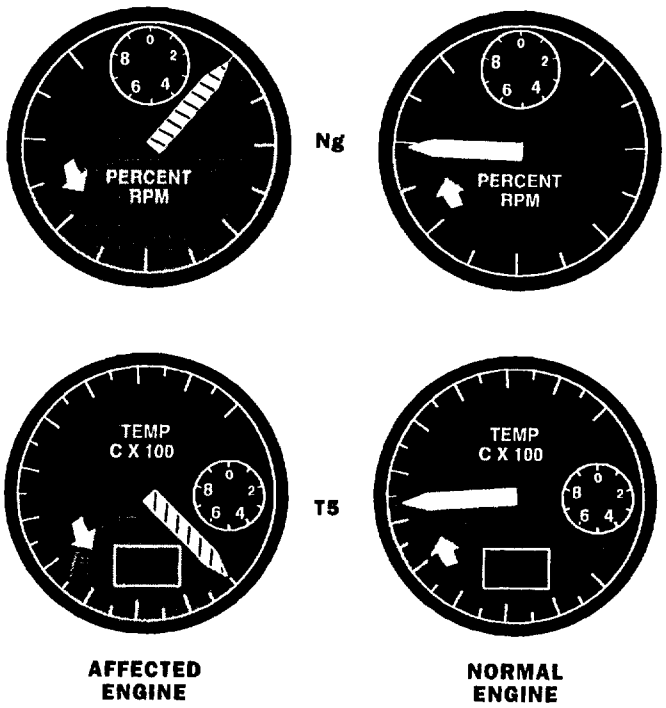
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Figure 12-4. Compressor Stall (Sheet 2 of 2)

ENGINE POWER LOSS	
SYMPTOMS	**CORRECTIVE ACTION**
1. Power loss caused by control/accessory malfunction; no stall, no flameout. Under certain conditions an N_f flex shaft failure will cause the affected engine to stabilize at flight idle with no control available through the speed control lever. Affected engine(s): All engine parameters decreasing. If the affected engine is producing any usable torque, its N_f will remain matched with the normal N_f/N_r. If torque drops to zero, N_f will likely split off and decay. Normal engine(s): All engine parameters increasing except N_f/N_r. If the normal engines' power available is not sufficient for the affected engine's power loss, (i.e., the total torque requirement cannot be met), N_f/N_r may droop/decay excessively depending on the degree of power deficit. Also, if the normal engines have sufficient power available to compensate for the affected engine's power loss, (i.e., the total torque requirement can be met), it is normal for N_f/N_r to droop about 1% to 2% as the normal engines are forced to assume the additional load. 2. Power loss caused by fuel contamination/fuel starvation (engine flameout). Affected engine(s): All parameters decreasing. Normal engine(s): All engine parameters increasing except N_f/N_r. If the normal engines' power available is not sufficient for the affected engine's power loss, (i.e., the total torque requirement cannot be met), N_f/N_r may droop/decay excessively depending on the degree of power deficit. Also, if the normal engines have sufficient power available to compensate for the affected engine's power loss, (i.e., the total torque requirement can be met), it is normal for N_f/N_r to droop about 1% to 2% as the normal engines are forced to assume the additional load.	*1. Collective — MAINTAIN N_r AT OR ABOVE 90%. *2. Airspeed — AS REQUIRED FOR SINGLE/DUAL ENGINE CAPABILITY. *3. Pickle — AS DESIRED. *4. Speed control levers — AS REQUIRED. 5. Continue to use affected engine if engine is producing some torque and all engine parameters are within limits. **WARNING** If the No. 2 engine is operating in a low-power condition and the N_g is less than 75%, hot exhaust gas may backflow into the engine compartment creating a fire hazard. Limit airspeed to less than 85 KIAS to reduce backflow. If dual-engine flight can be maintained, consideration should be given to securing the No. 2 engine. 6. Carefully monitor all engine parameters. 7. Secure affected engine as instructed under ENGINE SHUTDOWN IN FLIGHT in this section if any further engine malfunction is indicated, or if affected engine is not producing torque. **NOTE** If engine power loss takes place following fuel system transfer, selected fuel source is suspect for contamination or insufficient fuel.

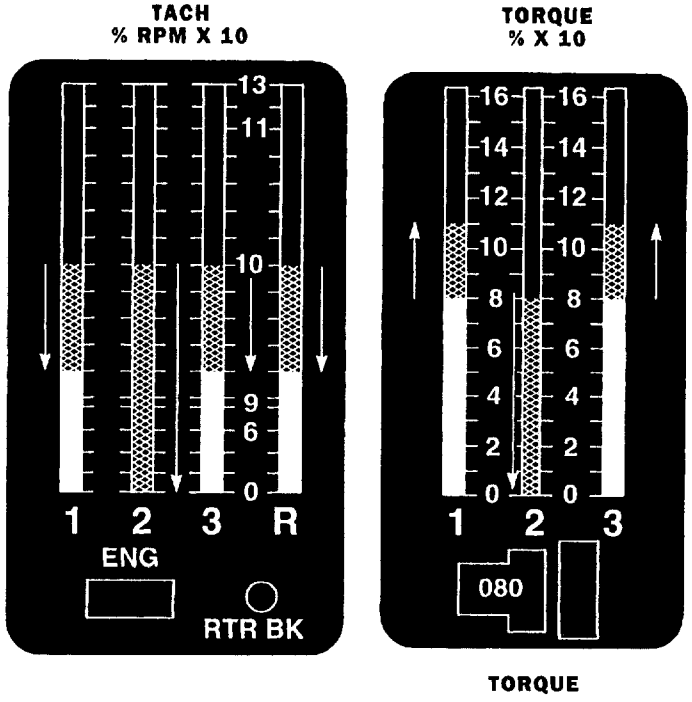
Figure 12-5. Engine Power Loss (Sheet 1 of 2)

ENGINE POWER LOSS
(ENGINE FLAMEOUT)



NOTE

GAGES REFLECT AN EXAMPLE OF ENGINE-TO-ENGINE-TO-ROTOR SYSTEM RELATIONSHIPS UPON ONSET OF THE EMERGENCY IN ONLY ONE OF MANY POSSIBLE REGIMES. ACTUAL ENGINE / ROTOR SYSTEM RESPONSE WILL VARY DEPENDENT UPON NORMAL ENGINES POWER AVAILABLE, AND THE AFFECTED ENGINES (REDUCED) POWER AVAILABLE, AND TOTAL TORQUE LOAD AT THE TIME. THE LOCATION OF INDICATORS ON Ng / T5 GAGES IS NOT IMPORTANT. HOWEVER, THEIR DIRECTION AND AMOUNT OF CHANGE IS IMPORTANT.



NOTE

IN THIS EXAMPLE, THE NORMAL ENGINES HAVE DEVELOPED TOPPING POWER WHICH IS NOT SUFFICIENT TO COMPENSATE FOR THE POWER LOSS. SINCE TOTAL POWER REQUIREMENTS CANNOT BE MET, Nf / Nr BEGINS TO DECAY.

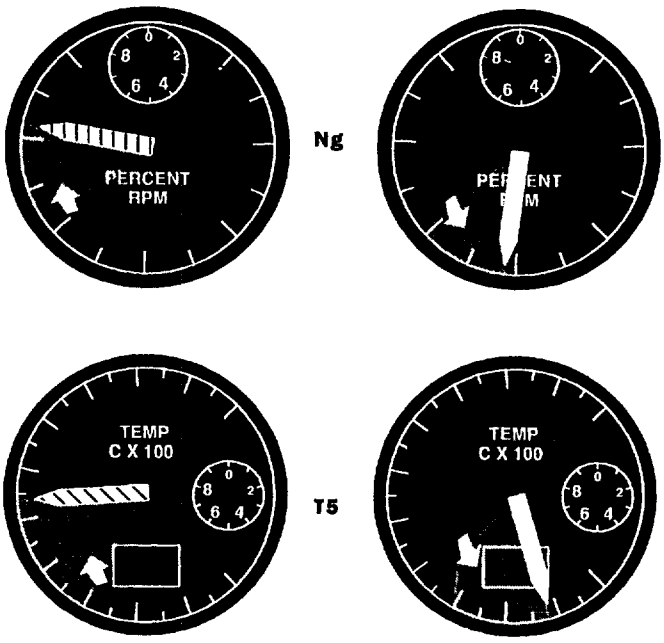
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Figure 12-5. Engine Power Loss (Sheet 2 of 2)

ENGINE OVERSPEED	
SYMPTOMS	**CORRECTIVE ACTION**
1. Engine fuel system malfunction/N_f flex shaft failure. See Gages Affected engine(s): All parameters increasing; fuel flow may jump to 1700 lbs or more. **NOTE** Engine may accelerate to maximum power. If engine attempts to deliver uncommanded power exceeding the total torque requirements, N_f/N_r will increase/overspeed depending on the degree of power surplus. Also, if the engine attempts to deliver uncommanded power less than the total torque requirements, N_f/N_r can be expected to increase slightly, about 1% to 2%. Normal engine(s): All parameters decreasing except N_f, which will remain the same or possibly increase with affected engine.	*1. Collective — MAINTAIN N_r. *2. Airspeed — AS REQUIRED. *3. Pickle — AS DESIRED. *4. Speed control levers — AS REQUIRED. Attempt to regain control of affected engine power by retarding affected engine's speed control lever below MIN GOV. **WARNING** If the No. 2 engine speed control lever is at or below MIN GOV and the N_g is less than 75%, hot exhaust gas may backflow into the engine compartment creating a fire hazard. Limit airspeed to less than 85 KIAS to reduce backflow. If dual-engine flight can be maintained, consideration should be given to securing the No. 2 engine. 5. If affected engine cannot be controlled manually without exceeding operating limits, secure engine as instructed under ENGINE SHUTDOWN IN FLIGHT. 6. If speed control lever can be used to control affected engine power without exceeding operating limitations, use it to match engine torques. Make all collective adjustments slowly to facilitate maintaining torques matched. **NOTE** Following an N_f flex shaft failure, the speed control lever will act as a direct throttle in the transition range, providing full control of engine power. Control may or may not be regained with a fuel control malfunction. 7. Make a normal landing in accordance with NORMAL LANDING procedures in Chapter 7, except copilot will do as follows, as directed by pilot: a. Control N_r throughout descent and approach by adjusting speed control lever of malfunctioning engine. b. While reducing collective on landing, retard speed control lever on malfunctioning engine to prevent rotor overspeed.
2. Power train failure.	1. See power train failure.

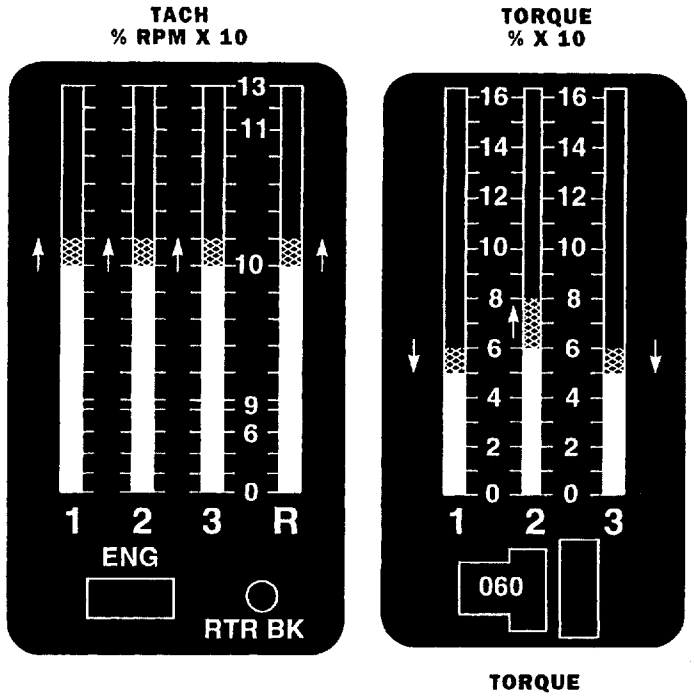
Figure 12-6. Engine Overspeed (Sheet 1 of 3)

ENGINE OVERSPEED
(FUEL REGULATION SYSTEM MALFUNCTION SHOWN)



NOTE

GAGES REFLECT AN EXAMPLE OF ENGINE-TO-ENGINE-TO-ROTOR SYSTEM RELATIONSHIPS UPON ONSET OF THE EMERGENCY IN ONLY ONE OF MANY POSSIBLE REGIMES. ACTUAL ENGINE / ROTOR SYSTEM RESPONSE WILL VARY DEPENDENT UPON NORMAL ENGINES POWER AVAILABLE, AND THE AFFECTED ENGINES (REDUCED) POWER AVAILABLE, AND TOTAL TORQUE LOAD AT THE TIME. THE LOCATION OF INDICATORS ON Ng / T5 GAGES IS NOT IMPORTANT. HOWEVER, THEIR DIRECTION AND AMOUNT OF CHANGE IS IMPORTANT.



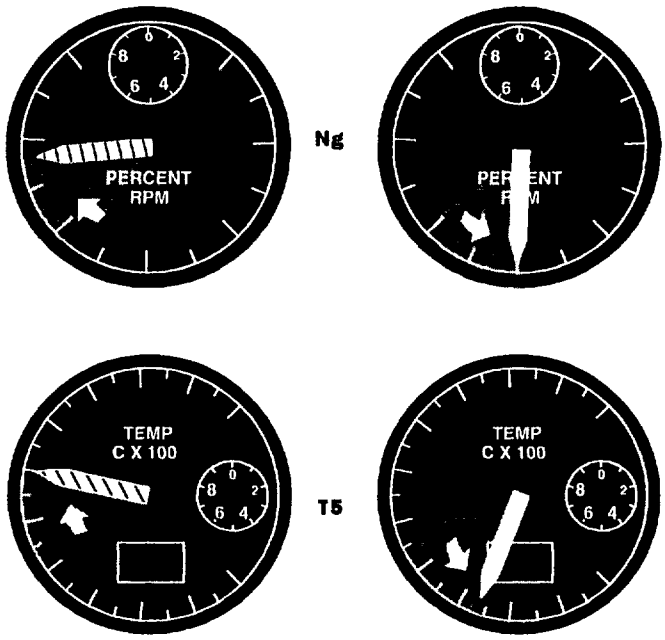
NOTE

IN THIS EXAMPLE, THE MALFUNCTIONING ENGINE EXHIBITS AN UNCOMMANDED INCREASE IN POWER WHICH IS NOT IN EXCESS OF TOTAL TORQUE REQUIREMENTS. ALL ENGINES CONTINUE TO SHARE THE LOAD.

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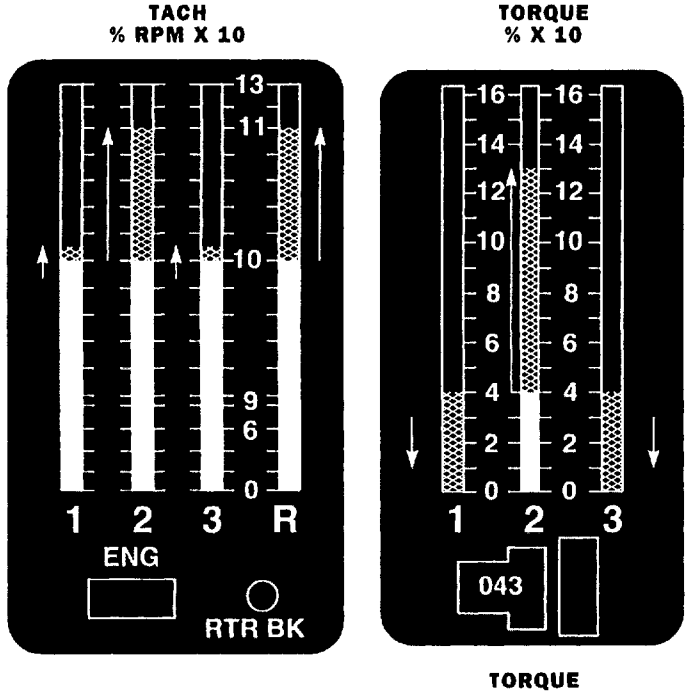
Figure 12-6. Engine Overspeed (Sheet 2 of 3)

ENGINE OVERSPEED
(Nf FLEX SHAFT FAILURE)



NOTE

GAGES REFLECT AN EXAMPLE OF ENGINE-TO-ENGINE-TO-ROTOR SYSTEM RELATIONSHIPS UPON ONSET OF THE EMERGENCY IN ONLY ONE OF MANY POSSIBLE REGIMES. ACTUAL ENGINE / ROTOR SYSTEM RESPONSE WILL VARY DEPENDENT UPON NORMAL ENGINES POWER AVAILABLE, AND THE AFFECTED ENGINES (REDUCED) POWER AVAILABLE, AND TOTAL TORQUE LOAD AT THE TIME. THE LOCATION OF INDICATORS ON Ng / T5 GAGES IS NOT IMPORTANT. HOWEVER, THEIR DIRECTION AND AMOUNT OF CHANGE IS IMPORTANT.



NOTE

IN THIS EXAMPLE, Nf FLEX SHAFT FAILURE HAS CAUSED AFFECTED ENGINE TO DELIVER MAXIMUM POWER, WHICH IS IN EXCESS OF TOTAL TORQUE REQUIREMENTS, AND THE AFFECTED ENGINE Nf / Nr INCREASE ABOVE SELECTED SPEED.

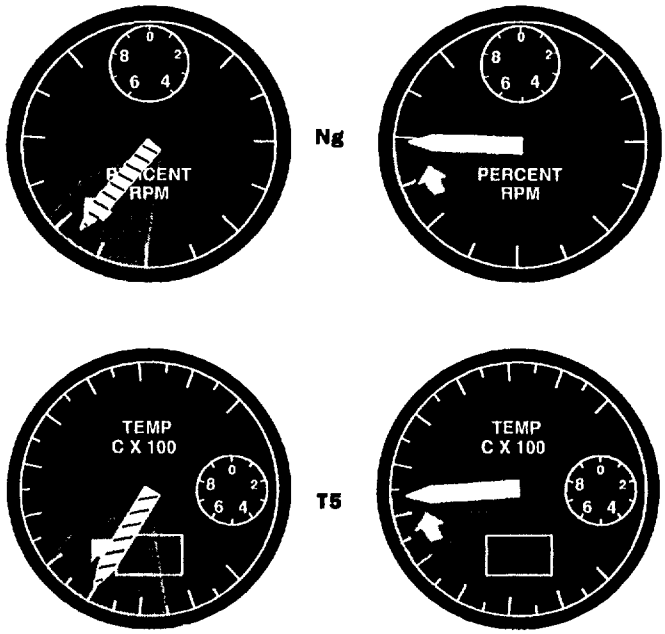
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Figure 12-6. Engine Overspeed (Sheet 3 of 3)

POWERTRAIN FAILURE	
SYMPTOMS	**CORRECTIVE ACTION**
1. Failure between power turbine and nose gear box. Affected engine(s): a. Sudden decrease to zero on N_f and torque indicators. b. N_g and T_5 increasing until overspeed system actuates, then cycles until SCL is retarded below MIN GOV position. c. Grinding/howling noise may be heard. Normal engine(s): All engine parameters increasing except N_f/N_r. If the normal engines' power available is not sufficient to offset the affected engine's power loss, (i.e., the total torque requirement cannot be met), N_f/N_r may droop/decay excessively, depending on the degree of power deficit. If the normal engines' power available is sufficient to offset the affected engine's power loss, (i.e., the total torque requirement can be met), it is normal for N_f/N_r to droop about 1% to 2% as the normal engines are forced to assume the additional load.	*1. Collective — MAINTAIN N_r AT OR ABOVE 90%. *2. Airspeed — AS REQUIRED FOR SINGLE/DUAL ENGINE CAPABILITY. *3. Pickle — AS DESIRED. *4. Speed control levers — AS REQUIRED (SECURE AFFECTED ENGINE(S)). **WARNING** Closely monitor hydraulic system quantities and flight controls due to the possibility of damage to those areas following a drive shaft failure. **CAUTION** Do not attempt to restart affected engine.
2. Failure between nose gear box and main gear box. Affected engine(s): N_g, T_5, and W_f decrease to flight idle. Torque decreases to zero. N_f initially increases rapidly until overspeed actuates at 110% ±2%, then decreases and stabilizes (will likely fluctuate above and below) above previous loaded speed (N_f exceeds N_r), until SCL is retarded. Torque — decrease to zero. Normal engine(s): All engine parameters increasing except N_f/N_r. If the normal engines' power available is not sufficient to offset the affected engine's power loss, (i.e., the total torque requirement cannot be met), N_f/N_r may droop/decay excessively, depending on the degree of power deficit. If the normal engines' power available is sufficient to offset the affected engine's power loss, (i.e., the total torque requirement can be met), it is normal for N_f/N_r to droop about 1% to 2% as the normal engines are forced to assume the additional load.	

Figure 12-7. Powertrain Failure (Sheet 1 of 2)

POWER TRAIN FAILURE
(FAILURE BETWEEN NO.1 ENGINE POWER TURBINE AND NOSE GEAR BOX)

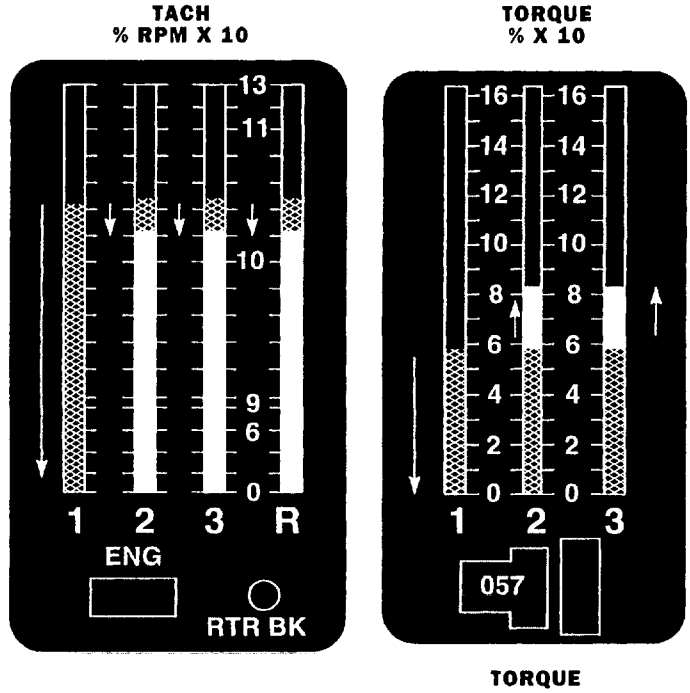


AFFECTED ENGINE

NORMAL ENGINE

NOTE

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NOTE

OPERATING AT 105% Nf / Nr AT THE ONSET OF THE EMERGENCY, WITH SUFFICIENT POWER AVAILABLE TO OFFSET LOSS OF AFFECTED ENGINE'S TORQUE.

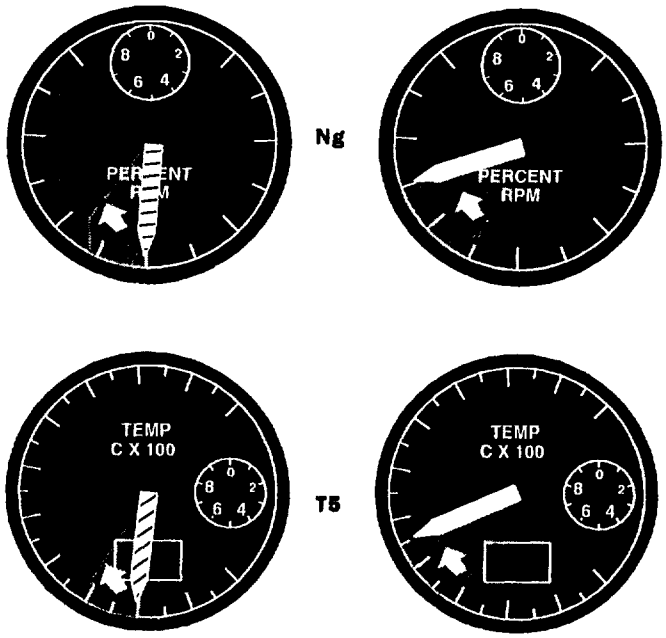
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Figure 12-7. Powertrain Failure (Sheet 2 of 2)

CONTROL LINKAGE FAILURE	
SYMPTOMS	**CORRECTIVE ACTION**
1. Speed control lever linkage disengaged. Engine response: See Gages a. When all speed control levers are advanced simultaneously, affected engine parameters (T_{5i}, N_g, Q) will decrease as normal engine(s) parameters increase. b. When all speed control levers are retarded simultaneously, affected engine parameters (T_5, N_g, Q) will increase as normal engine(s) parameters decrease.	1. Match torques using normal engine's speed control levers. 2. If N_r exceeds desired limits, reduce speed control lever position on normal engine(s) to decrease N_f/N_r. 3. Use fuel control lever of affected engine(s) to secure engine.
2. Collective compensation linkage (collective bias) disengaged. a. Reduced torque response on affected engine with change in collective position. b. Noticeable torque split with change in collective position. c. Rotor droop with increased collective input.	1. Trim engine speed control levers to maintain N_f/N_r. 2. Retrim, with load change, as necessary. **NOTE** Expect unusually large torque splits at high load conditions.

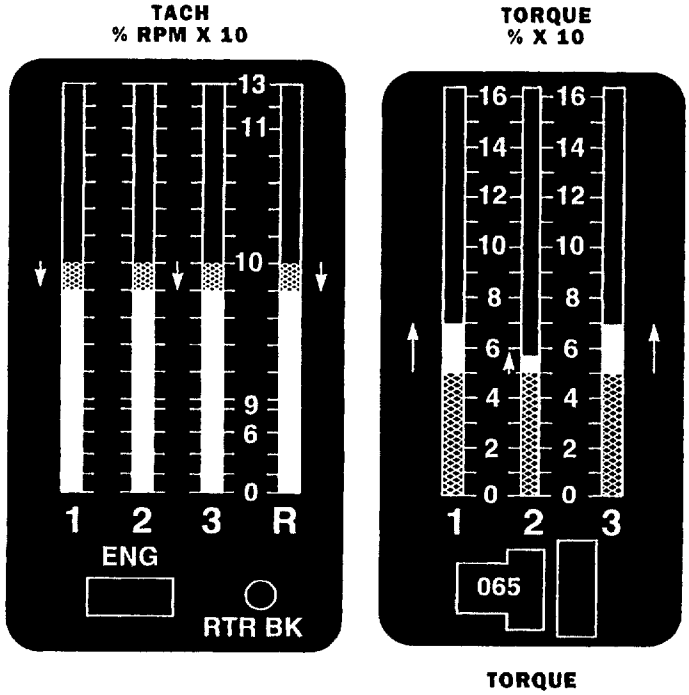
Figure 12-8. Control Linkage Failure (Sheet 1 of 2)

CONTROL LINKAGE
(INCREASE OF COLLECTIVE WITH #2 ENGINE COLLECTIVE BIAS FAILURE SHOWN)



NOTE

GAGES REFLECT AN EXAMPLE OF ENGINE-TO-ENGINE-TO-ROTOR SYSTEM RELATIONSHIPS UPON ONSET OF THE EMERGENCY IN ONLY ONE OF MANY POSSIBLE REGIMES. ACTUAL ENGINE / ROTOR SYSTEM RESPONSE WILL VARY DEPENDENT UPON NORMAL ENGINES POWER AVAILABLE, AND THE AFFECTED ENGINES (REDUCED) POWER AVAILABLE, AND TOTAL TORQUE LOAD AT THE TIME. THE LOCATION OF INDICATORS ON Ng / T5 GAGES IS NOT IMPORTANT. HOWEVER, THEIR DIRECTION AND AMOUNT OF CHANGE IS IMPORTANT.



NOTE

IN THIS EXAMPLE, AFFECTED ENGINE DOES NOT RESPOND AS WELL AS NORMAL ENGINES TO INCREASED COLLECTIVE. Nf / Nr DECREASED ONLY SLIGHTLY.

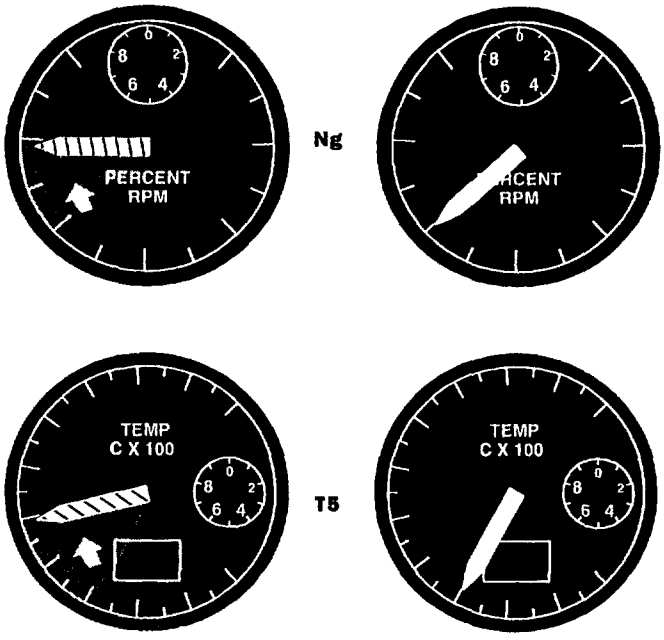
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Figure 12-8. Control Linkage Failure (Sheet 2 of 2)

POWER DETERIORATION	
SYMPTOMS	**CORRECTIVE ACTION**
1. Extended hover over salt water. a. T_5 and N_g slowly increasing, torque setting, N_f and N_r remain constant, all engines. b. Power can decrease below limits of single-point performance check.	1. Record low power indications for maintenance action. 2. Increase hover altitude to reduce salt buildup/power reduction rate. 3. Abort mission if power deterioration is excessive. **NOTE** A T_5 increase of 40°C at a constant Q is equal to a power loss of about 10%.
2. Compressor fouling. a. Reduced power output at any N_g/T_5 condition. b. Power can decrease below limits of single-point performance check. See Figure.	1. Record low power information for maintenance action. 2. Abort mission if power deterioration is excessive.
3. Compressor and turbine erosion/FOD. a. Reduced power output at any N_g/T_5 condition. b. Engine may fail to pass single-point performance check. See Figure 7-5. c. In serious instances of FOD, compressor stall/power low may occur (See Compressor Stall, Figure 12-4).	1. Record unusual symptoms and power data for maintenance action. 2. Abort mission if power deterioration is excessive.
4. Stator vane schedule shift. a. Unusual N_g/T_5 relationship on low power engine. b. Lower power engine may stall during overspeed check, deceleration, or acceleration. c. Low-power engine ground idle speed may shift to or below minimum ground idle limit.	1. Record unusual symptoms and power data for maintenance action. 2. Abort mission if power deterioration is excessive.
5. Excessive engine air bleed/leakage. a. High T_5 for given N_g on low-power engine.	1. Record unusual symptoms and power data for maintenance action. 2. Turn anti-icing system of low-power engine ON; look for slight increase in T_5. Turn system OFF; look for slight decrease in T_5. If T_5 remains steady, anti-ice system is inoperative. 3. Abort mission if power deterioration is excessive.

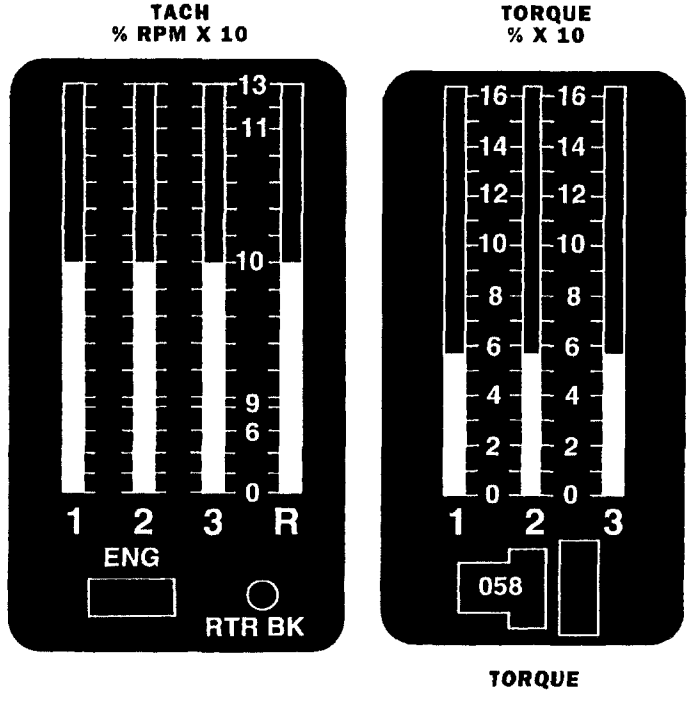
Figure 12-9. Power Deterioration (Sheet 1 of 2)

POWER DETERIORATION
(LOW ALTITUDE SALT WATER HOVER CONDITION SHOWN)



NOTE

GAGES REFLECT AN EXAMPLE OF ENGINE-TO-ENGINE-TO-ROTOR SYSTEM RELATIONSHIPS UPON ONSET OF THE EMERGENCY IN ONLY ONE OF MANY POSSIBLE REGIMES. ACTUAL ENGINE / ROTOR SYSTEM RESPONSE WILL VARY DEPENDENT UPON NORMAL ENGINES POWER AVAILABLE, AND THE AFFECTED ENGINES (REDUCED) POWER AVAILABLE, AND TOTAL TORQUE LOAD AT THE TIME. THE LOCATION OF INDICATORS ON Ng / T5 GAGES IS NOT IMPORTANT. HOWEVER, THEIR DIRECTION AND AMOUNT OF CHANGE IS IMPORTANT.



NOTE

POWER DEGRADATION MAY NOT DEVELOP AT A RATE READILY NOTICEABLE BY SUDDEN CHANGES IN PERFORMANCE GAGES.

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Figure 12-9. Power Deterioration (Sheet 2 of 2)

ENGINE LUBRICATION SYSTEM MALFUNCTION	
SYMPTOMS	**CORRECTIVE ACTION**
1. ENG OIL PRESS HIGH caution light on a. Cold oil b. Plugged lube jet	a.1. Maintain reduced speed/power on affected engine until engine oil pressure is within normal operating range. b.1. If critical power requirements exist, reduce power of affected engine to minimum needed for immediate requirements. 2. Transition to single- or dual-engine operating procedures as quickly as possible, and secure affected engine as instructed under ENGINE SHUTDOWN IN FLIGHT in this chapter.
2. ENG OIL PRESS LOW caution light on. **NOTE** Low pressure light may go on at ground idle if N_g is at or near minimum limit.	1. If critical power requirements exist, reduce power of affected engine to minimum needed for immediate requirements. 2. Transition to single- or dual-engine operating procedures as quickly as possible, and secure affected engine as instructed under ENGINE SHUTDOWN IN FLIGHT in this chapter.
3. High oil temperature **NOTE** Oil temperature may approach maximum limit during sustained high ambient temperatures.	T64-416/-416A Engine: 1. Reduce power of affected engine to minimum needed for immediate requirements. 2. If engine oil temperature decreases to within maximum limit, continue to operate affected engine at reduced power. 3. If engine oil temperature continues to exceed maximum operating limits, transition to single- or dual-engine operating procedures as quickly as possible, and secure engine as instructed under ENGINE SHUTDOWN IN FLIGHT in this chapter.

Figure 12-10. Engine Lubrication System Malfunction (Sheet 1 of 2)

ENGINE LUBRICATION SYSTEM MALFUNCTION	
SYMPTOMS	**CORRECTIVE ACTION**
3. High oil temperature (Continued) **NOTE** Oil temperature may approach maximum limit during sustained high ambient temperatures.	T64-419 Engine: 1. Increase power of affected engine (or reduce power of non-affected engines) in order to increase fuel flow of the affected engine. **NOTE** Engine oil cooling efficiency is directly related to fuel flow. Worst case cooling efficiency conditions are present at ground idle. 2. If engine oil temperature decreases to within maximum limit, continue to operate affected engine at increased power (or non-affected engines at reduced power). 3. If affected engine oil temperature does not decrease to within maximum operating limit while airborne, transition to single- or dual-engine operating procedures as quickly as possible and perform ENGINE SHUTDOWN IN FLIGHT emergency procedure. If on deck, secure engine.
4. Engine oil low level caution light on.	Replenish from auxiliary oil tank.

WARNING

- Level single- or dual- engine flight and/or safe single- or dual-engine hover landing may not be possible at certain combinations of helicopter gross weight and density altitude. Flight conditions may require that the decision to establish single- or dual- engine flight be deferred until a safe descent is possible. Select landing site suitable for running landing if available.

- If the No. 2 engine must be operated at less than 75% N_g, hot exhaust gas may back-flow into the engine compartment, creating a fire hazard. Limit airspeed to less than 85 KIAS to reduce backflow. If dual-engine flight can be maintained, consideration should be given to securing the No. 2 engine.

Figure 12-10. Engine Lubrication System Malfunction (Sheet 2 of 2)

12.10 ENGINE CHIP LOCATOR LIGHT

An engine chip locator light accompanied by unusual vibrations and/or low oil pressure/high oil temperature, or an engine chip locator light returning after resetting circuit breaker without the above indications, is cause to suspect probable engine failure. Failure of an engine following illumination of an engine chip detector light could occur in as little as 10 to 15 seconds. If an engine chip detector light goes on, do this:

*1. Establish dual-engine flight conditions (jettison AMCM equipment if required).

*2. RAD ALT/BAR ALT HOLD — DISENGAGE.

3. If chip locator light is not accompanied by other indications of malfunction, pull and reset engine chip circuit breaker.

4. If chip locator light returns after circuit breaker is reset, maintain dual engine flight conditions, and retard the affected engine to ground idle.

CAUTION

Excessive temperatures within the No. 2 engine compartment may occur in flight with the No. 2 engine at ground idle, resulting in possible engine compartment fire.

5. If critical power requirements exist, consideration should be given to rematching engine torques with the affected engine. Monitor the affected engine's performance.

6. If conditions exist where an engine chip locator light is accompanied with other indications of malfunctions, perform single or dual engine shut down procedures.

7. If chip locator light remains off, continue mission and monitor engine performance.

12.11 EMERGENCY DESCENT

There is no set procedure for an emergency descent. Damage to the helicopter or engines must be considered secondary to getting the helicopter on the ground. During an extreme emergency, the condition or type of landing may be a determining factor in the type of emergency descent to be made. If a long distance must be covered to a selected landing site, a dive with power would be most feasible. A normal power-on vertical landing may be made when the landing site is reached. A circling autorotation, at higher airspeeds, will provide a higher rate-of-descent and view of the landing site.

12.12 TAIL ROTOR SYSTEM FAILURE

Tail rotor system failure can be classified as drive system failure and control system failure.

12.12.1 Tail Rotor Drive System Failure

WARNING

Tail rotor drive system failure, in all regimes of flight, can produce violent helicopter response, therefore recognition of impending failure is extremely important. Extended flight at moderate airspeed is theoretically possible following tail rotor drive system failure in forward flight. Extended hovering flight is not possible following a tail rotor drive system failure.

Tail rotor drive system failure, where RPM and thrust are lost, may be caused by any one of a multitude of structural failures. A drive system failure, either in hover or forward flight, may be difficult to cope with because the stabilizing effect of rotating disk area and/or tail rotor thrust will be lost. Tail rotor drive system failure is usually preceded by excessive vibration or noise in the tail section, followed by a right yawing acceleration which will be proportional to the amount of torque which is being used at that time. If the failure occurs in forward flight, it will result in a right yaw acceleration that probably would be somewhat lower than loss of drive in a hover. However, in either case, the right yaw acceleration can be reduced by an immediate reduction in power.

Landing from forward flight without the tail rotor operating is hazardous due to the high possibility that the helicopter may touch down in an excessive skid and rollover. Following a tail drive failure in flight, if the right yaw acceleration is arrested after initial collective reduction and extended powered flight is achieved, a running landing may afford the best touchdown control, terrain permitting. The final approach should be made into the wind at approximately 80 KIAS. As airspeed is decreased below 100 to 120 KIAS on final, the reduced slipstream can be expected to result in somewhat greater skid;

however, this tendency should be offset by the lesser amount of torque required to fly 80 KIAS and descend, resulting in a tolerable in-flight skid. Approaching the intended point of touchdown, at approximately 50 to 75 feet AGL, coordinated collective power reduction and aft cyclic to minimize, if not eliminate, the torque load should produce acceptable nose alignment while further reducing ground speed prior to touchdown. In order to maintain nose alignment, all operating engines should be secured at approximately 5 to 20 feet AGL, before increasing collective to cushion the touchdown. However, if acceptable nose alignment is achieved at a low collective setting which can be maintained until ground contact, all engines should be secured soon after touchdown. In any case, judicious lateral cyclic should be applied to ensure the helicopter track over the ground follows the nose at/after ground contact. After touchdown differential braking should be used to help maintain directional control.

If extended flight is possible, however rough terrain/water precludes a running landing or nose alignment is not achieved as described above, a moderate side flare approaching the intended point of landing should be used to minimize groundspeed and drift prior to touchdown. All operating engines should be secured during the flare, prior to increasing collective to cushion the landing. Touching down tail first may aid in cushioning both forward and vertical deceleration on ground contact, and may even assist in maintaining a straight ground track.

If extended flight is not achievable, an immediate autorotative descent and landing should be made as outlined under Three-Engine Failure (Autorotative Landing), in this section.

Landing from a hover with an inoperable tail rotor is hazardous because of fuselage rotation. Fuselage rotation can be stopped or greatly reduced by retarding all engine speed selectors to the shut off position. However, the engines should not be shut down until the helicopter is clear of the height-velocity avoid area.

WARNING

Loss of tail rotor thrust will result in exaggerated pitch and roll response to collective and/or rudder inputs due to mechanical coupling.

12.12.1.1 Tail Rotor Drive System Failure (Hover and Take-Off)

*1. Collective — REDUCE (IF ALTITUDE PERMITS) TO INITIATE A MODERATE RATE OF DESCENT AND RETARD YAW RATE.

*2. Airspeed — AS REQUIRED (LAND LEVEL ATTITUDE).

*3. Pickle — AS DESIRED.

*4. Speed control levers — SHUTOFF AT 5 TO 20 FEET AGL.

*5. Collective — INCREASE (CUSHION LANDING).

12.12.1.2 Tail Rotor Drive System Failure (Cruise)

*1. Collective — REDUCE (ENOUGH TO STOP FUSELAGE ROTATION).

*2. Airspeed — 100 to 120 KIAS.

*3. Pickle — AS DESIRED.

*4. Speed control levers — AS REQUIRED.

*5. Rudder pedals — CENTERED.

WARNING

If the tail rotor/tail rotor gearbox/tail section has (have) departed the aircraft, absence of the tail rotor will necessitate an autorotative descent and landing. However, due to the forward shift of C. G. under such conditions, the pilot should use extreme caution during the flare recovery to avoid excessive forward pitch rates which may become uncontrollable.

If steps 1. through 5. are unsuccessful in regaining directional control:

*6. Immediately enter autorotation. Consider leaving SCLs forward. Flare and arrest rate of descent. Complete a landing using Tail Rotor Drive System Failure (Hover and Takeoff) procedures.

If steps 1. through 5. are successful in regaining directional control:

7. Alter bank angle and collective as required to maintain controllable flight. The magnitude of bank angle required for straight ground track will vary with airspeed and collective setting. As airspeed is reduced below 100 to 120 KIAS, a larger angle of bank or reduction in torque will be required to compensate for increased right yaw.

8. Land as soon as possible. If over suitable flat terrain, attempt a running landing. Consideration should be given to landing with the landing gear up if the surface is soft/uneven and possibility of shearing the landing gear or rolling over is judged to exist. Establish 80 KIAS on final and approaching 50 to 75 feet AGL, a combination of collective reduction/aft cyclic will minimize torque and slow groundspeed to assist in aligning the nose for touchdown. Secure all engines before increasing collective to cushion landing. If nose will not align or terrain is too rough for running landing, accomplish landing using a moderate side flare to minimize groundspeed and drift, secure all engines in the flare and contact ground tail first on flare and flare recovery.

9. At touchdown, secure all three engines (if not already secured).

12.12.1.3 Tail Rotor Drive System Failure During Landing. If the tail rotor drive system fails during the landing approach, the proper corrective action will depend upon the airspeed and altitude the helicopter has at the time of failure. The pilot should land the helicopter utilizing either the Tail Rotor System Failure (Cruise) landing procedure or the Tail Rotor Drive System Failure (Hover and Take Off) landing procedure, in this chapter. It is, therefore, incumbent upon the pilot to select the proper procedure based upon where the helicopter is in the landing profile.

12.12.1.4 Tail Rotor Drive System Failure While Towing, Streaming, or Recovering AMCM Equipment

*1. Collective — REDUCE/DISENGAGE RADAR ALTITUDE HOLD.

*2. Tension — REDUCE TO MINIMIZE GROUND SPEED.

Note

Do not release tow.

*3. Crewman — CLOSE RAMP.

*4. Speed control levers — SHUTOFF AT 5 to 10 FEET AGL.

*5. Collective — INCREASE (CUSHION LANDING).

12.12.2 Tail Rotor Control System Failure. The self-centering spring installation provides the capability of continued flight to a landing site with tail rotor control system failure. At a gross weight of 46,500 pounds the helicopter flies in a right sideslip (left yaw) below 135 KIAS, trims to balanced level flight at about 135 KIAS, and flies in a left sideslip (right yaw) at speeds above 135 KIAS. Balanced flight at gross weights above 46,500 pound is achieved at lower airspeeds, and below 46,500 pounds at higher airspeeds.

12.12.2.1 Approach and Landing with Tail Rotor Control System Failure. If an approach and landing is to be made, airspeed can be reduced while maintaining a reasonable trimmed flight condition by slowly reducing power and entering a left turn with cyclic. Balanced flight can be maintained during power and airspeed changes by increasing or decreasing the roll angle until about 35% to 40% torque and 50 to 60 KIAS is attained. Level flight can then be maintained with a small amount of right sideslip at 35% to 40% torque and 50 to 60 KIAS. Increasing collective too rapidly or too much will cause a sideslip to the left and decreasing collective too rapidly or too much will cause a sideslip to the right. It is recommended that a roll-on landing be made on a prepared surface. If the landing has to be made to an unprepared surface, consideration should be given to a wheels-up slide-on landing. It is important during the final phase of the landing to (1) retain attitude by referencing the ADI, (2) slightly apply collective just before touchdown to provide a nonslip condition for touchdown, and (3) immediately apply wheel brakes while slowly lowering the collective. A waveoff may be made any time before a small flare is initiated for final touchdown by accelerating into forward flight. While accelerating, the helicopter will enter a left sideslip condition that will decrease as airspeed is increased.

1. Flight path — 180° LEFT APPROACH.

2. Downwind leg — 200 FEET ALTITUDE AND 45 to 50 KIAS.

3. APP — START.

CAUTION

If emergency conditions warrant, the APP may be started and operated during flight. However, N_r settings above 103% may result in an unsuccessful APP start or uncommanded APP shutdown due to overspeed.

Note

- N_r settings above 103% may result in an unsuccessful APP start or uncommanded APP shutdown due to APP overspeed.
- Airspeed can be reduced during the turn to final approach or when rolling out of the turn to final approach.

4. Final approach — 6° TO 8° NOSE-UP ATTITUDE, AND ENOUGH TORQUE TO MAINTAIN 35 TO 45 KIAS AND 200 TO 300 FEET-PER-MINUTE RATE-OF-DESCENT.

WARNING

Rapid or too large increased collective application will cause the helicopter to sideslip to the left. Rapid or too large decreased collective application will cause the helicopter to sideslip to the right.

5. Collective — INCREASE SLIGHTLY TO REDUCE SIDESLIP AND MAINTAIN ALL CONDITIONS TO TOUCHDOWN.

6. Touchdown — COORDINATE SCL AND DIFFERENTIAL BRAKING WHILE SLOWLY LOWERING COLLECTIVE.

12.12.2.2 Tail Rotor Control Failure in a Hover. Loss of tail rotor control in hover will be characterized by unresponsive pedals. Aircraft response will depend on hover power required, wind speed, and aircraft heading relative to the wind. Collective increases will increase the right yawing moment. Collective decreases will decrease the right yawing moment. If the aircraft is yawing right, slowly reduce collective and touch down with minimum drift as tail yaws into the wind. If aircraft is yawing left, start the APP if possible, and slowly decrease N_r at 5 to 10 feet AGL to reduce tail rotor thrust and left yaw rate. Touchdown with minimum drift as tail yaws into wind and left yaw rate stops.

12.12.3 Pylon Unsafe for Flight Light. Illumination of the PYLON UNSAFE FOR FLIGHT light while operating at 100% N_r may provide warning of a malfunctioning tail rotor disconnect fitting. Total failure of the tail rotor disconnect fitting will result in loss of tail rotor drive. Failure to retract or premature extension of the tail rotor actuator could result in damage to the tail rotor head or tail rotor gear box. Extension or cycling of the tail rotor disconnect disengage flag may also indicate a malfunctioning tail rotor disconnect fitting.

If illumination of the PYLON UNSAFE FOR FIGHT light or extension/cycling of the tail rotor disengage flag occurs, execute the following procedures:

*1. If accompanied by abnormal vibration, noise in the tail section, or yaw kicks — LAND IMMEDIATELY.

*2. If not accompanied by these indications — LAND AS SOON AS POSSIBLE, MINIMIZE TAIL ROTOR STRESS, MINIMIZE CONTROL INPUTS, AND EXECUTE A RUNNING LANDING IF POSSIBLE.

WARNING

PYLON UNSAFE FOR FLIGHT caution light may be accompanied by loss of AFCS servos upon touchdown (weight-on-wheels), or when operating on the ground.

12.12.4 Uncommanded Ground Spin. An uncommanded ground spin can be caused by any number of system failures, pilot inputs, or a combination of several factors. These include tail rotor drive failure, loss of tail rotor control, AFCS or primary servo hardover, wheel brake failure, or loss of control during taxi. The key is not in identifying the source of the spin, but in rapid response to the emergency. If the nose wheel is allowed to cock 90° or more and a moment of sufficient force is generated at the tail, a violent spin could result. Experience has shown that, after as little as 180° of rotation, inertia may prevent any control input from halting the spin. If an uncommanded ground spin is entered, proceed as follows:

*1. Apply rudder pedal in opposite direction of spin.

*2. Collective — FULL DOWN.

WARNING

If control input is not immediately effective in arresting the rate of rotation, any delay in shutting down the aircraft could result in an out-of-control spin or cause dynamic rollover if sufficient angular moment is developed.

If the spin is not eliminated by immediate control inputs, do this:

*3. Emergency shutdown.

12.13 BEARING VIB LIMIT, BEARING TEMP DETECT, and BEARING TEMP LIMIT Caution Lights (AFC 491)

The BEARING VIB LIMIT, BEARING TEMP DETECT, and BEARING TEMP LIMIT caution lights are part of the bearing monitor system (BMS). Refer to Chapter 2 for additional BMS details.

Note

A VIB DETECT light on the BMP indicates that the BMS has sensed bearing vibration level(s) which are higher than normal. A 10-hour limitation (for SP-1 and/or SP-2 sensors) or a 50-hour limitation (for the DISC sensor) will be imposed and will require maintenance action.

12.13.1 BEARING VIB LIMIT Caution Light. If the BEARING VIB LIMIT caution light comes on:

1. Aircrew — ALERT.
2. Land as soon as practical.

12.13.2 BEARING TEMP DETECT Caution Light. If the BEARING TEMP DETECT caution light comes on:

1. Aircrew — ALERT.

*2. Land as soon as possible.

Aircrew:

1. Prepare for emergency landing.

12.13.3 BEARING TEMP LIMIT Caution Light. If the BEARING TEMP LIMIT caution light comes on:

1. Aircrew — ALERT.

*2. Land immediately.

Aircrew:

1. Prepare for emergency landing.

12.13.4 Bearing Monitor System Fault Isolation. The bearing monitor panel (BMP) shows bearing monitor system (BMS) fault indications to the aircrew. If a fault indication shows more than a maintenance condition, the pilots have to know immediately. This is normally done by the BEARING VIB LIMIT, BEARING TEMP DETECT, or BEARING TEMP LIMIT lights on the caution/advisory panel. If the aircrew sees a system or bearing fault condition on the BMP:

1. Tell the pilots about the indication and the sensor location shown on the BMP display.

2. If the BMP display shows a plus sign (+) next to the fault, press PREV or NEXT as necessary to identify all faults.

3. Tell the pilots about any other bearings or sensors which give fault indications.

Note

If the location shown on the BMP display has a fault, an applicable BEARING STATUS or SYSTEM STATUS annunciator light comes on.

4. BMP system reset (IF REQUIRED):

Note

Do not perform system reset after a PNL NG failure.

a. BMP display — ALL OK.

b. Press PREV button — RESET DISPLAYED.

c. Press SELECT button — RESET COMPLETE.

*5. Land as soon as practical if a system fault occurs which precludes monitoring of swashplate vibrations/temperatures as indicated by any of the following conditions:

a. Illumination of a TEMP or VIB system status light, and SP1 and SP2 fault indications appearing in the BMP alphanumeric display.

b. Illumination of the PANEL system status light and PNL NG fault indication appearing in the BMP alphanumeric display.

c. Failure of the BMP display or loss of system power.

Note

Failure of both the SP1 and SP2 sensors or failure of the bearing monitor panel (BMP) will result in loss of swashplate monitoring capabilities.

12.14 FIRE

CAUTION

The portable fire extinguisher contains CF3Br, which, although not poisonous, can cause asphyxiation through reduction of oxygen in confined spaces, and low temperature burns when in contact with the skin. High concentrations of CF3Br in the air (greater than 10 percent) has been shown to cause dizziness, impaired coordination, and possibly unconsciousness. If the portable fire extinguisher is used for cockpit or cabin fires, ventilation should be increased after fire fighting procedures are complete and a landing as soon as possible is recommended to evacuate the aircraft until safe concentration levels can be assured. Consider use of HEEDS prior to discharging the portable fire extinguisher in/around pilots/aircrewmen and remaining on HEEDS until air clears.

When possible, confirm presence of fire by sight or smell; then do as follows:

12.14.1 Engine Compartment Fire on the Ground. If an engine compartment fire occurs while on the ground, do this:

*1. Speed control lever — SHUT OFF.

*2. Emergency T-handle (for engine on fire) — PULL AFT. This shuts off fuel and selects engine compartment for fire extinguisher.

Note

If more than one emergency T-handle is moved full aft, the fire extinguishing agent will be directed to the engine compartment of the last emergency T-handle activated.

*3. Main engine fire extinguisher switch — MAIN, RESERVE, IF NECESSARY.

4. Ground crew — ALERTED.

Crewman. The crewman will do this:

1. Notify pilot of location and extent of fire.

2. If fire still persists after engine fire extinguishers have been discharged, discharge fire extinguisher into engine compartment access panels.

12.14.2 Single- or Dual-Engine Compartment Fire(s) in Flight. Engine fires are usually the result of an engine malfunction or failure of one of its component systems. Ruptured fuel and oil lines will usually be detected by engine instrument indications. To be sure the engine fire detection system is not being activated by the sun's rays, turn the helicopter 90° to its flight path. When possible, confirm presence of fire by sight or smell; then do this:

*1. Collective — MAINTAIN N_r.

*2. Airspeed — AS REQUIRED FOR SINGLE-/DUAL-ENGINE CAPABILITY.

*3. Pickle — AS DESIRED.

*4. Speed control lever — AS REQUIRED (AFFECTED ENGINE(S) SHUT OFF).

*5. Fire T-Handles — PULL AFT (AFFECTED ENGINE(S)).

Note

If more than one emergency T-handle is moved full aft, the fire extinguishing agent will be directed to the engine compartment of the last emergency T-handle activated.

*6. Main engine fire extinguisher switch — MAIN, RESERVE IF NECESSARY.

Note

If two bottles were discharged into one engine compartment, the remaining bottle can be discharged into either of the remaining compartments. The last bottle will be discharged by either the MAIN or RESERVE selection, depending on which two bottles have already been discharged, and which compartment has been selected. In this case, the most expeditious thing to do is to select MAIN and then RESERVE.

*7. If fire continues, land immediately.

*8. If extinguished, land as soon as possible.

12.14.3 Engine Postshutdown Fire. An engine postshutdown fire in the combustion chamber after shutdown may continue to feed itself unless it is blown out by compressor air. Indications would be a rise in T_5 above 320°C after shutdown and/or excessive smoke from the engine exhaust outlet.

*1. Speed control lever — SHUTOFF.

*2. Fuel selector lever — SHUTOFF.

*3. Emergency start switch — EMER.

*4. Starter button — PRESS.

Motorize engine until fire is put out, and observe T_5.

Note

If all engines have been shut down, APP should be operating.

5. If fire continues, be sure EAPS doors are open and have fire extinguisher discharged into air inlet duct while motoring engine.

6. Pull down on handle of speed control lever to stop starter.

If an engine fire warning light goes on:

7. Emergency T-handle — PULL AFT.

To select engine compartment for fire extinguisher.

8. Engine fire extinguisher switch — MAIN, RESERVE, IF NECESSARY.

12.14.4 Three Simultaneous Engine Compartment Fires in Flight

*1. Land immediately.

12.14.5 APP or Cabin Heater Fire. A fire in the APP or cabin heater will be indicated by the fire warning master lights and the fire warning lights in the APP emergency T-handle. Whenever the APP and cabin heater fire warning light is on, do this:

*1. APP emergency T-handle — PULL AFT (TO DISCHARGE FIRE EXTINGUISHER AND SHUTOFF APP AND HEATER FUEL).

*2. If fire persists — LAND IMMEDIATELY.

3. APP circuit breaker control switch — OFF, IF APP OPERATING.

4. Cabin heater rheostat control — OFF, IF CABIN HEATER OPERATING.

5. Alert ground crew (if on the ground).

12.14.6 Fuselage Fire

*1. Cockpit circular vents — CLOSED.

*2. Vent fan switch — OFF.

*3. If fire persists — LAND IMMEDIATELY.

Crewman: Do this:

1. Notify pilot of location and extent of fire.

2. Cabin doors and hatches — CLOSED.

3. Vent system diffusers — CLOSED.

4. Fight fire with portable fire extinguisher; then prepare for emergency landing.

5. Seat belt — FASTENED.

If fire is out:

6. Vent system diffusers open, cabin doors and hatches open.

CAUTION

Do not push out cabin windows or escape hatches while helicopter is in flight, as they may damage helicopter.

12.14.7 Electrical Fire. In case of an electrical fire, attempt to isolate the affected circuits by selectively securing electrical equipment or pulling circuit breakers. If fire persists, land immediately; while in flight, do as follows:

WARNING

Turning all generators off will result in immediate loss of all electrical instruments, warning systems, ICS, and AFCS, except servo 1. Helicopter response to total electrical loss may be violent. Landing gear may only be extended by the emergency method, and a positive gear down check will not be possible. Consideration should be given to all problems before turning all generators off.

*1. Circuit breaker (for affected circuit) — PULL.

*2. Fight fire with portable fire extinguisher.

*3. If fire persists — LAND IMMEDIATELY.

12.14.8 Main Transmission Area Fire. A fire in the main transmission area will be indicated by the fire warning master light and the MAIN XMSN FIRE light under the pilot's and copilot's glareshield. If a main transmission fire is detected/suspected, perform the following:

*1. Land immediately.

Note

The helicopter has no internal fire extinguishing agent routed to the main transmission area.

*2. Secure helicopter — IMMEDIATELY.

Note

If a rotor brake fire is suspected, consider a no-rotor brake shutdown.

3. Portable fire extinguisher — USE

12.14.9 Hydraulic Fire in Main Rotor Pylon. Hydraulic fire in the main rotor pylon area is most likely to occur during taxi, hover, or low airspeed operations. Hydraulic fire may be indicated by white smoke and/or flames in the vicinity of the main transmission and/or by illumination of a number of unassociated caution lights. Because of the intense heat generated, flight control components may disintegrate rapidly, causing the aircraft to become uncontrollable.

Note

On aircraft equipped with the 419 engine, two additional fire detector sensors are installed in the aft section of the main transmission/main rotor pylon to detect a fire in the vicinity of the rotor brake and/or number 2 engine area. If this should occur, a dedicated MAIN XMSN FIRE light will warn the pilot.

If a hydraulic fire is detected/suspected:

*1. Land immediately.

Note

If feasible, accomplish a running landing at 40 knots ground speed to maintain airflow through the rotary wing pylon.

*2. Secure helicopter — IMMEDIATELY.

WARNING

Delay in shutting down the helicopter may give the fire time to burn through a flight control component, causing the helicopter to roll over.

3. Portable fire extinguisher — USE.

12.14.10 Smoke and Fume Elimination

Pilot:

1. Vent fan — ON.
2. Register and diffusers — OPEN.

Crewman:

1. Diffusers — OPEN.
2. Upper half of personnel door — OPEN.
3. Emergency escape hatches — OPEN.
4. Cargo door — OPEN.

CAUTION

Do not push out cabin windows or escape hatches while helicopter is in flight, as they may damage helicopter.

12.14.11 #2 ENGINE OVERHEAT Caution Light (AFC 483, Part 2) When the temperature inside the No. 2 engine compartment rises above approximately 575°F, a signal is sent to illuminate the #2 ENGINE OVERHEAT caution light. Check engine instruments and proceed as follows:

*1. Collective — MAINTAIN N_R.
*2. Airspeed — AS REQUIRED.
*3. Pickle — AS DESIRED.
*4. Speed control levers — NO. 2 ENG SHUTOFF.
5. Perform single- or dual-engine procedures.
6. If subsequent fire is detected/suspected, perform single- or dual-engine compartment fire(s) in flight procedure.

CAUTION

Do not attempt to restart affected engine.

12.15 FUEL SYSTEM EMERGENCIES

12.15.1 Fuel Supply System Failure

12.15.1.1 Fuel Filter Bypass Light

One or two engines fuel filter being bypassed.

1. Engine instruments — MONITOR.
2. Land — AS SOON AS PRACTICAL.

Note

Consideration should be given to cross feeding the affected engine(s) to a non affected tank if adverse secondary indications are noted. In addition, fuel from affected tanks should be transferred only if necessary.

Three engines' fuel filters being bypassed.

1. Engine instruments — MONITOR.
2. Land — AS SOON AS POSSIBLE.

12.15.1.2 Engine-Driven Fuel Pump Failure. If an engine-driven fuel pump should fail, the engine will shut down due to fuel starvation. Refer to ENGINE SHUTDOWN IN FLIGHT in this chapter.

12.15.1.3 Fuel Boost Pump Failure. If a fuel boost pump should fail (as evidenced by an ENG FUEL BOOST caution light and its associated ENG FLTR BYPASS caution light), the engine-driven fuel pump will supply enough fuel for normal engine operation. Check engine operation and fuel flow. Land as soon as practical.

12.15.1.4 Fuel Control System Failure. Power loss resulting from complete fuel control system failure can be determined by an immediate reference to the indication of the torquemeter, accompanied by a large decrease in T_5, and further verified by a drop of power turbine

speed to zero. Engine stall is usually recognized by a rapid rise in T_5 and a hangup of N_g, possibly accompanied by an audible rumble or vibration, or a popping noise. Flameouts are recognized by an immediate decrease in T_5, N_g, fuel flow, torque, and N_f on the affected engine. If no engine malfunction was observed before the flameout, a restart may be attempted. If the fuel control has malfunctioned in a manner that has caused the engine to overspeed, retard the speed control lever to reduce the N_f to 100%. The engine overspeed protection system will normally control the overspeed when it reaches 110 ±2% N_f. If the overspeed protection system does not control overspeed, and N_f cannot be reduced to 100% by retarding the speed control lever, or raising the collective to droop the rotor, shut down the affected engine. It should be noted that the engine instruments often provide indications of fuel control system failure before actual engine failure. If engine failure is due to momentary malfunction of the fuel control system or to improper operating technique, an air start can usually be made to restore engine operation, when time and altitude permit.

12.15.1.5 Fuel Dump System Malfunction. In the event of a malfunction in the aircraft fuel dump system, as evidenced by rapidly decreasing fuel quantity in the affected tank(s), proceed as follows:

1. Fuel dump switches — OFF.

2. Fuel transfer/refuel pushbutton indicators — OFF, ARROWS EXTINGUISHED.

3. Left fuel dump pump circuit breaker, (2A PRI AC BUS) — PULL.

4. Right fuel dump pump circuit breaker, (3 PRI AC BUS) — PULL.

5. Fuel dump tubes — VISUALLY CHECK FOR SIGNS OF FLOW.

6. LAND AS SOON AS PRACTICAL.

CAUTION

Depending on the fuel dump malfunction, fuel may continue to siphon overboard after two minutes. Fuel draining onto a landing area may puddle and create a fire hazard.

Note

The aircraft fuel dump system will dump main tank fuel to the low fuel level, and secure.

12.16 AFCS SYSTEM FAILURES

12.16.1 AFCS Computer Malfunction. A malfunction in the AFCS computer can cause low to high random inputs into the main rotor or tail rotor controls, resulting in possible helicopter vibration.

The CMPTR POWER pushbutton on the AFCS CONTROL PANEL should be turned OFF if these conditions occur:

1. An increase in aircraft motion, vibration, or tip path plane movement accompanied by the AFCS

DEGRADED advisory light and all FAIL ADVISORY lights, except DESEN and SAS, indicates a single computer failure (SIMPLEX FAILURE) and that the AFCS is only partially functional.

2. An increase in aircraft motion, vibration, or tip path plane movement accompanied by the AFCS CAUTION light indicates a dual computer failure (DUPLEX FAILURE) and no AFCS functions are being performed.

3. For SIMPLEX FAILURE, secure TRIM and AFCS, then recycle computer power. For DUPLEX FAILURE, recycle computer power. If the malfunction does not clear, take the following action:

An AFCS caution light indicates both computers are switched off and no AFCS functions are being performed. If an AFCS caution light should go on, turn computer power OFF, and return it to ON. If the AFCS caution light does not go out, take the following action:

*1. Instrument meteorological conditions (IMC) — LAND AS SOON AS POSSIBLE.

2. Visual meteorological conditions (VMC) - LAND AS SOON AS PRACTICAL.

12.16.2 Desensitizer Failure. Any of the following conditions may indicate an inoperative desensitizer:

1. DSEN fail advisory light on the AFCS control panel is lit.

2. AFCS is off.

3. AFCS duplex failure.

4. FAS shearpin is sheared.

WARNING

Loss of a control desensitizer will, under certain circumstances, allow the pilot to interact with the fuselage bending modes to create a pilot-induced oscillation (PIO). This interaction can result in divergent helicopter oscillations. Delayed pilot response in eliminating these oscillations may result in helicopter damage and/or uncontrolled flight. If encountered, releasing the flight controls (HAND REMOVED FROM COLLECTIVE) for several seconds should eliminate the condition. During external cargo or AMCM operations, if PIO/PAO is encountered and cannot be controlled, immediately jettison the load or jettison/release the tow.

If a desensitizer failure occurs, perform the following:

1. MODE RESET pushbutton — RESET.

If the desensitizer failure does not clear after mode reset, the following precautions must be observed:

1. Avoid abrupt control inputs.

2. Minimize hover time.

3. Do not pick up an external load. If flying with an external load, continue to the destination and gently set the load down. Do not attempt to re-lift the load.

4. Do not commence AMCM operations. If engaged in AMCM operations, initiate recovery procedures. If PIO/PAO is experienced, jettison/release the AMCM gear and remove hands from controls.

12.16.3 AFCS Malfunction. An automatic flight control system (AFCS) malfunction could occur as a result of a stability augmentation system (inner loop, SAS) failure; autopilot (outer loop, trim) failure, or an AFCS servo hardover. The cues are distinctly different for each failure mode. An inner loop failure will be noted by an unusual uncommanded attitude change with no associated movement in the flight controls. Due to the limited authority (about 10%) of the inner loop functions of the AFCS, this failure mode is generally benign and easily controlled by the pilot.

An autopilot failure, on the other hand, is characterized by an uncommanded movement of the flight control. The rate of movement of the flight control is limited to 10 percent per second, which provides the pilot adequate time to control the autopilot failure (trim drive). Recovery is effected by depressing the trim release of the flight control in question and manually repositioning the control.

12.16.4 AFCS Servo Hardover. An AFCS servo hardover is an uncommanded movement of the flight controls which cannot be easily overridden by the pilot. The rate at which the control moves may vary from a relatively slow rate (about 1 inch per second) to full travel in less than one second (100% per second). When potentially high rates of control change are experienced, and depressing the trim release does not override the drive, suspect an AFCS servo hardover. A rapid response to this emergency will be required to retain control. If a hardover is experienced, proceed as follows:

*1. Transfer to other AFCS servo. If servo hardover condition is relieved — PROCEED AND LAND AS SOON AS PRACTICAL.

CAUTION

High control forces may change to normal of AFCS servo changeover.

*2. If servo hardover condition persists — SECURE AFCS SERVOS.

*3. VMC — LAND AS SOON AS PRACTICAL.

*4. IMC — LAND AS SOON AS POSSIBLE.

12.17 ELECTRICAL SYSTEM FAILURES

12.17.1 Electrical Power Supply System Malfunction

12.17.1.1 Alternating Current System Failure. The alternating current system, powered by three ac generators, is so designed that failure of a generator will cause the No. 1 and No. 3 monitor ac buses to be dropped from the system and the operating generators to power all other buses. If a generator failure caution light

should go on, place the appropriate generator switch to RESET OFF, and return it to ON. This will restore generator service if the malfunction was caused by momentary overvoltage or undervoltage.

1. Affected generator — RESET/OFF, THEN ON.

2. If one or two generators fail — LAND AS SOON AS PRACTICAL.

3. If all generators fail or if two generators fail during night, instrument, or icing conditions — LAND AS SOON AS POSSIBLE.

Operation with the No. 1 generator furnishes power to the No. 1 primary ac bus, No. 2A primary ac bus, emergency ac bus, and all of the dc buses, except the No. 1 monitor dc bus.

Operation with the No. 3 generator furnishes power to the No. 3 primary ac bus, No. 2B primary ac bus, emergency ac bus, and all of the dc buses, except the No. 1 monitor dc bus.

Operation with the No. 2 generator furnishes power to all buses except the No. 1 and No. 3 monitor ac buses.

Note

(AFC 490) When operating the aircraft with the No. 1 generator on, and the No. 2 and No. 3 generators off or failed; the No. 3 primary ac bus will be lost, failing the No. 2 AFCS computer, AHRS, TACAN, VOR, No. 1 and No. 2 HSIs, and the radar altimeter.

12.17.1.2 Direct Current System Failure. Failure of either rectifier will be indicated by lighting of its associated caution light, (RECT #). If one or both rectifiers fail, proceed as follows:

Day VMC Flight

1. Single rectifier failure — EXTEND LANDING GEAR, LAND AS SOON AS PRACTICAL.

2. Dual rectifier failure — LAND AS SOON AS POSSIBLE.

Night/IMC Flight

1. Single rectifier failure — ESTABLISH VMC IF ABLE, EXTEND LANDING GEAR, LAND AS SOON AS POSSIBLE.

2. Dual rectifier failure — LAND AS SOON AS POSSIBLE.

Note

- In the event of a dual rectifier failure, mission essential equipment including AFCS computers will become inoperative. Navigation, ICS, and communication equipment will also be degraded.
- With no down and locked indication in the cockpit, it will be necessary to use the emergency extension system to extend the landing gear.

12.18 HYDRAULIC SYSTEM FAILURES

12.18.1 Hydraulic Power Supply System Failure. A display of very low hydraulic fluid quantity indicated by the hydraulic fluid status gage, or as the caution panel dictates, for a condition that cannot be corrected with the manual hydraulic refill system, do this:

*1. First and second stage hydraulic systems fluid quantity low — LAND AS SOON AS POSSIBLE.

*2. First stage and utility 1 hydraulic systems fluid low — LAND AS SOON AS POSSIBLE.

3. First or second stage hydraulic system fluid low — LAND AS SOON AS PRACTICAL.

4. Second stage and utility 1 systems fluid quantity low — LAND AS SOON AS PRACTICAL.

5. Utility 1 hydraulic system fluid quantity low — LAND AS SOON AS PRACTICAL.

Note

AFCS servos will automatically transfer if pressure in second stage system drops below 650 psi or 1500 psi in utility 1 system. Fluctuating pressure in second stage or utility 1 hydraulic systems can result in erratic AFCS servo operation and transfer. To prevent undesirable helicopter response, manually select system operating properly.

6. Utility 2 hydraulic system fluid quantity low — DISCONTINUE AMCM OPERATIONS AND LAND AS SOON AS PRACTICAL.

12.18.2 Utility 1 Hydraulic System Failure. The primary visual indications of system malfunctions are: (1) The UTIL 1 HYD PRESS gage on the instrument panel, redlined at 2600 psi minimum or 3300 psi maximum, (2) the UTILITY 1 PRESS caution light that goes on when hydraulic pressure drops below 1500 psi, (3) the UTILITY 1 OIL HOT caution light that goes on when the hydraulic fluid temperature rises to 107°C or the cooler blower motor stops, and (4) the UTILITY QTY T/R caution light that goes on when reservoir quantity drops to an unsatisfactory level.

The utility 1 hydraulic system receives pressure from a pump driven by the accessory gear box, and failure will be indicated by the pressure gage or temperature caution light. The engine starting system, APP starting system, landing gear system, cargo ramp and door system, main wheel power brake system, blade/pylon fold systems, rotor head positioning for engine start, second stage side of tail rotor servo, AFCS SERVO 2 pitch, altitude, roll, and yaw servos, rescue hoist, and cargo winch will be inoperative if the utility hydraulic system pump should fail, or if pressure is lost from the system.

If utility 1 hydraulic system failure is indicated by either the UTILITY 1 PRESS caution light or the pressure gage is at zero or fluctuating near or below 1000 psi, do this:

WARNING

Extended flight with utility 1 hydraulic system failure is not recommended, due to possible loss of first stage hydraulic system and subsequent loss of tail rotor control.

*1. Landing gear — EXTEND.

CAUTION

Should utility 1 hydraulic failure occur with ramp at or below level position, ramp to ground contact may occur during landing.

*2. Land as soon as possible.

12.18.3 Utility 1 Hydraulic Fluid Hot. The utility 1 hydraulic system fluid is cooled by a heat exchanger on the upper left side of the fuselage. If the UTILITY 1 OIL HOT caution light goes on do this:

1. Hydraulic pressure and quantity gages — CHECK.

2. HEAT EXCH UTIL-1 (NO 1 PRI DC BUS) and HEAT EXCHANGE UTILITY-1 PWR (NO 1 PRI AC BUS) CBs — CHECK.

   a. If either CB is out, attempt to reset once only. Go to step 3.

   b. If both breakers are in when first checked, pull the UTIL OIL HOT (NO 3 PRI DC BUS) CB.

      (1) If the caution light extinguishes, the fluid has overheated. Reset CB and go to step 3.

      (2) If the caution light remains illuminated, the blower has overheated and shut down. Reset the UTIL OIL HOT CB. Then, pull the HEAT EXCH UTIL-1 CB for 1 to 2 minutes to allow the blower to cool and be restored.

         (a) If the caution light extinguishes while the HEAT EXCH UTIL-1 CB is pulled, the fluid is not overheated. Restored blower operation is verified by the caution light remaining off when the CB is reset.

         (b) If the caution light remains illuminated, the fluid is overheated (in addition to the blower). After resetting the HEAT EXCH UTIL-1 CB, the caution light will not go out until the fluid has cooled. Proper blower operation can be verified by pulling and resetting the UTIL OIL HOT CB and noting the caution light momentarily goes off.

3. If pressure is normal, lower landing gear, cycle cargo ramp, start APP, or actuate other utility 1 system.

4. If light remains on, land as soon as practical.

12.18.4 Utility 2 Hydraulic System Failure. The primary visual indications of system malfunctions are: (1) the UTIL 2 HYD PRESS gage on the instrument panel

redlined at 2600 psi minimum or 3300 psi maximum, (2) the UTILITY 2 PRESS caution light that goes on when hydraulic pressure drops below 675 psi, and (3) the UTILITY 2 OIL HOT caution light that goes on when the hydraulic fluid temperature rises to 107°C or the cooler blower motor stops.

The utility 2 hydraulic system receives pressure from a pump driven by the accessory gear box, and failure will be indicated by pressure gage or temperature caution light. The winch pallets, tow boom, and davit will be inoperative if the utility 2 hydraulic system pump should fail, or if pressure is lost from the system.

If utility 2 hydraulic system failure is indicated by either the UTILITY 2 PRESS caution light or the pressure gage at zero or fluctuating near or below 675 psi, do this:

1. Minimize AMCM operations.

2. Turn utility 2 pump switch OFF.

Note

If the utility 2 hydraulic system should fail during streaming or recover operation, the winches will be deenergized and hydraulically locked.

12.18.5 Utility 2 Hydraulic Fluid Hot. The utility 2 hydraulic system is cooled by a heat exchanger located on the upper starboard side of the fuselage, aft of the main gear box. Should the UTILITY 2 OIL HOT caution light go on, do this:

1. Hydraulic pressure and quantity gages — CHECK.

2. UTILITY 2 HEAT EXCH (NO 2 PRI DC BUS) and HEAT EXCHANGER UTIL 2 (NO 2A PRI AC BUS) circuit CBs — CHECK.

   a. If either CB is out, attempt to reset once only. Go to step 3.

   b. If both CBs are in when first checked, pull the UTIL-2 OIL HOT (NO 3 PRI DC BUS) CB.

      (1) If the caution light extinguishes, the fluid has overheated. Reset CB and go to step 3.

      (2) If the caution light remains illuminated, the blower has overheated and shut down. Reset the UTIL-2 OIL HOT CB. Then, pull the UTILITY 2 HEAT EXCH CB for 1 to 2 minutes to allow the blower to cool and be restored.

      (a) If the caution light extinguishes while the UTILITY 2 HEAT EXCH CB is pulled, the fluid is not overheated. Restored blower operation is verified by the caution light remaining off when the CB is reset.

      (b) If the caution light remains illuminated, the fluid is overheated (in addition to the blower). After resetting the UTILITY 2 HEAT EXCH CB, the caution light will not go out until the fluid has cooled. Proper blower operation can be verified by pulling and resetting the UTIL-2 OIL HOT CB and noting the caution light momentarily goes off.

3. If pressure/quantity is normal, cycle nonmission essential AMCM equipment.

4. If light remains on, recover AMCM equipment and terminate AMCM operations.

5. Turn utility 2 pump switch OFF.

12.18.6 Flight Control Hydraulic System Failure. The primary visual indications of system malfunctions are: (1) 1ST and 2ND STAGE HYD PRESS gages on the instrument panel redlined at 2600 psi minimum or 3300 psi maximum, (2) the 1 STG PRESS M/R T/R and 2 STG PRESS M/R caution lights that go on when pressure drops below 2000 psi, and (3) the 1 STG QTY M/R T/R and 2 STG QTY M/R caution lights that go on when reservoir fluid quantity drops to an unsatisfactory low level, and (4) the 2 STG OIL HOT caution light that goes on when the second stage hydraulic fluid temperature rises to 107 °C or the cooler blower motor stops.

WARNING

- Failure of first and second stages of flight control system will result in loss of control of helicopter.

- Rapid or abrupt movement of flight controls with only one primary flight control hydraulic system operating can result in control restrictions due to a reduction of pressure in operating system.

Note

- Do not turn a flight control system off if a constant abnormally high pressure is indicated. Land as soon as practical.

- In case of loss of pressure in first or second stage hydraulic system, check that both collective flight control servo switches are ON.

Control of the helicopter can be maintained by either the first stage or second stage hydraulic system if one or the other fails. Either system may be turned off by actuating either collective flight control servo switch, provided there is at least 2000 psi hydraulic pressure in the remaining system. When one servo system fails, it should not be shut off unless there is a definite restriction of controls; airspeed should be decreased to 80 to 100 KIAS. Flight should be terminated as soon as possible due to the possibility of failure of the remaining servo system. Loss of pressure in either servo system will be indicated by an appropriate low-pressure caution light and lower than normal operating pressure on the corresponding hydraulic pressure gage. A pressure switch interlock makes it impossible to turn off one servo system while the pressure in the other servo system is below 2000 psi. When the second stage hydraulic system is inoperative due to a loss of pressure, these systems or related components will also be inoperative.

1. The half of each primary tandem servo that is powered by the second stage hydraulic system; and when the second stage hydraulic system is turned off, the half of the tail rotor tandem servo that is powered by the utility hydraulic system.

2. Pitch, altitude, roll, and yaw channels of SERVO 1.

12.18.7 Primary Tandem Servo Malfunction. The primary visual indications of a primary tandem servo malfunction are the 1 STG M/R SERVO BYPAS or 2 STG M/R SERVO BYPAS caution lights that go on when a servo has malfunctioned in such a manner to cause it to bypass hydraulic pressure or it has lost system pressure.

WARNING

When the 1 STG M/R SERVO BYPAS caution light is observed after a utility hydraulic system failure, securing first stage flight control system will result in loss of tail rotor control. There are no interlocks to prevent turning off pressure to first or second stage hydraulic systems, when a servo in the other stage is in bypass. Turning off pressure to the non-bypassed stage results in loss of control of the servo.

An individual primary tandem servo malfunction will be indicated by a servo bypass caution light that indicates which flight control hydraulic system has the failed servo. The caution light does not indicate the individual servo that has failed. The servo bypass caution light will indicate a servo has failed in a manner that has subjected it to a loss of hydraulic pressure. The servo bypass caution light may go off with certain position of the servo piston, even though the malfunction still exists. In this case, check the appropriate flight control hydraulic system pressure gage to determine if the system has failed or the failure is within the servo. When a servo bypass caution light is observed, do not turn off the corresponding servo system unless there is a definite restriction of controls. Do this:

*1. Airspeed — REDUCE.

*2. Land as soon as possible.

12.18.8 Tail Rotor Tandem Servo Malfunction. The first stage flight control hydraulic system furnishes the necessary pressure to operate the first stage side of the tail rotor tandem servo. The first stage hydraulic quantity indicator and the caution light are the primary visual indication of loss of hydraulic fluid to the first stage system. The first stage hydraulic pressure gage and caution lights are an immediate indication of a loss of operating hydraulic pressure to the first stage side of the tail rotor tandem servo. The utility 1 hydraulic system furnishes the necessary pressure to operate the second stage side of the tail rotor tandem servo. The utility 1 hydraulic quantity indicator and the caution light are the primary visual indications of loss of hydraulic fluid to the utility system. The utility 1 pressure gage and caution lights are an immediate indication of loss of operating hydraulic pressure to the second stage side of the tail rotor tandem servo. The UTILITY T/R PRESS caution light goes

on when utility 1 pressure downstream of the second stage servo shutoff valve in the utility module drops below 1500 psi.

WARNING

Do not shut off first stage flight control hydraulic pressure when there is no utility 1 hydraulic pressure being furnished to the tail rotor tandem servo. Tail rotor control will be lost.

Tail Rotor Tandem Servo Malfunction. The primary visual indications of tail rotor tandem servo malfunction are the 1 STG T/R SERVO BYPAS and 2 STG T/R SERVO BYPAS caution lights that go on when the servo has malfunctioned in such a manner to cause if to bypass hydraulic pressure, or it has lost system pressure.

When a tail rotor servo bypass caution light is observed, do not turn off the corresponding servo system unless there is a definite restriction of controls. Do this:

*1. Airspeed — REDUCE.

*2. Land as soon as possible.

12.18.9 Second Stage Hydraulic Fluid Hot. Should the 2ND STG OIL HOT caution light illuminate, proceed as follows:

1. Hydraulic pressure and quantity gages — CHECK (REFER TO OTHER EPs APPROPRIATE FOR SECONDARIES).

2. Minimize maneuvering and maintain moderate airspeed.

3. HEAT EXCH NO 2 (NO 2 PRI DC BUS) and HEAT EXCHANGE 2ND STAGE PWR (NO 2B PRI AC BUS) CBs — CHECK.

a. If either CB is out, attempt to reset only once. Go to step 4.

b. If both CBs are in when first checked, pull the 2-STG OIL HOT (NO 1 PRI DC BUS) CB.

(1) If the caution light extinguishes, the fluid has overheated. Reset the CB and go to step 4.

(2) If the caution light remains illuminated, the blower has overheated and shut down. Reset the 2-STG OIL HOT CB. Then, pull the HEAT EXCH NO 2 CB for 1 to 2 minutes to allow the blower to cool and be restored.

(a) If the caution light extinguishes while the HEAT EXCH NO 2 CB is out, the fluid is not overheated. Restored blower operation is verified by the caution light remaining off when the CB is reset.

(b) If the caution light remains illuminated, the fluid is overheated (in addition to the blower). After resetting the HEAT EXCH NO 2 CB, the caution light will not go out until the fluid has cooled. If the caution light is on, proper blower operation can be verified by pulling and resetting the 2-STG OIL HOT CB and noting the caution light momentarily goes off.

4. If pressure and quantity remain normal, yet the light remains illuminated, land as soon as practical.

12.18.10 Restriction or Binding of the Flight Controls In Flight

1. Check for any cockpit obstructions to the flight controls.

2. Reduce airspeed to 80 to 100 KIAS.

3. Minimize flight control inputs.

4. Land as soon as possible.

12.18.11 Binding or Restriction On Ground

1. Hold slight pressure against binding or restriction.

2. Shut down aircraft.

3. Continue to hold pressure against binding and follow troubleshooters instructions.

WARNING

Ground crew should use extreme caution around the rotor arc during shutdown as the rotor tip path may be in a hazardous area.

12.19 HOIST MALFUNCTIONS

12.19.1 Hoist Electrical Failure. The hoist receives electrical power from the No 2 Pri DC bus. If the crew and pilot hoist controls both fail to raise or lower cable, do this:

1. Ensure hoist control master switch is in pilot or crew.

2. Circuit Breaker — RESET.

If hoist still does not respond:

3. Crewman recover cable utilizing the manual override.

WARNING

Use extreme caution when operating the hoist in the emergency mode. The limit switches are bypassed and will not stop the hoist at either extreme.

4. Stop reeling in cable when the spring compresses against the level wind.

Further use of the hoist should be in emergency cases only.

12.19.2 Hoist Hydraulic Failure. Hydraulic power is supplied to the hoist by the Utility 1 system through the isolation valve. If there is no hydraulic control of the hoist, do this:

1. Ensure hoist control master switch is in pilot or crew.

2. Isolation advisory light — ILLUMINATED.

If isolation advisory light is not illuminated, open isolation valve with another subsystem. This will allow the crewman to operate hoist with the manual override.

If unable to gain control of hoist:

3. Hoist control master switch — OFF.

4. Return personnel/cargo to the water/deck.

5. Pull cable hand over hand into the cabin and secure.

If unable to return personnel/cargo:

6. Secure hoist cable with the Chicago/Kline grip and gunner's belt or shear cable as required.

Note

The master switch on the hoist control panel has to be at CREW or PILOT before the hoist shear switch, on the cockpit console, can shear the cable. The master switch has to be at CREW before the crewman's hoist cable shear switch, in the cabin, can shear the cable.

12.19.3 Hoist Cable Jammed. If it is determined the cable is jammed, do this:

1. Hoist control master switch — OFF.

2. Return personnel/cargo to the water/deck.

3. Pull cable hand over hand into the cabin and secure.

If unable to return personnel/cargo to the water/deck:

4. Secure hoist cable with the Chicago/Kline grip and gunner's belt or shear cable as required.

Note

The master switch on the hoist control panel has to be at CREW or PILOT before the hoist shear switch, on the cockpit console, can shear the cable. The master switch has to be at CREW before the crewman's hoist cable shear switch, in the cabin, can shear the cable.

12.19.4 Hoist Cable Damaged/Broken. If a portion of the hoist cable is broken or damaged beyond use, do this:

1. Cut the damaged section off if required.
2. Thread remaining cable through the quick splice following the numbered holes.
3. Tuck the bitter end under the clip.

WARNING

The quick splice will not engage the upper limit switch. Separation of the quick splice is possible on subsequent hoistings when the cable reaches the upper limit.

12.19.5 Runaway Hoist Cable. If the hoist cable will not stop with electrical or hydraulic power, do this:

1. Hoist control master switch — OFF.
2. Hoist power circuit breaker — PULL.
3. Open isolation valve with another subsystem.
4. Regain control of the hoist with the manual override.

WARNING

Use extreme caution when operating the hoist in the emergency mode. The limit switches are bypassed and will not stop the hoist at either extreme.

12.20 LANDING GEAR SYSTEM FAILURE

Note

Aural ("GEAR, GEAR")/visual (GPWS ALERT) warning occurs when helicopter is less than 150 feet AGL, KIAS is less than 60 knots, and landing gear is up.

If the utility 1 hydraulic system should fail or the landing gear electrical system should fail, the landing gear cannot be retracted; however, the landing gear can be lowered by the landing gear emergency system. This system will lower the landing gear in a hover in about 10 seconds.

CAUTION

Pulling the landing gear emergency release handle while aircraft is in forward flight may cause one or more of the landing gear to hang up.

The system lowers the landing gear by compressed nitrogen from a 3000 psi capacity nitrogen bottle. To lower the landing gear, do this:

Condition:

Utility 1 pressure up, landing gear control handle down, both main landing gear down and locked, and nose landing gear not extended and/or nose landing gear closed.

1. Reduce airspeed to decease load on nose gear door (come to a hover if possible).
2. Raise the landing gear handle and wait for three up and locked indications.
3. Lower the landing gear handle. If the nose gear does not extend, proceed as indicated in the next following conditional procedures.

Condition:

Utility 1 pressure up, landing gear control handle down, all gear unlocked but one or more not extended.

CAUTION

Leave landing gear control handle in down position.

Note

- Do not actuate landing gear emergency release handle.

- If LANDING GEAR POS circuit breaker is pulled, there will be no down and locked indication in cockpit.

- If LANDING GEAR CONT circuit breaker is pulled, cockpit indication may not correspond to actual gear position.

1. Pull LANDING GEAR CONT circuit breaker, to cut hydraulic pressure to landing gear.

2. After 5 seconds, reset circuit breaker.

3. Repeat procedure if gear does not extend.

4. If gear fails to fully extend and lock, exert G forces on the helicopter using combinations of angle of bank and/or aft cyclic.

CAUTION

Do not exceed aircraft G limitations for given gross weight and ambient conditions.

5. Retract COMM 1 antenna.

6. If gear still does not extend, leave circuit breaker out, and have ground personnel move gear to down and locked position.

WARNING

Be sure helicopter is properly grounded before maintenance personnel attempt to lower gear.

Condition:

Utility 1 pressure not available to lower gear, or gear fails to unlock with landing gear control handle down, regardless of pressure indication.

CAUTION

Leave landing gear control handle in down position.

1. If able, establish a hover at intended point of landing, activate the landing gear emergency release handle.

2. Execute a vertical landing.

CAUTION

A ground taxi should not be initiated until landing gear lock pins have been installed.

If all gear unlock but one fails to fully extend, do this:

3. Pull LANDING GEAR CONT circuit breaker to deactivate four-way valve for landing gear control.

4. Reset landing gear emergency release handle.

5. Retract COMM 1 antenna.

WARNING

Be sure helicopter is properly grounded before maintenance personnel attempt to lower gear.

6. Exert G forces on the helicopter using combinations of angle of bank and/or aft cyclic or hover and have ground personnel move gear to down and locked position.

WARNING

Do not attempt to execute the G-Force maneuver in step 5 with loss of utility 1 system pressure.

CAUTION

Pitch attitudes of over 5° to 7° nose-up should not be exceeded when landing with wheels up. If the landing gear system experienced an electrical malfunction and the landing gear has been lowered by the emergency system, the tail skid will not be extended.

Proper selection of a landing site and care during hovering of touchdown will permit a landing with a minimum of danger to personnel and damage to the helicopter. If attempts to lower the landing gear by the emergency system are unsuccessful, it may be possible to jar the landing gear loose by an abrupt increase in collective pitch after a shallow dive. It is also possible to hover at an altitude that will permit ground personnel to exercise all possible means to lower the landing gear and insert the landing gear lockpins.

Note

Landings with all wheels retracted or with any one or two wheels down may be made by placing soft objects, such as mattresses, under the malfunctioning landing gear and the bottom of the fuselage. Ground personnel should place the soft objects before touchdown, and then direct pilot from a hover to a vertical landing on objects. The force of the rotor downwash should be considered during this evolution.

12.20.1 Landing With All Gear Retracted or Improperly Lowered. If a landing must be made with all wheels retracted or improperly lowered, choose a level spot with no obstructions and preferably with a soft surface, such as sand, grass, or bushes.

1. APP — START.

2. From a hover, let down slowly and smoothly with no forward or sideward motion.

3. If landing gear is not fully retracted, it may push forward as in partial retraction, and helicopter will settle on lower fuselage and sponsons.

4. Speed control levers — SLOWLY REDUCE POWER ON ALL ENGINES TO GRD IDLE.

Note

Note which way helicopter will tilt as rotor speed decays. Greatest damage will occur to the main rotor blades if the helicopter tips to one side and the blades strike the ground.

5. Cyclic — MAINTAIN CONTROL AS LONG AS POSSIBLE.

6. Shut down engines.

7. Rotor brake — APPLY IF HELICOPTER TIPS OR AFTER ROTOR HAS COASTED TO A STOP.

12.20.2 Landing With One Main Gear Retracted or Not Locked Down. If only one main gear and the nose gear are down and locked and all attempts fail to lower and/or lock the malfunctioning main gear, retract the other main gear to provide a symmetrical configuration for a safer landing, and to lessen damage to the helicopter. If the other landing gear will not retract, use this procedure to make a landing:

1. When one main gear and the nose gear are down and locked, it is possible to use shoring or soft padding under the malfunctioning main gear, to prevent the helicopter from tipping over.

2. APP — START.

3. From a hover, let down slowly and smoothly with no forward or sideward motion.

4. Speed control levers — SLOWLY REDUCE POWER ON ALL ENGINES TO GRD IDLE.

Note

Helicopter will tilt to the side that has the retracted main gear, as rotor speed decays. Greatest damage will be to main rotor blades.

5. Cyclic — MAINTAIN CONTROL AS LONG AS POSSIBLE.

6. Shut down engines.

7. Rotor brake — APPLY IF HELICOPTER TIPS OR AFTER ROTOR HAS COASTED TO A STOP.

12.20.3 Landing With Both Main Gear Retracted or Not Locked Down. If only the nose gear is down and locked and all attempts fail to lower and lock both malfunctioning main gear, attempt to retract the nose gear to provide a symmetrical configuration to lessen damage to the helicopter. If the main landing gear will not lower and lock and the nose gear does, use this procedure to make a landing:

1. When only the nose gear is down and locked, it is possible to use soft padding under the fuselage to lessen the tipping action.

2. APP — START.

3. From a hover, let down slowly and smoothly with no forward or sideward motion.

4. Speed control levers — SLOWLY REDUCE POWER ON ALL ENGINES TO GRD IDLE.

5. Cyclic — MAINTAIN CONTROL AS LONG AS POSSIBLE.

6. Shut down engines.

7. Rotor brake — APPLY WHEN CONTROL IS LOST OR ROTOR HAS COASTED TO A STOP.

12.20.4 Landing with Nose Gear Retracted or Not Locked Down. If only the main gears are down and locked and all attempts fail to lower the nose gear, land with this configuration and do not attempt to retract the main gear, to provide a symmetrical configuration, as the helicopter will not tip with both main gear extended. When only the main gears are down and locked, it is possible to use padding under the malfunctioning nose gear, or, if padding is not available, the helicopter may be landed by using this procedure:

1. APP — START.

2. From a hover, let down smoothly and slowly with no forward or sideward motion.

3. Wheel brakes — LOCKED.

4. Collective — LOWER SLOWLY AS MAIN LANDING GEAR CONTACTS GROUND, AND EASE CYCLIC BACK AS HELICOPTER SETTLES NOSE DOWN.

Do not bring cyclic back far enough to allow main rotor blades to hit droop stops.

5. Wheel chocks — IN PLACE.

6. Shut down engines when nose is firmly on ground.

7. Rotor brake — APPLY AFTER ROTOR HAS COASTED TO A STOP.

12.20.5 Ground Resonance or Nose Wheel Shimmy. Characteristics and the tendency for development of ground resonance are discussed in Part IV. Immediate corrective action at the onset of ground resonance is imperative to prevent structural damage. if ground resonance/nose wheel shimmy occurs, proceed as follows:

*1. If able — TAKEOFF.

*2. If unable to takeoff — EMERGENCY SHUTDOWN.

12.21 TRANSMISSION SYSTEM FAILURES

12.21.1 Main Gear Box Failure. Main gear box failure may be indicated by any abnormal noise. At that time, check all instruments, and monitor for adverse indications. If the instruments should show any unusual indications, make an emergency landing. Main gear box failure may also be indicated by unusual yaw kicks accompanied by fluctuations in the torquemeters. If indications of main gear box failure are noted, do this:

*1. Instruments and caution lights — CHECK.

*2. Land as soon as possible. When flying over water, return to nearest ship or shore at a reduced airspeed and low altitude. The altitude should be sufficient to permit a quick flare if an enroute emergency water landing is necessary.

*3. If abnormal noises persist, an unusual amount of power is required to maintain the same flight condition, or yaw kicks are experienced — LAND IMMEDIATELY.

12.21.2 Main Gear Box Chip Locator Light. When the CHIP DETECTED caution light is accompanied by the MAIN GB chip locator light on the chip locator panel, progressive failure of the main gear box may be occurring.

*1. Instruments and caution lights — CHECK.

*2. If malfunction verified — PERFORM MAIN GEAR BOX FAILURE PROCEDURES.

3. If malfunction not verified, have aircrewmen isolate which source chip is coming from by using the MAIN XMSN CHIP LOCATOR panel — LAND AS SOON AS POSSIBLE.

Note

There is a 30 second time delay relay incorporated into the main lubrication sump and auxiliary lubrication sump chip detector systems. The MAIN GB chip detector on the chip locator panel in the cabin is not affected by the 30 second time delay relay.

4. If chip detector light goes out, continue with mission and closely monitor all main gear box instruments and caution lights.

12.21.3 Main Gear Box Oil System Failure

Note

It is not necessary to abort a flight as a result of losing the main gear box auxiliary oil pump as indicated by the MGB AUX LUB PUMP caution light going on. Continue mission, monitoring all other main gear box gages, chip detector, and caution lights. Be sure condition is corrected before next flight.

Loss of the main gear box primary oil pump is indicated by a decrease in oil pressure. If the MGB OIL PRESS caution light goes on and a complete loss of oil pressure is indicated, the gear box has lost all primary means of lubrication. In this case, reduce airspeed to minimum power required for flight, descend to minimum altitude, duration of flight not to be over 30 minutes, land as soon as possible.

If the MGB OIL PRESS and the MGB AUX LUB PUMP caution lights both go on and the main gear box oil pressure drops rapidly or decreases below minimum, the main gear box has lost all means of lubrication and an immediate landing shall be made. In this case:

*1. Land immediately.

If transition from forward flight is required, perform the following:

1. Airspeed — 80 TO 100 KIAS.

2. Retard No. 2 engine to MIN GOV.

3. Commence a power-on descent.

4. Land immediately using No. 2 engine if necessary during the landing.

WARNING

Loss of main gear box oil pressure accompanied by an increase in noise, vibrations, yaw kicks, or power surges indicates main gear box seizure is imminent.

A malfunction of the main gear box or the oil cooling system that would cause improper or insufficient lubrication will be indicated by one or more of these symptoms:

1. MGB OIL PRESS caution light goes on.

2. MGB OIL HOT caution light goes on.

3. Maximum or minimum indications on the main gear box oil pressure and temperature gages.

If any of these symptoms are noted:

1. Maintain reduced airspeed and low altitude.

2. Land as soon as possible.

3. Flying over water — RETURN TO NEAREST SUITABLE LANDING SITE AT REDUCED AIRSPEED AND LOW ALTITUDE.

Note

Altitude should be sufficient to permit a quick flare if enroute water landing is necessary.

If a change of MGB pressure out of normal operating range (50 to 65 psi), but not exceeding maximum or minimum limits, is noted:

1. Land as soon as practical.

12.21.4 A Main Gear Box Oil Cooler Blower Failure. A main gear box oil cooler blower failure may be indicated by an abnormal noise or thump and short duration medium-frequency vibration/buffet felt through the flight controls and airframe. Damage to the system components in the vicinity of the oil cooler blower may occur. An oil cooler blower failure will be accompanied by one or more of the following indications:

1. Main gear box oil temperature and pressure caution lights and abnormal gage indication.

2. #2 ENG OIL PRESS LOW caution light and abnormal oil temperature, N_g, T_5, and W_f gage indications.

Components or systems susceptible to secondary damage include first stage hydraulic system, tail rotor drive shaft, tail rotor control linkage, utility tail rotor control pressure and return lines, and the No. 2 engine.

If indication of a main gear box oil cooler blower failure exists:

*1. Check appropriate instruments and caution lights.

*2. Shut down No. 2 engine (conditions permitting).

*3. Land as soon as possible.

12.21.5 Free-Wheeling Unit (FWU) Failure. FWU failure is a slippage condition which allows N_f to exceed N_r with no usable torque transmitted to the MGB. This condition, usually caused by FWU bearing spitout, may be momentary (sometimes occurring repeatedly) or permanent and may result in breakup of the FWU. Slippage is indicated by any or all of the following symptoms: N_f exceeding N_r, torque dropping to zero, or a slight to moderate left yaw kick as the FWU slips. Sudden FWU reengagement causes a jolt to the airframe. If momentary slippage and reengagement occurs too rapidly, symptoms may not be fully reflected on the cockpit quad tachs and torque indicators; therefore, pilots should carefully monitor instruments if a FWU malfunction is suspected. The FWU may also lock up following a momentary slippage, wherein the MGB can back-drive the engine. This is indicated by N_f not splitting off from N_r when the SCL of the selected engine is retarded to MIN GOV. If momentary FWU slippage is indicated:

Note

Following a FWU slippage and subsequent reengagement, torque indications may be inaccurate.

*1. Collective — MAINTAIN N_r AT OR ABOVE 90%.

*2. Airspeed — AS REQUIRED FOR SINGLE/DUAL ENGINE CAPABILITY.

*3. Pickle — AS DESIRED.

*4. Speed control lever — AS REQUIRED (AFFECTED ENGINE TO MIN GOV).

WARNING

If the No. 2 engine speed control lever is at or below MIN GOV and the N_g is less than 75%, hot exhaust gas may backflow into the engine compartment creating a fire hazard. Limit airspeed to less than 85 KIAS to reduce backflow. If a FWU slippage has occurred and dual-engine flight can be maintained, consideration should be given to securing the No. 2 engine. If a FWU lockup is suspected, maintain No. 2 engine at no less than 75% N_g to reduce the possibility of backflow and to ensure engine lubrication.

CAUTION

In the event of a No. 1 or No. 3 FWU lockup, maintain the affected engine at or above ground idle to ensure lubrication of the power turbine shaft bearings.

5. Land as soon as practical.

6. Affected engine (if locked up) — SHUT DOWN LAST.

If permanent slippage occurs (where FWU slips without reengaging), refer to emergency procedure titled POWERTRAIN FAILURE.

12.21.6 Nose Gear Box Failure. Nose gear box failure may be indicated by an abnormal noise or change in noise frequency. A malfunction that would cause a binding or restriction within the gear box will cause a high engine torque reading to be observed. A malfunction that would cause a no load condition on the engine should produce a tendency for the engine to overspeed. If indications of nose gear box failure are noted, do this:

*1. Instruments and caution lights — CHECK.

*2. Collective — MAINTAIN N_r.

*3. Airspeed — AS REQUIRED FOR SINGLE/DUAL ENGINE CAPABILITY.

*4. Pickle — AS DESIRED.

*5. Speed control levers — AS REQUIRED (SHUT DOWN AFFECTED ENGINE, CONDITIONS PERMITTING).

6. Land as soon as practical.

12.21.7 Nose Gear Box Chip Locator Light. When the CHIP DETECTED caution light is accompanied by either of the nose gear box chip locator lights, check all

other nose gear box cautions and gages and engines torquemeters to verify malfunction.

*1. Instruments and caution lights — CHECK.

*2. If malfunction verified or chip locator light does not go out — PERFORM NOSE GEAR BOX FAILURE PROCEDURES.

3. If chip locator light goes out, continue mission and closely monitor gear box instruments and associated caution lights.

Note

An increase in torque for a given flight condition is a positive sign of nose gear box internal binding or restriction.

12.21.8 Nose Gear Box Oil System Failure. Loss of nose gear box lubrication will be indicated by the nose gear box oil temperature gage and oil temperature and pressure caution lights. If indications of a nose gear box oil system failure are noted, do this:

*1. Instruments and caution lights — CHECK.

*2. Perform NOSE GEAR BOX FAILURE procedures.

12.21.9 Accessory Gear Box Failure. Accessory gear box failure may be indicated by any abnormal noise. If abnormal noise is heard, check all instruments and electrically operated equipment for adverse indications. Systems that operate from the accessory gear box may also give adverse indications. If indications of accessory gear box failure are noted, do this:

*1. Instrument and caution lights — CHECK.

*2. Land as soon as possible.

12.21.10 Main Gear Box to Accessory Gear Box Drive Shaft Failure. In the event of an inflight accessory gear box failure because of failure of the transmission to accessory gear box drive shaft, it may be possible to regain lost systems by starting the APP. If loss of all AGB driven system is indicated and malfunction was not preceded by loss of AGB oil pressure, nor accompanied by AGB chip light/abnormal noises, the AGB and its driven systems may be regained; do this:

*1. APP — START.

*2. Land as soon as possible.

Note

Failure of the main gear box to accessory drive shaft will result in the loss of second stage, utility 1, utility 2, engine start pumps, AFCS and associated systems, and the NO. 1 and No. 3 generators.

12.21.11 Accessory Gear Box Chip Locator Light

*1. Instruments and caution lights — CHECK.

*2. If malfunction is verified or chip locator light does not go out — LOWER LANDING GEAR, LAND AS SOON AS POSSIBLE.

*3. If chip locator light goes out, continue mission and closely monitor all accessory gear box and caution lights and gages for accessory gear box driven systems.

Note

Accessory gear box failure will result in the loss of second stage, utility 1, utility 2, and engine start pumps, AFCS and other associated systems, and the No. 1 and No. 3 generators.

12.21.12 Accessory Gear Box Oil System Failure. Loss of accessory gear box lubrication will be indicated by the accessory gear box oil temperature and pressure caution lights. If loss of accessory gear box lubrication is indicated, do this:

*1. Instruments and caution lights — CHECK.

*2. Lower landing gear.

*3. Land as soon as possible.

12.21.13 Intermediate or Tail Gear Box Failure and Chip Locator Light. Other than the chip light and the TRGB/IGB oil press caution lights, there are no other instruments or caution lights with which to verify impending failures. A combination of chip light and corresponding oil press caution light confirm an impending failure. Additional flight indications of impending failure may include heading control difficulty, yaw kicks, high frequency vibrations, and unusual or loud grinding noises from the tail or transition section.

If impending failure is imminent as noted by combination of chip and corresponding oil pressure light, or illumination of any caution light with additional flight indications discussed above, or any of the flight indications discussed above, proceed as follows:

*1. LAND IMMEDIATELY.

If only a single caution light illuminates without any additional indication of failure, proceed as follows:

*1. Land as soon as possible.

2. If caution light extinguishes — LAND AS SOON AS PRACTICAL.

3. If caution light returns — LAND AS SOON AS POSSIBLE.

12.22 ROTOR SYSTEM FAILURE

12.22.1 BIM Caution Light. If the BIM caution light goes on, have a crewmember check the No. 3 primary ac BIM circuit breaker in (on the right cabin circuit breaker panel). Due to the sensitivity of the system, the caution light may go on due to Electromagnetic Interference (EMI), giving the pilot a false indication of impending spar failure. If the caution light remains on with the circuit breaker in, and EMI is not verified, do this:

In Flight.

1. Airspeed — 80 KIAS, MINIMIZE MANEUVERING.

2. Altitude — MINIMUM SAFE.

3. No. 3 primary ac BIM circuit breaker — CHECK IN.

4. LAND AS SOON AS PRACTICAL. Do not exceed 2 flight hours unless necessary to reach a safe landing site.

On the Ground:

If all spar indicators are white, but the BIM® caution light remains on, or the IBIS BIT is unsatisfactory, a malfunction in the radiation detector or signal processor is indicated. The helicopter may be flown for 2 hours at 80 KIAS at minimum safe altitude (minimizing maneuvering). The helicopter must then be landed and reinspected before continuing on additional 2-hour legs. If a spar indicator shows black at any time, further flight shall not be attempted until qualified maintenance personnel check the integrity of the spar.

12.22.2 Suspected Rotor Damper Failure. When the rotor damper fails, an unbalanced rotor condition may be felt as a low-frequency beat or lateral vibration. Rotor blades will normally stay in track. If a rotor damper is suspected of failing, do this:

1. Make small, smooth control inputs.

2. Slowly increase main rotor rpm.

3. Slowly reduce airspeed to 80 KIAS.

4. Use small bank angles.

5. Land as soon as PRACTICAL.

6. If vibrations become excessive — LAND AS SOON AS POSSIBLE.

7. After aircraft has come to a stop, accomplish an engine shutdown without use of rotor brake.

Note

A shallow approach to a running landing is preferable. However, if conditions do not permit, then an approach to a touchdown (no hover) landing should be made.

12.23 AMCM SYSTEM EMERGENCIES

12.23.1 Fouled Hook During Air-to-Air Transfers. When a fouled hook is recognized, maintain aircraft position and determine which helicopter will retain the tow.

WARNING

If the recovery hook or automatic release becomes fouled with the tow or any other associated equipment, serious structural damage and personal injury could occur.

12.23.2 Streaming Winch Failure. If the streaming winches should fail while being reeled in or out, troubleshoot system, interchange AMCM pendants and attempt normal operation. If normal operation cannot be

regained, tow gear to a known safe area and guillotine. If the winches operate continuously, stop the winches by actuating the EMER STOP switch on the control pendants or the safety pendant. When an emergency stop has been made, the UTILITY 2 HYDRAULIC FLUID HOT caution light should be monitored. If the winches have experienced hydraulic failure, the winches will be deenergized and hydraulically locked.

WARNING

When any AMCM wires or tow members are to be sheared, reduce tension and make sure that crewmen are clear of the area, facing the bulkhead, and have visors down to prevent injury from flying particles.

1. Electrical failure (continuous operation):

   a. Emergency stop — ON.

   b. Advise pilot — AS REQUIRED.

   Note

   Pilot monitor UTILITY 2 OIL HOT caution light.

   c. Safety observer assign lookout — AS REQUIRED.

   d. Safety observer evaluate and advise pilot — AS REQUIRED.

   e. If situation warrants, refer to GUILLOTINE PROCEDURES.

2. U-2 hydraulic fluid failure:

   a. Winch control pendants — OFF.

   b. Emergency stops — ON.

   c. Advise pilot.

   d. Utility 2 pump — OFF.

   e. Perform PORTABLE GUILLOTINE PROCEDURES.

3. Runaway winch. The significance of a runaway winch cannot be overemphasized. The immediate simultaneous action of steps a. through e. is imperative.

   *a. First person seeing runaway winch report — "RUNAWAY WINCH."

   *b. Reduce tension (pilot) — HOVER.

   *c. Crew aft of winches face bulkhead.

   *d. After winches stop, winch control pendants — OFF.

   *e. Emergency stop switches — ON.

   Note

   Pilot monitor UTILITY 2 OIL HOT caution light.

   f. Safety observer evaluate and advise — AS REQUIRED.

12.23.3 Tension and Skew Angle Indicator System Failure. Complete failure of the tension and skew angle indicating system will deprive the pilot of indications of the two tension being exerted on the system and the skew angle from the centerline of the helicopter. If no tension indication is available, Doppler ground speed indicator may be used.

Note

Doppler ground speed may not correlate to sweep device speed/tension relationship.

If skew angle indications are not available, and the skew angle cannot be determined with mirrors, a crewman should be stationed at the ramp opening to relay skew angle information to the pilot. MK-104 operations should be terminated and recovery initiated when tension and ground speed indicating systems fail due to a potential danger from a MK-104 broach.

1. Tension failure under stream/recovery.

   a. Pilot notify crew — AS REQUIRED.

   b. Tension call from crew — AS REQUIRED.

   c. Port rampman monitor gear — AS REQUIRED.

d. Starboard rampman make reports — AS REQUIRED.

e. Safety observer evaluate and advise pilot — AS REQUIRED.

2. Streaming roller assembly failure.

a. Crew report — COME TO A HOVER.

b. Safety observer advise pilot — AS REQUIRED.

c. Port rampman monitor gear — AS REQUIRED.

d. Starboard rampman make repairs — AS REQUIRED.

e. Safety observer evaluate and advise pilot — AS REQUIRED.

Note

If streaming roller assembly cannot be repaired, it may be possible to perform a low tension recovery.

3. Tow tension failure.

a. Pilot notify crew — AS REQUIRED.

b. Rampman monitor gear — AS REQUIRED.

c. Safety observer evaluate and advise — AS REQUIRED.

4. Skew angle failure.

a. Pilot notify crew — AS REQUIRED.

b. Rampman monitor tow boom — AS REQUIRED.

Note

A combination of internal and external mirrors and crew conning may be used to maintain skew angle using TOW BOOM position calls vice SKEW calls.

12.23.4 Snagged Gear While Streaming or Towing. If the gear becomes snagged during streaming operations, immediately reduce tension and attempt to free gear. If unable to free the gear, either release or guillotine. However, attempts should first be made to recover as much gear as possible, then jettison the remaining gear by disconnecting fittings or guillotining, whichever is appropriate. If the gear becomes snagged during towing operations, tension will increase rapidly. Towing tension should be reduced and attempts made to free the gear, provided no safety hazard exists, by altering course and exerting tension from another direction. If necessary to release or guillotine, the pilot should inform the accompanying helicopter or surface vessel, if any, of his intention.

12.23.5 AQS-14 and ALQ-141 System Malfunctions

12.23.5.1 Tow Cable Jumps Off Pulley. this situation will usually occur during stream or recovery, putting device in or out of the water.

1. Crew notify pilot — MAINTAIN FORWARD SPEED.

2. Device — SURFACE.

3. If tow cable jumps off davit pulley wheel and recovery is almost complete, continue with recovery. If sufficient tow cable is out and positive vehicle control can be maintained, move davit full FWD. Remove 3 bolts from side of davit keeper assembly that the cable is over. Pick up cable and reinstall into davit pulley wheel. Reinstall 3 bolts from keeper assembly. Position davit as needed, continue with mission.

12.23.5.2 Speed Indication Failure. If speed indications are lost or are unreliable, AQS-14 and ALQ-141 tow operations shall be terminated, and recovery shall be initiated.

1. Console operator notify pilot — AS REQUIRED.

2. Pilot — MAINTAIN SLOW FORWARD SPEED.

3. Console operator — BRING DEVICE TO 15 to 30 FEET BELOW SURFACE.

4. Crew — RECOVER DEVICE WHEN DIRECTED BY PILOT.

12.23.5.3 Uncommanded Climb/Descent. If either device initiates a climb or descent, the console operator shall utilize readout information to determine if the device is malfunctioning. If a malfunction is suspected, do this:

CAUTION

When a device is operating in close proximity to the ocean bottom and an uncommanded climb/descent malfunction occurs, the operator must determine if an immediate hover is required without attempting to regain control.

1. Uncommanded climb.

   a. Console operator notify pilot — REQUEST REDUCE SPEED.

   b. Pilot — REDUCE SPEED.

   c. If device control regained, continue operations.

   d. If device control cannot be regained, initiate recovery.

2. Uncommanded descent.

   a. Console operator notify pilot — REQUEST COME TO HOVER.

   b. Pilot — COME TO HOVER.

   c. Console operator — ATTEMPT RESET DEVICE POWER.

   d. If device control regained, continue operations.

   e. If device control cannot be regained, initiate a back-down recovery.

CAUTION

Consideration should be given, conditions permitting, to increasing helicopter altitude when in a hover, to minimize device and ocean bottom impact.

12.23.5.4 Power Loss

1. In event of a power loss to the device, a vehicle disabled light on the AMCM console will go on. The device will be uncontrollable, requiring prompt corrective action to prevent damage.

   a. Console operator notify pilot — REQUEST COME TO HOVER.

   b. Pilot — COME TO HOVER.

   c. Console operator — ATTEMPT RESET DEVICE POWER.

   d. If device control regained, continue operations.

   e. If device control cannot be regained, initiate a back-down recovery.

2. Console power failure. In the event of a loss of power to the console, a loss of VIDEO and LED indications will occur. The device will be uncontrollable, requiring prompt corrective action to prevent damage.

   a. Console operator notify pilot — REQUEST COME TO HOVER.

   b. Pilot — COME TO HOVER.

   c. Console operator troubleshoot console power source.

   d. If console power can be regained, continue operations.

   e. If console power cannot be regained, initiate back-down recovery.

CAUTION

Consideration should be given, conditions permitting, to increasing helicopter altitude when in a hover, to minimize device and ocean bottom impact.

12.23.5.5 Stuck Roll Wing Condition. If a diverting device situation is encountered, the responses required depend on the ability of the console operator to neutralize the malfunction.

1. Console operator notify pilot — REQUEST REDUCE SPEED.

2. Console operator — SWITCH CONTROL FROM OPERATOR TO STANDBY.

3. Pilot — REDUCE SPEED, MONITOR SKEW.

WARNING

The pilot must prevent the diverting device from causing the tow boom to contact the helicopter.

4. If the device neutralizes, reestablish control and continue operations.

5. If the device diverts again — INITIATE RECOVERY, CONDUCT BITE CHECKS.

6. If the device continues to divert in the standby mode, a mechanical malfunction or damage has occurred. Do this:

a. Console control — STANDBY.

b. Recovery — COMPLETE.

c. Once device is onboard, visually inspect for damage and complete bit checks.

12.23.5.6 Hunting Winch Failure. If the hunting winch should fail; troubleshoot system, interchange AMCM pendants, and attempt normal operation. If normal operation cannot be regained, then the determining factor on the action to be taken will depend on how much cable is off the winch. If the length of the cable streamed precludes external transport of the device, it should be towed to shallow water or accompanying surface vessel prior to guillotining, conditions permitting.

CAUTION

- Extreme care must be taken when externally carrying either device. If the device begins to spin or swing uncontrollably, immediately reduce airspeed.
- Device power shall be secured prior to guillotining.

12.23.5.7 Davit Failure. In the event of a davit failure, all efforts should be made to recover the device and raise the ramp for landing. When the davit emergency retrieval kit is available, the follow steps can be performed with the helicopter in a hover (See Figure 12-11).

Port rampman actuate the davit manual override. If successful, continue recovery using davit manual override. If unsuccessful, do the following:

1. Place chain pawl on deck at station 342.

2. Attach shackles with screw pins on special overhead connecting cable to brackets in overhead at station 522.

3. Attach hook/pulley assembly on 20 foot cable to eye on overhead connecting cable.

4. Attach eyehook on free end of 20 foot cable to special pendant which is routed through pulley.

5. Place davit bypass valve to BYPASS.

6. Manually hoist davit to vertical position.

7. Place davit bypass valve to NORMAL.

8. Remove special pendant attached at pulley.

9. Entrap tow cable in davit pulley.

10. Restow all equipment.

11. Follow normal recovery procedures to retrieve towed body.

12.24 EMERGENCY AIR REFUELING

12.24.1 Breakaway Procedures. When a crewmember aboard either the tanker or the receiver determines that an emergency exists, he will transmit, on air refueling frequency, the tanker's call sign and the word "Breakaway" three times. This call is used to notify the tanker and receiver that an emergency condition exists, such as excessive rate of closure, receiver overrunning, etc. The aircraft do not necessarily have to be in contact-mode to call a breakaway. Relative position of both aircraft must be monitored closely by the tanker and receiver crewmembers during all phases of air refueling. If the tanker desires a breakaway while operating with loss of interplane communications, the crewmember will state on interphone, "(Tanker call sign), breakaway, breakaway," and observer will flash the Aldis lamp ON and OFF rapidly from the paratroop door window. If the

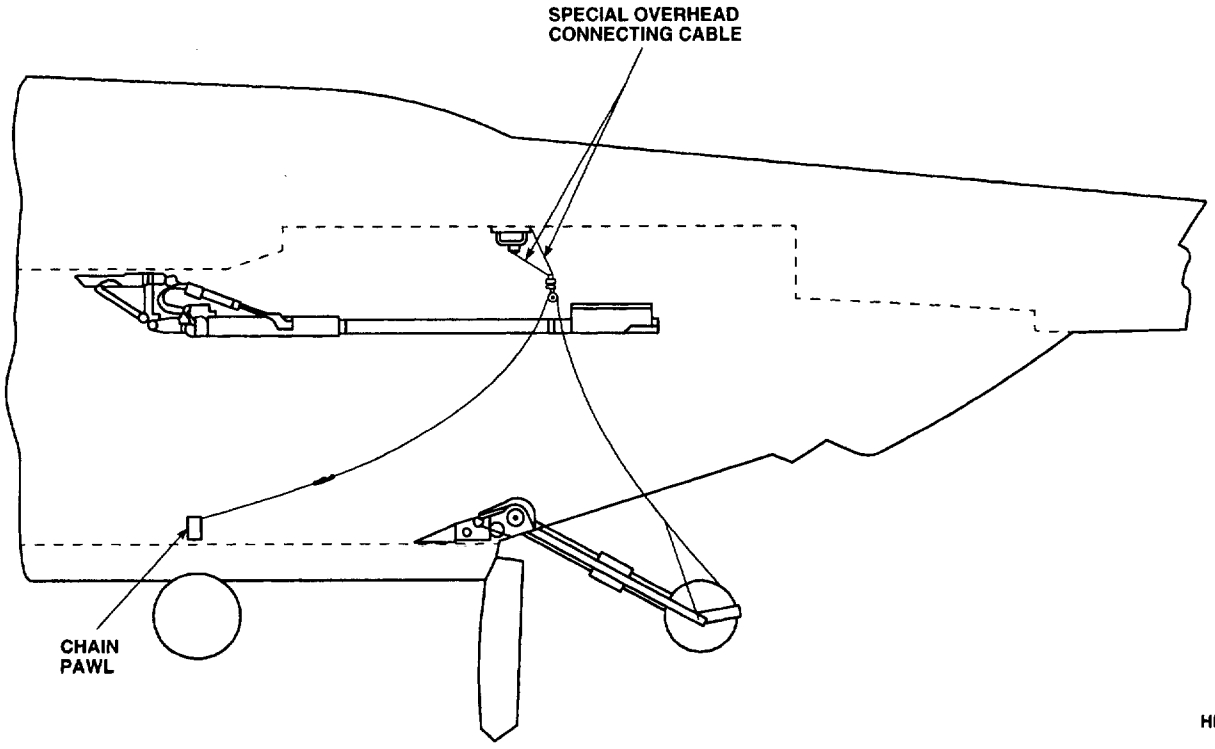


Figure 12-11. Davit Emergency Retrieval Kit Installation

receiver initiates a breakaway during loss of interphone communications, the tanker crewmember observing the breakaway will state so on the interphone, and the pilot will initiate the breakaway procedure.

During breakaway, the receiving pilot reduces airspeed slightly and maneuvers to the normal disconnect position (about 5 to 10 feet above the contact position). This causes the tanker to gradually pull away from the receiver and the refueling hose to extend. A normal disconnect occurs when the refueling hose reaches its maximum extension.

CAUTION

Extreme care shall be used by the receiver pilot to avoid descending during the operation. Maintaining altitude assures maximum rotor blade to drogue separation during and after disconnect.

12.24.2 System Malfunctions

12.24.2.1 Fuel Siphoning. At any time fuel siphoning is noticed, stop fuel transfer and notify the tanker. The requirement to continue fuel transfer is at the discretion of the receiver pilot.

WARNING

- If a large amount of fuel spray is coming from the probe, a serious fire hazard exists, as the entire outside of the helicopter could be sprayed with fuel. Radio transmission and electrical actuation of systems shall be held to those absolutely necessary. If the fuel spray continues, land as soon as practical. Make a running landing to preclude recirculation of fuel spray due to rotor wash during hover operations. After landing, shut down and have the helicopter washed immediately to eliminate any fire hazard.

- Purging with a damaged or malfunction probe may cause fuel under pressure to be sprayed on the nose of the helicopter.

Note

- A small amount of fuel spray from the nozzle and receptacle during fuel transfer does not require fuel transfer to be terminated. Notify the tanker and receiver pilots if this condition exists. The air refueling operations will be continued or discontinued at the discretion of the receiver pilot.

- If a probe head leaks and the probe is retracted, greatly increased fuel spray may be expected during the retraction process. When the retraction is completed, fuel spray should diminish to what was originally experienced before probe retraction or a lesser fuel spray condition.

12.24.3 Refueling with a Non-Extended Probe. Aerial refueling with a non-extended probe is possible in emergency fuel situations. Extreme caution and cyclic smoothness are necessary due to the close proximity of the rotor blade tips and the refueling hose and drogue.

12.24.3.1 Emergency Air Refueling Disconnect. If a receiver helicopter is unable to disconnect from the tanker during air refueling, the hose may be jettisoned as follows:

CAUTION

The receiver helicopter must be in the correct position, before hose jettison, to be sure that the hose will fall down and below the helicopter.

1. The receiver moves to a high refueling position with the refueling probe above the tanker hose pod. The hose should be pushed in to the minimum A/R range.

CAUTION

The receiver helicopter will experience a slight pitch down when the hose is jettisoned.

2. The receiver pilot calls for "hose jettison".

3. The tanker guillotines the hose.

4. The receiver initiates a slow breakaway from the tanker and slows to an airspeed commensurate with stability and flight characteristics of the hose.

5. The receiver completes the post air refueling checklist. If the probe fails to retract, do not attempt to recycle, as damage to the probe may result.

6. The receiver performs an approach and vertical landing from high hover.

12.25 INADVERTENT ENTRY INTO IFR CONDITIONS

(Figure 12-12.) Formation flights into IFR conditions should be avoided at all times. If the lead elements of a formation enter IFR conditions, follow on elements should attempt to remain VFR or land as soon as possible. If the flight or portions of the flight enter inadvertent IFR condition, the following procedures are recommended:

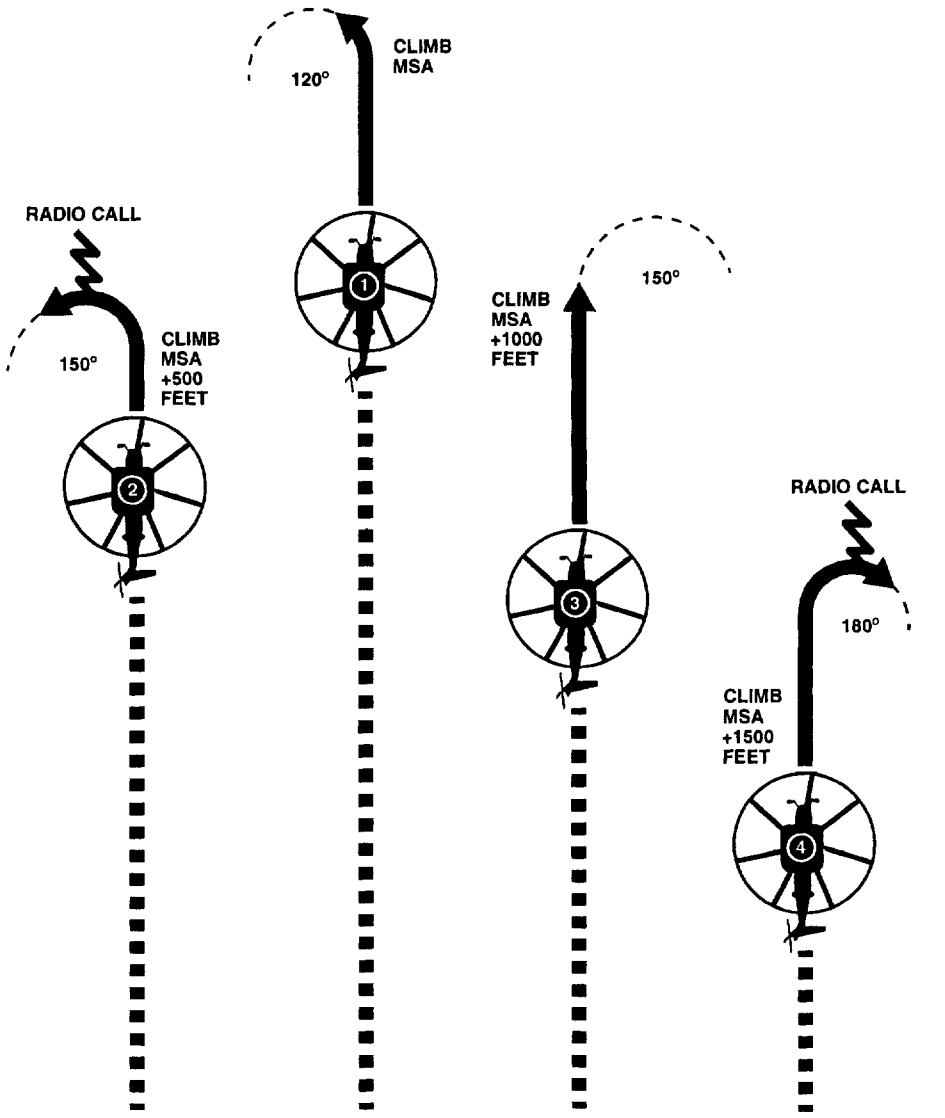
1. Helicopter No. 4 will climb to the minimum safe altitude (MSA) + 1500 feet and commence a turn for 180° away from helicopter NO. 3, reporting passing the 90° position.

2. Helicopter No. 3 will climb to the MSA + 1000 feet and commence a turn for 150° away from helicopter No. 2, after receiving the radio call from helicopter No. 4.

3. Helicopter No. 2 will climb to the MSA + 500 feet and commence a turn for 150° away from the lead helicopter, reporting passing the 90° position.

4. Helicopter No. 1 will climb to the MSA and commence a turn for 120° away from helicopter No. 3, upon receiving the radio call from helicopter No. 2.

Airspeeds may be adjusted in the course of executing these procedures. At no time should airspeed exceed the briefed flight cruise speed. If helicopters regain VFR flight conditions, they may execute a join-up and proceed as briefed. If VFR conditions cannot be regained each helicopter will individually contact the local IFR controlling agency for instructions. Base altitude, airspeed and heading should be called by the flight leader upon execution of these procedures. Terrain avoidance should be the primary concern when executing inadvertent IFR procedures.



1. ALL TURNS SRT
2. RENDEZVOUS WHEN VFR IS REGAINED.

NOTE

MINIMUM SAFE ALTITUDE (MSA)

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Figure 12-12. Lost Sight During IFR Flight Procedures

12.25.1 Inadvertent IMC On Landing. To initiate a wave-off following loss of visual reference during landing, proceed as follows:

*1. Collective - INCREASE TO CLIMB.

WARNING

Not only must descent be stopped to prevent impact with the surface, but also a positive rapid climb is necessary to regain visual flight conditions. Any delay may allow drift to develop which could cause impact with ground/obstacles. Consideration should be given to external cargo jettison.

*2. Cyclic — HOVER ATTITUDE (ON INSTRUMENTS).

Consideration should be given to activating DEPART COUPLER.

*3. Selected heading — MAINTAIN.

12.25.2 Inadvertent Entry Into IMC Conditions During AMCM Operations. Intentional entry into IMC conditions for the purpose of initialization, streaming, towing, or recovery of AMCM equipment is prohibited. This does not preclude intentional entry into IMC conditions while under positive control if VMC will be regained prior to initiating AMCM operations. The PIC must be constantly aware of changing weather conditions and should initiate an early recovery if it appears that VMC conditions cannot be maintained until the scheduled recovery time. If the PIC determines that VMC conditions cannot be maintained through the completion of recovery, PIC should jettison the gear prior to the loss of VMC. Should IMC conditions be encountered, the following procedures are recommended:

1. Stabilize the aircraft in a hover using the hover coupler.

2. Jettison or guillotine the AMCM gear.

3. Initiate an automatic departure using the departure coupler.

12.26 LOST PLANE PROCEDURES

The primary requirements when lost are:

1. CONFESS.
2. CLIMB.
3. COMMUNICATE.
4. CONSERVE.
5. CONFORM.
6. Know any peculiar local area/ship procedures.

12.27 UNUSUAL ATTITUDE RECOVERY

Unusual attitudes are considered to the attitudes of over 30° pitch and 60° bank. There are three general unusual attitudes, nose-low, nose-high, and high bank angles. During all unusual attitude recoveries, the nose-low attitude is the desired condition from which to complete all recoveries. Under flight conditions with less than +1 G-force on the helicopter, there is a substantial reduction in the longitudinal and lateral flight control effectiveness. The reduction in flight control effectiveness requires a large cyclic displacement to achieve the desired control response, which can result in rotor/fuselage contact. The tail rotor maintains the most control effectiveness during flight conditions with less than +1 G-force, and should be used as the primary recovery control. The following general techniques should be used for unusual attitude recovery:

12.27.1 Nose-Low. This is the easiest recovery to effect. The ball should be centered with the pedals, the wings leveled by smooth application of lateral cyclic, and then a smooth cyclic pullout should be begun.

12.27.2 Nose-High. Nose-high recoveries are made by applying rudder and a minimum of lateral cyclic to establish a coordinated turn toward the nearest horizon. The collective should be maintained initially and then adjusted as necessary to maintain N_r as the helicopter goes into a nose-low attitude. Longitudinal cyclic should be neutralized until a nose-low attitude is reached; then recover as in nose-low procedures. This procedure will reduce the possibility of rotor/fuselage contact resulting from a forward cyclic input to effect recovery.

12.27.3 High Bank Angles. High bank angle unusual attitudes are recovered from by applying appropriate lateral cyclic, being careful not to inadvertently apply

longitudinal cyclic. High bank angles in combination with nose-high attitudes should be recovered from by applying the nose-high recovery procedures first and correcting the high bank angle when a nose-low attitude has been attained. Final recovery is made by using the nose-low procedures.

Note

If the unusual attitude is accompanied by loss of rotor rpm, all recoveries can be made as specified above, while moving collective as necessary to recover rpm.

12.28 EXTERNAL CARGO JETTISON

*1. Area — CLEARED IF POSSIBLE.

*2. Cargo release — ACTIVATED.

WARNING

Prior to jettison of external cargo, alert the crew to prevent injury.

12.29 WINDSHIELD FAILURE

When a windshield breaks, the entire surface may craze. Visibility through a crazed windshield can be severely limited. If the inner surface of a failed windshield remains intact:

1. Reduce airspeed to 80 knots.

2. Manually close EAPS doors.

3. Land as soon as practical.

If a complete failure of the windshield occurs:

1. Reduce airspeed as necessary for comfort within the cockpit.

2. Manually close EAPS DOORS.

3. Monitor engine instruments for indications of possible FOD.

4. Land as soon as practical.

12.30 LIGHTNING STRIKE

Lightning strike can occur while flying in the vicinity of thunderstorms. Damage to main and tail rotor blades in the form of arcing, erosion, and heat annealing will result. Engineering analysis of blades subjected to an actual in-flight lightning strike concluded that the damage to the blades can be so severe that the fatigue life would be reduced to a few hours or even minutes. If a lightning strike is suspected, the helicopter should be landed and inspected. In past cases, major hidden damage was inflicted and was associated with minor appearing visible/external damage to the blade. However, no hidden damage was found without visible/external indications of some kind.

If lightning strike suspected:

*1. Airspeed — 80 KIAS.

*2. Land as soon as possible.

12.31 RAMP SYSTEM MALFUNCTIONS

If the ramp cannot be raised due to electrical failure and the utility 1 system is operating normally, do this:

Crew:

1. Activate the ramp control servo valve clockwise to raise the ramp to the desired position.

If the ramp cannot be raised due to a utility 1 system failure, do this:

Crew:

1. Place ramp manual control valve to RAMP UP.

2. Place hydraulic system handpump selector valve to position A.

3. Actuate hydraulic system handpump located just aft of the personnel door.

If ramp cannot be raised using alternate methods, do this:

1. Use the mechanical retraction device (come-along) located on the aft starboard side of the cabin.

12.31.1 Ramp System Failure. If the ramp cannot be raised by any method and ground contact will occur on landing, do this:

1. Attempt to land the helicopter with the ramp positioned beyond a ship's deck edge or a seawall.

If a landing must be made with the ramp making ground contact, do this:

1. Crewman place the ramp/door selector valve handle to DOOR ONLY.

2. Make a 0 to 10 knot forward speed landing while maintaining helicopter attitude as level as possible.

12.32 DITCHING/ABANDONING AIRCRAFT (See Figure 12-13)

WARNING

Swim well clear of helicopter to prevent being struck by rotor blades or other parts of the sinking helicopter.

12.32.1 Ditching Preparation

Pilot/Copilot

Time permitting, perform the following procedures:

1. Alert crewmembers.

2. Order all doors, hatches and cargo ramp/door secured.

3. Lock seat harness.

4. Follow emergency radio procedures.

Aircrewman

1. Jettison cargo — AS REQUIRED.

2. Notify cabin occupants and ensure their seat belts are fastened. Remind occupants to keep their legs from under the seats.

3. Ensure maximum possible water tight integrity of helicopter.

4. Emergency equipment — READIED.

5. Crewman — FASTEN SEAT BELT.

6. Notify pilot that cabin occupants are prepared for water landing.

WARNING

Do not inflate flotation equipment inside aircraft.

Note

Ensure that cabin occupants wearing LPP-1 have them released from container and properly donned.

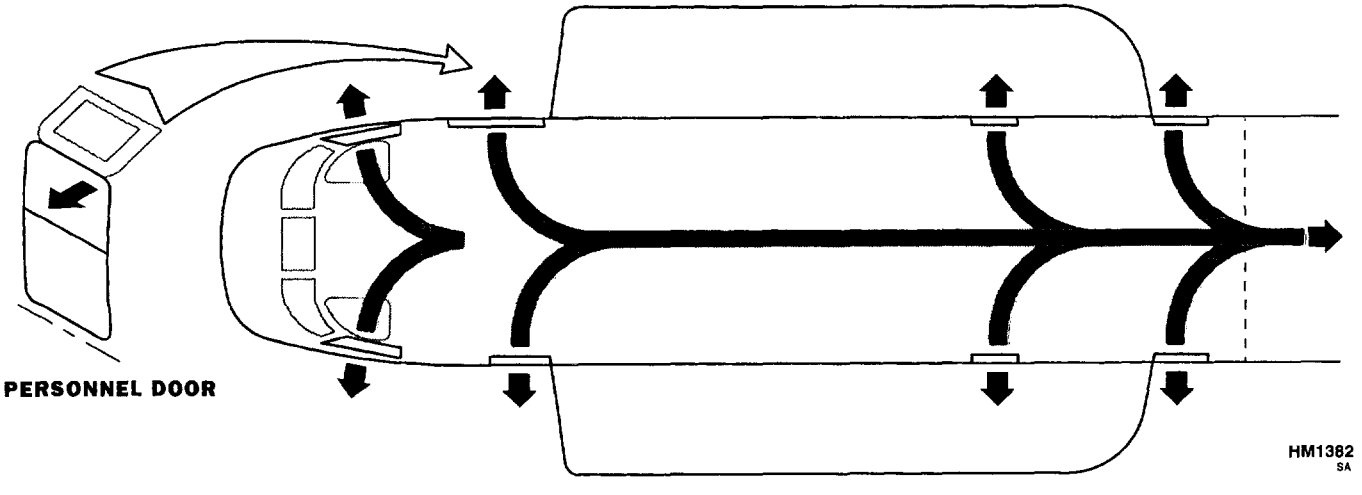


Figure 12-13. Evacuation Exits on Water

12.32.2 After Water Landing Checklist

12.32.2.1 Helicopter Floating On Surface, Power On. If the helicopter is floating on the surface with power on and it is necessary to abandon it, do this:

Pilot:

1. APP — ON.
2. Landing gear — DOWN.
3. Engines — SHUTDOWN.
4. Cyclic — MAINTAIN ATTITUDE.
5. Rotor brake — DO NOT APPLY.
6. Personnel — ABANDON AIRCRAFT.

Crewman:

1. Signal passengers — UNSTRAP.

WARNING

Consideration should be given to inflating multiplace rafts only after rotor shutdown or when rafts are well clear of the rotor system, due to the minimal clearance between the ditched aircraft's rotor and the water's surface. This will also preclude personnel from prematurely boarding a raft and possibly being struck by the rotor system.

2. Life rafts — DEPLOY ALL.
3. Passengers — CONTROL & ASSIST.
4. Check — ALL PASSENGERS OUT.
5. ABANDON HELICOPTER.
6. Assist — PASSENGERS INTO RAFTS.

12.32.3 Egress

12.32.3.1 Pilot/Copilot Emergency Water Egress

WARNING

Copilot must ensure that the collective lever does not block egress through window.

1. Emergency rotor brake — EMERGENCY, IF APPLICABLE.
2. Seat — FULL BACK.
3. Disconnect ICS.
4. Armorplate wing to rear (if applicable).
5. Appropriate Window — EMERGENCY RELEASE.
6. If helicopter begins to overturn after impact:
   a. Wait until rotors have stopped.
   b. Place one hand on seat harness release.
   c. Place other hand on known reference point.
   d. Remain strapped in 5 to 8 seconds after impact or until water is no longer rushing into cockpit.

Note

Helicopters modified by crash-attenuating seats have a rotary buckle.

7. Release seat harness.

WARNING

Do not inflate LPU until outside helicopter.

8. Exit helicopter, grasp sides of window frame pulling body through, use feet to push off on any available surface.
9. Once in water outside helicopter, inflate LPU and swim well away from the helicopter.

12.32.4 Aircrewman Emergency Water Egress

1. Signal passengers to unstrap once aircraft has settled and all violent motion has stopped.

   a. Passengers pull release lever fully up and aft to release.

2. Deploy all life rafts.

CAUTION

To prevent loss of raft, retain control of raft retention lanyard after deployment. Uninflated, raft package will float from 10 to 20 minutes, depending on sea state.

   a. Grasp raft and move to personnel door or ramp area.

   b. Open upper half of personnel door and lock in up position.

   c. Locate raft retention lanyard.

   d. Locate raft inflation handle (continuation of retention lanyard).

   e. Push raft through upper half of ramp door or over top of lower personnel door. Pull sharply on inflation handle.

3. Control and assist passengers. Brief passengers to remain seated until all violent motion has stopped.

   a. Assist passengers with unstrapping and exit helicopter.

WARNING

- If helicopter begins to overturn after impact:
  a. Wait until rotors have stopped.
  b. Passengers place one hand on seat belt release.
  c. Remain strapped in 5 to 8 seconds after impact or until water is no longer rushing into cabin.
  d. Release seat harness.
  e.Exit helicopter through nearest exit.
- Do not inflate LPU until outside helicopter.

Note

If the helicopter is inverted, use of the single point suspension hatch should be considered for exit.

4. Check all passengers out at helicopter.

5. Abandon helicopter through appropriate exit.

12.32.5 Personnel Door

1. If damage or other causes makes it difficult to open and lock up the upper half of personnel door, remove the upper half by rotating both handles clockwise and pulling upper half inward.

2. Exit aircraft over top of lower door.

12.32.6 Cabin Emergency Escape Hatch

1. Grasp and turn upper handle clockwise. Remove hatch by pulling inboard.

2. Exit aircraft through hatch.

12.32.7 Cabin/Cargo Door Window

1. Locate and grasp handle and pull tab on lower right of window. Pull tab to release window from rubber seal.

2. Pull window inboard.

3. Exit helicopter through window.

12.32.8 Cargo Ramp and Door

WARNING

When the helicopter is on the surface with power on, do not exit the helicopter through the cargo ramp or door, because of the danger of being struck by the operating tail rotor blade.

12.32.9 Helicopter Emergency Egress Device (HEED)

WARNING

Orientation of the HEED in the survival vest is critical. It must angle away from the aviators head. Otherwise, during a crash, the head may impact the HEED, causing serious injury and/or incapacitation.

12.32.9.1 Method 1 (Technique)

1. Preflight — CHECK HEED IS FULL AND NOT LEAKING AND LEAVE ON.

2. After impact, if time permits — PLACE MOUTH PIECE IN MOUTH AND BEGIN USING HEED EVEN WHILE SUBMERGING.

3. After violent motion ceases — MAKE NORMAL EGRESS (I. E., OPEN EXITS, GRASP A REFERENCE, RELEASE RESTRAINTS, USE HAND-OVER-HAND TO EXIT AND PULL OUT).

4. Swim to surface — INHALING FROM HEED AND EXHALING THRU NOSE NORMALLY.

WARNING

To prevent injury: after breathing compressed air from the HEED, you must continually exhale while ascending/surfacing to vent the expanding air from your lungs. Divers call this the "blow and go" technique. Inflating the LPU will cause a rapid ascent rate which will require a more forceful exhalation.

12.32.9.2 Method 2 (Technique)

1. Preflight — CHECK HEED IS FULL AND NOT LEAKING AND LEAVE ON.

2. If time does not permit placing mouth piece in mouth — MAKE NORMAL EGRESS.

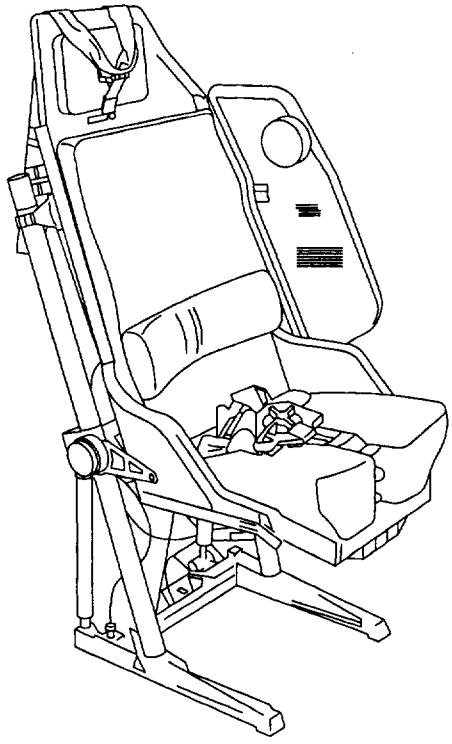
3. If you become entangled, disoriented, or for whatever reason egress is delayed — HOLD ONTO A REFERENCE WITH ONE HAND, REMOVE HEED FROM CARRIER, PLACE MOUTH PIECE INTO MOUTH, CLEAR WATER FROM MOUTH PIECE, AND CONTINUE WITH NORMAL EGRESS PROCEDURES.

4. Swim to surface — INHALING FROM HEED AND EXHALING THRU NOSE NORMALLY.

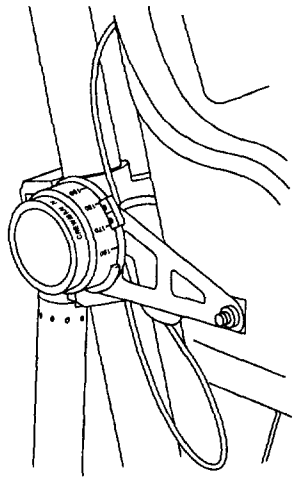
Note

The HEED provides approximately two minutes of breathing air at moderate depths and exertion levels. Lower breathing rates extend useful time and higher rates will decrease useful times.

12.32.10 MH-53 Crash-attenuating Seat. The seat is floor mounted and provides for adjustment in the fore and aft directions. Vertical adjustment of 4.8 inches is provided. The seat includes load-limiting stroke in the forward direction. The optional armored wing panel is mounted on either side of the seat depending upon position (pilot or copilot) in the aircraft.



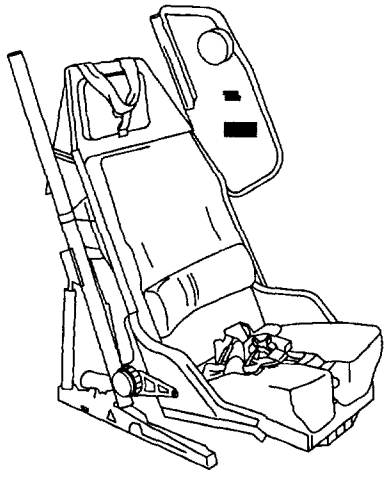
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Occupants adjust control dial to their specific weight plus weight of equipment worn. The vertical energy absorption system can be set to decelerate any equipped occupant weight from 164 to 254 pounds.

12.32.11 MH-53 Crash-attenuating Seat (Stroked Position). If seat strokes, occupant and seat



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will shift downward and possibly forward up to 18 inches. Windows, hatches, doors, and handles will be more difficult to reach.

12.33 EMERGENCY GROUND EGRESS

Pilot/Copilot:

1. Order — PREPARE TO ABANDON AIRCRAFT.
2. Emergency rotor brake — EMERGENCY.
3. Three speed control levers — SIMULTANEOUSLY TO SHUTOFF.

WARNING

Prior to exiting the helicopter during emergency egress, wait until the rotors and violent motion have stopped.

4. Order — ABANDON HELICOPTER.
5. Seat — FULL BACK.
6. ICS — DISCONNECT.
7. Armor plate wing to rear (if applicable).
8. Appropriate window — EMERGENCY RELEASE (IF DETERMINED EXIT).
9. Release seat harness.
10. Exit helicopter through appropriate exit.

WARNING

If exiting through copilot's window, copilot must ensure that collective pitch lever does not block exit path.

Aircrewman:

1. Signal passengers to unstrap.
2. Assist and control passengers egressing helicopter.
3. Ensure all passengers are out.
4. Abandon helicopter.

PART VI

ALL-WEATHER OPERATION

Chapter 13	Instrument Procedures
Chapter 14	Extreme Weather Operations

CHAPTER 13
Instrument Procedures

13.1 INSTRUMENT FLIGHT PROCEDURES

The MH-53E is capable of instrument flight concurrent with minimums established for conventional dual-piloted aircraft. The installed navigation equipment can supply the pilot with range and bearing information to a preselected destination. With the automatic flight control and trim systems engaged, the flight characteristics are stabilized in altitude, pitch, roll, and yaw. A selected altitude can be automatically maintained by engaging the BAR ALT feature of AFCS. As with all instrument flying, careful preflight planning is necessary. Except for some repetition necessary for continuity, the procedures and techniques here are only those that differ from, or are in addition to, the normal operating procedures covered elsewhere in the manual. Refer to the NATOPS Instrument Flight Manual for detailed instrument flight procedures.

13.1.1 Simulated Instrument Flight. Safety precautions and procedures for conducting simulated instrument flights are in OPNAVINST 3710.7.

13.1.2 Preflight Inspection. Refer to the range charts in Part XI to be sure that instrument flight fuel requirements can be met. Complete the normal exterior and interior inspections. Consider completing the checklist up to but not including engine starting, before receipt of ATC clearance. Once clearance has been received and is accepted by the pilots, then the engines should be started and the checklist (including the instrument flight checklist) should be completed.

13.1.3 Instrument Flight Checklist.

1. Pitot heaters — AS REQUIRED.
2. Ice detector switch — TEST, USE AS REQUIRED.
3. Exterior lights — AS REQUIRED.
4. Vertical velocity indicator — CHECK.
5. Clocks — OPERATING.
6. Radios — CHECK ALL FUNCTIONS.
7. ADIs — SET ON INDEX DOT.
8. Windshield wiper — CHECK OPERATION.
9. Navigation self-test procedures — COMPLETE AS REQUIRED.

13.1.4 Takeoff. When a normal hover is not possible, the helicopter may be flown off the deck and into a normal climb, without any outside reference.

1. Maintain heading with feet on pedal switches until airborne. Once airborne, allow AFCS to maintain heading (feet off pedal switches).
2. Increase collective to takeoff power, and maintain a hover attitude by referencing attitude indicator.
3. As helicopter passes through 20 feet on radar altimeter, move cyclic forward to assume a 5° nose-down attitude, and accelerate into forward climbing flight.
4. As helicopter accelerates, recheck radar altimeter to be sure helicopter is gaining altitude.

Note

- Attitude indicator will give dependable attitude indications at all speeds. However, until about 40 knots of forward airspeed are indicated, pilot cannot definitely ascertain helicopter's direction of motion.
- Heading and radio frequency changes should not be initiated prior to 300 feet and 80 KIAS.

5. Maintain a smooth acceleration up to 100 KIAS with reference to attitude indicator and airspeed indicator.
6. Establish a rate-of-climb of at least 500 feet-per-minute with reference to altimeter and vertical velocity indicator.

13.1.5 Climb. Climb under instrument conditions is similar to the climb technique and procedure described and a normal climb. Consult the climb charts in Part XI for the best climb speed at various gross weights and alti-

tudes. The AFCS will maintain the heading and attitude established by the pilot. Limit climbing turns to a maximum bank angle of 20°.

13.1.6 Cruise. After leveling off, stabilize airspeed and power and engage the BAR ALT channel of AFCS, if desired. Pay particular attention to navigation as a slow airspeed results in large drift angles. Speed limitations for various weights, altitudes, and N_r are outlined in Part I, Chapter 4. Under instrument flight conditions, these upper limits should be approached with caution.

A minimum speed of 40 knots should be observed to maintain the normal flight characteristics associated with forward flight. The airspeed indicator system is less reliable below 40 knots. The coordinated turn features of AFCS will be inoperative below 60 KIAS.

Note

There will be slightly increased fuel consumption with continued use of BAR ALT.

13.1.7 Holding. Any cruising airspeed can be easily maintained in the normal holding pattern.

13.1.8 Descent. Normal descents are made by reducing power until the desired rate-of-descent is accomplished. Enroute descents are normally made at cruising airspeed.

13.1.9 Instrument Approaches. Refer to NATOPS Instruments Flight Manual 00-80T-112 for typical approach procedures. See Part IV for recommended approach speeds.

CHAPTER 14
Extreme Weather Operations

14.1 COLD WEATHER PROCEDURES

The major problems in cold weather operations are the preparation for flight, restricted visibility from blowing snow, and the adverse effects on helicopter materials. Moisture, usually from condensation or melted ice, may freeze in critical areas. Tire, landing gear strut, fire extinguisher bottle, and accumulator air pressures will decrease as temperatures decrease. Extreme diligence on the part of both ground and flight crews is required for successful cold weather operation.

The greatest dangers caused by ice accumulation are lowered main rotor blade efficiency and possible damage to the tail rotor blades. The MH-53E has no main or tail rotor blade anti-ice or deice capability. Icing of the engine air inlet area is an ever-present possibility when operating in weather with temperatures near or below 0°C. When any form of icing is anticipated or encountered, the EAPS doors shall be manually closed and remain closed until after engine shutdown, for engine anti-icing and to prevent shedding ice from entering the engines. In addition, the engine anti-icing systems shall be turned on by placing the engine anti-ice switches to ON/CONT IGN, with or without EAPS installed.

When operating on an unknown snow surface, the danger of breaking through snow crust is lessened by maintaining power. Pilots should be aware of the fact that the horizon may be lost when flying over large unbroken expanses of snow. In this condition, the helicopter should be flown entirely by instruments at a safe instrument altitude. To prevent snow blindness, colored glasses should be worn in snow areas.

WARNING

Human efficiency is reduced sharply as temperature drops below -18°C. In arctic and subarctic operations, rotor wash is known to have a supercooling effect that is hazardous to personnel. Consequently, exposure of personnel being evacuated or of ground personnel to rotor wash should be held to a minimum. Absolutely no part of a person's skin shall be exposed for any length of time under the rotor downwash when in an arctic climate. Exposed skin may freeze in as little as 30 seconds.

Note

- Following exposure to temperatures of -5° or colder for 1 hour, full pressurization of the rotor brake may not occur. This will result in increase stopping time for the rotor. The electrical rotor brake release may not function as well. The manual rotor brake release may be used as required.

- The nose gear may not swivel at temperatures below -37°C because the fluid in the nose gear viscous damper may become solid at these temperatures.

14.1.1 Anti-Icing Systems. In visible moisture below 4°C, the EAPS doors shall be manually closed and remain closed until after engine shutdown. In addition, the engine, windshield, and pitot heat anti-ice systems shall be turned on. If there is dry snow at an OAT of -4°C or lower, engine anti-ice should be turned off, and the use of windshield anti-ice is optional. Helicopters operating in icing conditions shall be in accordance with Figure 14-1.

CAUTION

Damage to the cockpit windshields may occur any time the windshield anti-ice is activated. Consideration should be given to activating the low position prior to the high position.

CONFIGURATION	ICING INTENSITY	FLIGHT DURATION
Anti-ice on; EAPS closed.	Trace	No limit
	Light	30 Min

WARNING

Flight in moderate or severe icing is prohibited.

Figure 14-1. Anti-icing Summary

14.1.2 Preflight Inspection. In addition to doing a normal preflight inspection the main rotor head and blades, tail rotor, and flight controls should be thoroughly inspected and made free of all ice and snow accumulations. Failure to remove accumulations while on the ground can result in serious aerodynamic and structural effects when flight is attempted. Check that the helicopter surfaces, controls, ducts, blades, IBIS detector, IBIS spar pressure indicators, oleo shock struts, fuel tank vents, static ports, and pitot tubes are free from accumulations. Check that the landing gear struts, tires, and hydraulic accumulators are properly inflated. Check the lower section of the engine air inlet and the lower portion of the EAPS barrel for evidence of ice and snow accumulations. Moisture collected on the previous flight can accumulate in the lower section and freeze. An attempted engine start could cause damage. If ice is suspected, check the engine to be sure it is free to rotate. If not, apply external heat to the forward engine section to permit thawing. Start the engine as soon as possible after thawing, to remove all moisture before it freezes again.

CAUTION

Remove all ice and snow accumulation before flight. Do not attempt to chip or scrape accumulations from any surface or controls. Portable ground heaters or deicing fluid may be used to remove any accumulation that cannot be swept off.

14.1.3 APP/Engine Starting. For APP start, a longer start interval may be obtained by using both APP accumulators simultaneously. This can be accomplished by pulling the T-handle in the cabin section down prior to commencing APP start. Be sure that ground heater ducts have been removed and EAPS doors are manually closed, then make normal engine start.

CAUTION

- High engine oil pressure will exist until the oil has warmed. Should engine ENG OIL PRESS HIGH light stay on for over 3 minutes, secure the engine. Do not exceed GRD IDLE until oil pressure is within normal operating limits.

- When engaging rotor on ice, use the alternate start procedures, to prevent sliding from abrupt rotor torque input.

14.1.4 Post Engine Start. Immediately after engine start and rotor engagement, turn on the cabin heater, engine anti-icing systems, pitot heat, and windshield anti-icing systems.

Note

Allow a longer warmup period during cold weather, due to the time required to bring engine and transmission oil temperatures up to desired operating range.

14.1.5 Taxi. In cold weather, make sure all instruments have warmed up enough for normal operation. Check for sluggish instruments during taxiing.

Note

The nose gear may not swivel at temperature below -37°C because the fluid in the nose gear viscous damper may become solid at these temperatures.

The helicopter can be taxied in soft snow. The deeper the snow, the more difficult taxiing and directional control may become, and increased collective pitch may be necessary. Helicopters should not be taxied on a snow-covered surface that is suspected or known to contain hidden obstructions or hazards. Normally, the rotor wash at taxiing power will not obstruct visibility from blowing snow. Ground handling characteristics of the helicopter on loose or compacted snow at temperatures below -18°C

are good, and wheel braking action is fair to good. However, as temperatures rise toward freezing, snow-covered surfaces become more slippery and increasing caution must be taken.

When it is necessary to taxi on ice-covered surfaces, use slow ground speeds so that cyclic displacement may be used as the primary braking force.

14.1.6 Takeoff. The pilot must be certain that the helicopter wheels are not frozen to the surface. A slight yawing motion, induced by light rudder pedal motion, should break the wheels free when they are frozen to the surface. Takeoff into fog or low clouds when the temperature is at or near freezing could result in engine air inlet icing. Select an area devoid of loose or powdery snow, to lessen the restriction to visibility from blowing snow.

14.1.7 Cruise. During cruise, use the cabin heater, engine anti-ice systems, pitot heat, and windshield anti-ice protective systems as required. After takeoff from water, wet snow, or slush-covered field, operate the landing gear through several complete cycles to prevent their freezing in the retracted position. Expect slower operation of the landing gear in cold weather due to stiffening of all lubricants.

If icing conditions are encountered, close the EAPS doors manually and keep them closed until after engine shutdown on the ground. Although the EAPS HIGH PRESS LOSS caution light may go on, indicating excessive clogging of the strata tubes, keep the EAPS closed. Cycling the EAPS with ice on the doors could FOD the engine as the broken ice pieces are ingested.

During icing conditions, the main rotor assembly and blades will collect ice. After a certain amount has collected, vibration may be noted in the controls and the airframe. When icing is present during low altitude flights or approach, additional power will be necessary for safe flight. Also, do not lower the landing gear until in the landing pattern, to avoid too much ice accumulation on the landing gear and exposed components.

WARNING

To prevent engines from ingesting ice when icing is anticipated or encountered, manually close the EAPS doors and keep the doors closed until engines are shut down after landing.

Note

As ice accumulates upon the rotor system, increased power may be required to maintain level flight. While changing altitude to avoid icing conditions, adjust torque setting and airspeed to maintain power turbine inlet temperatures and torques within operating limits.

14.1.8 Landing. Make a normal landing; but, if icing is present, increased power may be necessary for a safe landing. If power requirements become critical and terrain permits, a running landing may be made. Be sure EAPS doors are manually closed and remain closed until after engine shutdown.

Landing in snow can be hazardous because of unknown hazards beneath the snow, and reduced visibility due to blowing snow. Landings in unprepared areas are especially hazardous. The slope of the terrain may be masked by snow drifts, and obstacles beneath the snow can damage the landing gear, ramp, and underside of the helicopter. Unlike sandy conditions where a no hover landing is usually the best, landings conducted on unprepared surfaces of heavy snow should be made by coming into a high hover and blowing the loose snow clear of the landing zone. Several approaches may be necessary to reach an acceptable level of visibility. A no hover landing can be made to prepared surfaces where the slope and obstacles are known. Damage to the helicopter can occur if a no hover landing is done in deep snow and the helicopter settles onto obstacles or uneven terrain. In deep snow the helicopter may never settle to the ground and the isolation valve will not open. Clearance of both the tail rotor and main rotor will be lower depending on the depth of the snow and the amount the helicopter settles. After performing a higher hover to blow away loose snow, keep a visual reference on a object forward of the helicopter, and slowly lower the helicopter to the ground. If no object is available, consideration should be given to dropping an object (tire, stake, etc.) from the single-point cargo door to provide a visual reference. Landing without a visual reference on an all white surface can result in helicopter drift and possible roll over. As the helicopter touches down, slowly lower the collective, as the helicopter settles. Power may have to be kept on the helicopter to provide safe clearances for the tail rotor and main rotor and passengers embarking or debarking. Attempts to fully lower the ramp can cause damage to the ramp hinges. Operate the ramp incrementally and visually check the hinge area. Passengers may have to embark and debark from a level ramp position or from the personnel door. If

power is kept on the helicopter to prevent settling, the embarking and debarking of passengers will be more time consuming and difficult due to the increased rotor wash, and blowing snow.

WARNING

Main rotor and tail rotor blade ground clearance are reduced with the helicopter resting on the fuselage. Therefore, personnel entering or leaving the helicopter should use extreme caution to prevent being struck by the blades.

CAUTION

If the smoke grenade (or the object being used as a reference) should become completely obscured during the approach and/or landing, accomplish a waveoff.

14.1.9 Engine Shutdown. Make a normal engine shutdown as outlined in Chapter 7. As soon as the helicopter is parked, chock the wheels and release the brakes.

CAUTION

When shutting down engines on ice, allow rotors to coast to a stop, then apply rotor brake.

14.1.10 Postflight Inspection. Whenever possible, leave the helicopter parked with full fuel tanks. Make every effort during servicing to prevent moisture from entering the fuel system. Drain condensation from the fuel and oil sumps and drains, and remove all ice and snow from vents, drains, and breathers. Close all doors and hatches, and clean landing gear oleo struts of dirt, snow, and ice with a clean cloth soaked in hydraulic fluid. Check that protective covers have been installed. Engine exhaust and air inlet (without EAPS) protective covers should not be installed until after engines have cooled down.

14.2 HOT HUMID WEATHER OPERATIONS

High humidity usually results in the condensation of moisture throughout the helicopter. Possible results include malfunctioning of electrical equipment, fogging of instruments, rusting of steel 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 Chapter 7 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. Plan the flight thoroughly, to compensate for existing conditions, by using the charts in Part XI. Check for the presence of corrosion or fungus at joints, hinge points, and similar locations. Remove any fungus or corrosion. If instruments, equipment, and controls are moisture-coated, wipe them dry with a clean, soft cloth. When weather conditions permit, leave windows and doors open on the ground, to ventilate the helicopter.

Note

Fuel densities will decrease as the ambient temperature rises, resulting in a decrease in operating range.

14.3 DESERT OPERATIONS

Desert operation generally means operation in a very dry, dusty, often-windy atmosphere. Under such conditions, sand and dust will often be found in vital areas of the helicopter. Severe damage may be caused by sand and dust. Tow the helicopter into takeoff position, which, if possible, should be on a hard, clean surface, free from sand and dust. EAPS should be installed and fully operational for all operations.

CAUTION

Dust and/or sand laden air can extend upward for several thousands of feet. EAPS doors shall be manually closed when operating under these conditions.

14.3.1 Preflight Inspection. Plan the flight thoroughly to compensate for existing conditions, by using the performance charts in Part XI. Check for sand and dust in control hinges and actuating linkages, and inspect tires for proper inflation. High temperatures may cause overinflation. Check oleo struts for sand and dust, especially in the area next to the cylinder seal, and remove any accumulation with a clean, dry cloth. Inspect for and remove any sand and dust deposits on instrument panel and switches and on and around flight and engine

controls. Expect higher fail rates on items such as main gear oleos, dampers, blade fold pins, and actuating cylinders, etc.

14.3.2 Engine Starting. If possible, engine starting and ground operation should be made from a hard, clean surface. The EAPS doors shall be manually closed, the vent blower off, and the windows closed when operating in a sand/dust environment. Prior to engine start with EAPS doors closed, the MAIN TR INT GB PRESS (14 psi) circuit breaker (EMERGENCY DC BUS) should be pulled and left out for thirty seconds once APP is on line. This procedure will activate the EAPS blower motors and clear the EAPS of any accumulated dust and sand prior to engine start. Do the normal engine start, warmup, and ground tests, but limit ground operation to a minimum, as the downwash from the main rotor may stir up clouds of sand. Make every effort to lessen the sand from being blown up around the main rotor and engines.

14.3.3 Taxi. When it is absolutely necessary to taxi in sand and dust, get the helicopter airborne as quickly as possible lessen sand/dust intake by the engines and erosion of the rotor blades.

CAUTION

Turning in loose sand or soil could result in the nosewheel cocking 90°, and the nosewheel tires being rolled off the rims.

14.3.4 Takeoff. Execute a normal takeoff and climb as rapidly as possible. Takeoff in heavy sand/dust may result in disorienting IFR conditions. The non-flying pilot should furnish the pilot at the controls with a constant flow of flight information during this period.

14.3.5 Cruise. Avoid flying through sand/dust storms when possible. Dust and grit in the air causes considerable damage to the internal engine parts and erosion of the rotor blades. The EAPS doors shall be manually closed, the vent blower off, and the windows closed when operating in a sand/dust environment.

14.3.6 Landing. The best procedure for landing, to reduce blowing sand/dust, is a rolling landing, if conditions permit. If conditions do not permit a rolling landing, fly a minimum power approach with a no hover landing. The EAPS doors shall be manually closed, the vent blower off, and the windows closed when operating in a sand/dust environment.

14.3.7 Engine Shutdown. Shut down the engine as soon as practical after landing, to reduce the intake of sand/dust.

14.3.8 Postflight Inspection. Install all protective covers and shields. When operating in high ambient temperatures, leave the windows, doors, and hatches open to ventilate the helicopter, except when sand/dust is blowing or is forecast to blow.

14.4 TURBULENCE AND THUNDERSTORMS

14.4.1 Turbulent Air Operation. Avoid flying under conditions of severe turbulence. When operating in turbulent air, use pilot discomfort as a guide to determine the extent of roughness that is acceptable. Decreasing airspeed and/or increasing N_r during cruise conditions will improve handling characteristics and decrease the possibility of blade stall. Make descents with low rate-of-descent and a comfortable airspeed. Refer to MOUNTAIN AND ROUGH TERRAIN FLYING in this chapter.

14.4.2 Thunderstorms. Avoid flights through or near thunderstorms. If thunderstorms are encountered during flight, land as soon as practical and wait for the storm to pass. Violent turbulence and restricted visibility may be encountered in thunderstorms. When lightning is encountered at night, turn the cockpit white light and instrument lights to full intensity, to prevent temporary blindness. Lightning striking the main or tail rotor can damage the blades so severely that the fatigue life could be reduced to a few minutes.

14.4.3 Heavy Precipitation. If heavy precipitation is encountered, continuous ignition should be activated by placing the engine anti-ice switch to ON/CONT IGN, with or without EAPS installed. If EAPS are installed, closing the EAPS doors may prevent engine flameout due to water ingestion and/or hail damage.

14.4.4 Lightning Strike. Lightning strike can occur while flying in the vicinity of thunderstorms. Damage to main and tail rotor blades in the form of arcing, erosion and heat annealing will result. Engineering analysis of blades subjected to an actual in-flight lightning strike concluded that the damage to the blades can be so severe that the fatigue life would be reduced to a few hours or even minutes. If a lightning strike is suspected, the helicopter should be landed and inspected. In past cases, major hidden damage was inflicted and was associated with minor appearing visible/external damage to the spot. However, no hidden damage was found without visible/external indications of some kind.

14.5 MOUNTAIN AND ROUGH TERRAIN FLYING

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, are 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, meteorology 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. For this reason, each landing site must be evaluated at the time of intended operation. Altitude and temperature are major factors in determining helicopter power performance. Gross weight limitations under specific conditions can be computed from the performance data in Part XI. A major factor improving helicopter lifting performance is wind. Weight carrying capability increases rapidly when increases in wind velocity are related to the 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 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 roll-on landing and takeoff will be necessary for the mission. Data for these conditions can be computed from the charts in Part XI.

14.5.1 Wind Direction and Velocity. There are several methods of determining the wind direction and velocity in rough areas, the most reliable being by the use of smoke. However, it must be noted that the hand-held day night distress signal and the standard ordnance issue smoke hand grenade, while satisfactory for wind indication, constitute a fire hazard when used in areas covered with combustible vegetation. Observation of foliage will indicate to some degree the direction of the wind, but is of limited value in estimating wind velocity. Helicopter drift, determined by eyesight without the use of navigational aids is the first method generally used by experienced pilots. The accuracy with which wind direction may be determined through the drift method becomes a function of wind velocity. The greater the wind value, the more closely the direction may be defined.

14.5.2 Landing Wind Line Estimate. When over the landing zone (Figure 14-2), start a 360° standard rate turn to the right or left. After completing the turn, the helicopter will be on the wind line downwind from the landing zone. Execute a turn into the wind that will provide adequate distance for a normal approach.

14.5.3 Landing Site Evaluation. Five major considerations in evaluating the landing area are: (1) height of obstacles which determine approach angle, (2) size and topography of the landing zone, (3) possible loss of wind effect, (4) power available, and (5) departure route. The transition period is the most difficult part of any approach. As helicopter performance decreases, the transition period becomes more critical, and of necessity approaches must be shallower, and transition more gradual. Therefore, as the height of the obstacle increases, larger areas will be required. As wind velocity increases, so does helicopter performance. However, when the helicopter drops below an obstacle, a loss of wind generally occurs as a result of the airflow being unable to immediately negotiate the change prevalent at the upwind side of the landing zone, where a virtual null area exists. This null area (Figure 14-3) extends toward the downwind side of the clearing and will become larger as the height of the obstacle and wind velocity increases. It is therefore important in the landing phase that this null area be avoided if marginal performance capabilities are anticipated. The null area is of particular concern in making a takeoff from a confined area. Under heavy load or limited power conditions, it is desired to achieve a significant value of forward velocity and translational lift before transitioning to a climb, so that the overall climb performance of the helicopter will be improved. If the takeoff cycle is not begun from the most downwind portion of the area, and the translational velocity is not achieved before arrival in the null area, a significant loss in lift may occur at the most critical portion of the takeoff. Also, in the vicinity of the null area, nearly vertical downdraft of air

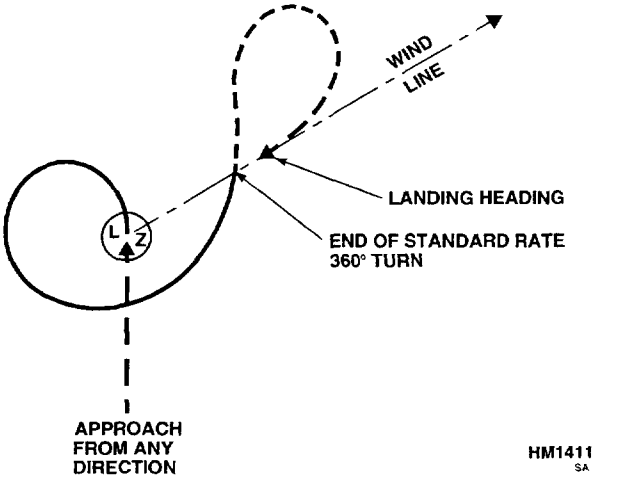


Figure 14-2. Landing Wind Line Estimate

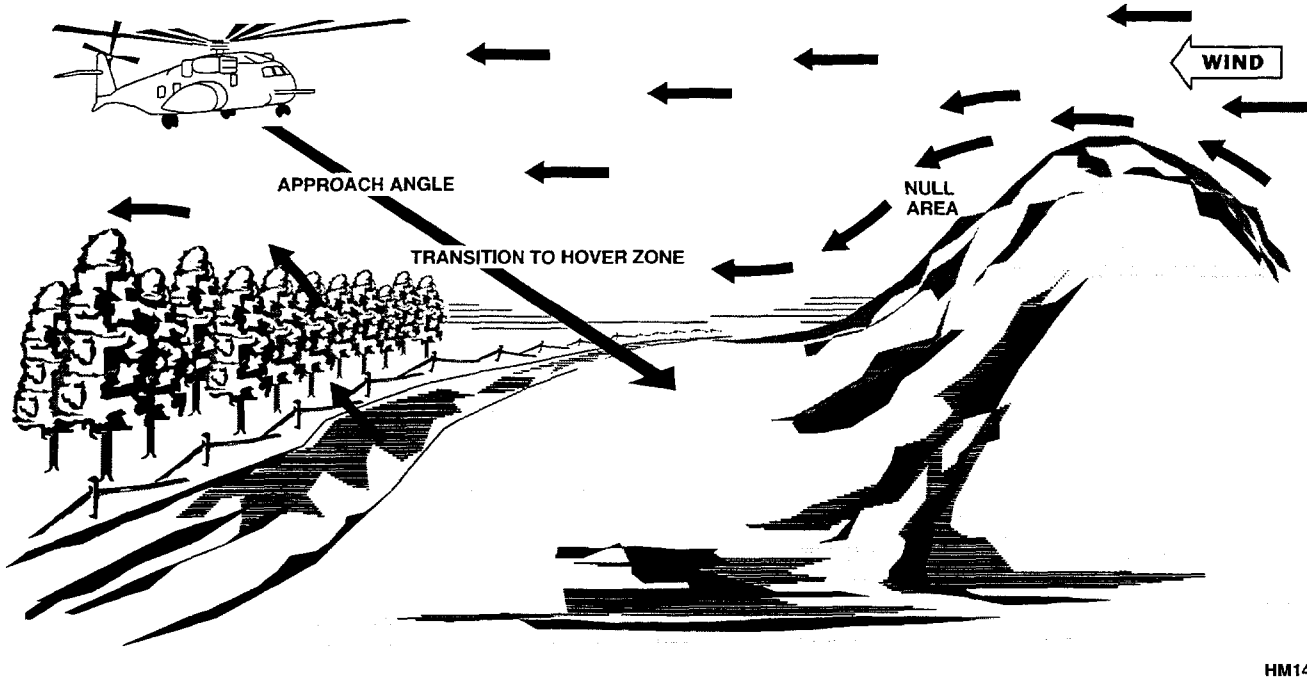
may be encountered, which will further reduce the actual climb rate of the helicopter. It is feasible that, under certain combinations of limited area, high obstacles upwind, and limited power available, the best takeoff route would be either crosswind or downwind, terrain permitting. The effects of detrimental wind flow and the requirement to climb may thus be minimized or circumvented. Even though this is a departure from the cardinal rule of takeoff into the wind, it may well be the proper solution when all factors are weighed in their true perspective. Never plan an approach to confined area wherein there is no reasonable route of departure. The terrain within a site is considered from an evaluation of vegetation, surface characteristics, and slope. Take care to avoid placing the rotors in low brush or branches. Obstacles covered by grass may be located by flattening the grass with rotor wash before landing. Power should be maintained so that an immediate takeoff may be made should the helicopter start tipping from soft earth or a gear dropping into a hole. Crosslope, upslope, or downslope landing can be made. Landing upslope affords maximum ramp and tail rotor clearance.

Note

Landing downslope affords an easier wave-off, but greatly reduces the ramp and tail rotor clearance to the ground, and should be avoided whenever possible. See SLOPE LANDINGS in Chapter 11.

14.5.4 Effects of High Altitude. Decreased hov performance, decreased forward airspeed limits, a increased susceptibility to blade stall are associated w high altitude operations. Operating limitations and pe formance data should be carefully reviewed before ope ating at high altitudes. Maneuverability is generally d creased and shallower turns at slower airspeeds a required to avoid blade stall than at lower altitude Smooth and timely control application and anticipation power requirements are of prime importance in fully usi the performance capabilities of the helicopter at hi altitude.

14.5.5 Turbulent Air Flight Techniques. He copter pilots must be constantly alert to evaluate a avoid areas of severe turbulence; however, if encou tered, immediate steps must be taken to avoid continu flight through it to prevent exceeding the structural limits the helicopter. An increase in N_r will improve the helico ter's gust response, providing a smoother ride, a decrease susceptibility to blade stall. Severe turbulence often found in thunderstorms, and helicopter operatio



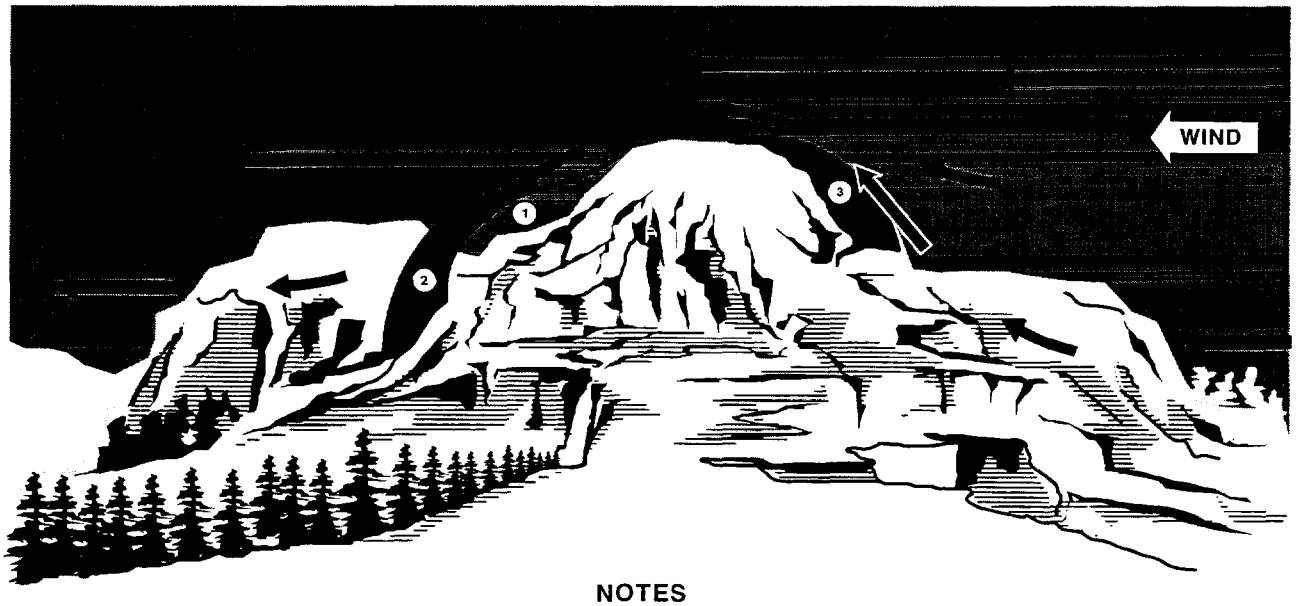
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Figure 14-3. Wind Effect in a Confined Area

should not be conducted in their vicinity. 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 (Figure 14-4). It will always be found on the tops of ridges associated with updrafts on the upwind side and downdrafts on the downwind side. Its extent on the downwind slope depends on the strength of the wind and the steepness of the slope. If the wind is fairly strong (15 to 20 knots) and the slope is steep, the wind will have a tendency to blow off the slope and not follow it down. However, there will still be some tendency to follow the slope. In this situation there will probably be 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 rough surface. It will not follow sharp contours as readily as gentle contours.

Man-made obstructions and vegetation will also cause turbulence. Extreme care should be taken when hovering near buildings, hangers, and similar obstructions. The best method to overfly ridgelines from any direction is to acquire sufficient altitude before crossing, to avoid leeward downdrafts. If landing on ridgelines (Figure 14-5), the approach should be made along the ridge in the updraft, or select an approach angle into the wind that is above the leeward turbulence. When the wind blows across a narrow canyon or gorge (Figure 14-6), 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 overdraft 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 it 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



NOTES

1. NULL AREA USUALLY FOUND ON LEEWARD SIDE AT CREST OF SLOPE.
2. IN VERY STRONG WIND CONDITIONS, AND / OR ON VERY STEEP SLOPES, TURBULENCE WILL BE FOUND ON THE LEEWARD SIDE OF THE SLOPE IN CLEAR AIR.
3. UP-DRAFTS WILL EXTEND ABOVE THE SURFACE FURTHER THAN THE TURBULENCE, DEPENDING ON WIND SPEED.

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Figure 14-4. Wind Flow Over and Around Peaks

affords an upslope wind. This procedure not only provides additional lift, but also a 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 (Figure 14-7), 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 cause convective turbulence. This is most 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 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 covered by vegetation or snow. Convective turbulence seldom gets severe enough to cause structural damage.

Note

A rotor speed above 100% N_r is recommended during flight through turbulence to reduce the susceptibility to blade stall.

14.5.6 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 everpresent. Air currents are unpredictable and may cause cloud formation to shift rapidly. Since depth perception with relation to distance from cloud formation and cloud movement is poor, low hanging clouds and scud should be given a wide berth at all times. In addition to being briefed, the pilot should carefully study the route to be flown. A careful check on the helicopter compass should be maintained in order to fly a true heading if the occasion demands.

14.5.7 Summary. The following guide lines are considered to be most important for mountain and rough terrain flying:

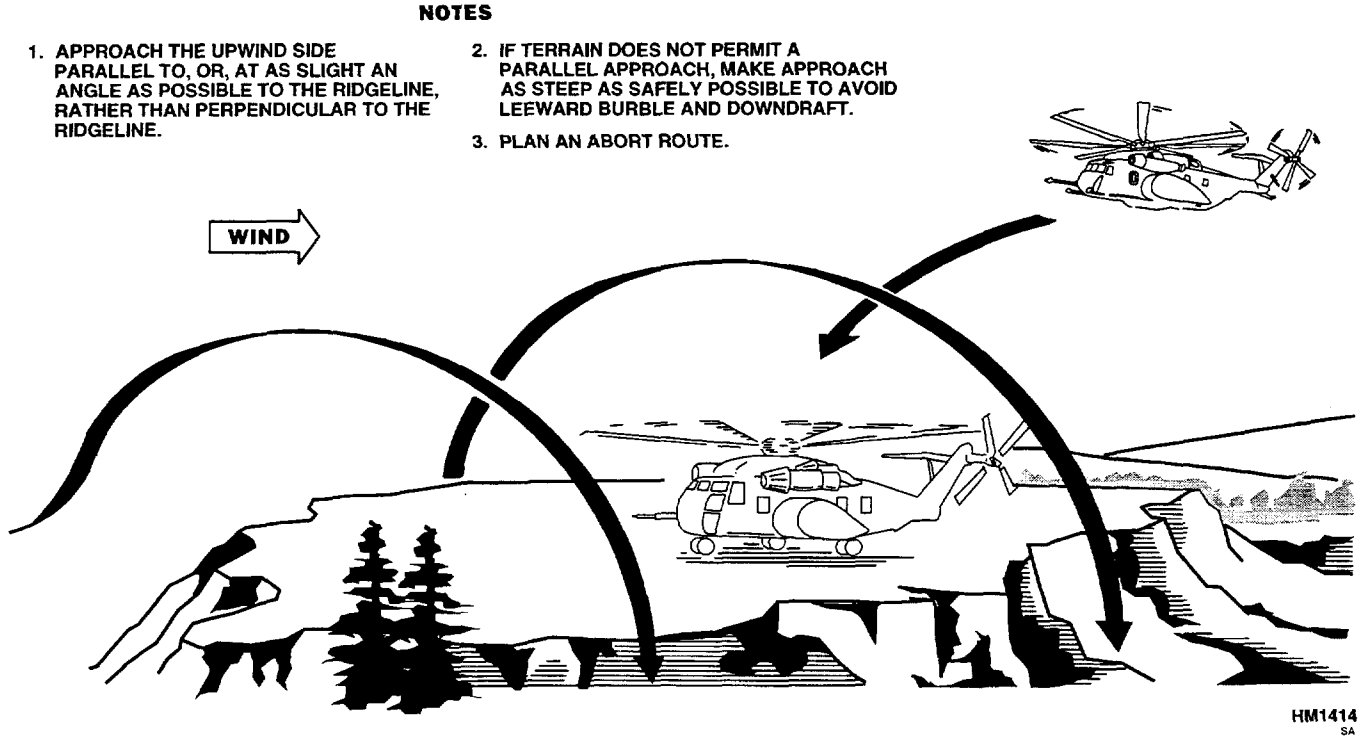


Figure 14-5. Wind Effect on Ridgeline Approach



AVOID THIS SIDE OF GORGE OR NARROW CANYON BECAUSE OF TURBULENCE OR DOWNDRAFTS

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Figure 14-6. Wind Flow Over Gorge or Canyon

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, to take full advantage of any possible wind effect.

4. When evaluating a landing site in noncombat operations, execute as many fly-bys as necessary with at least one high and one low pass, before conducting operations into a strange landing area.

5. Evaluate the obstacles in the landing site and consider possible null area and routes of departure.

6. Do not base landing site section solely on convenience. Give consideration to all relevant factors.

7. Determine ability to hover out of ground effect before attempting a landing.

8. It is recommended that BAR ALT and RDR ALT be disengaged when flying in turbulence.

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 of downdrafts on the leeward of the crest.

13. Avoid downdrafts prevalent on leeward slopes.

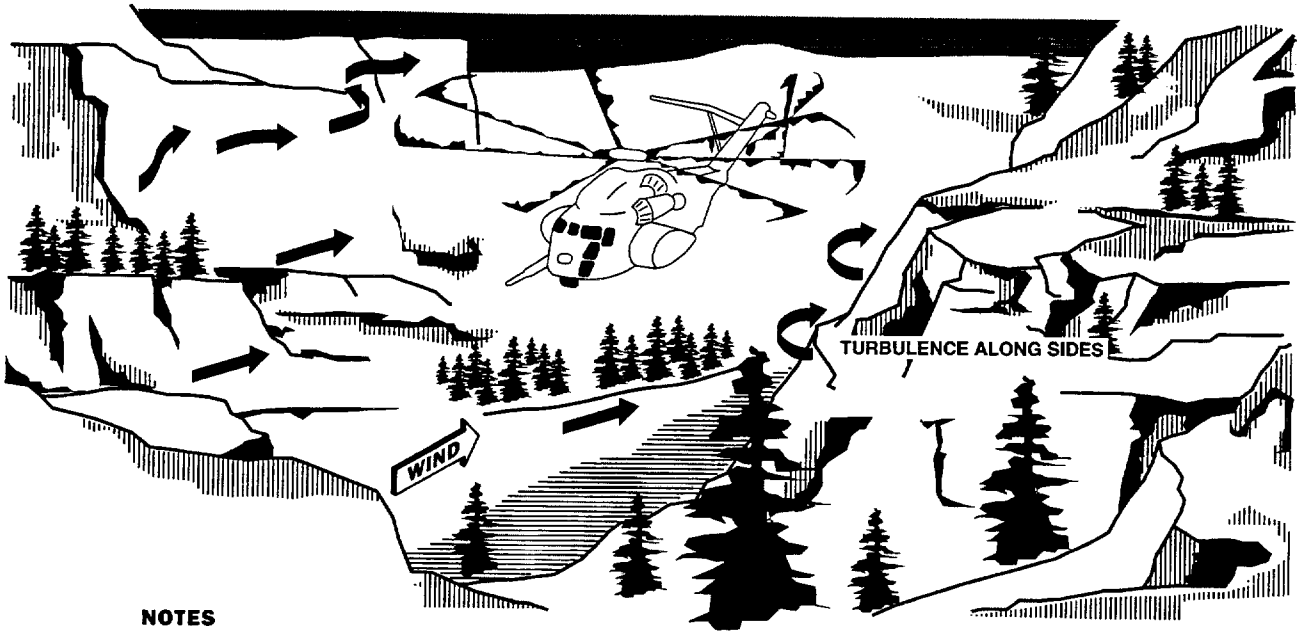
14. Plan your flight to take advantage of the updrafts on the windward slopes.

15. Whenever possible, make approaches to ridges along the ridge, rather than perpendicular to it.

16. Avoid high rates-of-decent when approaching landing sites.

17. Know your route and brief well for flying in these areas.

18. When operating below ridgelines, be alerted for power and telephone lines.



NOTES

1. INCREASED WIND VELOCITIES MAY BE FOUND IN THIS AREA DUE TO VENTURI EFFECT.
2. EXCESSIVE TURBULENCE NEAR BOTTOM.

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Figure 14-7. Wind Flow in Valley or Canyon

PART VII

COMMUNICATIONS

Chapter 15 Communications

CHAPTER 15
Communication/Navigation Systems

15.1 COMMUNICATION AND NAVIGATION EQUIPMENT

Radio communication and navigation equipment is operated through individual control panels on the center console (FO-7) and the overhead control panel (FO-1). Figure 15-1 lists the equipment installed, and Figure 15-2 shows antennas. Interphone and radio integration is made with the intercommunication system (ICS) control panels at 11 internal and 2 external crewmember stations (FO-10, FO-11). The emergency dc bus circuit breaker panel in the cockpit furnishes power to the pilots' ICS through two circuit breakers marked CPLT and PLT under the general heading ICS. The PLT furnishes power to the pilot and the CPLT furnishes power to the copilot. The No. 1 primary dc bus furnishes power through the ICS CAB-LH circuit breaker to the ICS stations at the jump seat, precise navigation operator, mid LH cabin, aft LH cabin, and LH tow positions. The No. 3 primary dc bus furnishes power through the ICS CAB-RH circuit breaker under the general heading RADIO to ICS stations at the external nose, aircrewman, external pylon, mid RH cabin, aft RH cabin, and RH tow positions.

The external nose station beneath the pilot's window, and the external pylon station on the right side of the main rotor pylon near the work platform provide ICS control panels for ground personnel.

ICS transmission and receiver selection for each internal station is made through an AIC-14A ICS radio control panel marked ICS and a radio transmitter/receiver selector panel marked RAD.

The pilots have complete communication and navigation selection capability. The pilots' cyclic grips have three-position spring-loaded rocker microphone trigger switches marked ICS and RADIO. The switch connects their respective microphones to the interphone transmission circuit when held at ICS, and to the radio transmission circuit when held at RADIO. A foot switch for each pilot is on the cockpit floor to the right of their respective rudder pedals. Pressing the floor switch will provide interphone or radio transmission when ICS or RAD, respectively, is set on the RAD selector panel ICS-RAD-ISOL switch.

An ICS cockpit isolation switch, with marked positions ISOL-NORM, is on the copilot's miscellaneous switch panel. ISOL isolates the pilots form other flight crew stations. NORM places the pilots on the intercommunication system with the other flight crew stations.

The jump seat station has a telephone-type handset with an integral keying switch. A special cable may be connected to allow use of a protective helmet with headset and microphone. A 75-foot walkaround cord is included for use with the jump seat or either of the two external stations. The jump seat station has complete intercommunication capability, radio transmit and receive capability of COMM 1, COMM 2, and HF radios, and radio receiver monitoring for the ADF.

The cabin stations have complete intercommunications capability and radio receiver selection for monitoring COMM 1, COMM 2, HF, and ADF radios. The aircrewman station microphone circuit is connected to the interphone transmission circuit by pressing a button on the key cord. The aircrewman has an auxiliary station aft of the cabin door for headset connection. At the auxiliary station, interphone transmission is provided through a mike trigger switch marked ICS on the hoist grip assembly. The precise navigation station and two midcabin microphone circuits are connected to the interphone transmission circuit by pressing the ICS inline key cord.

The two aft cabin station and two tow station helmet headphone connections are made through the winch pendant control cables, which have retracting reels in the cabin overhead. Push-to-talk ICS and CALL buttons are provided on the AMCM winch pendants. During utility missions the mid cabin and precise navigation (PNS) stations are used with 20 foot walk-around cords for ICS communication.

Note

The term precise navigation refers only to mine field navigation systems. Precise navigation is discussed in A1-H53ME-NFM-100 (AMCM Mission Systems Supplement).

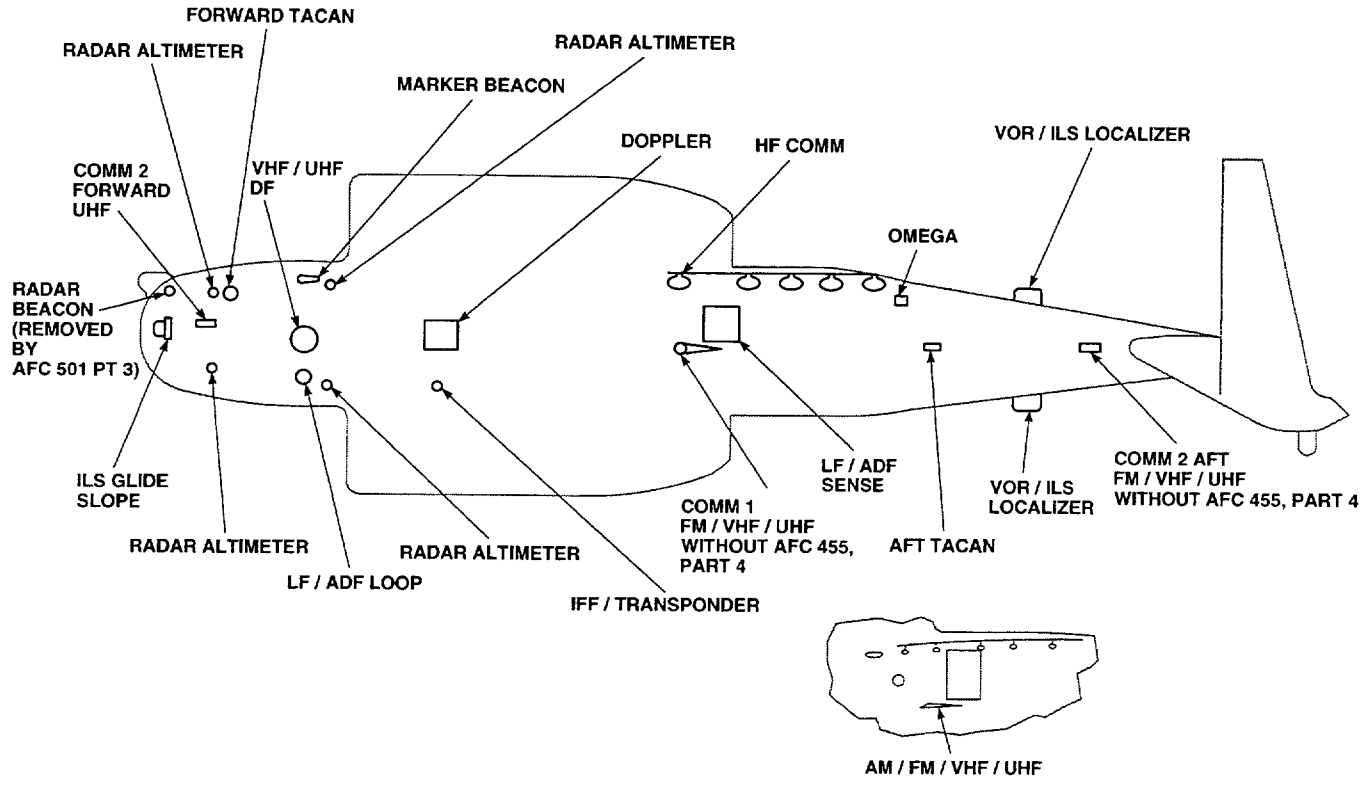
15.1.1 ICS Radio Control Panel. Eleven of these panels marked ICS are at the internal ICS stations (FO-

TYPE	DESCRIPTION	FUNCTION	PRIMARY OPERATOR	APPROXIMATE RANGE	CONTROL LOCATION
ICS	AN/AIC-14A	Interphone and radio integration	All	-	Cabin & cockpit
HF COMM	AN/ARC-174	Communication	Pilots	Depends on conditions	Cockpit
FM/VHF/UHF COMM	AN/ARC-182	Communication	Pilots	*LOS	Cockpit
## AM/FM/ VHF/UHF COMM	AN/ARC-210(V)	Communication	Pilots	*LOS	Cockpit
Speech	KY-58 (VHF-UHF AM/FM)	Communications	Pilots	LOS	Cockpit
VHF/UHF-DF	OA-8697/ARD	VHF/UHF-ADF	Pilots	LOS 25 miles	Cockpit
LF/ADF	AN/ARN-89	Navigation and communication	Pilots	Transmitter power and weather	Cockpit
TACAN	AN/ARN-118	Navigation	Pilots	LOS rec 390 miles A/A 200 miles	Cockpit
VOR/ILS	VIR-31A	Navigation	Pilots	LOS	Cockpit
IFF/Transponder	AN/APX-72	Identification	Pilots	LOS	Cockpit
# Radar beacon	AN/APN-154	Extend identification range	Pilots	Depends on conditions	Cockpit
Doppler	AN/APN-217A	Navigation	Pilots	N/A	Cockpit

* Line of sight
# Removed by AFC 501, Part 3
AFC 455, Part 4

Figure 15-1. Communications - Navigation Equipment

10). Each panel consists of an amplifier selector switch marked AMPL SEL, a microphone selector switch marked MIC SEL, an interphone volume control knob marked INTPH VOL, and VOX SENS knob. The amplifier selector is a four-position rotary switch marked EMERG-NORM-ALT 1-ALT 2. NORM is used for normal operation. Failure of the receiver amplifier disables some of the ICS functions. Full operation can be regained selecting ALT 1, which routes all signals through the interphone amplifier. Failure of the interphone amplifier disables some of the ICS functions. Full operation can be regained selecting ALT 2, which routes all signals through the receiver amplifier. When the AMPL SEL is at EMERG the applicable ICS station is connected directly to the COMM 1, COMM 2, and HF radio sets, to permit transmitting and receiving at the cockpit stations and receiving only at the cabin stations using radio sidetone. The microphone selector has three positions: COLD is used in normal operation and requires the use of a microphone keying switch; HOT gives the operator continuous microphone hands-off operation; and CALL, a spring-loaded override position, allows ICS to all interphone stations, regardless of their switch positions. CALL selected at any station will override the isolation feature of the pilots' ICS cockpit isolation switch, and any RAD panel ICS-RAD-ISOL switch at ISOL. Upon releasing the MIC SEL switch from CALL, the microphone selector switch will return to HOT, and only the station that has initiated the call circuit will have a hot microphone. The VOX SENS knob has OFF and a counterclockwise pointing arrow. The system is energized by



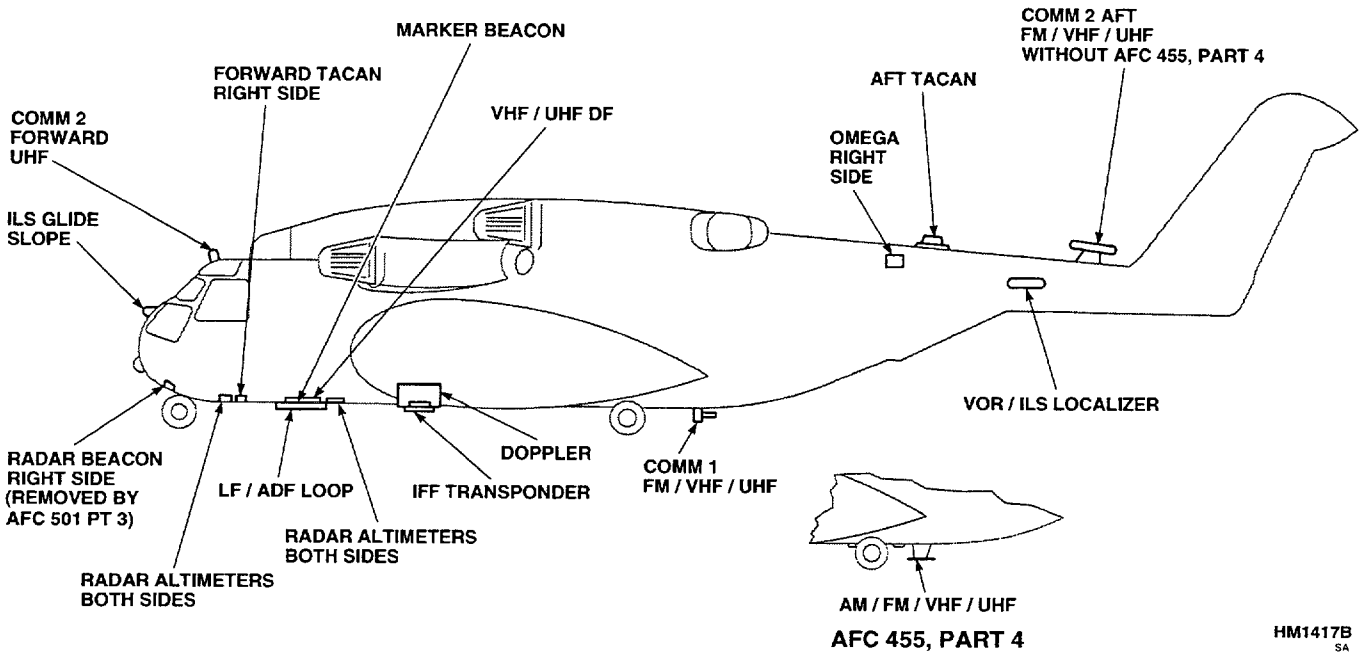


Figure 15-2. Antennas

turning the knob clockwise out of the OFF detent. The ICS system should be keyed with the station key switch or by placing the MIC SEL switch to HOT. The VOX SENS knob should be adjusted so that the microphone is energized when the operator talks in a normal tone, and deenergized when the operator stops talking. Turning the knob clockwise increases the sound level necessary to key the microphone. The INTPH VOL adjusts the interphone receiver volume.

15.1.2 Radio Transmitter/Receiver Selector Panel. Eleven of these panels marked RAD are at the internal ICS stations (FO-10). The panel allows the user to select various interphone and radio transmit and receive combinations, and to adjust radio receiver volume. The lower right three-position function switch has marked positions ICS-RAD-ISOL. At the pilots' stations, ICS provides interphone keying when a pilot's ICS foot switch is pressed. The RAD positions provide selected radio keying when an ICS foot switch is pressed. At the jump seat station the RAD function selections provided are the same as the pilot's, but are initiated when the handheld key switch is pressed. At ISOL the station is isolated from all incoming ICS and radio transmissions.

Note

At ISOL normal transmission functions at that station are operable, with no side tone. Therefore it is possible to transmit and not be aware of it.

The adjacent light goes on when any function is keyed. At cabin stations the switch is locked to the ICS position.

The top row of the toggle switches in the R (lower) position allow selected radio reception. The OFF (center) position turns selected radios off at the station. The RT (upper) position allows selected radio reception and transmission. When transmitting or receiving on a selected radio, the associated toggle switch light at the station will go on. When more than one switch is up, only one radio will transmit, and the switch on the right will have priority. The COMM 1, COMM 2, and HF toggle switches may be used for emergency interphone operation when they are in the up position and the ICS radio control panel is placed to EMERG. The bottom row of navigation toggle switches are two position switches. The vertical position turns the selected navigation radio off at the station. The down position allows the selected radio reception aural identification at the station. The pilots and jump seat navigation function lights go on when the respective station receives a signal. The RAD VOL knob adjusts radio receiver volume.

15.1.3 ICS External Stations. The external ICS stations (FO-11) are for ground support personnel. Both stations are identical and consist of a volume control knob marked INTPH VOL. The nose station is equipped with a telephone-type handset, but a headset-microphone will have to be plugged into the main rotor pylon station.

15.2 MODE SELECTOR PANEL

Two mode selector panels marked MODE SEL are on the instrument panel (FO-5), to allow each pilot to select the source of heading and attitude reference to their respective ADI and HSI. Two rows of pushbuttons provide the ADI and HSI functions marked. The function lit on the pushbutton face is provided, and pushing the button will change the function or turn off the light on the pushbutton. Figure 15-3 is a summary of ADI and HSI functions provided with each mode selector panel pushbutton. The ADI pushbutton OMEG-OFF at the OMEGA position directs signal function to the ADI vertical command needle, to provide OMEGA navigation course deviation information, and to the NAV flag. The OFF position removes the mode selector panel from control of all navigation signals to the ADI functions and removes all flags and pointers from view. RAYD-DPLR directs precise navigation or Doppler signals to the ADI command bars and deviation pointers, and the respective DOP or RAY flags. In the RAYD position the vertical command bar provides course deviation and the horizontal command bar provides speed deviation; the vertical pointer indicates the helicopters relative position in the sector, and the course deviation pointer indicates the helicopters lateral position in the sector. In the DPLR position the vertical and horizontal command bars provide. Doppler lateral drift and longitudinal velocity respectively. The vertical pointer provides Doppler referenced vertical velocity and the course deviation pointer is inoperative. VOR-TACN directs respective signal to the ADI course deviation pointer and the NAV flag. When in the VOR position and an ILS frequency is selected the horizontal command bar will provide glide slope deviation information and a GS flag functional signal is provided. The BACK CRS position reverses polarity of the selected ILS course signal to provide conventional display signal for ADI and HSI, and signals the NAV flags. The HSI pushbutton BRG 1 OMEG-ADF pushbutton directs respective navigation signals to the No. 1 pointer. The BRG 2 VOR-TACN pushbutton directs respective navigation signals to No. 2 pointer, NAV flag, course deviation bar, and TO/FROM indication. (When the VOR selection is an ILS frequency the No. 2 needle and TO/FROM indication are not signaled and the glide slope pointer and glide slope flag are signaled. When TACN is selected the DME function is enabled.) The CRS SEL VOR-TACN pushbutton allows the course knob

on the HSI to select and set in the COURSE window a VOR or TACAN course respectively. Power to operate the mode selector panels is furnished from the No. 3 primary dc bus through circuit breakers marked MODE SEL, PILOT and CO-PLT under the general heading RADIO. When a power failure to the pilot's mode selector panel occurs the pilot's ADI and HSI will provide normal TACAN and ADF functions when an appropriate frequency is selected. When a power failure to the copilot's mode selector panel occurs the copilot's ADI and HSI will provide normal VOR-ILS and ADF functions when an appropriate frequency is selected.

15.3 HF/COMM SET

The AN/ARC-174(V) HF radio provides airborne voice communication in the frequency range of 2 to 29.9999 MHz (280,000 channels). The HF radio, as installed in this helicopter, has the capability of transmitting and receiving on upper side band (USB), lower sideband (LSB), and amplitude modulation (AM). The set is remotely controlled from the control panel marked HF on the cockpit console (FO-7). The No. 1 primary dc bus circuit breaker panel provides power through circuit breakers marked HF RT under the general heading RADIO.

15.3.1 HF/COMM Control Panel. The control panel marked HF contains a mode control switch marked OFF-USB-AM-CW-SVU-SVL-RF TEST, four frequency control knobs, a SQL knob, RF TEST lamp, and a frequency readout window. OFF removes power from the set. USB, LSB, and AM select the respective voice modes of radio transmission and reception. CW, SVU, and SVL are not used in this installation. RF test position allows isolation of HF radio fault to an individual unit by selecting an HF frequency and keying the system. The status of the HF TEST lamp will indicate which unit is faulty: light out indicates normal, and light on steady or blinking gives malfunction indications useful to maintenance personnel. The four rotary selector controls change the drum frequency display in the readout window marked MHz to select the usable HF frequencies in the range from 2.0000 to 29.9999 MHz in increments of 100 HZ. The squelch (SQL) control provides a selection of eight squelch threshold-level settings which reduce the background noise level between transmissions.

To operate the HF/COMM set:

1. Select USB, LSB, or AM mode of operation using the mode select switch.

2. Select desired frequency by adjusting the four frequency rotary switches and observing the frequency readout scale.

3. If monitoring only is desired, place the HF switch on the transmitter/receiver selector to R.

WARNING

Do not operate HF transmitter on deck when personnel are within 50 feet of the antennas. A radiation hazard exists.

4. To transmit, position the HF switch on the radio transmitter/receiver selector panel to R/T.

5. Key transmitter to tune selected frequency. A constant tone will be heard during the tune cycle for approximately 3 seconds. Once the tune cycle has been completed, the radio is tuned.

6. Key the transmitter to transmit.

CAUTION

To lessen the probability of equipment damage, tune transmitter to 29.000 MHz and key the selected frequency before securing the transmitter.

15.4 VHF/UHF COMM SET (Without AFC 455, Part 4)

Two AN/ARC-182 (V) sets provide frequency modulated and amplitude modulated spectrum coverage to give communication for VHF and UHF between 30.000 MHz and 399.975 MHz. The left and right panels are designated COMM 1 and COMM 2, respectively. Tuneable frequencies are available in 0.025 MHz increments. The following frequencies are covered: VHF FM - 30.000 MHz to 89.975 MHz, VHF AM - 108.000 MHz to 117.975 MHz (receive only), VHF AM - 118.000 MHz to 155.975 MHz, VHF FM - 156.975 MHz to 173.975 MHz, and VHF/UHF AM/FM - 225.000 MHz to 399.975 MHz.

The set includes guard receivers that permit continuous monitoring of guard frequencies whenever the main transmitter-receiver is turned to another frequency. The guard channels are normally set at 40.5 FM, 121.5 and 156.8 VHF, and 243.0 UHF.

The set also provides automatic direction finding (ADF) in conjunction with the VHF/UHF direction finder. Relative bearing to the radio transmission source will be shown by the No. 1 pointer on the selected pilot HSI.

MODE SELECTOR	ATTITUDE DIRECTOR INDICATOR							
	COMMAND BARS		POINTERS		FLAGS			
	VERT	HORIZ	VERT	HORIZ	NAV	GS	DOP	RAY
POWER OFF PILOT AND COPILOT	CENTERED	CENTERED	CENTERED	CENTERED	IN VIEW	IN VIEW	IN VIEW	IN VIEW
ADI OFF	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW
OMEG	OMEGA	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	OMEGA	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW
RAYD	PNS CRS DEVIATION	PNS SPEED DEVIATION	PNS LENGTH LOCATION	PNS WIDTH LOCATION	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	RAYDIST (PNS)
DPLR	DOPPLER LATERAL DRIFT	DOPPLER LONGI-TUDINAL DRIFT	DOPPLER VERTICAL VELOCITY	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	DOPPLER	OUT OF VIEW
VOR (VOR FREQ)	VOR DEVIATION	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	VOR	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW
VOR (ILS FREQ)	ILS DEVIATION	GS DEVIATION	OUT OF VIEW	OUT OF VIEW	ILS	GS	OUT OF VIEW	OUT OF VIEW
BACK CRS	ILS DEVIATION	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	ILS	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW
TACN	TACAN DEVIATION	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW	TACAN	OUT OF VIEW	OUT OF VIEW	OUT OF VIEW

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SA

Figure 15-3. Mode Selector Panel Function (Sheet 1 of 2)

MODE SELECTOR	HORIZONTAL SITUATION INDICATOR									
	CRS SET KNOB	NO. 1 POINTER	NO. 2 POINTER	CRS DEV BAR	TO/FROM	NAV FLAG	GS		RANGE	
							POINTER	FLAG	MILES	FLAG
POWER OFF PILOT'S SIDE	TACAN	ADF	TACAN	TACAN	TACAN	TACAN	CEN-TERED	IN VIEW	TACAN	TACAN
POWER OFF CPLT'S SIDE (VOR FREQ)	VOR	ADF	VOR	VOR	VOR	VOR	CEN-TERED	IN VIEW	OPEN	IN VIEW
POWER OFF CPLT'S SIDE (ILS FREQ)	NA	ADF	VOR	ILS	VOR	ILS	GS	GS	OPEN	IN VIEW
BRG 1 OMEG	–	OMEGA	–	–	–	–	–	–	–	–
BRG 1 ADF	–	ADF	–	–	–	–	–	–	–	–
BRG 2 VOR (VOR FREQ)	–	–	VOR	VOR	VOR	VOR	OUT OF VIEW	OUT OF VIEW	OPEN	IN VIEW
BRG 2 VOR (ILS FREQ)	–	–	–	ILS	–	ILS	GS	GS	OPEN	IN VIEW
BRG 2 TACN	–	–	TACAN	TACAN	TACAN	TACAN	OUT OF VIEW	OUT OF VIEW	TACAN	TACAN
CRS SEL VOR	VOR	–	–	–	–	–	–	–	–	–
CRS SEL TACN	TACAN	–	–	–	–	–	–	–	–	–

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Figure 15-3. Mode Selector Panel Function (Sheet 2 of 2)

The emergency dc bus circuit breaker panel provides power for the COMM 1 system through a circuit breaker marked COMM 1 under the general heading RADIO. The No. 2 primary dc bus circuit breaker panel provides power to the COMM 2 system through a circuit breaker marked COMM 2 RADIO under the general heading RADIO.

15.4.1 FM/VHF/UHF COMM Control Panel. The panels marked V/UHF are on the cockpit console (FO-7). The VOL switch adjusts the audio output. The squelch toggle switch at OFF disables the receiver squelch, and at SQL enables the receiver's squelch. The UHF toggle switch selects the FM or AM operating mode when tuned to a frequency in the UHF band. The BRT switch controls brightness of FREQ/(CHAN) lighting intensity. The four frequency selectors set the frequency shown in the readout window marked FREQ/(CHAN). From left to right the four frequency selectors set hundred and tens, units, tenths, and hundredths respectively during manual operation.

Note

Flashing or blanking of the FREQ/(CHAN) windows on the COMM 1 and COMM 2 control panels may occur during shipboard operations due to shipboard electromagnetic emissions.

The MODE switch has marked positions OFF-T/R-T/R + G-DF-TEST. OFF removes power from the set. T/R enables the main transmitter and receiver. TR + G has the same function as T/R, plus the guard receiver. The guard receiver is tuned to the proper frequency for the selected operating band of the main receiver. DF permits operation of homing indicator when radio is tuned to frequency in low VHF (FM) band. Test is used for maintenance functions.

The CHAN SEL switch has an inner and outer selector. The inner switch permits selection of preset frequencies (channels) when outer selector is set to PRESET. The outer selector is marked 243-MAN-G-PRESET-READ-LOAD. 243 turns main receiver and transmitter to UHF guard (243.0). All panel functions except VOL, SQL, and BRT are disabled. MAN permits manual frequency change using frequency control switches. G tunes receiver-transmitter to guard frequency of the band to which the radio was last tuned. PRESET permits selection of any one of 30 preset operating frequencies. Selected channel number is displayed in the FREQ/(CHAN) window at the units and tenths positions. READ permits display of frequency of preset operating channel instead of channel number. Displayed frequency may be altered by use of frequency control switches, but stored frequency will not change. LOAD loads frequency selected in READ mode into memory to alter preset channel frequency. No change to stored preset frequency unless frequency has been changed while frequency mode selector has been set to READ.

To operate the FM/VHF/UHF COMM set:

1. Select T/R, TR + G, or DF mode of operation using the mode select switch.

2. Select desired preset frequency by placing outer channel selector switch to PRESET and adjust the center two frequency rotary switches and observe the frequency readout scale.

3. Select desired manual frequency by placing outer channel selector switch to MAN and adjust the four frequency rotary switches and observe the frequency readout scale.

4. When the COMM 1 transmitter/receiver is to be used insure the COMM 1 antenna is extended.

5. When the COMM 2 transmitter is to be used:

   a. UHF only — Select FWD on COMM 2 pushbutton on pilot's miscellaneous switch panel.

   b. FM/VHF/UHF — Select AFT on COMM 2 pushbutton on pilot's miscellaneous switch panel.

6. When monitoring only is desired, place the desired selector (COMM 1 or COMM 2) transmitter/receiver switch to R.

7. To transmit, place the desired selector (COMM 1 or COMM 2) transmitter/receiver switch to R/T. Key the transmitter to transmit.

15.4.2 FM/VHF/UHF Antennas. Three antennas (Figure 15-2) are provided. The lower FM/VHF/UHF antenna is retractable and is used only with the COMM 1 transmitter/receiver. It is controlled by a switch marked COMM 1 ANTENNA, with positions EXTEND-AUTO-RETRACT, on the copilot's MISC SWITCH panel. The switch is normally left in AUTO, which permits the antenna to automatically extend when the landing gear is retracted and automatically retract when the landing gear is extended. Placing the switch to EXTEND or RETRACT will cause the antenna to automatically extend or retract, regardless of landing gear position.

CAUTION

Do not place the switch to EXTEND while on the ground. This may cause damage to the antenna and extending mechanism.

The No. 2 primary dc bus circuit breaker furnishes power to the retractable antenna through a circuit breaker marked COMM 1 ANT under the general heading RADIO.

The upper forward UHF and upper aft FM/VHF/UHF antennas are used only with the COMM 2 transmitter/receiver. The COMM 2 selector switch on the pilot's miscellaneous switch panel, when pressed, will light to indicate which antenna has been selected (FWD or AFT). The forward (FWD) antenna is for UHF use only, and the aft (AFT) antenna is for FM/VHF/UHF use.

Note

COMM 1 and COMM 2 radios have identical functions. However, the COMM 1 antenna is more appropriate for FM use due to reduced range and antenna placement beneath the helicopter.

15.5 AN/ARC-210(V) RADIO (AFC 455, Part 4)

Two AN/ARC-210(V) radio sets provide communication frequencies in the AM/FM/VHF/UHF bands between 30.000 MHz and 400.000 MHz. The left and right panels are designated COMM 1 and COMM 2, respectively. Tuning frequencies are available in 25 kHz increments, 5 kHz or 10 kHz offset tuning is provided over the 30.000 MHz to 400.000 MHz frequency range. The radio receiver-transmitter provides simplex 2-way communication in normal and secure voice. The frequency bands include 30 through 88 MHz (FM normal/secure voice), 108 through 156 MHz (AM normal/secure voice), 108 through 156 MHz (AM normal/secure voice, 121.5 MHz guard channel, 108 through 118 MHz receive only), 136 through 174 MHz (FM normal/secure voice), 225 through 400 MHz (AM normal/secure voice; automatic direction finder (ADF); 243 MHz guard transmission; command activity sonobuoy system (CASS/DICASS) command), 225 through 400 MHz (FM normal/secure voice).

WARNING

- The receiver-transmitter contains a radio frequency transmitter which, when operated through an antenna, may produce electromagnetic fields in close proximity to the antenna that are in excess of Occupational Safety and Health Administration (OSHA) standards. Be sure all personnel are clear of antenna when performing radio checks.

- Do not exceed radio receiver duty cycle of 1 minute transmit followed by 5 minute receive.

The radio set includes a guard receiver that permits continuous monitoring of guard frequencies whenever the main transmitter-receiver is tuned to another frequency. The guard channels are normally set at 121.5 MHz and 243 MHz AM.

The radio set scanning consists of preset channels 22 through 25 and the command channel is 22. When the radio receiver-transmitter is keyed during scanning, transmit is on the command channel frequency. When activity is detected on a scanned channel, the channel number and frequency are displayed by the radio set control. The radio receiver-transmitter transmits on the active channel frequency. The channel remains active for 3 seconds after the last detected activity or transmission, where upon scanning resumes.

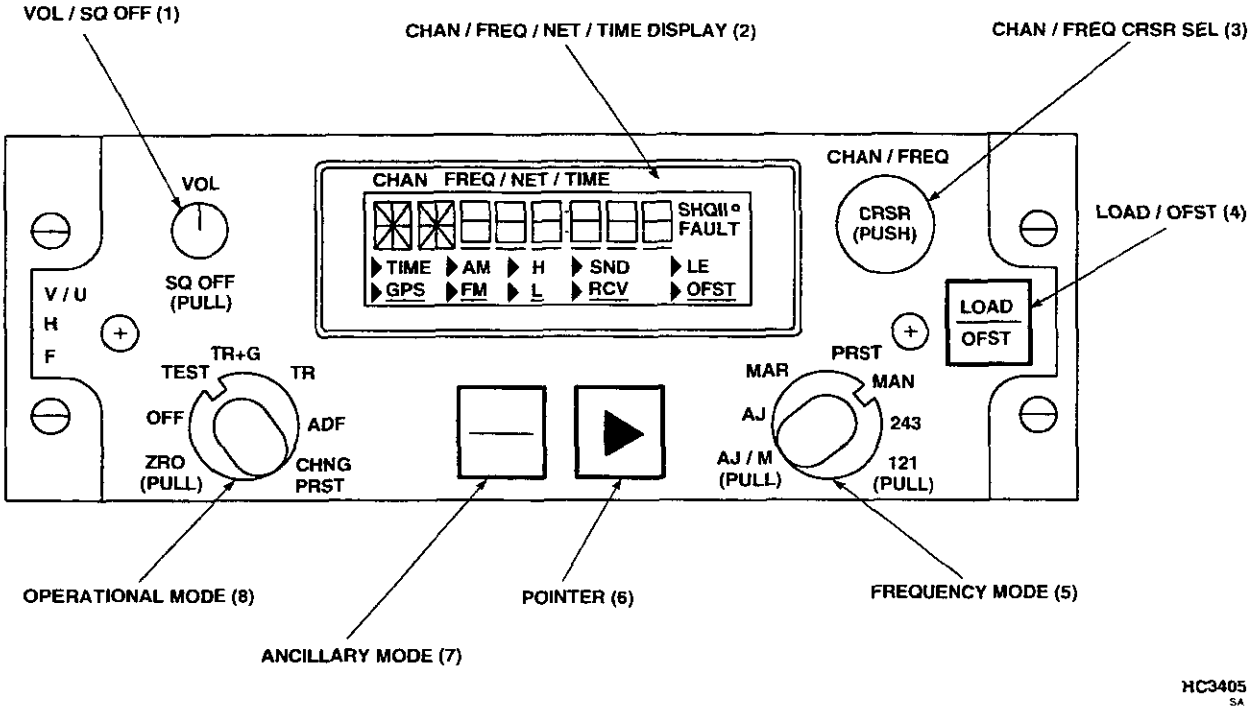
The radio set also provides automatic direction finding (ADF) in conjunction with the VHF/UHF direction finder. Relative bearing to the radio transmission source will be shown by the No. 1 pointer on the selected pilot BDHI.

The radio set has 30 preset channels, using the channel/frequency CRSR switch. The pilot may select up to 25 (channels 1 through 25) preset operating frequencies for simplex operation or channels 26 through 30 with dual frequencies for halfduplex operation. When the frequency mode is in MAR, it allows the pilot to select one of 57 preset Maritime channels (channels 1 through 28, and 60 through 88), using frequencies 156 to 173.975 MHz. The maritime channel and transmit frequency are displayed on the control panel.

15.5.1 Control Panel. The controls and indicators of the radio set are shown in Figure 15-4. The control

panels are marked V/UHF and are located on the cockpit center console (FO-7). The panels control mode select, function, and display.

15.5.1.1 Control Panel Built-In Test (BIT). Set operational mode to TEST. While BIT is running, display will be blank except for decimal point. After 15 to 20



ITEM	CONTROL/ INDICATOR	FUNCTION
1	VOL/SQ OFF	VOL Potentiometer/SQ OFF push-pull switch. Potentiometer adjusts audio output level. SQ OFF push-pull switch disables main receiver squelch in the out position and enables squelch in the in position.
2	CHAN/FREQ/NET/ TIME Display	Liquid crystal module display. Displays channel, frequency, net, time, mode, or built-in-test (BIT) results.
3	CHAN/FREQ CRSR Selector	CHAN (channel)/FREQ (frequency) CRSR (cursor) pushbutton rotary switch. Each time switch is depressed, the cursor position changes. Rotating the switch changes channel or frequency value depending upon mode selected and cursor position.
4	LOAD/OFST	Pushbutton switch. When depressed, enables the loading of various data depending upon the mode selected. Depressing this switch within 2 seconds after the operational mode selector has been placed to TEST causes the radio system to go into step self-test rather than end-to-end self-test.

Figure 15-4. AN/ARC-210(V) Control Panel, Indicators, and Function (Sheet 1 of 4)

ITEM	CONTROL/ INDICATOR	FUNCTION
5	Frequency Mode Selector	Isolated position rotary switch selects the following frequency modes:
		NOTE
		Knob must be pulled out to enter or exit positions marked PULL.
	AJ/M (PULL)	With the frequency mode selector pulled and placed in the AJ/M position (pull-to-turn), AJ/M (antijam/master net) mode is selected. Provides same capabilities as AJ mode plus the added functions associated with a SINCGARS master net controller.
	AJ	ECCM AJ (Anti-Jam) mode. Operator may select up to 25 AJ preset networks, either HAVE QUICK or SINCGARS ECCM nets, if all 25 channels are loaded with fill information, or the SINCGARS CUE channel and preset net number are displayed or AF presets and CS is displayed when the Cold Start channel is selected. Following operator selection, the CD-17/ARC applique supplies all frequency and control data for operation of the receiver-transmitter and antenna. The operator may define a HAVE QUICK channel by loading the WOD and type. In HAVE QUICK, the GPS and SND/RCV time ancillary modes are available. In SINCGARS, GPS SND/RCV, ERF (ECCM Remote Fill), H (Hop sets), L (Lockout Sets), and LE (Late Entry) modes are available and SINCGARS CUE channel is monitored.
	MAR	Maritime mode. Operator may select any one of the 57 preset maritime channels (channels 1 through 28 and 60 through 88). Maritime channel and transmit frequency is displayed. Alternately depressing the LOAD/OFST pushbutton while in the MAR mode changes transmit frequency and station operation from ship to station and back.
	PRST	Preset mode. Using the CHAN/FREQ switch, the operator may select up to 25 preset channels (1 through 25) for simplex operation, channels 26 through 30 with dual frequencies for halfduplex or Wide-Band Dedicated Channel UHF SATCOM (non-DAMA) operation, and channels 36 through 40 with dual frequencies for Demand Assigned Multiple Access (DAMA) UHF SATCOM operation. The selected channel, frequency, and modulation type (AM/FM) is displayed. SCAN mode is enabled when SCAN is displayed. Operator may also select SINCGARS CU (CUE) channel (31). When selected, CU and the frequency are displayed. Preset channels 22 through 25 are scanned. Channel 22 is the command channel and 23 through 25 are secondary channels. When a signal is detected on a scan channel, the channel number and frequency are displayed. Depressing LOAD/OFST during scanning will result in the selection of the last active channel being displayed and scanning to cease. Depressing LOAD/OFST a second and/or third time will tune the receiver/transmitter to the last active second and/or third channels that were last active. Depressing LOAD/OFST a fourth time will resume scanning operation. The same ancillary modes described for MAN mode are also available in the PRST mode.

Figure 15-4. AN/ARC-210(V) Control Panel, Indicators, and Function (Sheet 2 of 4)

seconds, 888.888 and all functions of the display are illuminated, indicating that the system has successfully passed BIT. Refer to Figure 15-5 for BIT readout examples.

The Emergency dc bus circuit breaker panel provides power for the COMM 1 system through a circuit breaker marked COMM 1 under the general heading RADIO. The No. 2 Primary dc bus circuit breaker panel provides power to the COMM 2 system through a circuit breaker marked COMM 2 under the general heading RADIO.

The radio set interfaces and operates with the TSEC/KY-58 secure voice equipment with the Electronic Counter Countermeasure (ECCM) applique. The applique

ITEM	CONTROL/ INDICATOR	FUNCTION
	MAN	Manual Frequency Select mode. Operator may select any of the radio operating frequencies. The following ancillary modes may also be selected: **NOTE** To select the ancillary modes, first remove the cursor from under the CHAN/FREQ digits by alternately depressing and then releasing the CRSR pushbutton. The ancillary mode pushbutton is used to position the cursor under the desired mode, and the pointer pushbutton is used to select or deselect the mode.
	Manual Ancillary Modes:	
	TIME/GPS	Global Positioning System (GPS) Time mode. Enables the receipt of time from a GPS receiver when a CD-17/ARC Frequency Countermeasure Controller is attached to the receiver-transmitter.
	AM/FM	AM/FM mode. Identifies modulation to be employed in the VHF band 136 to 155.985 MHz and the UHF band 225 to 399.985 MHz.
	SND/RCV	Send (SND) and Receive (RCV) mode. Used for over-the-air transfers between radios on the same frequency when the LOAD/OFST pushbutton is depressed. HAVE QUICK TOD may be transferred with the radio operating frequency in the UHF range. SINCGARS ERF may be transferred, if the radio operating frequency is in the VHF-FM (30 to 88 MHz) range. This switch is also used for Emergency Start time if time has not been loaded. This switch also changes display of frequency of SIMPLEX channel, SND displays transmit frequency and RCV displays receive frequency.
	OFST	Offset mode. Enables the selection of any frequency in the valid operating bands from 30 to 400 MHz in 5 kHz steps. Offsets of 0 kHz ±5 kHz and ±10 kHz can be selected after the pointer is placed in front of the OFST menu selection, and pressing the LOAD/OFST pushbutton to increment in ±5 kHz steps. Display shows offset frequency pointer must be turned off to exit mode.
	243	With the rotary switch pulled and placed in the 243 position (pull-to-turn), UHF guard mode is selected. The transmitter and main receiver are tuned to 243.000 MHz (AM). The preset and manual frequency selector controls become inoperative. Selection of this mode will also turn the radio on with the operational mode selector in the OFF position with primary power present.
	121 (PULL)	With the frequency mode selector pulled and placed in the 121 position (pull-to-turn), VHF guard mode is selected. The transmitter and main receiver are tuned to 121.500 MHz (AM). The preset and manual frequency selector controls become inoperative.
6	▶	Pointer pushbutton. Positions pointer to select or deselect ancillary mode select switch.
7		Ancillary mode pushbutton. Positions cursor under various ancillary mode options. Used with pointer pushbutton to select and deselect ancillary modes.

Figure 15-4. AN/ARC-210(V) Control Panel, Indicators, and Function (Sheet 3 of 4)

provides for appropriate transmission security/ commu- nication security (TRANSEC/COMSEC) and privacy

ITEM	CONTROL/ INDICATOR	FUNCTION
8	Operational Mode Selector	Isolated position rotary switch selects the following operational modes: **NOTE** Knob must be pulled out to enter or exit positions marked Pull.
	ZRO (PULL)	With operational mode selector pulled and placed in the ZRO (zeroize) position, all ECCM fill data is zeroized by completely erasing it from memory. ZRO is displayed.
	OFF	Selects OFF mode. Turns power off.
	TEST	Selects Test mode. Initiates Built-in-Test (BIT) of the control unit, receiver-transmitter, CD-17/ARC applique, antenna converter unit, and antenna. Display is blanked, except for a momentary side pointer followed by the decimal point with the test in progress. Faults detected are displayed (refer to Figure 15-5, BIT Display Codes and Faulty Component). With no faults detected, the display illuminates all function indicators. The operator may single-step through each test and display the results by depressing the LOAD/OFST pushbutton within 2-seconds of selecting test mode. Test mode takes precedence over all operations except 243 MHz Guard.
	TR+G	Selects main receiver-transmitter mode. The main receiver, transmitter, and guard receiver are on and able to perform all functions.
	TR	Selects main receiver-transmitter mode. The main communications receiver and transmitter are on. Guard receiver is off.
	ADF	Selects automatic direction finding mode. Transmitter functions normally. The main receiver is connected to the ADF antenna port. The receiver will provide normal received audio in addition to providing the demodulated ADF signal. Guard receiver is on. In FM mode, degraded operation may be noted.
	CHNG PRST	Selects change preset mode. Preset channels including COLD START and CUE channels, and corresponding operating frequencies and modulation can be loaded into receiver-transmitter memory and the HAVE QUICK ECCM net codes loaded into the ECCM controller memory. Presets may be loaded by the operator via the control unit, MIL-STD-1553B data bus or data transfer device.

Figure 15-4. AN/ARC-210(V) Control Panel, Indicators, and Function (Sheet 4 of 4)

modes. In HAVE QUICK mode of operation, the radio set A8 applique interfaces a number with the KY-58 that is compatible with all hop rates.

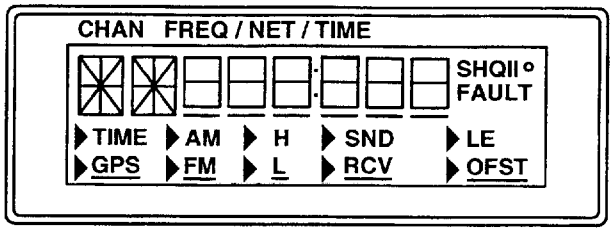
15.5.2 Normal Operating Procedures. The following procedures are applicable for operating the AN/ARC-210(V) Radio Sets and Control Panels. The following information consists of predeparture instructions to prepare the system for normal and ECCM operation.

15.5.2.1 COMM 1 Radio Checkout

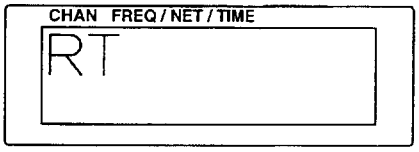
CAUTION

Do not exceed RT-1556/ARC duty cycle of 1 minute transmit followed by 5 minutes receive.

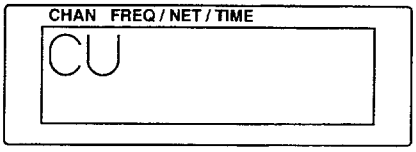
1. SET COMM 1 C-11898/ARC control as follows:



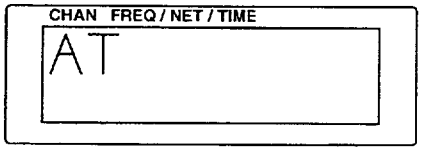
GOOD SYSTEM



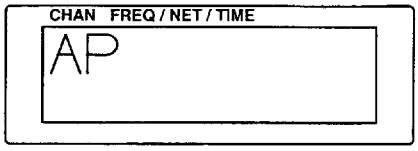
RT–1556 FAULT



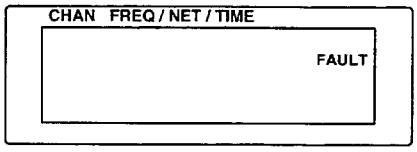
CV–4092 / A FAULT



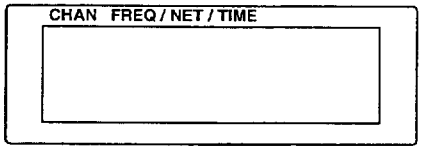
AS–3972 / A FAULT



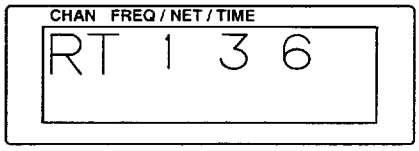
CD–17 FAULT



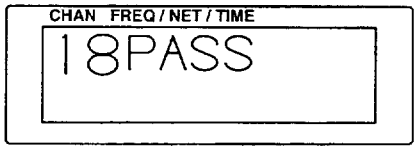
CONTINUOUS MONITOR
FAULT IN SYSTEM



CONTINUOUS MONITOR
FAULT IN CONTROL



LOAD / OFST PUSHED
FOR FAILED SRA



TEST 18 PASSED OR
10 FAIL IF TEST FAILED
(SINGLE STEP)



HC3406
SA

Figure 15-5. BIT Display Codes and Faulty Component

Operational Mode Selector	T/R or T/R&G
Freq Mode Selector	MAN
VOL	MID-Range
SQL	Push-Pull Switch in

2. Built-In Test (BIT).

Set operational mode to TEST. While BIT is running, display will blank except for decimal point. After 15 to 20 seconds, 888.888 and all functions of the display are illuminated, indicating that the system has successfully passed BIT. Refer to Figure 15-5 BIT Display Codes and Faulty Component, for BIT readout examples.

3. Radio Communications Test.

Select local authorized test frequencies and establish communications. Verify the station receives transmitted audio clearly. Verify presence of sidetone and received audio is heard clearly in headset. Repeat for UHF/AM/VHF/FM and GUARD RECEIVE.

4. Other Function Testing.

ADF Test: Enable ADF equipment by setting operational mode to ADF. Set frequency mode to proper frequency and verify proper ADF operation.

Squelch Disable: On VOL/SQ OFF switch, select squelch disable (pull). Noise should be heard in headset. Enable squelch and verify reduced noise is heard in headset.

Panel Lamps: Set panel illumination with console and panel control on the aircraft lighting panel. Verify faceplate lamps of C-11898 controls are variable in brilliance on both control boxes.

GPS Interface: Using the ancillary mode pushbutton, select GPS, then highlight with pointer button. Engage LOAD/OFFSET button. Time: Exits automatically and only GPS is displayed.

15.5.2.2 AN/ARC-210(V) ECCM Operating Procedures. By selecting AJ or AJ/M on the frequency mode selector, the operator may select up to 25 AJ preset channels containing HAVE QUICK I, HAVE QUICK II, or SINCGARS network data. An additional channel (channel 31) may be programmed with a SINCGARS cue frequency.

Note

AN/ARC-210(V) ECCM operation may only be activated if the CD-17/ARC Frequency Countermeasures Controller "applique" is attached to the RT-1556/ARC. SINCGARS data may be transferred into the applique utilizing the CYZ-10 Data Transfer Device (DTD), MIL-STD-1553B DATA BUS or via ECCM remote fill (ERF). HAVE QUICK data may be transferred utilizing the DTD, MIL-STD-1553B DATA BUS or loaded manually by the operator.

15.5.2.3 HAVE QUICK Operation

1. The following procedures will allow the operator to access many of the HAVE QUICK ancillary functions as well as operate the radio in the HAVE QUICK mode.

Note

Utilizing the CYZ-10 Data Transfer Device (DTD) to program HAVE QUICK operational data into the transceiver will normally negate the need to access most of the ancillary functions. It should be noted, however, that the CYZ-10 DOES NOT program Time-Of-Day (TOD) information into the transceiver. Therefore, provisions for TOD entry must be made.

2. A HAVE QUICK preset channel is represented by the symbols HQ I or HQ II in the upper right corner of the C-11898/ARC display. The applique stores preset channels containing HAVE QUICK Word-Of-Day (WOD), Multiple Words-Of-Day (MWOD), NET ID number, and Time-Of-Day (TOD). TOD will be the same for all HAVE QUICK operations, providing the time synchronization references are identical.

15.5.2.4 Operational Check HAVE QUICK I

1. Ensure that WOD/MWOD have been loaded either manually or with a data transfer device such as the CYZ-10, and TOD has been loaded via RF transfer or GPS receiver. Operational Day of Month (DOM) must be selected prior to HAVE QUICK operation.

a. TOD Emergency-Start: The following procedure allows the operator to initialize the transceiver's internal clock for use as a TOD reference.

(1) On the radio set control unit, select any frequency while in the normal or preset mode. The frequency selection is not

band dependent. (AJ or AJ/M modes may NOT be used.)

(2) Using the ancillary mode select and pointer pushbuttons, select both SND and RCV functions.

(3) Push the LOAD/OFST pushbutton. This resets the HAVE QUICK master clock to zero and restarts it to provide a timing reference.

Note

TOD is maintained for a minimum of 7 seconds during a power loss. If a power loss exceeds 7 seconds, TOD must be re-loaded.

b. TOD Hardwired Transfer (GPS): The following procedure allows the operator to receive either random time or Universal Coordinated Time (UTC) from a GPS receiver hardwired to the transceiver. This action synchronizes the transceiver's internal clock to random time or UTC.

2. On the radio set control unit, select the GPS function using the ancillary mode and pointer pushbuttons.

3. Push the LOAD/OFST pushbutton. This updates the HAVE QUICK master clock with reception of the GPS timing reference.

4. TOD RF Transfer: The following procedure allows the operator to transmit or receive TOD utilizing an RF link. This action synchronizes the transceiver's internal clock to that of the transmitting radio.

a. A communications link must be established between the two radios. If the transfer is done in manual or preset modes, the entire time is passed (days, hours, seconds, and fractions of seconds).

b. To send TOD, the operator will use the ancillary mode and pointer pushbuttons to select SND.

c. To receive TOD, the operator will use the ancillary mode and pointer pushbuttons to select RCV.

d. The operator receiving TOD pushes the LOAD/OFST pushbutton.

e. The operator sending TOD then has 60 seconds to push the LOAD/OFST pushbutton to initiate the TOD transfer.

f. Ensure that WOD/MWOD have been loaded either manually or with a data transfer device such as the CYZ-10, and TOD has been loaded via RF transfer or GPS receiver. Operational Day of Month (DOM) must be selected prior to HAVE QUICK operation.

g. Set the frequency mode to AJ.

h. Using the CHAN/FREQ switch, select an authorized HQ I or HQ II net.

i. Establish 2-way communications with another station on the selected net.

5. Verify WOD/MWOD Date: The following procedure allows the operator to verify WOD/MWOD date.

a. Set the frequency mode to PRST and select channel 20 with CHAN/FREQ and operational mode to CHNG PRST.

b. Select operating frequency of 220.000 by pushing CRSR switch until cursor is below desired frequency digit. Rotate CHAN/FREQ switch until desired value is obtained. Repeat for each digit until desired operating frequency is selected. Press LOAD/OFST.

c. CHAN FREQ/NET/TIME display should display 00.

d. Enter day of month to be verified (00 for HQ, 01 through 31 for HAVE QUICK II) by rotating the CHAN/FREQ switch. Press LOAD/OFST. A double tone heard in the headset indicated a MWOD has been loaded for that day. No tone indicates MWOD for that day has not been loaded.

6. WOD/MWOD Load (Manual): The following procedure allows the operator to verify Manual loading of WOD/MWOD.

a. Set frequency mode to PRST and select channel 20 with CHAN/FREQ and operational mode to CHNG PRST.

b. Select operating frequency of 220.025 by pushing CRSR switch until cursor is below desired frequency digit. Rotate CHAN/FREQ switch until desired value is obtained. Repeat for each digit until desired operating frequency is selected. Press LOAD/OFST.

c. CHAN FREQ/NET/TIME display should display 20 200.000.

d. Enter first segment of WOD. The segment consists of six digits. Select digit by pushing CRSR switch until cursor is below desired digit. Rotate CHAN/FREQ switch until desired value is obtained. Repeat for each digit until desired WOD segment is selected. The last two digits of segment 20 determine the hop rate (00 for the slowest, 75 for the fastest). Press LOAD/OFST when entry is complete.

e. A short tone should be heard in the headset, and CHAN FREQ/NET/TIME display should display 19 300.000.

f. Enter second segment of WOD. Select digit by pushing CRSR switch until cursor is below desired digit. Rotate CHAN/FREQ switch until desired value is obtained. Repeat for each digit until desired WOD segment is selected. In a multiple segment load, segment 19 designates if the WOD is in conference mode. For conference mode selection, enter 00 or 50 in the last two digits of the segment. Press LOAD/OFST when entry is complete.

g. A short tone should be heard in the headset, and CHAN FREQ/NET/TIME display should display 18 300.000.

h. Enter remaining segments (channels 18 through 15), pressing LOAD/OFST when each entry is completed.

i. CHAN FREQ/NET/TIME display should display two digits 00 through 31.

j. For HAVE QUICK II MWOD, rotate CHAN/FREQ switch to select two digit day of month (01 through 31). For HAVE QUICK WOD, display remains at 00. Press LOAD/OFST.

k. A double tone should be heard in the headset, and CHAN FREQ/NET/TIME display should display 20 220.025.

l. For HAVE QUICK II, repeat steps c. through k. for remaining five MWOD. For HAVE QUICK, the WOD load is completed.

7. MWOD Erase: The following procedure allows the operator to erase the MWOD.

a. Set frequency mode to PRST and select channel 20 with CHAN/FREQ and operational mode to CHNG/PRST.

b. Select operating frequency of 220.050 by pushing CRSR switch until cursor is below desired frequency digit. Rotate CHAN/FREQ switch until desired value is obtained. Repeat for each digit until desired operating frequency is selected.

c. Press LOAD/OFST.

8. Operational Date (DOM) Load: The following procedure allows the operator to load DOM.

a. Set frequency mode to PRST and select channel 20 with CHAN/FREQ and operational mode to CHNG PRST.

b. Select operating frequency of 220.125 by pushing CRSR switch until cursor is below desired frequency digit. Rotate CHAN/FREQ switch until desired value is obtained. Repeat for each digit until desired operating frequency is selected. Press LOAD/OFST.

c. CHAN FREQ/NET/TIME display should display 20 00.

d. Rotate CHAN/FREQ switch to select two-digit day of month (DOM) (01 through 31). Press LOAD/OFST. A short tone should be heard in the headset.

15.5.2.5 SINCGARS Operation

1. The following procedure allows the operator to access many of the SINCGARS ancillary functions as well as operate the radio in SINCGARS mode.

Note

When using the CYZ-10 (DTD) to transfer SINCGARS operational data, it will normally negate the need to access most ancillary functions. Base Time is not part of the DTD transfer function.

2. A SINCGARS preset channel is represented by the symbol "s" (small s) in the upper right corner of the C-11898/ARC display. The preset channel identifies net data sorted in the applique containing the Net ID, Hopset, and TRANSEC Variable. This net data is sorted in nonvolatile memory and will be retained in the event of power loss. In addition, SINCGARS operation requires SINCGARS Base Time to synchronize the frequency hopping operations. SINCGARS Base Time (including the mission day) may be loaded using hardwired transfer via GPS receiver, over-the-air RF transfer from another radio or Emergency Time start. If hardwired transfer via GPS or over-the-air RF transfer is used, the SINCGARS Base Time shall be equal to the received time and the SINCGARS mission day shall be equal to the least significant two digits of the three digit day-of-year. SINCGARS Base Time may be viewed in the form of days, hours, and minutes (DD HH:MM). If the operator updates the SINCGARS Base Time manually, all NET TIME OFFSET will be zero.

3. In the AN/ARC-210(V), the internal clock is referenced to the HAVE QUICK TOD. Internal clock timing will be retained for a minimum of 7 seconds during a power loss. Beyond 7 seconds, the internal clock may need to be reloaded. The AN/ARC-210(V) has provisions for an external battery backup to maintain internal timing. If utilized, a loss of primary power will not effect the radio's internal timing as long as battery backup power is not interrupted.

15.5.2.6 Operational Check, SINCGARS

1. Ensure that SINCGARS data has been loaded by ECCM remote fill (ERF) or via a data transfer device such as the CYZ-10 Data Transfer Device (DTD).

2. Set the frequency mode to AJ or AJ/M.

3. Using the CHAN/FREQ switch, select an authorized SINCGARS channel.

4. Establish 2-way communications with another station on the selected net.

a. If communication is "scratchy", a late entry function should be performed to synchronize radios. It is performed as follows:

(1) Ensure COMM 1 and COMM 2 and local station are on the same preset SINCGARS channel.

(2) Both stations should enter wristwatch time by using ancillary mode cursor and pointer to select time. With FREQ/CHAN, enter new time in days, hours, minutes format. The time must be loaded to within one minute of net SINCGARS TIME to work.

(3) Return to the SINCGARS MENU on both radios by de-selecting time.

(4) Enter LOAD/OFST on both radios.

(5) On COMM 1, select LE using cursor and pointer.

(6) Enter LOAD/OFST.

(7) Key local station to synchronize COMM 1.

(8) Repeat for COMM 2.

(9) Repeat operational SINCGARS testing to verify improved clarity.

5. SYNC Time Change (Manual): The following procedure allows the operator to change time manually.

a. Set frequency mode to AJ or AJ/M.

b. Select a SINCGARS channel (indicated by an "s" in the upper right corner of the display) using CHAN/FREQ.

c. Press ancillary mode cursor until cursor is under GPS. Press pointer pushbutton to select time.

d. CHAN FREQ/NET/TIME display displays days, hours, and minutes (DD HH:MM) 01 07:00.

e. Enter new time in days, hours, and minutes by pushing CRSR switch until cursor is below desired digit. Rotate CHAN/FREQ switch

until desired value is obtained. Repeat for each digit until desired time is selected. Press LOAD/OFST.

6. Late Net Entry: The following procedure allows the operator to make late entry into the receiver.

Note

Late net entry allows a radio set into a SINCGARS net without prior time synchronization. SINCGARS hopset, lockout set, and TRANSEC variable must be loaded prior to late net entry.

a. Set frequency mode to AJ. Load SYNC time (refer to paragraph 5, SYNC Time Change (Manual)). Sync time must be within 1 minute of net sync time.

b. Press ancillary mode cursor until cursor is under LE. Press pointer pushbutton to select LE. Press LOAD/OFST.

c. Establish communications with net radio sets. Late entry mode exits when the radio set becomes synchronized.

7. Electronic Protection (EP) Remote Fill: The following procedure allows the operator to fill the receiver.

a. Set frequency mode to AJ or AJ/M.

b. To receive ECCM Remote Fill (ERF), press ancillary mode select pushbutton until cursor is under RCV. Press pointer pushbutton to select RCV. Press LOAD/OFST. Perform steps d., e., f., and g.

c. To transmit ERF, press ancillary mode select pushbutton until cursor is under SND. Press pointer pushbutton to select SND. Press LOAD/OFST. Perform steps d., e., f., and g.

d. CHAN FREQ/NET/TIME display displays 01 (set number) in the CHAN position and an H (Hop set) or L (Lockout set) in the ancillary mode menu.

e. Select either H or L to select hopset or lockout set to be transferred.

f. Select desired set number to be transferred with CHAN/FREQ.

g. The receiving operator presses LOAD/OFST. CHAN FREQ/NET/TIME display returns to the state prior to ERF. The radio set operates normally and accepts ERF when it is sent.

h. The transmitting operator presses LOAD/OFST. CHAN FREQ/NET/TIME display sends the selected ERF and returns to the state prior to ERF.

8. Cold Start: The following procedure allows the operator to cold start SINCGARS operation.

Note

Valid SINCGARS TRANSEC variable must be loaded prior to cold start operation.

a. Set frequency mode to AJ.

b. Rotate CHAN/FREQ until CS is displayed on CHAN FREQ/NET/TIME display.

c. Set operational mode to CHNG PRST.

d. Select cold start operating frequency by pushing CRSR switch until cursor is below desired frequency digit. Rotate CHAN/FREQ switch until desired value is obtained. Repeat for each digit until desired operating frequency is selected. Press LOAD/OFST.

e. Set operational mode to TR+G. Establish 2-way communication with a similarly equipped transceiver to request ERF parameters.

f. Select RCV with ancillary mode and pointer pushbuttons to receive ERF (or SND to transmit ERF). Press LOAD/OFST.

g. CHAN FREQ/NET/TIME display displays an 01 in the channel position. Using the pointer, select H (Hop set) or L (Lockout set) to be transferred. Using CHAN/FREQ switch, select desired set number to be transferred.

h. Press LOAD/OFST. CHAN FREQ/NET/TIME display returns to the state that existed prior to ERF.

9. CUE Preset Load: The following procedure allows the operator to load CUE frequencies.

a. Set frequency mode to PRST.

b. Rotate CHAN/FREQ until CU is displayed on the CHAN FREQ/NET/TIME display.

c. Set operational mode to CHNG PRST.

d. Push CRSR switch until cursor is under desired frequency digit. Rotate CHAN/FREQ until desired value is obtained. Repeat for each digit until valid cue frequency is selected.

e. Press LOAD/OFST.

10. CUE Operation: The following procedure allows the operator to select antijam channels.

a. Set frequency mode to AJ or AJ/M.

b. Rotate CHAN/FREQ and select an antijam SINCGARS channel, indicated by an "s" displayed in the upper right corner of the display.

c. When a signal is received on the SINCGARS cue frequency, a short tone is heard in the headset and a "C" is displayed on the CHAN FREQ/NET/TIME display.

11. Zeroize: The following procedure allows the operator to zeroize fill data.

a. Pull operational mode selector and set to ZERO.

b. When data fill is deleted, ZRO is displayed.

15.5.3 AM/FM/VHF/UHF Antenna. Two antennas (Figure 15-2) are provided. The antennas are 9" tunable, that will receive and transmit in the 30 MHz to 400 MHz frequency range. Each antenna requires the use of a Digital Converter. The digital converter is an interface between the radio receiver output and the antenna control input. The No. 2 primary dc bus circuit breaker and emergency dc bus circuit breaker marked COMM 1 and COMM 2, under the general heading RADIO, provide electrical power to the antennas.

15.5.4 Digital Converter. The digital converter changes Manchester II encoded frequency information from the radio receiver, into a digital output for use by the tunable antenna. Built-in test (BIT) circuits within the digital converter provide a status output to the radio receiver-transmitter indicating the operational state of both the digital converter and tunable antenna. Interface with radio receiver and antenna control input is provided by three connectors located on the digital converter front panel. The No. 2 primary dc bus circuit breaker furnishes power to the digital converter through circuit breakers marked COMM 1 and COMM 2 under the general heading RADIO.

15.6 VHF/UHF DIRECTION FINDER

The purpose of the OA-8697/ARD direction finder is to receive signals in the VHF/UHF ranges of 100 to 400 MHz and provide relative bearing information with the HSIs No. 1 pointers. Selecting DF with COMM 1 or COMM 2 mode switch activates the VHF/UHF direction finder, and selecting ADF on the respective pilot's mode select panel provides a signal to the respective pilot's HSI. The VHF/UHF-DF antenna will receive AM signals in the 100 to 400 MHz range.

Note

- If both pilots select ADF on their respective mode select panels and COMM 1 and COMM 2 both have DF selected, but different frequencies selected the COMM 2 direction finder takes priority. There is only one VHF/UHF-DF antenna.

- UHF/DF bearing information on the No. 1 needle of the HSI using COMM 1 or COMM 2 may be unreliable while transmitting on the other AN/ARC-182 radio.

A 100 Hz tone will be heard when a VHF/UHF signal is being received which will decrease in volume when the signal is acquired and the HSI's No. 1 needle points toward the selected signal source. If the LF/ADF is on and homing on a station and the VHF/UHF-DF is activated, the VHF/UHF-DF will have priority, and HSI's No. 1 needle will point to the VHF/UHF-DF signal source. The No. 3 primary ac bus furnishes power through a circuit breaker marked UHF DF under the general heading 26V RADIO.

To operate the VHF/UHF-DF:

1. Select desired manual or preset frequency in the appropriate COMM selector window. (Frequency range of 100 to 400 MHz only).

2. Select DF on the appropriate COMM mode switch.

3. Select ADF under HSI BRG 1 on the appropriate COMM mode selector panel.

4. Reference appropriate COMM HSI No. 1 pointer for DF homing.

Note

Reduced reception and bearing accuracy may be experienced any time the station is not on the nose of the helicopter.

15.7 SPEECH SECURITY SYSTEMS

The KY-58 system is controlled by a panel on the pilot's center control (FO-7). The panel is associated with the FM/VHF/UHF COMM set (COMM 1 and COMM 2). With AFC 455, Part 4, the panel is associated with the AM/FM/VHF/UHF COMM set. The KY-58 installation and associated equipment comprise a speech security system. Operating procedures and related support should be received from the facility security office. Mounting provisions are provided for two T SEC/KY-58 main units in the cabin beneath the precise navigation operator's radio selector control panels. Controls on the main unit are selected by maintenance personnel at the time of installation. Secure speech capability is available with the COMM 1 and COMM 2 FM/VHF/UHF COMM sets. The emergency dc bus circuit breaker panel furnishes power to the KY-58 through a circuit breaker marked COMM JULIET under the general heading RADIO.

The AN/ARC-210(V) COMM set (AFC 455, Part 4) is AM/FM/VHF/UHF capable. The COMM set utilizes HAVE QUICK and SINCGARS anti-jamming to enhance the secure speech capabilities. There are two TSEC/KY-58s located in the cabin equipment rack. The emergency dc bus circuit breaker provides electrical power to COMM 1 and COMM 2 KY-58.

Note

Transmission of classified or secure information is prohibited in uncoded mode of operation.

When the T SEC/KY-58 (main unit) is not installed, its attaching harness connectors should be connected to the jumper harness permanently installed near the mounting frame.

15.7.1 Speech Security System Control Panel.

The KY-58 control panel is marked KY/RLY. Functions indicated as 1 and 2 apply to COMM 1 and COMM 2 radios respectively. A guarded toggle switch marked ZEROIZE is used to erase code in the secure voice T SEC/KY-58 unit in the cabin. Under KY 1 and KY 2 the DELAY toggle switches marked IN-OUT, when placed to IN, initiate a delay in the secure voice unit to allow the system to act as a retransmit (relay) station. OUT removes the relay capability. The MODE switches provide secure voice on FM band frequencies at the BB position and AM band frequencies at the DP position. The operational mode selector switch has positions OFF-PLAIN RELAY-CRYPTO RELAY-CRYPTO 1-CRYPTO 2-CRYPTO 1 + 2. OFF allows COMM 1 and COMM 2 radios to operate normally in plain text voice. PLAIN RELAY allows two radios to operate in relay mode with plain text. The intercom system has take-command authority over either radio. CRYPTO RELAY performs the same functions as PLAIN RELAY, but in encrypted text. At CRYPTO 1 two radios operate independently: COMM 1 in cipher and COMM 2 in plain text. At CRYPTO 2 two radios operate independently: COMM 1 in plain text and COMM 2 in cipher. At CRYPTO 1 + 2, if two T SEC/KY-58 units are in the system, both radios operate independently in cipher text.

To operate the KY-58:

1. Place KY DELAY for desired COMM 1 or COMM 2 system to OUT for normal procedures or to DELAY for relay procedures (cipher or plain).

2. Place KY MODE switch for desired COMM 1 or COMM 2 system to BB for FM or AM frequencies.

3. Place CRYPTO at 1 for COMM 1 in crypto, 2 for COMM 2 in crypto, or 1 + 2 for COMM 1 and COMM 2 in crypto. Place CRYPTO at PLAIN RELAY for plain use or RELAY for relay.

4. Transmit/receive using normal radio procedures.

15.8 LF/ADF SET

The AN/ARN-89A (low frequency/automatic direction finding) radio compass set automatically indicates the direction from which an incoming radio frequency (rf) signal is received. The set operates in the frequency range of 100 to 3000 kilohertz (kHz). The No. 1 pointer of the selected HSI will show the relative bearing of the transmitting station, in regard to the heading of the helicopter, when the VHF/UHF-DF set is not in use.

The No. 3 primary ac bus furnishes power through a circuit breaker marked LF ADF under the general heading 26V RADIO. The No. 1 primary dc bus furnishes power through a circuit breaker marked ADF under the general heading RADIO.

15.8.1 LF/ADF Control Panel. The panel, marked ADF RCVR, is on the cockpit console (FO-7). The mode selector knob is a four-position switch marked OFF-COMP-ANT-LOOP. The OFF position disables the set. The COMP position provides ADF operation. ANT allows the set to be used as an AM and CW receiver using the sense antenna. LOOP allows the set to be used as a manual direction finder using the loop antenna. The loop skew knob marked LOOP permits the loop to be slewed L (left) or R (right). The knob is spring-loaded to the center position. The AUDIO knob adjusts volume. The coarse tune knob tunes the receiver in 100 kHz steps as indicated by the first two digits in the frequency window. The fine tune knob provides selection of 10 kHz digits (continuous tuning), as indicated by the last two digits in the frequency window. The CW-VOICE-TEST switch is a three-position switch. With CW and COMP mode selected, it allows the tone oscillator to provide an audible tone for tuning to a CW station. With CW and ANT mode or LOOP mode selected, it enables the beat frequency oscillator to permit tuning to a CW station. With VOICE selected, it permits the set to operate as an AM receiver with the mode switch at COMP, ANT, or LOOP. With TEST and COMP mode selected, it provides slewing of the loop through 180°, to check operation of the receiver. The tune meter, marked TUNE, indicates relative signal strength while tuning receiver to a specific radio signal. The window marked KILO-HERTZ indicates operating frequency to which receiver is tuned.

To operate the LF/ADF set:

1. Press desired mode selector panel HSI BRG 1 ADF function switch on.

2. Tune set as described above.

3. The ADF signal is referenced on the selected HSI No. 1 pointer.

To operate the LF/ADF test functions:

Manual Self-Test. To initiate the self-test, select COMP on the ADF function switch, and set the HSI BRG 1 on the pilot and copilot's MODE SEL panels to ADF. Place the ADF test switch to TEST and the pilot and copilot's No. 1 HSI needles slew 180°. Place the ADF test switch to VOICE and the test is complete.

15.9 TACAN SET

The AN/ARN-118(V) TACAN set is a polar coordinate navigation system that is used to determine the magnetic bearing and slant line distance from the aircraft to a selected TACAN station. The selected TACAN station can be a ground, shipboard, or airborne TACAN station. The ground and shipboard TACAN stations are considered surface stations and supply both bearing and distance to the helicopter. An airborne station without a bearing transmitter only supplies distance information. An airborne station with a bearing transmitter supplies bearing and distance information. The installation in this helicopter is not capable of transmitting bearing information but does supply distance information when interrogated. Although maximum range of station reception is governed by line of sight considerations, the maximum operating range of the set is 390 nautical miles when the selected TACAN station is a surface station, and 200 nautical miles when the selected station is an airborne station. The TACAN navigation set has provisions for 126 X channels and 126 Y channels. The X channels are those presently used by surface stations. The Y channels differ from the X channels in frequency assignment and pulse spacing.

TACAN navigational signal information is sent to the ADI and HSI when TACN is selected under ADI and HSI on the respective pilot's mode selector panel. The ADI vertical command bar will display helicopter course deviation relative to the course selected. The bar is fully displaced when the helicopter is off course more than 10°. Vertical bar deflection across one half of each side of the horizontal command bar is 5°. Appearance of the NAV flag indicates that the course indicator is not receiving a signal strong enough for reliable information. When a power failure to the pilot's mode selector panel occurs the pilot's ADI and HSI will provide normal TACAN functions when an appropriate frequency is selected.

The magnetic bearing of a selected TACAN station is indicated by the HSI's No. 2 pointer. The distance to the TACAN station is indicated by the HSI's range display window. The HSI's TO-FROM indicator shows whether the selected course is to or from the TACAN station. With CRS SEL TACN selected on the respective pilot's mode selector panel the HSI course select knob will set TACAN course information in the course set display window. Each course deviation dot is 5°. The HSI NAV warning flag appears when unreliable signals below minimum usage are received. When correct bearing information cannot be determined, the HSI's No. 2 pointer will search or turn in a manner that prevents the pilot from deriving improper information from it.

Note

Although the course indicator may be receiving a signal strong enough to keep the range masking bar out of view, reliability is indicated only if the NAV flag is not displayed, the station identification is being received, and the No. 2 HSI pointer is pointing to the NAVAID.

See Attitude Director Indicator (ADI) and Horizontal Situation Indicator (HSI) in Chapter 2 for a detailed description of these indicators.

The No. 3 primary ac bus furnishes power to the set through a circuit breaker marked TACAN PWR, under the general heading RADIO, and through a circuit breaker marked TACAN under the general heading 26V RADIO. The No. 3 primary dc bus furnishes power to the set through a circuit breaker marked TACAN, under the general heading RADIO.

15.9.1 TACAN Control Panel. The control panel marked TACAN is on the cockpit console (FO-7). The controls include a function selector switch, tens channel selector switch, units channel selector switch, X/Y channel selector, volume control knob, and self-test button. The control panel also contains a test indicator light and channel digital display.

A five-position function selector knob marked OFF-REC-T/R-A/A REC-A/A T/R selects the mode of operation. OFF removes power from the set. REC allows only bearing information to be received from a surface station. T/R allows both bearing information and distance data to be received from a surface station. A/A REC allows only bearing information to be received from a suitably equipped cooperating aircraft. At A/A T/R, both bearing and distance information are received from another aircraft. If the cooperating aircraft is not equipped to transmit bearing signals, only the distance will be received in this mode.

Note

- Bearing information will not be transmitted at the A/A T/R position.

- Operation in the air-to-air mode requires prearrangement with a cooperating aircraft. The second aircraft must be equipped with an air-to-air TACAN which is set to the air-to-air mode of operation and is set to a channel 63 channels away from the channel setting of the TACAN in the aircraft. Both aircraft must be on the same X or Y channel. One aircraft may reply to as many as five others, but it will only display the distance to the nearest aircraft.

- The TACAN navigation set requires a 90-second warmup period, regardless of the position selected by the function selector knob.

The tens channel selector and units channel selector switches are rotary knobs that tune the TACAN navigation set to any of 126 TACAN channels. The X/Y channel selector, a movable ring around the units channel selector knob, selects either the X set of 126 channels or the Y set of 126 channels.

CAUTION

The units channel selector knob contains a built-in mechanical stop to prevent turning past the nine (9) position. Do not attempt to override this mechanical stop. Direction of knob must be reversed when the stop is reached.

The volume control knob, marked VOL, varies the volume of the audio signals.

To operate the TACAN set:

1. Press the desired mode selector panel ADI VOR-TACN function switch to TACN.

2. Press the desired mode selector panel HSI BRG 2 CRS switch to TACN, and CRS SEL switch to TACN.

3. Select desired channel (include proper X-Y setting).

4. Select function as REC-T/R-A/A REC-A/A T/R as desired.

5. Adjust volume to identify station.

6. Set desired HSI course.

7. Reference the HSI No. 2 pointer, range display window, and TO-FROM; and ADI vertical command bar.

To operate the self-test functions:

The manual self-test button, marked TEST, provides a test of the complete TACAN system, except for the antennas, when pressed.

Manual Self-Test. To initiate the self-test, select T/R, select a TACAN frequency, and set a course of 180° in the pilot or copilot's course set display window. Set HSI BRG 2 and CRS SEL and ADI TACN on pilot and copilot's MODE SEL panels to TACN. Press the TEST button and observe that the test indicator light goes on for about 1 second, the ADI and HSI NAV flags come into view for about 7 seconds, and the No. 2 pointers of the pilot and copilot's HSI indicates 270°. For the next 15 seconds, the ADI and HSI NAV flags go out of view, the range indicator displays 000.0 (±0.5), the No. 2 pointer indicates 180°. When the self-test is complete, all indicators return to the indications displayed prior to the initiation of self-test. A failure is recorded if the test indicator light remains on during the test and/or the indicators are out of limits. The test can be done again in the REC mode, and if the indicator light does not go on, the malfunction is isolated to the transmitter section and the bearing information is valid.

Automatic Self-Test. To be sure that the TACAN system is operating properly, an automatic self-test occurs when the receiver signal becomes unreliable or the signal is lost. The results of the automatic self-test are the same as for the manual self-test except that the ADI and HSI NAV flags remain in view throughout the test.

CAUTION

Be prepared for the possibility of TACAN equipment failure if the test indicator light goes on. 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.

15.10 VOR/ILS SET

The VIR-31A VOR/ILS set receives signals transmitted by VOR and ILS stations. When a VOR frequency is selected, the signal output is sent to the ADI and HSI selected on the respective pilot's mode selector panel. The ADI vertical command bar displays helicopter course deviation relative to the course selected. The bar is fully displaced when the helicopter is off course more than 10°. Vertical bar deflection across one half of each side of the horizontal command bar is 5°. Appearance of the NAV flag indicates that the course indicator is not receiving a signal strong enough for reliable information. When a power failure to the copilot's mode selector panel occurs the copilot's ADI and HSI will provide normal VOR or ILS functions when an appropriate frequency is selected. The HSI No. 2 pointer displays magnetic bearing to the VOR station. The TO/FROM will show the position of the VOR station from the helicopter. Each course deviation dot is 5°. The HSI NAV warning flag appears when unreliable signals below minimum usage is received. When correct bearing information cannot be determined, the HSI's No. 2 pointer will turn to and remain at the 90° right position to prevent the pilot from deriving improper information from it. With CRS SEL VOR selected on the respective pilot's mode selector panel the HSI course select knob will set VOR course information in the course set display window.

When an ILS frequency is selected, the signal output is applied to the ADI and HSI selected on the respective pilots mode selector panel. When used for ILS signals the ADI and HSI indicators provide precise ILS localizer course and glide slope information for the specific approach. Full-scale deflection on the ADI vertical command bar and the HSI course deviation bar differ with the width of the localizer course (3° to 6°). Example: If the localizer course is 5° wide, the full-scale deflection is 2-1/2° and each dot is 1-1/4°; if the localizer course is 3° wide, full-scale deflection is 1-1/2° and each dot is 3/4°. Deflection on the ADI horizontal command bar and HSI glide slope scale display glide slope position in relation to the helicopter. If the respective indicator is above or below center, the glide slope is above or below the helicopter respectively. Full scale deflection of the indicator differ with the width of the glide slope (1 to 1.8°). Example: If the glide slope width is 1°, full-scale deflection is 1/2°, and each dot is 1/4°. Appearance of the GS flags indicate the signal is unreliable.

See Attitude Director Indicator (ADI) and Horizontal Situation Indicator (HSI) in Chapter 2 for a detailed description of these indicators.

The No. 3 primary ac bus furnishes power through a circuit breaker marked VOR, under the general heading 26V RADIO. The No. 3 primary dc bus furnishes power through a circuit breaker marked VOR LOC-GS, under the general heading RADIO.

15.10.1 VOR/ILS Control Panel. The control panel is on the cockpit console (FO-7). The left knob is

marked MB VOL. The inner knob selects frequency in 1 MHz steps and the movable outer ring controls marker beacon volume. The right knob is marked NAV VOL. The inner knob selects frequency is 50 KHz steps. The movable outer ring controls VOR/ILS volume. Frequency is displayed in an indicating window, and the frequency range is from 108.00 to 117.95 MHz. A two-position MB switch has positions HI and LO. LO provides a standard marker beacon width sensitivity. HI provides a longer period of marker beacon sensitivity. A three position function selector switch is marked TEST-ON-OFF. ON provides power to the unit, OFF removes power, and TEST initiates the BIT.

To operate the VOR/ILS set:

VOR frequency.

1. Press the desired mode selector panel ADI VOR-TACN function switch to VOR.

2. Press the desired mode selector panel HSI BRG 2 CRS switch to VOR, and CRS SEL switch to VOR.

3. Set NAV panel switch to PWR.

4. Select desired VOR frequency.

5. Adjust volume to identify station.

6. Set desired HSI course.

7. Reference the HSI No. 2 pointer and TO-FROM indicator, and ADI vertical command bar.

ILS frequency.

1. Press the desired mode selector panel ADI VOR-TACN function switch to VOR (press BACK CRS as required).

2. Press the desired mode selector panel HSI BRG 2 CRS switch to VOR.

3. Set NAV panel switch to PWR.

4. Select desired ILS frequency.

5. Adjust volume to identify station.

6. Reference the HSI course deviation bar and ADI vertical and horizontal bars.

Note

The ADI horizontal bar does not provide glide slope information when BACK CRS is selected.

To operate the VOR/ILS test functions:

VOR Test. Tune in and identify a VOR station. Set HSI BRG 2 and CRS SEL and ADI VOR on pilot and copilot's MODE SEL panels to VOR. Then hold the ring control at TEST. If a VOR signal is present, the ADI and HSI NAV flags stay out of view, the HSI course deviation bar deflects right and the HSI TO/FROM indicator indicates TO. Release the ring control to PWR. The ADI and HSI NAV flags comes into view in 1 second, and go out of view in 5 seconds. Test is satisfactory.

If no VOR station is available, set HSI BRG 2 and CRS SEL and ADI VOR on pilot and copilot's MODE SEL panels, to VOR, select any VOR frequency, and hold the ring at TEST. The ADI and HSI NAV flags go out of view after 3 seconds, and the HSI course deviation bar deflects right and the HSI TO/FROM indicator indicates TO. Release the ring control to PWR, and the ADI and HSI NAV flags comes into view in 1 second. Test is satisfactory.

ILS Test. Set HSI BRG 2 and CRS SEL and ADI VOR on pilot and copilot's MODE SEL panels to VOR. Tune in and identify an ILS station, and then hold the ring control at TEST. The ADI and HSI NAV and GS flags stay out of view, the HSI course deviation bar deflects to the right, and the ADI vertical pointer and HSI glide slope pointers deflect down. Release the ring control to PWR. The ADI and HSI NAV flags come into view in 1 second, and go out of view in 5 seconds. The ADI and HSI GS flags come into view in 0.5 second, and goes out of view in 2.5 seconds. Test is satisfactory.

If no ILS station is available, set HSI BRG 2 and CRS SEL and ADI VOR on pilot and copilot's MODE SEL panels to VOR, select any ILS frequency and hold the ring selector at TEST. The ADI and HSI NAV flags go out of view after 3 seconds, the ADI and HSI GS flags go out of view after 1.5 seconds, the HSI course deviation bar deflects right, and the ADI vertical pointer and HSI glide slope pointers deflect down. Release the ring control to PWR. The ADI and HSI NAV flags come into view in 1 second, and the ADI and HSI GS flags come into view in 0.5 second. Test is satisfactory.

Note

The ILS function tests can be performed with the MODE SEL panel BACK CRS selector engaged. A satisfactory test will be the same as a normal test.

15.11 IFF/TRANSPONDER SYSTEM

The AN/APX-72 system provides automatic radar identification and altitude information of the helicopter to all suitable equipped challenging facilities. Mode 1, 2, 3/A, C, or 4 interrogation signals are received by the system and decoded. The received signals are checked for valid code and proper mode, and if the proper interrogating signal has been received, a coded replay is sent. In addition to these normal identification and altitude reply signals, specially coded identification of position (I/P) and emergency signals may be sent in response to interrogating signals. The I/P relay signal is used to distinguish between aircraft displaying identical coding, and the emergency reply signal indicates an emergency or distress condition of the helicopter in flight. Normal identification operation, as well as transmission of the I/P or emergency signals, is done in operating modes 1, 2, and 3/A. Altitude interrogations and replies are done in mode C operation. The code for mode C is determined by the pressure altitude of the helicopter and is encoded in 100-foot units, mode 4 operation gives a secure (encrypted) IFF capability through the use of a transponder computer. The code for mode 4 must be set into the computer before flight. The IFF/transponder system includes a test set that provides for the go/no-go self-testing of the system in modes 1, 2, 3/A, and C. System self-testing for mode 4 operation is performed automatically by the transponder computer. The system consists of a receiver-transmitter, transponder control, transponder test set, antenna, altimeter encoder, and a transponder computer. The encoder is discussed under BAROMETRIC ALTIMETER/ENCODER in Chapter 2. The transponder computer, when installed, processes mode 4 interrogations and generates appropriate reply signals. These reply signals are then sent to the transponder for transmission. A caution light marked IFF on the instrument panel will go on and an audio signal will be heard in the pilot's headsets when the IFF caution light circuit detects an inoperative mode 4 capability. Specific discrepancies monitored by the IFF caution light are mode 4 codes zeroized, transponder failure to reply to a proper mode 4 interrogation, or the automatic self-test function of the transponder computer revealing a malfunctioning transponder computer.

The No. 2B primary ac bus circuit breaker panel furnishes operating power through a circuit breaker marked IFF under the general heading RADIO. The No. 1 primary dc bus circuit breaker panel furnishes control and test power through circuit breakers marked TEST and PWR under the general heading IFF and RADIO.

15.11.1 IFF/TRANSPONDER Control Panel. The control panel is on the cockpit console (FO-7). The IDENT-OUT-MIC switch controls identification of position (I/P) operation. When momentarily placed to IDENT (spring-loaded return to OUT), transmission of specially coded I/P relay signals to mode 1, 2, and/or 3/A interrogations is possible. When the switch is placed to MIC, I/P reply signals are possible when the FM/VHF/UHF COMM set is keyed. Either method allows the sending of I/P reply signals for about 20 seconds. The OUT position prevents triggering I/P signals.

The MASTER switch removes power from the transponder at OFF. At STBY, the receiver-transmitter is energized and kept in the standby condition. The LOW position permits transponder operation with reduced receiver sensitivity. NORM permits transponder operation at normal receiver sensitivity and responds to mode 1, 2, 3/A, and C interrogations, regardless of the position of the mode control switches.

The mode control switches marked M-1, M-2, M/3A, and M-C each have marked positions ON-OUT-TEST. TEST (up) allows the transponder test set to locally interrogate the receiver in that mode. The TEST light will go on to show that the system is working properly. Placing a mode control switch to OUT will deenergize that mode, providing the MASTER control selector is not at EMER. With the mode control switches ON (center), each switch will operate as follows:

1. The M-1 switch controls mode 1 transponder operation and allows a code from 00 to 73 to be selected.

2. The M-2 switch controls mode 2 transponder operation.

3. The M-3A switch controls mode 3/A transponder operation and allows a code from 0000 to 7777 to be selected.

4. The M-C switch controls mode C transponder operation for altitude replies.

The TEST LIGHT goes on when the transponder system responds properly to mode 1, 2, 3/A, and C self-test signals.

The MODE 1 code selector switches select and indicate the mode 1 two-digit reply code number. Desired codes are selected from 00 to 73.

The MODE 3/A code selector switches select and indicate the mode 3/A four-digit reply code number. Desired codes are selected from 0000 through 7777.

The RAD TEST-OUT-MON switch at RAD TEST permits the transponder to be interrogated by selected mode signals from external test equipment. The MON position turns on test set monitoring circuits. At MON, the TEST light will go on to indicate replies are being sent in mode 1, 2, 3/A, or C. OUT disables the RAD TEST and MON functions. The mode 4 ON-OUT switch controls transponder mode 4 operation. The ON position enables the transponder system to reply to mode 4 interrogations. OUT disables mode 4 operation.

The mode 4 REPLY light will go on to indicate valid mode 4 replies when the mode 4 AUDIO-OUT-LIGHT switch is at either AUDIO or LIGHT. The REPLY light will go on when pressed-to-test, providing the AUDIO-OUT-LIGHT switch is not at OUT.

The mode 4 AUDIO-OUT-LIGHT switch selects mode 4 monitoring methods. When placed on AUDIO, aural and REPLY light monitoring of valid mode 4 interrogations and replies are possible. An audio tone in the pilot's headset indicates valid mode 4 interrogations are being received, and lighting of the REPLY light indicates replies are being transmitted. When placed to LIGHT, the REPLY light goes on to indicate valid mode 4 replies. When placed to OUT, aural and REPLY light monitoring of mode 4 interrogations and replies are disabled. The OUT position disables the REPLY light press-to-test function.

The mode 4 CODE switch has marked positions ZERO, B, A, and HOLD. The switch must be lifted over a detent to select ZERO. It is spring-loaded to return from HOLD to the A position. A and B select separate preset mode 4 codes which enable the transponder system to reply to code A or B interrogations, respectively. Both codes are mechanically inserted with a code changing key. The codes are mechanically held in the transponder computer until the first time the helicopter becomes airborne. Thereafter mode 4 codes automatically cancel (zeroize) any time the master switch is turned off or power is removed from transponder computer. The code setting can be mechanically retained with weight on wheels by turning the code switch to HOLD (only momentary actuation is required) and releasing it at least 15 seconds before the master switch or helicopter power is turned off. The ZERO position zeroizes the transponder mode 4 codes.

Starting Procedure:

1. Place transponder control mode 1 and 3/A code select switches to the required operational codes.

2. Place receiver-transmitter mode 2 code select switches in the electronics compartment to the required operational code. This is done before flight.

3. Place transponder control mode enable switches M-1, M-2, M-3/A, and M-C to ON. (If operational requirements specify that only certain modes are to be used, place all other mode switches to OUT.)

4. Place the transponder control MODE 4 ON-OUT switch ON and CODE switch to A or B (as required) when equipped with the transponder computer and flying into a known mode 4 interrogating environment.

5. Place transponder RAD TEST-OUT-MON switch to OUT, AUDIO-OUT-LIGHT switch to LIGHT, and IDENT-OUT-MIC switch to OUT.

6. Place transponder control MASTER switch to STBY for 1 minute (normal ambient temperature) or 5 minutes (extremely low ambient temperatures). Then place to NORM.

Self-Test Procedure:

1. Press to test REPLY and TEST lights. Lights should go on.

2. Press PRESS TO TEST switch on caution panel. IFF light should go on.

Note

If mode 4 codes are zeroized, IFF caution light will be on before and after this test.

3. Place transponder control mode enable switches M-1, M-2, M-3/A, and M-C in sequence to TEST. TEST indicator should go on when each switch is at TEST, indicating a system go condition for particular mode being tested. Reset mode enable switches to ON or OUT as required.

4. Transponder computer automatically self-tests mode 4 circuits. Observe that IFF caution light is off. IFF caution light will go on when a mode 4 no-go condition is detected.

Normal Operating Procedures:

Note

If desired to retain mode 4 codes between flights, it is necessary to lock codes into transponder computer before turning MASTER control OFF. Turning the MASTER control to OFF or removing power from helicopter without first locking codes into transponder computer will zeroize mode 4 codes. To lock code, momentarily place CODE control to HOLD after landing, and then do normal locking procedure. When power is next applied, transponder computer will again operate normally. If it is again desired to lock code in transponder computer, repeat HOLD procedure. Transponder computer will zeroize any time power is applied and CODE control is turned to ZERO, even if HOLD function has been activated. Once code is zeroized, code is not available until reset.

Mode 4 Monitoring:

Place transponder control AUDIO-OUT-LIGHT switch to AUDIO to provide aural and visual (REPLY light) monitoring of valid mode 4 interrogations and replies. Place AUDIO-OUT-LIGHT switch to LIGHT to allow REPLY light monitoring only, if desired.

Monitoring Modes 1, 2, 3/A, and C:

Place transponder control RAD TEST-OUT-MON switch to MON, for monitoring replies to selected 1, 2, 3/A and/or C operating modes.

Identification of Position (I/P) Operation:

Receiver-transmitter will transmit specially coded I/P reply signals to mode 1, 2, 3/A interrogations when IDENT-OUT-MIC switch on transponder control is energized. Transmission of I/P reply signals requires appropriate mode enable switches to be ON. Use one of the following two methods to control transmission of I/P reply signals:

1. Momentarily hold IDENT-OUT-MIC switch at IDENT, and then release it. This action will cause the receiver-transmitter I/P reply signals for about 20 seconds in response to mode 1, 2, or 3/A interrogations. Repeat as required.

2. Place IDENT-OUT-MIC switch to MIC. I/P reply signals can now be transmitted by momentarily keying UHF command set. When there is no more need for transmitting I/P reply signals, return IDENT-OUT-MIC switch to OUT.

Emergency Operating Procedures:

During a helicopter emergency of distress condition, the system may be used to send specially coded emergency reply signals to mode 1, 2, or 3/A interrogations. These emergency reply signals will be sent as long as the MASTER switch on the transponder control remains at EMER, regardless of the positions of the mode enable switches.

1. Lift MASTER switch knob and turn to EMER.

2. When emergency is over, return MASTER switch to NORM or LOW.

Inoperative Mode 4 Operation:

When lit, IFF caution light shows that equipment will not respond to mode 4 interrogations, and that operation in a known mode 4 interrogation environment should be avoided. To attempt correction, place MASTER switch to NORM (if in STBY or LOW), check that mode 4 ON-OUT switch is ON, and that proper A or B code has been selected for current code time period. If IFF caution light remains on, use applicable flight procedures that are operationally directed for an inoperative mode 4 condition.

Stopping Procedure:

1. Place transponder CODE switch to HOLD or ZERO as required.

2. Place transponder control MASTER switch OFF. Place IDENT-OUT-MIC, M-1, M-2, M-3/A, M-C, MODE 4, AUDIO-OUT LIGHT and RAD TEST-OUT-MON switches to OUT.

15.12 RADAR BEACON SET (Prior to AFC 501 PT 3)

The radar beacon set (AN/APN-154), operating in the frequency range of 8500 or 9600 megahertz (MHz), is an airborne radar beacon that extends the tracking range of a ground-based system. When interrogated, the beacon provides an electrically-enhanced target. The set does not require visual or aural indications of operation. The set is controlled from a control panel marked RADAR BEACON, on the overhead control panel (FO-1), that contains a mode selector and, ACLS TEST light pushbutton, and

power switch. The MODE selector switch has an ACLS position, a SINGLE position, plus marked positions 1, 2, 3, 4, and 5 under the general heading DOUBLE. The ACLS (automatic carrier landing system) is not used in this installation. The SINGLE position permits the set to respond to the single pulse of any code group received. The numbered positions, under the general heading DOUBLE, permit the set to respond to one of five double pulse interrogations. The ACLS TEST light pushbutton is not used in this installation. The power switch, with marked positions POWER, STDBY, and OFF, operates in the standard manner. The No. 3 primary dc bus circuit breaker panel furnishes power through a circuit breaker marked RADAR BEACON under the general heading RADIO.

CAUTION

The set will warm up in about 5 minutes with the power switch at either STDBY or POWER. However, it is recommended that STDBY be used to prohibit the set from responding to a premature or unintentional interrogation signal that may cause equipment damage.

To operate the radar beacon:

1. Power switch — STDBY.

CAUTION

Allow 5 minutes of warmup time in standby power position, to prevent premature responses that might damage transmitter.

2. Power switch — POWER.
3. Mode selector switch — POSITION as follows:
   a. If set is to respond to a single-pulse interrogation — SINGLE.
   b. If set is to respond to double-pulse interrogations — DOUBLE, and select 1, 2, 3, 4, or 5 of double bracket.

15.13 DOPPLER RADAR NAVIGATION SET

The AN/APN-217 radar navigation set provides helicopter ground speed, drift angle, and vertical velocity information. It is designed to operate reliably even in low sea state conditions. It is a self-contained surface velocity sensor that uses continuous-wave radar energy to automatically measure the heading, drift, and vertical components of the helicopter's motion. From these measurements, the heading, drift and vertical velocities of the helicopter are calculated and displayed to the pilots. For navigational phase of flight the Doppler provides ground speed and drift angle information on the pilot's ground speed drift angle indicators (GSDA). Precise Doppler information is provided on the selected pilot's ADI. When Doppler is selected on the respective pilot's mode selector panel by pressing DPLR under ADI, the Doppler will signal the ADI vertical command bar for lateral drift velocity, the horizontal command bar for longitudinal velocity, the vertical pointer for vertical velocity, and the DOP flag, (the horizontal pointer is inoperative). The vertical and horizontal command bars are marked with 12 divisions, each division equals 11 knots. The horizontal command bar velocity is measured in its movement along the vertical command bar. The vertical command bar velocity is measured in its movement along the horizontal command bar. On the vertical velocity pointer scale each dot equals 40 foot/minute climb/descent.

The system is operated from a cockpit-mounted control panel. The system consists of a receiver-transmitter, signal data converter, power supply, and controls and indicators. The Doppler will maintain a reliable track over sea state one at steady bank angles up to and beyond 45°. However, Doppler tracking is severely degraded by vertical acceleration, roll acceleration and pitch and roll rate, (especially in combination), and dirty antenna (covered with salt spray). The DOPPLER light on the caution panel goes on when the system has failed.

Note

Use of the GRD SPD hold is not recommended when frequent memory conditions are encountered.

Power is provided by the No. 3 primary dc bus through a circuit breaker marked DOPPLER, under the general heading RADIO; and by the No. 3 primary ac bus through a circuit breaker marked DOPPLER, under the general heading RADIO. Temperature control for the system is provided by a dehydrator kit which receives power from a No. 1 primary ac circuit breaker marked DOPPLER FAN.

CAUTION

Do not block the Doppler fan intake located on the port side of the cabin, to prevent overheating the Doppler fan motor.

15.13.1 Doppler Control Panel. The control panel marked DOPPLER is on the copilot's overhead console (FO-1). It has a mode selector switch marked OFF-LAND-SEA-TEST. OFF removes power from the system. The LAND and SEA positions are for receiving and transmitting over land and water respectively. TEST initiates a self-test function which will indicate 27 KTS/225° on the GSDA when functioning properly. During TEST, the ADI horizontal command bar will displace 1/2 up the vertical command bar reference area, the vertical command bar will displace 1/2 right on the horizontal command bar reference area, and the vertical pointer will displace slightly down. The mode selector switch must be pushed in and then turned to select TEST.

15.13.2 GSDA Indicator. Two GSDA indicators are on the instrument panel (FO-5) for providing drift angle and ground speed information for the pilot and copilot. Each indicator has a self-test button on the left side which will indicate 888 under GS on the indicator, light all segments and pointer of the DFT ANG indicator, and light TEST, when pressed and the system is functioning properly. The GSDA indicator window has indications for MEM-GS KTS-TEST-DFT ANG. MEM lights to indicate when the system is operating in memory mode. GS KTS provides a position to show the helicopter ground speed digitally in knots. TEST lights when the system test pushbutton is pressed. DFT ANG provides compass heading segments at 30 increments and a pointer which lights to display ground speed drift angle.

To operate the Doppler:

1. Place DOPPLER switch to LAND or SEA (depending on terrain being overflown).

2. Reference GSDA indicator for drift angle and ground speed information.

Prior to coupled approach:

1. Select DPLR on mode selector panel.

2. Reference ADI for drift and vertical velocity information.

PART VIII

MISSION SYSTEMS

Chapter 16 Mission Systems

PART VIII

MISSION SYSTEMS

Chapter 16 Mission Systems

CHAPTER 16
Mission Systems

See A1-H53ME-NFM-100 (AMCM Mission Systems Supplement, Navy Model MH-53E Helicopters); PART I, Mission Systems.

CHAPTER 17
Flight Crew Coordination

17.1 INTRODUCTION

The duties of the pilot/aircrew are necessarily integrated, and each shall support and contribute to the performance of the other. In this chapter, specific responsibilities are delineated. In general, however, the ultimate responsibility for safety of flight and mission accomplishment rests with the pilot in command (PIC). The PIC shall constantly monitor total aircrew performance to ensure that all flight operations are conducted in the most professional manner possible. Strict adherence to regulations, a thorough aircrew brief, and clear, concise open communication between aircrew are imperative to ensure the cooperation, initiative, and coordination essential, during system malfunctions, emergencies, and unfamiliar circumstances, to ensure the safe conduct of the flight and mission accomplishment. The PIC shall remain attuned to the development of any friction or distraction which could adversely impact aircrew performance. There are a number of elements that affect every aircrew's level of situational awareness. These include: physical flying skills, experience and training, spatial orientation, health and attitude, and cockpit management skills. Situational awareness is the responsibility of the entire crew. The contents of this chapter are not designed to be used as an inflight checklist but should be used as the basis for squadron and unit ground training syllabi. So used, this section will enhance the successful and safe completion of each unit's mission through intelligent and proper compliance with all NATOPS procedures and other applicable directives.

17.2 GENERAL RESPONSIBILITIES

17.2.1 Pilot In Command (PIC)

The PIC shall be in command of the aircraft and is responsible for the safe and orderly conduct of the flight. This responsibility exists from the time the PIC accepts the flight and the crew has reported for such flight, until the flight is completed and/or the PIC is relieved from duty by proper authority. The authority and responsibility of the PIC for the flight are delineated in OPNAVINST 3710.7. The PIC will be thoroughly familiar with this manual, squadron manuals and directives, and all other pertinent directives from higher authority. The PIC shall ensure that all crewmembers are utilized effectively, and that no one crewmember, including himself, is overtasked during any portion of the flight. The PIC shall ensure that he maintains cognizance of the status of all ground and flight procedures and that crew responsibilities are fully understood by the respective crewmembers. At the discretion of the PIC, the aircrew duties and responsibilities outlined in the following paragraphs may be reassigned as appropriate within the crew. The PIC shall ensure that both pilots are constantly aware of who is the pilot at the controls (PAC) and what general flight parameters are being observed. However, the delineation of PAC and pilot not at the controls (PNAC) duties listed below shall not be interpreted in a manner that would relieve the PIC of total responsibility for the safety and conduct of the flight. The PIC has the authority to delay or discontinue a flight. Should the PIC deem it allowable and/or necessary to continue into a situation not briefed, he shall ensure, as time permits, that the crew is fully briefed on any reassignment of their responsibilities and that he has analyzed crew inputs prior to continuing into a situation not briefed.

17.2.2 Copilot

The copilot is second in command and responsible for assisting the PIC's duty performance, and such other duties as may be assigned. The copilot may control the aircraft in any phase/mode of flight, at the PIC's discretion, provided the individual is qualified for such flight in accordance with this manual and other directives. In the event of disability of the PIC's during flight, the copilot with the highest designation shall take command of the aircraft and assume the authority, duties, and responsibilities of the PIC to the next enroute station or to a closer alternate, as the situation warrants. For the purposes of this publication, a pilot under instruction is considered as a copilot and shall have the same general and specific responsibilities.

17.2.3 Pilot At the Controls (PAC)

The primary responsibility of the PAC is safe control of the aircraft in flight. Either pilot may perform duties as the PAC. The PAC should request all ground and flight checklists. The PAC shall utilize the other pilot and crewmembers in a manner that allows him to devote his full attention to actual control of the aircraft, whether on the deck or in flight.

17.2.4 Pilot Not At the Controls (PNAC)

The PNAC is that pilot not performing PAC duties. The PNAC shall read all checklists and shall initiate all checklists at the appropriate time if the PAC fails to do so. The PNAC shall use good judgment in that he shall also at least visually verify the setting of critical cockpit systems and controls which are made by the PAC. The PNAC should normally make as many changes to the cockpit configuration as physically possible in order to allow the PAC to maintain actual control of the aircraft. In flight, the primary responsibility of the PNAC is to monitor the PAC continually and immediately notify the PAC of any flight parameter discrepancy. If necessary to avoid an unsafe situation, the PNAC should assume PAC duties in sufficient time to effect a safe recovery.

17.2.5 Aircrewman

The aircrewman is third in command. The aircrewman is the PIC's extension of authority in the cabin section. The aircrewman shall carry out the PIC's instructions and is responsible for supervision of the safe, orderly embarkation/debarkation of all passengers, their conduct inflight, the loading/unloading of all internal cargo and baggage, and monitoring the hook up, lift, and delivery of all externally transported cargo. The aircrewman shall maintain a constant communication link (ICS or visual) with the cockpit and cabin during flight operations. The aircrewman shall monitor aircraft performance and shall advise the PIC of any discrepancy. The aircrewman shall directly supervise operation of any aircraft system activated from the cabin and shall ensure that an aircrew member visually clears the ramp prior to actuation. The aircrewman shall maintain constant situational awareness, monitor flight maneuvers as practical, and when, in the individual's opinion, the flight is bordering on unsafe conditions, advise the pilot and copilot. Additional aircrewmen shall be assigned as necessary and have a thorough knowledge of the missions and positions assigned to each flight.

17.3 SPECIFIC RESPONSIBILITIES

17.3.1 Mission/Flight Planning

PIC — Mission/flight planning is the ultimate responsibility of the PIC and shall cover all matters pertinent to the mission/flight to be flown. At a minimum this shall include:

Mission Equipment Requirements
Aircraft Limitations
Flight Crew Composition and Qualifications
Weather Evaluation
Aircraft Performance Data Based on Weather Evaluation
Fuel Planning
Weight and Balance Computation

Pertinent publications, charts, and manuals shall be reviewed as required.

Copilot — The copilot shall assist the PIC in mission/flight planning as directed and shall prepare as thoroughly as possible for the flight.

Aircrewman — The aircrewman shall coordinate installation of mission equipment with maintenance control and shall verify aircraft fuel loading.

17.3.2 Flight Crew/Ground Crew Briefing

PIC — The PIC shall insure all flight crew members are briefed on the mission/flight in accordance with Part III of this manual and/or the NAVAIR 01-1ASH-1T Tactical Manual pocket guide, as appropriate. The briefing of the copilot and other flight crew may be separate; however, the PIC shall ensure that all members of the crew have a clear understanding of he mission, their duties, and integrated functioning. At the brief, the PIC shall assign specific responsibilities to the pilot at controls, pilot not at controls, and aircrewman for each phase of flight. Inter and intra aircraft communication/signals must be clearly understood by the entire flight crew. The PIC shall ensure briefings with ground crew/support personnel and passengers are conducted as the mission requires. These briefings shall emphasize communications, command and control, safety, and emergency procedures. The PIC shall assign specific responsibilities for normal and emergency procedures for pilot at controls and the pilot not at controls. They may be conducted face to face or via telephone/radio as the mission/flight requires. Passenger briefing topics include, but are not limited to the following:

1. Aircraft side number
2. Time to takeoff
3. Time of arrival
4. Safety regulations

a. Use of seat belts.

b. Movement inside the aircraft

c. Smoking

5. Emergency procedures

a. Emergency exits

b. Aircraft fire, in flight/on ground

c. Ditching/Forced landings

d. Proper fit and operation of cranials and flotation equipment

Copilot/Aircrewman — These aircrew members shall be responsible to query the PIC on any matter or crew duty not clearly understood during the briefing.

17.3.3 Preflight

PIC — The PIC shall ensure that a thorough preflight is conducted per Part III of this manual.

Copilot/Aircrewman — These crewmembers shall assist in performance of the preflight as directed by the PIC. They shall call any discrepancies noted to the attention of the PIC.

17.3.4 Prestart/Start/Pre-taxi

PIC — The PIC shall ensure prestart, start, pre-taxi procedures contained in Part III of this manual are completed utilizing the appropriate NATOPS pocket checklist. Verbal challenge and response shall be given for all applicable checklist items.

Copilot — The copilot shall perform duties as directed by the PIC. The copilot shall advise the PIC of any abnormality noted.

Aircrewman — The aircrewman shall perform such duties as directed by the PIC, and in addition shall:

- Maintain communication (ICS or visual) with the aircrew.

- Observe and clear the area prior to blade/pylon movement, including control checks and rotor engagement.

- Observe the blade and pylon spread/fold sequence and notify the pilot in command of any irregularities or malfunctions as they occur.

- Ensure that a qualified fire guard is posted during APP and engine starts.

- Notify the PIC of any irregularity noted during prestart, start, and pre-taxi.

- Supervise internal loading of the aircraft.

- Ensure passenger briefing completed as required.

- Ensure required safety/protective equipment is properly donned by embarked passengers and aircrew.

- Ensure all gear is properly stowed/secured in the cabin and passenger seat belts fastened prior to taxi.

- Advise the PIC of the number of passengers embarked and the amount of cargo aboard prior to taxi.

- Ensure that landing gear pins and chocks are removed when directed by the PIC.

- Act as taxi director when necessary.

- Ensure pre-taxi checklist complete.

17.3.5 Taxi

PIC — The PIC, whether physically at the controls or not, shall monitor flight control displacement/movement during taxi, shall ensure obstacle clearance, and the safe movement of the aircraft not only with regard to his aircraft but also with regard to personnel and equipment in proximity to his taxi path. When away from home operating base without adequate, familiar taxi line markings or in any case of impaired visibility, ground taxi directors shall be utilized. The PIC shall also ensure completion of the taxi checklist as per Part III of this manual.

Copilot — The copilot shall perform such duties during taxi as directed by the PIC. The copilot shall assist in aircraft clearance and advise the PIC of any obstacles noted. The copilot shall monitor appropriate radio frequencies and advise the PIC of any taxi amendments/traffic not acknowledged.

Aircrewmen — The aircrewmen shall perform such duties as directed by the PIC and shall assist in aircraft clearance and advise the PIC of any obstacles noted. The aircrewmen shall check cabin integrity during taxi and advise the PIC of any abnormalities.

17.3.6 Pre-Takeoff/Takeoff/Departure

PIC — The PIC shall ensure that all checklists contained in Part III of this manual are completed prior to takeoff. The PIC shall assign responsibility to monitor and advise on rotor performance, engine performance, caution panel, climb rate, altitude, attitude, airspeed, and obstacle clearance as required. Dual engine and abort speeds and altitudes shall have been pre-briefed.

Copilot — The copilot shall perform such duties as directed by the PIC and shall advise the PIC of any discrepancy.

Aircrewmen — The aircrewmen shall complete their pretakeoff checklist and perform such duties as directed by the PIC and shall provide assistance as required by monitoring aircraft performance, clearing obstacles, and shall advise the PIC of any discrepancy.

17.3.7 Instrument Procedures

PIC — The PIC should have included specific cockpit crew responsibilities for the pilot at the controls and the pilot not at the controls regarding communication, navigation, and other cockpit duties not directly affecting physical control of the aircraft. In addition the PIC should have reviewed/briefed approach procedures.

Copilot — The copilot shall perform such duties as directed by the PIC. When not at the controls, monitor aircraft performance, advise the PIC of any discrepancies, and brief attitude, airspeed, bank, or altitude limitation deviations. If necessary, take control of the aircraft if the PIC requests assistance due to spatial disorientation or if a loss of control appears imminent. If at the controls, the copilot shall advise the PIC should symptoms of spatial disorientation be experienced.

Aircrewmen — The aircrewmen shall perform such duties as directed by the PIC.

17.3.8 Enroute

PIC — Assign responsibility for and ensure periodic monitoring of performance instruments, caution and advisory panels, and fuel management panel. Ensure completion of cruise checklist. Ensure lookout maintained. Periodically confer with the aircrewmen to ascertain cabin conditions.

Copilot/Aircrewmen — Perform aircrew flight checklist whenever directed by PIC and such duties as may be assigned. Alert the PIC of any hazard noted.

PAC — Requests adjustments to altitude and automatic features, acknowledges all advisory crew calls during normal or mission operations, and requests initiation of all in-flight checklists. Prior to transfer of aircraft control, PAC will ensure that the PNAC is aware of coupled features engaged and assigned headings and altitudes. The PAC will adjust his communication mixer switches after transferring control.

PNAC — Makes and reports all adjustments to altitude and automatic features at the request of the PAC and reads all in-flight checklists. Prior to transfer of aircraft control, PNAC will pass all navigation and tactical material to the PAC via the glareshield and readjust his communication mixer switches.

17.3.9 Mission

PIC — Perform the assigned mission as planned for, briefed, and in accordance with the procedures established in Part III and VI of this manual and Part II of MH-53E Mission Supplement (A1-H53ME-NFM-100). The PIC shall evaluate and brief "add on" missions as they are assigned.

Copilot — Perform such duties as assigned by the PIC. Verify computed aircraft performance data based on ambient conditions encountered and advise the PIC of any changes. The copilot shall advise the PIC of any hazard, or discrepancy.

PNAC — Reports steady on altitude whenever transitioning to a new altitude during streaming, towing, or recovery; monitors status of mission operations using applicable mission checklists; and logs mission data on the appropriate form.

Aircrewmen — Perform such duties as assigned and advise the PIC of any system degradation/malfunction which could adversely impact mission accomplishment. Alert the PIC to any hazard or discrepancy. Additional aircrewman specific mission procedures, including external cargo operations and hoist operations, are discussed in paragraphs 17.4.1 through 17.4.5.

17.3.10 Pre-Landing/Landing

PIC — Ensure the applicable checklist are completed. The PIC shall monitor flight control displacement, descent and closure rates during all landings to ensure that aircraft limitations are not exceeded. The PIC should initiate a wave off anytime a safe landing is in doubt.

Copilot — The copilot shall perform such duties as assigned by the PIC. The copilot shall advise the PIC of radio frequencies, traffic, clearance, and call for a wave off anytime, in his opinion, a safe landing is in doubt.

Aircrewmen — Perform such duties as directed by the PIC. Aircrewmen shall check cabin integrity, ensure all gear is properly secured/stowed, and the passengers are seated and properly restrained prior to landing, report completion of prelanding checklist, assist in obstacle clearance as required. Any aircrewman shall alert the PIC to any hazard or abnormality noted, and shall call for a wave off anytime a safe landing is in doubt.

17.3.11 Post Landing

PIC — Shall ensure all post landing evaluations are safely completed.

Copilot — Perform such duties as directed by the PIC. Alert the PIC of any hazard or discrepancy.

Aircrewmen — Perform such duties as assigned. Ensure that embarked passengers remain seated with seat belts secured until given clearance to debark by the PIC. When cleared by the PIC, supervise the offload/onload of internal cargo, aircraft fueling and the embarkation and debarkation of passengers with special emphasis on tip path hazards. Ensure that embarked passengers and cargo are secured prior to aircraft movement as outlined in pre-start/start/pre-taxi duties. Alert the PIC to any discrepancies or hazard.

17.3.12 Shutdown

PIC — Ensure shutdown is conducted in accordance with the checklist. Monitor flight control positioning during shutdown to prevent damage/injury.

Copilot — Perform such duties as directed by the PIC. Assist the PIC with the shutdown checklist. Alert the PIC of any hazard or discrepancy.

Aircrewmen — Perform such duties as directed by the PIC. Ensure personnel remain clear of rotor arc until rotor head is stopped. Alert the PIC to any hazard or discrepancy.

17.3.13 Post Flight

PIC — Ensure that a thorough postflight inspection is conducted. Note any discrepancies and report them to maintenance control.

Copilot/Aircrewmen — Perform postflight duties as directed and report.

17.3.14 Debrief

PIC — Debrief flight crew personnel involved in the mission concerning crew coordination performance.

Copilot/Aircrewman — Provide input on crew performance and mission accomplishment, as pertinent, to the PIC during the debrief.

17.3.15 Emergencies

The PIC is responsible for the safe operation of the aircraft and the safety of all personnel aboard. Prior to flight, he shall ensure that specific crew duties, in the event of an emergency, are thoroughly briefed and understood. Upon encountering an emergency, the PIC shall ensure the rapid and accurate application of corrective/ precautionary procedures.

Copilot — The copilot shall be thoroughly familiar with the emergency procedures and shall perform such other duties as directed by the PIC.

PAC — The primary responsibility of the PAC is to fly the aircraft and maintain the proper flight regime.

PNAC — Backs up the PAC by performing all steps necessary to allow the PAC to maintain physical control of the aircraft. This does not preclude transfer of aircraft control at the discretion of the PIC.

Aircrewmen — The aircrewman shall be thoroughly familiar with the emergency procedures, and shall prepare the cabin, as required, for emergency landing and evacuation. The aircrewmen shall perform such other duties as directed by the PIC.

17.4 GENERAL AIRCREWMAN MISSION PROCEDURES

17.4.1 External Cargo Operations

The aircrewman shall:

1. Direct the pilot as necessary using standard flight crewmember ICS voice reports defined in Chapter 9 of this manual.

2. Notify the pilot of any potential hazards.

3. Ensure that the cargo hook(s) is/are properly closed and that the load is correctly attached prior to lifting the load.

4. Observe the load in flight and keep the pilots informed of its ride and condition.

5. Release the load if directed by the pilot in command.

17.4.2 Operational Troop/Passenger Lifts

The aircrewman shall:

1. Install sufficient aircraft troop seats and extend their safety belts to maximum length.

2. Embark and debark passengers.

3. Provide flotation devices, and use instructions to all passengers prior to overwater flight.

4. Ensure all passengers are seated with safety belt installed and properly fastened.

5. Secure all loose baggage or equipment.

6. Report the following:

   a. Number of passengers embarked.

   b. Cabin occupants and internal cargo ready for taxi/takeoff.

7. Ensure life preservers are returned when overwater flight is completed.

8. Signal passengers when clear to debark the aircraft.

17.4.3 Formation Flights

The aircrewman shall:

1. Advise the pilots of any formation change.

2. Advise the pilots of any other aircraft in the vicinity of the formation.

17.4.4 Shipboard Based Procedures

The aircrewman shall:

1. Ensure the tiedowns are slack before starting engines and engaging the main rotor.

2. Ensure all tiedowns and chocks are removed before takeoff.

17.4.5 Hoisting Operations

The aircrewman shall:

1. Notify the pilot when configured for hoist operations.

2. Direct the pilot, as necessary, using standard flight crewman ICS voice signals as defined in Chapter 9 of this manual.

3. Maneuver the aircraft using the aft crew hover station as directed by the pilot.

4. Report any obstructions or potential hazards.

5. Ensure that all loads being lowered are secure and correctly attached to the hoist, and that proper aircraft grounding has been achieved.

6. Secure hoisted loads.

7. Alert the pilot of snagged cables and be prepared to activate the hoist shear switch as briefed.

17.5 AMCM MISSION PROCEDURES

See A1-H53ME-NFM-100 (AMCM Mission Systems Supplement, Navy Model MH-53E Helicopters); Part II, Flight Crew Coordination.

PART X

NATOPS EVALUATION

Chapter 18 Natops Evaluation

CHAPTER 18
NATOPS Evaluation

18.1 CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating the helicopter. The NATOPS evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatibility with various operational commitments and missions of both Navy and Marine Corps units. The prime objective of the NATOPS evaluation program is to assist the unit commanding officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS evaluation program will be achieved only through the active, vigorous support of all pilots and crewmembers.

18.2 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating Naval aircraft. The various categories of flight crewmembers desiring to attain/retain qualification in the helicopter shall be evaluated in accordance with OPNAVINST 3710.7. Individual and unit NATOPS evaluations will be conducted annually; however, instruction in and observation of adherence to NATOPS procedures must be on a daily basis within each unit to obtain maximum benefits from the program. The NATOPS coordinators, evaluators, and instructors shall administer the program as outlined in OPNAVINST 3710.7. Evaluees who receive a grade of unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a reevaluation. A maximum of 60 days may elapse between the date the initial ground evaluation was commenced and the date the flight evaluation is satisfactorily completed.

18.3 DEFINITIONS

The following terms, used throughout this section, are defined as to their specific meaning within the NATOPS program.

18.3.1 NATOPS Evaluation. A periodic evaluation of individual flight crewmember standardization consisting of an open book examination, a closed book examination, an oral examination, and a flight evaluation. Figures 18-1 and 18-2 will be utilized for all NATOPS evaluations and will be locally reproduced.

18.3.2 NATOPS Reevaluation. A partial NATOPS evaluation administered to a flight crewmember who has been placed in an unqualified status by receiving an unqualified grade for any of his ground examinations or the flight evaluation. Only those areas in which an unsatisfactory level was noted need be observed during a reevaluation.

18.3.3 Qualified. That degree of standardization demonstrated by a very reliable flight crewmember who has a good knowledge of standard operating procedures and a thorough understanding of aircraft capabilities and limitations.

18.3.4 Conditionally Qualified. That degree of standardization demonstrated by a flight crewmember who meets the minimum acceptable standards. He is considered safe enough to fly as pilot in command or to perform normal duties without supervision, but more practice is needed to become qualified.

18.3.5 Unqualified. That degree of standardization demonstrated by a flight crewmember who fails to meet minimum acceptable criteria. He should receive supervised instruction until he has achieved a grade of qualified or conditionally qualified.

18.3.6 Area. A routine of preflight, flight, or postflight.

18.3.7 Sub Area. A performance subdivision within an area, which is observed and evaluated during an evaluation flight.

18.3.8 Critical Area/Sub Area. Any area or sub area which covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

18.3.9 Emergency. An aircraft component, system failure, or condition that requires instantaneous recognition, analysis, and proper action.

18.3.10 Malfunction. A component or system failure or condition that requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

18.4 GROUND EVALUATION

Before commencing the flight evaluation, an evaluee must achieve a minimum grade of qualified on the open book and closed book examinations. The oral examination is also part of the ground evaluation, but may be conducted as part of the flight evaluation. To assure a degree of standardization between units, the NATOPS instructors shall use the bank of questions contained in this section in preparing portions of the written examinations.

18.4.1 Open Book Examination. The number of questions on the examination will not exceed 100 or be less than 50. The purpose of the open book examination portion of the written examination is to evaluate the crewmember's knowledge of appropriate publications and the aircraft. The maximum time for this examination shall not exceed 60 days. The examination should be completed within 60 days of the flight evaluation.

18.4.2 Closed Book Examination. The number of questions on the examination will not exceed 50 or be less than 25. The examination should be completed within 60 days of the flight evaluation.

18.4.3 Oral Examination. The questions may be taken from this manual and drawn from the experience of the instructor/evaluator. Such questions should be direct and positive and should in no way be opinionated.

18.4.4 Operational Flight Training (OFT) Procedures Evaluation. An OFT may be used to assist in measuring the crewmember's efficiency in the execution of normal operating procedures and his reaction to emergencies and malfunctions. In areas not served by these facilities, this may be done by placing the crewmember in an aircraft and administering the appropriate questions.

18.4.5 Grading Instructions. Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of qualified or unqualified.

18.4.5.1 Open Book Examination. To obtain a grade of qualified, an evaluee must obtain a minimum score of 3.5.

18.4.5.2 Closed Book Examination. To obtain a grade of qualified, an evaluee must obtain a minimum score of 3.3.

18.4.5.3 Oral Examination and OFT Procedure Check (If Conducted). A grade of qualified or unqualified shall be assigned by the instructor/evaluator.

18.5 FLIGHT EVALUATION

The NATOPS evaluation flight is intended to evaluate unit/individual compliance with approved standardized operating procedures. The successful completion of all ground checks and examinations is required before commencement of the flight evaluation. Insofar as possible, evaluation flights will be scheduled so as not to interfere with squadron operations. The flight evaluation should conform to any syllabus flight. Only those areas observed or required by the mission assigned will be evaluated. Critical areas/subareas are indicated by an asterisk (*). Determination of the final flight evaluation grade will be made as outlined in FINAL GRADE DETERMINATION in this Chapter.

18.5.1 Pilot

BRIEFING

PREFLIGHT

1. Records check.

*2. Preflight check.

3. Crew briefing.

4. Proficiency in CG computer usage.

START/ENGAGE/POST ENGAGEMENT

*1. Start.

*2. Engage.

*3. Post engagement.

TAXI.

1. Procedures.

2. Taxi.

TAKEOFF/TRANSITION.

*1. Procedures.

2. Type takeoff.

   a. Vertical.

   b. Running.

c. Crosswind.

d. Maximum gross.

3. Transition.

CLIMB/CRUISE.

1. Procedures.

2. Power control.

3. Helicopter control.

APPROACH AND LANDING.

*1. Procedures.

2. Power control.

3. Helicopter control.

4. Type of landing.

a. Vertical.

b. Running.

c. Crosswind.

d. Maximum gross.

AUTOROTATION.

1. Procedures.

2. RPM control.

3. Airspeed control.

4. Recovery.

EMERGENCY PROCEDURES.

*1. Procedures.

2. Helicopter control.

SHUTDOWN/POSTFLIGHT.

*1. Shutdown.

2. Postflight inspection.

CREW COORDINATION.

DEBRIEFING.

MISSION EVALUATION AREAS.

CONFINED AREA LANDING.

1. Procedures.

2. Approach.

3. Power control.

4. Helicopter control.

INTERNAL CARGO.

1. CG within limits.

EXTERNAL CARGO.

1. Procedures (single- and two-point).

2. Signal response.

3. Helicopter control.

NAVIGATION.

HIFR.

HELICOPTER AIR REFUELING.

SEARCH AND RESCUE.

18.5.2 AMCM Mission Commander

BRIEFING.

PREFLIGHT.

1. Aircraft tow kit.

2. MK-103.

3. MK-104 (optional).

4. MK-105/106 (optional).

5. AQS-14 (optional).

6. ALQ-141.

7. ALQ-166 (optional).

8. Precise navigation (optional).

STREAMING.

1. MK-103.

2. Heading control.

3. Altitude control.

4. Crew coordination.

5. Tension control.

TOWING.

1. MK-103.

2. Heading control.

3. Skew control.

4. Altitude control.

5. Turns.

6. Tow coupler operation.

7. Raydist navigation (optional).

8. Heading hold operation.

9. Tension control.

RECOVERY.

1. MK-103.

2. Altitude control.

3. Heading control.

4. Tension control.

EMERGENCY PROCEDURES.

1. Procedures.

2. Helicopter control.

DEBRIEF.

18.5.3 Aircrew

PREFLIGHT AND POSTFLIGHT EVALUATION.

PREFLIGHT.

1. Aircraft discrepancy book.

2. Aircraft inspection.

3. Yellow sheet.

4. Compliance with MRCs.

CONDITION OF AIRCRAFT.

1. Cleanliness.

2. Aircraft material condition.

CABIN GEAR.

1. Security.

2. Condition.

GROUND SAFETY PRECAUTIONS.

1. Observance.

LOADING INTERNAL CARGO.

1. Weight and balance.

2. Use of tiedowns.

AUXILIARY POWER PLANT.

1. Inspection.

2. Operation.

RANGE EXTENSION FUEL SYSTEM.

1. Installation.

2. Operation.

BRIEFING OF PASSENGERS.

HAND SIGNALS.

1. Day.

2. Night.

FUELING AND SERVICING.

1. Gravity.

2. Pressure.

3. HIFR.

POSTFLIGHT AND DAILY.

1. Inspection.

2. Compliance with MRCs.

SECURING OF AIRCRAFT.

1. Stowage of gear.

2. Tiedowns and covers.

FLIGHT EVALUATION.

PERSONAL FLIGHT EQUIPMENT.

1. Availability.

2. Condition.

3. Usage.

SAFETY REGULATIONS.

1. Compliance.

EMERGENCY PROCEDURES.

1. Proficiency.

2. Compliance.

FLIGHT PARAMETERS.

1. Knowledge.

2. Alertness.

VOICE PROCEDURES.

CONFINED AREA LANDINGS.

1. Observation.

2. Communication.

INSTRUMENT FLIGHT.

1. Alertness.

2. Communication.

EXTERNAL CARGO OPERATIONS.

1. Procedures (single- and two-point).

2. Voice procedures.

CARGO WINCH OPERATIONS.

1. Loading.

2. Unloading.

RESCUE HOIST OPERATIONS.

1. Procedures

2. ICS communication.

18.5.4 AMCM Aircrewman

PREFLIGHT.

1. MK-103.

2. MK-104 (optional).

3. MK-105.

4. Precise Navigation.

5. Aircraft tow kit.

STREAMING.

1. MK-103.

2. Voice procedures.

3. Emergencies.

TOWING.

1. Voice procedures.

2 Emergencies.

RECOVERY.

1. MK-103.

2. Voice procedures.

POST FLIGHT.

PILOT-CREW COORDINATION

18.5.5 Flight Evaluation Grading Criteria. Only those sub areas provided or required will be graded. The grades assigned for a sub area shall be determined by comparing the degree of adherence to standard operating procedures with adjectival ratings listed below. Momentary deviations from standard operating procedures should not be considered as disqualifying provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action.

18.5.5.1 Qualified. Well standardized; evaluee demonstrated highly professional knowledge of and compliance with NATOPS standards and procedures. Momentary deviations from minor missions in noncritical areas are permitted if prompt and timely remedial action is initiated by the evaluee.

18.5.5.2 Conditionally Qualified. Satisfactorily standardized; one or more significant deviations from NATOPS standards and procedures, but no errors in critical areas and no errors jeopardizing mission accomplishment or flight safety.

18.5.5.3 Unqualified. Not acceptably standardized; evaluee fails to meet minimum standards regarding knowledge of and/or ability to apply NATOPS procedures; one or more significant deviations from NATOPS standards and procedures which could jeopardize mission accomplishment or flight safety.

18.5.6 Records and Reports. The NATOPS Evaluation Report, OPNAV 3760.17 (Rev 3-95) shall be completed for each evaluation conducted and forwarded to the evaluee's commanding officer only. This report shall be filed in the Naval Aviator/Naval Flight Officer/Qualification Jacket and retained therein for 5 years.

18.5.7 Flight Evaluation Grade Determination. Utilizing the MH-53 Pilot NATOPS Evaluation Worksheet (Figure 18-1), the following procedures shall be used in determining the flight evaluation grade. A grade of unqualified in any critical area/sub area will result in an overall grade of unqualified for the flight. Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical equivalents to the adjective grade for each sub area. Only the numerals 0, 2, and 4 will be assigned in sub areas. No interpolation is allowed.

Unqualified	0.0
Conditionally qualified	2.0
Qualified	4.0

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the sub areas and divide this sum by the number of sub areas graded. The objective grade shall then be determined on the basis of the following scale:

0.0 to 2.19 — Unqualified

2.2 to 2.99 — Conditionally qualified

3.0 to 4.0 — Qualified

EXAMPLE:

$$\frac{4+2+4+2+4}{5} = \frac{16}{5} = 3.20$$ Qualified (add sub area numerical equivalents)

In the case of enlisted flight crewmembers, an entry shall be made in the administrative remarks section of his personnel record upon satisfactory completion of the NATOPS evaluation as follows:

(DATE) Completed a NATOPS evaluation in (aircraft designation) as (flight crew position) with an overall grade of (qualified or conditionally qualified).

18.6 FINAL GRADE DETERMINATION

The final NATOPS evaluation grade shall be the same as the grade assigned to the flight evaluation. An evaluee who receives an unqualified on any ground examination or the flight evaluation shall be placed in an unqualified status until he achieves a grade of conditionally qualified or qualified on a reevaluation.

An entry shall be made in the Pilot/NFO Log Book under "Qualifications and Achievements" as follows:

QUALIFICATION		DATE	SIGNATURE	
NATOPS eval.	(Aircraft model)	(Crew posit.)	(Date)	(Authenticating signature)	(Unit which administered eval.)

MH-53E PILOT NATOPS EVALUATION WORKSHEET

NAME		GRADE	SSN
SCUADRON / UNIT		AIRCRAFT MODEL	
TOTAL PILOT HOURS	TOTAL HELO HOURS	TOTAL HOURS IN MODEL	DATE OF LAST EVAL

NATOPS EVALUATION

REQUIREMENTS	DATE COMPLETED	GRADE Q	GRADE CQ	GRADE U
OPEN BOOK EXAMINATION				
CLOSE BOOK EXAMINATION				
ORAL EXAMINATION				
FLIGHT EVALUATION				

FLIGHT DURATION	AIRCRAFT BUNO	OVERALL FINAL GRADE
GRADE, NAME OF EVALUATOR / INSTRUCTOR		DATE

REMARKS

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MH-53E PILOT NATOPS EVALUATION WORKSHEET

OFT / ORAL PROCEDURE & EVALUATION

1. SYSTEMS, GENERAL	ADJECTIVE AREA GRADE Q	CQ	U	POINTS
A. ENGINE (S)				
B. ROTOR				
C. FUEL				
D. ELECTRICAL				
E. TRANSMISSION				
F. HYDRAULIC				
G. AFCS				
H. COMMUNICATIONS / NAV				
I. FLIGHT CONT				
J. LANDING GEAR				
K. BLADE / PYLON FOLD				
L. MISSION SYSTEMS				
M. (BLANK)				
NUMERICAL AREA GRADE		TOTAL POINTS		

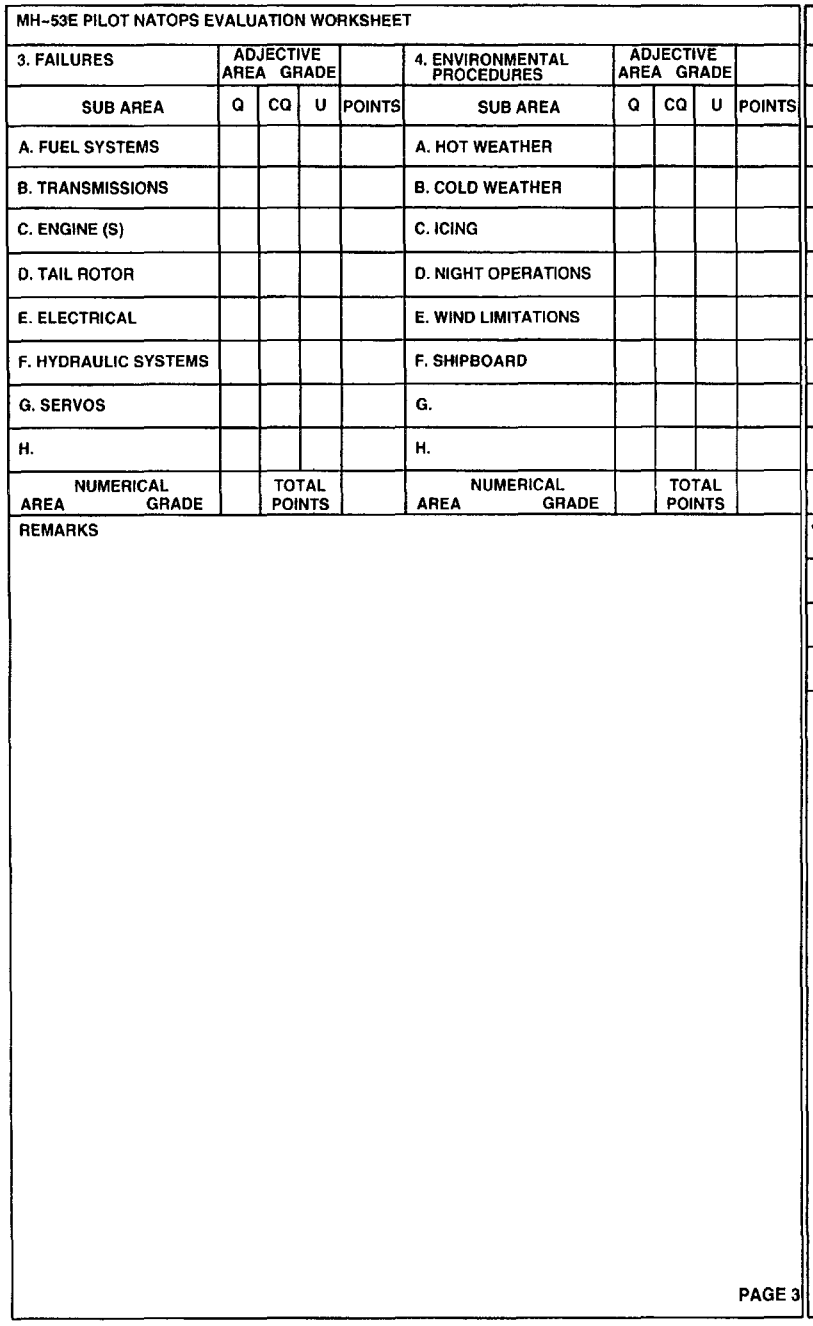
2. MALFUNCTION ANALYSIS	ADJECTIVE AREA GRADE Q	CQ	U	POINTS
A. CHIP DETECTOR				
B. AFCS				
C. FIRE				
D. FUEL SUPPLY SYSTEM				
E. LANDING GEAR				
F. ELECTRICAL POWER				
G.				
H.				
I.				
NUMERICAL AREA GRADE		TOTAL POINTS		

REMARKS

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Figure 18-1. Pilot Evaluation Worksheet (Sheet 1 of 3)



MH-53E PILOT NATOPS EVALUATION WORKSHEET

3. FAILURES	ADJECTIVE AREA GRADE				4. ENVIRONMENTAL PROCEDURES	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	POINTS	SUB AREA	Q	CQ	U	POINTS
A. FUEL SYSTEMS					A. HOT WEATHER				
B. TRANSMISSIONS					B. COLD WEATHER				
C. ENGINE (S)					C. ICING				
D. TAIL ROTOR					D. NIGHT OPERATIONS				
E. ELECTRICAL					E. WIND LIMITATIONS				
F. HYDRAULIC SYSTEMS					F. SHIPBOARD				
G. SERVOS					G.				
H.					H.				
NUMERICAL AREA GRADE		TOTAL POINTS			NUMERICAL AREA GRADE		TOTAL POINTS		

REMARKS

PAGE 3

MH-53E PILOT NATOPS EVALUATION WORKSHEET

FLIGHT EVALUATION *ASTERISK (*) denotes critical areas*

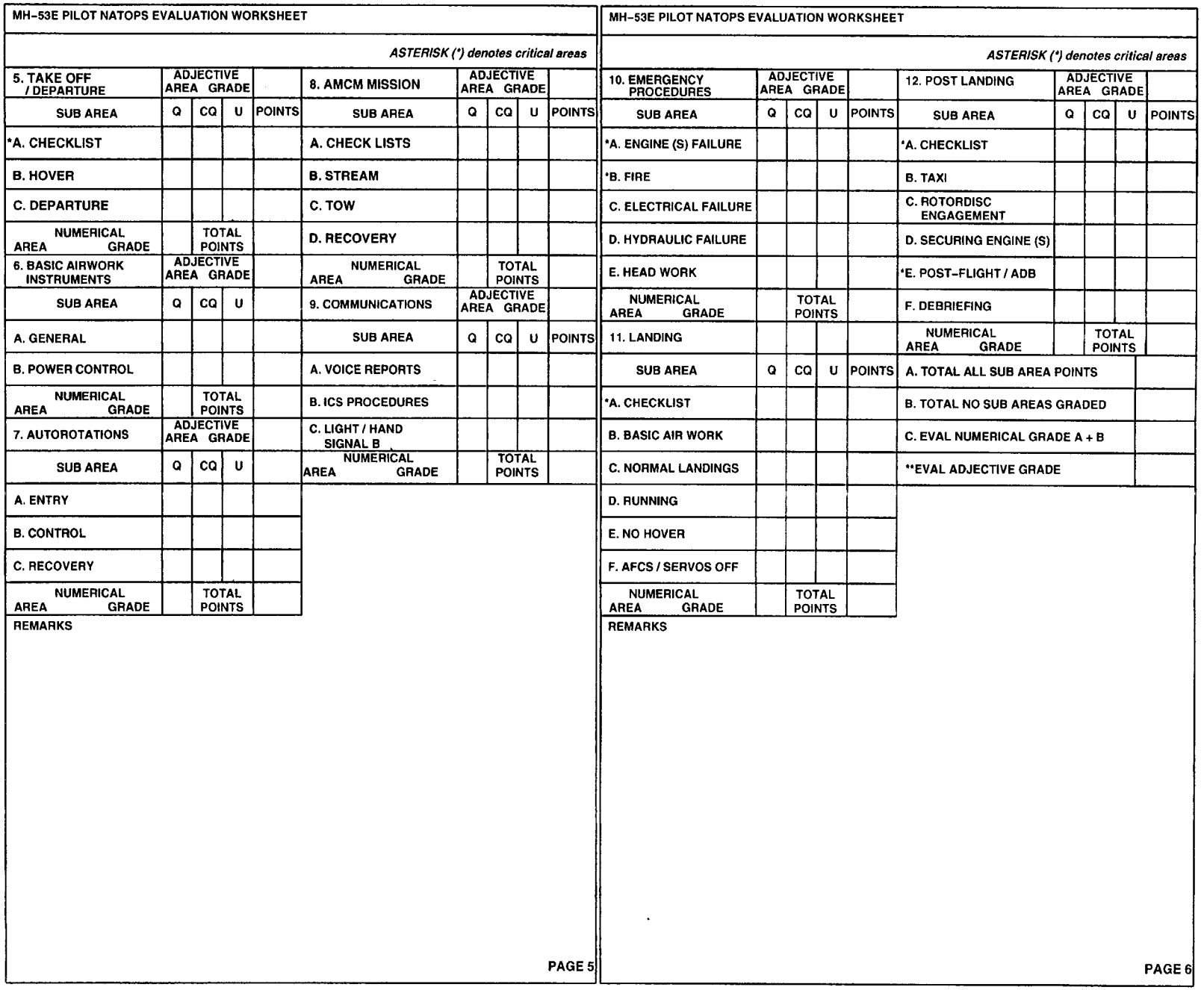
1. MISSION PLANNING	ADJECTIVE AREA GRADE				3. PREFLIGHT	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	POINTS	SUB AREA	Q	CQ	U	POINTS
A. KNOWN EDGE ON PUBS / CHARTS					A. ADB REVIEW				
B. ROUTE PLANNING					B. AIRCRAFT INSPECTION				
C. NAVIGATION					NUMERICAL AREA GRADE		TOTAL POINTS		
D. FILING					4. PRETAKEOFF PROCEDURES	ADJECTIVE AREA GRADE			
NUMERICAL AREA GRADE		TOTAL POINTS			SUB AREA	Q	CQ	U	POINTS
2. BRIEFING	ADJECTIVE AREA GRADE				*A. COCKPIT CHECKLIST				
SUB AREA	Q	CQ	U	POINTS	B. ENGINE (S) START				
A. MISSION BRIEF					C. ROTOR ENGAGE				
*B. EMERGENCY PROCEDURES					D. TAXI				
C. CREW FLIGHT GEAR									
D. FILING PROCEDURES									
NUMERICAL AREA GRADE		TOTAL POINTS			NUMERICAL AREA GRADE		TOTAL POINTS		

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Figure 18-1. Pilot Evaluation Worksheet (Sheet 2 of 3)



MH-53E PILOT NATOPS EVALUATION WORKSHEET

ASTERISK (*) denotes critical areas

5. TAKE OFF / DEPARTURE	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	POINTS
*A. CHECKLIST				
B. HOVER				
C. DEPARTURE				
NUMERICAL AREA GRADE		TOTAL POINTS		
6. BASIC AIRWORK INSTRUMENTS	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	
A. GENERAL				
B. POWER CONTROL				
NUMERICAL AREA GRADE		TOTAL POINTS		
7. AUTOROTATIONS	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	
A. ENTRY				
B. CONTROL				
C. RECOVERY				
NUMERICAL AREA GRADE		TOTAL POINTS		

8. AMCM MISSION	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	POINTS
A. CHECK LISTS				
B. STREAM				
C. TOW				
D. RECOVERY				
NUMERICAL AREA GRADE		TOTAL POINTS		
9. COMMUNICATIONS	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	POINTS
A. VOICE REPORTS				
B. ICS PROCEDURES				
C. LIGHT / HAND SIGNAL B				
NUMERICAL AREA GRADE		TOTAL POINTS		

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MH-53E PILOT NATOPS EVALUATION WORKSHEET

ASTERISK (*) denotes critical areas

10. EMERGENCY PROCEDURES	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	POINTS
*A. ENGINE (S) FAILURE				
*B. FIRE				
C. ELECTRICAL FAILURE				
D. HYDRAULIC FAILURE				
E. HEAD WORK				
NUMERICAL AREA GRADE		TOTAL POINTS		
11. LANDING				
SUB AREA	Q	CQ	U	POINTS
*A. CHECKLIST				
B. BASIC AIR WORK				
C. NORMAL LANDINGS				
D. RUNNING				
E. NO HOVER				
F. AFCS / SERVOS OFF				
NUMERICAL AREA GRADE		TOTAL POINTS		

12. POST LANDING	ADJECTIVE AREA GRADE			
SUB AREA	Q	CQ	U	POINTS
*A. CHECKLIST				
B. TAXI				
C. ROTORDISC ENGAGEMENT				
D. SECURING ENGINE (S)				
*E. POST-FLIGHT / ADB				
F. DEBRIEFING				
NUMERICAL AREA GRADE		TOTAL POINTS		

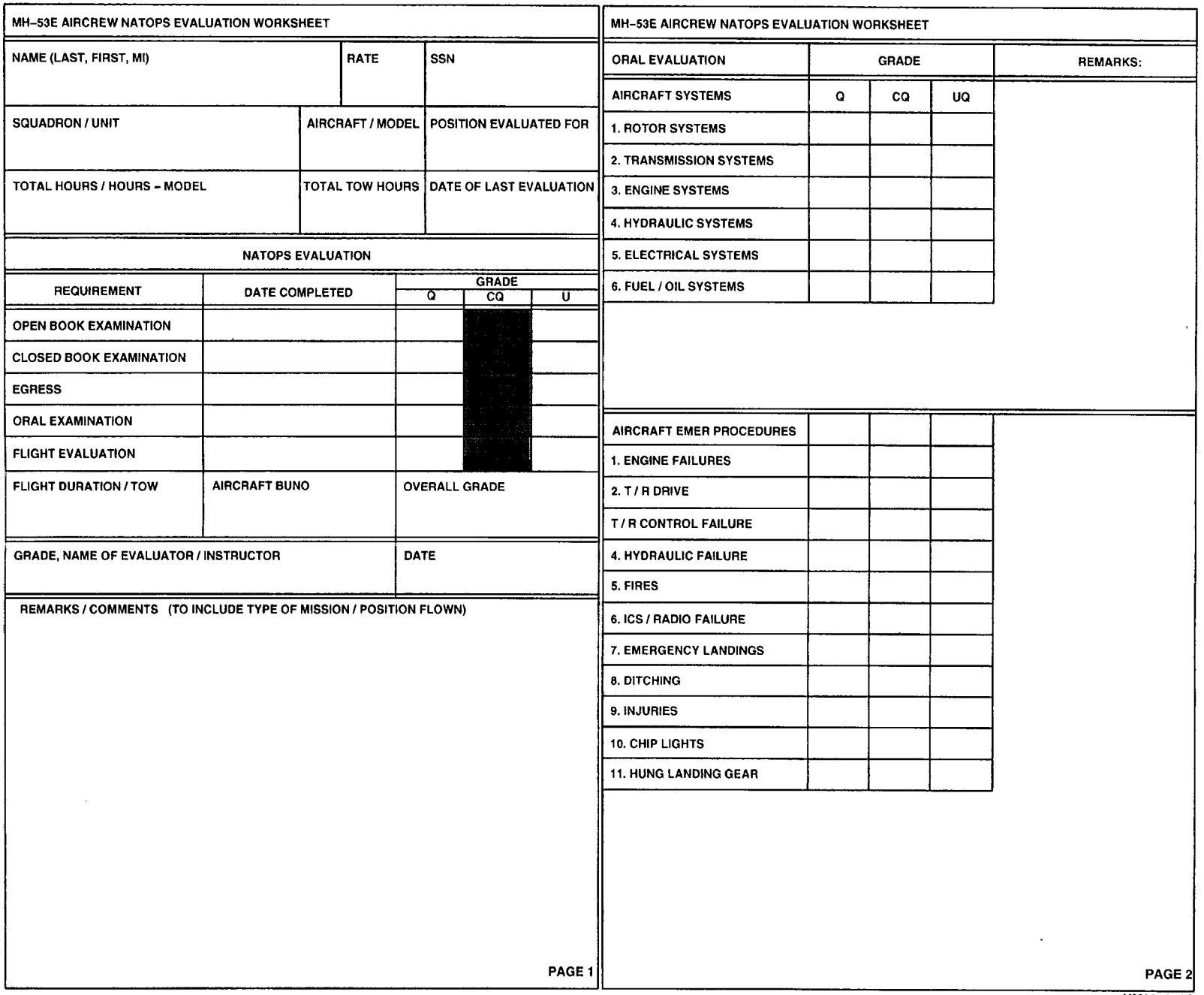
A. TOTAL ALL SUB AREA POINTS	
B. TOTAL NO SUB AREAS GRADED	
C. EVAL NUMERICAL GRADE A + B	
**EVAL ADJECTIVE GRADE	

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Figure 18-1. Pilot Evaluation Worksheet (Sheet 3 of 3)



MH-53E AIRCREW NATOPS EVALUATION WORKSHEET

NAME (LAST, FIRST, MI)	RATE	SSN

SQUADRON / UNIT	AIRCRAFT / MODEL	POSITION EVALUATED FOR

TOTAL HOURS / HOURS - MODEL	TOTAL TOW HOURS	DATE OF LAST EVALUATION

NATOPS EVALUATION

REQUIREMENT	DATE COMPLETED	GRADE Q	GRADE CQ	GRADE U
OPEN BOOK EXAMINATION				
CLOSED BOOK EXAMINATION				
EGRESS				
ORAL EXAMINATION				
FLIGHT EVALUATION				

FLIGHT DURATION / TOW	AIRCRAFT BUNO	OVERALL GRADE

GRADE, NAME OF EVALUATOR / INSTRUCTOR	DATE

REMARKS / COMMENTS (TO INCLUDE TYPE OF MISSION / POSITION FLOWN)

PAGE 1

MH-53E AIRCREW NATOPS EVALUATION WORKSHEET

ORAL EVALUATION	GRADE Q	GRADE CQ	GRADE UQ	REMARKS:
AIRCRAFT SYSTEMS				
1. ROTOR SYSTEMS				
2. TRANSMISSION SYSTEMS				
3. ENGINE SYSTEMS				
4. HYDRAULIC SYSTEMS				
5. ELECTRICAL SYSTEMS				
6. FUEL / OIL SYSTEMS				
AIRCRAFT EMER PROCEDURES				
1. ENGINE FAILURES				
2. T / R DRIVE				
T / R CONTROL FAILURE				
4. HYDRAULIC FAILURE				
5. FIRES				
6. ICS / RADIO FAILURE				
7. EMERGENCY LANDINGS				
8. DITCHING				
9. INJURIES				
10. CHIP LIGHTS				
11. HUNG LANDING GEAR				

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Figure 18-2. Aircrew Evaluation Worksheet (Sheet 1 of 3)

MH-53E AIRCREW NATOPS EVALUATION WORKSHEET

ORAL EVALUATION	GRADE			REMARKS:
AMCM SYSTEMS	Q	CQ	UQ	
1. MK – 103				
2. MK – 104				
3. MK – 105				
4. MOP				
5. AN / AQS – 14				
6. AN / ALQ – 141				
7. GPS				

AMCM EMER. PROCEDURES				
1. STREAMING WINCH MAL.				
2. RAMP FAILURE				
3. DAVIT FAILURE				
4. TENSION / SKEW FAILURE				
5. SNAGGED / TANGLED GEAR				
6. GEAR OSCILLATIONS				
7. JETTISONING GEAR				
8. ICS FAILURE				
9. RESCUE HOIST FAILURE				
10. U – 2 SYSTEM FAILURE				
11. INJURIES				

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MH-53E AIRCREW NATOPS EVALUATION WORKSHEET

ORAL EVALUATION	GRADE			REMARKS:
SPECIAL SYSTEMS	Q	CQ	UQ	
1. VOD / CARGO				
2. PAX				
3. EXTERNALS				
4. FORM FLIGHTS				
5. SAR				
6. INTERNAL FUEL SYSTEMS				
7. COLD WEATHER				
8. XM 218 (50 CAL)				

PLANE CAPTAIN				
1. DAILY INSPECTION				
2. TURNAROUND INSPECTION				
3. FUELING PROCEDURES				
4. A / C TOWING PROCEDURES				
5. MOVE DIRECTOR				
6. BRAKE RIDER				
7. FINAL PANEL INSP. / TFOA				
8. TRANSIENT MAINTENANCE				

ORAL EVALUATION GRADE	Q	CQ	UQ

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Figure 18-2. Aircrew Evaluation Worksheet (Sheet 2 of 3)

MH-53E AIRCREW NATOPS EVALUATION WORKSHEET

FLIGHT EVALUATION	GRADE			REMARKS:
	Q	CQ	UQ	
PREFLIGHT				
1. FLIGHT GEAR				
2. BRIEF				
3. NAVFLIR NALCOMIS				
4. AIRCRAFT INSPECTION				
5. AMCM GEAR INSPECTION				
6. VOD GEAR INSPECTION				
7. AIRCRAFT PREPARATION				
FLIGHT				
1. TAXI / TAKEOFF				
2. CREW / CABIN CONTROL				
3. TOOL CONTROL				
4. MISSION PROCEDURES				
5. INFLIGHT EMERGENCIES				
6. CREW COORDINATION				
POSTFLIGHT				
1. AIRCRAFT INSPECTION				
2. VIDS / MAF - NALCOMIS USE				
3. DEBRIEF				
FLIGHT EVALUATION GRADE				

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MH-53E AIRCREW NATOPS EVALUATION WORKSHEET

OVERALL EVALUATION	GRADE			REMARKS:
	Q	CQ	UQ	
1. ORAL EVALUATION				
2. FLIGHT EVALUATION				
3. ACT / ORM				
4. SAFETY				
5. PLANE CAPTAIN				
6. ATTITUDE				

OVERALL EVALUATION (circle one) QUALIFIED UNQUALIFIED

SIMULATED EMERGENCIES:

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INSTRUCTIONS:

1. Three total marks of "CQ" requires an overall grade of "UQ".
2. Two total marks of "CQ" in any one section is an overall grade of "UQ".
3. One mark of "UQ" in the flight section is an overall grade of "UQ".
4. The written exams must be completed prior to the oral / ground exam.
5. All exams must be completed prior to the check flight.

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Figure 18-2. Aircrew Evaluation Worksheet (Sheet 3 of 3)

18.7 NATOPS EVALUATION QUESTION BANK

The following bank of questions is intended to assist the unit NATOPS instructor/evaluator in the preparation of ground examinations and to provide an abbreviated study guide. The questions from the bank may be combined with locally originated questions in the preparation of ground examinations. Unit NATOPS coordinators are responsible for ensuring applicability of questions depending on current airframe changes.

18.7.1 Pilot's NATOPS Question Bank

1. A precautionary landing is described as a landing when _____. Such landings shall be governed by the following:

   a. _____
   _____

   b. _____
   _____

   c. _____
   _____

2. The engine overtorque caution light will go on and the aural tone will activate any time the output of one or more engines exceeds _____% torque.

3. For a single- or dual-engine fly away, based on preflight criteria, consideration should be given to establishing immediately a _____ or immediately _____ and executing a flyaway.

4. Engine power degradation due to salt spray ingestion is not a concern during single-/dual-engine fly away situations.

   a. True

   b. False

5. Flare effectiveness at airspeeds for minimum rate of descent will be _____ in arresting _____.

6. Optimum N_r for autorotative descent is _____ to _____%.

7. For optimum flare effectiveness, the entry airspeed for the cyclic flare maneuver should be _____ to _____ KIAS.

8. Allowing autorotative airspeed to decrease below _____ KIAS will cause a(n) _____ in rate of descent.

9. If an operating engine and a failed or secured engine have the same tank selected, the operating engine may _____ if the failed or secured engine's fuel selector lever was not placed to _____.

10. No. 2 engine in-flight restart should be determined by _____. If the No. 2 engine is shut down and/or subsequently restarted, reduce airspeed to less than _____ to reduce the possibility of a fire hazard caused by hot exhaust gas backflow into the aft engine compartment.

11. A No. 2 engine restart in flight presents no unusual hazards.

   a. True

   b. False

12. With AFC 483, a(n) _____ caution light lets the pilots know when the No. 2 engine compartment is above critical limits.

13. Failure of an engine following illumination of an engine chip detector light could occur in as little as _____.

14. Following a tail drive failure in flight, if the right yaw acceleration is arrested after initial collective reduction and extended powered flight is achieved, the final approach should be made into the wind at approximately _____ KIAS.

15. With a compressor stall in the No. 2 engine, any delay in shutting down the engine can result in _____, with the probable onset of an _____.

16. If the No. 2 engine is operating in a low-power condition and the N_g is less than _____, hot exhaust gas may backflow into the engine compartment creating a fire hazard.

17. Following a power train driveshaft failure, _____ and _____ should be closely monitored to guard against possible damage.

18. Following a speed control linkage failure, the _____ of the affected engine may be used to secure the engine.

19. Loss of tail rotor thrust will result in exaggerated _____ and _____ response to _____ and/or _____ inputs due to mechanical coupling.

20. The _____ installation provides the capability of continued flight to a landing site with tail rotor control system failure.

21. Following a tail rotor control system failure, the helicopter trims to balanced level flight at about _____ KIAS at 46,500 pounds. Above 46,500 pounds at _____ airspeeds.

22. A PYLON UNSAFE FOR FLIGHT caution light may be accompanied by _____.

23. A VIB DETECT light on the BMP indicates that the BMS has sensed bearing vibration level(s) which are _____.

24. In case of an electrical fire, attempt to isolate affected circuits by selectively securing _____.

25. After the engine is secured following a No. 2 engine overheat, if subsequent fire is detected/ suspected, perform _____.

26. During a fuel supply system failure as evidenced by a fuel filter bypass light, consideration should be given to _____ if adverse secondary indications are noted.

27. If desensitizer failure occurs, the following precautions must be observed.

a. _____

b. _____

c. _____

d. _____

28. In the event of a dual rectifier failure, mission essential equipment including _____ will become inoperative. _____ will also be degraded.

29. AFCS servos will automatically transfer if pressure in second stage system drops below _____ or _____ in the utility 1 system.

30. Rapid or abrupt movement of flight controls with only one primary flight control hydraulic system operating can result in _____ due to a reduction in pressure in the operating system.

31. The LANDING GEAR CONT circuit breaker removes hydraulic pressure to the landing gear and does not affect the down and locked indication in the cockpit.

a. True

b. False

32. The landing criteria for a MGB oil pressure of 45 psi is "Land as soon as practical".

a. True

b. False

33. FWU failure is a slippage condition which allows _____ to exceed _____ with no _____ transmitted to the MGB.

34. FWU slippage is indicated by any or all of the following symptoms:

a. _____

b. _____

c. _____

35. During FWU lockup, maintain the affected engine at or above _____, ensuring the lubricating of power turbine shaft bearings.

36. Due to sensitivity of the IBIS system, a false indication of impending spar failure may be caused by _____.

37. The automatic control circuit, in conjunction with two pressure switches, function to open the EAPS doors between _____ KIAS.

38. The engine overspeed system actuates at about _____ N_f to protect against actual overspeed.

39. The engine overspeed test circuit will function after the engine has attained _____.

40. The engine fuel control unit senses, _____, _____, _____, _____, _____, and _____.

41. The engine fuel control functions to prevent _____, _____, _____, _____, and _____.

42. The engine oil pressure lights on the caution panel (will/will not) indicate whether the oil pressure is too high or too low.

43. It is possible for the engine chip detector light to go on and remain on because of minute metal particles that have washed away.

a. True

b. False

44. Ground idle N_g is variable with _____ and it's range is _____ to _____.

45. A rise in T_5 to _____ before the engine reaches ground idle is an indication of a hot start.

46. When airborne, the _____ _____ interlocks are automatically by-passed by a microswitch on the main landing gear scissors switch.

47. On aircraft equipped with 419 engines, the ENGINE OVERTORQUE caution light comes on whenever the torque on any engine exceeds _____% and remains lit when the torque on any engine exceeds _____%.

48. The start abort switches (do/do not) shut off fuel to the engines.

49. With only two engines operating, a total torque indication of 70% would mean that:

a. The total (sum) of the torques of the two operating engines equals 70%.

b. The average torque of the two operating engines is 70%.

c. The average torque of all three engines is 70%.

d. Each operating engine is producing 70% Q.

50. A green rotor brake light on the lower portion of the tachometer goes on whenever N_r is between _____ and _____.

51. On aircraft powered by 419 engines, the engine oil coolers do not function until the rotors are engaged.

a. True

b. False

52. The hydraulic dampers on the main rotor head provide the following three functions:

_____,
_____,
_____.

53. _____,
_____,
_____, or
_____
will result in the BIM caution light going on.

54. The TEMP LIMIT caution light indicates that a bearing has reached 350°F and is indicative of _____.

55. Nose gear box oil temperature caution lights will activate when the oil temperature reaches _____.

56. Main gear box oil temperature indicated on the gage is detected from separate source may not coincide with the main gear box oil hot caution light going on.

a. True

b. False

57. The tail rotor gear box combination fuzz burn chip and temperature detector lights the TAIL GB chip locator when _____ or when _____.

58. The _____ chip detector and the _____ chip detector are connected to a 30 second time delay relay which will energize when a chip has been present for approximately 30 seconds.

59. The rotor brake system is a utility 1 subsystem.

a. True

b. False

60. Before releasing the rotor by pulling the manual override release handle, be sure the high pressure rotor brake switch is _____.

61. The fuel low caution light will go on when there is approximately _____ pounds of JP-5 fuel remaining in either the No. 1 or No. 3 tank or _____ lbs of fuel in either the No. 2 left or right tanks.

62. The helicopter's fuel system cannot be purged while pressure refueling or fuel transfer is taking place.

a. True

b. False

63. When pressure fueling the aircraft to maximum fuel loads, securing the main fuel fill switches after high level shut off with refuel master power on will allow _____ fuel to enter the tank, which may overfill.

64. Each sponson can dump fuel at a rate of _____ gallons per minute with one tank selected and _____ gallons per minute with both tanks selected.

65. The fuel dump system is capable of dumping all fuel from the main fuel cells.

a. True

b. False

66. The automatic shutdown feature of the APP, due to _____ and _____ _____, is bypassed during main engine start.

67. Under frequency protection is provided when N_r drops below _____.

68. Normally, the emergency AC bus is powered by the _____.

69. With three generators or the No. 2 generator only on line, the external power is automatically cut out.

a. True

b. False

70. The following are components of the U1 module except:

a. 1500 psi wheel brake pressure reducer

b. Landing gear emergency bypass valve

c. 650 psi servo transfer valve

d. Priority valve

71. Neither side of the primary tandem servos may be turned off unless there is _____ in the other side, providing there is no electrical malfunction.

72. To smooth out pilot roll inputs a _____ is incorporated in the roll linkage between the cyclic and the AFCS roll servo.

73. The _____ coupling provides increased tail rotor thrust for collective increases.

74. The _____ provides longitudinal cyclic inputs proportional to pedal inputs, to compensate for the pitching moment produced by the vertical thrust component of the canted tail rotor.

75. The _____ loop is primarily a stability augmentation system that employs rate damping to improve helicopter stability.

76. The _____ loop maintains the flight regime selected by the pilot when he trims his flight controls.

77. Which of the following is not a function of inner loop control:

a. Stability augmentation

b. Force augmentation (FAS)

c. Hover augmentation

d. Control desensitization

78. The longitudinal bias actuator provides the pilot with a positive longitudinal cyclic gradient.

a. True

b. False

79. The output of the AFCS roll servo is linked directly to the mixing unit, which furnishes a single input to the _____ primary servo.

80. During the engine start sequence, if fuel flow is over _____ pph prior to lite-off, a hot start may occur and the start should be aborted.

81. The FAS PRESS switch is used to remove hydraulic pressure from the FAS actuator, as an alternative to _____, in case of a leak in the FAS actuator.

82. Fail operational describes a mode not necessary for minimum safe operations and a single failure will cause such a mode to stop operating.

a. True

b. False

83. Airspeed hold holds airspeed (5 knots up to _____ angle of bank then fades out.

84. The longitudinal bias actuator is fully retracted from _____ to _____ knots and is fully extended at _____.

85. Failure of the RAD ALT hold while in a coupled hover will cause the RAD ALT hold to disengage and automatically switch to BAR ALT hold.

a. True

b. False

86. When the AFCS servos are not pressurized, their only function is to provide a mechanical link _____.

87. The _____ loop stability signals are applied to the servo output and do not move the cockpit flight controls.

88. The output of the AFCS _____ and _____ servos are linked directly to the mixing unit, which furnishes output to the tail rotor servo plus the forward, aft, and lateral primary servos.

89. Pitch attitude hold, airspeed hold, and pitch trim are done by the _____ actuator from computer inputs.

90. During normal operations, each AFCS computer furnishes _____ of the correction signal to the AFCS servos and the longitudinal bias actuator.

91. _____ provides damping and short term dynamic stability in pitch, roll and yaw inner loop axis.

92. Turn coordination provides yaw channel inputs to coordinate turns above _____ knots.

93. Above 60 knots, beeping the CYCLIC STICK TRIM BEEP BUTTON FWD and AFT trims the helicopter at a rate of _____ knots-per-second to hold selected airspeed.

94. When the struts are compressed, the electrical circuitry associated with the weight on wheels switch performs the following functions except:

a. Disables the attitude hold portion of the AFCS outer loop

b. Disables fuel dump capability

c. Disables BAR ALT Hold

d. Opens the isolation valve

95. The attitude warning system will function if the helicopter has experienced a single computer failure.

a. True

b. False

96. During forward flight, with an airload on the nose gear door, emergency extension may take from _____ to _____ minutes.

97. The airspeed indicators in the cockpit are unreliable below _____ KIAS.

98. The copilot's ADI normally receives inputs from the _____ vertical gyro, and the pilot's ADI receives inputs from the _____.

99. When the PUSH-TO-TEST control knob on the radar altimeter indicator is pressed, a visual indication of _____ on the indicator indicates satisfactory system operation.

100. The RDR ALT switch on the pilot's miscellaneous switch panel allows selection of the radar tracking rate.

The LAND mode tracks at _____ per second, while the SEA mode tracks at _____ per second.

101. Both altimeters will _____ in high rates of descent (autorotation) if the RDR ALT switch is at SEA.

102. If a radar altimeter is manually shut down for any reason, do not attempt to turn the system back on if the _____ mode of the AFCS is engaged.

103. The engine air anti-ice solenoid valves are energized to the _____ position to make sure of a flow of anti-icing air in case of a complete electrical failure.

104. When the HOIST CONTROL panel is placed to PILOT, placing the control switch to either UP or DOWN will cause the hoist cable to travel in the mode selected at a maximum cable speed of _____ feet-per-minute.

105. For T64-416A engines, maximum continuous power turbine inlet temperature is limited to _____°C, military operation for 30 minutes is limited to _____°C, and maximum for 10 minutes is limited to _____°C.

106. T64-419 engines may reach as high as _____N_g and _____°C during OEI operations.

107. Use of contingency power exceeds normal operating limits and requires the completion of a _____ specifying the exceeded parameters and duration thereof.

108. The maximum continuous gas generator turbine (N_g) speed for T64-416 engines is _____%.

109. The maximum continuous gas generator turbine (N_g) speed for T64-419 engines is _____%.

110. The maximum engine oil temperature for T64-416 engines is _____°C.

111. The maximum engine oil temperature for T64-416 engines is _____°C.

112. The nose gear box oil normal operating temperature is _____ to _____°C.

113. An increase in OAT, at a constant pressure altitude, causes _____ engine performance.

114. No. 2 engine backflow is most prevalent under the following conditions:

a. _____.

b. _____.

c. _____.

115. Ensure the pitch lock switch is in the disengage position before:

a. _____.

b. _____.

116. Engine oil high-pressure light may stay on for as long as _____ minutes, until oil has warmed.

117. Failure to chock both main landing gear while the aircraft is operating at 100% may result in a(n) _____.

118. The No. 2 engine shall not be started with aircraft relative winds _____ to _____ degrees.

119. Should the APP flame out before rotor engagement, there will be no _____ or _____ power available.

120. During transition to forward flight as airspeed increases above approximately _____ knots, translational lift will become effective and tend to cause the helicopter to climb.

121. A single-point performance check is done to determine if the engine is producing _____ acceptable torque, at a specific T_5, OAT, and pressure altitude.

122. While in a descent, fuel shall not be dumped below _____ KIAS or above 130 KIAS. In level flight, fuel shall not be dumped below _____ KIAS or above 130 KIAS. Fuel shall not be dumped if the rate of descent exceeds _____ feet-per-minute.

123. Landing on slopes up to approximately _____ differ very little from normal, level landing, and any direction of landing may be accomplished.

124. When approaching power and telephone lines, it is advisable to fly over the poles or tower rather than over the wire.

a. True

b. False

125. To provide engine cooling before engine shutdown, one of the following conditions must occur before moving the speed control levers to SHUT-OFF.

a. _____

b. _____

c. _____

126. An emergency brake application can be made at any N_r with all engines shut off and high-pressure rotor brake switch at EMER.

a. True

b. False

127. Hoist operations at gross weights above _____ pounds should be avoided.

128. Land as soon as possible means:

a. Landing site and duration of flight is at the discretion of the pilot in command.

b. Land at the first site at which a safe landing can be made.

c. Land immediately.

129. A precautionary landing is described as a landing when further flight is possible but inadvisable.

a. True

b. False

130. A T_5 increase of 40 °C at a constant torque is equal to a power loss of about _____%.

131. The maximum gross weight at which hover or level flight can be maintained _____ as density altitude increases.

132. During an uncommanded ground spin, experience has shown that, after as little as _____ of rotation, inertia may prevent any control input from halting the spin.

133. Flight indications of impending intermediate or tail rotor gear failure are:

a. _____,

b. _____,

c. _____,

d. _____.

134. When the 1 STG M/R SERVO BYPAS caution light is observed after a utility hydraulic system failure, securing first stage flight control system will result in _____.

135. Main gear box failure may be indicated by any _____. Main gear box failure may also be indicated by unusual _____, accompanied by _____ in the torque meters.

136. Minimum visibility for VMC rendezvous during air-to-air refueling is _____ miles.

137. A good stabilized position is when the end of the probe is no more than _____ to _____ feet from the paradrogue.

138. In the pitch linkage between the AFCS pitch servo and the mixing unit there is a _____ that functions as a mechanical connection with AFCS off.

139. Auto bank automatically disengages and engages with attitude retention during a maneuver above _____ knots.

140. With AFCS off, pressing and lighting the TRIM pushbutton to read TRIM turns on _____, _____, and _____.

141. A _____ will be indicated by a failure of the gas generator to accelerate to proper idle speed, accompanied by a low T_5 indication.

142. If engine lite-off does not occur within 10 seconds after fuel flow indication, the start must be aborted.

a. True

b. False

143. The landing gear and attitude warning systems may be disabled in AMCM operations by depressing the _____ pushbutton on the MCM TOW CONTROL panel.

144. Why is it mandatory to release the radar altitude hold feature during a single engine emergency while streaming or recovering AMCM gear?
_____

145. Do not droop N_r below _____% when making heavy lift or high power landings or takeoffs.

146. Failure of any one of the AC generators will result in the loss of the _____ buses.

147. When encountering turbulence, an increase in N_r will improve the helicopter's gust response, provide a smoother ride, and decrease susceptibility to blade stall.

a. True

b. False

148. Operating the FM/VHF/UHF radio at VHF/UHFDF will control the _____ needle on the selected HSI.

149. Two helicopters equipped with TACAN can range on one another provided both set their function switches to _____ position and select channel numbers that are _____ apart.

150. The RAD ALT 1 or 2 switches on the copilot's overhead panel energize the pilot's or copilot's radar altimeters.

a. True

b. False

151. With a single computer failure only the following will remain operational.

a. _____

b. _____

c. _____

d. _____

152. The hover coupler provides _____ and _____ ground speed control and stabilization about the selected ground speed, and automatic altitude retention.

153. The collective mounted engine speed trim switches can only be beeped to decrease when the engine speed control levers are above _____.

154. Following an N_f flex cable failure, the speed control lever for the malfunctioning engine can be used as a direct manual throttle after it has been retarded below _____.

155. Whenever possible, approaches to ridge lines should be along the ridge rather than perpendicular to it.

a. True

b. False

156. The ability to hover out of ground effect should be determined before attempting a mountain or rough terrain landing.

a. True

b. False

157. After an IFR takeoff, turns should not normally be made below _____ feet above the ground.

158. In order to transmit the emergency transponder code 7700, the pilot need only move the IFF master selector switch to emergency.

a. True

b. False

159. What features of the tow coupler are disengaged when cyclic trim is pressed?

a. _____

b. _____

c. _____

160. In order to select continuous ignition, the _____ must be turned on.

161. Holding the low-pressure rotor brake switch at _____ for about _____ seconds engages the rotor brake with _____ psi hydraulic pressure.

162. A loss of about _____ of each engine's horsepower will result at maximum, when the engine air anti-icing system is on.

163. Rotors should not be engaged or disengaged in winds from any direction over _____ knots.

164. The tail skid/oil shock strut will withstand inadvertent ground contact to a sink rate of _____ feet-per-minute at 46,500 pounds gross weight.

165. The hover coupler mode is engaged automatically at the termination of automatic approach, or can be engaged manually when the helicopter is hovering, by pressing the _____ on the approach/hover control panel.

166. To smooth out pilot roll inputs, a _____ is incorporated in the roll linkage between the cyclic and the AFCS roll servo. To smooth out pilot pitch inputs, the _____ also acts as a damper. To prevent overstressing the helicopter from too rapid movement of the rudder pedals, a damper is incorporated in the _____.

167. Automatic depart will result in automatic accelerations to _____ KIAS and an increase in altitude to _____ feet.

168. Tension hold and ground speed hold can be engaged simultaneously.

a. True

b. False

169. The pilot's engine speed switches always have _____ over the copilot's switches.

170. The landing gear warning system will provide an audible warning below _____ feet and _____ KIAS if the landing gear is _____.

18.7.2 General NATOPS Question Bank

1. Checklist items marked with an asterisk (*) shall be completed without _____.

2. The TOW HOOK OPEN light provides positive indication that the tow has been released.

a. True

b. False

3. Tow hook release operation requires a minimum of _____ pounds tension.

4. In case of single-, dual-, or three-engine failure, consideration should be given to starting the APP so that electrical power will be available to the _____, _____, _____, and _____ should N_r droop below 91% to 96% on touchdown.

5. During a tail rotor drive system failure in an AMCM environment, the tow should be released as soon as possible.

a. True

b. False

6. To confirm the engine fire detection system is not being activated by the sun's infrared rays, turn the helicopter _____ to its flight path.

7. Helicopter response to a total electrical loss may be _____.

8. A hydraulic fire in the main rotor pylon area is most likely to occur during _____, _____, or _____ operations.

9. A MGB AUX LUBE PUMP caution light requires that the flight be aborted.

a. True

b. False

10. Components or systems susceptible to secondary damage following a main gear box oil cooler blower failure include:

a. _____

b. _____

c. _____

d. _____

e. _____

11. If the AMCM winches have experienced hydraulic failure, the winches will be _____ and _____.

12. Folding troop seats equipped with safety belts for _____ passengers may be installed. The seating arrangement is _____ troops on the cabin walls aft of the personnel door, and _____ seats facing right along cabin center.

13. The overall length of the helicopter with blades and pylon spread is _____ .

14. The main rotor diameter is _____.

15. The height of the helicopter with pylon spread is _____.

16. The starter circuit to the start valve is routed through the _____, _____, _____, _____, _____ and _____.

17. The _____ switch positions the head for engine start so that hot engine exhaust gases do not damage the main rotor blades.

18. The helicopter has a single, articulated main rotor and an antitorque tail rotor.

a. True

b. False

19. The main rotor blades have a(an) _____ spar.

a. Aluminum

b. Fiberglass

c. Titanium

d. Stainless Steel

20. The hollow main rotor blade spar is pressurized with _____ to about _____ at an ambient temperature of _____ to _____.

21. The IBIS spar pressure indicator test button is always pressed with a _____ to prevent radiation escape.

22. The main transmission gear box has _____ chip detectors, the accessory gear box has _____, and the intermediate, tail rotor and both engine nose gear boxes each have _____.

23. The input drive to the main gear box from the No. 2 engine is through a _____.

24. The main rotor head has a built-in forward tilt of _____.

25. The rotor brake caution light will go on whenever the manifold pressure is above _____.

26. The ROTOR BRAKE ON advisory light indicates that the rotor brake system pressure is _____ psi.

27. There must be electrical power on the helicopter in order to release the rotor brake.

a. True

b. False

28. The accessory gear box drives the:

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

29. The accessory gear box has two chip detectors, one for _____ and the other for _____.

30. The main gear box auxiliary oil system has no associated warning system.

a. True

b. False

31. The tail rotor gear box and the intermediate gear box have combination chip and temperature detectors.

a. True

b. False

32. Under what three conditions will the automatic fuzz-burn feature be disabled in the main gear box?

a. _____
_____
_____

b. _____
_____
_____

c. _____
_____
_____

33. The pilot can, from the cockpit, identify which chip detector in the main gear box has picked up chips.

a. True

b. False

34. Fuel for the APP is supplied from the _____ fuel tank.

35. The fuel dump system has two dump pumps in each sponson.

a. True

b. False

36. The APP control lever should be held at _____ until clutch engagement, and then allowed to return to _____.

37. Which of the following APP protective circuits is not bypassed during the engine start cycle:

a. Low oil pressure.

b. High exhaust gas temperature.

c. Overspeed.

d. Fire detection.

38. The _____ and _____ generators are driven by the accessory gear box.

39. Under frequency protection (is/is not) available when the weight of the helicopter is removed from the landing gear.

40. Each generator is routed through its supervisory panel that provides control and protection of the electrical system from _____, _____, _____ and _____.

41. _____ during starting may occur if the generator has not been turned off before shutting down the APP and/or main rotor head after the preceding flight.

42. Relay chatter can be eliminated by _____.

43. The loss of any single generator will result in the loss of which bus(es)?

a. No. 1 primary dc bus.

b. No. 2B primary ac bus.

c. No. 1 monitor ac bus.

d. No. 3 monitor ac bus.

44. The purpose of the three autotransformers is to reduce 115 vac down to 26 vac.

a. True

b. False

45. The emergency ac and dc circuit breakers are located in the _____.

46. Current limiters function to limit the flow of current regardless of the voltage applied to the system.

a. True

b. False

47. The engine start hydraulic system draws its fluid from which hydraulic reservoir?

a. 1st stage reservoir.

b. 2nd stage reservoir.

c. Utility 1 reservoir.

d. Engine start reservoir.

48. The second stage and both utility hydraulic systems are equipped with a heat exchanger.

a. True

b. False

49. The hydraulic fluid from the second stage and utility hydraulic systems is cooled as it returns to its respective hydraulic systems reservoir.

a. True

b. False

50. In addition, the first stage hydraulic system is cooled by a _____ (finned tube) at the inlet of the main transmission oil cooler, and uses the airflow of this blower.

51. The utility 1 hydraulic system provides subsystem pressure for the following:

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

h. _____

i. _____

j. _____

52. The top cylinder of the primary tandem servos is powered by the and the bottom cylinder is powered by the _____.

53. The 1 STG M/R SERVO BYPASS or 2 STG M/R SERVO BYPASS caution light will go on to indicate

a. _____
_____
_____

b. _____
_____
_____

54. The first stage of the AFCS servo, when selected, is pressurized by the _____ flight control hydraulic system.

55. The second stage of the AFCS servo, when selected, is pressurized by the _____ flight control hydraulic system.

56. Lighting of the #1, #2, or #3 ENG OIL QTY LOW caution light indicates the associated tank has been depleted by _____ of its usable capacity and shall be replenished by _____.

57. There are _____ fuel flow switches that will sense a fuel flow above _____ gpm and cause the appropriate fuel flow indicator light to go on.

58. The _____ is used to remove hydraulic pressure from the FAS actuator in case of a hydraulic leak in the FAS actuator.

59. The nose landing gear _____ prevents nose gear vibration during forward motion on the ground.

60. If the pin is extended on the top of the landing gear strut, is this an indication that (hydraulic/ nitrogen) servicing is necessary? _____.

61. With the utility 1 hydraulic system not pressurized, the wheel brakes are capable of holding the helicopter, loaded to 46,500 lbs on a _____ slope.

62. An overheat switch in the heater will shut off if for any reason, the heat in the plenum chamber rises to _____.

63. The heater should be cut off _____ minutes before removing electrical power from the system.

64. The vent fan and combustion air fan will continue to operate after the heater is shut off, until the temperature in the plenum chamber drops to _____.

65. With EAPS installed, No. 1 and No. 3 engines _____ _____ _____ _____ anti-icing capability is disabled.

66. The single-point hook opens automatically when the weight on the hook is reduced to _____ pounds when in the automatic mode.

67. Jettisoning of airborne cargo of over _____ pounds with the pilot's cargo release buttons or aircrewman's pendant may cause the cargo hook to recoil and strike the fuselage.

68. The rescue hoist has a capacity for _____ pounds with about _____ feet of usable cable length.

69. The hoist winch motor receives hydraulic power from the _____ hydraulic system and is controlled by an electrohydraulic hoist control valve.

70. The cabin section has provisions for the installation of _____ pole type litters.

71. Whenever one or more of the _____ _____ _____, _____ _____ _____, or _____ _____ _____ _____ caution lights illuminate, fuzz burn control unit No. 1's capacitive charge is dissipated to ground and fuzz burn is no longer available to the main gear box or nose gear boxes.

72. If more than one emergency T-handle is moved full aft, the fire extinguishing agent will be directed to the engine compartment of the _____ emergency T-handle actuated.

73. When pressure refueling, make sure that pressure from the fueling source is not over _____ psi before beginning fueling.

74. When tied down properly, the helicopter can withstand winds of up to _____ knots.

75. The two-point suspension system shall never be used in conjunction with the single-point system.

a. True

b. False

76. The _____ weight of a transport helicopter is the weight of the helicopter including the crew and all equipment required for the mission, but not including fuel or payload.

77. Any time an attempted APP start is aborted or not completed, place the APP control lever to SHUT-OFF and do not attempt a restart for _____ minutes.

78. The mechanical gust lock engaged interlock is automatically bypassed, when airborne, by a microswitch on the main landing gear scissors switch.

a. True

b. False

79. The failure of either rectifier will cause the _____ to be dropped from the system.

80. The master switch on the hoist control panel has to be at _____ or _____ before the hoist shear switch, on the cockpit console, can shear the cable.

81. Accessory gear box failure will result in the loss of _____ _____, _____ _____, _____ _____, and _____ _____ _____, _____ and other associated systems, and the _____ _____ and _____ _____ generators.

82. Each AFCS computer will store, indefinitely, up to _____ in-flight failure codes until cleared by maintenance personnel.

83. When the start valve is energized by depressing the engine starter button, the engine start pump provides _____ psi hydraulic pressure for engine starting.

84. When and where possible, always confirm the presence of a fire by sight in addition to the fire detection system.

a. True

b. False

85. If the engine-driven fuel pump should fail, the engine will _____.

86. With the 90° stub ramp fully lowered, forward airspeed is limited to _____ KIAS.

87. The front frame struts and the inlet guide vanes of each engine are anti-iced by _____.

88. The ice detection system warns of ice accumulation only and does not automatically activate the helicopter anti-icing systems.

a. True

b. False

89. Servicing of all hydraulic systems can be accomplished both on the ground and in flight by the _____.

90. A crash-generated force of _____ Gs automatically discharges the _____ and causes the _____ to come on.

91. Immersion of the helicopter into the water will cause the _____ to come on.

92. All chip detectors except the _____ have fuzz burnoff capability incorporated.

93. Fuzz burnoff is disabled when the accessory gear box _____ or _____ caution lights go on.

94. The jump seat, in the cockpit entrance way, should not be occupied during takeoff, landing, or adverse weather conditions.

a. True

b. False

95. The utility 2 hydraulic system provides subsystem pressure for:

a. _____

b. _____

c. _____

96. With the _____ switch in the _____ or position on the AMCM tow control panel, automatic tow release is disabled.

97. The two methods of securing the utility 2 hydraulic system are:

a. _____

b. _____

98. When tension exceeds the hi limit setting, _____ display flashes on the tension/skew indicator. A display of _____ flashes to indicate skew angels greater than _____.

99. N_r will be set at _____ for all AMCM operations.

100. When _____ power is off, the AFCS caution light should be on, indicating that both computers are shut down.

101. Improperly nulled _____ may cause degraded AFCS tow heading hold performance.

102. During extension and retraction of the landing gear, utility 1 hydraulic pressure may drop to _____ psi.

103. The RAD altimeter may furnish _____ indications when carrying external loads.

104. For rotor brake engagement reference, a RTR BK light on the N_f/N_r tachometers goes on when N_r decays to 50 ±4% N_r, and remains on until N_r decays below _____ ± _____ %.

105. Before releasing the rotor by pulling the manual override release handle, make sure the high pressure rotor brake switch is _____.

18.7.3 Questions of Particular Interest to Aircrewmen

1. The NATOPS Aircrew Pocket Checklist is a required item of equipment on all flights by aircrewmen.

a. True

b. False

* 2. What are the aircrewman's actions if the helicopter develops an APP fire during ground operation?

If fire persists:

a. _____

b. _____

* 3. What actions should the aircrewman take after notification by the pilot of an impending emergency landing (land)?

a. _____

b. _____

c. _____

d. _____

e. _____

* 4. What are the aircrewman actions for smoke and fume elimination?

a. _____

b. _____

c. _____

d. _____

5. During pressure refueling, fuel pumping pressure should be _____ to _____ psi.

6. The aircrewman will refuel the helicopter, making sure that the proper type of fuel is used and that the helicopter and single-point nozzle are properly _____.

7. When not strapped in a seat, the aircrewman must wear a _____ _____ at all times.

8. The APP high exhaust temperature circuit breaker is set to function at _____ °C.

9. A stowage rack for five _____ and five _____ marine location markers is on the port forward cabin bulkhead.

10. MIL-L-23699 oil is used throughout the helicopter (engines, gearboxes, rotors, etc.).

a. True

b. False

11. During fueling, A minimum of _____ should be maintained from other aircraft or structures and _____ from any operating radar set.

12. When towing MK-103 Mod 06 with 50° pendants, how should the lead float be configured? _____.

13. A passenger briefing guide is included in the Air Crew Pocket Checklist.

a. True

b. False

14. The helicopter requires _____ volt, _____-phase, _____ ac external power.

15. Tension must not fall below _____ pounds while crewmen are removing quick release pin from automatic release hook (ARH).

16. When doing on air-to-air transfer with the MK-105, when does the receiving helicopter raise the grounding strap? _____ _____ _____ _____.

17. When carrying the MOP under the aircraft, _____ straps are required on the roller assembly.

18. When the external power monitor panel rejects an external power input, the _____ switch must be placed to the RESET position.

19. During high wind conditions, the _____ should be engaged.

20. The cabin compartment floor is capable of sustaining loads of 300 pounds per square foot.

a. True

b. False

21. The cargo tie-down rings installed in the cargo cabin floor are rated at _____ pounds.

22. Before lowering ramp, be sure that the area under it is clear of _____, _____, and _____, that the ground is of equal load-carrying capability to avoid twisting the ramp when heavy loads are applied, and that the flippers are up.

23. The pilot's master ramp control switch must be in the _____ position before the crew ramp control panel will function.

24. An APP start shall be aborted whenever:

a. _____

b. _____

c. _____

d. _____

25. When the APP _____, is actuated, the APP and cabin heater fire areas will simultaneously receive fire extinguishing agent and fuel will be cut off to both systems.

26. Although the T-64 engine has an adjustment on it's fuel control to accommodate for the specific gravity of the particular fuel type being used, it is a very tolerant engine with respect to this fuel property.

a. True

b. False

27. During paratroop delivery operations, the anchor cables shall be rigged so that the aft end of the static line extends between _____ and _____ feet beyond the ramp edge when the ramp is lowered to _____ to _____ degrees below level.

28. When checking engine oil level after engine has been idle for some time, or the engine is cold, the engine should be _____ for _____ before checking the oil level.

29. The engine oil tank is fully serviced when the appropriate _____ _____ light goes on.

30. If a landing must be made with the ramp making ground contact, place the ramp/door selector valve handle to _____.

31. The filler necks on each engine oil tank shall not be used for servicing.

a. True

b. False

32. When towing the helicopter, speed will not exceed _____ mph and sudden stops and starts will be avoided.

33. The 28 vdc external power receptacle is collocated with the 115/200 vac external power receptacle.

a. True

b. False

34. When using other than chain tie-downs to secure the helicopter or the rotor blades, sufficient slack should be provided in all ropes to prevent overtightening due to moisture absorption.

a. True

b. False

35. The recommended streaming altitude after both outboard sections of MK-103 sweep have been deployed is _____ feet.

36. There are currently _____ changes to the Aircrewman's Pocket Checklist.

* 37. What are the aircrewman's actions if the helicopter develops a fuselage fire in flight?

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

38. When carrying internal cargo, and/or range extension fuel tanks, each piece of cargo is required to be secured in five different directions: forward, aft, side (both left and right), and vertical (up).

a. True

b. False

39. If pylon was spread manually, _____ may be extended.

40. For aircraft equipped with 416 engines, why will high engine oil temperatures occur when the helicopter engines are operating and the rotor is not engaged? Why is this not applicable to aircraft equipped with 419 engines? _____

_____

41. During landing gear system failure, be sure helicopter is _____ before maintenance personnel attempt to lower gear.

42. During the cargo hook system functional check, the emergency cargo hook release handle is not tested.

a. True

b. False

43. During IBIS signal processor test panel, selecting SAFE and pressing the pushbutton, the BIM caution light goes on for _____ to _____ seconds when the PRESS-TO-TEST pushbutton is released.

44. Following exposure to temperatures of -5° or colder for 1 hour, full pressurization of the rotor brake _____ _____ _____.

45. The blades and pylon may be folded separately; however, the blades cannot be folded if the pylon has already been folded.

a. True

b. False

46. The parking brakes are not to be set during freezing weather due to _____.

47. When pressure fueling the aircraft to maximum fuel loads, ensure that all main fuel tanks _____ after high level shut-off is achieved, fuel flow light out.

48. While inflight or away from home base maintenance facilities, malfunction information and troubleshooting and adjustment procedures can be found in the A1-H53ME-NFM-900, which is also known as the _____.

49. If the rescue hoist jams, do not attempt to _____ or _____ it any further, this could shear the cable.

50. The main fuel tank sump drain valves are provided to _____ or to _____.

51. If, after opening a precheck valve on the pressure refueling panel, fuel continues to flow into that fuel tank, a malfunction exists in the respective _____.

52. When starting the APP with no external power applied to the helicopter, fire detection is in effect at _____ %.

53. Only one range extension fuel tank per range extension tank control panel circuit breaker can be operational at one time due to the electrical load involved.

a. True

b. False

54. During external cargo operations, if collective bounce is encountered and cannot be controlled, _____ the collective and _____ the load.

55. Two access panels, located on the _____ cabin bulkhead behind the _____ and _____ _____, provide access to either the port or starboard electronic compartment in case of fire.

56. What would happen if the fuel boost pump would fail? _____.

57. The infrared-type flame detectors sense _____ _____, which will cause the proper warning lights to go on.

58. During extension of the refueling probe, be sure no personnel or vehicles are _____ _____ _____ of the refueling probes.

59. Make sure that all paratroopers leave the helicopter from the _____ side of the cargo ramp.

60. What are the flight characteristics for the external single-point transport of a milvan?

_____

_____

61. The manually-operated precheck valves, on the ground pressure refueling, are spring-loaded _____.

62. "Land as soon as possible" means:

_____

_____

63. What is the intent of a flight evaluation?

_____

_____

PART XI

PERFORMANCE DATA

Chapter 19	Standard Data
Chapter 20	Takeoff
Chapter 21	Climb
Chapter 22	Range/Cruise
Chapter 23	Endurance
Chapter 24	Tow Performance
Chapter 25	Emergency
Chapter 26	Special

CHAPTER 19
STANDARD DATA

19.1 STANDARD DATA

Note

A specially programmed Hewlett Packard (HP-41 C) calculator is available for helicopter performance computations.

The T64-GE-416 and T64-GE-416A engine designations shall be generally abbreviated to 416 engine(s) unless it is necessary to differentiate between the models. In this instance, they shall be called 416 engines or 416A engines, as appropriate. The T64-GE-419 engine shall be referred to as the 419 engine.

A loss of about 3% of each engine's horsepower will result at maximum horsepower with engine anti-icing turned on.

Indicated torque readout can vary ±3% from actual torque, due to instrument error. This applies to all charts where torque appears.

Several charts are based on standard temperature. Standard temperature is defined as 15°C at sea level decreasing 2°C every 1000 ft of pressure altitude as shown in Figure 19-3. For example:

Standard temperature at 5000 ft = 15°C -2°C/1000 ft. 5000 ft = 5°C.

Standard temperature -30°C at sea level = -15°C. Standard temperature -30°C at 5000 ft = 25°C.

19.2 AIRSPEED CALIBRATION CHART

The airspeed calibration chart (Figure 19-1) converts KIAS to KCAS in a climb or level flight.

For example, enter the bottom of the chart at 80 KIAS, trace up to the climb and level flight curves, then trace left and read 83 KCAS for climb and 89 KCAS for level flight.

19.3 TEMPERATURE CONVERSION SCALE

The temperature conversion scale (Figure 19-2) permits conversion between Fahrenheit and Celsius temperatures.

19.4 DENSITY ALTITUDE CHART

The density altitude chart (Figure 19-3) furnishes density altitude by applying temperature to pressure altitude. In addition, the chart furnishes an airspeed conversion factor that, when multiplied by KCAS, furnishes KTAS.

For example, enter the bottom of the chart at 20°C, trace up to 4000 feet pressure altitude, and then trace left and right. Density altitude read on the left is 5500 feet, and the airspeed conversion factor read on the right is 1.085.

19.5 TORQUE VS SHAFT HORSEPOWER CHART

The torque vs. shaft horsepower chart (Figure 19-4) converts indicated torque to shaft horsepower at 95%, 100%, and 103% N_r.

For example, to find the shaft horsepower at 115% torque and 100% N_r, enter the bottom of the chart at 115% torque, trace up to the 100% N_r curve and then trace left and read 3680 horsepower.

19.6 ENGINE PERFORMANCE CHARTS

The engine performance charts provide torque, at specific T_5 temperatures, when ambient temperature is applied to pressure altitude.

On the 416 engine charts, dual scales provide torque values for both a degraded engine (one which will just pass the maintenance manual performance check) and a specification engine. Engine limitations that should not be exceeded are appropriately identified on the 416 engine charts.

19.6.1 419 Engine Contingency Power (2 Minute Limit) Chart The 419 engine contingency power (2 minute limit) chart (Figure 19-5) provides specification engine torque at sea level for 100% N_f and 103% N_f. The procedure for this chart is similar to the maximum power available chart procedure described in 19.6.2.

19.6.2 Maximum Power Available Charts. The maximum power available charts (Figure 19-6 for the 416 engine and Figure 19-7 for the 419 engine) provide

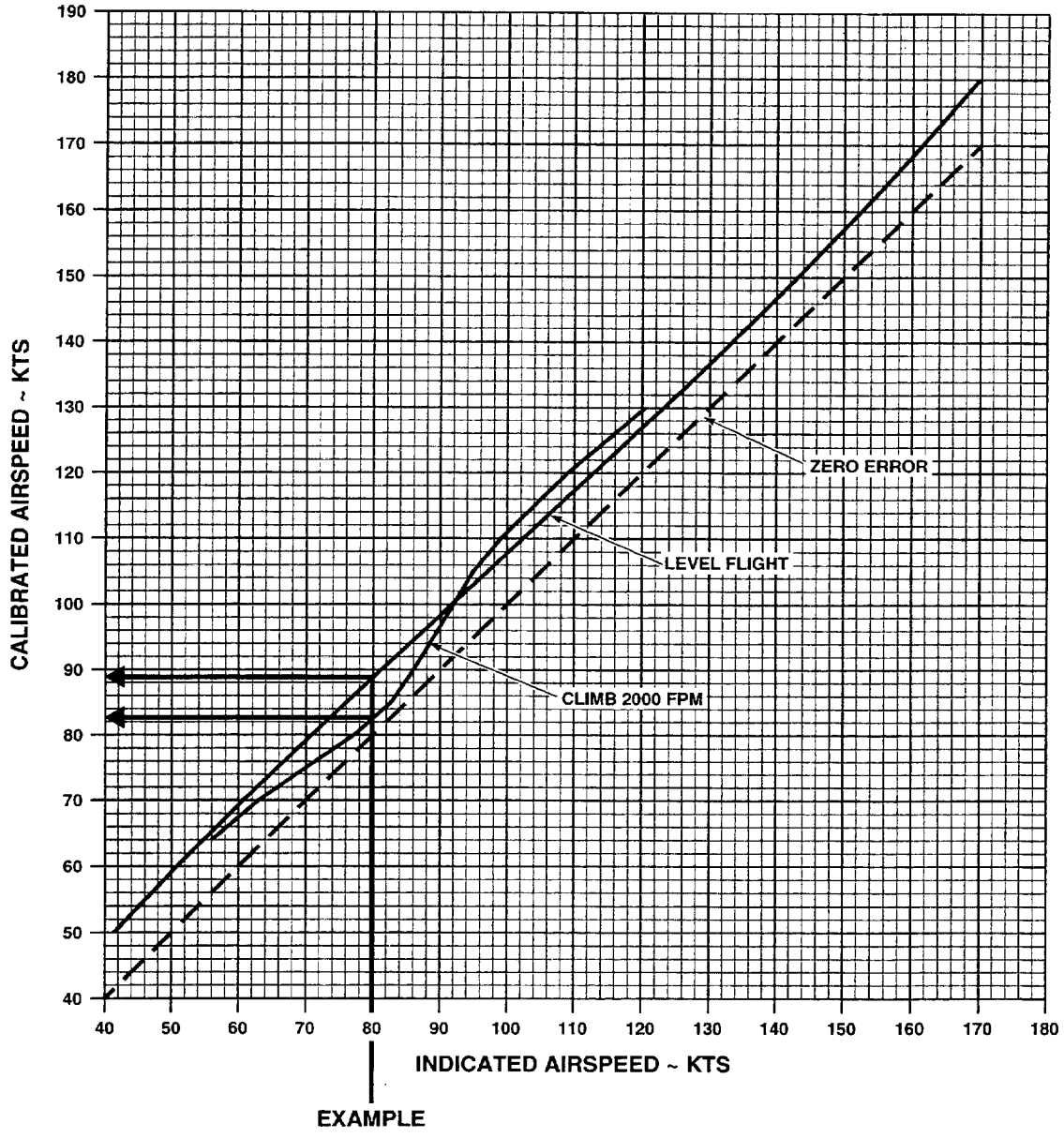
torque at 773°C (416 engine), 792°C (416A engine), or 829° (419 engine) T_5 when wheel height and ambient temperature factors are applied to pressure altitude. Charts are included for both 103% N_r and 100% N_r.

For example, if the helicopter is hovering at 19 feet wheel height at sea level with an ambient temperature of 32°C, enter the wheel height chart from the left. Trace across to intersect the curve, and down to read a 9.5° rise above ambient. Add 9.5 to the ambient temperature, enter at 41.5°C from the bottom. Trace up to sea level (note, power limited by temperature). Trace left to read 95.5% torque for degraded engine performance, and 102.5% torque for specification engine performance.

19.6.3 Military Power Available Charts. The military power available charts (Figure 19-8 for the 416 engine and Figure 19-9 for the 419 engine) uses like factors in the same way as Figure 19-5 to provide torque available at 753°C T_5 for the 416 engine and 809°C for the 419 engine. The 419 engine charts are presented for both 103% N_r and 100% N_r.

AIRSPEED CALIBRATION
PILOT'S AND COPILOT'S SYSTEM

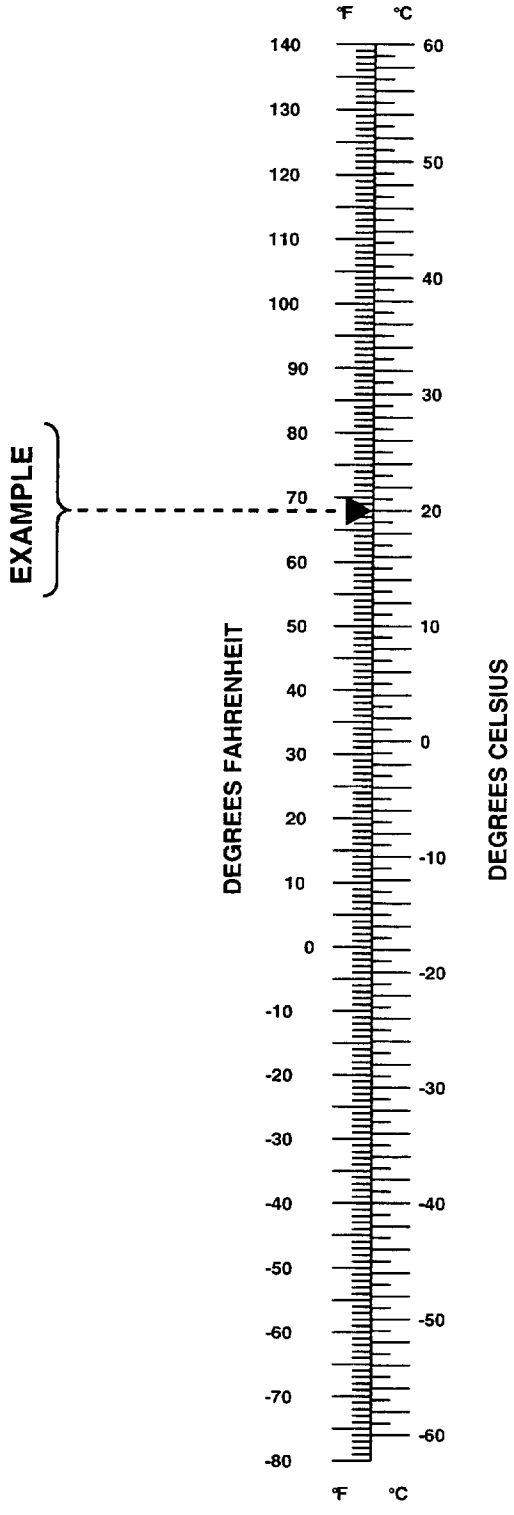
MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED



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Figure 19-1. Airspeed Calibration

TEMPERATURE CONVERSION



NF1428C
SB

Figure 19-2. Temperature Conversion Scale

DENSITY ALTITUDE CHART

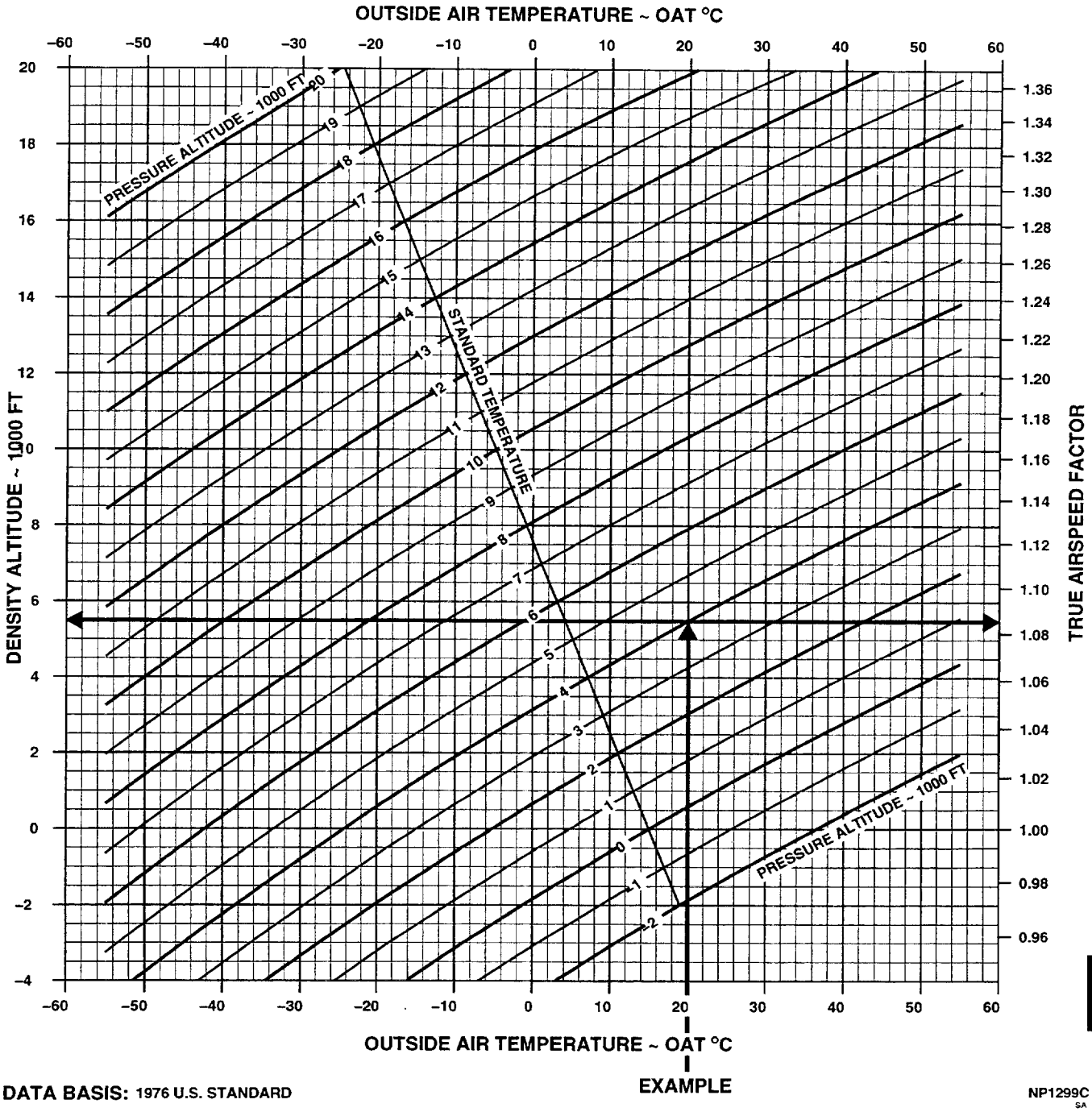
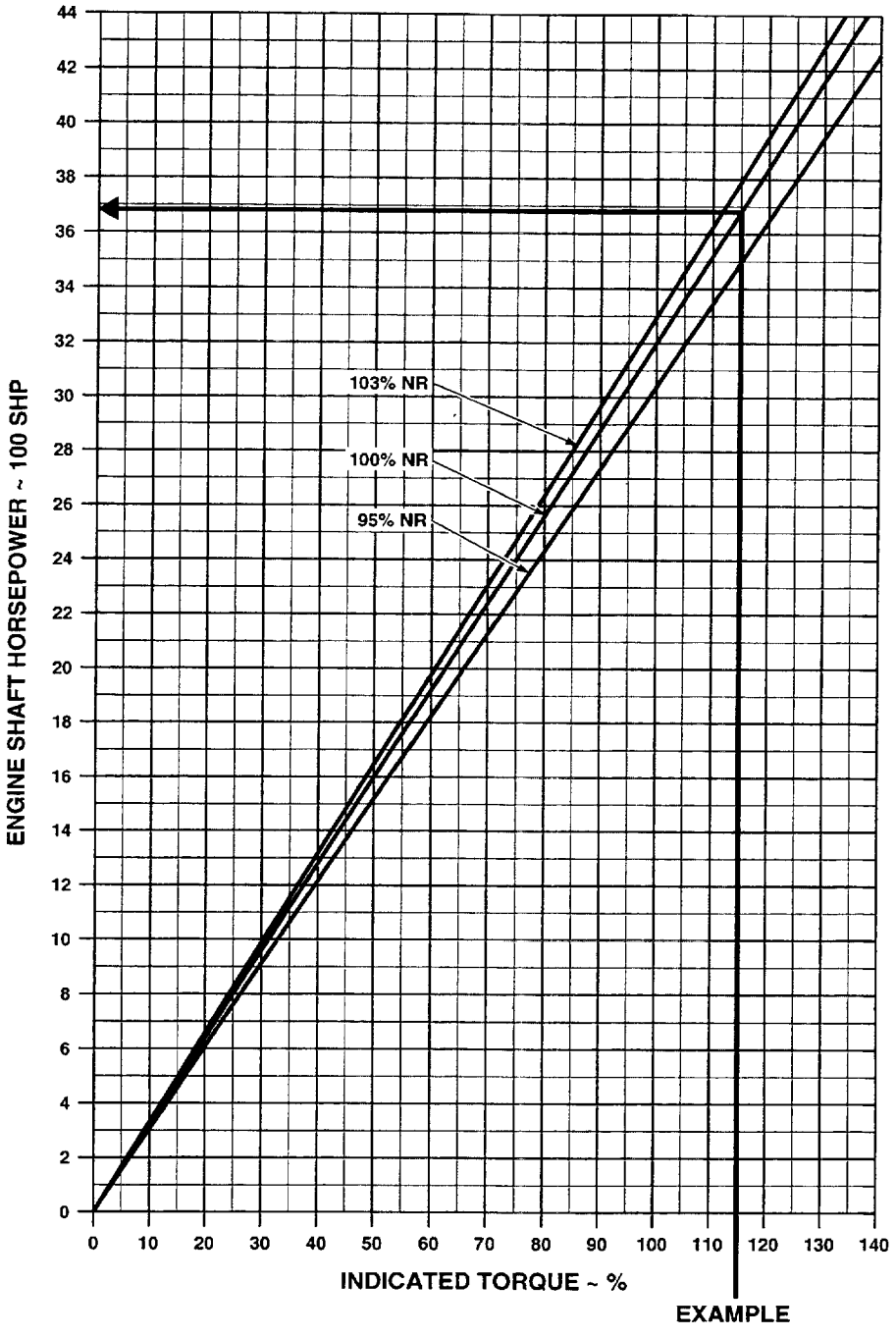


Figure 19-3. Density Altitude

INDICATED TORQUE VS ENGINE SHAFT HORSEPOWER

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ENG MFG SPEC



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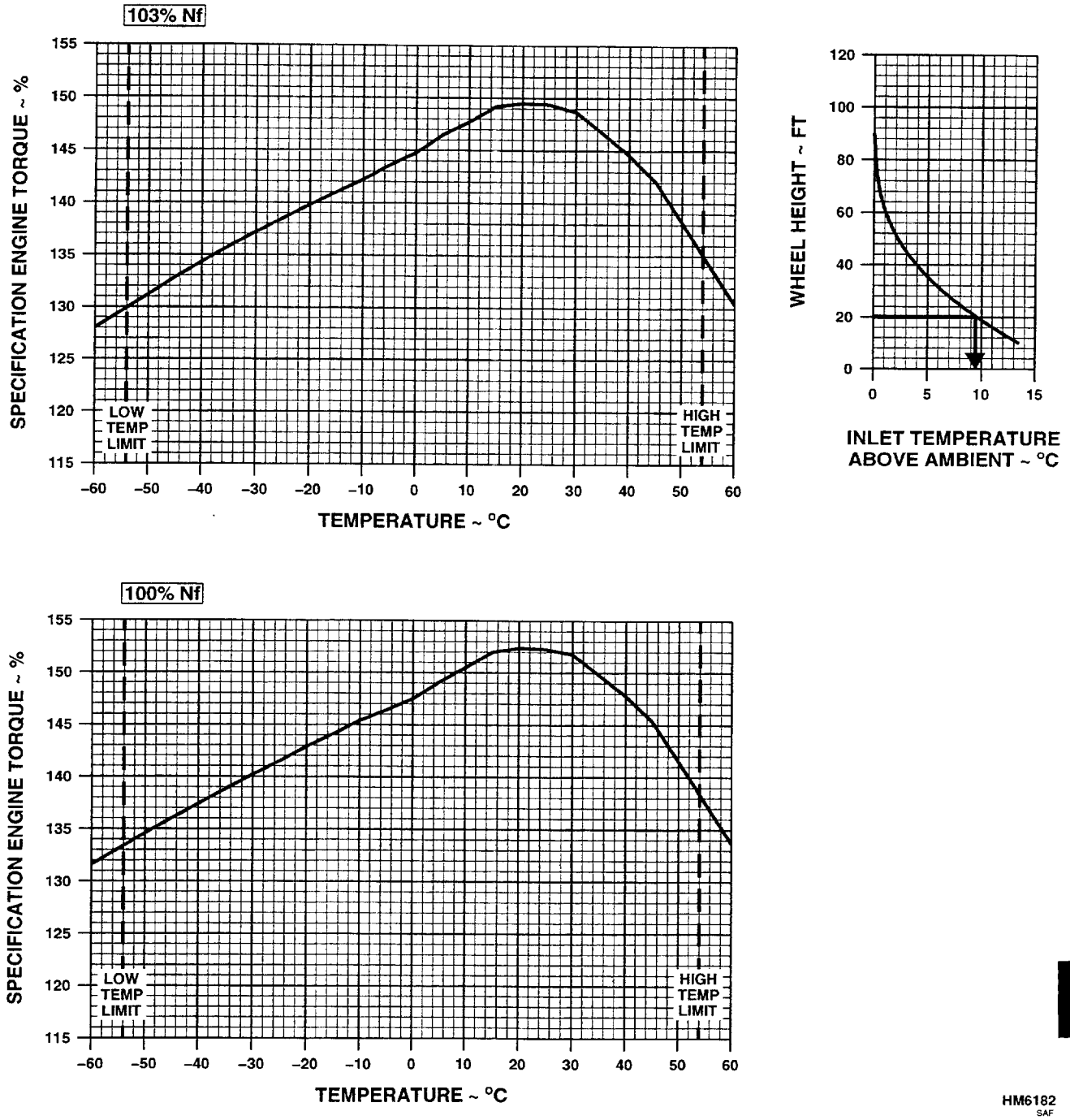
Figure 19-4. Torque vs Shaft Horsepower

ENGINE PERFORMANCE

CONTINGENCY POWER (2 MINUTE LIMIT)
PRESSURE ALTITUDE: SEA LEVEL
ZERO AIRSPEED

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ENG MFG SPEC
CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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SAF

Figure 19-5. 419 Engine Contingency Power (2 Minute Limit)

ENGINE PERFORMANCE
773 °C (T64-416) OR 792 °C (T64-416A) T_5 MAX PWR
103% Nf ~ 14,708 RPM
ZERO AIRSPEED

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: ENG MFG SPEC

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED
NOTE: WITH EAPS NOT INSTALLED INCREASE TORQUE BY 1%

LIMITATIONS:
- TEMPERATURE
- SPEED
- FUEL FLOW
- AMBIENT TEMPERATURE

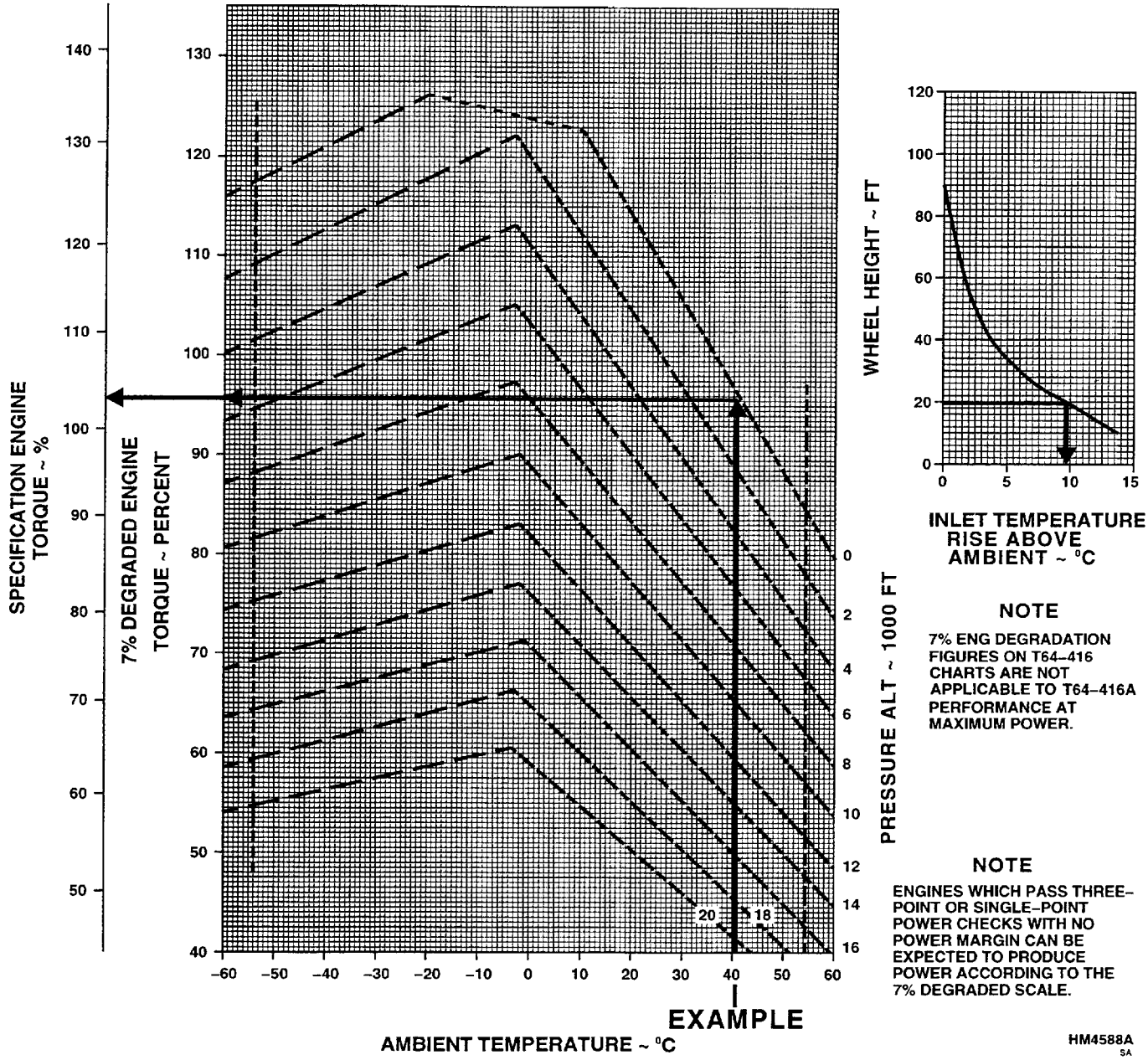


Figure 19-6. Maximum Power Available (416 Engine) (Sheet 1 of 2)

ENGINE PERFORMANCE

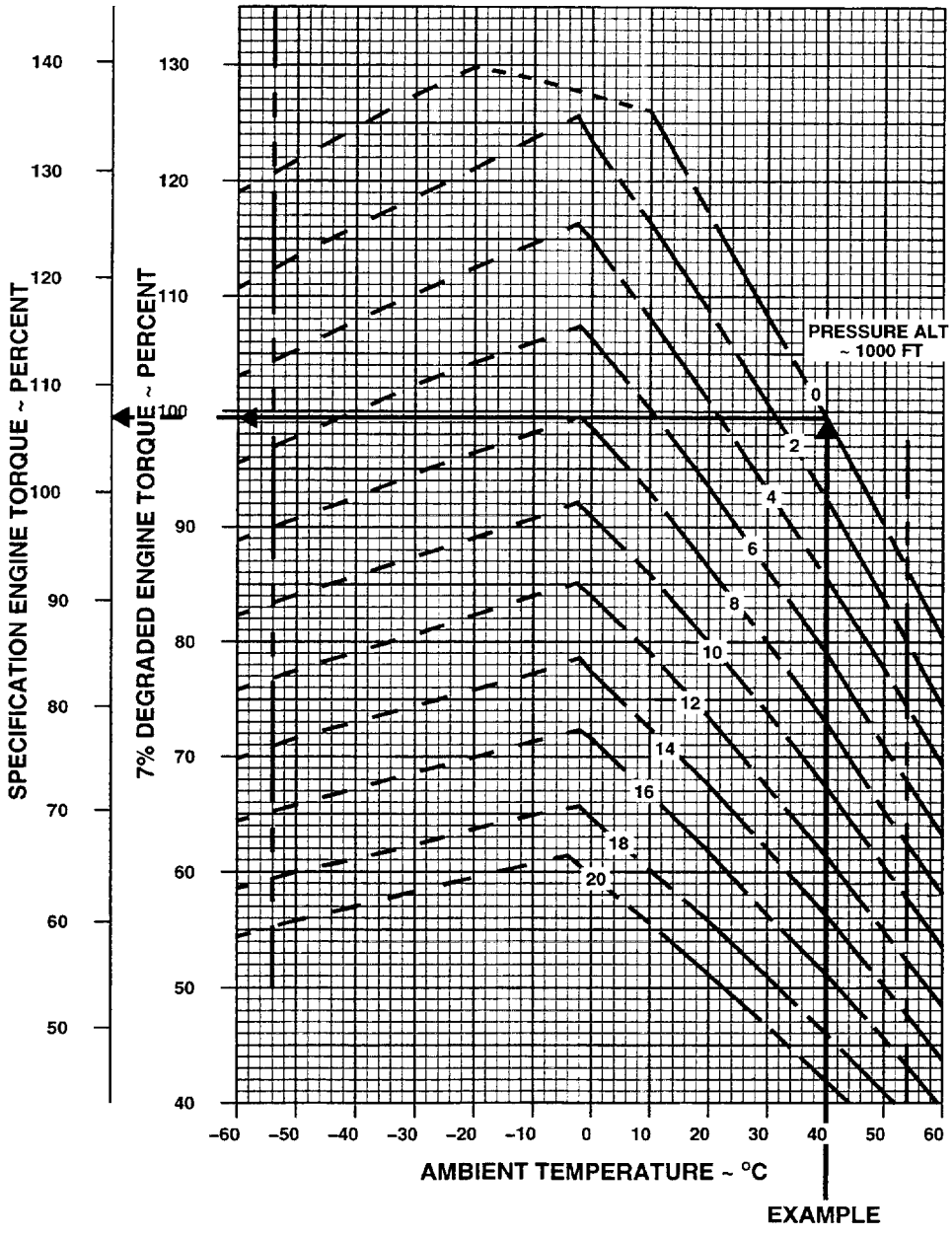
773 °C (T64–416) OR 792 °C (T64–416A) T5 MAX PWR
100% Nf ~ 14,280 RPM
ZERO AIRSPEED

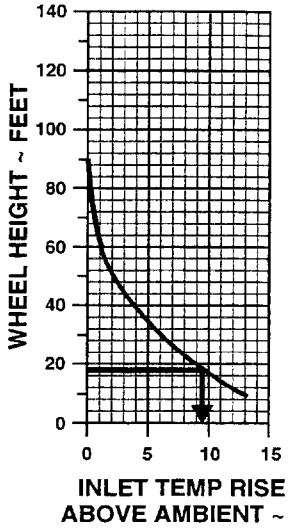
MODEL: CH–53E
DATA AS OF: 31 MARCH 1981
DATA BASIS: ENG. MFG. SPEC.

ENGINE: T64–GE–416
FUEL GRADE: JP–4/JP–5/JP–8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED
NOTE: WITH EAPS NOT INSTALLED INCREASE TORQUE BY 1%

LIMITATIONS:
- SPEED
- TEMPERATURE
- FUEL FLOW
- AMBIENT TEMPERATURE





NOTE

7% ENG DEGRADATION FIGURES ON T64–416 CHARTS ARE NOT APPLICABLE TO T64–416A PERFORMANCE AT MAX PWR.

NOTE

ENGINES WHICH PASS THREE–POINT OR SINGLE–POINT POWER CHECKS WITH NO POWER MARGIN CAN BE EXPECTED TO PRODUCE POWER ACCORDING TO THE 7% DEGRADED SCALE.

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Figure 19-6. Maximum Power Available (416 Engine) (Sheet 2 of 2)

ENGINE PERFORMANCE

MAXIMUM POWER (10 MINUTE LIMIT) 829°C T5
103% Nf
ZERO AIRSPEED

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ENG MFG SPEC
CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

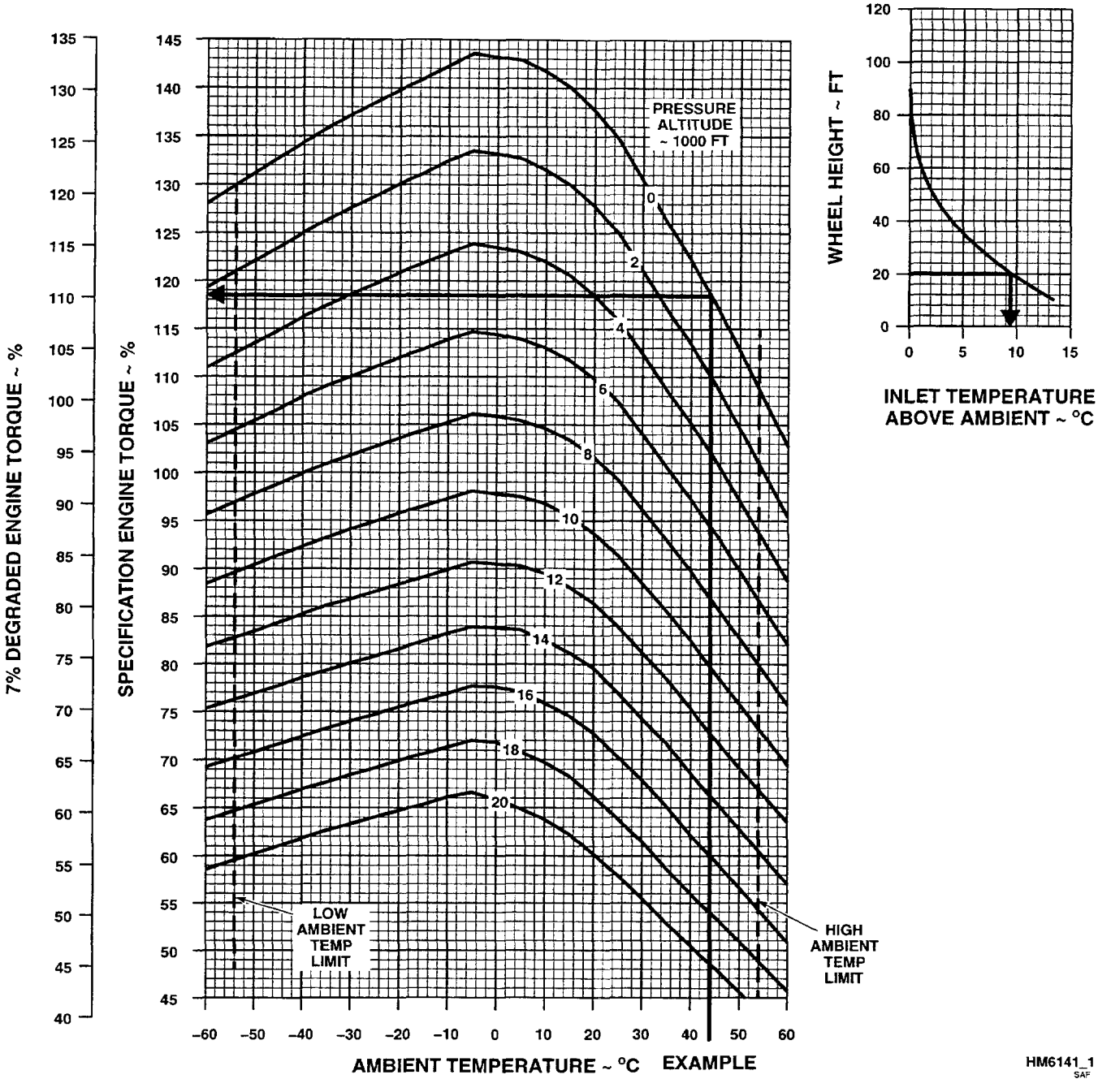


Figure 19-7. Maximum Power Available (419 Engine) (Sheet 1 of 2)

ENGINE PERFORMANCE

MAXIMUM POWER (10 MINUTE LIMIT) 829°C T5
100% Nf
ZERO AIRSPEED

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ENG MFG SPEC
CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

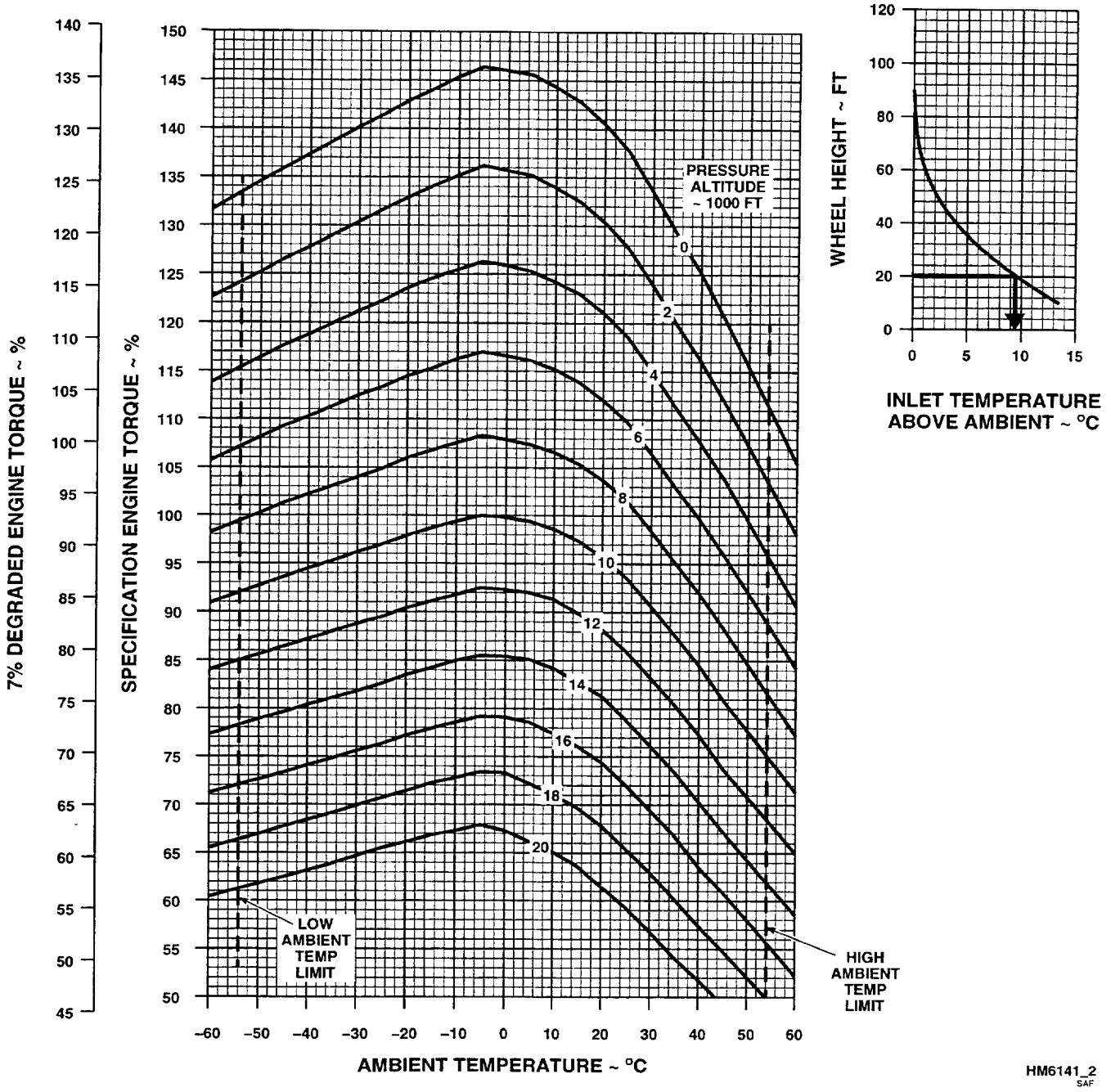


Figure 19-7. Maximum Power Available (419 Engine) (Sheet 2 of 2)

ENGINE PERFORMANCE

753°C T5 MILITARY POWER
103% Nf ~ 14,708 RPM

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: ENG MFG SPEC

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED
NOTE: WITH EAPS NOT INSTALLED INCREASE TORQUE BY 1%

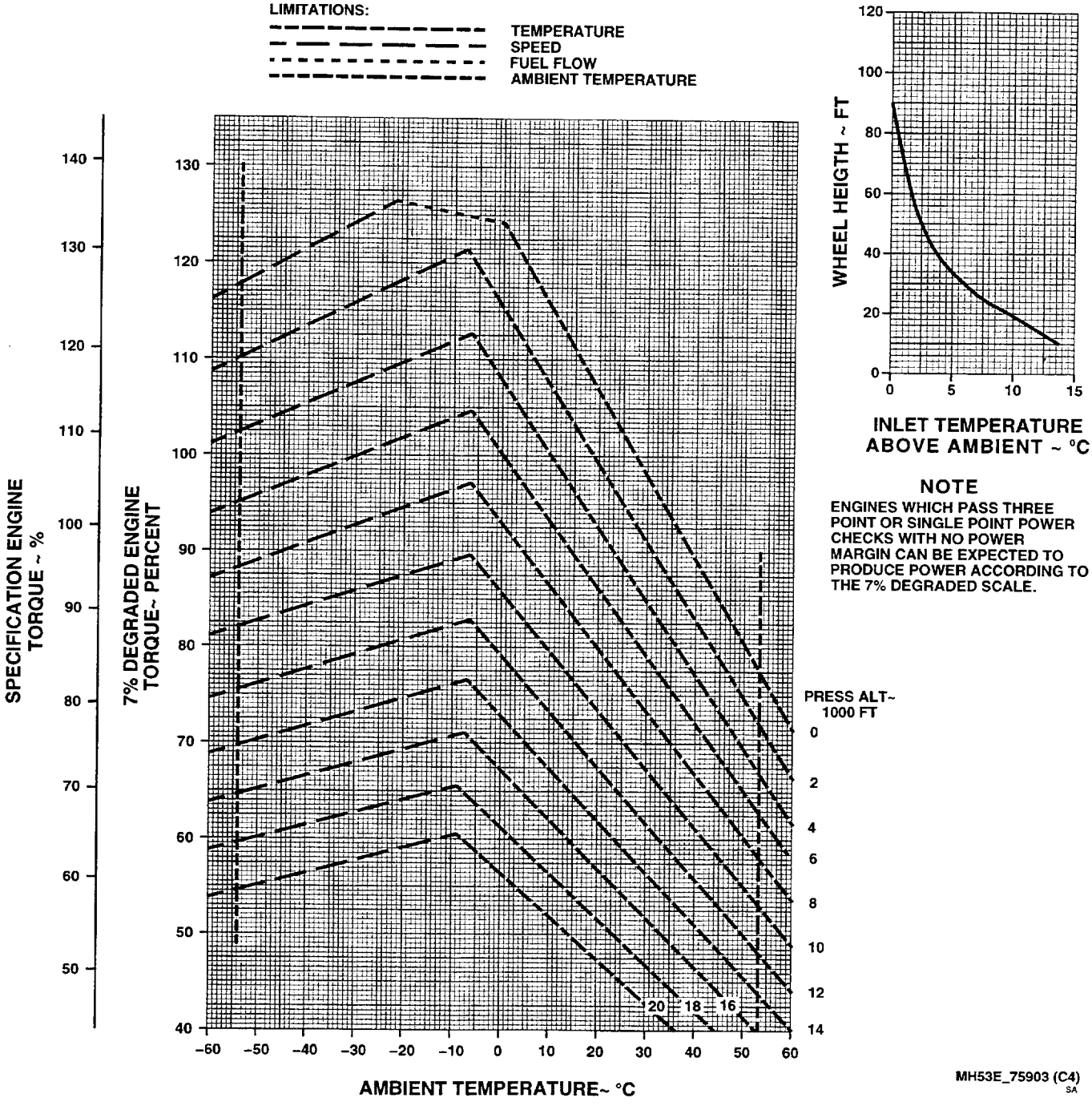


Figure 19-8. Military Power Available (416 Engine)

ENGINE PERFORMANCE

MILITARY POWER (30 MINUTE LIMIT) 809°C T5
103% Nf
ZERO AIRSPEED

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ENG MFG SPEC
CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

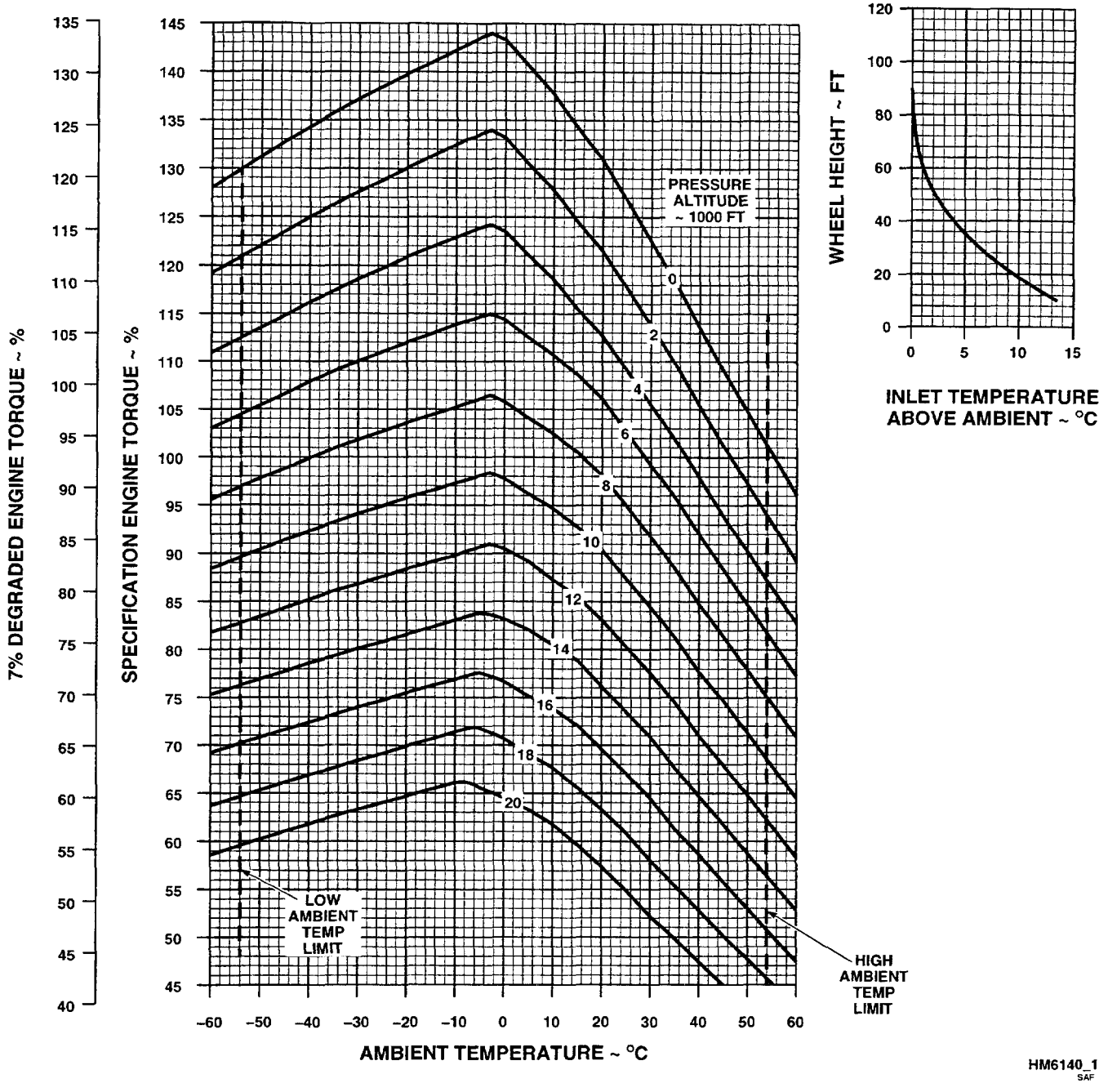


Figure 19-9. Military Power Available (419 Engine) (Sheet 1 of 2)

ENGINE PERFORMANCE

MILITARY POWER (30 MINUTE LIMIT) 809°C T5
100% Nf
ZERO AIRSPEED

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ENG MFG SPEC
CONFIGURATION: EAPS INSTALLATION AND EXHAUST NOZZLE LOSS INCLUDED
EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

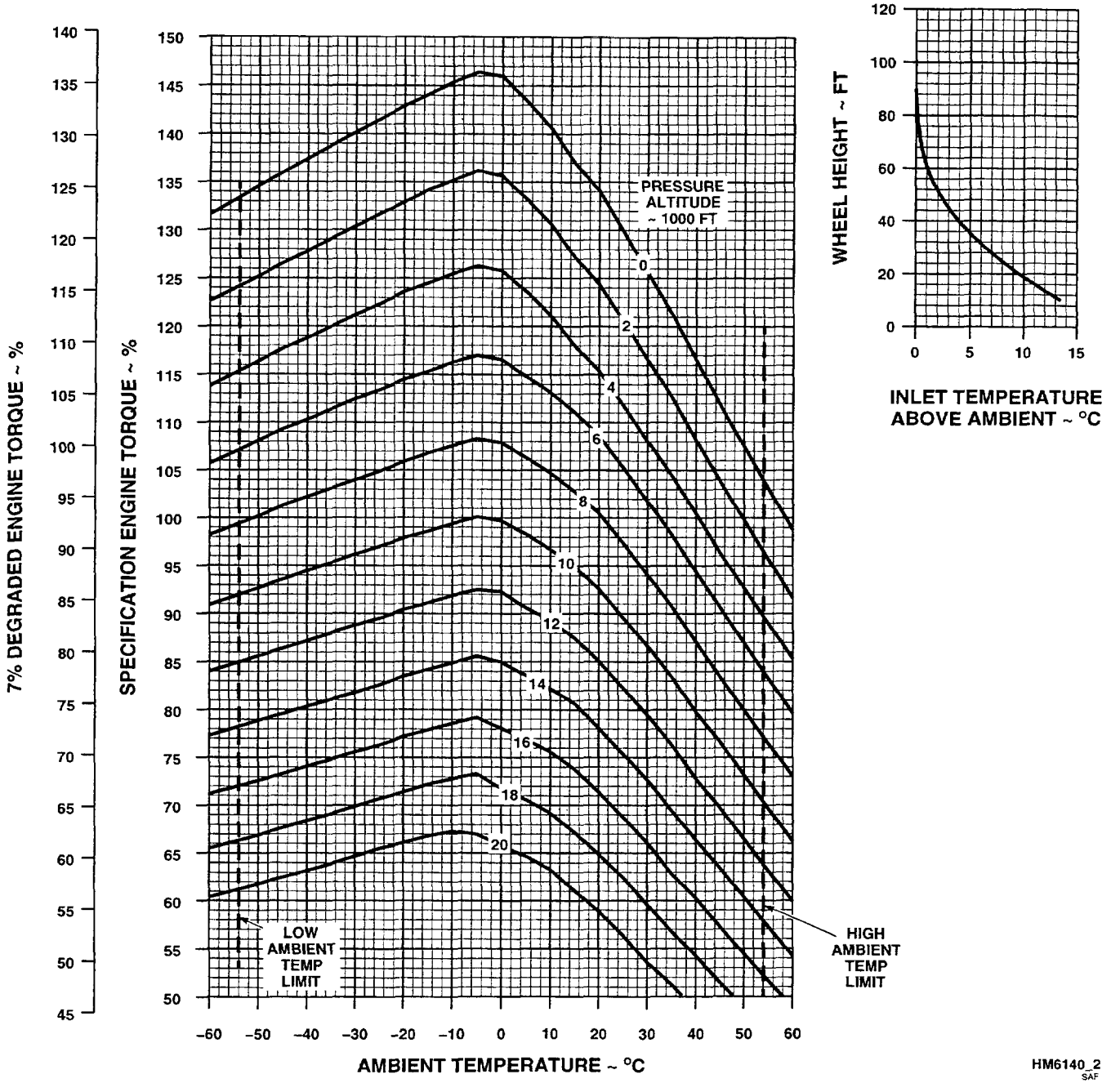


Figure 19-9. Military Power Available (419 Engine) (Sheet 2 of 2)

CHAPTER 20
Takeoff

20.1 HOVER CHARTS

The indicated torque required to hover charts provide data for various wheel heights in and out of ground effect, when density altitude is applied to gross weight and headwind factors. The ability to hover out of ground effect at various rotor speeds (N_r) chart provides the gross weight that can be hovered out of ground effect when pressure altitude is applied to outside air temperature and rotor speed factors.

20.1.1 Factors. The charts provide data with EAPS installed. For ability to hover chart (Figure 20-7 for the 416 engine and Figure 20-8 for the 419 engine) increase gross weight by 400 lbs if EAPS are not installed.

20.1.2 Takeoff Distance to Clear 50 Feet Chart. The takeoff distance to clear 50 feet chart (Figure 20-1 for the 416 engine and Figure 20-2 for the 419 engine) reads takeoff distance using pressure altitude, ambient temperature and headwind as variables. The 416 engine chart is based on degraded engine performance and the 419 engine chart is based on specification engine performance.

For example, if the helicopter was at a gross weight of 50,000 pounds, pressure altitude of 6000 feet, ambient temperature of 0°C, and had a 6-knot headwind, enter the chart at 50,000 pounds gross weight, trace up to 6000 feet pressure altitude. Trace right to the 0°C ambient temperature line. Then trace down to the baseline and follow the influence line from there to 6 knots. Trace straight down to read 510-foot takeoff distance.

20.1.3 Torque Required to Hover at 10 Feet Chart. The torque required to hover at 10 feet chart (Figure 20-3) provides data for when density altitude is applied to gross weight and headwind factors.

For example, to find the torque required for a 10-foot hover at 65,000 pounds gross weight at a density altitude of 4000 feet and with a 16-knot headwind, enter the left side of the chart at 4000 feet and trace right to the 65,000-pound gross weight curve. Then trace down to the headwind baseline and follow the influence line to the 16-knot headwind intersection. Trace down and note that 87% torque is required to hover under these conditions.

20.1.4 Torque Required to Hover at 40 Feet Chart. The torque required to hover at 40 feet chart (Figure 20-4) is used the same way as Figure 20-3.

20.1.4.1 One Engine Inoperative Hover Capability. To best determine OEI hover in ground effect capability, proceed as follows:

1. Obtain operating area pressure altitude and OAT from best available sources.

2. Determine operating area density altitude from Figure 19-3 (Density Altitude Chart), using data determined in Step 1.

3. Determine aircraft maximum power available as read from the specification engine torque scale in the appropriate Maximum Power Available chart of from the 419 Engine Contingency Power (2 Minute Limit) chart (both in Chapter 19) using data determined in Step 1.

4. Compute dual engine torque power available (with only two engines operating) by multiplying computed specification engine torque (as determined in Step 3) by 0.67.

5. Determine the maximum aircraft gross weight allowable for two-engine hover using Figure 20-3 (Torque Required to Hover at 40 Feet Chart).

   a. Enter Figure 20-3 with the torque derived in Step 4 (assume 0 knots wind).

   b. Trace vertically to the density altitude determined in Step 2.

   c. Read gross weight (this represents the maximum aircraft gross weight, given local ambient conditions, where a 40-foot hover can be maintained in the event of a single engine failure under tow.)

20.1.5 Torque Required to Hover at 70 Feet Chart. The torque required to hover at 70 feet chart (Figure 20-5) is used the same way as Figure 20-3.

20.1.6 Torque Required to Hover OGE Chart. The torque required to hover OGE chart (Figure 20-6) uses like factors in the same way as Figure 20-3.

The minimum height established for out of ground effect is 80 feet between the wheels and the takeoff surfaces.

20.1.7 Ability to Hover OGE at Various N_r's Chart. The ability to hover OGE at various N_r's chart (Figure 20-7 for the 416 engine and Figure 20-8 for the 419 engine) provides the gross weight that the helicopter can hover out of ground effect when pressure altitude is applied to outside air temperature and rotor speed factors.

On the 416 engine chart, dual gross weight scales depict hover performance with both degraded engine performance (that which will just pass the maintenance manual engine performance check) and for specification engine performance. The 419 engine chart represents specification engine performance, only.

For example, to find the gross weight a helicopter can hover out of ground effect at 35°C, with a pressure altitude of 4000 feet, and 95% N_r, enter the left side of the chart at 4000 feet, trace right to 35°C, and then trace down to the rotor speed baseline. Then follow the influence line down to 95% N_r. Now trace down and read 53,000 pounds gross weight with degraded engines, and 55,500 pounds gross weight with specification engines.

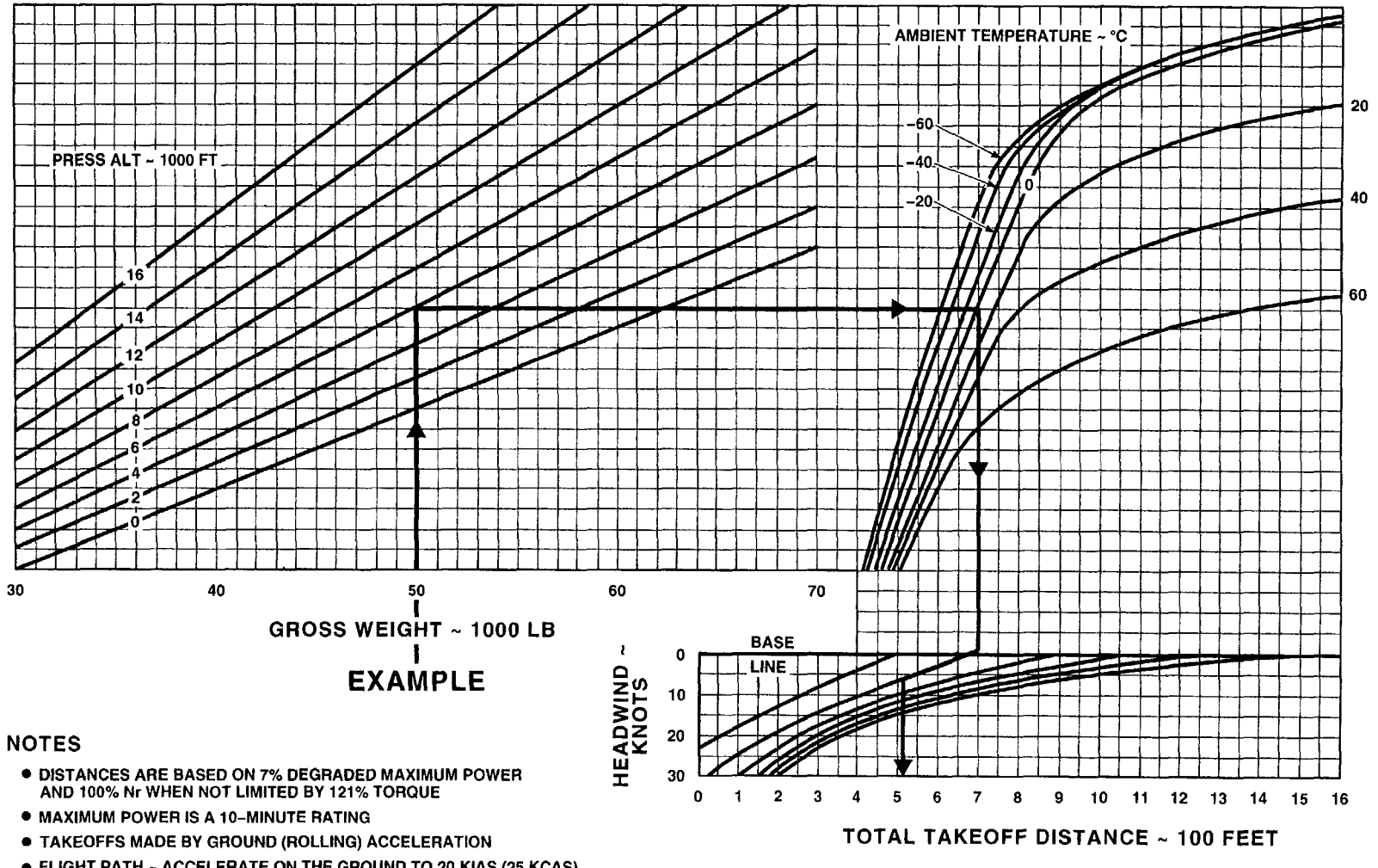
20.1.8 Blade Stall Chart. The blade stall chart (Figure 20-9) gives structural blade stall limits in level flight and level turn as indicated airspeed. This is done using the variables of pressure altitude, temperature, N_r%, gross weight, and angle of bank. For example, enter the chart from the top left at 8000-feet pressure altitude, go right, across to 60°C. Trace down to the first baseline and up the influence line to 105% N_r. Trace down to the second baseline and follow the influence line up to 50,000 pounds gross weight. Now trace down to the last baseline, and follow influence lines to angle of bank of 17°. Trace down to 147 knots CAS and 140 knots IAS.

THREE-ENGINE ROLLING TAKEOFF
TOTAL DISTANCE TO CLEAR 50 FEET

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: ESTIMATED

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED



NOTES

- DISTANCES ARE BASED ON 7% DEGRADED MAXIMUM POWER AND 100% Nr WHEN NOT LIMITED BY 121% TORQUE
- MAXIMUM POWER IS A 10-MINUTE RATING
- TAKEOFFS MADE BY GROUND (ROLLING) ACCELERATION
- FLIGHT PATH ~ ACCELERATE ON THE GROUND TO 20 KIAS (25 KCAS) THEN ACCELERATE AND CLIMB TO CLEAR 50 FT BARRIER AT (30 KIAS) 40 KCAS

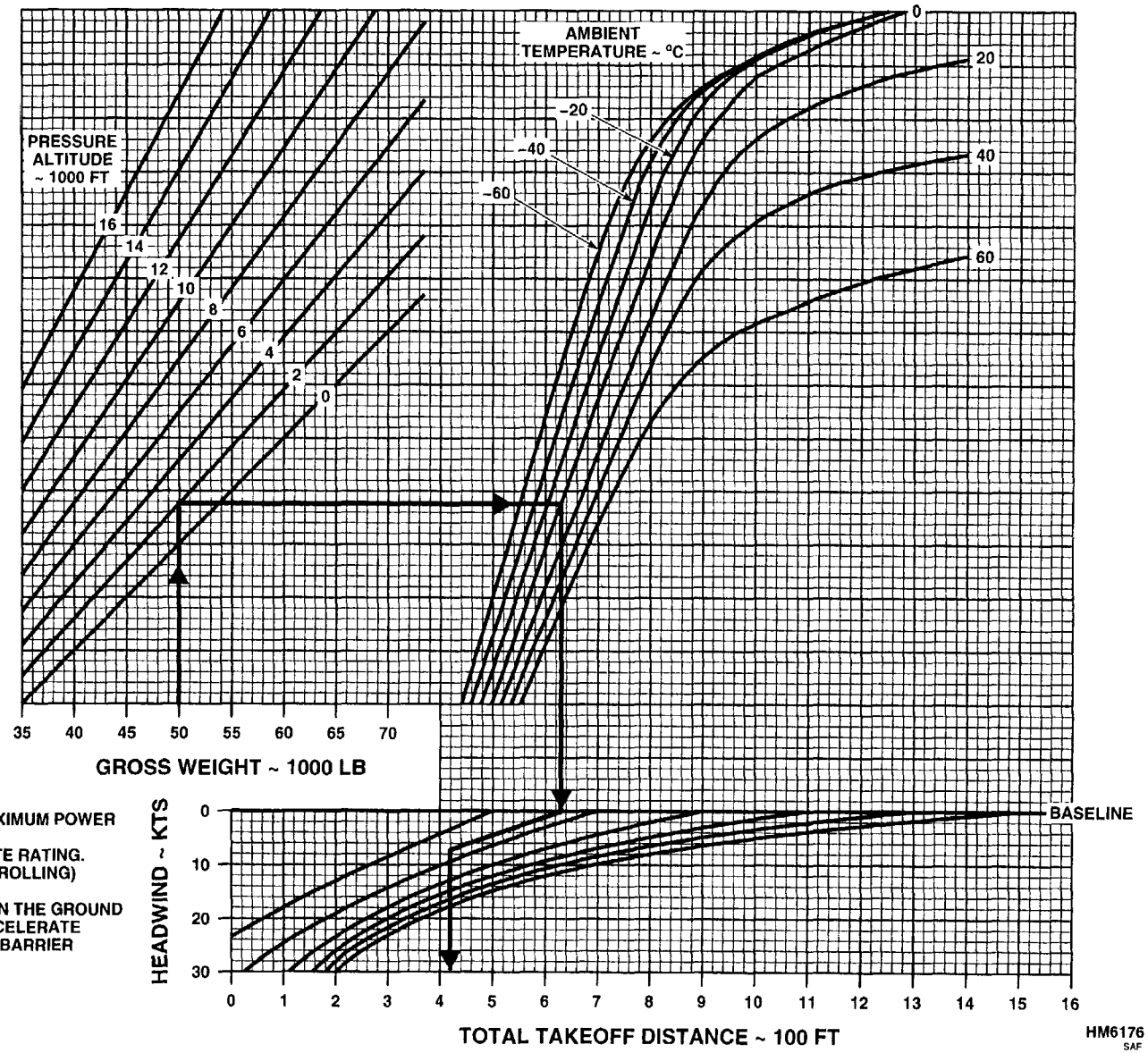
HM1423
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Figure 20-1. Takeoff Distance to Clear 50 Feet (416 Engine)

THREE ENGINE ROLLING TAKEOFF
TOTAL DISTANCE TO CLEAR 50 FEET

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ESTIMATED
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



NOTES

- DISTANCES ARE BASED ON MAXIMUM POWER AND 103% Nr.
- MAXIMUM POWER IS A 10 MINUTE RATING.
- TAKEOFFS MADE BY GROUND (ROLLING) ACCELERATION.
- FLIGHT PATH - ACCELERATE ON THE GROUND TO 20 KIAS (25 KCAS) THEN ACCELERATE AND CLIMB TO CLEAR 50 FOOT BARRIER AT 30 KIAS (40 KCAS).

Figure 20-2. Takeoff Distance to Clear 50 Feet (419 Engine)

INDICATED TORQUE REQUIRED TO HOVER IN GROUND EFFECT 10–FOOT WHEEL HEIGHT STANDARD TEMPERATURE 103% Nr

MODEL: MH–53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64–GE–416/–419
FUEL GRADE: JP–4/JP–5/JP–8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

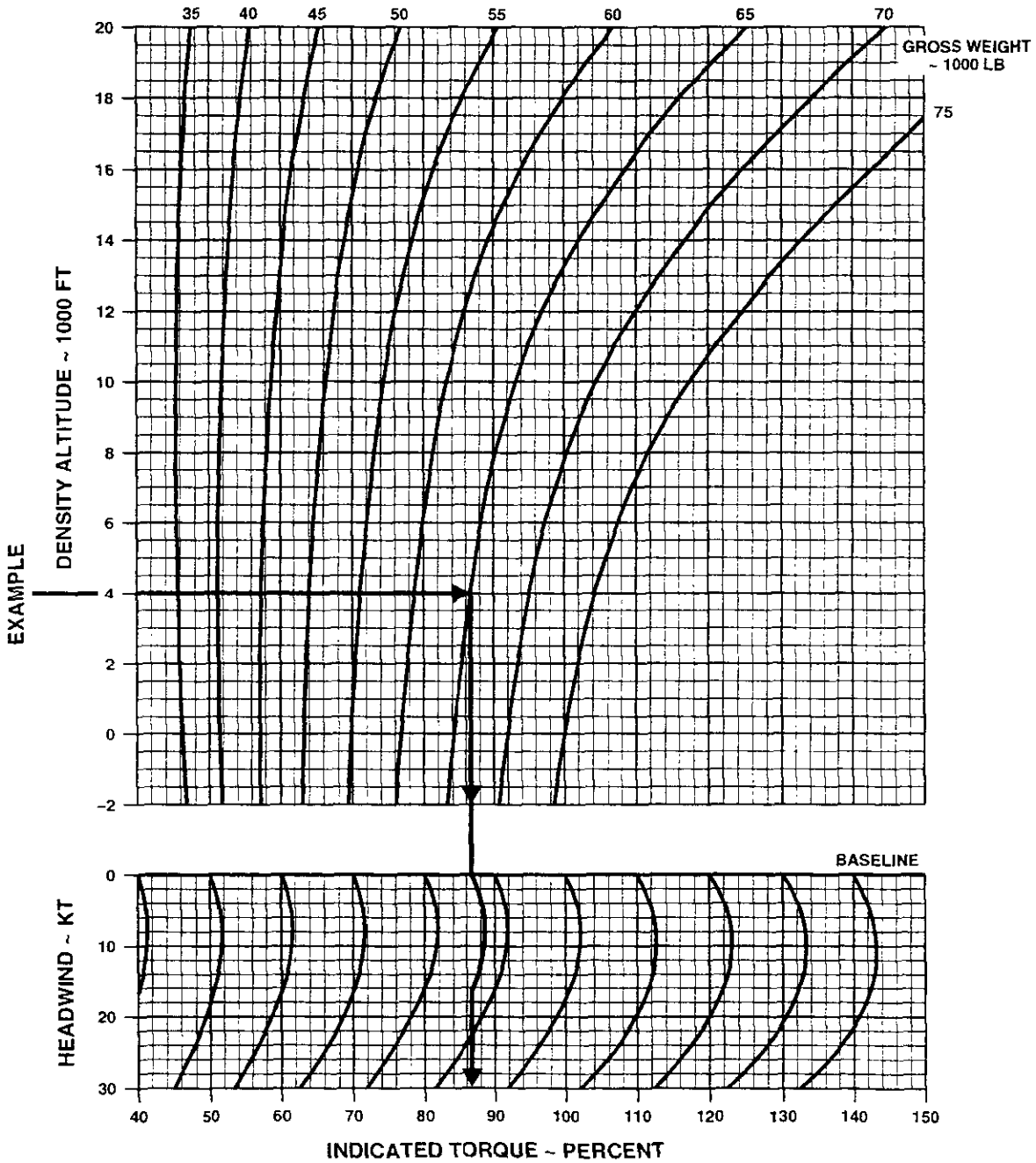


Figure 20-3. Torque Required to Hover at 10 Feet

INDICATED TORQUE REQUIRED TO HOVER IN GROUND EFFECT 40–FOOT WHEEL HEIGHT STANDARD TEMPERATURE 103% Nr

MODEL: MH–53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64–GE–416/–419
FUEL GRADE: JP–4/JP–5/JP–8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

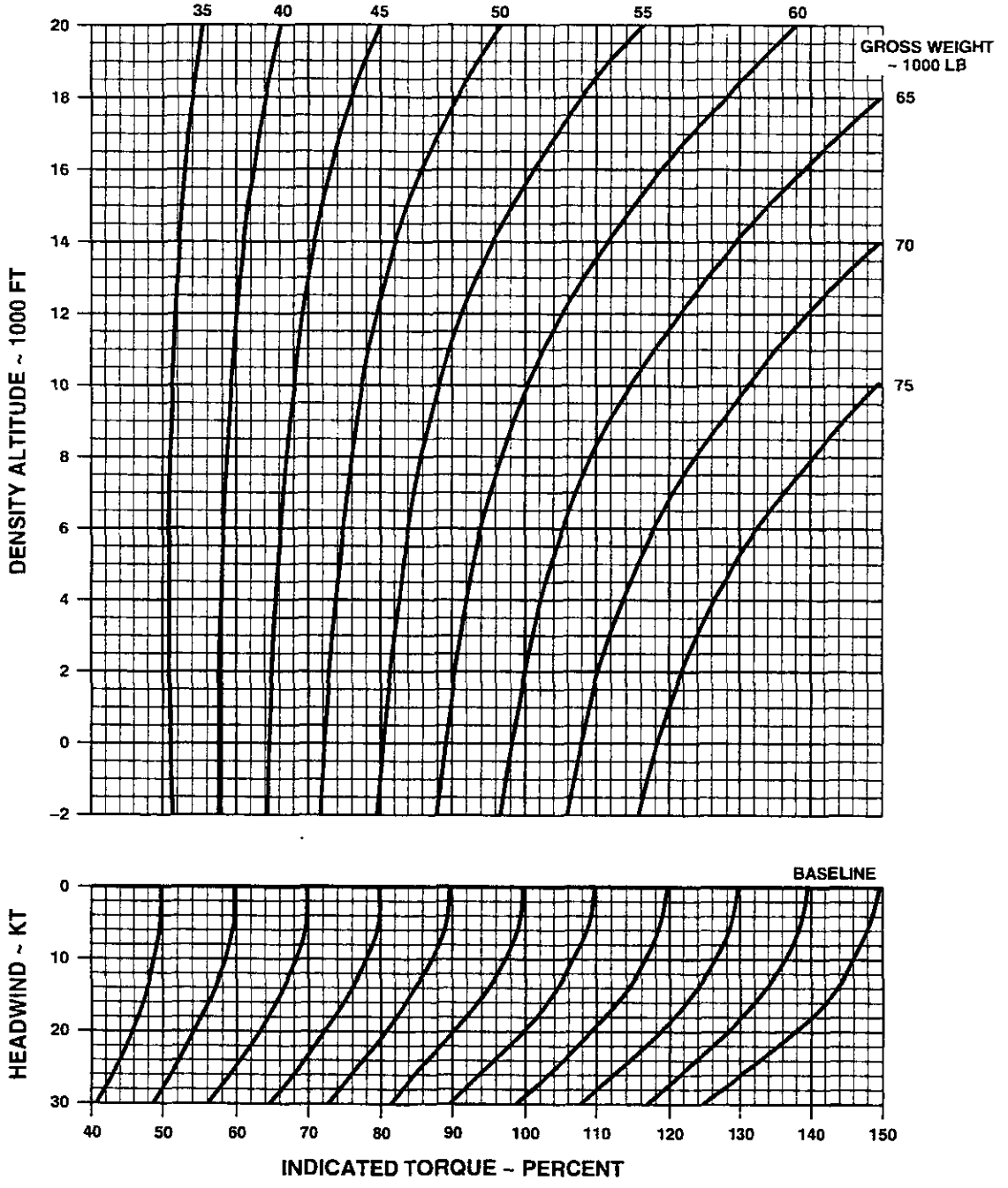


Figure 20-4. Torque Required to Hover at 40 Feet

INDICATED TORQUE REQUIRED TO HOVER IN GROUND EFFECT 70–FOOT WHEEL HEIGHT STANDARD TEMPERATURE 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-416/-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

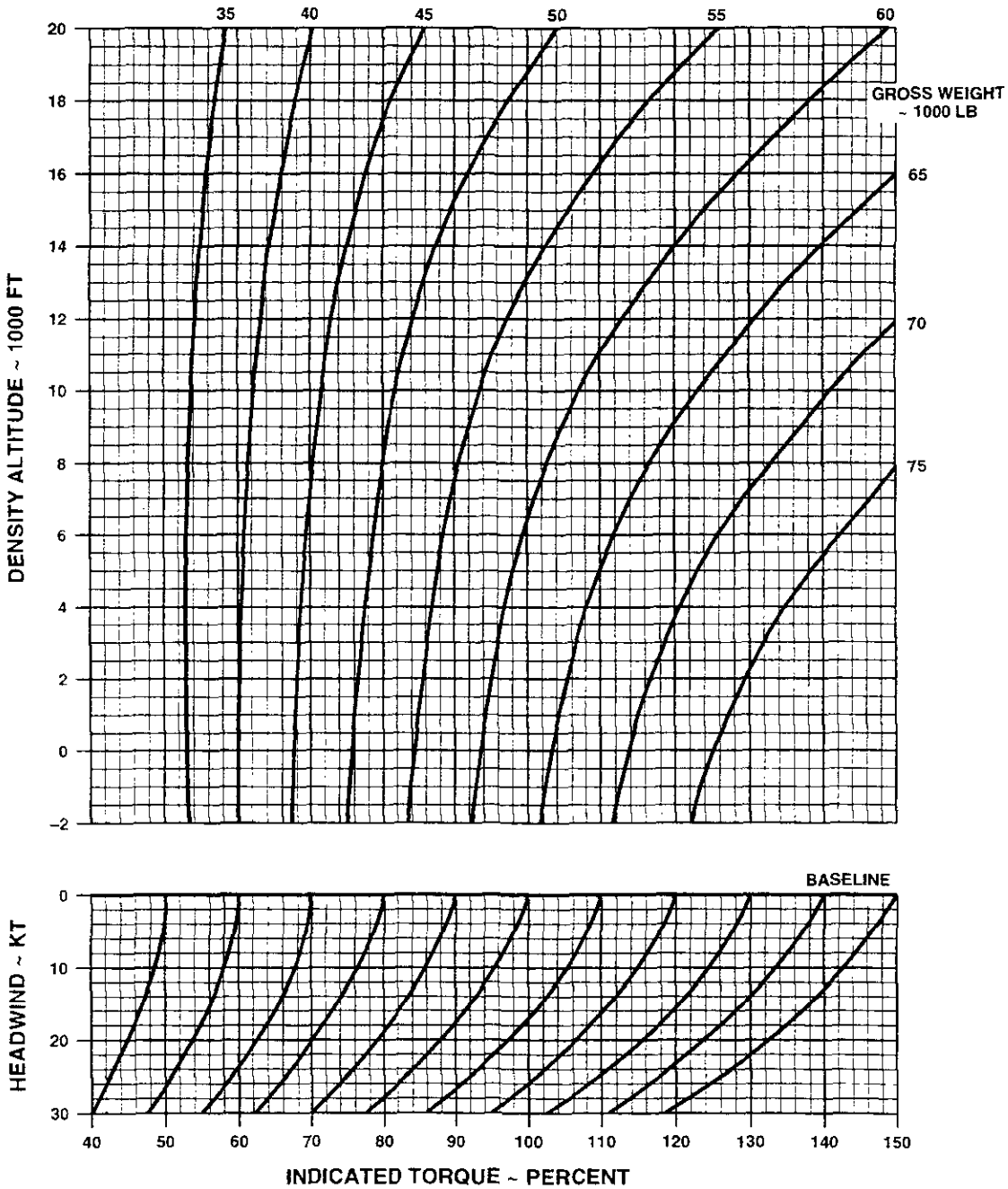


Figure 20-5. Torque Required to Hover at 70 Feet

INDICATED TORQUE REQUIRED TO HOVER OUT OF GROUND EFFECT STANDARD TEMPERATURE 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-416/-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

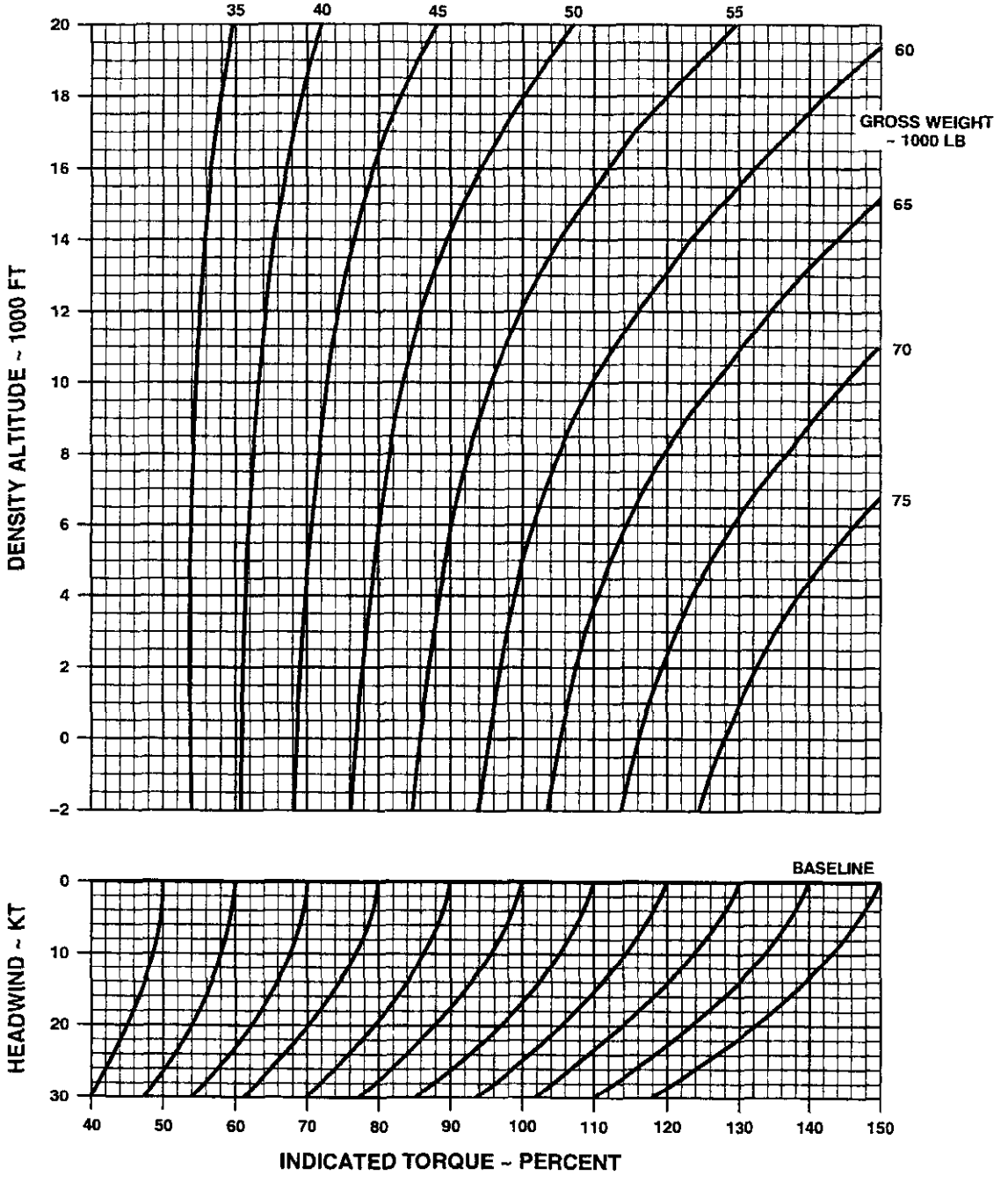


Figure 20-6. Torque Required to Hover OGE

THREE-ENGINE ABILITY TO HOVER OUT OF GROUND EFFECT AT VARIOUS ROTOR SPEEDS MAXIMUM POWER

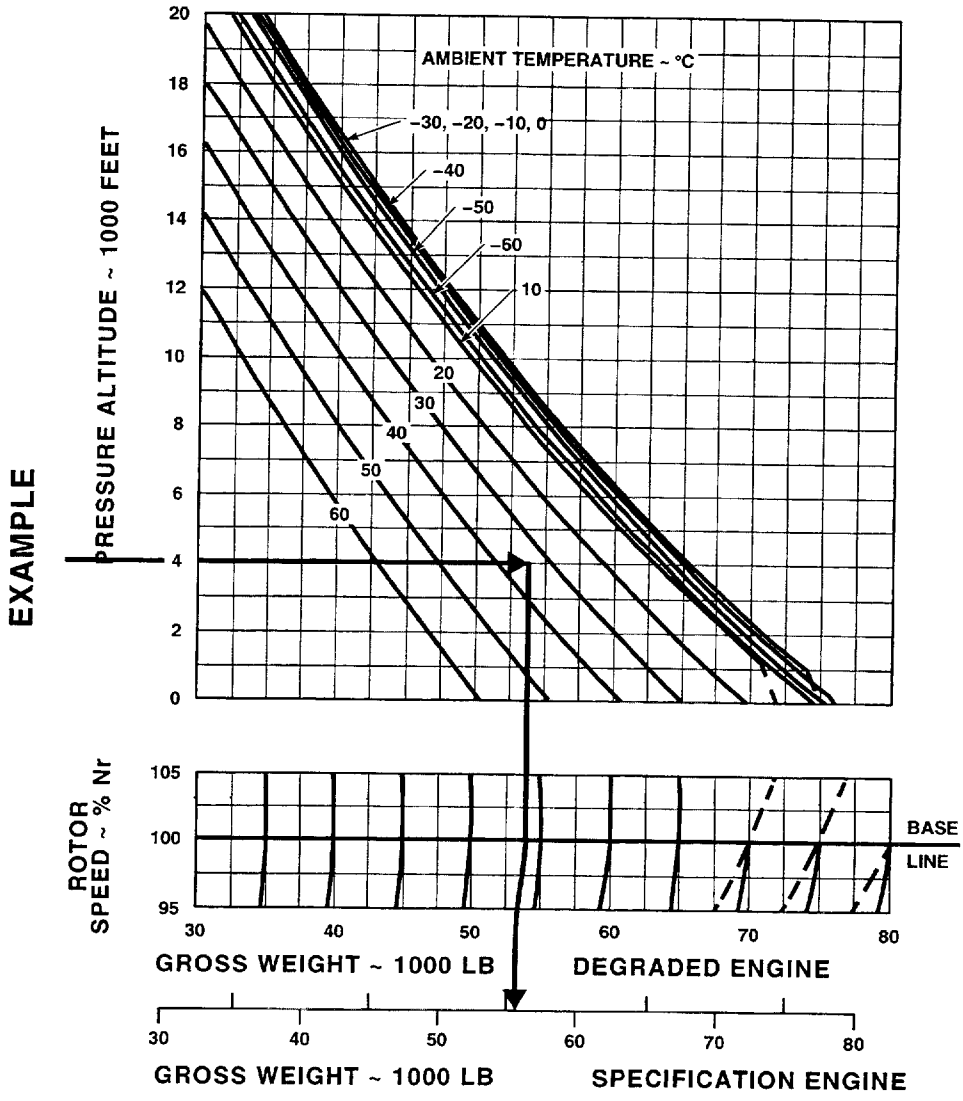
MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOOR CLOSED

NOTES:

- INCREASE GROSS WEIGHT BY 400 LBS IF EAPS NOT INSTALLED
- – — – 30 MINUTE TRANSMISSION TORQUE RATING IN UPPER CHART
- WHEN LIMITED BY TRANSMISSION RATING USE DASHED INFLUENCE LINES ON ROTOR RPM SCALE
- WHEN LIMITED BY TRANSMISSION RATING DO NOT USE SPECIFICATION ENGINE GROSS WEIGHT SCALE



HM1428
SA

Figure 20-7. Ability to Hover OGE at Various N_r's (416 Engine)

THREE ENGINE ABILITY TO HOVER OUT OF GROUND EFFECT AT VARIOUS ROTOR SPEEDS MAXIMUM POWER (829 °C T5) 10 MINUTE LIMITATION

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTES —— 30 MINUTE (121%) TRANSMISSION TORQUE RATING IN UPPER CHART
WHEN LIMITED BY TRANSMISSION RATING USE DASHED INFLUENCE LINES ON ROTOR RPM SCALE

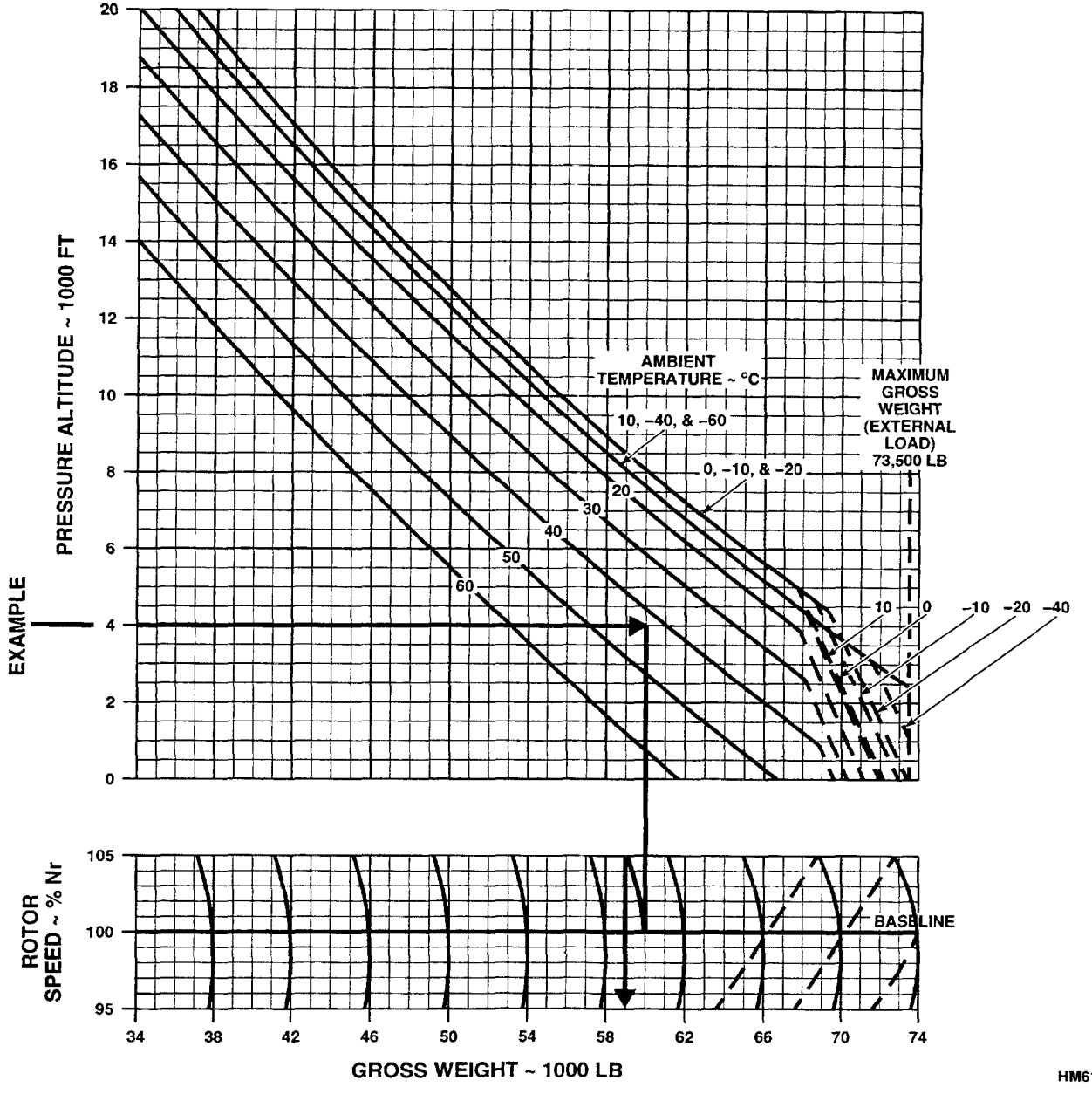


Figure 20-8. Ability to Hover OGE at Various N_r's (419 Engine)

INCIPIENT BLADE STALL

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST

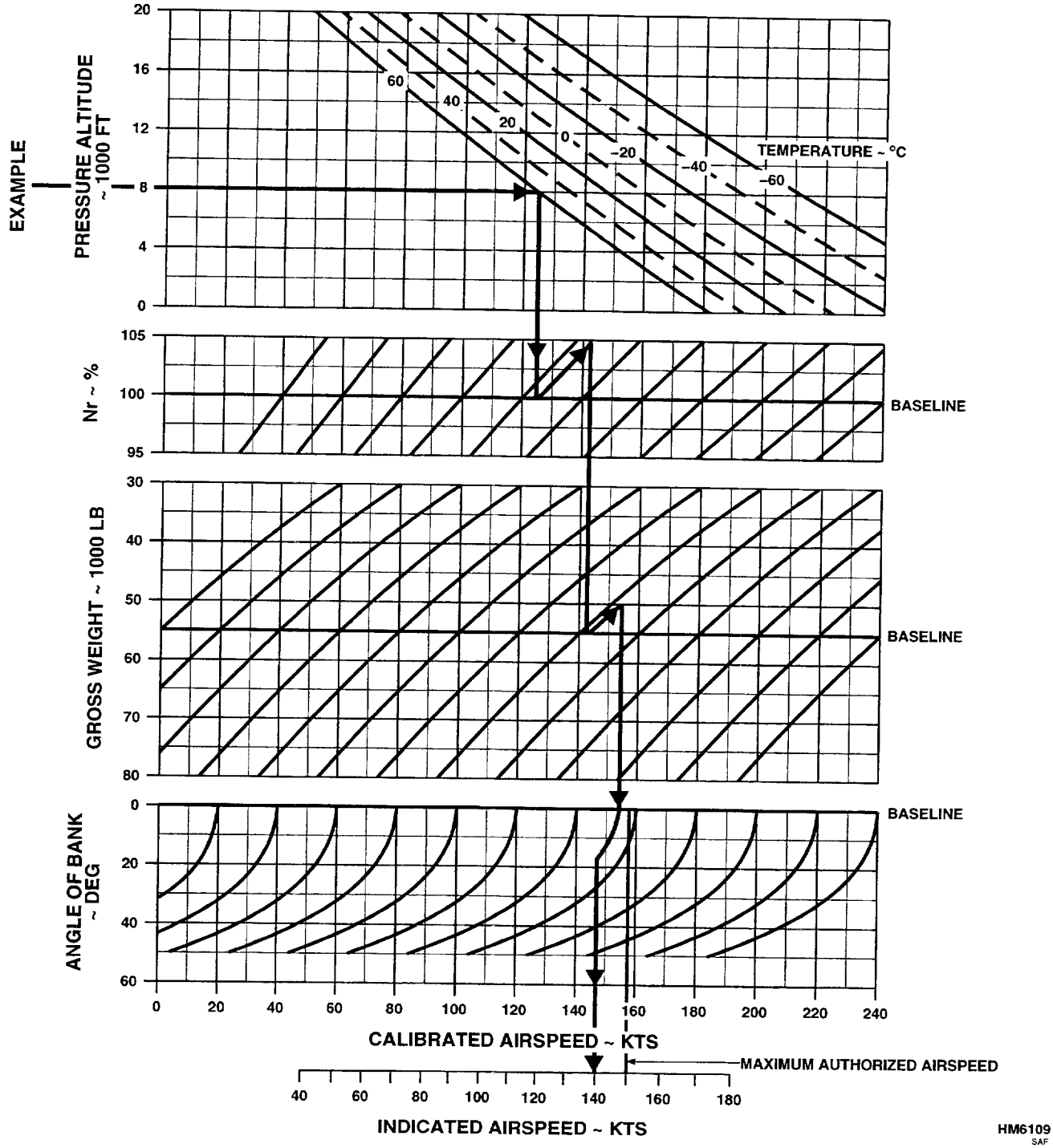


Figure 20-9. Blade Stall Chart

CHAPTER 21
Climb

21.1 ENGINE CLIMB CHARTS

The charts presented in this section are based on degraded engine performance.

21.1.1 Three-Engine Climb at Military Power - Cold Day. The three-engine climb at military power-cold day chart (Figure 21-1) provides the time to climb, horizontal distance covered, fuel consumed, rate of climb, at various gross weights, for a cold day.

Note

Since the takeoff is from above a sea level pressure altitude, it will be necessary to determine climb data from sea level pressure altitude to 2000 feet pressure altitude and from sea level pressure altitude to 8000 feet pressure altitude. The difference between the data necessary to climb to both altitudes will then be the data necessary to climb from 2000 feet pressure altitude to 8000 feet pressure altitude.

1. Enter bottom of chart at 40,000 pounds gross weight, trace up to 2000 feet pressure altitude in the time parameter block, then trace left to the temperature baseline. Follow the influence line to the -20°C line, then trace left and note that time to climb to 2000 feet pressure altitude is 30 seconds. Follow the same procedure to determine that the time to climb to 8000 feet pressure altitude and -32°C OAT is 2 minutes. The difference between the time to climb to 2000 feet pressure altitude and the time to climb to 8000 feet pressure altitude is 90 seconds, which is the computed time to climb from 2000 to 8000 feet pressure altitude.

2. Enter bottom of chart at 40,000 pounds gross weight, trace up to 2000 feet pressure altitude in the distance parameter block, then trace left to the parameter baseline. Follow the influence line to the -20°C line, then trace left and note that the distance covered in a climb to 2000 feet pressure altitude is 1 nautical mile. Follow the same procedure to determine that the distance covered in a climb to 8000 feet pressure altitude and 32°C OAT is 3 nautical miles. The difference between the distance covered to climb to 2000 feet pressure altitude and the distance covered to climb to 8000 pressure altitude is 2, which is the computed distance covered to climb from 2000 to 8000 feet pressure altitude.

3. Enter bottom of chart at 40,000 pounds gross weight, trace up to the 2000 feet pressure altitude in the fuel parameter block, then trace left to the temperature baseline. Follow the influence line to the -20°C line, then trace left and note the fuel consumed in a climb to 2000 feet pressure altitude is 550 pounds. Follow the same procedure to determine that the amount of fuel consumed in a climb to a pressure altitude of 8000 feet and -32°C OAT is 720 pounds. The difference between the fuel used to climb to 2000 feet pressure altitude and fuel used to climb to 8000 feet pressure altitude is 170 pounds, which is the computed fuel used to climb from 2000 to 8000 feet pressure altitude. Take 520 pounds of fuel for warmup and taxi. Add the 170 pounds to show a total fuel consumption of 690 pounds to takeoff from a 2000 feet pressure altitude site and climb to a 8000-foot pressure altitude level.

4. Enter bottom of chart at 40,000 pounds gross weight, trace up to 2000 feet pressure altitude in the rate of climb parameter block, then trace left to the temperature baseline. Follow the influence line to the -20°C line, then trace left and note 4000 feet-per-minute initial rate of climb. Follow the same procedure to determine that the final rate of climb at 8000 feet pressure altitude and -32°C OAT is 2650 feet-per-minute. The average rate of climb is 3325 feet-per-minute.

5. Enter left side of climb speed schedule at 2000 feet pressure altitude, trace right to the best climb speed curve, then trace down and read best climb speed of 75 KIAS. Follow the same procedures to determine that the best climb speed for 8000 pressure altitude is 69 KIAS. Note that the initial rate of climb of 4000 feet per minute at 75 KIAS changes to 2650 feet per minute at 69 KIAS.

21.1.2 Three-Engine Climb at Military Power - Warm Day Chart. The three-engine climb at military power - warm day chart (Figure 21-2) uses like factors in the same way as Figure 21-1.

21.2 419 ENGINE CLIMB CHARTS

21.2.1 Climb Performance Charts. The climb performance charts (Figure 21-3) for the 419 engine provide a means for determining the rate of climb, time to climb, horizontal distance covered, and fuel consumed for various gross weights, pressure altitudes, and temperatures at military power. Three charts are provided; one for standard temperature as well as one each for 30° above or below standard temperature.

Note

- When the takeoff pressure altitude is above sea level pressure altitude, it will be necessary to determine climb data from sea level pressure altitude to the takeoff pressure altitude and from sea level pressure altitude to the cruise level pressure altitude. The difference between that data will be the appropriate data necessary to climb from takeoff pressure altitude to cruise level pressure altitude.
- If OAT at the desired pressure altitude is the same as approximate standard day temperature, use STD DAY baseline to compute time to climb fuel used and distance traveled. If OAT is not the same as approximate standard day temperature, compute the difference, e.g., PA (10,000 ft), OAT (-10°C), *STD DAY TEMP* (-5°C), subtract the difference to obtain differential factor (-5°C).

For example, enter chart at gross weight (60,000 lbs) and trace right to pressure altitude (4000 ft). Trace straight down, noting the airspeed for maximum rate-of-climb (64.5 KIAS). Continue downward to the appropriate gross weight arc and trace left to read the rate-of-climb (2200 ft/min). Continue downward to intersect the fuel used baseline and trace left to read the fuel used (165 lbs). Continue downward to either the distance or the time baseline and trace left to read either the distance traveled (2.2 nm) or the time to climb (00:01:45 min).

THREE-ENGINE CLIMB
753 °C T5 MILITARY POWER
30-MINUTE LIMITATION
COLD DAY
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

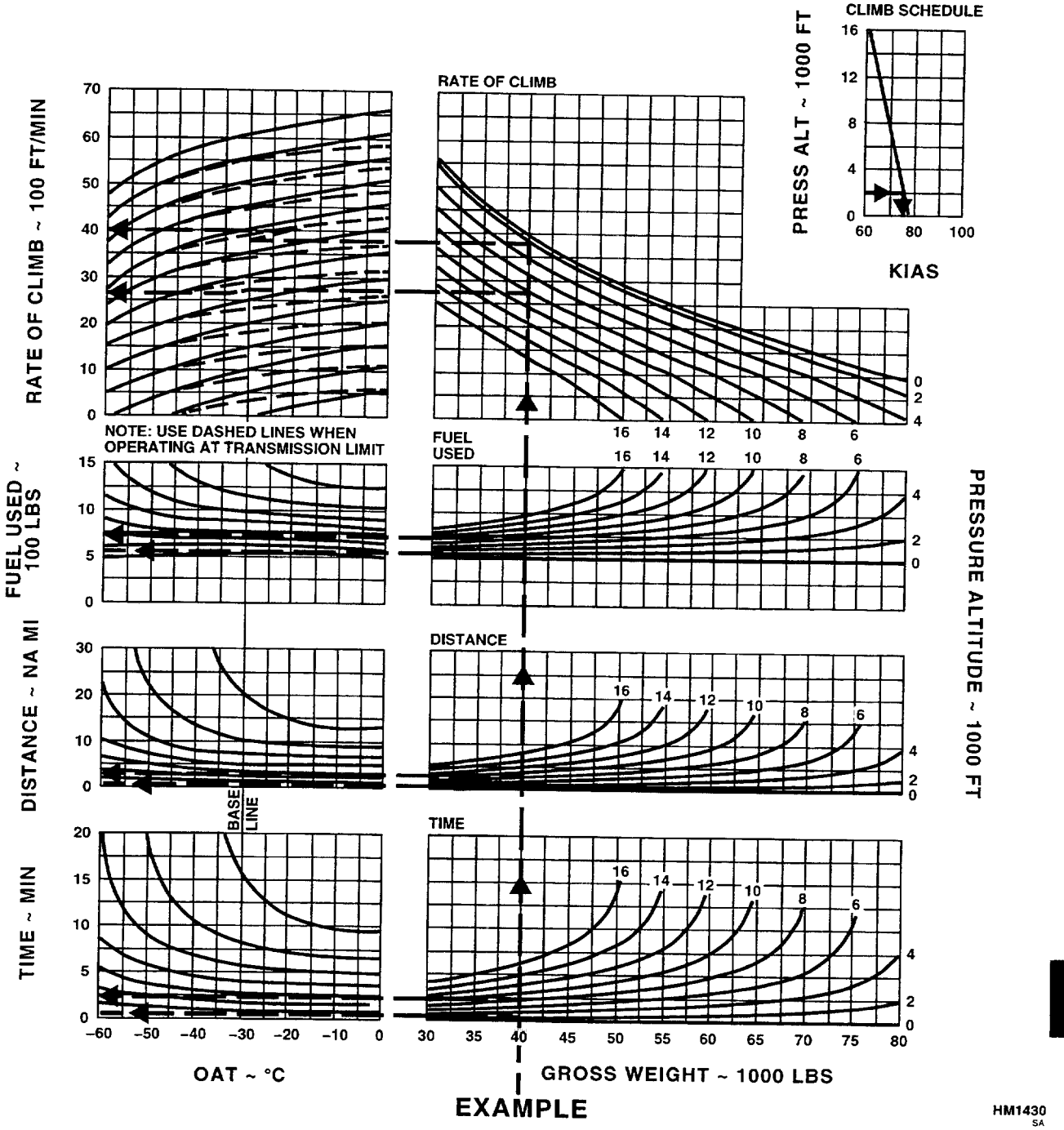


Figure 21-1. Three-Engine Climb at Military Power - Cold Day (416 Engine)

THREE-ENGINE CLIMB
753 °C T5 MILITARY POWER
30-MINUTE LIMITATION
WARM DAY
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

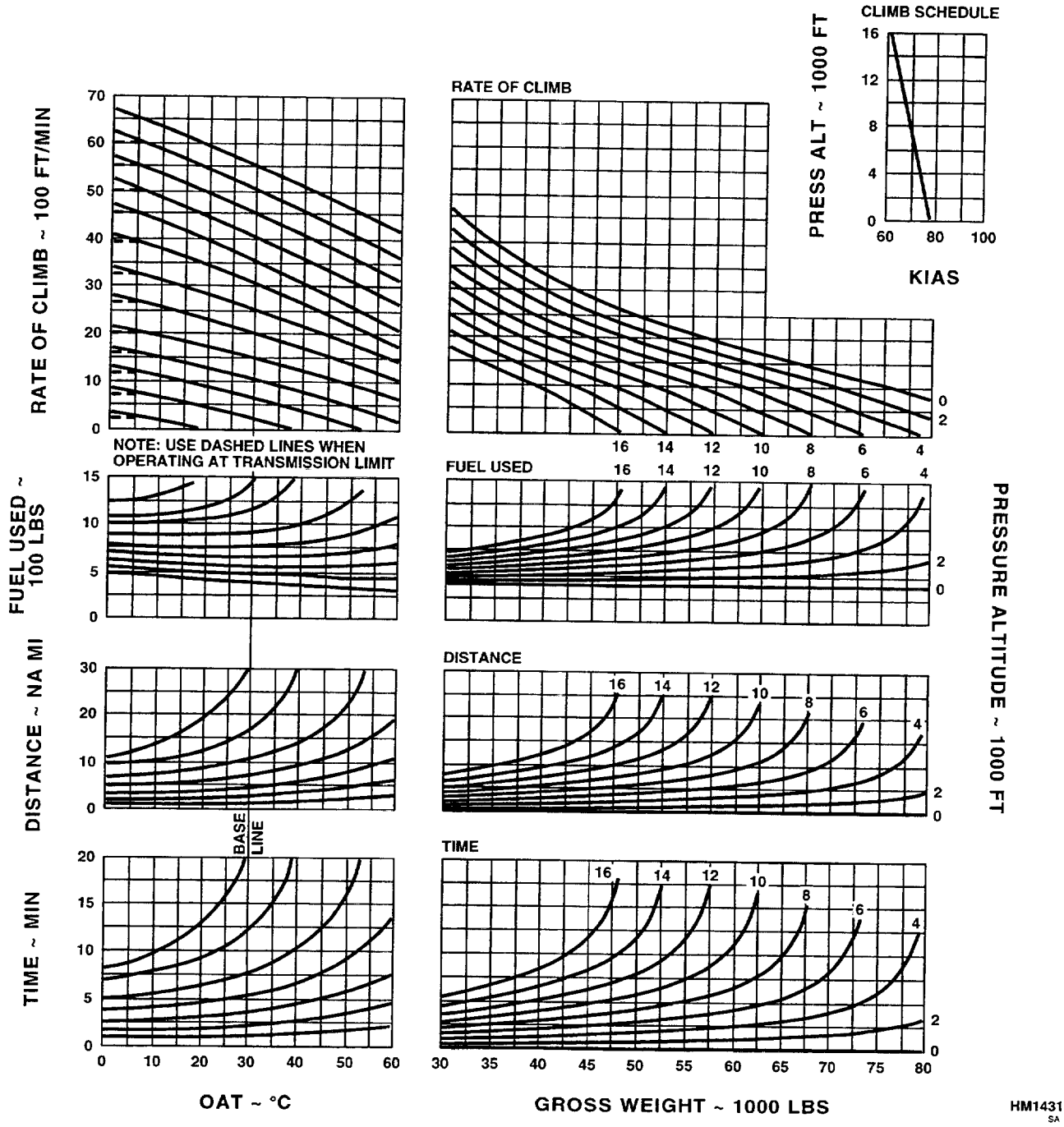


Figure 21-2. Three-Engine Climb at Military Power - Warm Day (416 Engine)

CLIMB PERFORMANCE
THREE ENGINE – MILITARY POWER (809°C T5)
30 MINUTE LIMITATION
STANDARD TEMP –30°C, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GA

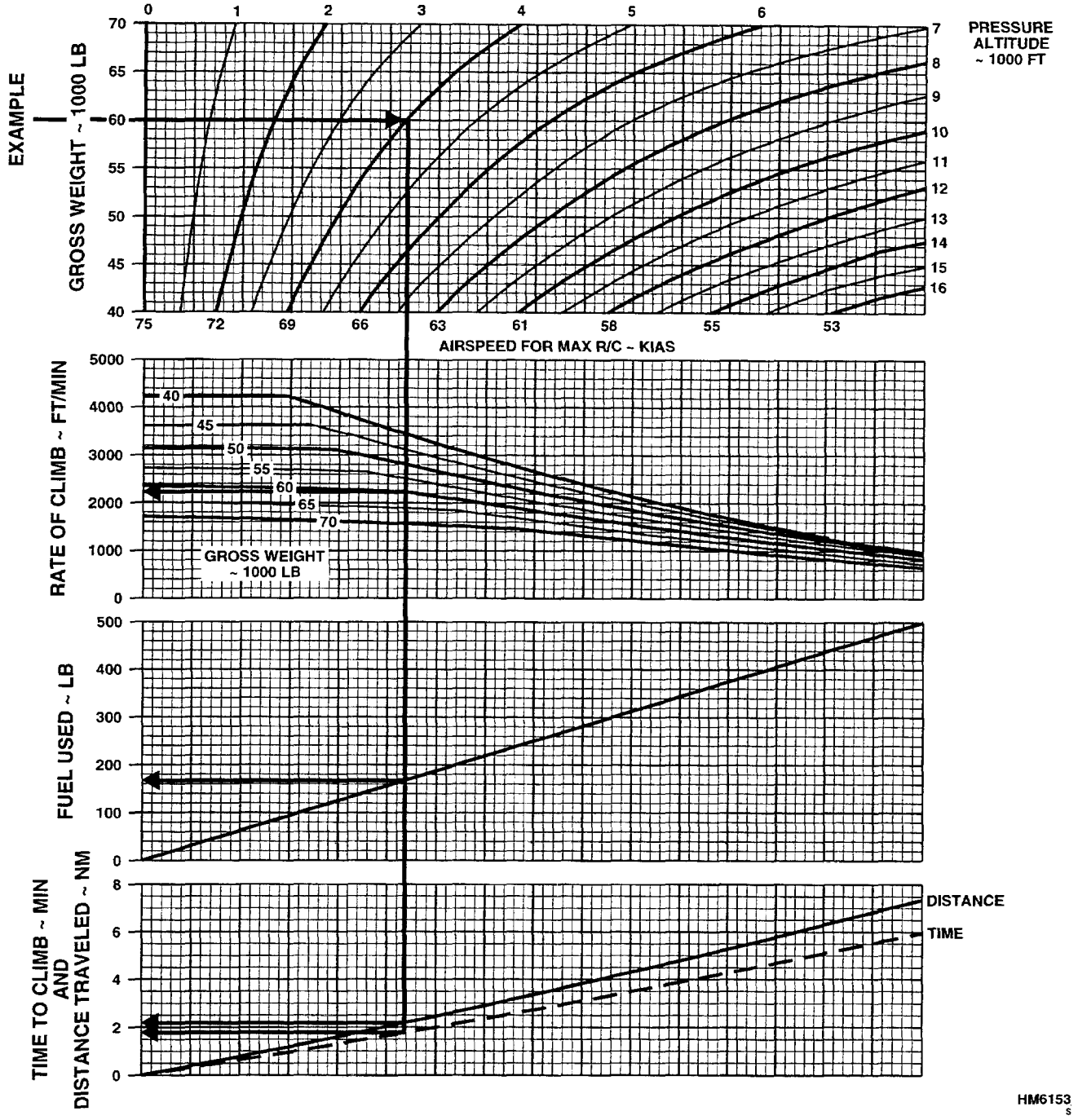


Figure 21-3. Climb Performance (419 Engine) (Sheet 1 of 3)

CLIMB PERFORMANCE
THREE ENGINE – MILITARY POWER (809°C T5)
30 MINUTE LIMITATION
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

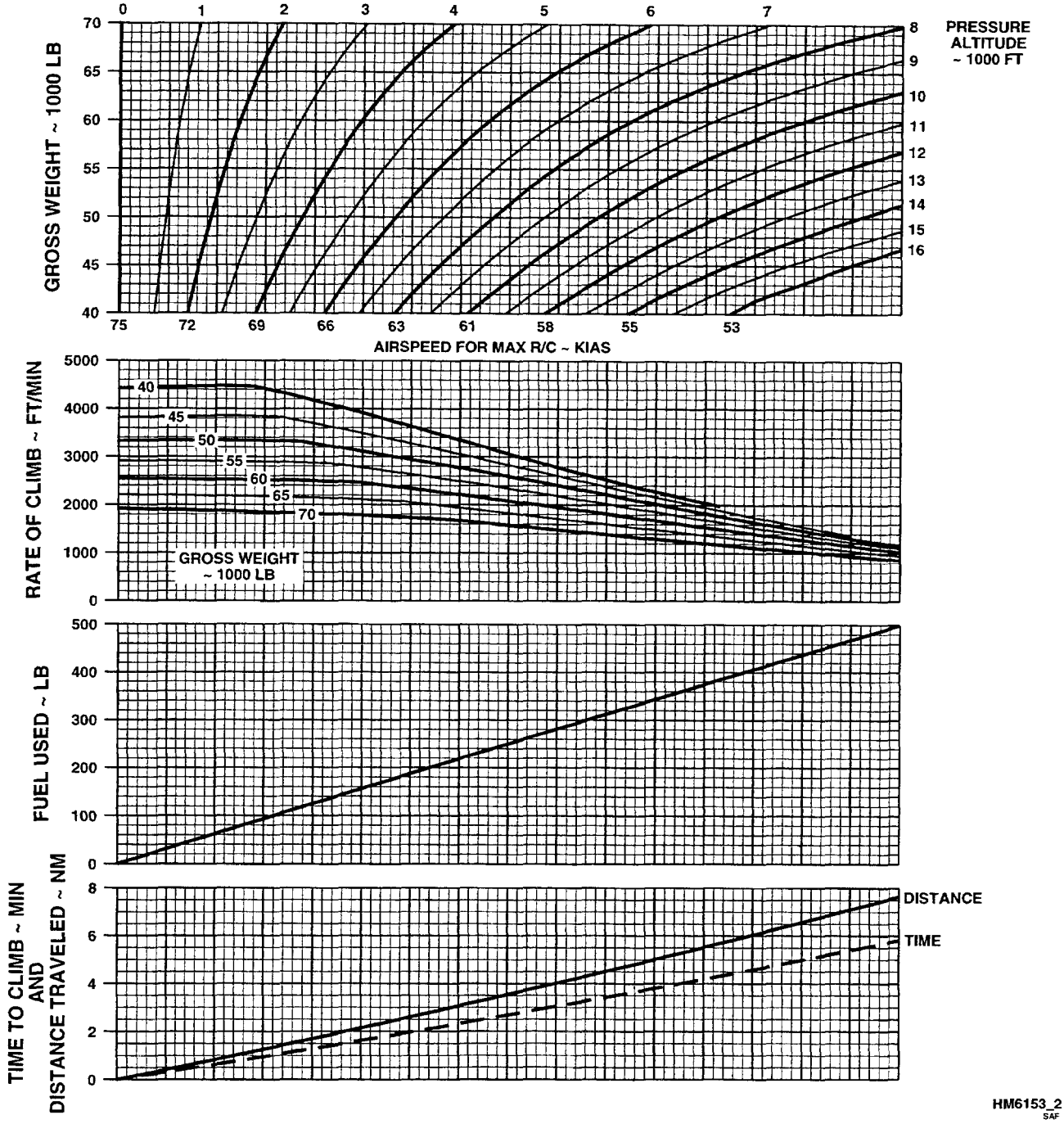


Figure 21-3. Climb Performance (419 Engine) (Sheet 2 of 3)

CLIMB PERFORMANCE
THREE ENGINE – MILITARY POWER (809°C T5)
30 MINUTE LIMITATION
STANDARD TEMP +30°C, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

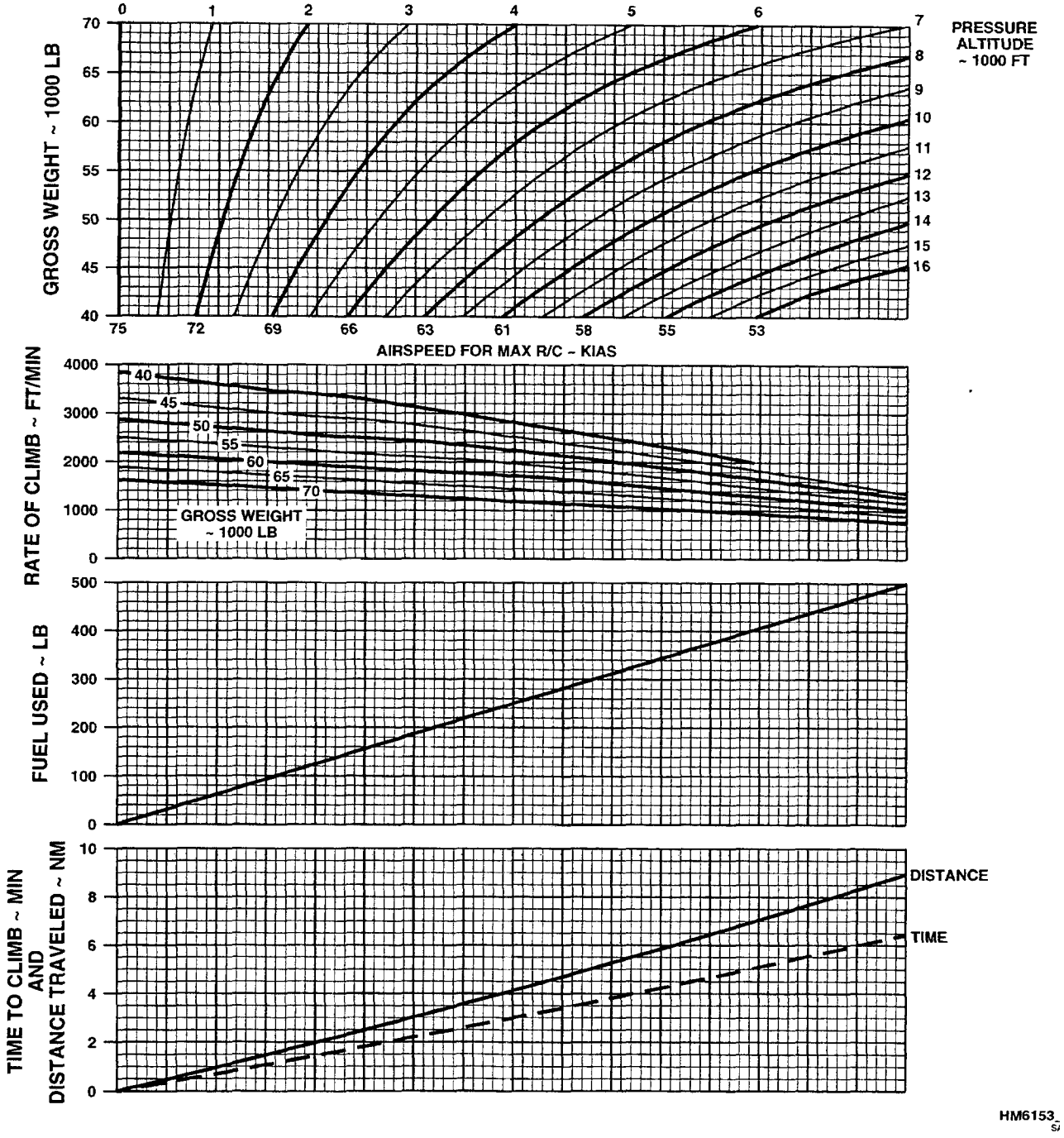


Figure 21-3. Climb Performance (419 Engine) (Sheet 3 of 3)

CHAPTER 22
Range/Cruise

22.1 416 ENGINE RANGE/CRUISE CHARTS

The 416 engine range charts provide unit range, indicated and calibrated airspeed, and approximate torque when gross weight is applied to pressure altitude. The optimum cruise altitude chart provides data for determining the pressure altitude and airspeed that will produce optimum cruising range based on gross weight and ambient temperature. The three engine and dual engine range charts at maximum continuous power are based on specification engine performance.

22.1.1 Factors. The charts provide data with EAPS installed. For maximum range charts (Figures 22-1 thru 22-3) increase unit range by .0008, and speed by two knots if EAPS are not installed. For maximum continuous power range charts (Figure 22-4) increase unit range by .0007, and speed by two knots if EAPS are not installed. For dual engine maximum range or maximum continuous power charts (Figures 22-5 thru 22-8) increase unit range by .001, and speed by two knots if EAPS are not installed.

22.1.2 Three-Engine Maximum Range, Hot Day, Standard Temperature +30°C Chart. The three-engine maximum range, hot day, standard temperature +30°C chart (Figure 22-1) provides the unit range, indicated and calibrated airspeed, and approximate torque when gross weight is applied to pressure altitude to produce maximum range for the helicopter.

For example, to find the unit range, cruise speed, and torque required for maximum range at 50,000 pounds gross weight at a pressure altitude of 6000 feet, enter the bottom of the chart at 50,000 pounds gross weight. Trace up to the 6000-foot curve, then trace left and read the unit range in nautical miles per pound of fuel 0.0405. Enter the next grid at 50,000 pounds, trace up to the 6000-foot curve, and then trace left and read 119 KIAS, the cruise speed required for maximum range. The approximate torque required to maintain this speed is found by entering the next grid at 50,000 pounds, tracing up to the 6000-foot curve, and then tracing left to read 67.0% torque.

22.1.3 Three-Engine Maximum Range, Standard Temperature Chart. The three-engine maximum range, standard temperature chart (Figure 22-2) is used the same way as Figure 22-1.

22.1.4 Three-Engine Maximum Range, Cold Day, Standard Temperature - 30°C Chart. The three-engine maximum range, cold day, standard temperature - 30°C chart (Figure 22-3) is used the same way as Figure 22-1.

22.1.5 Three-Engine Range at Maximum Continuous Power Chart. The three-engine range at maximum continuous power chart (Figure 22-4) is used the same way as Figure 22-1.

22.1.6 Dual-Engine Maximum Range, Hot Day, Standard Temperature +30°C Chart. The dual-engine maximum range, hot day, standard temperature +30°C chart (Figure 22-5) is used the same way as Figure 22-1.

22.1.7 Dual-Engine Maximum Range, Standard Temperature Chart. The dual-engine maximum range, standard temperature chart (Figure 22-6) is used the same way as Figure 22-1.

22.1.8 Dual-Engine Maximum Range, Cold Day, Standard Temperature - 30°C Chart. The dual-engine maximum range, cold day, standard temperature - 30°C chart (Figure 22-7) is used the same way as Figure 22-1.

22.1.9 Dual-Engine Range at Maximum Continuous Power Chart. The dual-engine range at maximum continuous power chart (Figure 22-8) is used the same way as Figure 22-1.

22.1.10 Optimum Cruise Altitude, Hot Day, Standard Temperature +30°C Chart. The optimum cruise altitude, hot day, standard temperature +30°C chart (Figure 22-9) provides data for determining the pressure altitude and airspeed that will produce optimum cruising range based on gross weight and ambient temperature. Unit range and approximate torque required for optimum range may also be determined from this chart. Conditions at which two-engine operation will result in extending cruise range beyond that provided by three-engine operation may also be determined from this chart.

For example, using 50,000 pounds, trace from the bottom of the chart up to the range, calibrated airspeed, pressure altitude and torque graphs, respectively. Then

trace left on each one to read 0.0418 nautical miles-per-pound, 98 knots CAS, 90 knots IAS, 4500 feet pressure altitude and 73% torque, respectively.

22.1.11 Optimum Cruise Altitude, Standard Temperature Chart. The optimum cruise altitude, standard temperature chart (Figure 22-10) is used the same way as Figure 22-9.

Optimum Cruise Altitude, Cold Day, Standard Temperature - 30°C Chart. The optimum cruise altitude, cold day, standard temperature - 30°C chart (Figure 22-11) is used the same way as Figure 22-9.

22.2 419 ENGINE RANGE/CRUISE CHARTS

22.2.1 419 Engine Cruise Charts. The 419 engine cruise charts (Figures 22-13 thru 22-18) present torque required and total fuel flow as a function of airspeed, altitude, temperature, and gross weight at 103% N_p. Scales for both true airspeed and indicated airspeed are provided. Maximum airspeed is obtained at the intersection of the gross weight arc and either the airspeed limit, continuous torque available, or 30-minute transmission limit, whichever is lower. Airspeeds which will produce maximum range, maximum endurance, and maximum rate of climb are also shown. Cruise charts are provided from sea level to 10,000 feet pressure altitude in units of 2000 feet. Each figure number represents a different altitude. The charts provide cruise data for a range of either eight or six specific outside air temperatures, depending on pressure altitude.

The primary use of the cruise charts is illustrated by the example on Figure 22-12. To use the charts, it is usually necessary to know the planned pressure altitude, estimated outside air temperature, planned cruise speed, and gross weight. An appropriate chart is selected on the basis of pressure altitude and OAT. Enter the chart at the cruise indicated airspeed (IAS), then note true airspeed (TAS) on the opposite scale. Trace up or down to the proper gross weight arc and trace to the left to read torque required or to the right to read associated fuel flow.

Maximum performance conditions are determined by entering the chart where the long range line or the maximum endurance and rate-of-climb line intersects the gross weight line, then reading airspeed, fuel flow and torque required. Normally, sufficient accuracy can be obtained by selecting the chart nearest the planned cruising altitude and OAT. If greater accuracy is required, interpolation between altitudes and/or temperatures is permissible. To be conservative, use the gross weight at the beginning of the cruise flight. For greater accuracy on long flights, however, it is preferable to determine cruise information for several flight segments to allow for the decreasing gross weight.

22.2.1.1 Airspeed. True and indicated airspeeds are presented on opposite sides of each chart. On any chart, indicated airspeed can be directly converted to true airspeed (or vice versa) by reading directly across the chart without regard for the other chart information. The level flight airspeed calibration for the clean configuration was used to convert indicated to true airspeed.

22.2.1.2 Torque. Since pressure altitude and temperature are fixed for each chart, torque required varies according to gross weight and airspeed. The torque and torque limits shown on these charts are for three-engine operation. The maximum torque available is presented on each chart as either the transmission torque limit or torque available-30 minute. Higher torque than that represented by these lines may be used if it is available without exceeding the limitations presented in Chapter 4.

22.2.1.3 Fuel Flow. Fuel flow scales are provided opposite the torque scales. On any chart, torque may be converted directly to fuel flow without regard to other chart information. Data shown in this section is for three-engine operation. For one-engine fuel flow, refer to Engine Fuel Flow.

22.2.1.4 Long Range. The long range lines (LONG RANGE) indicate the combinations of gross weight and airspeed that will produce 99% of the maximum flight range per pound of fuel under zero wind conditions. When the long range airspeed line is above the maximum torque available, the resulting maximum airspeed should be used for maximum range. Maximum range may be obtained by reducing the long range speed by 10 KIAS. A rule of thumb for cruising flight at maximum range speed is to increase IAS by 2.5 knots per each 10 knots of effective headwind (which reduces flight time and minimizes loss in range) and decrease IAS by 2.5 knots per 10 knots of effective tailwind for economy.

22.2.1.5 Maximum Endurance and Rate of Climb. The maximum endurance and rate-of-climb lines (MAX, END, and R/C) indicate the combinations of gross weight and airspeed that will produce the maximum endurance and the maximum rate of climb. The torque required for level flight at this condition is a minimum, providing a minimum fuel flow (maximum endurance) and a maximum torque change available for climb (maximum rate of climb).

Note

If a more accurate cruise chart maximum rate of climb airspeed is required, refer to airspeed calibration chart (Figure 19-1).

22.2.1.6 Additional Uses. The low speed end of the cruise chart (below 40 knots) is shown primarily for familiarization with the low speed power requirements of the helicopter. It shows the power margin available for climb or acceleration during maneuvers, such as NOE flight. At zero airspeed, the torque represents the torque required to hover out of ground effect. In general, mission planning for low speed flight should be based on hover out of ground effect.

22.2.2 Cruise Capability Chart. The cruise capability chart (Figure 22-19) provides the endurance or cruise time and the range for various fuel weights, fuel flows, and true airspeeds. The time and range portion of this chart provides the enroute time and distance achieved in level cruise with calm winds. The information required for the use of this chart is the fuel weight, fuel flow, and cruise true airspeed.

22.2.3 Three-Engine Maximum Range Bingo Profiles. The three-engine maximum range bingo profiles (Figure 22-20) show the optimum indicated airspeed and torque, for different gross weights, at which maximum range can be attained under standard conditions. Three range profiles provide the range, in nautical miles, for standard temperature as well as 30° above or below standard temperature.

CAUTION

Bingo profiles do not provide for reserve fuel requirements.

22.2.4 Three-Engine Maximum Continuous Power Bingo Profile. The three-engine maximum continuous power bingo profile (Figure 22-21) is used the same way as the maximum range bingo profile to show the range, in nautical miles for that power setting.

22.2.5 Dual-Engine Bingo Profiles. The dual-engine bingo profiles for both maximum range and maximum continuous power (Figure 22-22 and Figure 22-23) are used the same way as Figure 22-20 and Figure 22-21.

22.2.6 Optimum Altitude for Maximum Range Charts. The Optimum Altitude for Maximum Range charts (Figure 22-24) provide the cruise pressure altitude to obtain the maximum possible range for any gross weight and OAT condition.

For example, enter left side of chart at the current cruise or takeoff OAT (22°C) and trace right to the line depicting current pressure altitude. Follow the slope of the temperature trend lines to an appropriate gross weight for cruise arc (50,000 lbs). Trace down to read optimum altitude (10,800 ft) and left to read estimated OAT (4°C) for maximum range. Use the cruise chart closest to these values (10,000 ft/0°C) for specific cruise information.

THREE-ENGINE MAXIMUM RANGE
STANDARD TEMPERATURE +30 °C
HOT DAY
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

STANDARD TEMPERATURE +30 °C AT SEA LEVEL = 45 °C

STANDARD TEMPERATURE +30 °C AT 5000 FT = 35 °C

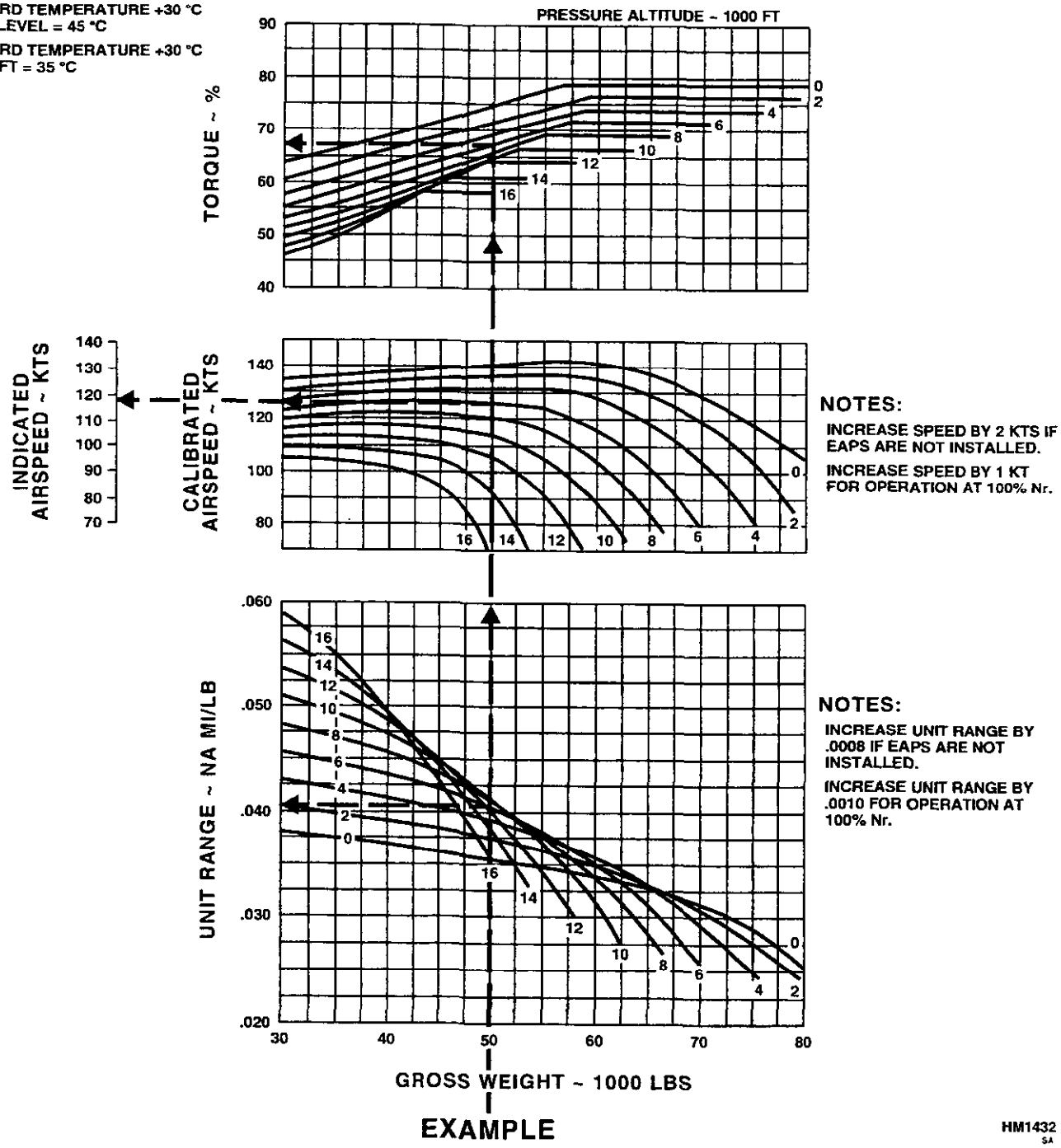


Figure 22-1. Three-Engine Maximum Range, Hot Day, Standard Temperature +30°C (416 Engine)

THREE-ENGINE MAXIMUM RANGE
STANDARD TEMPERATURE
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

— — — MAXIMUM CONTINUOUS TRANSMISSION TORQUE RATING
STANDARD TEMPERATURE AT SEA LEVEL = 15 °C
STANDARD TEMPERATURE AT 5000 FT = 5 °C

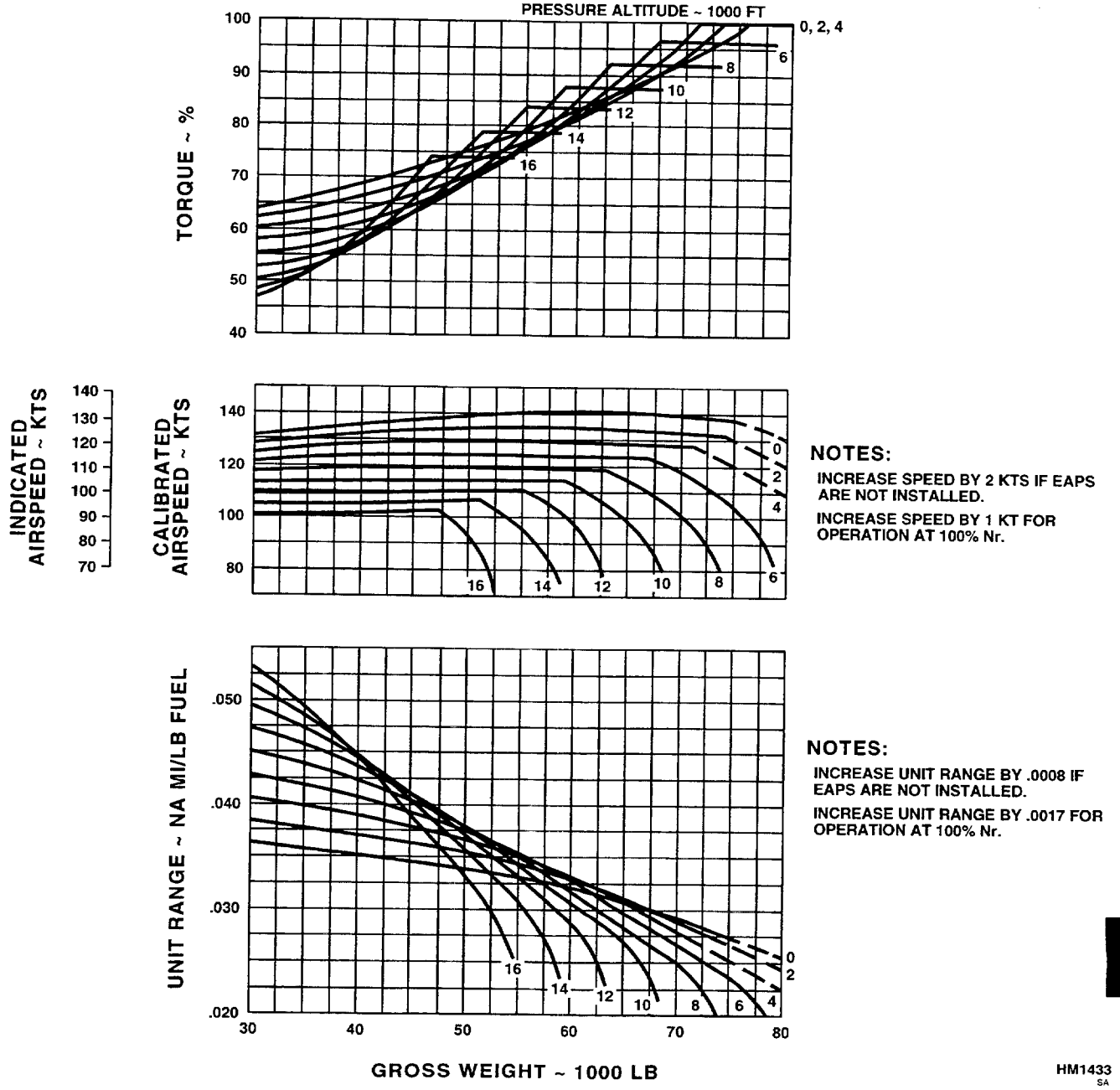


Figure 22-2. Three-Engine Maximum Range, Standard Temperature (416 Engine)

THREE-ENGINE MAXIMUM RANGE
STANDARD TEMPERATURE -30 °C
COLD DAY
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

— — — MAXIMUM CONTINUOUS TORQUE TRANSMISSION RATING
STANDARD TEMPERATURE -30 °C AT SEA LEVEL = -15 °C
STANDARD TEMPERATURE -30 °C AT 5000 FT = -25 °C

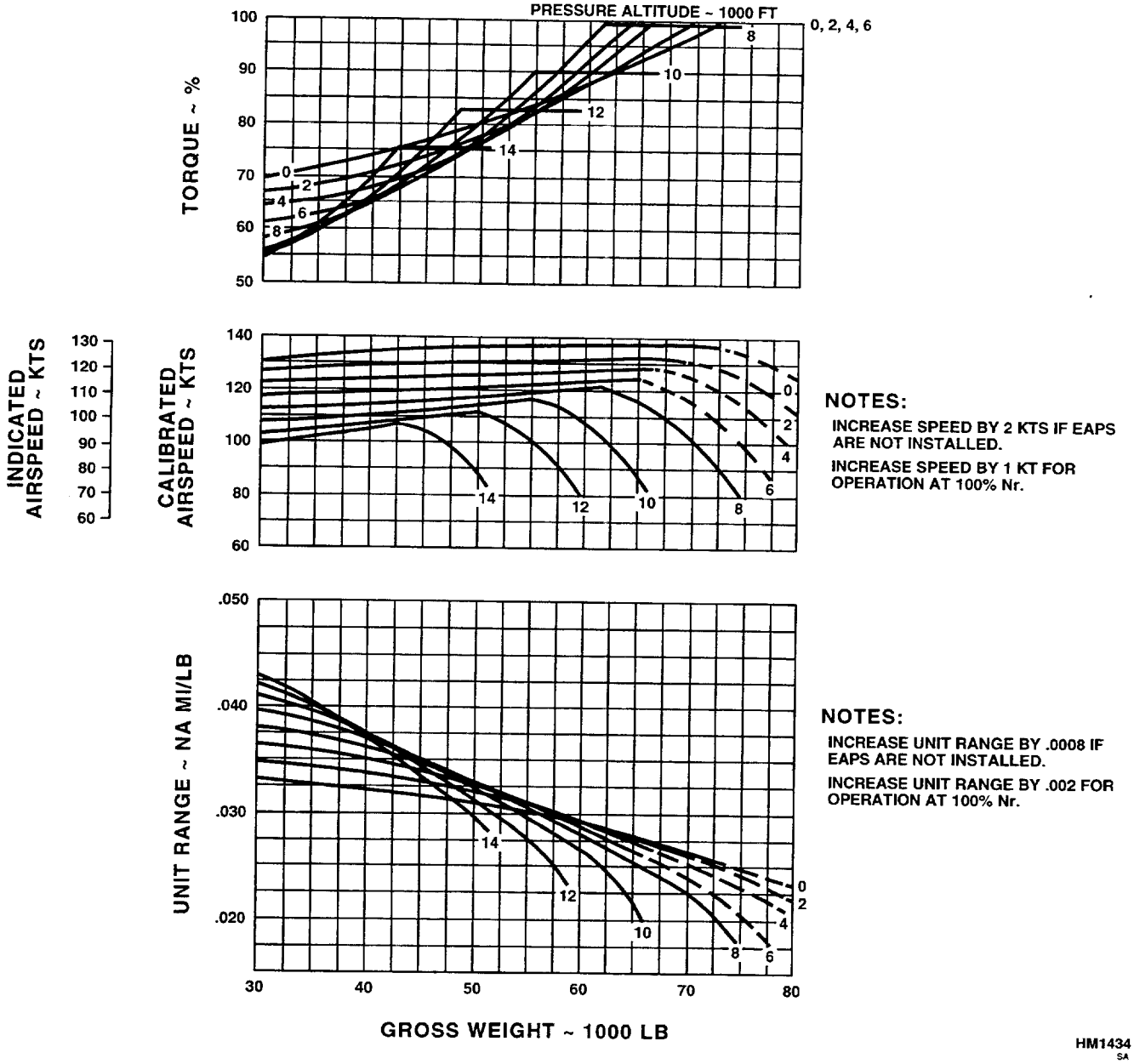


Figure 22-3. Three-Engine Maximum Range, Cold Day, Standard Temperature -30°C (416 Engine)

THREE-ENGINE RANGE AT MAXIMUM CONTINUOUS POWER

STANDARD TEMPERATURE

103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

— — — MAXIMUM CONTINUOUS TRANSMISSION TORQUE RATING
STANDARD TEMPERATURE AT SEA LEVEL = 15 °C
STANDARD TEMPERATURE AT 5000 FT = 5 °C

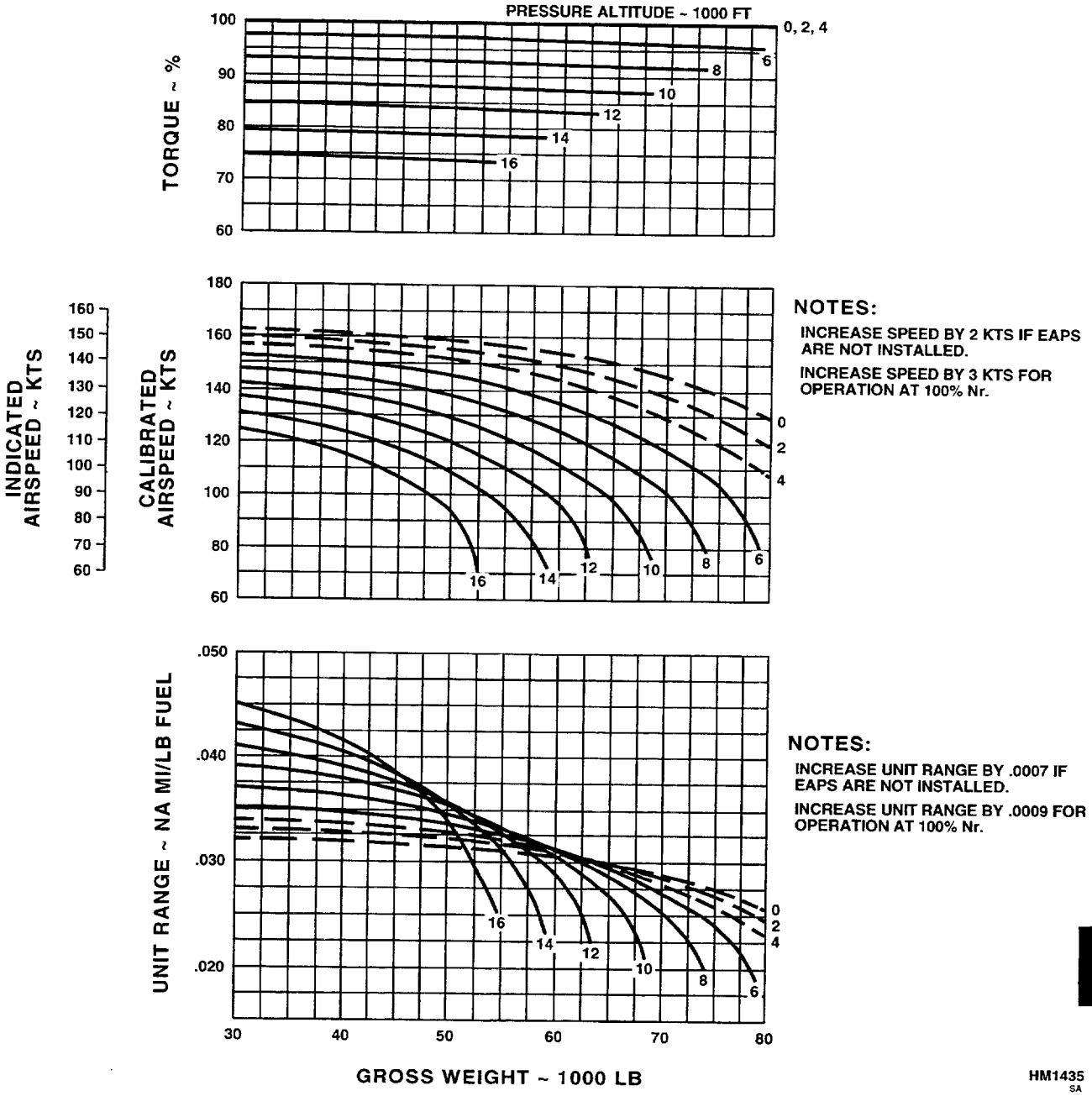


Figure 22-4. Three-Engine Range at Maximum Continuous Power (416 Engine)

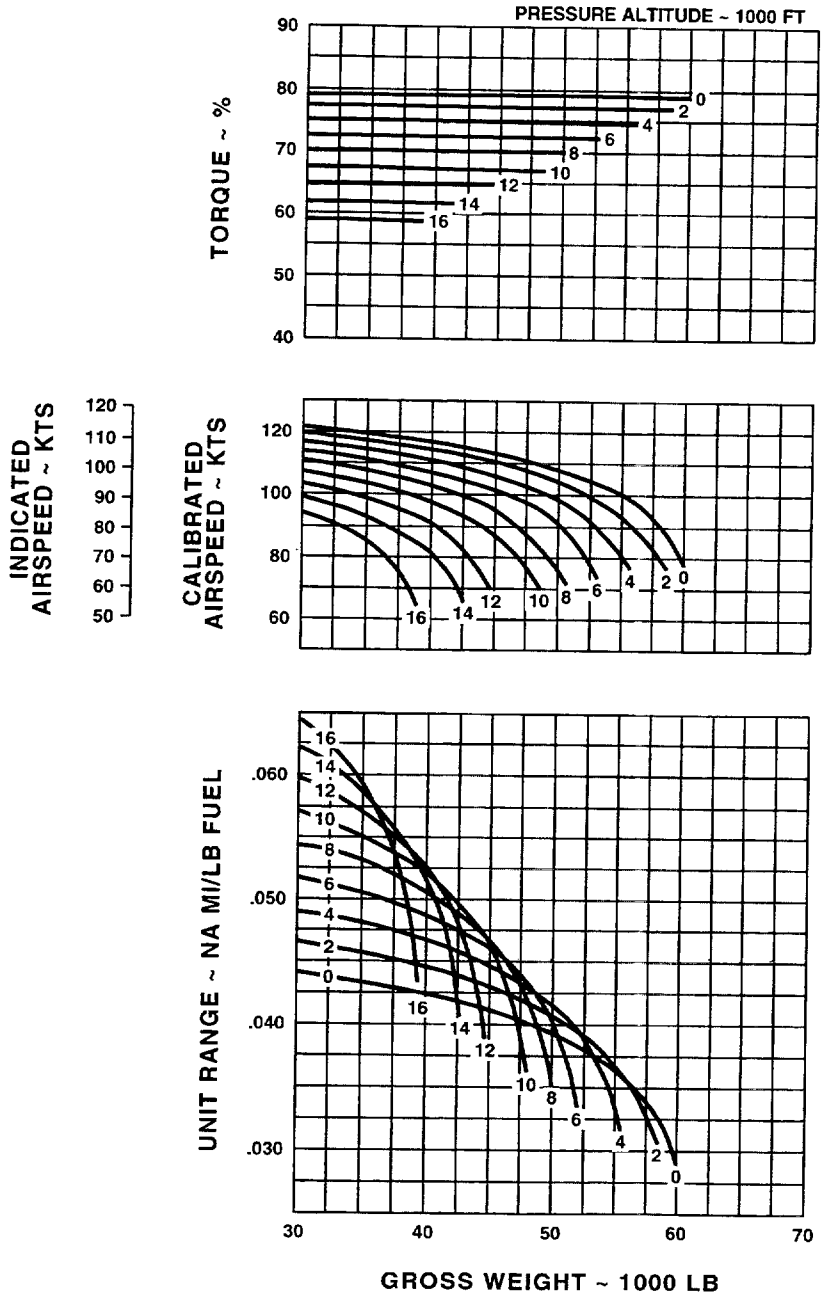
DUAL–ENGINE MAXIMUM RANGE
STANDARD TEMPERATURE +30 °C
HOT DAY
103% Nr

MODEL: MH–53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64–GE–416
FUEL GRADE: JP–4 / JP–5 / JP–8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

STANDARD TEMPERATURE +30 °C AT SEA LEVEL = 45 °C
STANDARD TEMPERATURE +30 °C AT 5000 FT = 35 °C



FOR BEST RANGE AT INDICATED ALTITUDES, TRANSITION FROM DUAL TO THREE–ENGINE OPERATION AT OR ABOVE SPECIFIED GROSS WEIGHT

ALTITUDE	GROSS WEIGHT
0	57,200
2000	55,500
4000	53,000
6000	50,000
8000	48,000
10,000	46,000
12,000	43,000
14,000	41,200
16,000	38,000

NOTES:

INCREASE SPEED BY 2 KTS IF EAPS ARE NOT INSTALLED.

INCREASE SPEED BY 3 KTS FOR OPERATION AT 100% Nr.

NOTES:

INCREASE UNIT RANGE BY .001 IF EAPS ARE NOT INSTALLED.

INCREASE UNIT RANGE BY .0018 FOR OPERATION AT 100% Nr.

HM1436 SA

Figure 22-5. Dual-Engine Maximum Range, Hot Day, Standard Temperature +30°C (416 Engine)

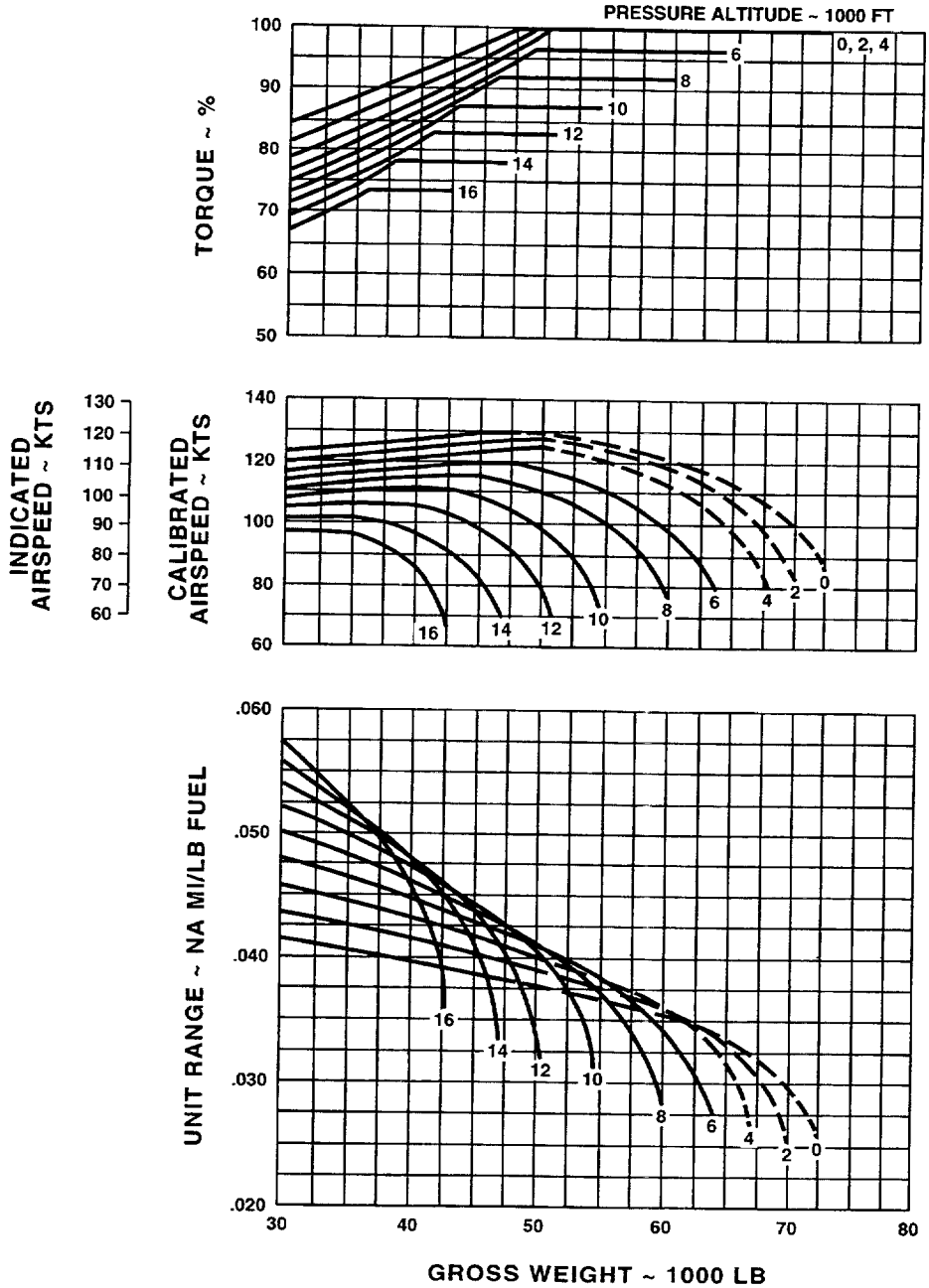
DUAL-ENGINE MAXIMUM RANGE
STANDARD TEMPERATURE
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

— — — MAXIMUM CONTINUOUS TRANSMISSION TORQUE RATING
STANDARD TEMPERATURE AT SEA LEVEL = 15 °C
STANDARD TEMPERATURE AT 5000 FT = 5 °C



FOR BEST RANGE AT INDICATED ALTITUDES, TRANSITION FROM DUAL TO THREE-ENGINE OPERATION AT OR ABOVE SPECIFIED GROSS WEIGHT

ALTITUDE	GROSS WEIGHT
0	70,000
2000	67,500
4000	65,500
6000	61,600
8000	57,600
10,000	53,500
12,000	48,000
14,000	45,000
16,000	40,500

NOTES:

INCREASE SPEED BY 2 KTS IF EAPS ARE NOT INSTALLED.

INCREASE SPEED BY 3 KTS FOR OPERATION AT 100% Nr.

NOTES:

INCREASE UNIT RANGE BY .001 IF EAPS ARE NOT INSTALLED.

INCREASE UNIT RANGE BY .0021 FOR OPERATION AT 100% Nr.

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Figure 22-6. Dual-Engine Maximum Range, Standard Temperature (416 Engine)

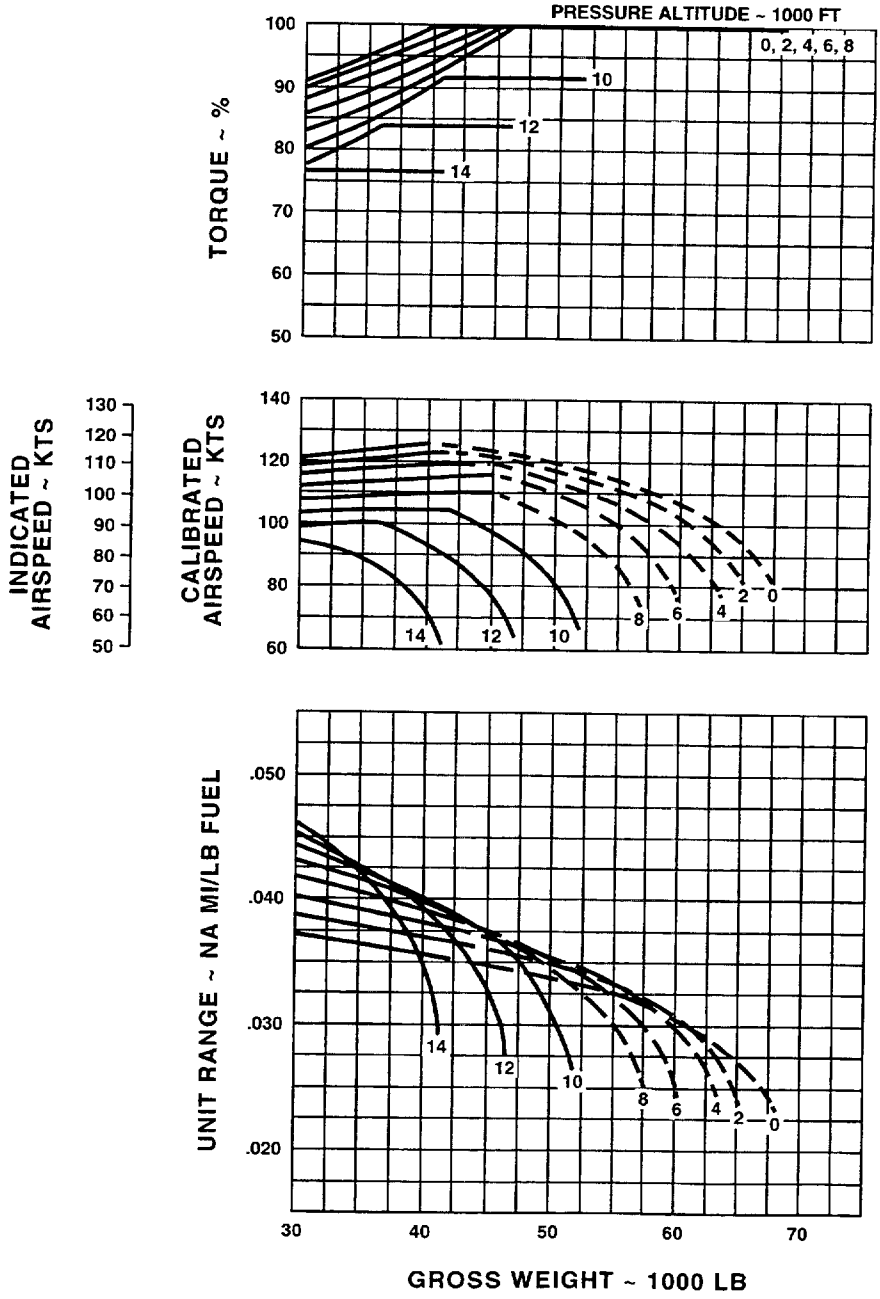
DUAL-ENGINE MAXIMUM RANGE
STANDARD TEMPERATURE -30 °C
COLD DAY
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

— — — MAXIMUM CONTINUOUS TRANSMISSION TORQUE RATING
STANDARD TEMPERATURE -30 °C AT SEA LEVEL = -15 °C
STANDARD TEMPERATURE -30 °C AT 5000 FT = -25 °C



FOR BEST RANGE AT INDICATED ALTITUDES, TRANSITION FROM DUAL TO THREE-ENGINE OPERATION AT OR ABOVE SPECIFIED GROSS WEIGHT

ALTITUDE	GROSS WEIGHT
0	64,000
2000	63,000
4000	61,000
6000	57,500
8000	54,500
10,000	49,000
12,000	44,000
14,000	38,000

NOTES:

INCREASE SPEED BY 2 KTS IF EAPS ARE NOT INSTALLED.

INCREASE SPEED BY 3 KTS FOR OPERATION AT 100% Nr.

NOTES:

INCREASE UNIT RANGE BY .001 IF EAPS ARE NOT INSTALLED.

INCREASE UNIT RANGE BY .0028 FOR OPERATION AT 100% Nr.

HM1438
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Figure 22-7. Dual-Engine Maximum Range, Cold Day, Standard Temperature -30°C (416 Engine)

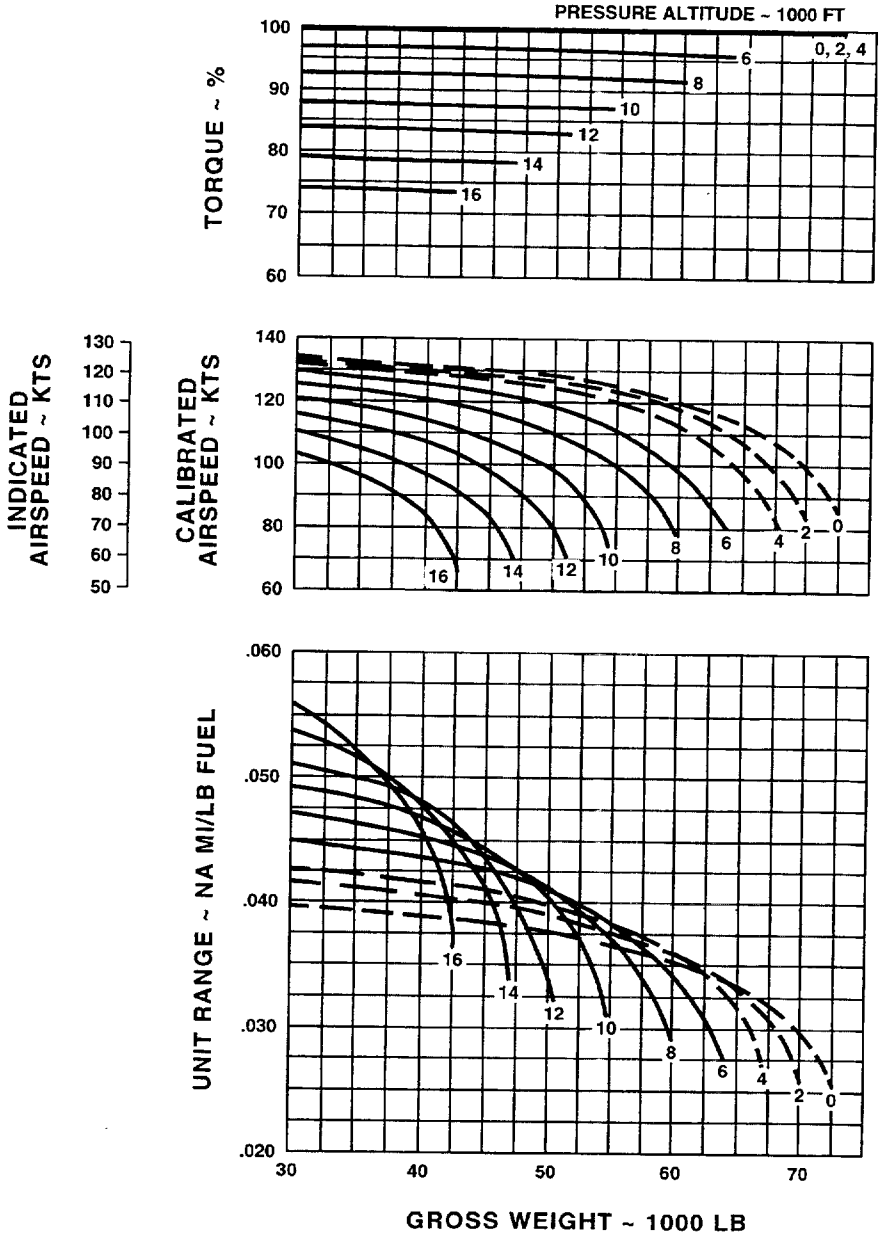
DUAL-ENGINE RANGE AT MAXIMUM CONTINUOUS POWER
STANDARD TEMPERATURE
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

— — — MAXIMUM CONTINUOUS TRANSMISSION TORQUE RATING
STANDARD TEMPERATURE AT SEA LEVEL = 15 °C
STANDARD TEMPERATURE AT 5000 FT = 5 °C



NOTES:

INCREASE SPEED BY 2 KTS IF EAPS ARE NOT INSTALLED.

INCREASE SPEED BY 3 KTS FOR OPERATION AT 100% Nr.

NOTES:

INCREASE UNIT RANGE BY .001 IF EAPS ARE NOT INSTALLED.

INCREASE UNIT RANGE BY .0018 FOR OPERATION AT 100% Nr.

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Figure 22-8. Dual-Engine Range at Maximum Continuous Power (416 Engine)

DUAL OR THREE-ENGINE OPTIMUM CRUISE ALTITUDE
STANDARD TEMPERATURE +30 °C
HOT DAY
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

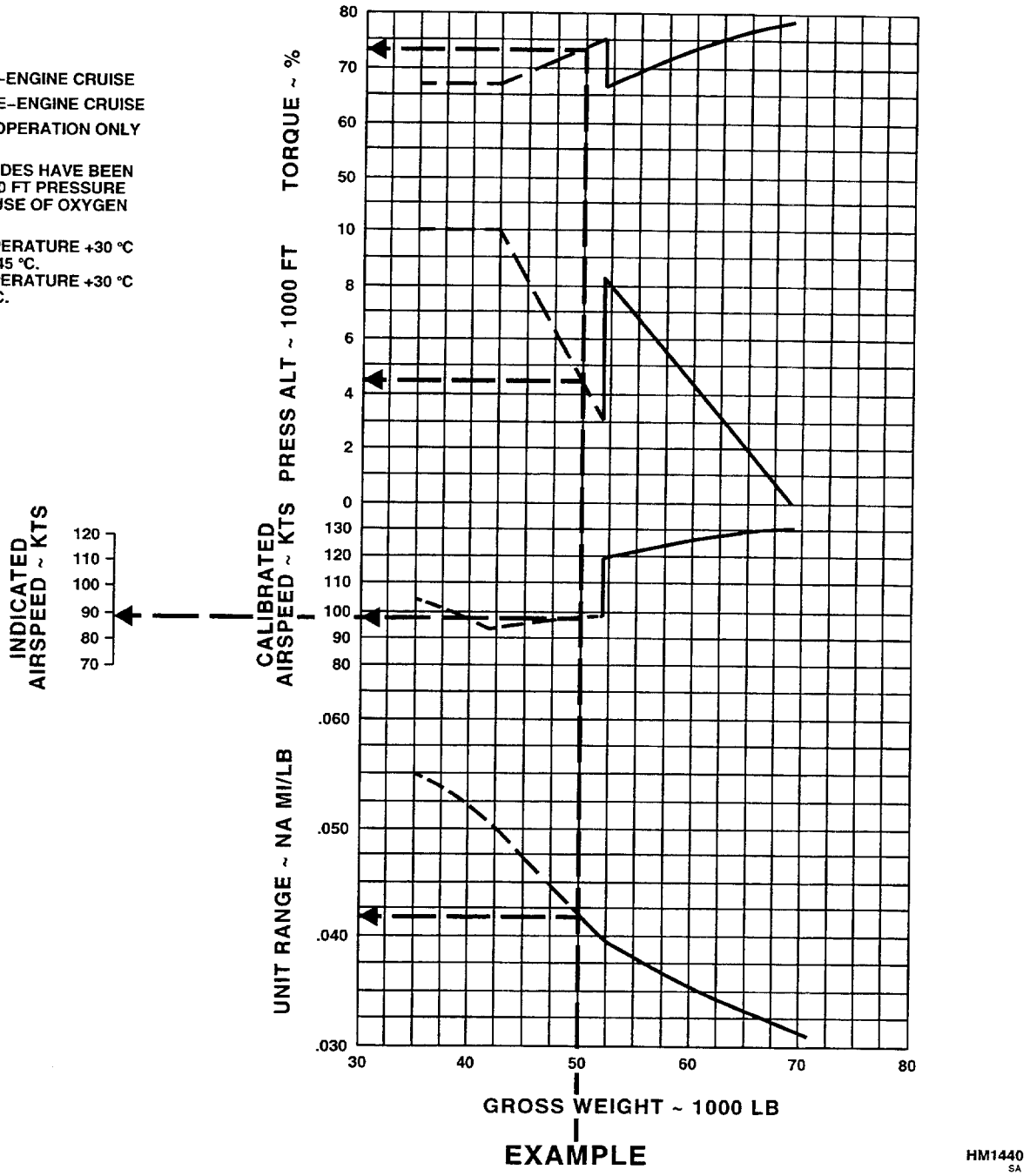
— — — DUAL-ENGINE CRUISE

——— THREE-ENGINE CRUISE

THREE-ENGINE OPERATION ONLY BELOW 3000 FT.

OPTIMUM ALTITUDES HAVE BEEN LIMITED TO 10,000 FT PRESSURE ALTITUDE BECAUSE OF OXYGEN REQUIREMENTS.

STANDARD TEMPERATURE +30 °C AT SEA LEVEL = 45 °C.
STANDARD TEMPERATURE +30 °C AT 5000 FT = 35 °C.



HM1440 SA

Figure 22-9. Optimum Cruise Altitude, Hot Day, Standard Temperature +30°C (416 Engine)

DUAL OR THREE-ENGINE OPTIMUM CRUISE ALTITUDE
STANDARD TEMPERATURE
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

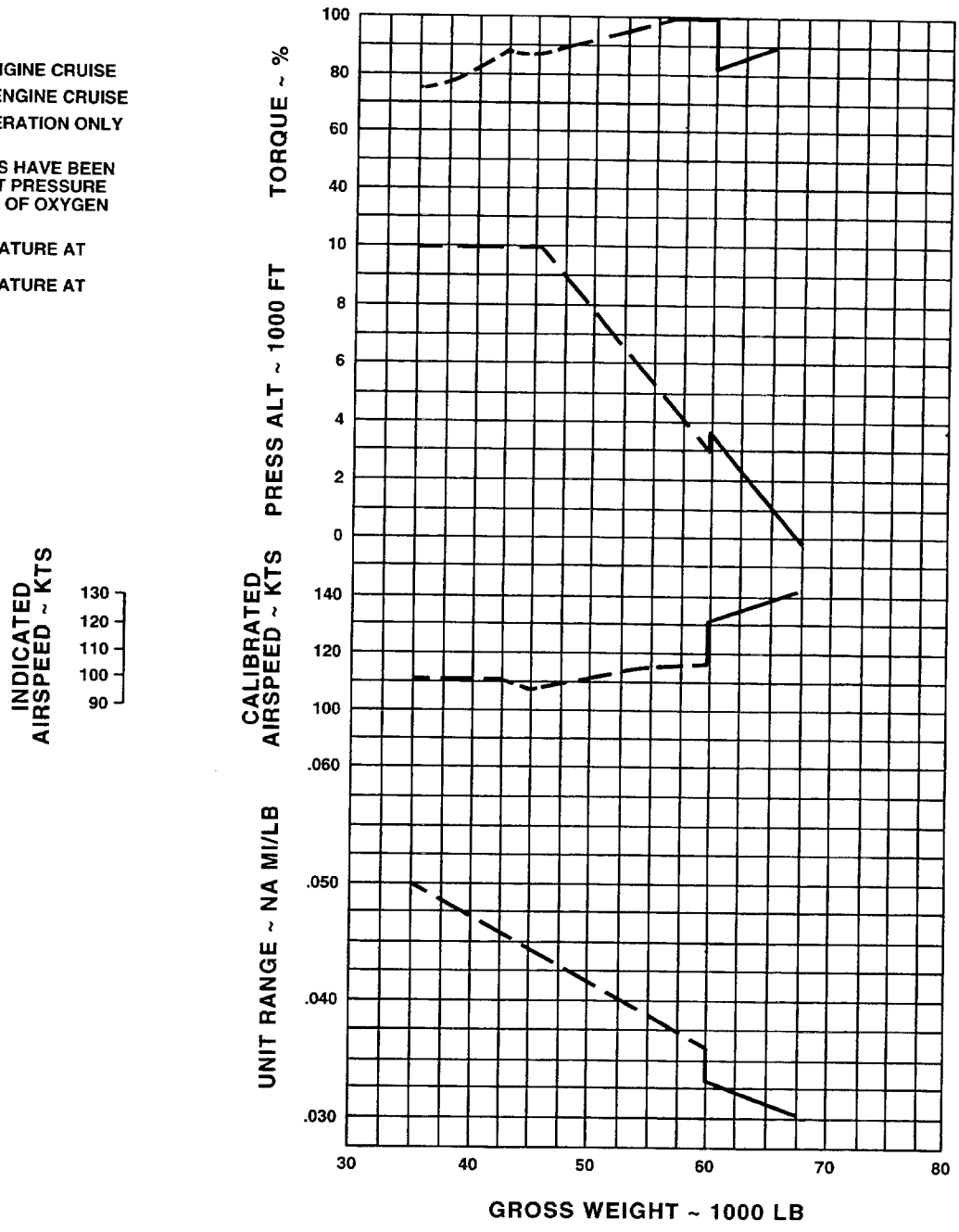
— — — DUAL-ENGINE CRUISE

——— THREE-ENGINE CRUISE

THREE-ENGINE OPERATION ONLY BELOW 3000 FT.

OPTIMUM ALTITUDES HAVE BEEN LIMITED TO 10,000 FT PRESSURE ALTITUDE BECAUSE OF OXYGEN REQUIREMENTS.

STANDARD TEMPERATURE AT SEA LEVEL = 15 °C.
STANDARD TEMPERATURE AT 5000 FT = 5 °C.



HM1441
SA

Figure 22-10. Optimum Cruise Altitude, Standard Temperature (416 Engine)

DUAL OR THREE-ENGINE OPTIMUM CRUISE ALTITUDE
STANDARD TEMPERATURE -30 °C
COLD DAY
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

— — — DUAL-ENGINE CRUISE

——— THREE-ENGINE CRUISE

THREE-ENGINE OPERATION ONLY BELOW 3000 FT.

OPTIMUM ALTITUDES HAVE BEEN LIMITED TO 10,000 FT PRESSURE ALTITUDE BECAUSE OF OXYGEN REQUIREMENTS.

STANDARD TEMPERATURE -30 °C AT SEA LEVEL = -15 °C.
STANDARD TEMPERATURE -30 °C AT 5000 FT = -25 °C.

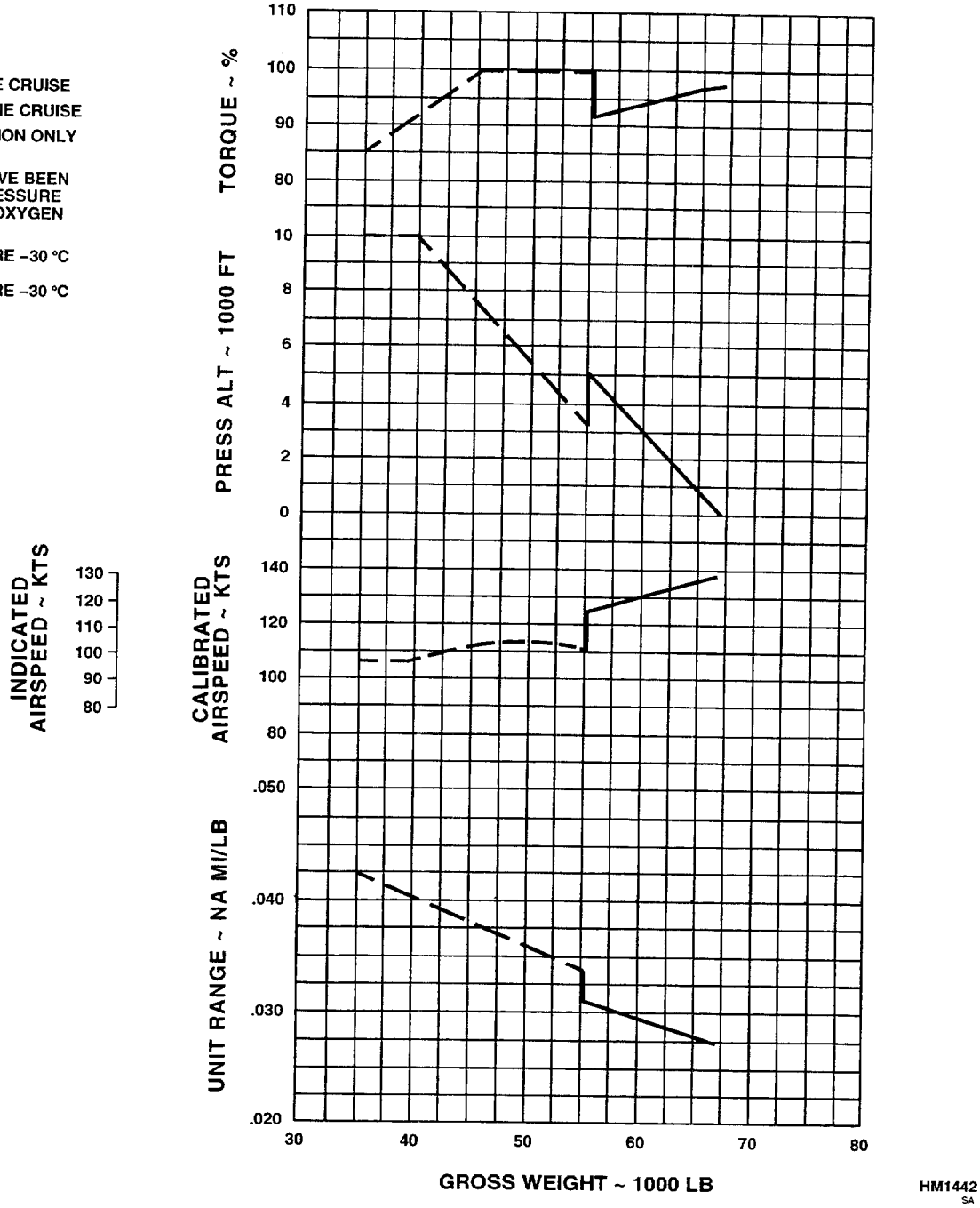


Figure 22-11. Optimum Cruise Altitude, Cold Day, Standard Temperature -30°C (416 Engine)

EXAMPLE
CRUISE
103% Nr PRESSURE ALT: 6000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

WANTED

A. CRUISE CONDITIONS FOR MAXIMUM RANGE
B. CONDITIONS FOR MAXIMUM ENDURANCE
C. MAXIMUM AIRSPEED IN LEVEL FLIGHT
D. MAXIMUM GROSS WEIGHT AND AIRSPEED FOR DUAL ENGINE (DE) LEVEL FLIGHT

KNOWN

OAT = +38° C
PRESSURE ALTITUDE = 5800 FT
GW = 52,500 LB

METHOD

A. TURN TO CRUISE CHART NEAREST KNOWN FLIGHT CONDITIONS, AT INTERSECTION OF LONGE RANGE LINE AND THE KNOWN VALUE OF GROSS WEIGHT:
MOVE DOWN, READ TAS = 147 KTS
MOVE UP, READ IAS = 119 KTS
MOVE LEFT, READ TORQUE = 70%
MOVE RIGHT, READ TOTAL FUEL FLOW = 3760 LB/HR

B. AT INTERSECTION OF MAX END AND R/C LINE AND KNOWN VALUE OF GROSS WEIGHT:
MOVE DOWN, READ TAS = 86 KTS
MOVE UP, READ IAS = 64 KTS
MOVE LEFT, READ TORQUE = 48%
MOVE RIGHT, READ TOTAL FUEL FLOW = 2900 LB/HR

C. AT THE INTERSECTION OF GROSS WEIGHT AND THE TORQUE AVAILABLE ~ 30 MINUTE OR AIRSPEED LIMIT, WHICHEVER OCCURS FIRST:
MOVE DOWN, READ TAS = 158 KTS
MOVE UP, READ IAS = 129 KTS
MOVE LEFT, READ TORQUE = 82%
MOVE RIGHT, READ TOTAL FUEL FLOW = 4230 LB/HR

D. AT INTERSECTION OF TORQUE AVAILABLE ~ 30 MINUTE LINE AND TORQUE PER ENGINE SCALE READ TORQUE = 92%
ENTRY FOR DE LEVEL FLIGHT IS
0.66 X 92 = 61%
AT INTERSECTION OF 61% TRQ AND MAX END AND R/C LINE, MOVE UP, READ IAS = 70 KTS
INTERPOLATE MAX GROSS WEIGHT = 63,600 LB

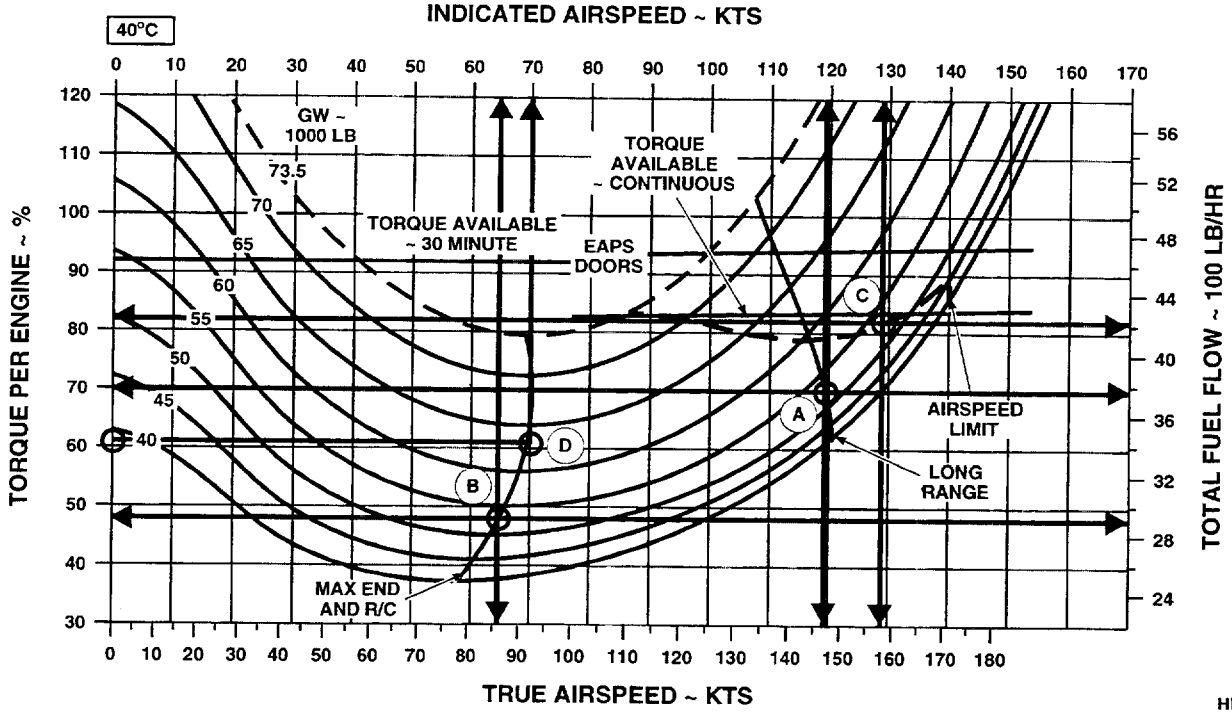


Figure 22-12. Cruise - Pressure Altitude Example (419 Engine)

CRUISE
103% Nr PRESSURE ALT: 0 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

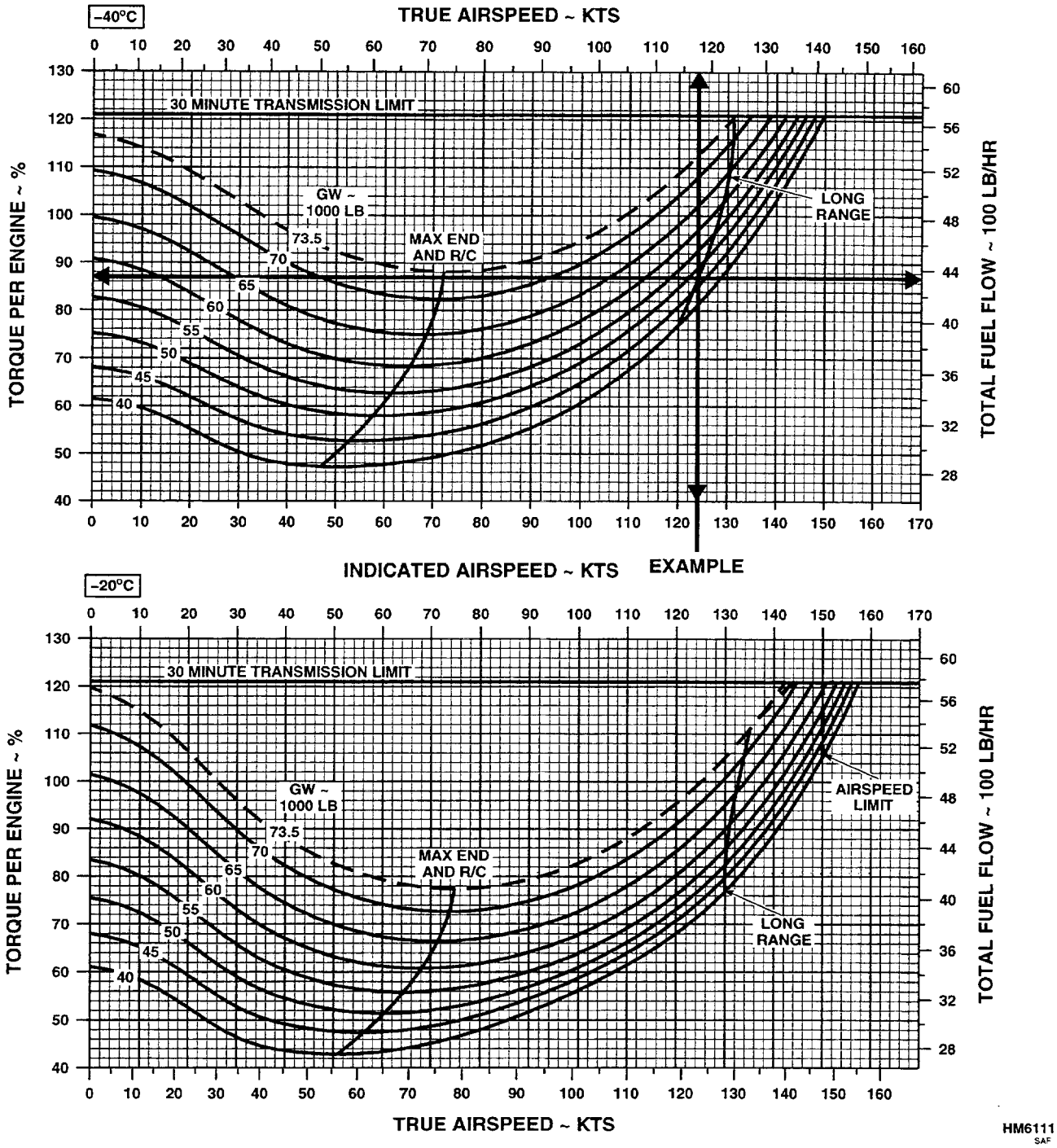


Figure 22-13. Cruise - Pressure Altitude Sea Level (419 Engine) (Sheet 1 of 4)

CRUISE
103% Nr PRESSURE ALT: 0 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

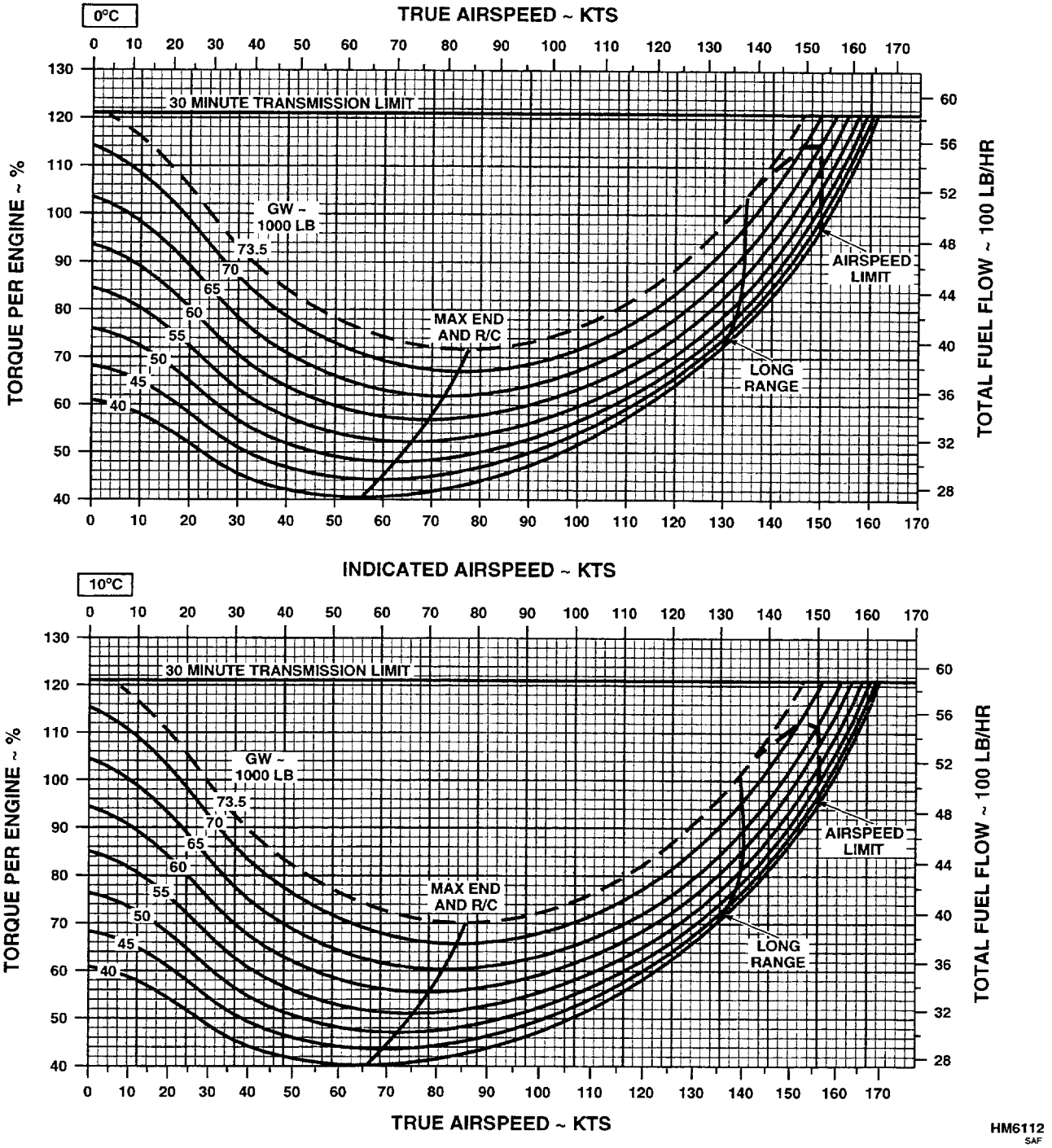


Figure 22-13. Cruise - Pressure Altitude Sea Level (419 Engine) (Sheet 2 of 4)

CRUISE
103% Nr PRESSURE ALT: 0 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

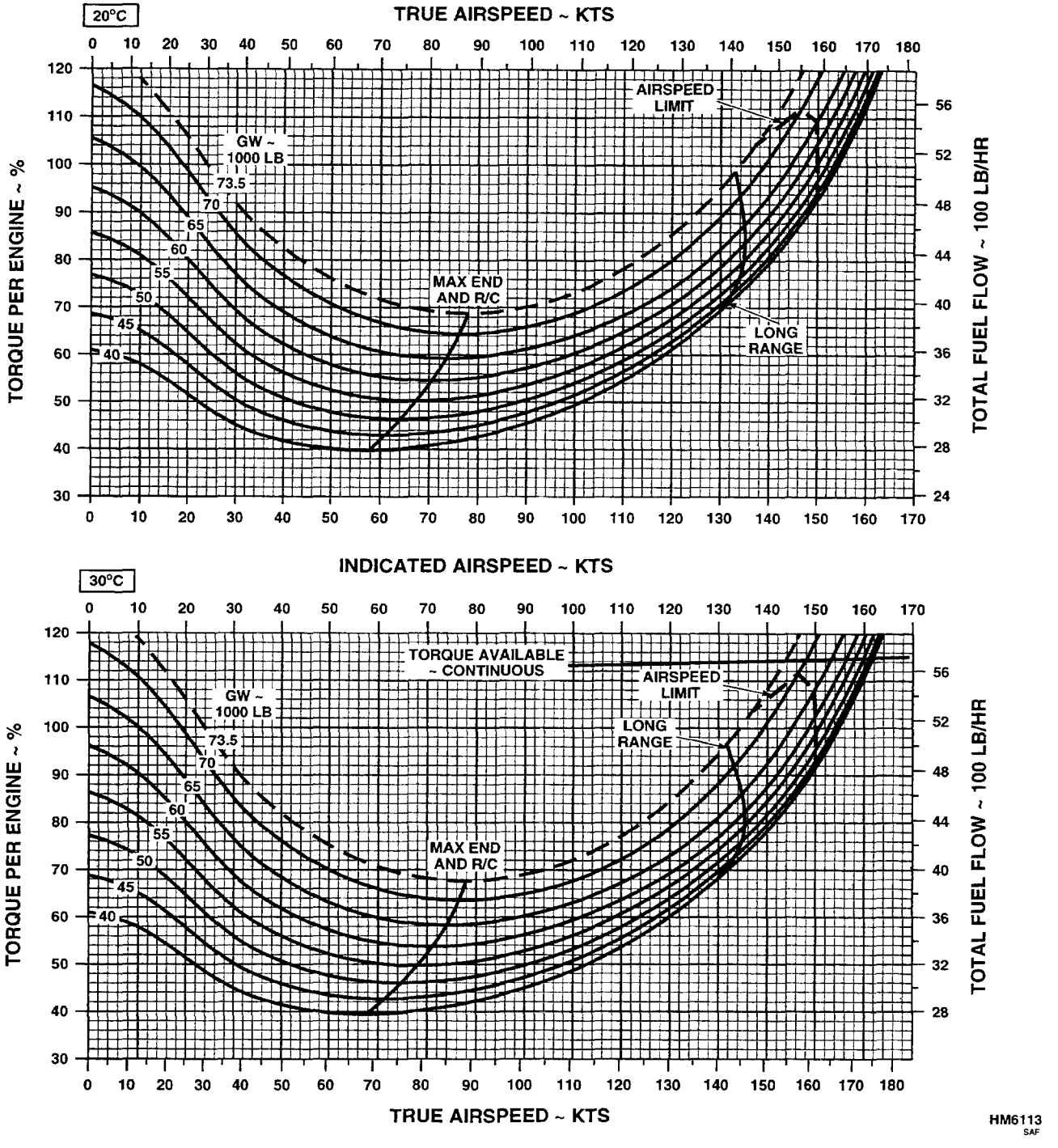


Figure 22-13. Cruise - Pressure Altitude Sea Level (419 Engine) (Sheet 3 of 4)

CRUISE
103% Nr PRESSURE ALT: 0 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

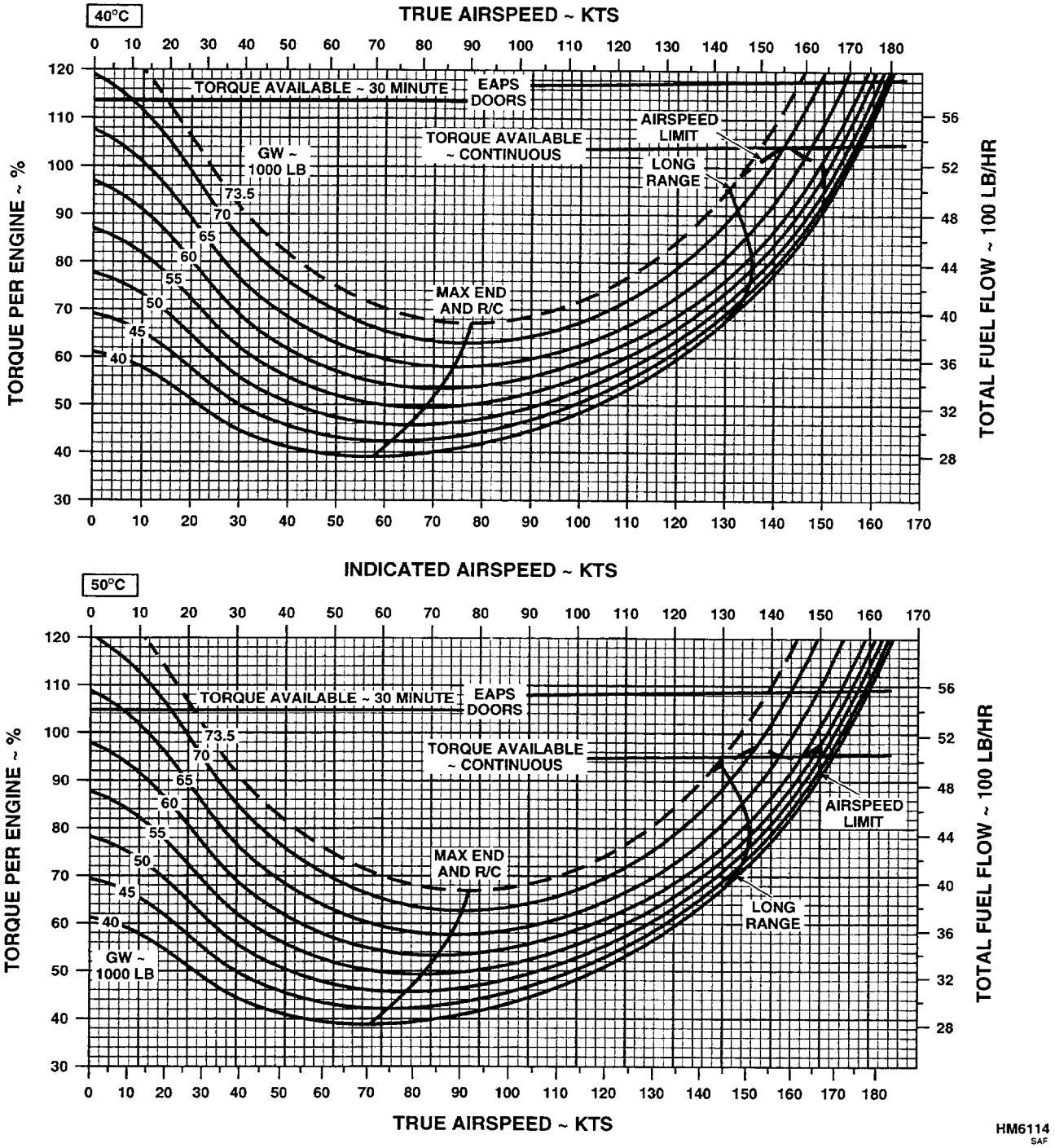


Figure 22-13. Cruise - Pressure Altitude Sea Level (419 Engine) (Sheet 4 of 4)

CRUISE
103% Nr PRESSURE ALT: 2000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

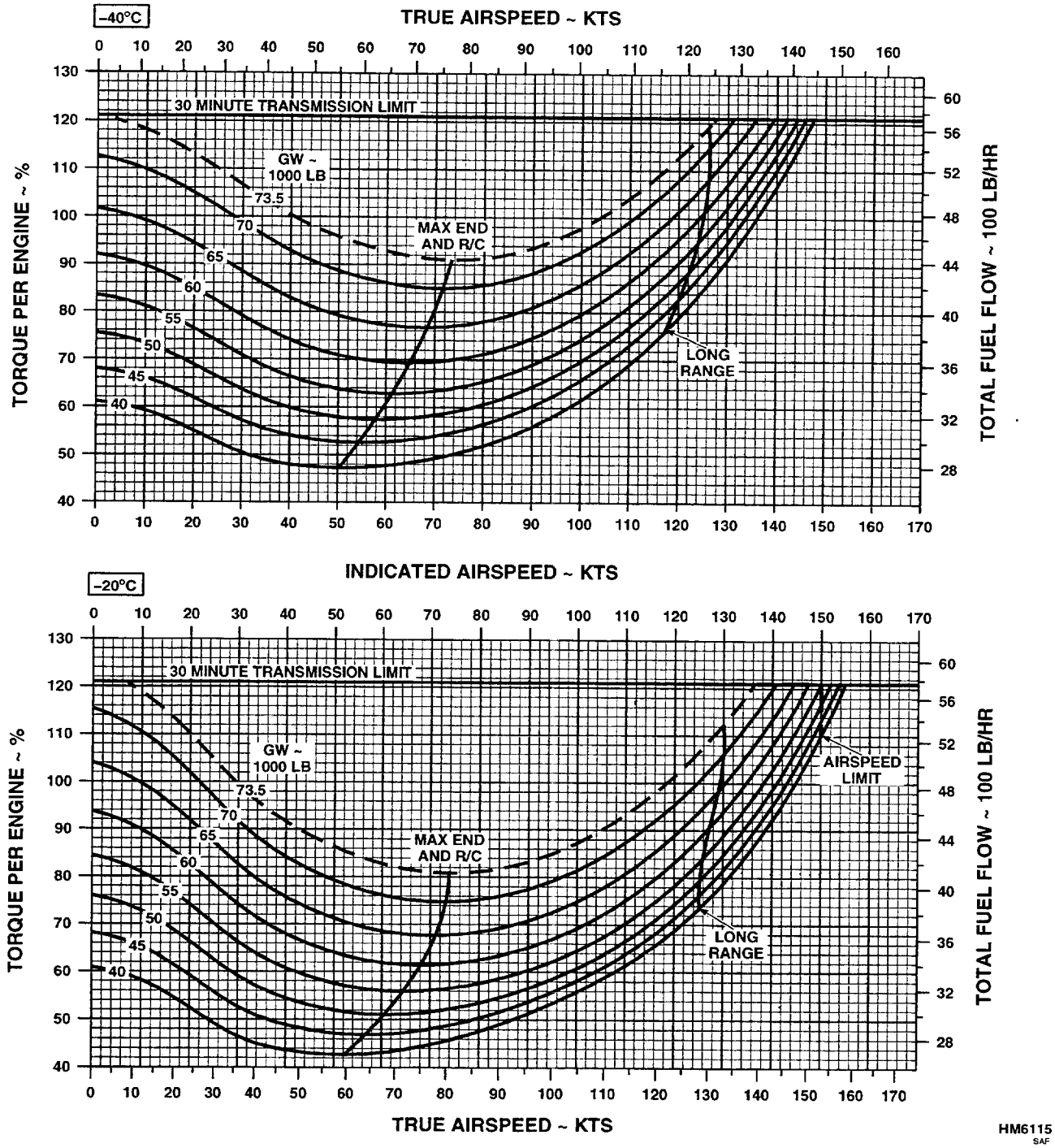


Figure 22-14. Cruise - Pressure Altitude 2000 Feet (419 Engine) (Sheet 1 of 4)

CRUISE
103% Nr PRESSURE ALT: 2000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

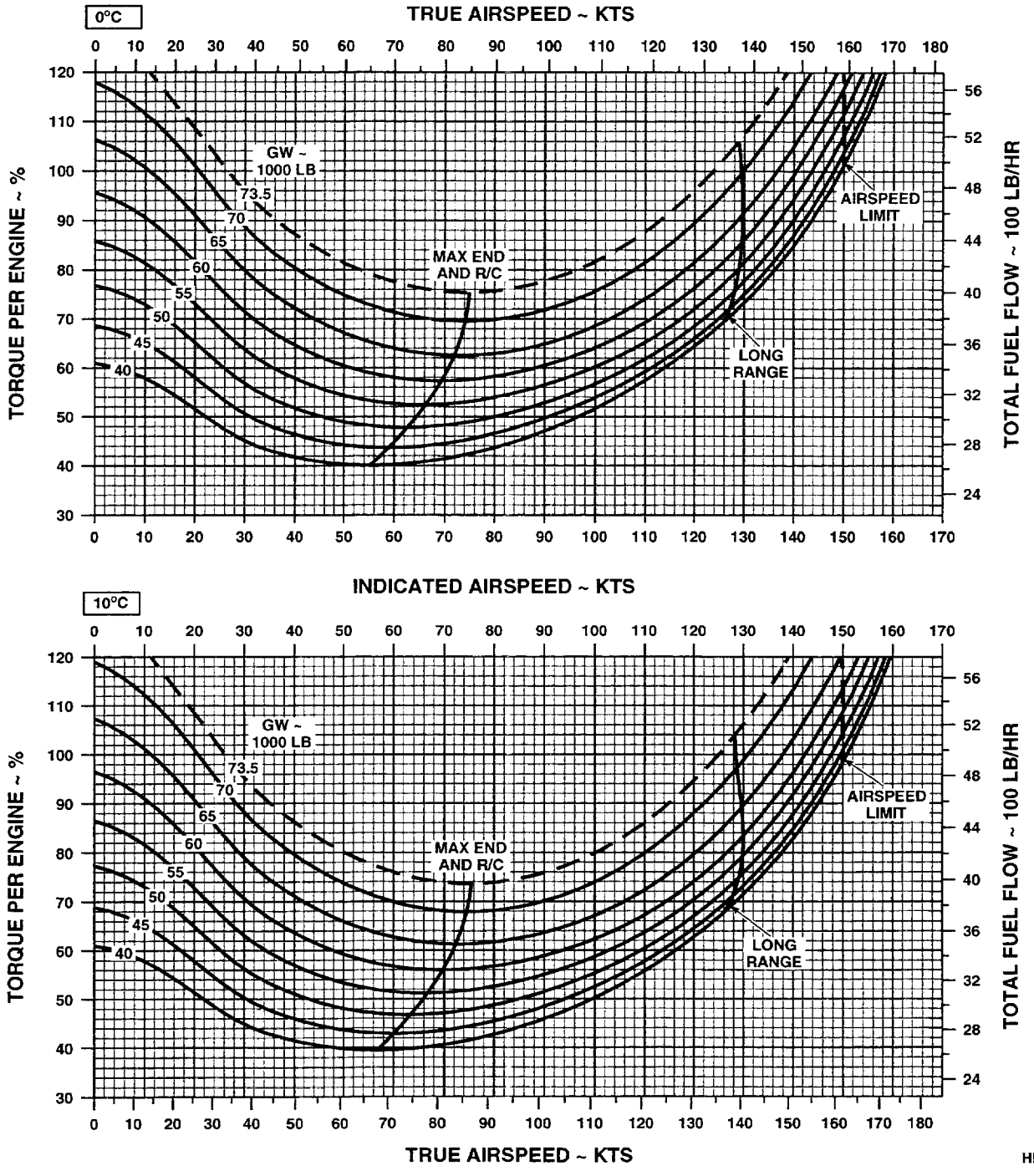


Figure 22-14. Cruise - Pressure Altitude 2000 Feet (419 Engine) (Sheet 2 of 4)

CRUISE
103% Nr PRESSURE ALT: 2000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

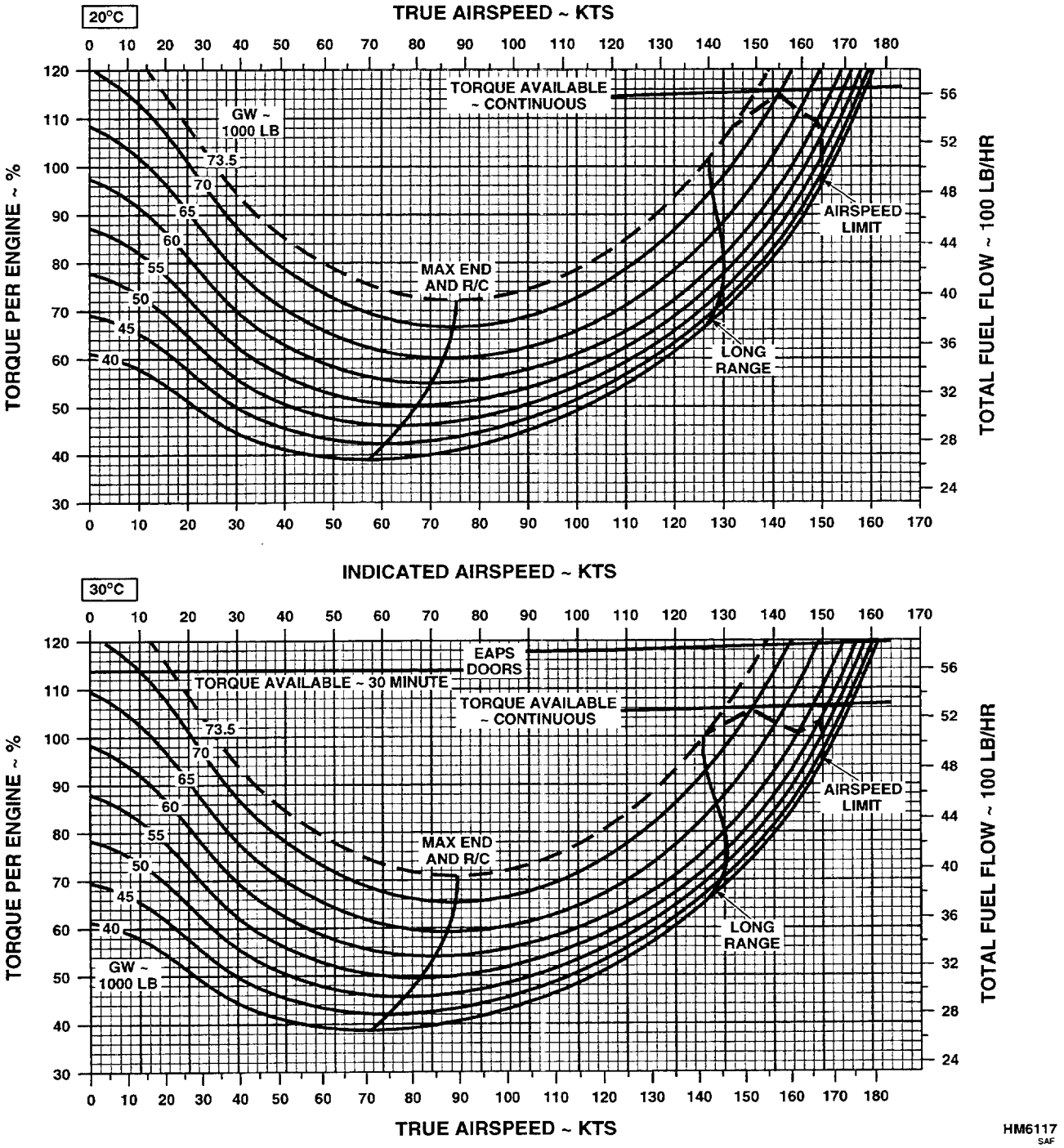


Figure 22-14. Cruise - Pressure Altitude 2000 Feet (419 Engine) (Sheet 3 of 4)

CRUISE
103% Nr PRESSURE ALT: 2000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

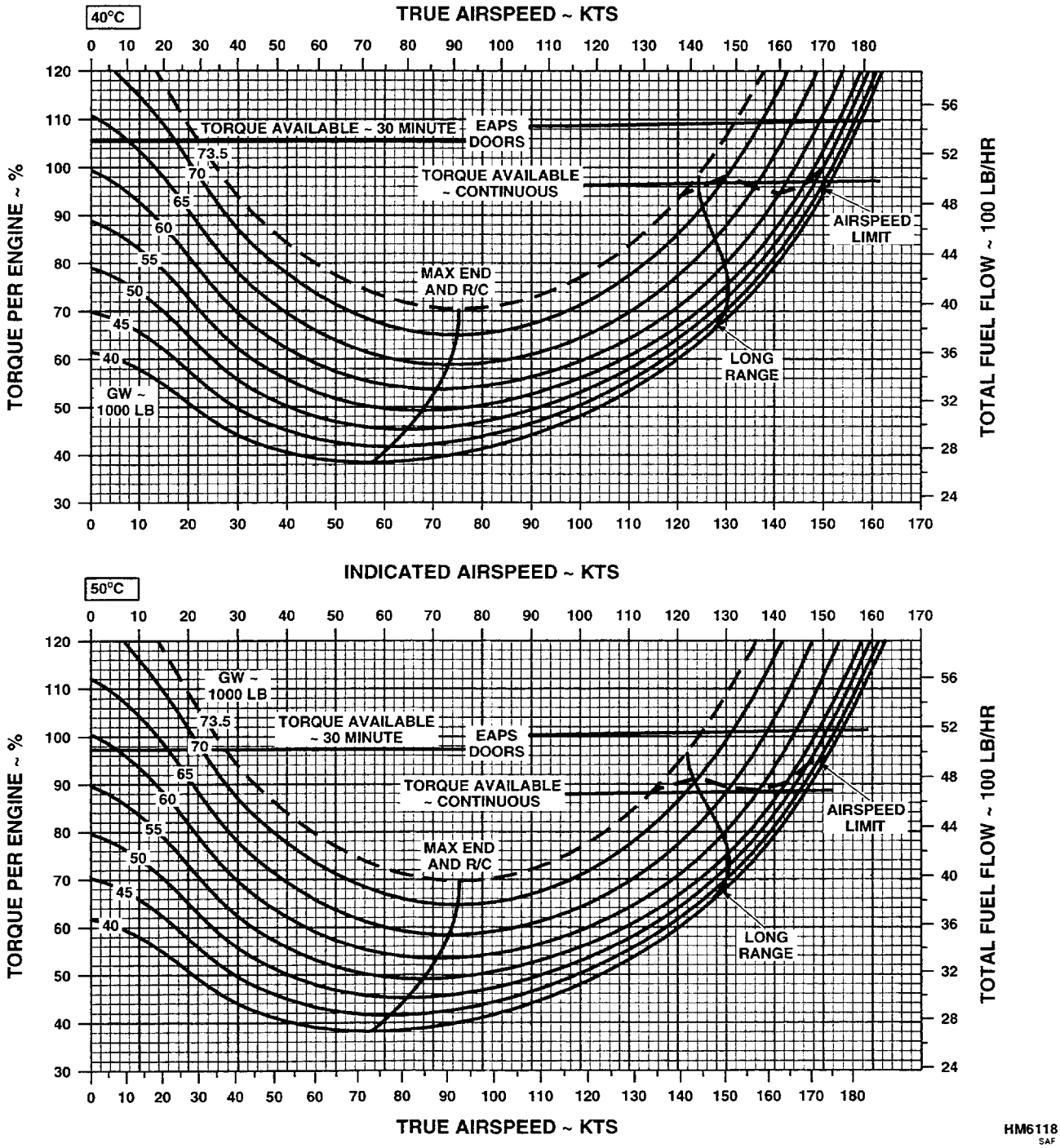


Figure 22-14. Cruise - Pressure Altitude 2000 Feet (419 Engine) (Sheet 4 of 4)

CRUISE
103% Nr PRESSURE ALT: 4000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

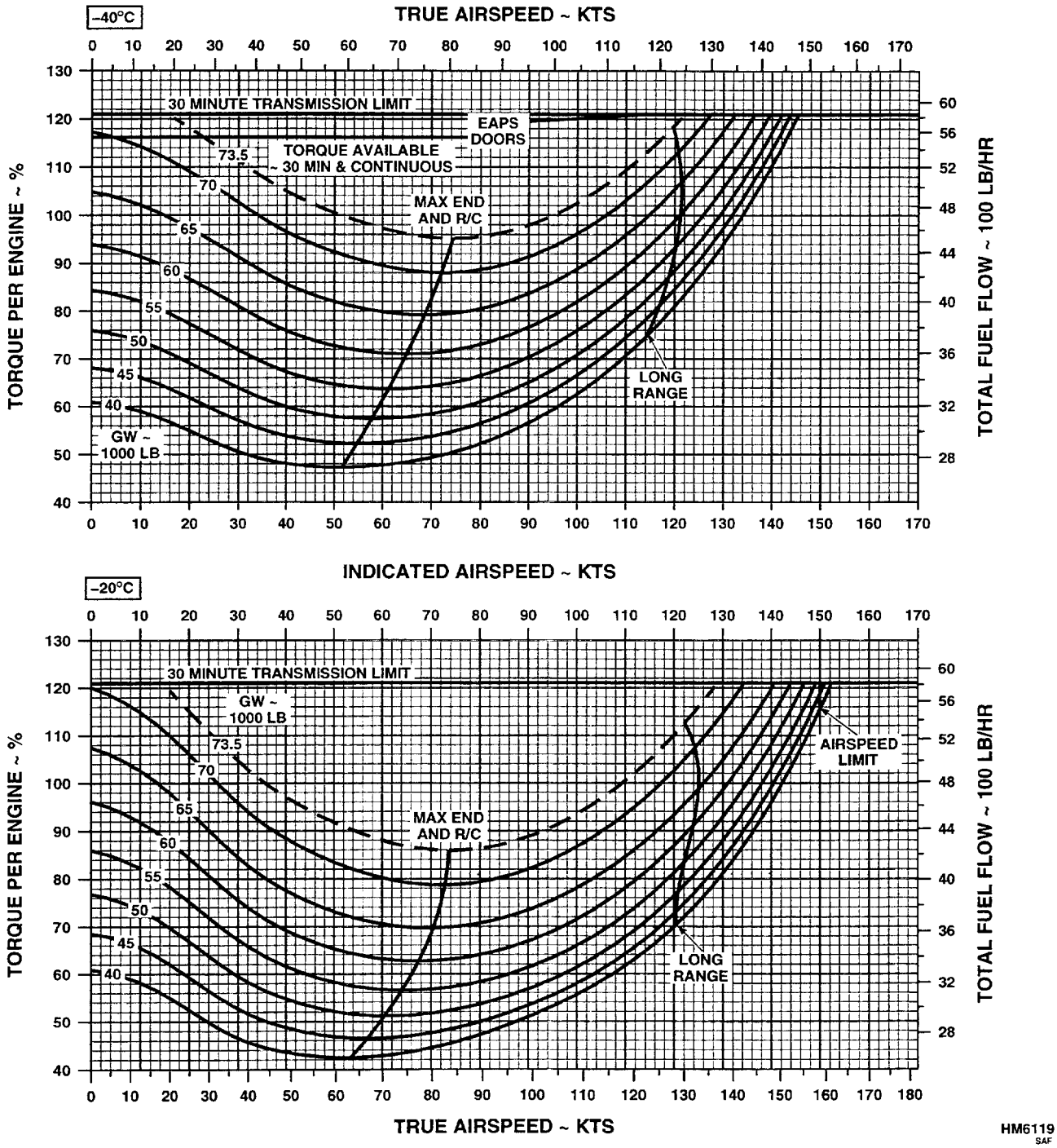


Figure 22-15. Cruise - Pressure Altitude 4000 Feet (419 Engine) (Sheet 1 of 4)

CRUISE
103% Nr PRESSURE ALT: 4000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

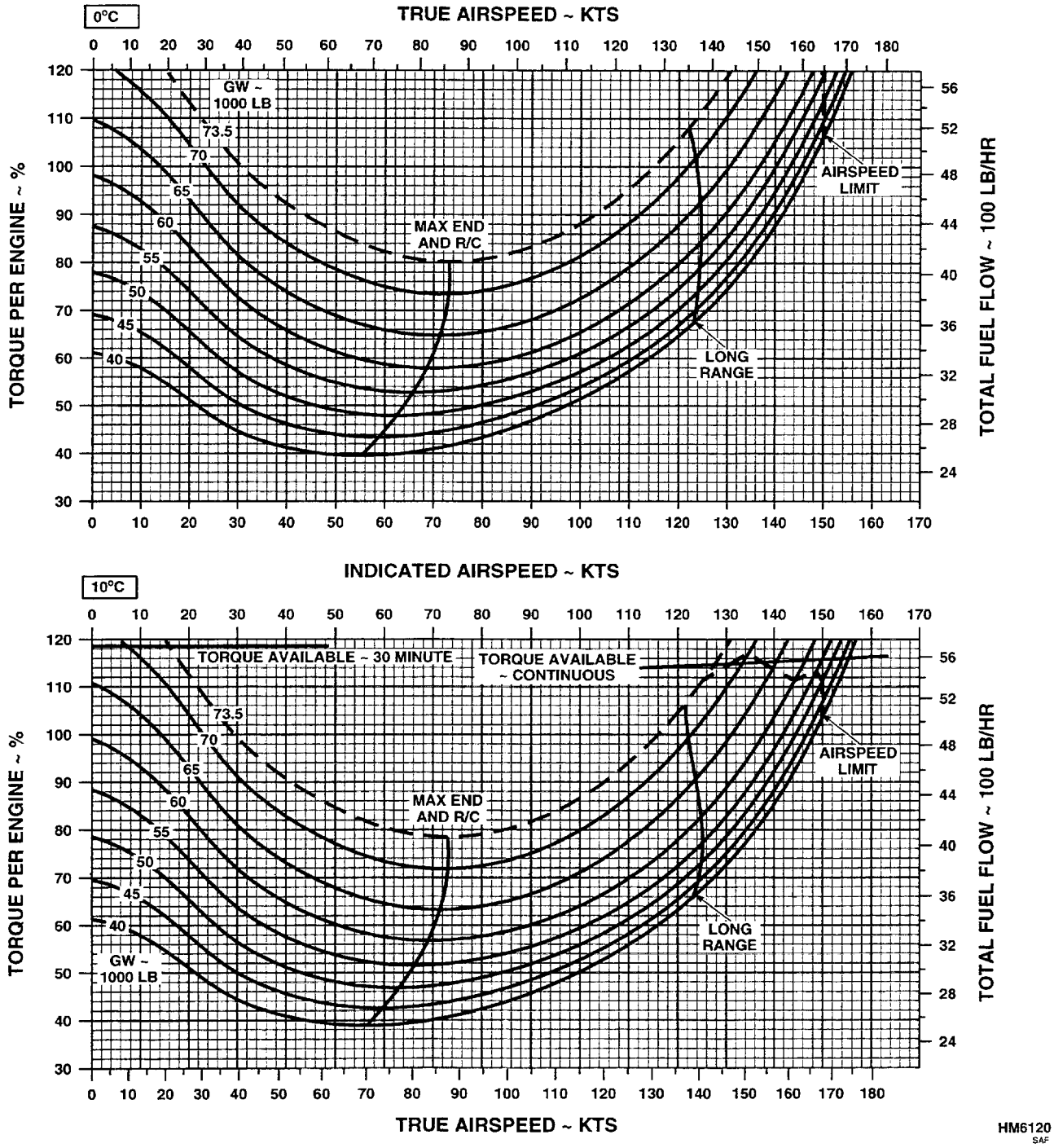


Figure 22-15. Cruise - Pressure Altitude 4000 Feet (419 Engine) (Sheet 2 of 4)

CRUISE
103% Nr PRESSURE ALT: 4000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

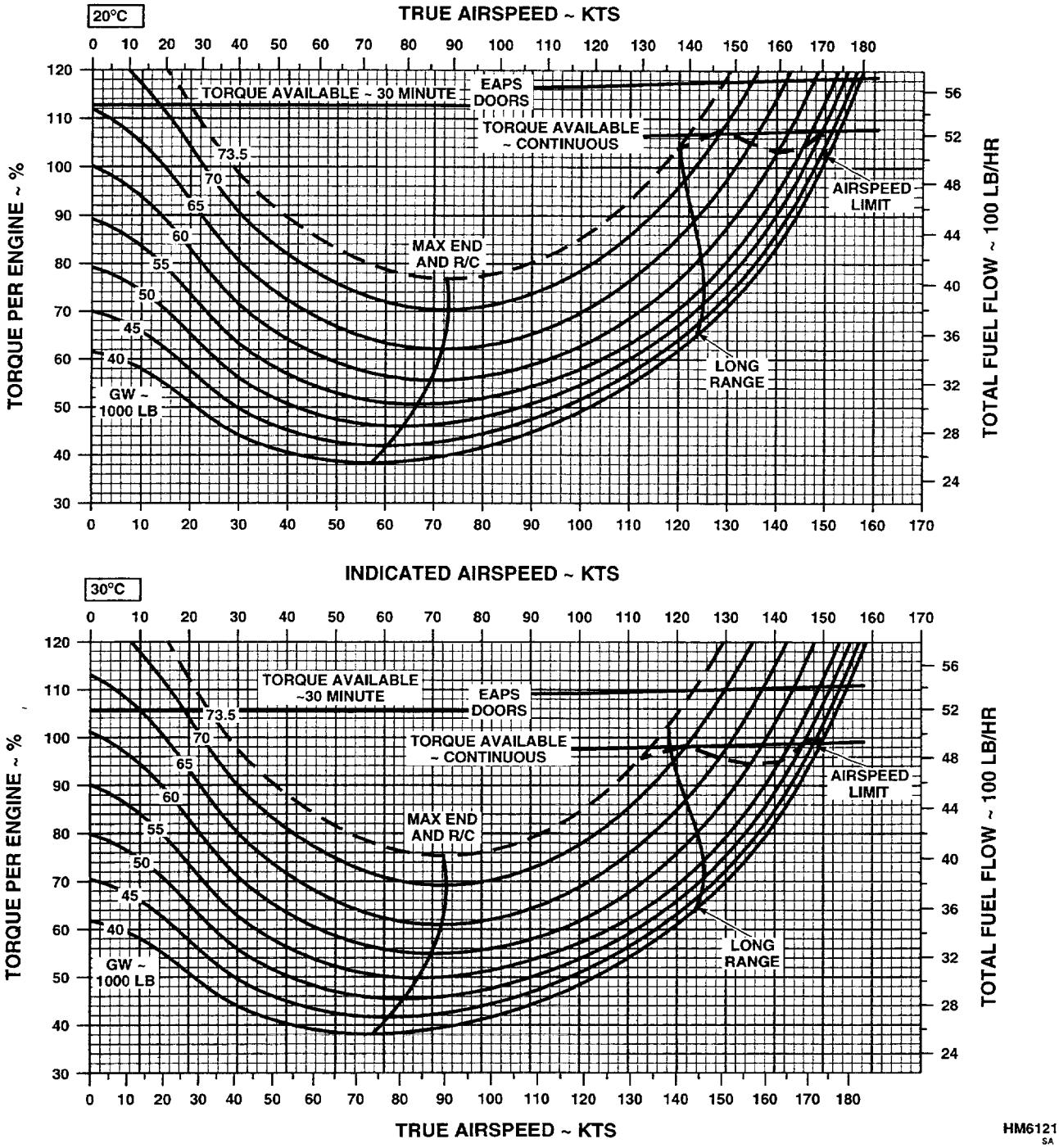


Figure 22-15. Cruise - Pressure Altitude 4000 Feet (419 Engine) (Sheet 3 of 4)

CRUISE
103% Nr PRESSURE ALT: 4000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

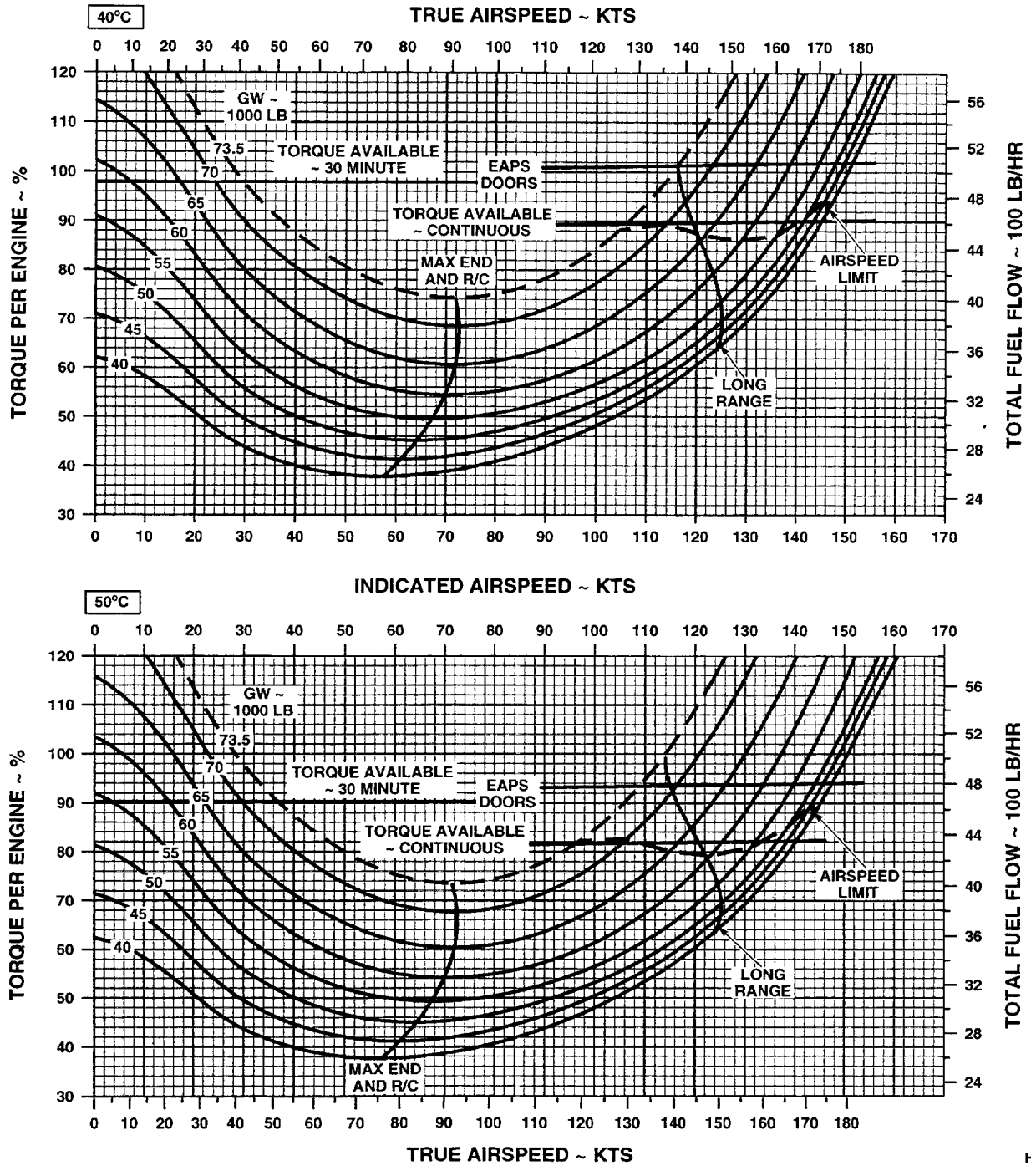


Figure 22-15. Cruise - Pressure Altitude 4000 Feet (419 Engine) (Sheet 4 of 4)

CRUISE
103% Nr PRESSURE ALT: 6000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

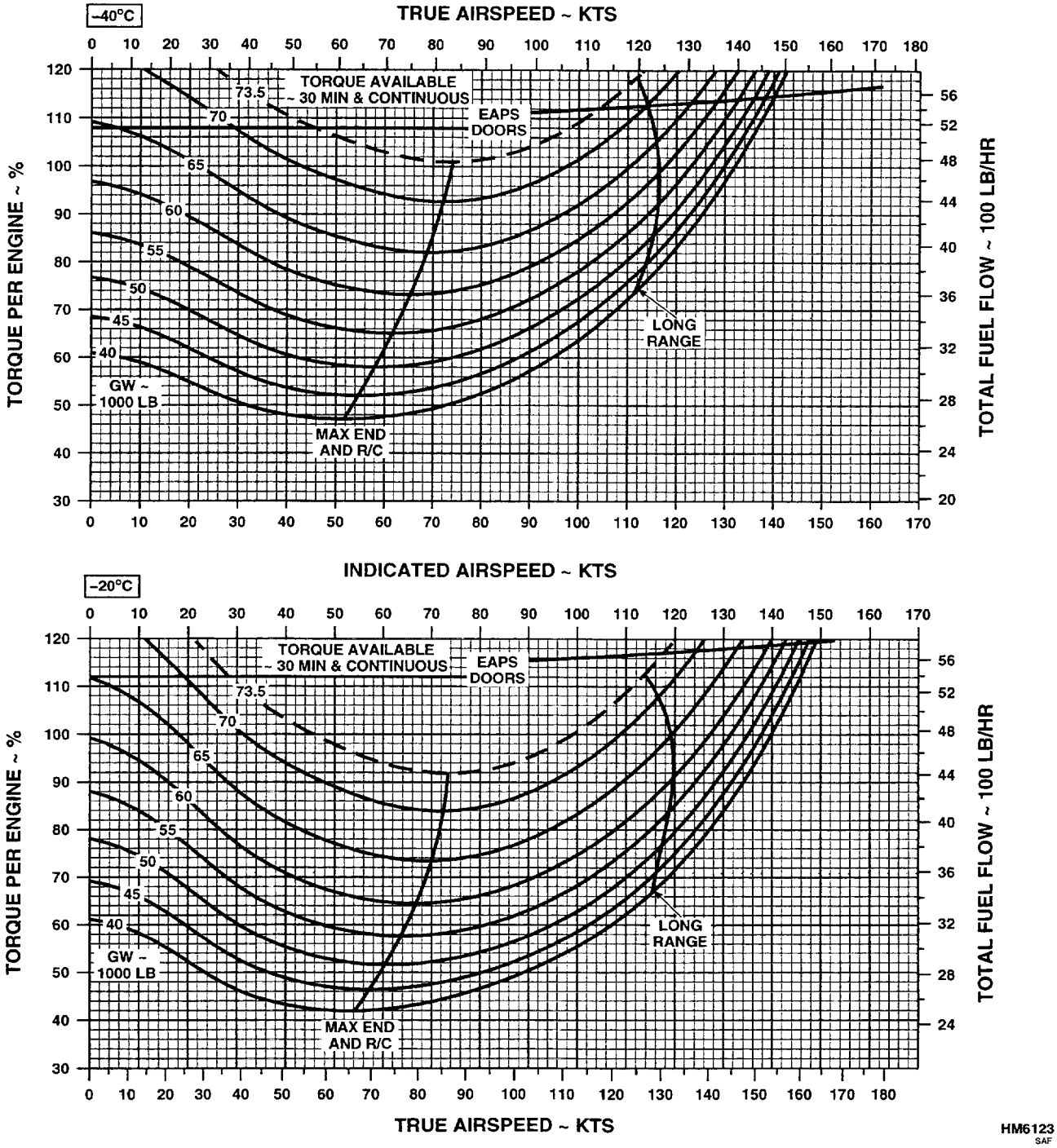


Figure 22-16. Cruise - Pressure Altitude 6000 Feet (419 Engine) (Sheet 1 of 4)

CRUISE
103% Nr PRESSURE ALT: 6000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

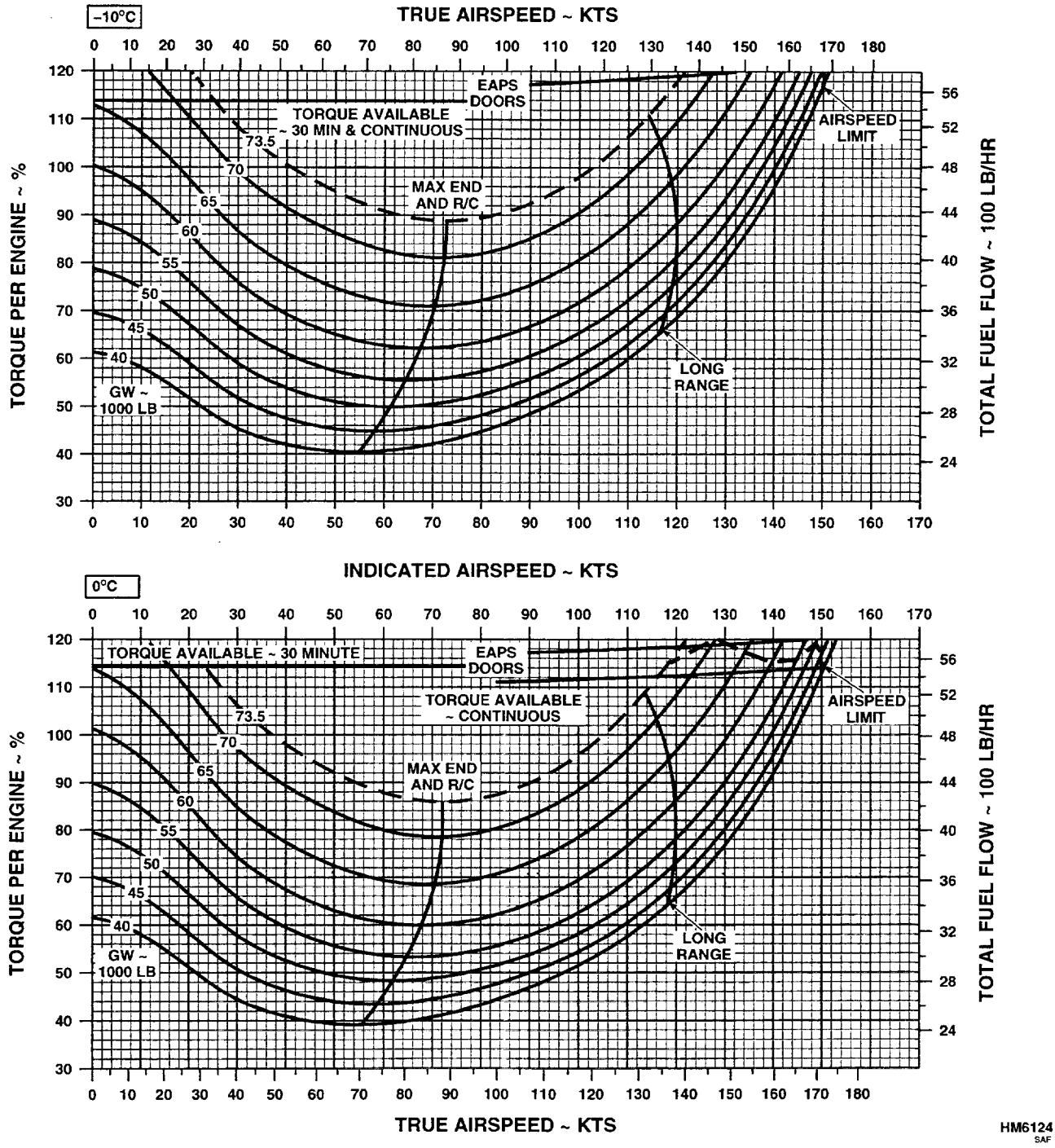
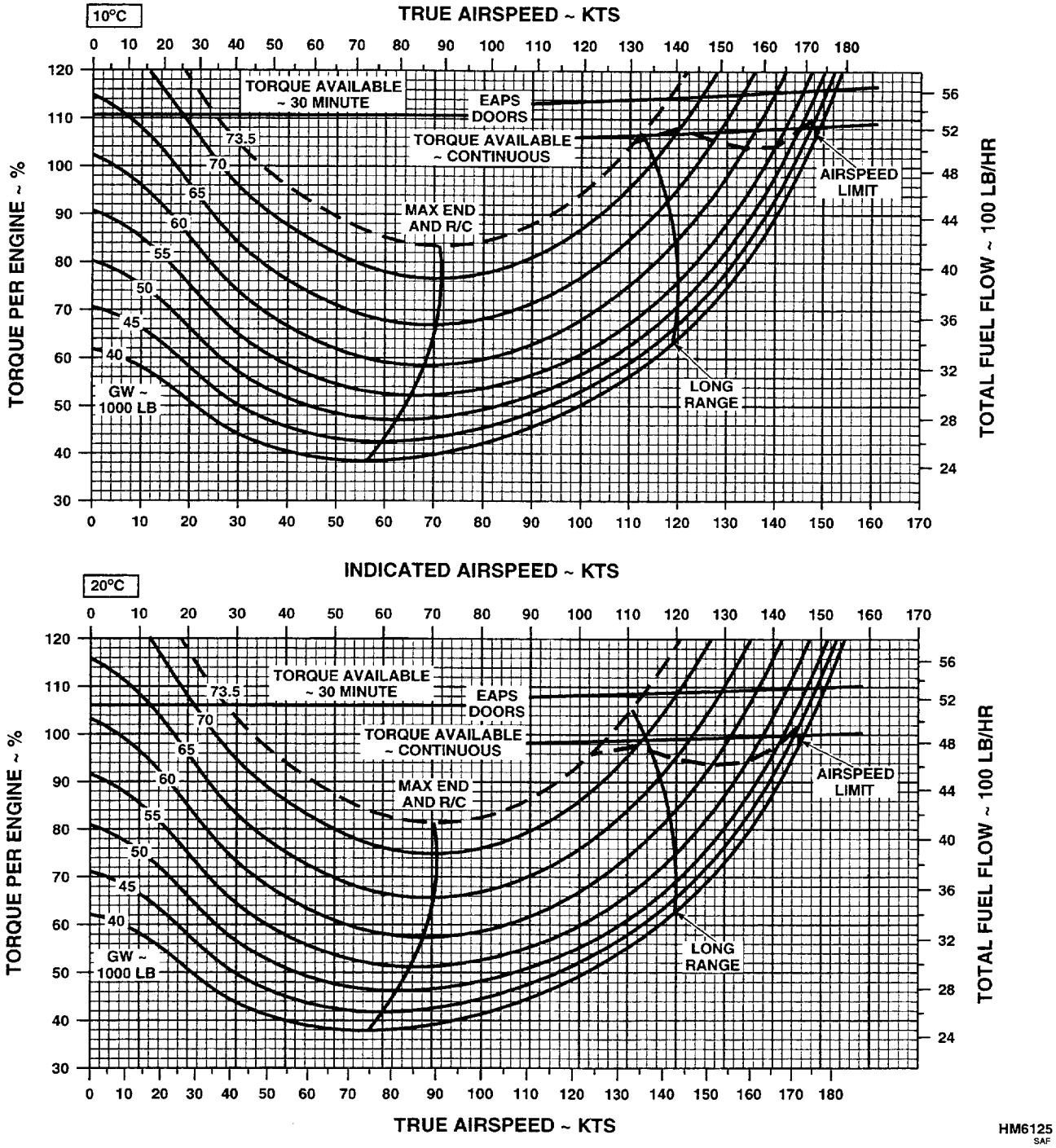


Figure 22-16. Cruise - Pressure Altitude 6000 Feet (419 Engine) (Sheet 2 of 4)

CRUISE
103% Nr PRESSURE ALT: 6000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 22-16. Cruise - Pressure Altitude 6000 Feet (419 Engine) (Sheet 3 of 4)

CRUISE
103% Nr PRESSURE ALT: 6000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

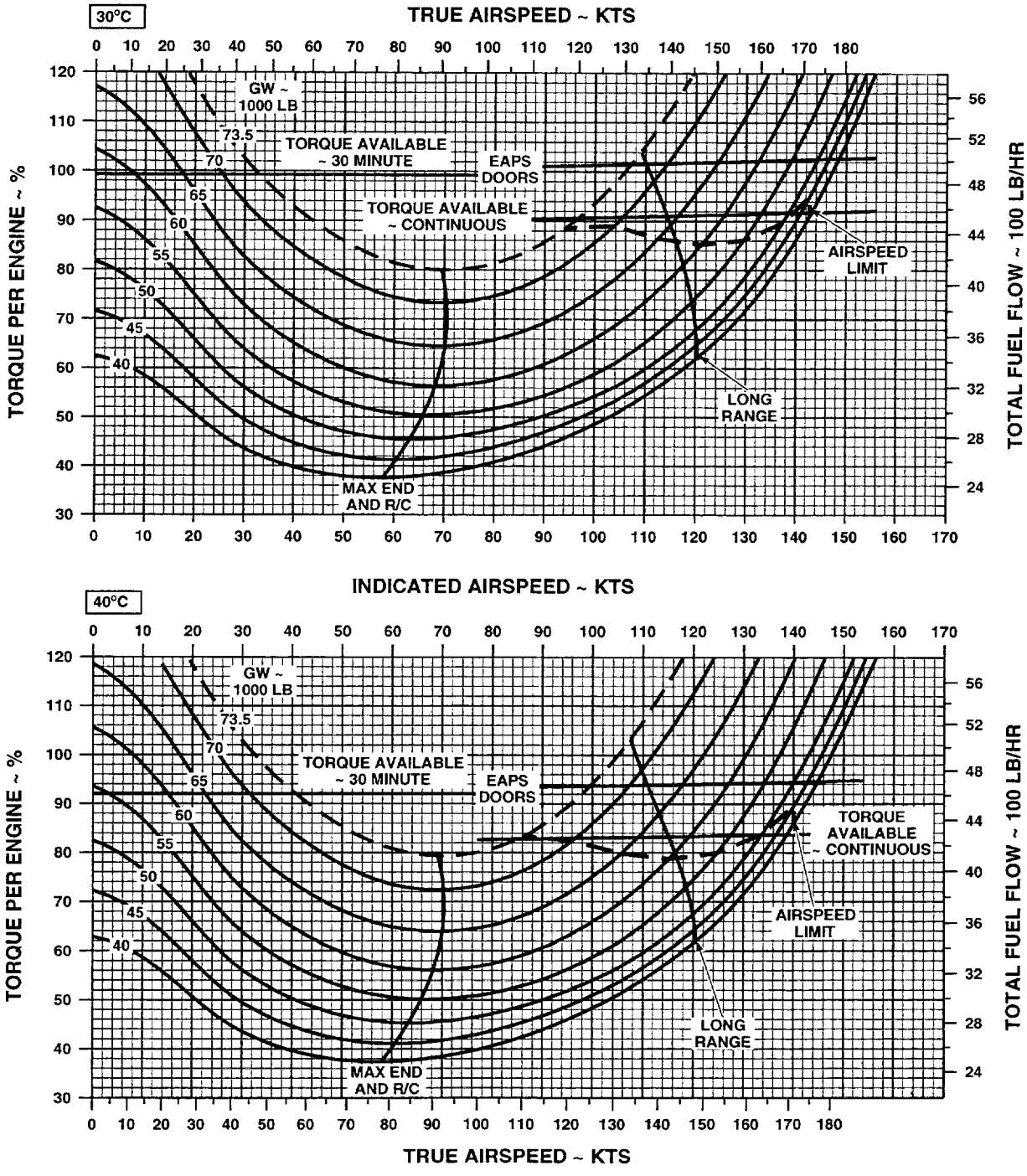


Figure 22-16. Cruise - Pressure Altitude 6000 Feet (419 Engine) (Sheet 4 of 4)

CRUISE
103% Nr PRESSURE ALT: 8000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

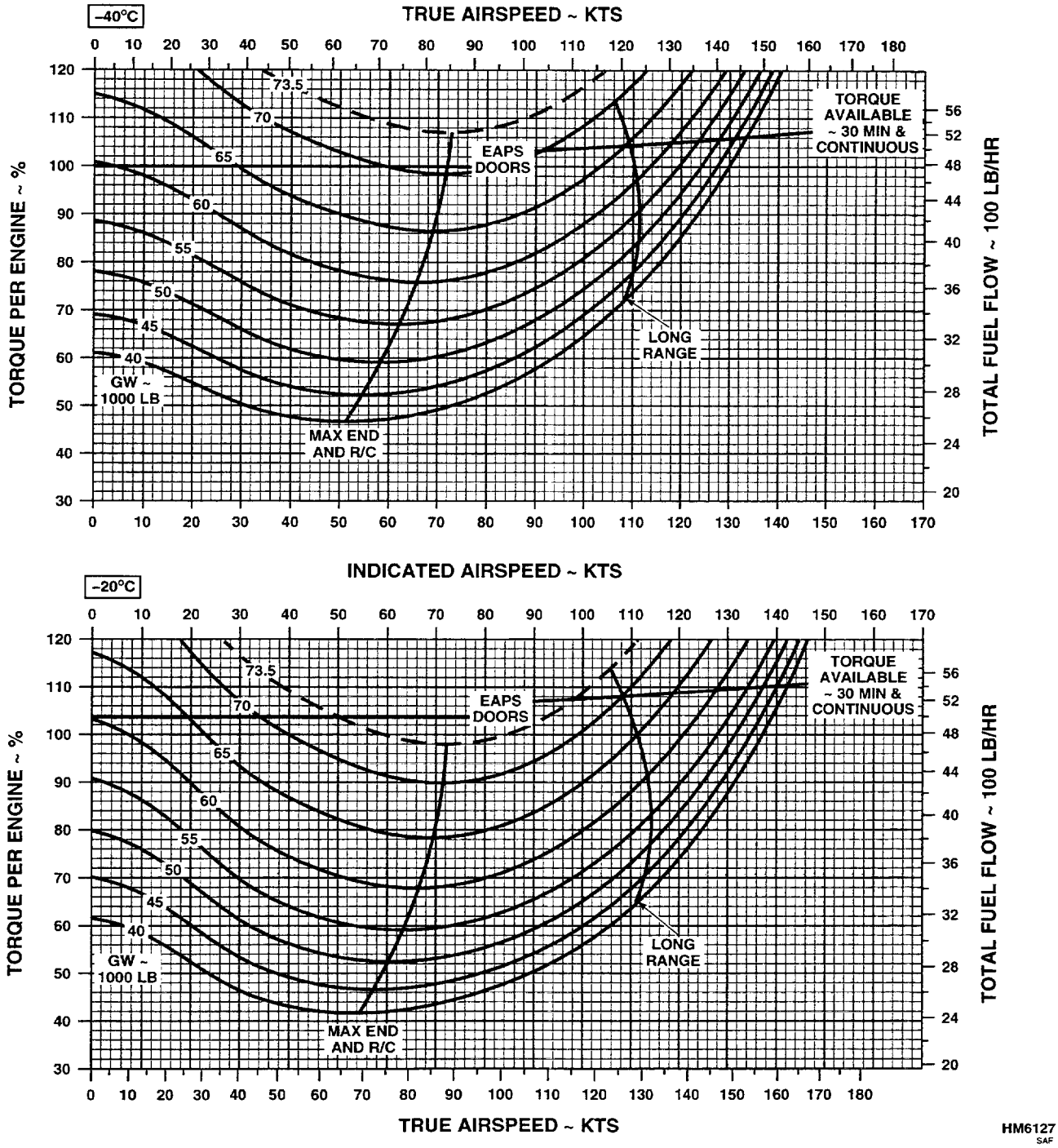
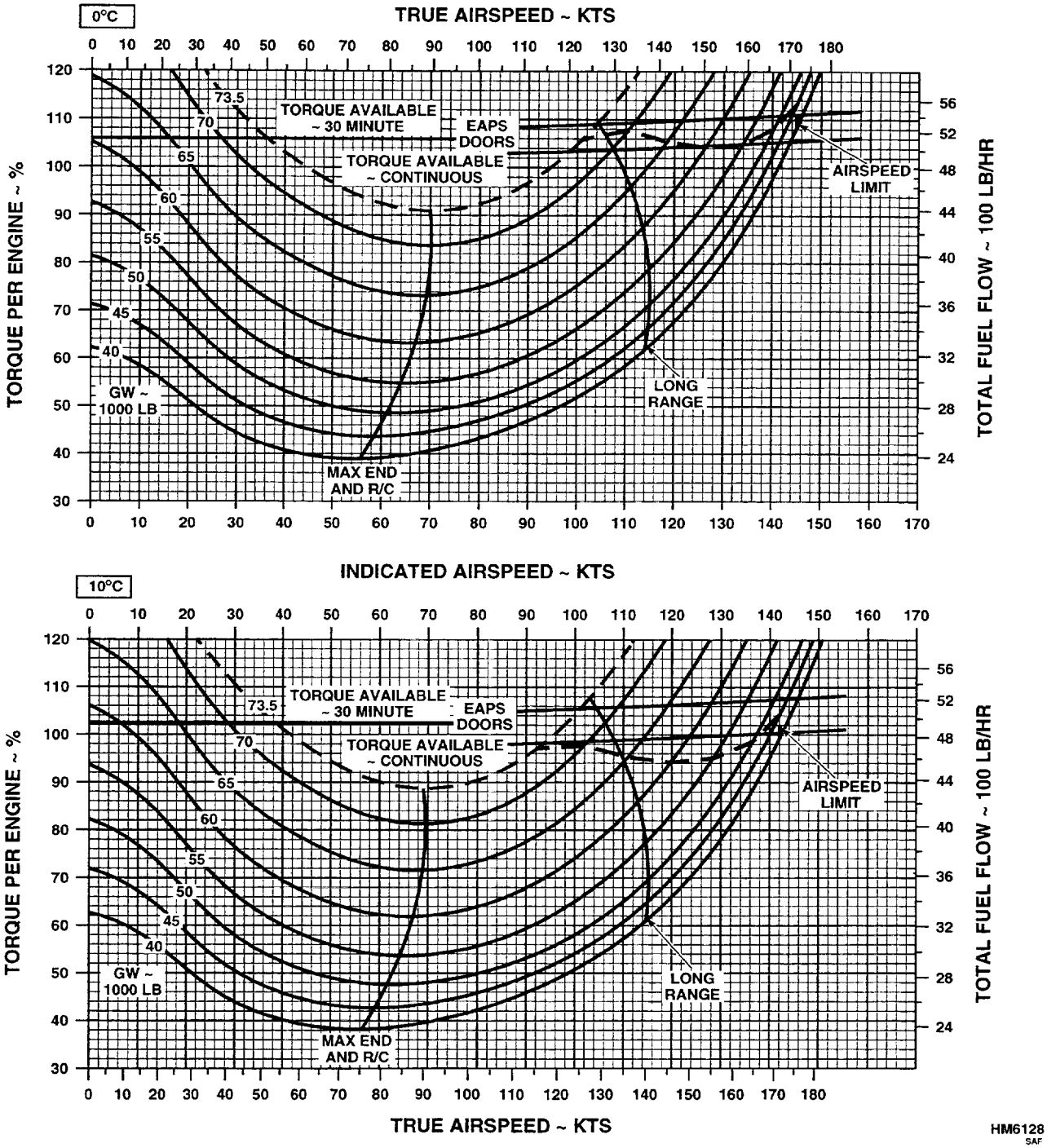


Figure 22-17. Cruise - Pressure Altitude 8000 Feet (419 Engine) (Sheet 1 of 3)

CRUISE
103% Nr PRESSURE ALT: 8000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



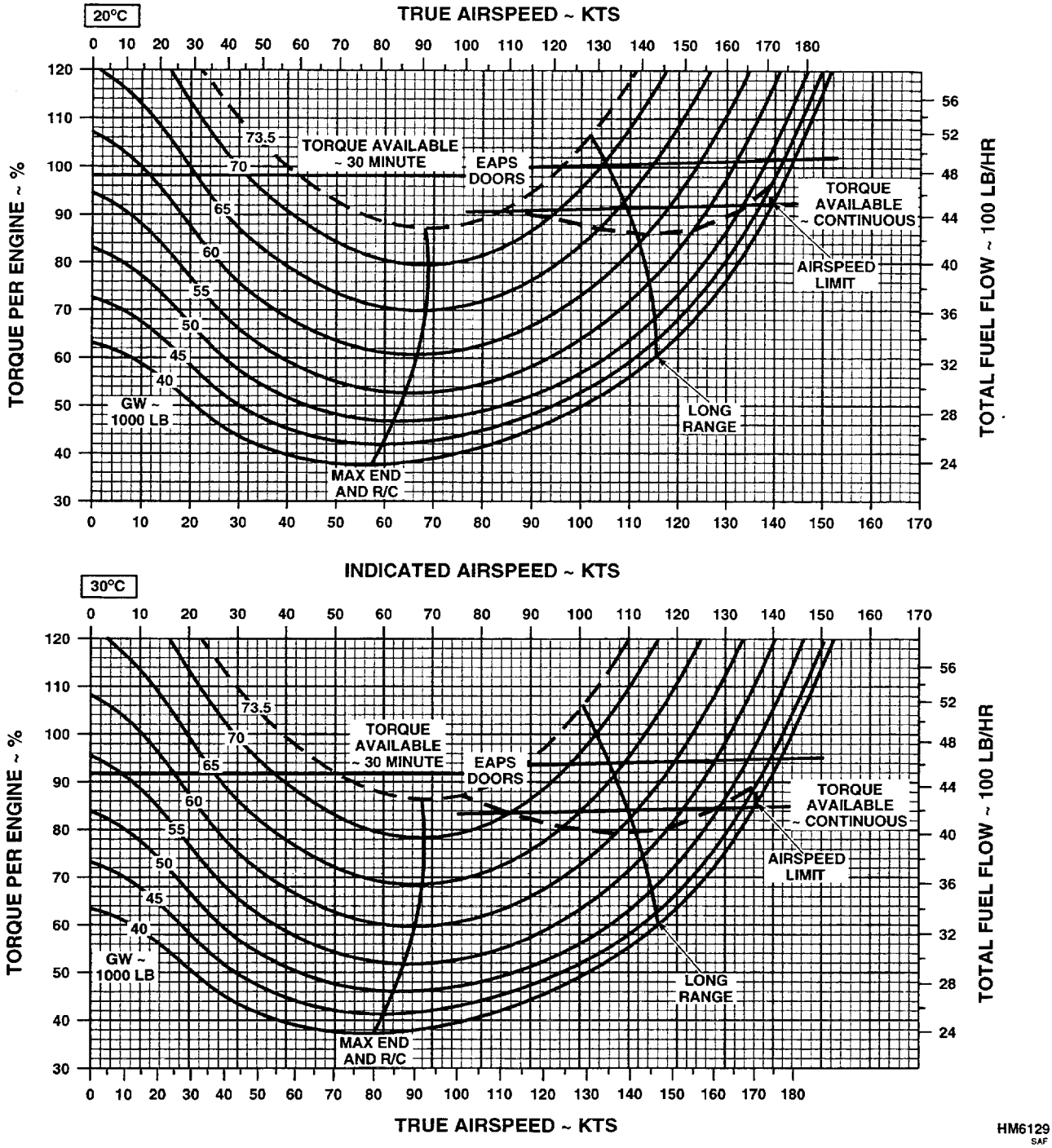
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Figure 22-17. Cruise - Pressure Altitude 8000 Feet (419 Engine) (Sheet 2 of 3)

CRUISE
103% Nr PRESSURE ALT: 8000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 22-17. Cruise - Pressure Altitude 8000 Feet (419 Engine) (Sheet 3 of 3)

CRUISE
103% Nr PRESSURE ALT: 10000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

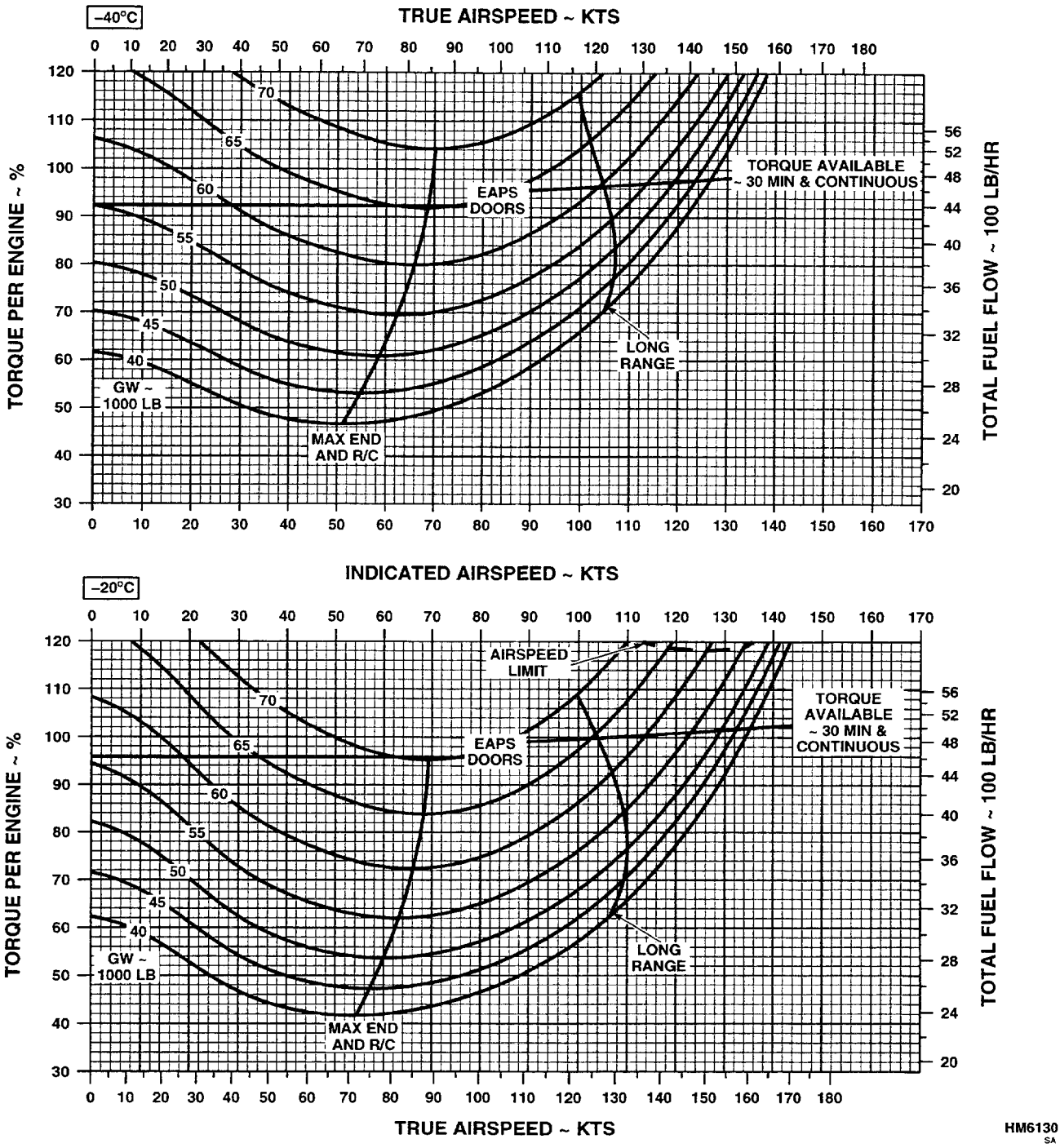


Figure 22-18. Cruise - Pressure Altitude 10,000 Feet (419 Engine) (Sheet 1 of 3)

CRUISE
103% Nr PRESSURE ALT: 10000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

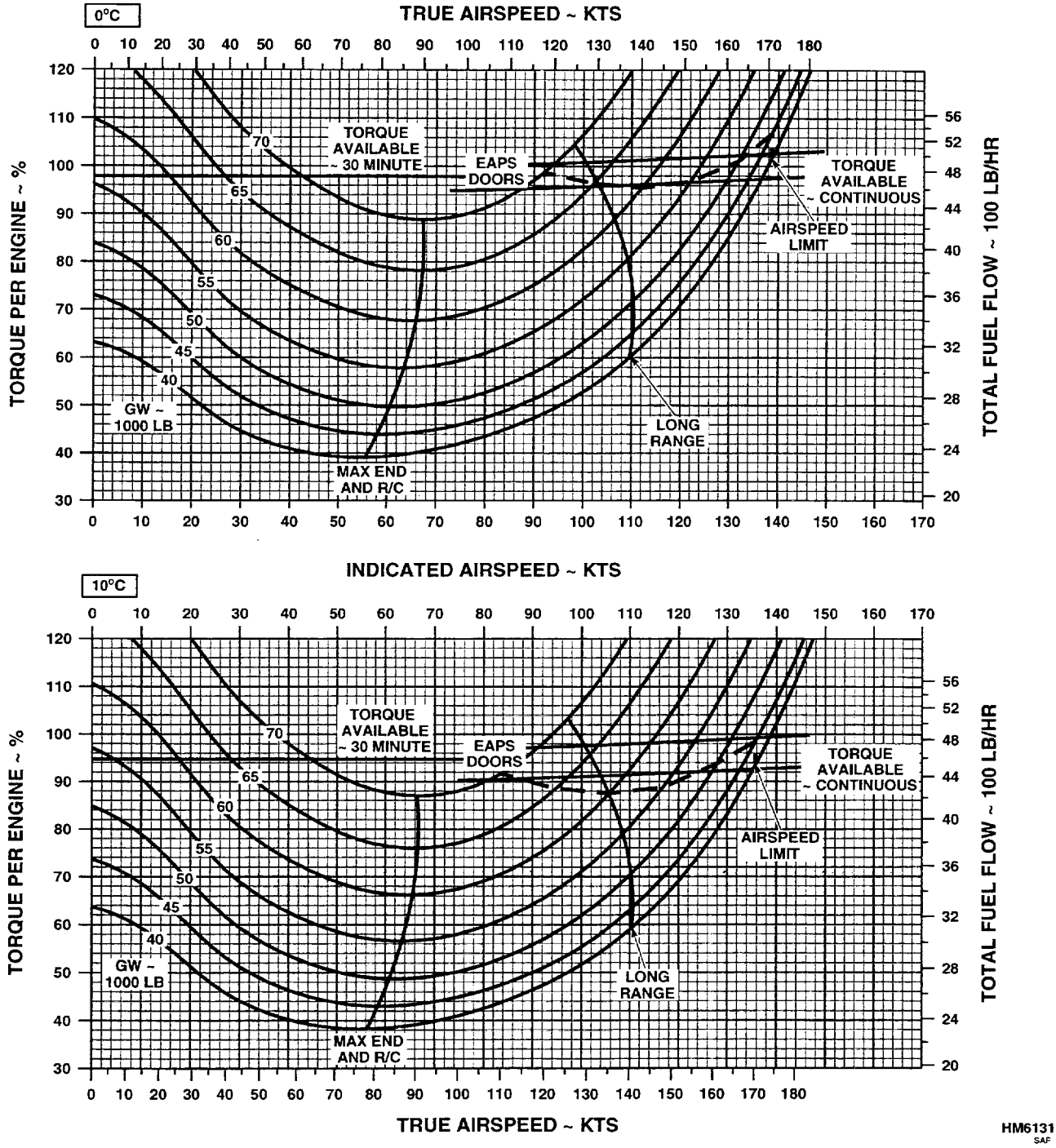


Figure 22-18. Cruise - Pressure Altitude 10,000 Feet (419 Engine) (Sheet 2 of 3)

CRUISE
103% Nr PRESSURE ALT: 10000 FT

MODEL: MH-53E
DATE: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINES:(3) T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

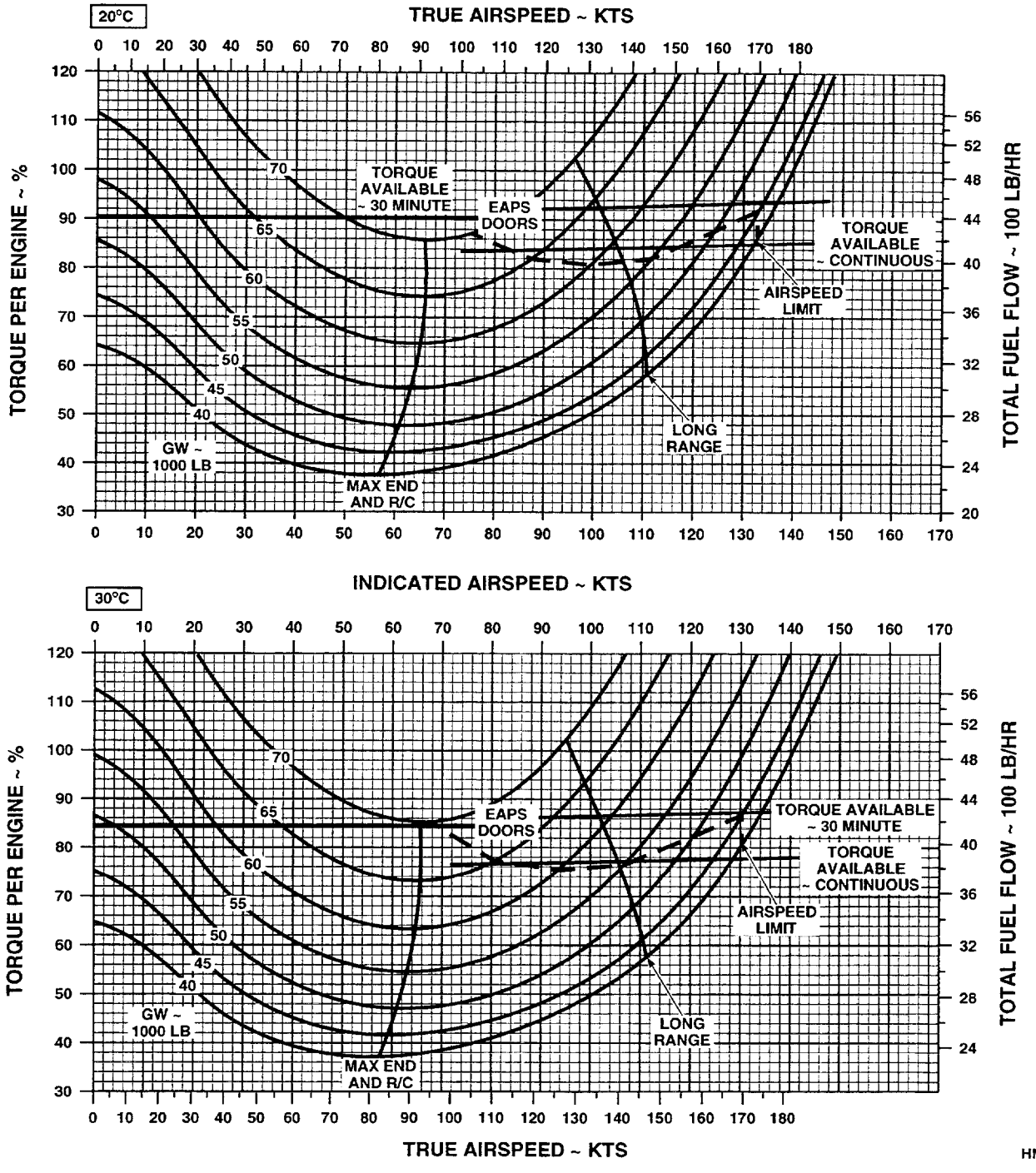


Figure 22-18. Cruise - Pressure Altitude 10,000 Feet (419 Engine) (Sheet 3 of 3)

CRUISE CAPABILITY

TIME AND RANGE
ZERO WIND NO RESERVES

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ESTIMATED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

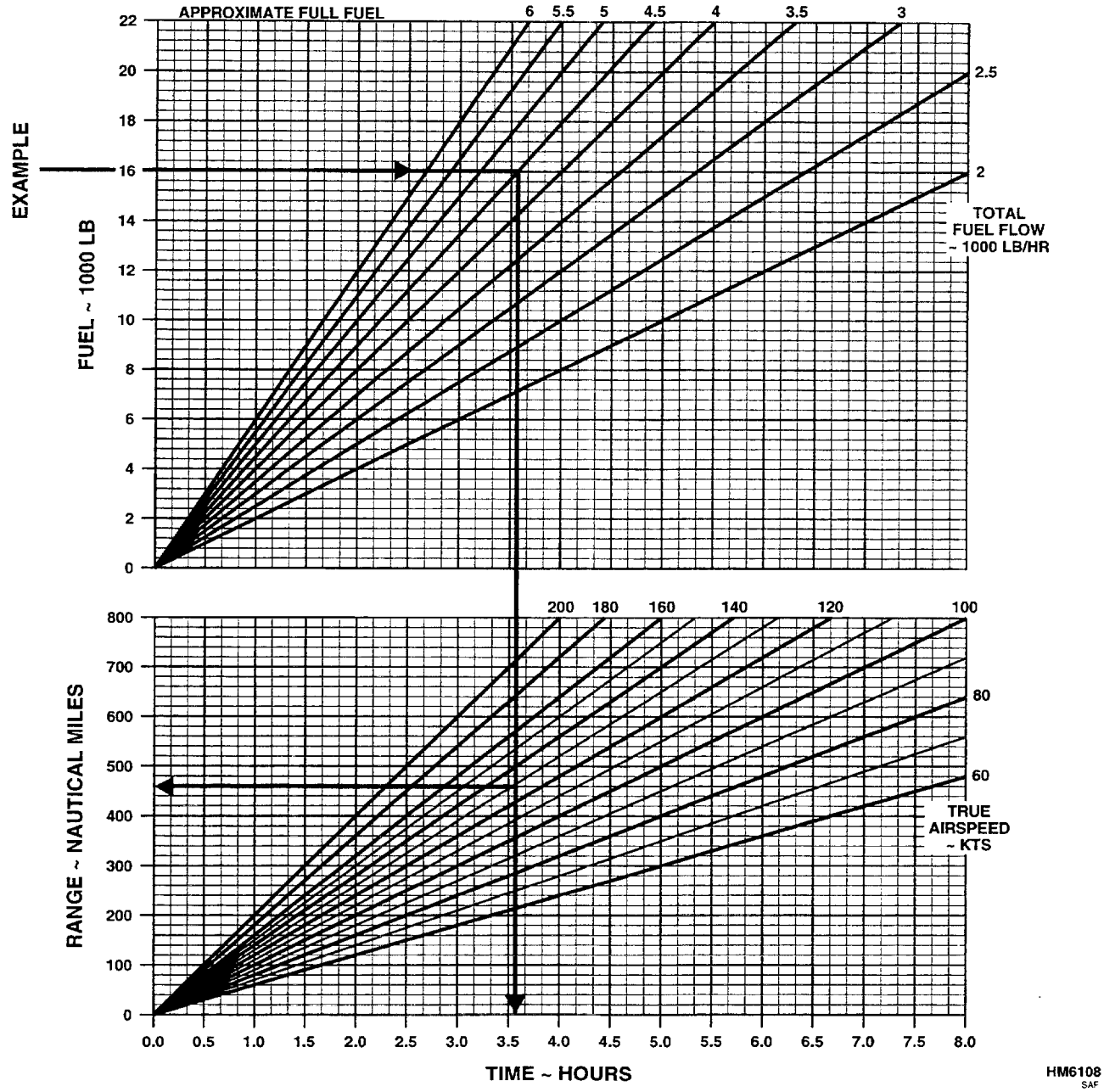


Figure 22-19. Cruise Capability Chart (419 Engine)

BINGO PROFILE
THREE ENGINE – MAXIMUM RANGE
STANDARD TEMP –30°C, ZERO WIND, 103% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH–53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64–GE–419
FUEL GRADE: JP–4/JP–5/JP–8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
	10	–34.8				NO CAPABILITY AT THIS ALTITUDE FOR 70,000 LB GROSS WEIGHT								
	* 8	–30.8	4748	93	100	531	452	339	226	113	90	68	45	23
	* 6	–26.9	4716	106	100	583	496	372	248	124	99	74	50	25
	* 4	–22.9	4743	116	100	613	522	392	261	131	104	78	52	26
	* 2	–19.0	4807	125	100	627	534	401	267	134	107	80	53	27
70	* 0	–15.0	4895	131	100	627	534	401	267	134	107	80	53	27
	*10	–34.8	4646	92	97	557	474	356	237	119	95	71	47	24
	* 8	–30.8	4736	108	100	606	516	387	258	129	103	77	52	26
	* 6	–26.9	4708	117	100	639	544	408	272	136	109	82	54	27
	* 4	–22.9	4738	125	100	656	558	419	279	140	112	84	56	28
	2	–19.0	4761	129	98	653	556	417	278	139	111	83	56	28
65	0	–15.0	4815	133	97	646	550	413	275	138	110	83	55	28
	10	–34.8	4550	105	96	639	544	408	272	136	109	82	54	27
	8	–30.8	4484	113	95	672	572	429	286	143	114	86	57	29
	6	–26.9	4472	120	94	686	584	438	292	146	117	88	58	29
	4	–22.9	4459	124	92	689	586	440	293	147	117	88	59	29
	2	–19.0	4479	127	90	686	584	438	292	146	117	88	58	29
60	0	–15.0	4578	132	90	674	574	431	287	144	115	86	57	29
	10	–34.8	4166	108	89		608	456	304	152	122	91	61	30
	8	–30.8	4167	114	88		618	464	309	155	124	93	62	31
	6	–26.9	4176	118	87		620	465	310	155	124	93	62	31
	4	–22.9	4185	122	85		618	464	309	155	124	93	62	31
	2	–19.0	4244	126	84		610	458	305	153	122	92	61	31
55	0	–15.0	4385	131	85		594	446	297	149	119	89	59	30
	10	–34.8	3863	108	82			492	328	164	131	98	66	33
	8	–30.8	3886	113	81			494	329	165	132	99	66	33
	6	–26.9	3916	117	80			492	328	164	131	98	66	33
	4	–22.9	3961	121	79			486	324	162	130	97	65	32
	2	–19.0	4062	125	79			476	317	159	127	95	63	32
50	0	–15.0	4238	130	81			459	306	153	122	92	61	31
	10	–34.8	3589	108	75				351	176	140	105	70	35
	8	–30.8	3637	112	75				348	174	139	104	70	35
	6	–26.9	3702	116	74				343	172	137	103	69	34
	4	–22.9	3793	120	75				336	168	134	101	67	34
	2	–19.0	3938	125	76	FUEL LOADING			326	163	130	98	65	33
45	0	–15.0	4134	130	79	UNATTAINABLE			313	157	125	94	63	31
	10	–34.8	3351	106	69	FOR GW'S				186	149	112	74	37
	8	–30.8	3432	110	69	SPECIFIED				183	146	110	73	37
	6	–26.9	3541	115	70					178	142	107	71	36
	4	–22.9	3681	120	72					173	138	104	69	35
	2	–19.0	3838	125	73					168	134	101	67	34
40	0	–15.0	4013	129	75					161	128	96	64	32

NOTES

1. CAUTION – NO RESERVE FUEL
2. (*) – LIMITED BY MCP OR 100% TORQUE

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Figure 22-20. Three-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 1 of 3)

BINGO PROFILE
THREE ENGINE – MAXIMUM RANGE
STANDARD TEMP, ZERO WIND, 103% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
	* 10	-4.8	4679	89	98	571	486	365	243	122	97	73	49	24
	* 8	-0.8	4771	103	100	618	526	395	263	132	105	79	53	26
	* 6	3.1	4783	113	100	649	552	414	276	138	110	83	55	28
	* 4	7.1	4836	123	100	667	568	426	284	142	114	85	57	28
	2	11.0	4852	129	97	677	576	432	288	144	115	86	58	29
70	0	15.0	4837	134	94	684	582	437	291	146	116	87	58	29
	10	-4.8	4670	103	98	649	552	414	276	138	110	83	55	28
	8	-0.8	4598	111	96	684	582	437	291	146	116	87	58	29
	6	3.1	4569	118	94	705	600	450	300	150	120	90	60	30
	4	7.1	4540	124	92	719	612	459	306	153	122	92	61	31
	2	11.0	4536	130	89	726	618	464	309	155	124	93	62	31
65	0	15.0	4609	135	88	721	614	461	307	154	123	92	61	31
	10	-4.8	4279	107	90	731	622	467	311	156	124	93	62	31
	8	-0.8	4242	114	88	757	644	483	322	161	129	97	64	32
	6	3.1	4223	120	86	771	656	492	328	164	131	98	66	33
	4	7.1	4229	125	83	778	662	497	331	166	132	99	66	33
	2	11.0	4317	130	83	766	652	489	326	163	130	98	65	33
60	0	15.0	4485	135	85	745	634	476	317	159	127	95	63	32
	10	-4.8	3927	110	82		692	519	346	173	138	104	69	35
	8	-0.8	3896	115	79		708	531	354	177	142	106	71	35
	6	3.1	3921	120	78		708	531	354	177	142	106	71	35
	4	7.1	4018	125	78		696	522	348	174	139	104	70	35
	2	11.0	4167	130	79		676	507	338	169	135	101	68	34
55	0	15.0	4343	135	81		654	491	327	164	131	98	65	33
	10	-4.8	3589	111	73			575	383	192	153	115	77	38
	8	-0.8	3611	115	72			572	381	191	152	114	76	38
	6	3.1	3715	120	72			560	373	187	149	112	75	37
	4	7.1	3849	124	73			543	362	181	145	109	72	36
	2	11.0	4012	129	75			525	350	175	140	105	70	35
50	0	15.0	4196	134	77			504	336	168	134	101	67	34
	10	-4.8	3335	110	66				410	205	164	123	82	41
	8	-0.8	3411	115	66				402	201	161	121	80	40
	6	3.1	3541	119	68				390	195	156	117	78	39
	4	7.1	3696	124	69				375	188	150	113	75	38
	2	11.0	3869	128	71	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			359	180	144	108	72	36
45	0	15.0	4045	132	73				343	172	137	103	69	34
	10	-4.8	3133	109	61					217	173	130	87	43
	8	-0.8	3249	114	62					211	168	126	84	42
	6	3.1	3400	118	64					202	161	121	81	40
	4	7.1	3562	122	66					193	154	116	77	39
	2	11.0	3728	126	68					184	147	110	73	37
40	0	15.0	3889	129	69					175	140	105	70	35

NOTES

1. CAUTION – NO RESERVE FUEL
2. (*) – LIMITED BY MCP OR 100% TORQUE

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Figure 22-20. Three-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 2 of 3)

BINGO PROFILE
THREE ENGINE – MAXIMUM RANGE
STANDARD TEMP +30°C, ZERO WIND, 103% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
	10	25.2				NO CAPABILITY AT THIS ALTITUDE FOR 70,000 LB GROSS WEIGHT								
	* 8	29.2	4159	86	84	637	542	407	271	136	108	81	54	27
	* 6	33.1	4347	101	87	679	578	433	289	144	116	87	58	29
	* 4	37.1	4630	116	92	699	595	446	297	149	119	89	59	30
	2	41.0	4772	125	92	705	600	450	300	150	120	90	60	30
70	0	45.0	4810	132	90	710	605	453	302	151	121	91	60	30
	* 10	25.2	3907	84	79	683	581	436	291	145	116	87	58	29
	* 8	29.2	4042	97	81	726	618	464	309	155	124	93	62	31
	* 6	33.1	4236	110	84	752	640	480	320	160	128	96	64	32
	4	37.1	4447	121	86	755	643	482	321	161	129	96	64	32
	2	41.0	4479	127	85	761	647	486	324	162	129	97	65	32
65	0	45.0	4616	134	85	753	641	481	320	160	128	96	64	32
	* 10	25.2	3840	96	78	783	667	500	333	167	133	100	67	33
	* 8	29.2	3981	108	80	808	688	516	344	172	138	103	69	34
	6	33.1	4115	117	80	814	693	520	347	173	139	104	69	35
	4	37.1	4141	122	78	820	697	523	349	174	139	105	70	35
	2	41.0	4287	129	80	809	688	516	344	172	138	103	69	34
60	0	45.0	4502	136	83	785	668	501	334	167	134	100	67	33
	10	25.2	3826	107	77		736	552	368	184	147	110	74	37
	8	29.2	3797	113	74		750	563	375	188	150	113	75	38
	6	33.1	3812	118	72		756	567	378	189	151	113	76	38
	4	37.1	3973	125	74		742	557	371	186	148	111	74	37
	2	41.0	4170	131	77		718	539	359	180	144	108	72	36
55	0	45.0	4360	136	79		686	515	343	172	137	103	69	34
	10	25.2	3482	109	68			614	409	205	164	123	82	41
	8	29.2	3528	115	67			615	410	205	164	123	82	41
	6	33.1	3674	121	69			603	402	201	161	121	80	40
	4	37.1	3850	126	71			579	386	193	154	116	77	39
	2	41.0	4030	130	73			552	368	184	147	110	74	37
50	0	45.0	4221	135	75			527	351	176	140	105	70	35
	10	25.2	3249	111	62				446	223	178	134	89	45
	8	29.2	3384	116	63				434	217	174	130	87	43
	6	33.1	3542	121	65				416	208	166	125	83	42
	4	37.1	3712	125	67				397	199	159	119	79	40
	2	41.0	3892	129	69	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			378	189	151	113	76	38
45	0	45.0	4081	133	72				359	180	144	108	72	36
	10	25.2	3103	111	58					234	187	140	94	47
	8	29.2	3249	116	60					225	180	135	90	45
	6	33.1	3405	120	62					215	172	129	86	43
	4	37.1	3570	124	64					204	163	122	82	41
	2	41.0	3751	127	66					194	155	116	77	39
40	0	45.0	3945	131	68					184	147	110	73	37

NOTES

1. CAUTION – NO RESERVE FUEL
2. (*) – LIMITED BY MAX ALLOWABLE AIRSPEED

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Figure 22-20. Three-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 3 of 3)

BINGO PROFILE
THREE ENGINE RANGE AT MAXIMUM CONTINUOUS POWER
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MCP RANGE KIAS	MCP RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
	10	-4.8	4679	89	98	571	486	364	243	121	97	73	49	24
	8	-0.8	4771	103	100	617	525	394	263	131	105	79	53	26
	6	3.1	4783	113	100	648	552	414	276	138	110	83	55	28
	4	7.1	4836	123	100	667	568	426	284	142	114	85	57	28
	2	11.0	4916	131	100	678	577	433	289	144	115	87	58	29
70	0	15.0	5011	139	100	682	581	436	290	145	116	87	58	29
	10	-4.8	4708	103	98	645	549	412	274	137	110	82	55	27
	8	-0.8	4762	114	100	676	575	432	288	144	115	86	58	29
	6	3.1	4776	123	100	698	594	446	297	149	119	89	59	30
	4	7.1	4830	131	100	711	605	454	302	151	121	91	60	30
	2	11.0	4909	138	100	714	608	456	304	152	122	91	61	30
65	0	15.0	5006	144	100	707	602	452	301	151	120	90	60	30
	10	-4.8	4730	114	99	702	597	448	299	149	119	90	60	30
	8	-0.8	4755	123	100	726	618	463	309	154	124	93	62	31
	6	3.1	4770	131	100	742	631	474	316	158	126	95	63	32
	4	7.1	4825	138	100	746	635	476	318	159	127	95	64	32
	2	11.0	4905	143	100	738	628	471	314	157	126	94	63	31
60	0	15.0	5003	147	100	723	615	461	308	154	123	92	62	31
	10	-4.8	4744	123	99		638	479	319	160	128	96	64	32
	8	-0.8	4749	131	100		654	491	327	164	131	98	65	33
	6	3.1	4765	137	100		660	495	330	165	132	99	66	33
	4	7.1	4822	141	100		652	489	326	163	130	98	65	33
	2	11.0	4903	145	100		640	480	320	160	128	96	64	32
55	0	15.0	5000	149	100		627	470	313	157	125	94	63	31
	10	-4.8	4759	131	100			504	336	168	134	101	67	34
	8	-0.8	4745	136	100			509	339	170	136	102	68	34
	6	3.1	4763	140	100			506	337	169	135	101	67	34
	4	7.1	4819	144	100			499	333	166	133	100	67	33
	2	11.0	4901	148	100			489	326	163	130	98	65	33
50	* 0	15.0	4893	150	97			483	322	161	129	97	64	32
	10	-4.8	4777	134	100				344	172	138	103	69	34
	8	-0.8	4743	139	100				346	173	138	104	69	35
	6	3.1	4761	143	100				344	172	138	103	69	34
	4	7.1	4817	146	100				338	169	135	101	68	34
	2	11.0	4899	150	100	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			330	165	132	99	66	33
45	* 0	15.0	4814	150	95				327	163	131	98	65	33
	10	-4.8	4775	137	100					175	140	105	70	35
	8	-0.8	4741	141	100					176	141	106	70	35
	6	3.1	4759	145	100					174	139	105	70	35
	4	7.1	4816	148	100					171	137	103	68	34
	* 2	11.0	4796	150	97					169	135	101	68	34
40	* 0	15.0	4754	150	94					166	132	99	66	33

NOTES

1. CAUTION - NO RESERVE FUEL
2. (*) - LIMITED BY MAXIMUM ALLOWED AIRSPEED

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Figure 22-21. Three-Engine Maximum Continuous Power Bingo Profile (419 Engine)

BINGO PROFILE
DUAL ENGINE – MAXIMUM RANGE
STANDARD TEMP –30°C, ZERO WIND, 103% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
70	0	–15.0			NO CAPABILITY AT THIS ALTITUDE FOR 70,000 LB GROSS WEIGHT									
	4	–22.9			NO CAPABILITY AT THIS ALTITUDE FOR 65,000 LB GROSS WEIGHT									
	2	–19.0												
65	* 0	–15.0	3288	85	100	630	536	402	268	134	107	80	54	27
	8	–30.8			NO CAPABILITY AT THIS ALTITUDE FOR 60,000 LB GROSS WEIGHT									
	6	–26.9												
	* 4	–22.9	3176	86	100	698	594	446	297	149	119	89	59	30
	* 2	–19.0	3219	95	100	731	622	467	311	156	124	93	62	31
60	* 0	–15.0	3280	100	100	731	622	467	311	156	124	93	62	31
	10	–34.8			NO CAPABILITY AT THIS ALTITUDE FOR 55,000 LB GROSS WEIGHT									
	* 8	–30.8	3171	82	100		606	455	303	152	121	91	61	30
	* 6	–26.9	3151	91	100		652	489	326	163	130	98	65	33
	* 4	–22.9	3170	99	100		676	507	338	169	135	101	68	34
	* 2	–19.0	3215	105	100		680	510	340	170	136	102	68	34
55	* 0	–15.0	3276	108	100		666	500	333	167	133	100	67	33
	* 10	–34.8	3077	83	96			488	325	163	130	98	65	33
	* 8	–30.8	3164	95	100			519	346	173	138	104	69	35
	* 6	–26.9	3146	101	100			536	357	179	143	107	71	36
	* 4	–22.9	3167	107	100			542	361	181	144	108	72	36
	* 2	–19.0	3212	111	100			536	357	179	143	107	71	36
50	* 0	–15.0	3273	113	100			521	347	174	139	104	69	35
	10	–34.8	3060	94	96				366	183	146	110	73	37
	8	–30.8	3074	101	98				375	188	150	113	75	38
	6	–26.9	3139	107	99				377	189	151	113	75	38
	* 4	–22.9	3164	111	100				376	188	150	113	75	38
	* 2	–19.0	3210	115	100	FUEL LOADING			369	185	148	111	74	37
45	* 0	–15.0	3271	116	100	UNATTAINABLE			356	178	142	107	71	36
	10	–34.8	2824	95	90	FOR GW'S				201	160	120	80	40
	8	–30.8	2897	101	92	SPECIFIED				200	160	120	80	40
	6	–26.9	3007	107	95					197	158	118	79	39
	4	–22.9	3148	114	99					193	154	116	77	39
	* 2	–19.0	3208	118	100					190	152	114	76	38
40	* 0	–15.0	3270	119	100					183	146	110	73	37

NOTES

1. CAUTION – NO RESERVE FUEL
2. (*) – LIMITED BY MCP OR 100% TORQUE

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Figure 22-22. Dual-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 1 of 3)

BINGO PROFILE
DUAL ENGINE – MAXIMUM RANGE
STANDARD TEMP, ZERO WIND, 103% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH–53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64–GE–419
FUEL GRADE: JP–4/JP–5/JP–8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
70	* 0	15.0	3370	91	100	693	590	443	295	148	118	89	59	30
	* 4	7.1	3241	89	100	747	636	477	318	159	127	95	64	32
	* 2	11.0	3295	99	100	787	670	503	335	168	134	101	67	34
65	* 0	15.0	3361	105	100	790	672	504	336	168	134	101	67	34
	* 8	–0.8	3190	84	100	766	652	489	326	163	130	98	65	33
	* 6	3.1	3197	96	100	834	710	533	355	178	142	107	71	36
	* 4	7.1	3233	104	100	862	734	551	367	184	147	110	73	37
	* 2	11.0	3289	109	100	860	732	549	366	183	146	110	73	37
60	* 0	15.0	3357	112	100	837	712	534	356	178	142	107	71	36
	*10	–4.8	3115	87	97		714	536	357	179	143	107	71	36
	* 8	–0.8	3182	100	100		766	575	383	192	153	115	77	38
	* 6	3.1	3191	107	100		786	590	393	197	157	118	79	39
	* 4	7.1	3230	112	100		782	587	391	196	156	117	78	39
	* 2	11.0	3286	115	100		766	575	383	192	153	115	77	38
55	* 0	15.0	3354	118	100		744	558	372	186	149	112	74	37
	10	–4.8	3044	100	96			617	411	206	164	123	82	41
	8	–0.8	3078	107	97			629	419	210	168	126	84	42
	6	3.1	3189	113	99			620	413	207	165	124	83	41
	* 4	7.1	3227	117	100			612	408	204	163	122	82	41
	* 2	11.0	3283	120	100			596	397	199	159	119	79	40
50	* 0	15.0	3351	122	100			576	384	192	154	115	77	38
	10	–4.8	2843	102	90				449	225	180	135	90	45
	8	–0.8	2929	108	92				445	223	178	134	89	45
	6	3.1	3045	114	94				434	217	174	130	87	43
	4	7.1	3180	119	97				420	210	168	126	84	42
	* 2	11.0	3282	123	100	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			407	204	163	122	81	41
45	* 0	15.0	3349	124	100				392	196	157	118	78	39
	10	–4.8	2682	103	84					240	192	144	96	48
	8	–0.8	2793	109	87					235	188	141	94	47
	6	3.1	2920	113	90					226	180	135	90	45
	4	7.1	3054	118	92					217	173	130	87	43
	2	11.0	3188	121	95					207	166	124	83	41
40	0	15.0	3316	124	98					198	158	119	79	40

NOTES

1. CAUTION – NO RESERVE FUEL
2. (*) – LIMITED BY MCP OR 100% TORQUE

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Figure 22-22. Dual-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 2 of 3)

BINGO PROFILE
DUAL ENGINE – MAXIMUM RANGE
STANDARD TEMP +30°C, ZERO WIND, 103% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
70	* 0	45.0	3420	96	99	751	639	479	320	160	128	96	64	32
	* 4	37.1	3036	72	89	697	594	445	297	148	119	89	59	30
	* 2	41.0	3253	98	95	830	706	530	353	177	141	106	71	35
65	* 0	45.0	3417	109	99	839	714	536	357	179	143	107	71	36
	8	29.2			NO CAPABILITY AT THIS ALTITUDE FOR 70,000 LB GROSS WEIGHT									
	* 6	33.1	2940	85	88	860	732	549	366	183	146	110	73	37
	* 4	37.1	3092	100	92	912	776	582	388	194	155	116	78	39
	* 2	41.0	3251	109	96	912	776	582	388	194	155	116	78	39
60	* 0	45.0	3416	116	99	891	758	569	379	190	152	114	76	38
	10	25.2			NO CAPABILITY AT THIS ALTITUDE FOR 70,000 LB GROSS WEIGHT									
	* 8	29.2	2782	87	84		814	611	407	204	163	122	81	41
	* 6	33.1	2940	101	88		850	638	425	213	170	128	85	43
	* 4	37.1	3092	109	92		842	632	421	211	168	126	84	42
	* 2	41.0	3250	116	96		818	614	409	205	164	123	82	41
55	* 0	45.0	3414	121	99		784	588	392	196	157	118	78	39
	* 10	25.2	2629	88	80			678	452	226	181	136	90	45
	* 8	29.2	2784	101	85			693	462	231	185	139	92	46
	* 6	33.1	2940	109	89			686	457	229	183	137	91	46
	* 4	37.1	3093	115	92			660	440	220	176	132	88	44
	* 2	41.0	3249	119	96			632	421	211	168	126	84	42
50	* 0	45.0	3413	124	99			605	403	202	161	121	81	40
	* 10	25.2	2632	100	81				504	252	202	151	101	50
	* 8	29.2	2784	108	85				492	246	197	148	98	49
	* 6	33.1	2939	114	89				473	237	189	142	95	47
	* 4	37.1	3091	118	92				452	226	181	136	90	45
	* 2	41.0	3249	123	96	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			432	216	173	130	86	43
45	* 0	45.0	3413	127	100				411	206	164	123	82	41
	* 10	25.2	2632	106	81					264	211	158	106	53
	8	29.2	2799	111	84					252	201	151	101	50
	6	33.1	2928	116	87					242	193	145	97	48
	4	37.1	3065	119	90					230	184	138	92	46
	2	41.0	3209	123	93					219	175	131	87	44
40	0	45.0	3363	126	96					208	166	125	83	42

NOTES

1. CAUTION – NO RESERVE FUEL
2. (*) – LIMITED BY MCP OR 100% TORQUE

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Figure 22-22. Dual-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 3 of 3)

BINGO PROFILE
DUAL ENGINE RANGE AT MAXIMUM CONTINUOUS POWER
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MCP RANGE KIAS	MCP RANGE TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
70	0	15.0	3370	91	100	694	591	443	295	148	118	89	59	30
	4	7.1	3241	89	100	748	636	477	318	159	127	95	64	32
	2	11.0	3295	99	100	787	670	502	335	167	134	100	67	33
65	0	15.0	3361	105	100	789	672	504	336	168	134	101	67	34
	8	-0.8	3190	84	100	765	651	488	326	163	130	98	65	33
	6	3.1	3197	96	100	834	710	533	355	178	142	107	71	36
	4	7.1	3233	104	100	862	734	550	367	183	147	110	73	37
	2	11.0	3289	109	100	859	731	548	365	183	146	110	73	37
60	0	15.0	3357	112	100	838	713	535	357	178	143	107	71	36
	10	-4.8	3115	87	97		715	536	357	179	143	107	71	36
	8	-0.8	3182	100	100		767	575	383	192	153	115	77	38
	6	3.1	3191	107	100		787	590	394	197	157	118	79	39
	4	7.1	3230	112	100		782	587	391	196	156	117	78	39
	2	11.0	3286	115	100		766	574	383	191	153	115	77	38
55	0	15.0	3354	118	100		744	558	372	186	149	112	74	37
	10	-4.8	3132	102	98			610	407	203	163	122	81	41
	8	-0.8	3177	110	100			623	415	208	166	125	83	42
	6	3.1	3188	114	100			621	414	207	166	124	83	41
	4	7.1	3277	117	100			612	408	204	163	122	82	41
	2	11.0	3283	120	100			596	397	199	159	119	79	40
50	0	15.0	3351	122	100			576	384	192	154	115	77	38
	10	-4.8	3142	109	98				432	216	173	130	86	43
	8	-0.8	3175	115	100				433	217	173	130	87	43
	6	3.1	3186	118	100				430	215	172	129	86	43
	4	7.1	3225	121	100				421	210	168	126	84	42
	2	11.0	3282	123	100	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			407	204	163	122	81	41
45	0	15.0	3349	124	100				392	196	157	118	78	39
	10	-4.8	3154	114	99					224	179	134	90	45
	8	-0.8	3172	119	100					224	179	134	89	45
	6	3.1	3185	122	100					220	176	132	88	44
	4	7.1	3224	124	100					215	172	129	86	43
	2	11.0	3280	125	100					207	166	124	83	41
40	0	15.0	3348	126	100					199	159	119	79	40

NOTE

CAUTION – NO RESERVE FUEL

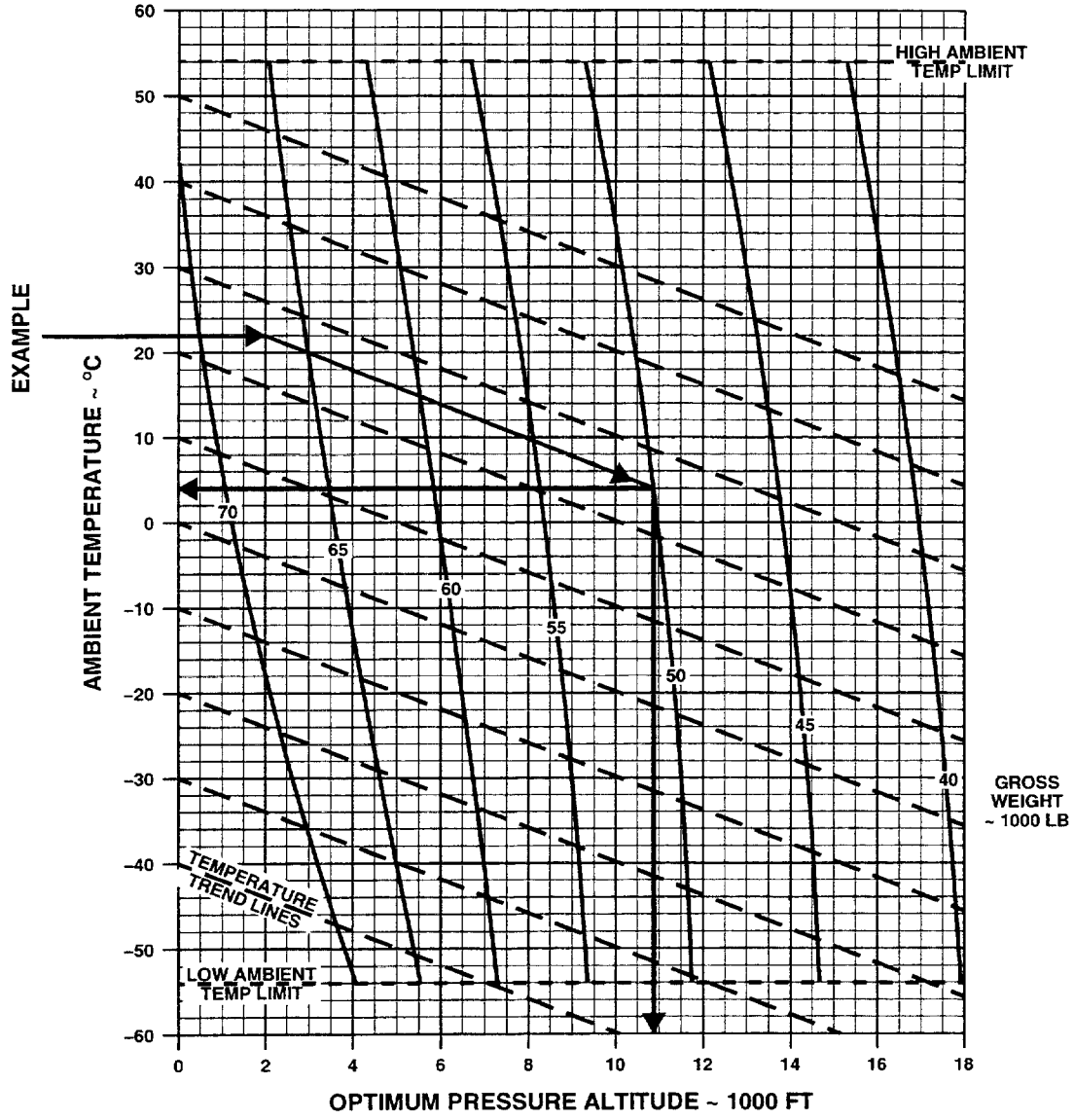
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Figure 22-23. Dual-Engine Maximum Continuous Power Bingo Profile (419 Engine)

THREE ENGINES
OPTIMUM ALTITUDE FOR MAXIMUM RANGE
ZERO WIND 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



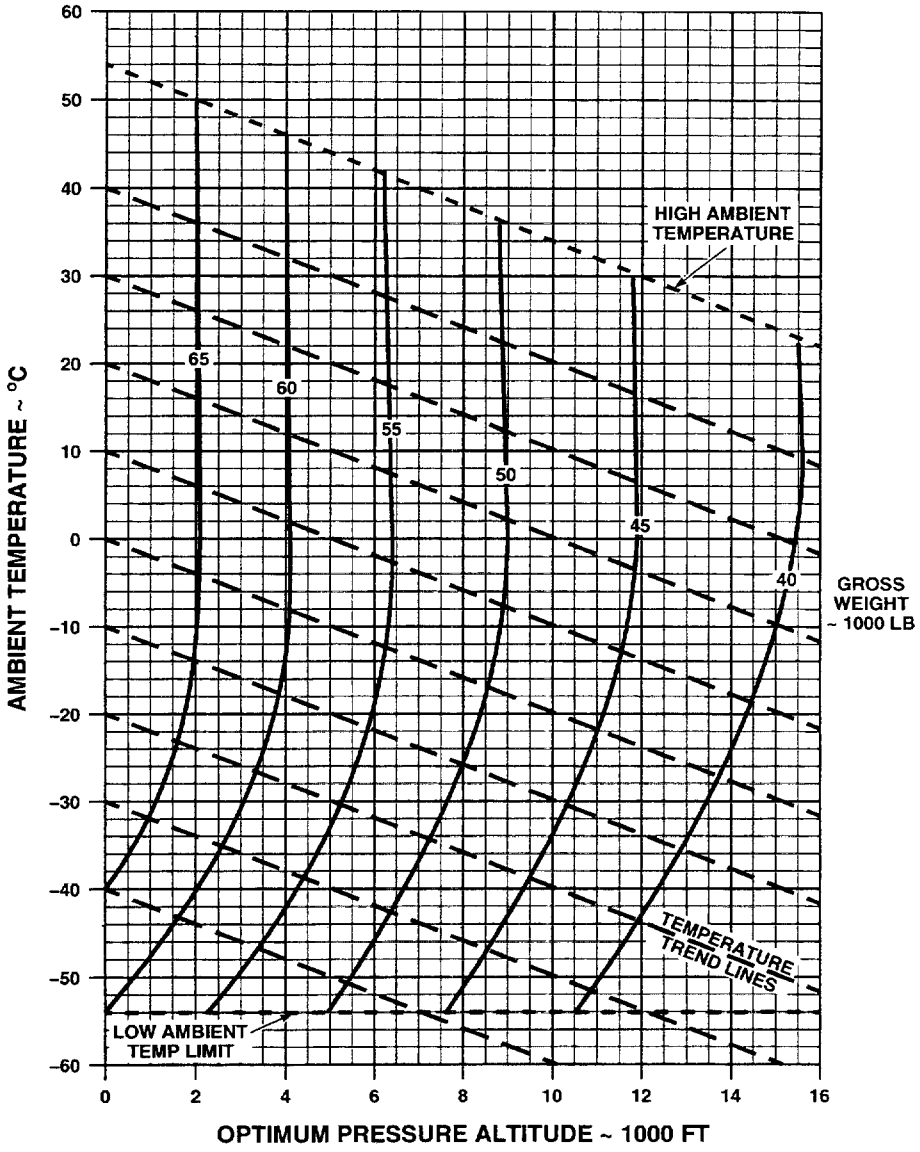
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Figure 22-24. Optimum Altitude for Maximum Range (419 Engine) (Sheet 1 of 2)

DUAL ENGINE
OPTIMUM ALTITUDE FOR MAXIMUM RANGE
ZERO WIND 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 22-24. Optimum Altitude for Maximum Range (419 Engine) (Sheet 2 of 2)

CHAPTER 23
Endurance

23.1 ENDURANCE CHARTS

The endurance charts provide fuel flow, indicated and calibrated airspeed, and approximate torque when gross weight is applied to pressure altitude to produce maximum endurance.

23.1.1 Three-Engine Maximum Endurance (416 Engine) Chart. The three-engine maximum endurance (416 engine) chart (Figure 23-1) provides the fuel flow indicated and calibrated airspeed, and torque required when gross weight is applied to pressure altitude to produce maximum endurance for the helicopter.

For example, to find the fuel consumption, cruise speed and approximate torque required for maximum endurance at 65,000 pounds gross weight at a pressure altitude of 10,000 feet, enter the bottom of the chart at 65,000 pounds. Trace up to the 10,000 foot curve, then trace left and read the fuel consumption: 3950 pounds per hour. Enter the next grid at 65,000 pounds, trace up to the 10,000 foot curve, and then trace left and read 66 KIAS, the cruise speed for maximum endurance. The approximate torque required to maintain this speed is found by entering the next grid at 65,000 pounds, tracing up to the 10,000 foot curve, and then tracing left to read 79% torque.

23.1.2 Dual-Engine Maximum Endurance (416 Engine) Chart. The dual-engine maximum endurance (416 engine) chart (Figure 23-2) is used the same way as Figure 23-1.

23.1.3 Three-Engine Maximum Endurance Bingo Profiles (419 Engine). The three-engine maximum endurance bingo profiles (Figure 23-3) show the optimum indicated airspeed and torque, for different gross weights, at which maximum endurance can be attained under standard conditions. The range profile provides the range, in nautical miles and the time profile provides the time, in hours, for the amount of fuel on board.

CAUTION

Bingo profiles do not provide for reserve fuel requirements.

23.1.4 Dual-Engine Maximum Endurance Bingo Profiles (419 Engine). The dual-engine maximum endurance bingo profiles (Figure 23-4) are used the same way as Figure 23-3.

23.1.5 25-Knot Endurance Charts. The 25-knot endurance charts (Figure 23-5 for the 416 engine and Figure 23-6 for the 419 engine) provide fuel flow at 25 knots when gross weight is applied to pressure altitude and ambient temperature.

For example, if fuel flow was desired when the ambient temperature was +24°C, pressure altitude was 6000 feet, and gross weight was 65,000 pounds. Enter the chart from the left at 65,000 pounds and trace right to 6000 feet pressure altitude. Trace down from this point to the baseline and follow the influence lines up to +24°C. Trace down to read 4780 pounds/hour of fuel flow.

23.1.6 Hover Endurance Charts. The hover endurance charts (Figure 23-7 for the 416 engine and 23-8 for the 419 engine) provide the fuel flow when gross weight is applied to pressure altitude and outside air temperature to provide hovering endurance.

For example, to find the fuel consumption when hovering out of ground effect at 2000, at 65,000 pounds gross weight, with an OAT of 32°C, enter the left side of the chart at 65,000 pounds. Trace right to the pressure altitude and then trace down to the temperature baseline. Follow the influence line up to 32°C, and then trace down to real fuel consumption, 5550 pounds-per-hour.

THREE–ENGINE MAXIMUM ENDURANCE
STANDARD TEMPERATURE
103% Nr

MODEL: MH–53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

ENGINE: T64–GE–416
FUEL GRADE: JP–4 / JP–5 / JP–8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

STANDARD TEMPERATURE AT SEA LEVEL = 15 °C

STANDARD TEMPERATURE AT 5000 FT = 5 °C

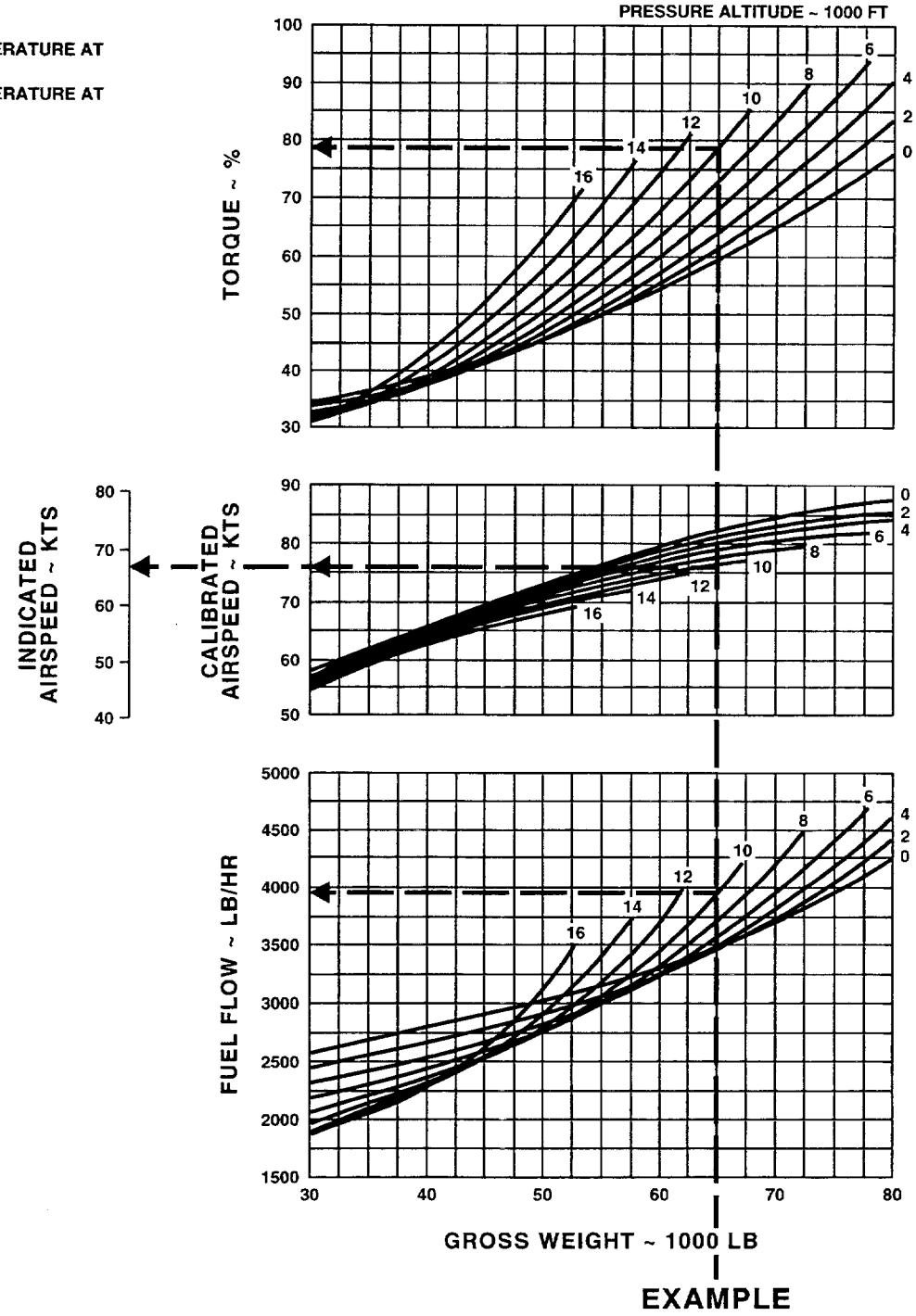


Figure 23-1. Three-Engine Maximum Endurance (416 Engine)

DUAL-ENGINE MAXIMUM ENDURANCE
STANDARD TEMPERATURE
103% Nr

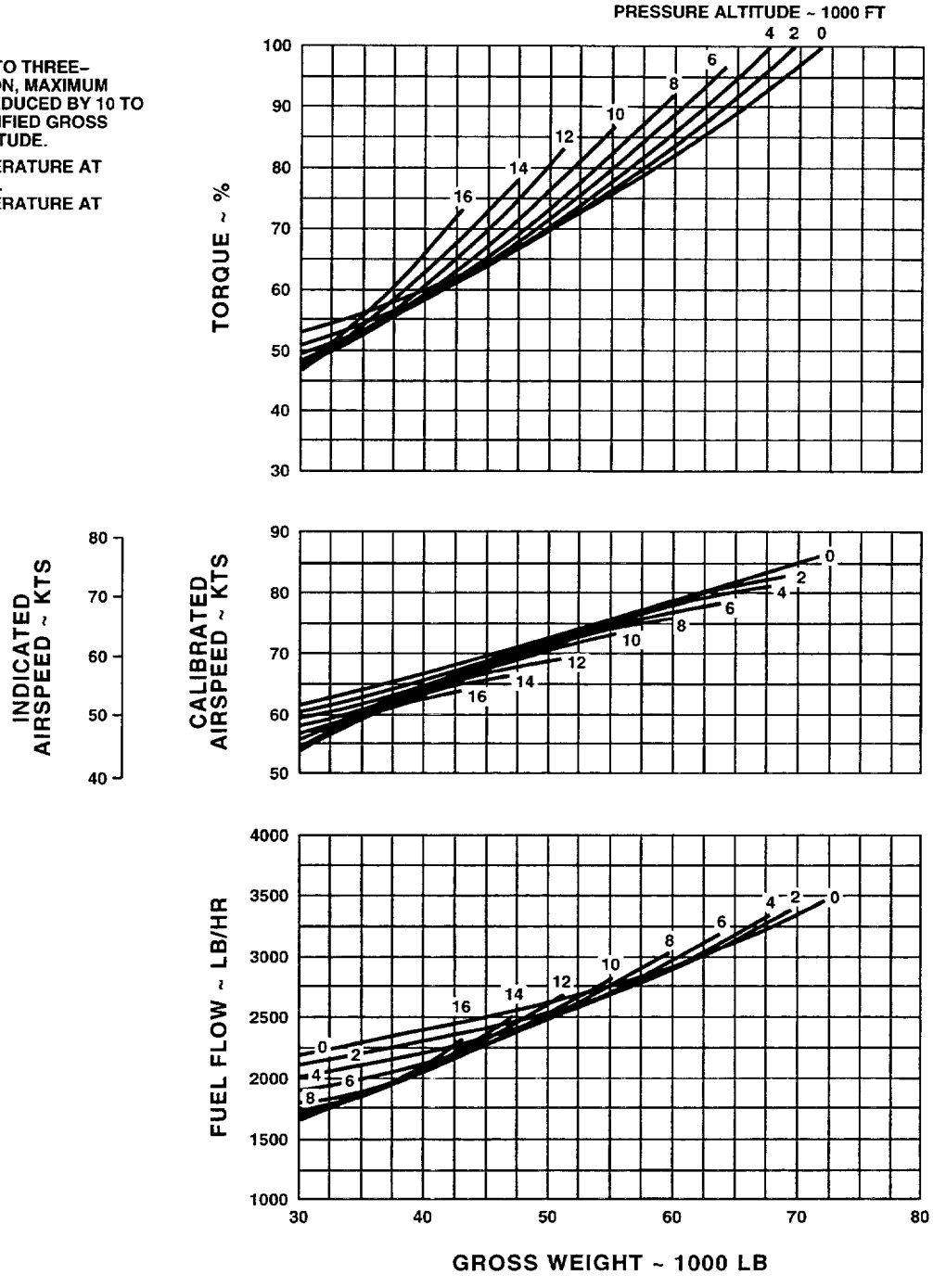
MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

FOR TRANSITION TO THREE-ENGINE OPERATION, MAXIMUM ENDURANCE IS REDUCED BY 10 TO 20% AT ANY SPECIFIED GROSS WEIGHT AND ALTITUDE.

STANDARD TEMPERATURE AT SEA LEVEL = 15 °C.
STANDARD TEMPERATURE AT 5000 FT = 5 °C.



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Figure 23-2. Dual-Engine Maximum Endurance (416 Engine)

BINGO PROFILE
RANGE AT MAXIMUM ENDURANCE SPEED
THREE ENGINE
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX END KIAS	MAX END TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
	10	-4.8	4310	68	90	490	417	313	208	104	83	63	42	21
	8	-0.8	4095	70	84	514	437	328	219	109	87	66	44	22
	6	3.1	3952	71	78	523	445	334	223	111	89	67	45	22
	4	7.1	3834	73	72	530	451	338	226	113	90	68	45	23
	2	11.0	3755	75	68	540	460	345	230	115	92	69	46	23
70	0	15.0	3748	76	65	535	455	341	228	114	91	68	46	23
	10	-4.8	3853	68	80	544	463	347	232	116	93	69	46	23
	8	-0.8	3693	69	73	557	474	356	237	119	95	71	47	24
	6	3.1	3582	69	68	564	480	360	240	120	96	72	48	24
	4	7.1	3512	71	64	571	486	365	243	122	97	73	49	24
	2	11.0	3505	73	61	567	482	362	241	121	96	72	48	24
65	0	15.0	3547	73	60	544	463	347	231	116	93	69	46	23
	10	-4.8	3436	66	69	594	506	379	253	126	101	76	51	25
	8	-0.8	3321	66	63	601	511	383	256	128	102	77	51	26
	6	3.1	3260	68	60	608	518	388	259	129	104	78	52	26
	4	7.1	3257	70	57	603	513	385	257	128	103	77	51	26
	2	11.0	3298	70	56	579	493	370	247	123	99	74	49	25
60	0	15.0	3354	70	55	553	471	353	236	118	94	71	47	24
	10	-4.8	3068	63	59		548	411	274	137	110	82	55	27
	8	-0.8	3001	65	55		557	418	279	139	111	84	56	28
	6	3.1	3007	66	53		550	413	275	138	110	83	55	28
	4	7.1	3052	66	52		524	393	262	131	105	79	52	26
	2	11.0	3108	66	51		501	376	250	125	100	75	50	25
55	0	15.0	3179	67	50		478	359	239	120	96	72	48	24
	10	-4.8	2758	62	51			451	301	150	120	90	60	30
	8	-0.8	2763	63	49			441	294	147	118	88	59	29
	6	3.1	2811	62	48			418	279	139	111	84	56	28
	4	7.1	2863	63	47			399	266	133	106	80	53	27
	2	11.0	2934	63	47			381	254	127	102	76	51	25
50	0	15.0	3029	64	47			364	242	121	97	73	48	24
	10	-4.8	2538	58	45				309	155	124	93	62	31
	8	-0.8	2565	58	44				297	148	119	89	59	30
	6	3.1	2617	59	43				284	142	114	85	57	28
	4	7.1	2690	59	43				271	135	108	81	54	27
	2	11.0	2788	60	43	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			257	129	103	77	51	26
45	0	15.0	2905	62	43				244	122	97	73	49	24
	10	-4.8	2332	54	40					159	127	95	63	32
	8	-0.8	2372	55	39					152	121	91	61	30
	6	3.1	2450	55	39					144	115	86	58	29
	4	7.1	2551	56	39					136	109	82	54	27
	2	11.0	2673	57	40					128	102	77	51	26
40	0	15.0	2811	58	40					119	95	71	48	24

NOTE

CAUTION – NO RESERVE FUEL

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Figure 23-3. Three-Engine Maximum Endurance Bingo Profile (419 Engine) (Sheet 1 of 2)

BINGO PROFILE
TIME AT MAXIMUM ENDURANCE SPEED
THREE ENGINE
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						ENDURANCE TIME ~ HOURS								
						LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX END KIAS	MAX END TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
	10	-4.8	4310	68	90	5.5	4.6	3.5	2.3	1.2	0.9	0.7	0.5	0.2
	8	-0.8	4095	70	84	5.7	4.9	3.7	2.4	1.2	1.0	0.7	0.5	0.2
	6	3.1	3952	71	78	5.9	5.1	3.8	2.5	1.3	1.0	0.8	0.5	0.3
	4	7.1	3834	73	72	6.1	5.2	3.9	2.6	1.3	1.0	0.8	0.5	0.3
	2	11.0	3755	75	68	6.3	5.3	4.0	2.7	1.3	1.1	0.8	0.5	0.3
70	0	15.0	3748	76	65	6.3	5.3	4.0	2.7	1.3	1.1	0.8	0.5	0.3
	10	-4.8	3853	68	80	6.1	5.2	3.9	2.6	1.3	1.0	0.8	0.5	0.3
	8	-0.8	3693	69	73	6.4	5.4	4.1	2.7	1.4	1.1	0.8	0.5	0.3
	6	3.1	3582	69	68	6.6	5.6	4.2	2.8	1.4	1.1	0.8	0.6	0.3
	4	7.1	3512	71	64	6.7	5.7	4.3	2.8	1.4	1.1	0.9	0.6	0.3
	2	11.0	3505	73	61	6.7	5.7	4.3	2.9	1.4	1.1	0.9	0.6	0.3
65	0	15.0	3547	73	60	6.6	5.6	4.2	2.8	1.4	1.1	0.8	0.6	0.3
	10	-4.8	3436	66	69	6.8	5.8	4.4	2.9	1.5	1.2	0.9	0.6	0.3
	8	-0.8	3321	66	63	7.1	6.0	4.5	3.0	1.5	1.2	0.9	0.6	0.3
	6	3.1	3260	68	60	7.2	6.1	4.6	3.1	1.5	1.2	0.9	0.6	0.3
	4	7.1	3257	70	57	7.2	6.1	4.6	3.1	1.5	1.2	0.9	0.6	0.3
	2	11.0	3298	70	56	7.1	6.1	4.5	3.0	1.5	1.2	0.9	0.6	0.3
60	0	15.0	3354	70	55	7.0	6.0	4.5	3.0	1.5	1.2	0.9	0.6	0.3
	10	-4.8	3068	63	59		6.5	4.9	3.3	1.6	1.3	1.0	0.7	0.3
	8	-0.8	3001	65	55		6.7	5.0	3.3	1.7	1.3	1.0	0.7	0.3
	6	3.1	3007	66	53		6.7	5.0	3.3	1.7	1.3	1.0	0.7	0.3
	4	7.1	3052	66	52		6.6	4.9	3.3	1.6	1.3	1.0	0.7	0.3
	2	11.0	3108	66	51		6.4	4.8	3.2	1.6	1.3	1.0	0.6	0.3
55	0	15.0	3179	67	50		6.3	4.7	3.1	1.6	1.3	0.9	0.6	0.3
	10	-4.8	2758	62	51			5.4	3.6	1.8	1.5	1.1	0.7	0.4
	8	-0.8	2763	63	49			5.4	3.6	1.8	1.4	1.1	0.7	0.4
	6	3.1	2811	62	48			5.3	3.6	1.8	1.4	1.1	0.7	0.4
	4	7.1	2863	63	47			5.2	3.5	1.7	1.4	1.0	0.7	0.3
	2	11.0	2934	63	47			5.1	3.4	1.7	1.4	1.0	0.7	0.3
50	0	15.0	3029	64	47			5.0	3.3	1.7	1.3	1.0	0.7	0.3
	10	-4.8	2538	58	45				3.9	2.0	1.6	1.2	0.8	0.4
	8	-0.8	2565	58	44				3.9	1.9	1.6	1.2	0.8	0.4
	6	3.1	2617	59	43				3.8	1.9	1.5	1.1	0.8	0.4
	4	7.1	2690	59	43				3.7	1.9	1.5	1.1	0.7	0.4
	2	11.0	2788	60	43	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			3.6	1.8	1.4	1.1	0.7	0.4
45	0	15.0	2905	62	43				3.4	1.7	1.4	1.0	0.7	0.3
	10	-4.8	2332	54	40					2.1	1.7	1.3	0.9	0.4
	8	-0.8	2372	55	39					2.1	1.7	1.3	0.8	0.4
	6	3.1	2450	55	39					2.0	1.6	1.2	0.8	0.4
	4	7.1	2551	56	39					2.0	1.6	1.2	0.8	0.4
	2	11.0	2673	57	40					1.9	1.5	1.1	0.7	0.4
40	0	15.0	2811	58	40					1.8	1.4	1.1	0.7	0.4

NOTE

CAUTION – NO RESERVE FUEL

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Figure 23-3. Three-Engine Maximum Endurance Bingo Profile (419 Engine) (Sheet 2 of 2)

BINGO PROFILE
RANGE AT MAXIMUM ENDURANCE SPEED
DUAL ENGINE
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX END KIAS	MAX END TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
70	0	15.0	3325	76	97	603	513	385	257	128	103	77	51	26
	4	7.1	3147	71	96	638	543	407	271	136	109	81	54	27
	2	11.0	3112	73	92	638	543	407	272	136	109	81	54	27
65	0	15.0	3130	73	90	617	525	394	262	131	105	79	52	26
	8	-0.8	3046	66	95	655	557	418	279	139	111	84	56	28
	6	3.1	2923	68	89	678	577	433	289	144	115	87	58	29
	4	7.1	2892	70	86	679	578	434	289	145	116	87	58	29
	2	11.0	2910	70	84	657	559	419	279	140	112	84	56	28
60	0	15.0	2944	70	82	631	537	403	268	134	107	81	54	27
	10	-4.8	2820	63	88		596	447	298	149	119	89	60	30
	8	-0.8	2690	65	82		621	466	311	155	124	93	62	31
	6	3.1	2670	66	79		620	465	310	155	124	93	62	31
	4	7.1	2692	66	78		594	446	297	149	119	89	59	30
	2	11.0	2726	66	77		571	428	285	143	114	86	57	29
55	0	15.0	2774	67	76		548	411	274	137	110	82	55	27
	10	-4.8	2472	62	76			503	335	168	134	101	67	34
	8	-0.8	2451	63	73			498	332	166	133	100	66	33
	6	3.1	2475	62	72			475	316	158	127	95	63	32
	4	7.1	2508	63	71			456	304	152	122	91	61	30
	2	11.0	2557	63	70			438	292	146	117	88	58	29
50	0	15.0	2626	64	70			419	279	140	112	84	56	28
	10	-4.8	2245	58	67				350	175	140	105	70	35
	8	-0.8	2252	58	66				338	169	135	101	68	34
	6	3.1	2286	59	65				325	162	130	97	65	32
	4	7.1	2340	59	64				311	156	124	93	62	31
	2	11.0	2412	60	64	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			297	149	119	89	59	30
45	0	15.0	2502	62	65				283	141	113	85	57	28
	10	-4.8	2039	54	60					181	145	109	73	36
	8	-0.8	2063	55	59					174	140	105	70	35
	6	3.1	2122	55	58					166	133	100	67	33
	4	7.1	2199	56	59					158	126	95	63	32
	2	11.0	2294	57	59					149	119	89	60	30
40	0	15.0	2401	58	60					139	111	83	56	28

NOTE

CAUTION – NO RESERVE FUEL

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Figure 23-4. Dual-Engine Maximum Endurance Bingo Profile (419 Engine) (Sheet 1 of 2)

BINGO PROFILE
TIME AT MAXIMUM ENDURANCE SPEED
DUAL ENGINE
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS IN AUTOMATIC

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						ENDURANCE TIME - HOURS								
						LBS OF FUEL								
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX END KIAS	MAX END TRQ	23,500	20,000	15,000	10,000	5000	4000	3000	2000	1000
70	0	15.0	3325	76	97	7.1	6.0	4.5	3.0	1.5	1.2	0.9	0.6	0.3
	4	7.1	3147	71	96	7.5	6.4	4.8	3.2	1.6	1.3	1.0	0.6	0.3
	2	11.0	3112	73	92	7.6	6.4	4.8	3.2	1.6	1.3	1.0	0.6	0.3
65	0	15.0	3130	73	90	7.5	6.4	4.8	3.2	1.6	1.3	1.0	0.6	0.3
	8	-0.8	3046	66	95	7.7	6.6	4.9	3.3	1.6	1.3	1.0	0.7	0.3
	6	3.1	2923	68	89	8.0	6.8	5.1	3.4	1.7	1.4	1.0	0.7	0.3
	4	7.1	2892	70	86	8.1	6.9	5.2	3.5	1.7	1.4	1.0	0.7	0.3
	2	11.0	2910	70	84	8.1	6.9	5.2	3.4	1.7	1.4	1.0	0.7	0.3
60	0	15.0	2944	70	82	8.0	6.8	5.1	3.4	1.7	1.4	1.0	0.7	0.3
	10	-4.8	2820	63	88		7.1	5.3	3.5	1.8	1.4	1.1	0.7	0.4
	8	-0.8	2690	65	82		7.4	5.6	3.7	1.9	1.5	1.1	0.7	0.4
	6	3.1	2670	66	79		7.5	5.6	3.7	1.9	1.5	1.1	0.7	0.4
	4	7.1	2692	66	78		7.4	5.6	3.7	1.9	1.5	1.1	0.7	0.4
	2	11.0	2726	66	77		7.3	5.5	3.7	1.8	1.5	1.1	0.7	0.4
55	0	15.0	2774	67	76		7.2	5.4	3.6	1.8	1.4	1.1	0.7	0.4
	10	-4.8	2472	62	76			6.1	4.0	2.0	1.6	1.2	0.8	0.4
	8	-0.8	2451	63	73			6.1	4.1	2.0	1.6	1.2	0.8	0.4
	6	3.1	2475	62	72			6.1	4.0	2.0	1.6	1.2	0.8	0.4
	4	7.1	2508	63	71			6.0	4.0	2.0	1.6	1.2	0.8	0.4
	2	11.0	2557	63	70			5.9	3.9	2.0	1.6	1.2	0.8	0.4
50	0	15.0	2626	64	70			5.7	3.8	1.9	1.5	1.1	0.8	0.4
	10	-4.8	2245	58	67				4.5	2.2	1.8	1.3	0.9	0.4
	8	-0.8	2252	58	66				4.4	2.2	1.8	1.3	0.9	0.4
	6	3.1	2286	59	65				4.4	2.2	1.7	1.3	0.9	0.4
	4	7.1	2340	59	64				4.3	2.1	1.7	1.3	0.9	0.4
	2	11.0	2412	60	64	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			4.1	2.1	1.7	1.2	0.8	0.4
45	0	15.0	2502	62	65				4.0	2.0	1.6	1.2	0.8	0.4
	10	-4.8	2039	54	60					2.5	2.0	1.5	1.0	0.5
	8	-0.8	2063	55	59					2.4	1.9	1.5	1.0	0.5
	6	3.1	2122	55	58					2.4	1.9	1.4	0.9	0.5
	4	7.1	2199	56	59					2.3	1.8	1.4	0.9	0.5
	2	11.0	2294	57	59					2.2	1.7	1.3	0.9	0.4
40	0	15.0	2401	58	60					2.1	1.7	1.2	0.8	0.4

NOTE

CAUTION – NO RESERVE FUEL

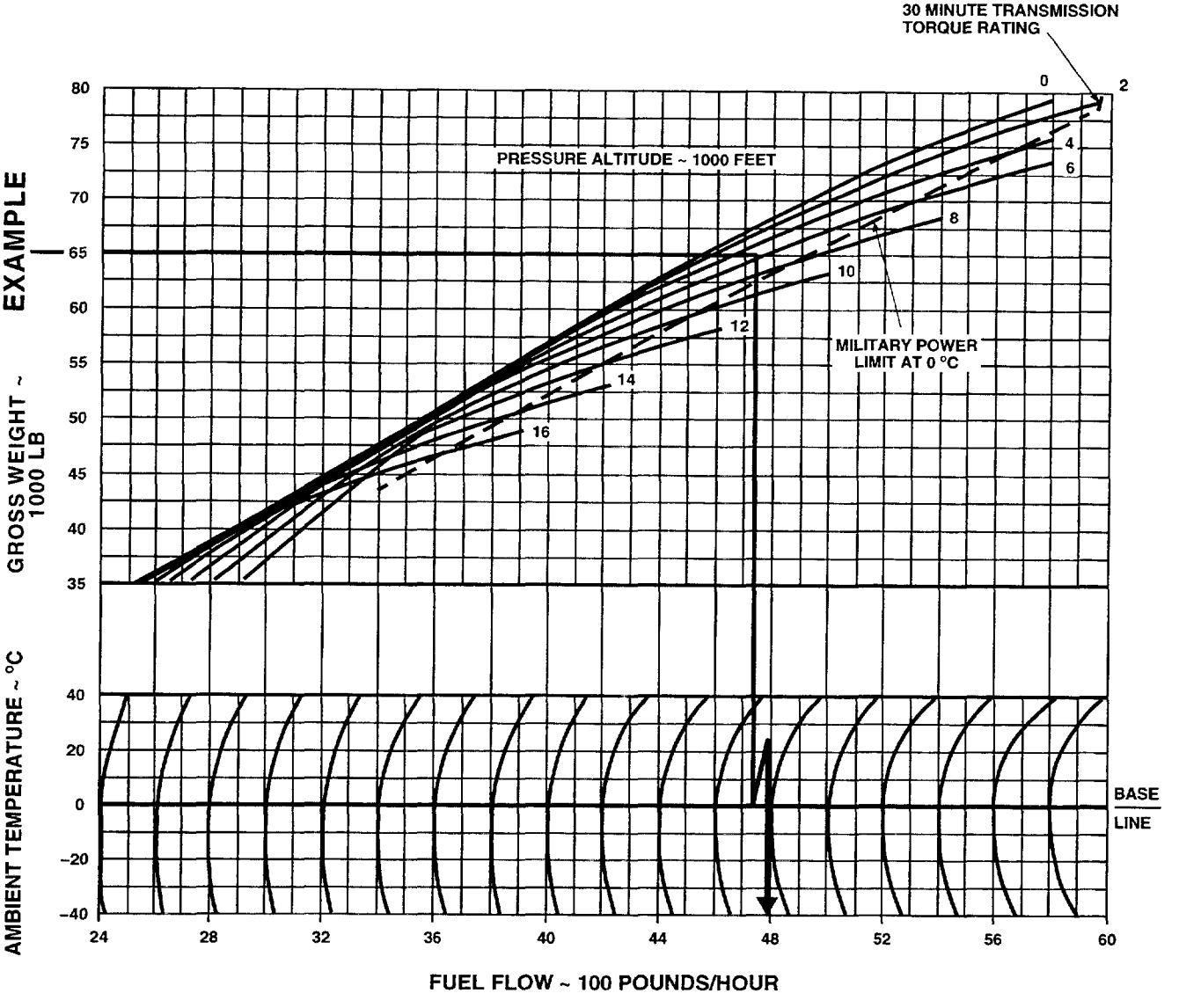
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Figure 23-4. Dual-Engine Maximum Endurance Bingo Profile (419 Engine) (Sheet 2 of 2)

THREE–ENGINE ENDURANCE AT 25 KNOTS
OUT OF GROUND EFFECT
103% Nr

MODEL: MH–53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

ENGINE: T64–GE–416
FUEL GRADE: JP–4 / JP–5 / JP–8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



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Figure 23-5. 25-Knot Endurance (416 Engine)

THREE ENGINE ENDURANCE AT 25 KNOTS TRUE AIRSPEED OUT OF GROUND EFFECT 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

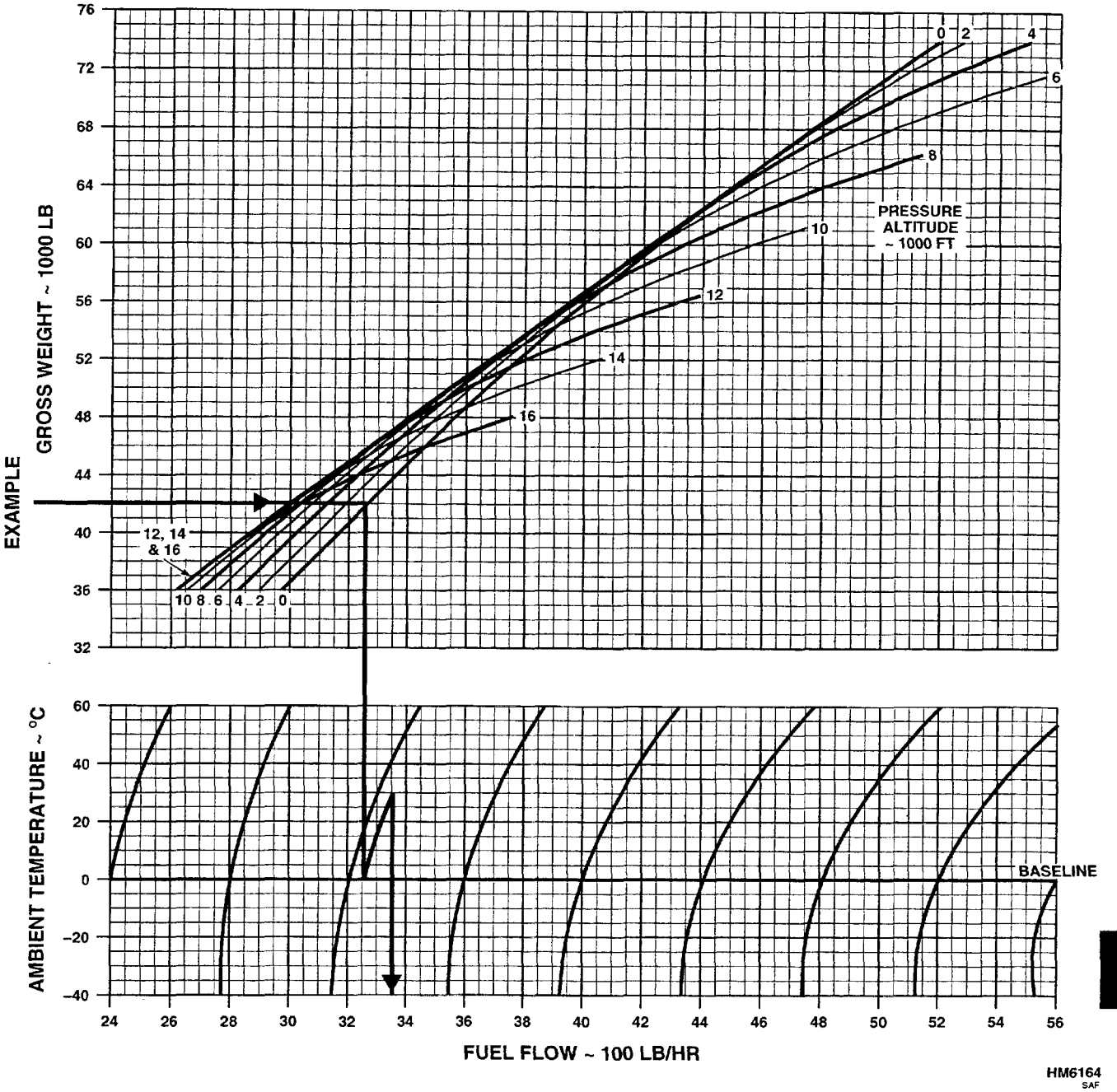


Figure 23-6. 25-Knot Endurance (419 Engine)

THREE-ENGINE HOVER ENDURANCE
OUT OF GROUND EFFECT
103% Nr

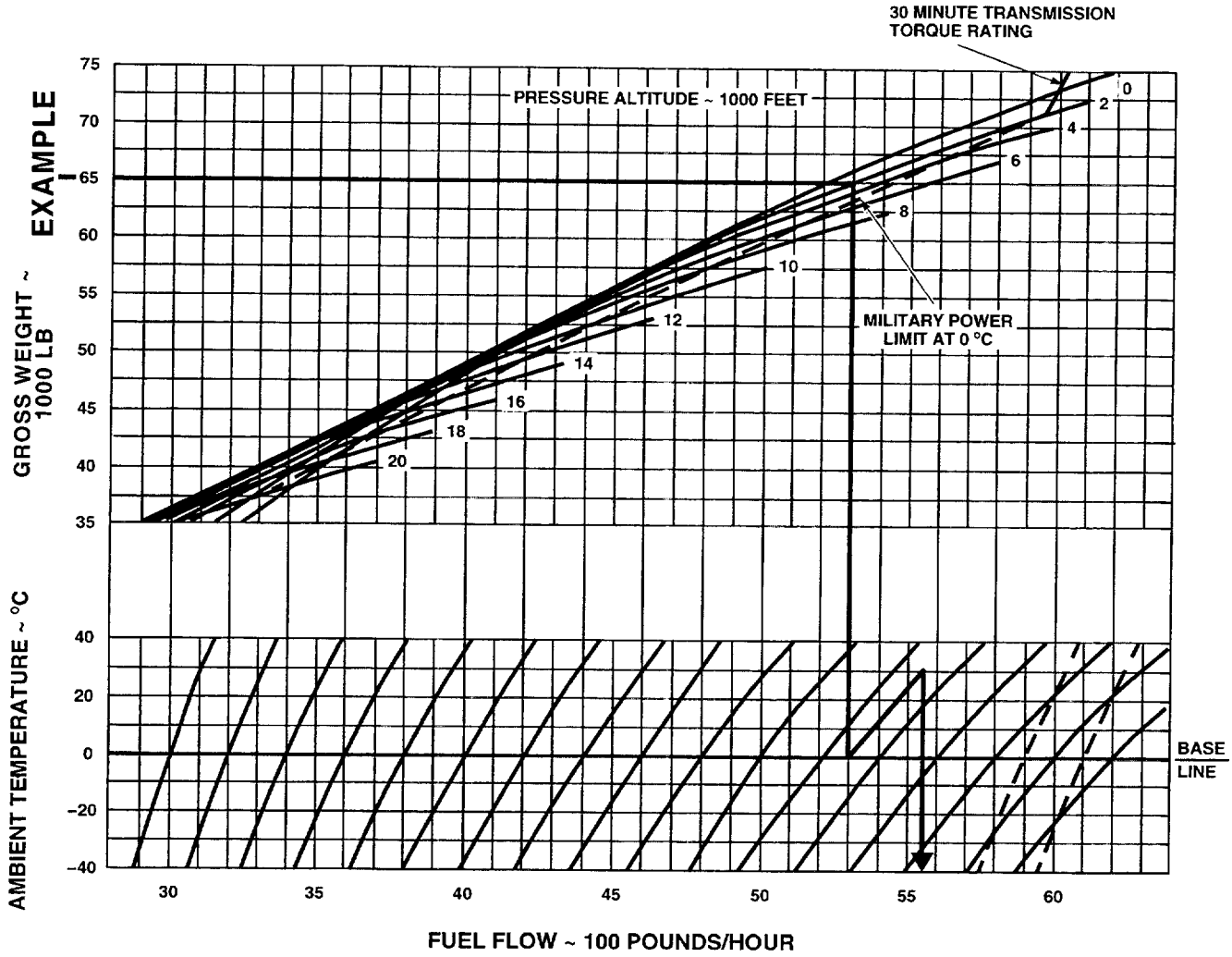
MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES: REFER TO ABILITY TO HOVER CHART FOR DETERMINING MAXIMUM GROSS WEIGHTS

WHEN LIMITED BY TRANSMISSION RATING USE DASHED INFLUENCE LINES ON TEMPERATURE SCALE



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Figure 23-7. Hover Endurance (416 Engine)

THREE ENGINE HOVER ENDURANCE
OUT OF GROUND EFFECT
103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

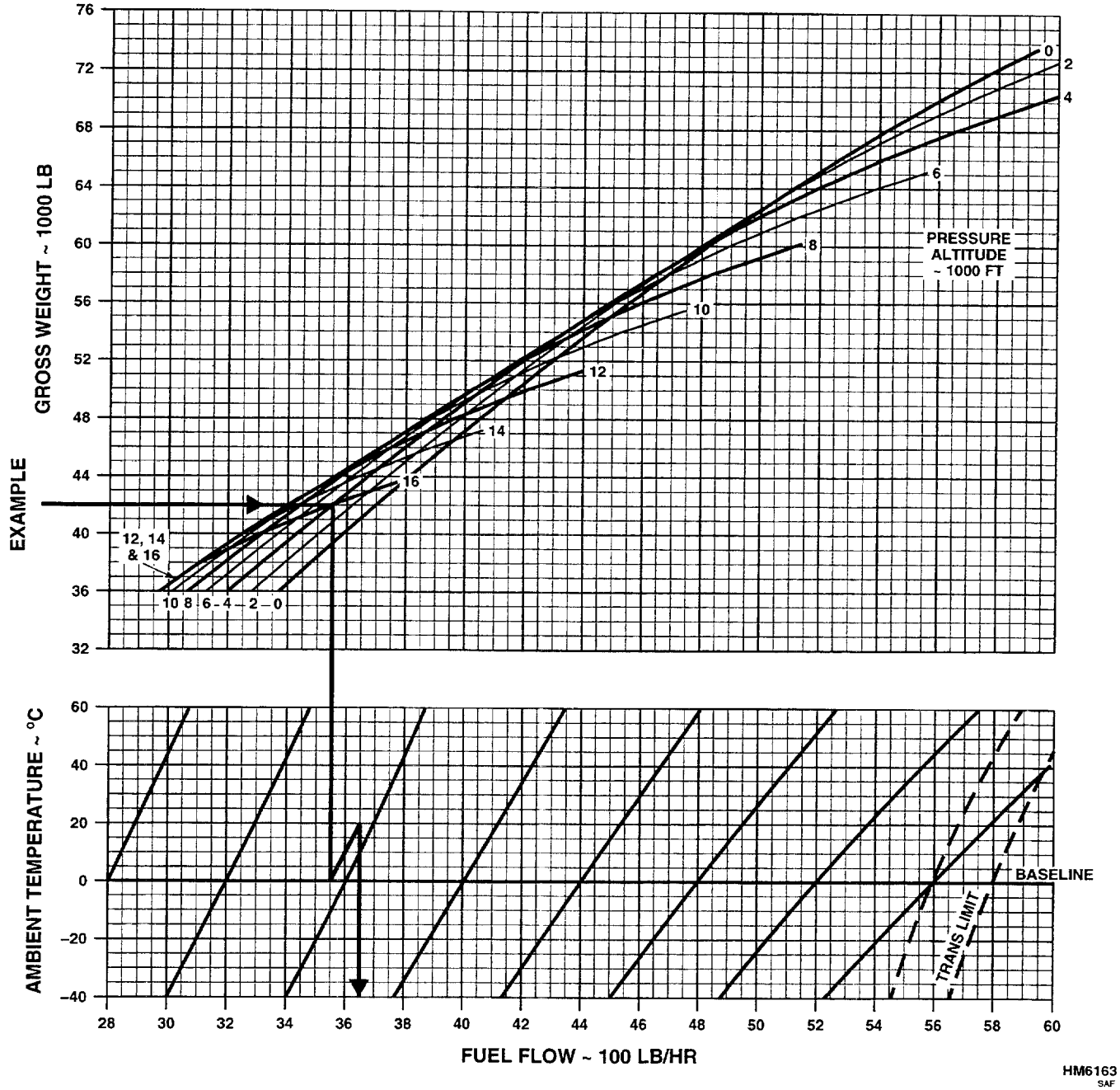


Figure 23-8. Hover Endurance (419 Engine)

CHAPTER 24
Tow Performance

24.1 TOW PERFORMANCE

The tow performance charts provide the torque required to tow and the resulting fuel flow for a range of tow tensions, gross weights and relative wind speeds. Data are presented for 15°C, 32°C, and 40°C at sea level. On the 416 engine charts, (Figures 24-1 thru 24-6) the maximum continuous power (MCP) and maximum power available lines are based on 7% degraded engines. The 419 engine charts (Figures 24-7 thru 24-12) are based on specification engine performance with a 30 minute transmission limit. Note that the maximum steady state tow tension is 25,000 lbs. The downwind tow tension limitations shown are from Figure 4-5.

24.1.1 Torque Required for Towing. The torque required for towing charts (Figures 24-1, 24-3, and 24-5 for the 416 engine and Figures 24-7, 24-9, and 24-11 for the 419 engine) provide torque required for towing using ambient temperature, relative wind speed, gross weight and tow tension as variables. For example, determine the torque required to tow downwind at 10 kts towed vehicle water speed with 30 kts of wind at 50,000 lbs and 10,000 lbs tow tension at sea level 15°C. 10 kts water speed downwind in 30 kts water speed downwind in 30 kts of wind results in a relative wind speed of -20 kts. Enter the -20 kt sea level 15°C chart at 10,000 lbs tow tension and trace up to the 50,000 lb gross weight line. Then trace left and read 80% torque required for tow at these conditions.

24.1.2 Fuel Flow Required for Towing. The fuel flow required for towing charts (Figures 24-2, 24-4, and 24-6 for the 416 engine and Figures 24-8, 24-10, and 24-12 for the 419 engine) are used the same way as the torque required for towing charts (Figures 24-1, 24-3, and 24-5).

TORQUE REQUIRED FOR TOWING
SEA LEVEL 15 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

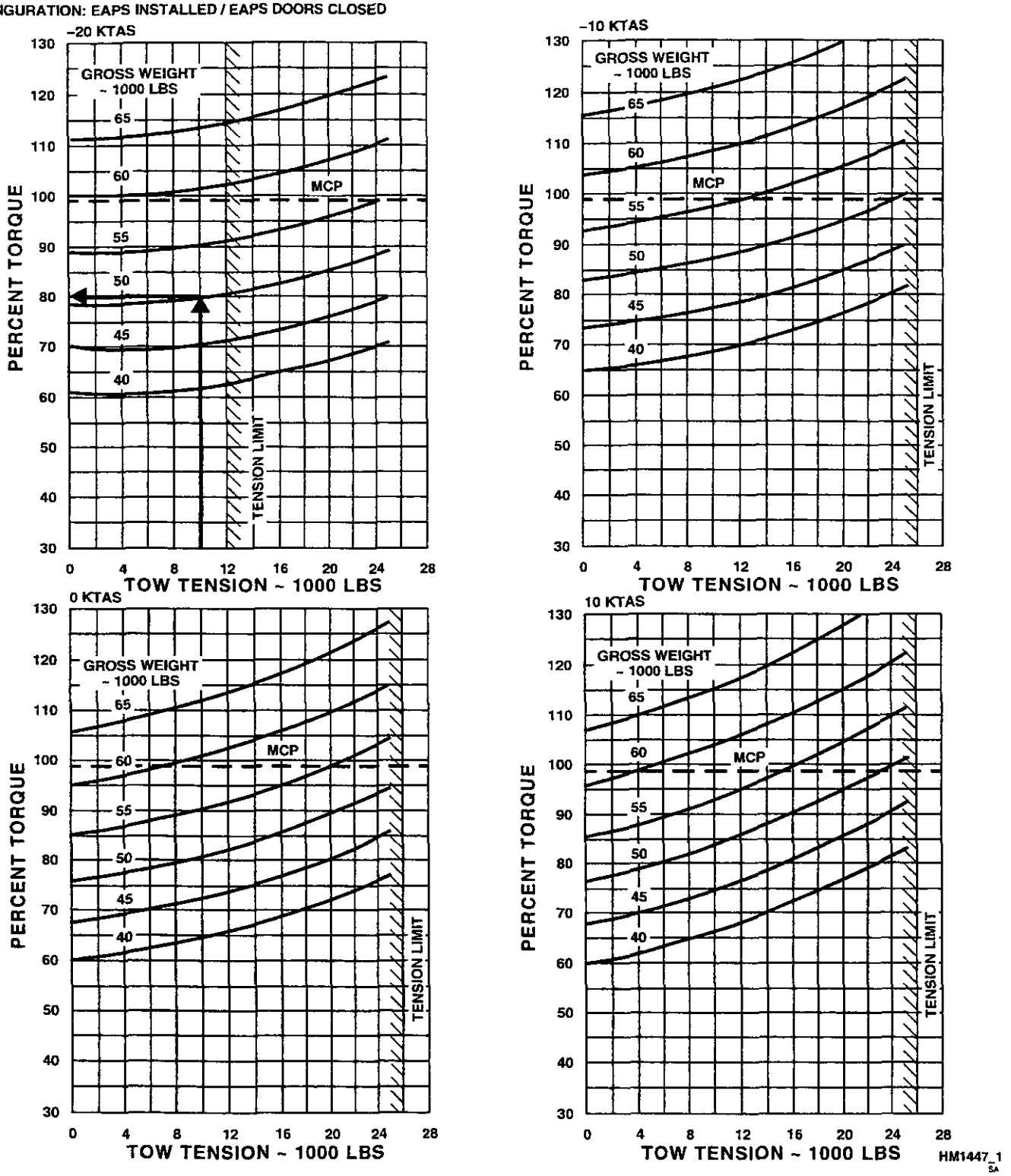


Figure 24-1. Torque Required for Towing - Sea Level 15°C (416 Engine) (Sheet 1 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 15 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

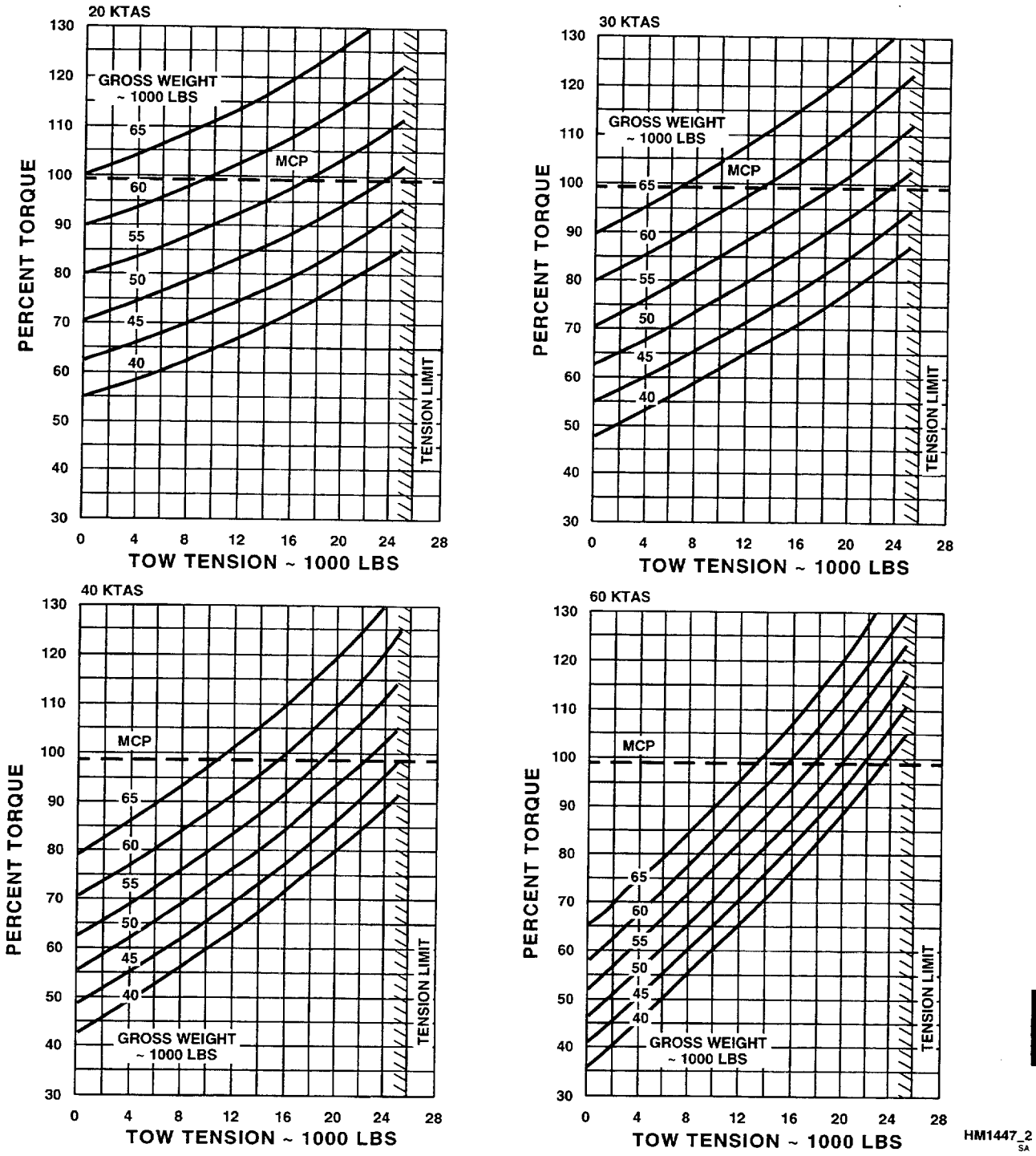


Figure 24-1. Torque Required for Towing - Sea Level 15°C (416 Engine) (Sheet 2 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 15 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

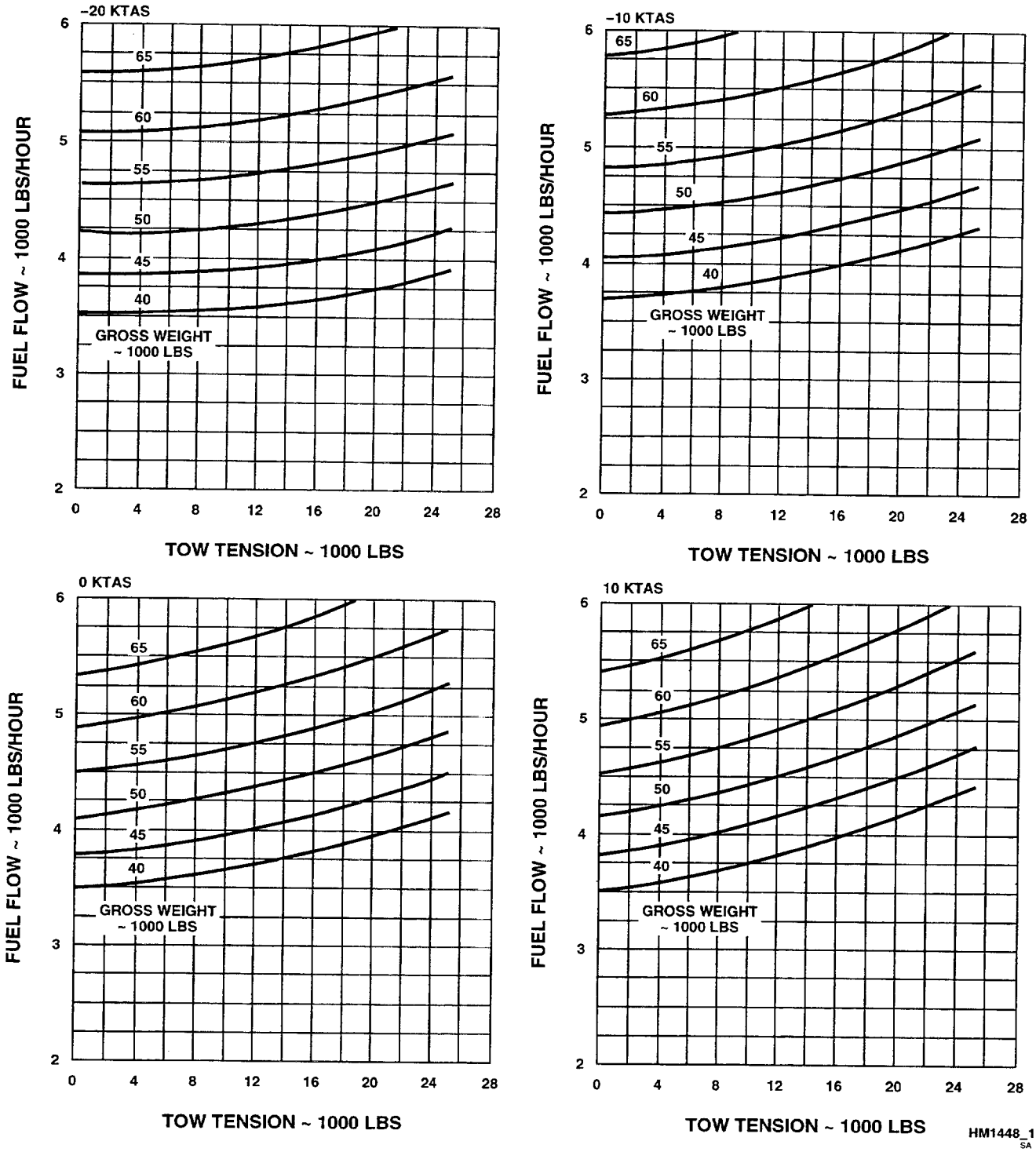


Figure 24-2. Fuel Flow for Towing - Sea Level 15°C (416 Engine) (Sheet 1 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 15 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

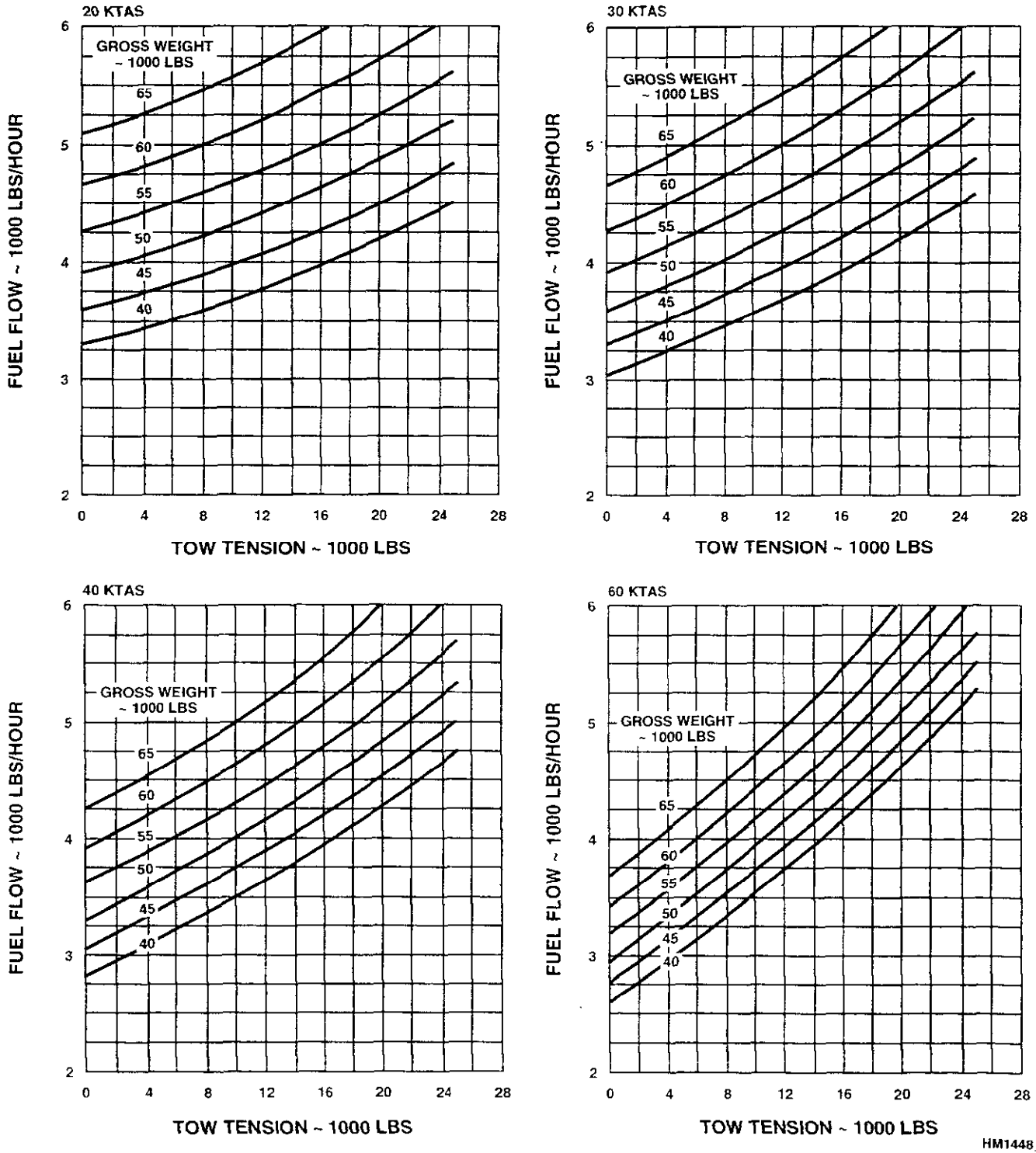


Figure 24-2. Fuel Flow for Towing - Sea Level 15°C (416 Engine) (Sheet 2 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 32 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

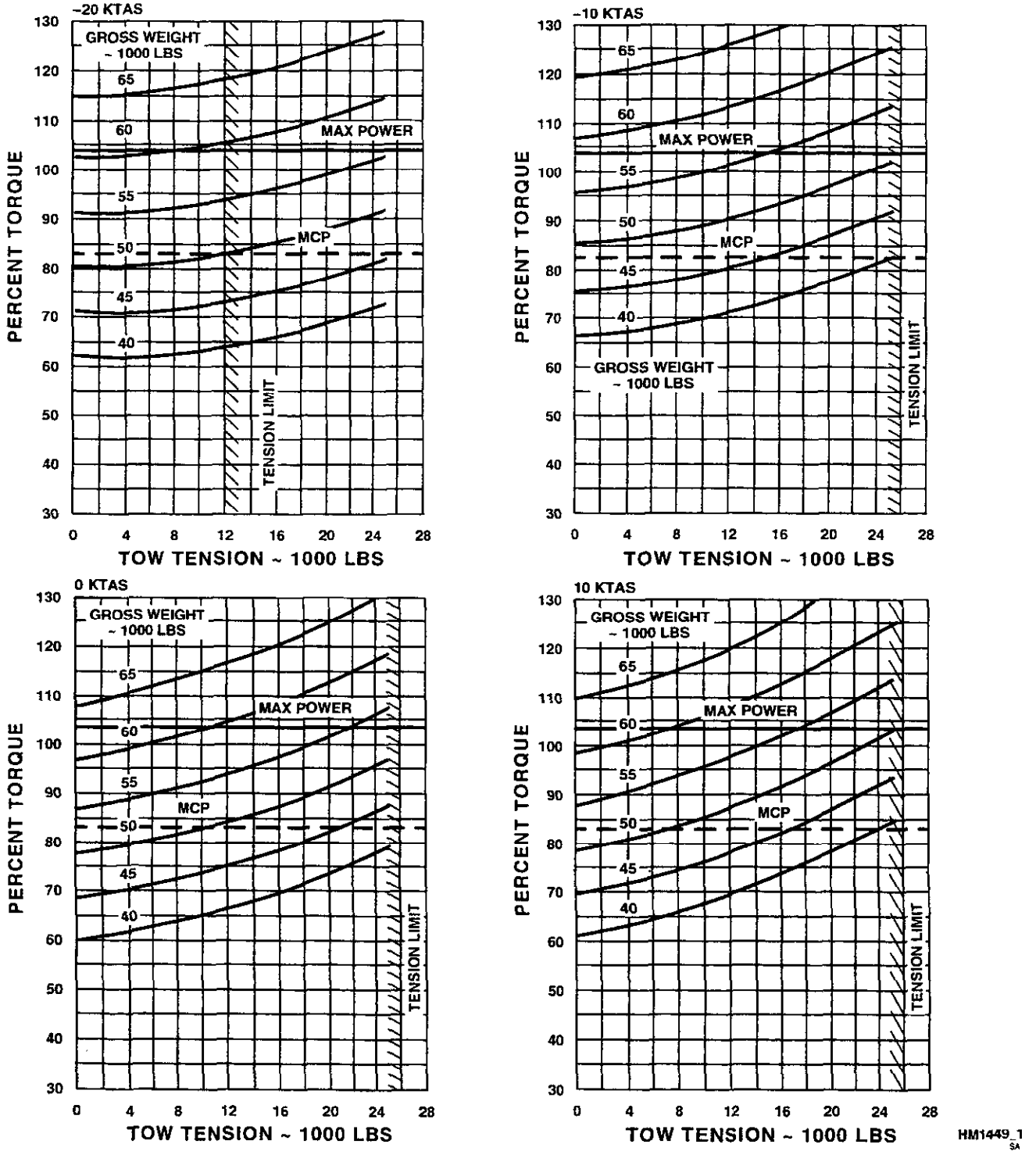


Figure 24-3. Torque Required for Towing - Sea Level 32°C (416 Engine) (Sheet 1 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 32 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

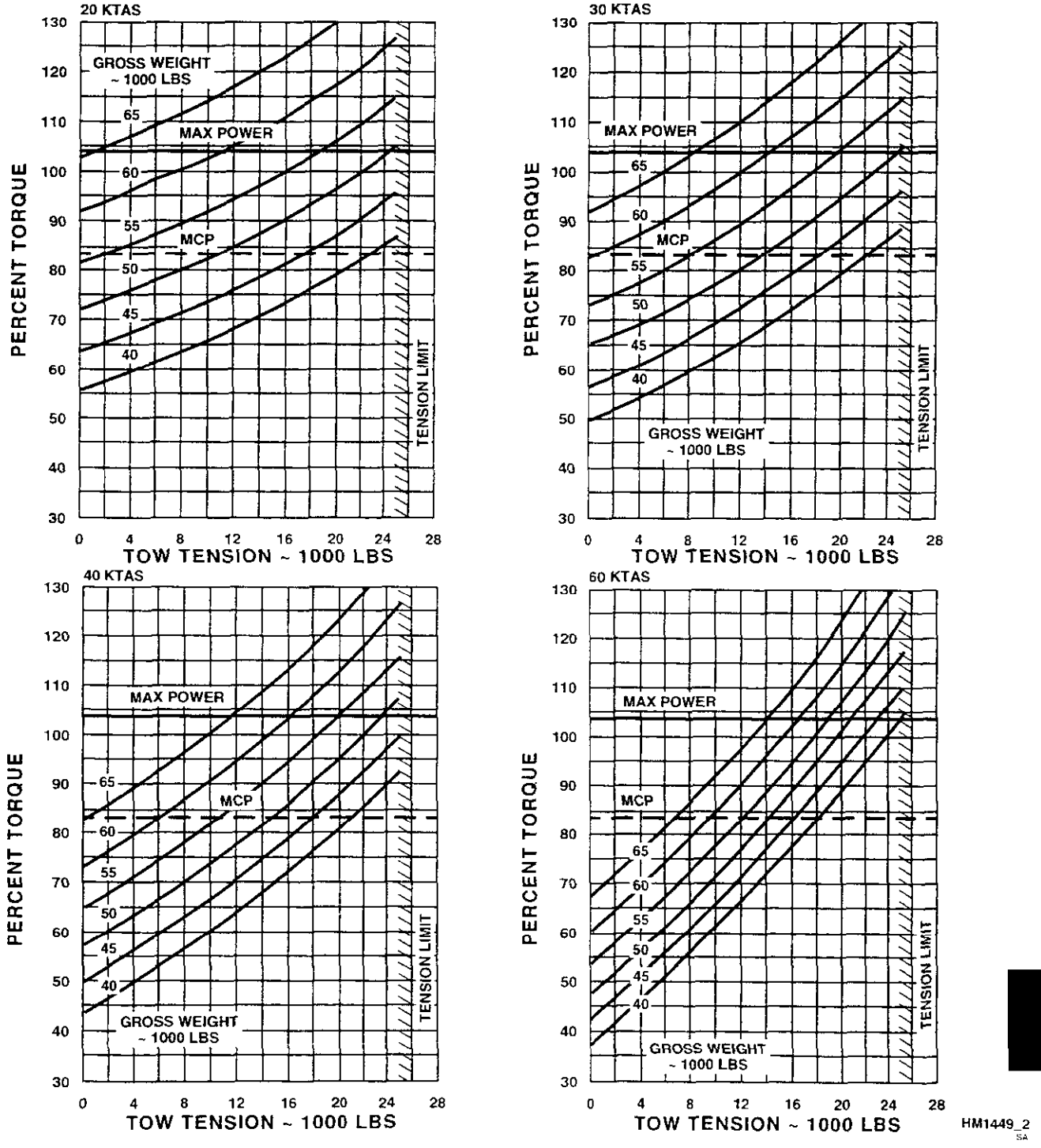


Figure 24-3. Torque Required for Towing - Sea Level 32°C (416 Engine) (Sheet 2 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 32 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

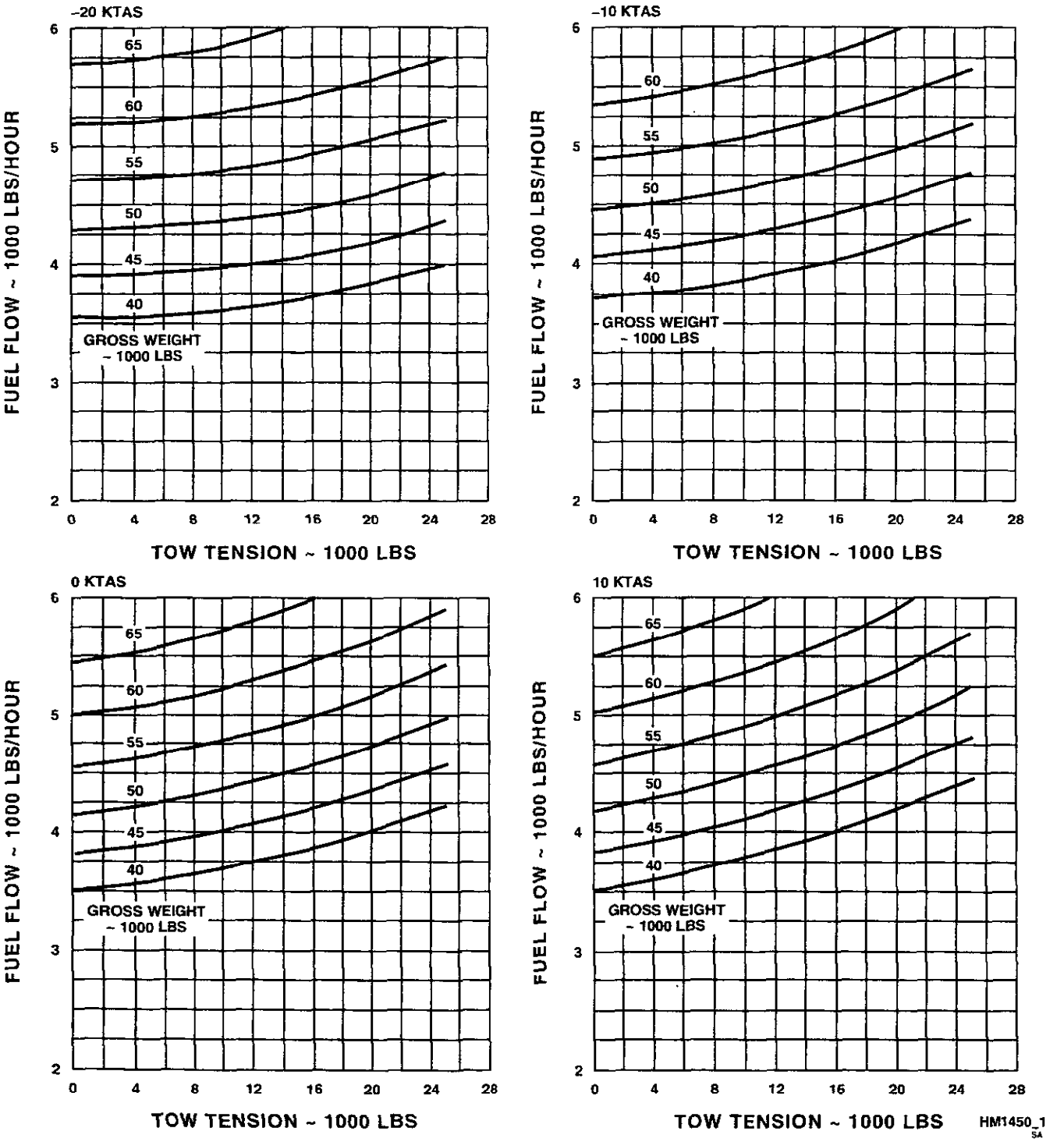


Figure 24-4. Fuel Flow for Towing - Sea Level 32°C (416 Engine) (Sheet 1 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 32 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

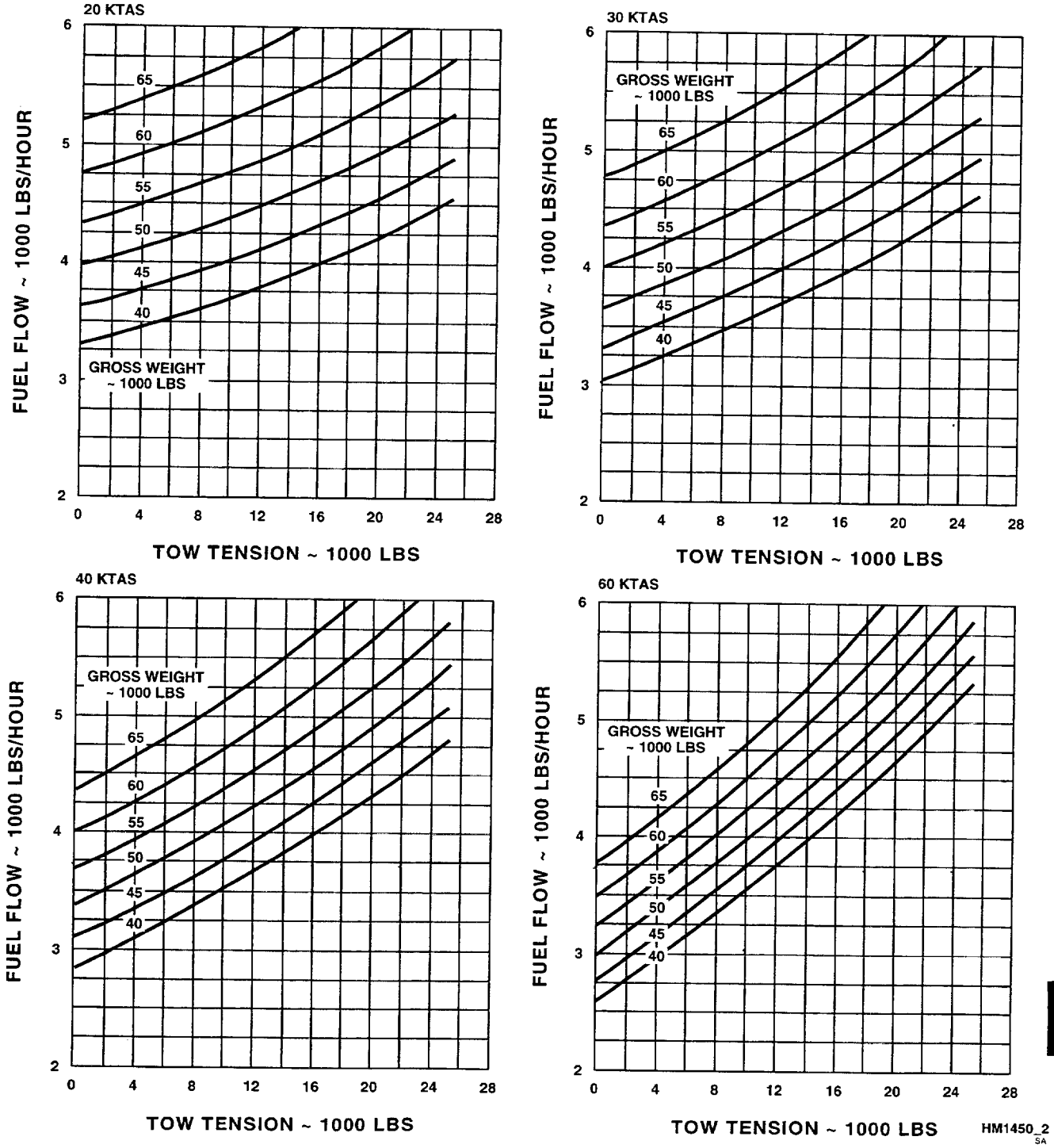


Figure 24-4. Fuel Flow for Towing - Sea Level 32°C (416 Engine) (Sheet 2 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 40 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

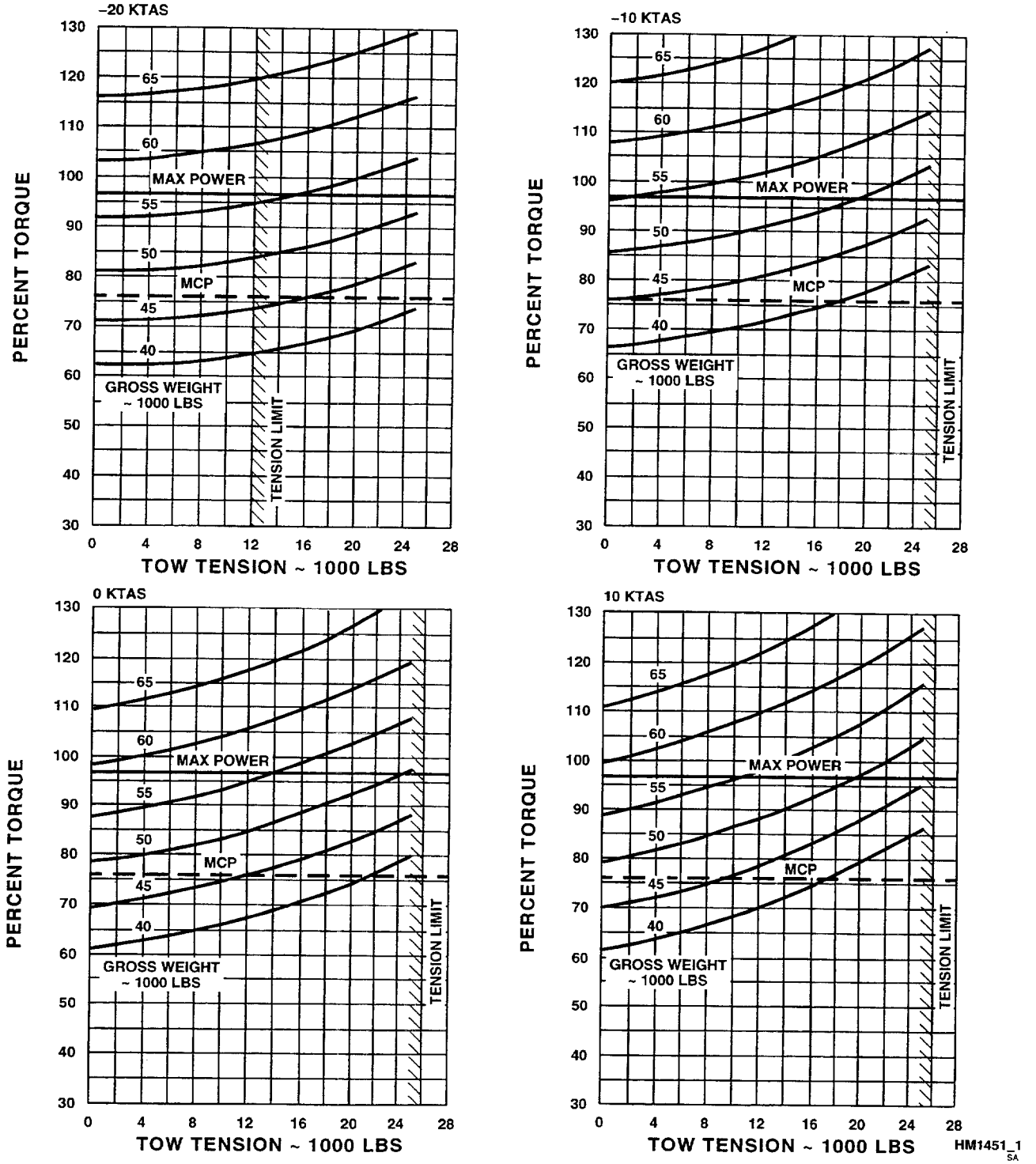


Figure 24-5. Torque Required for Towing - Sea Level 40°C (416 Engine) (Sheet 1 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 40 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

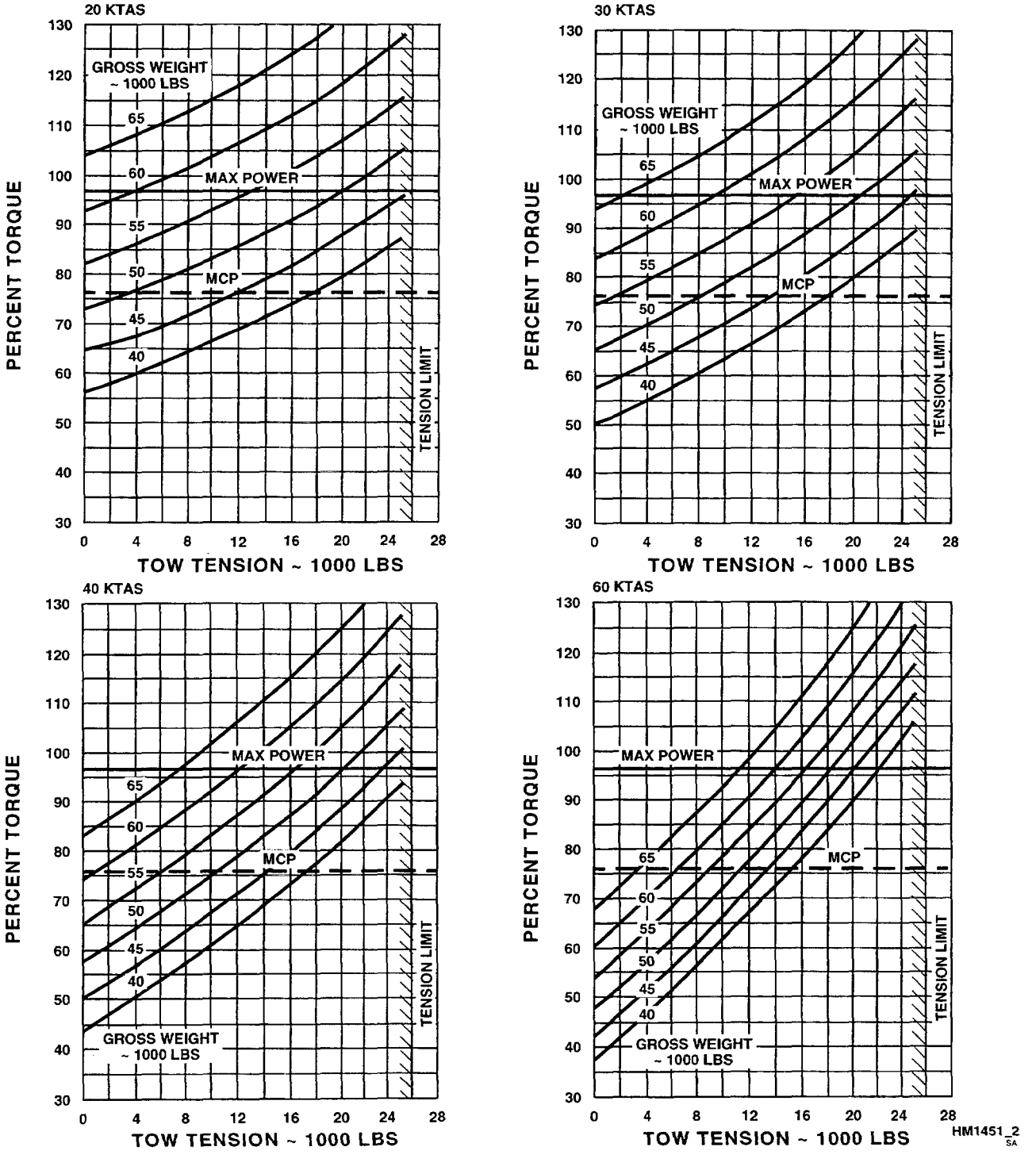


Figure 24-5. Torque Required for Towing - Sea Level 40°C (416 Engine) (Sheet 2 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 40 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

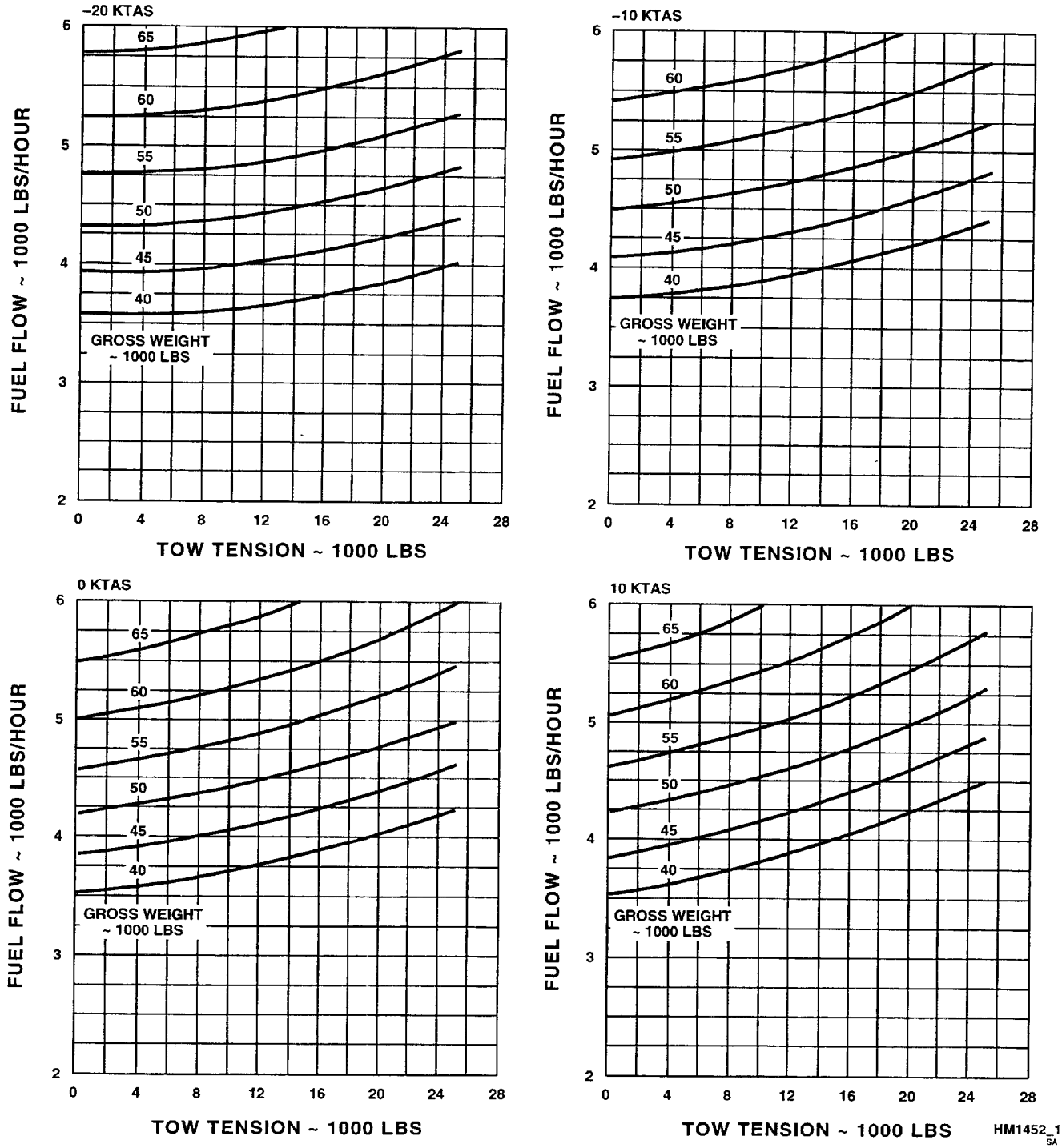


Figure 24-6. Fuel Flow for Towing - Sea Level 40°C (416 Engine) (Sheet 1 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 40 °C

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

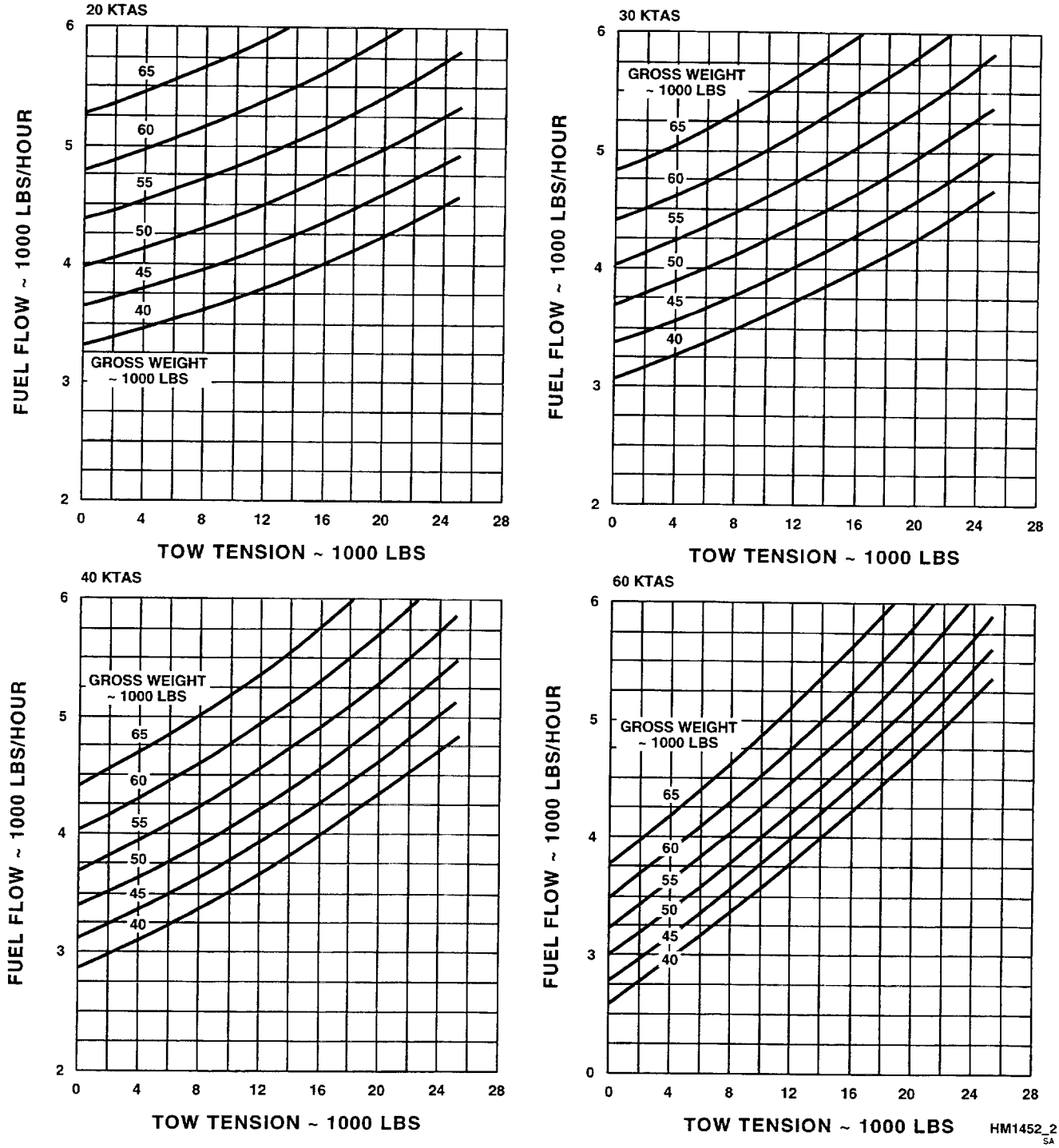


Figure 24-6. Fuel Flow for Towing - Sea Level 40°C (416 Engine) (Sheet 2 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 15° C
103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

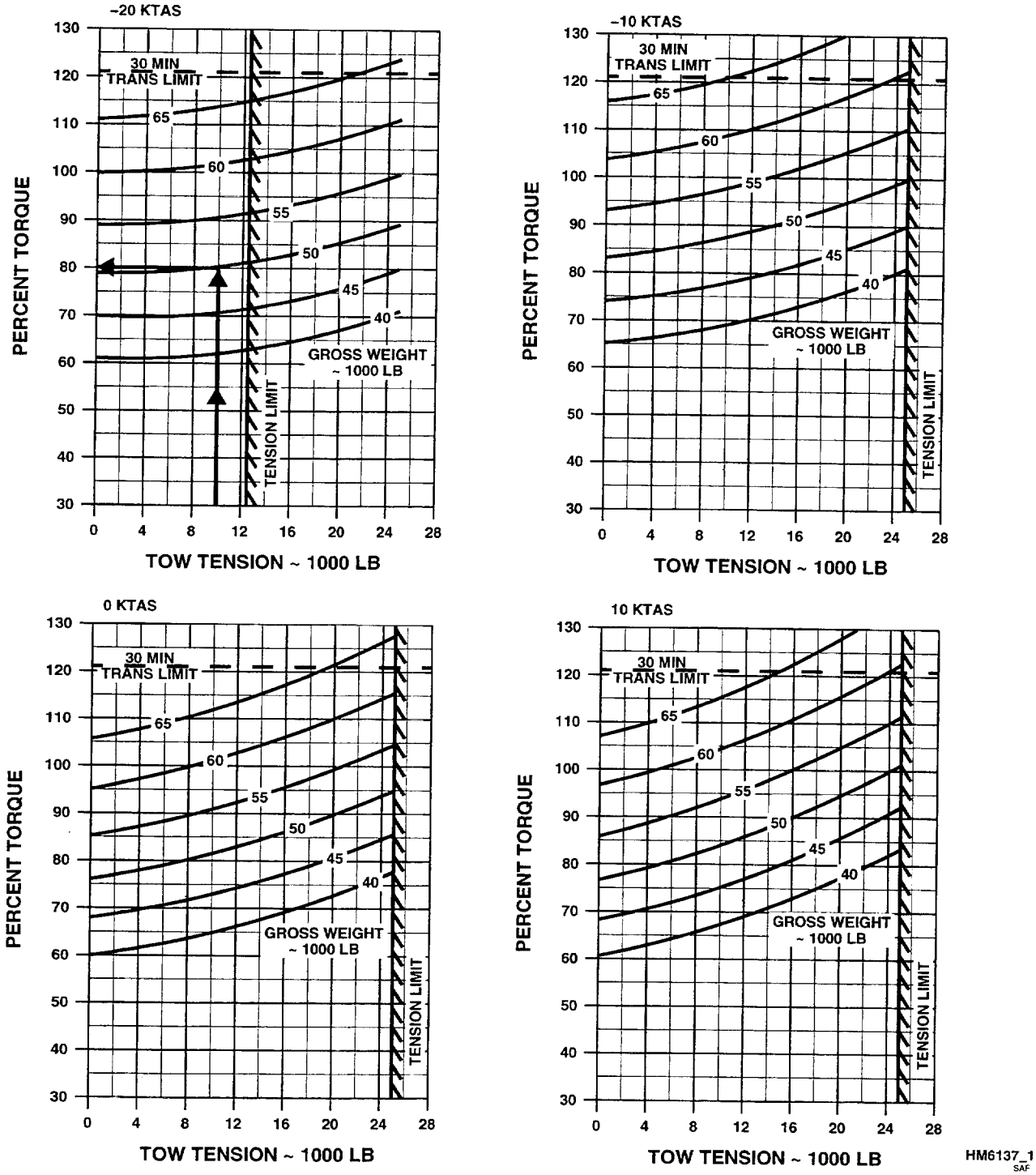


Figure 24-7. Torque Required for Towing - Sea Level 15°C (419 Engine) (Sheet 1 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 15° C
103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

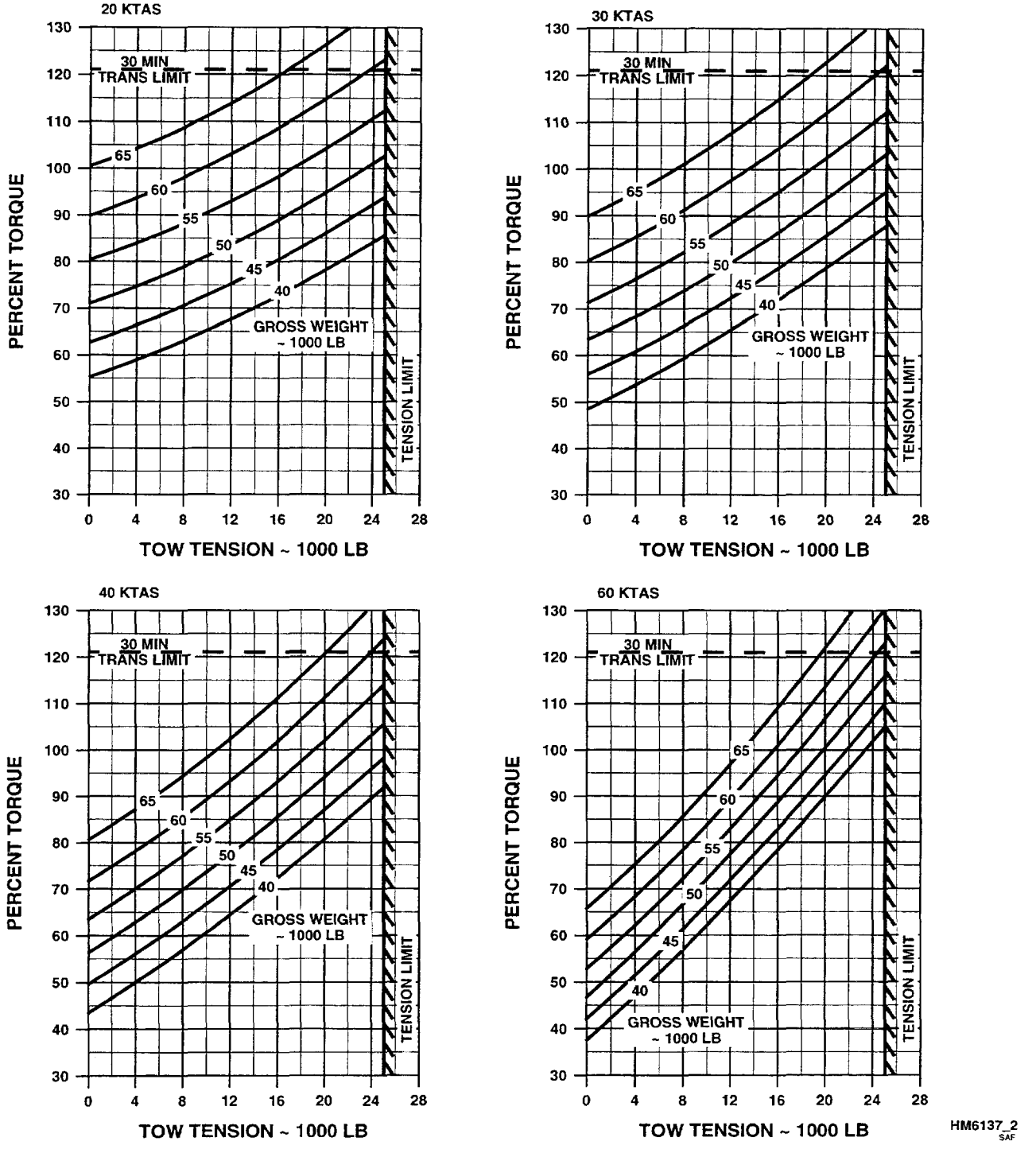


Figure 24-7. Torque Required for Towing - Sea Level 15°C (419 Engine) (Sheet 2 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 15° C

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

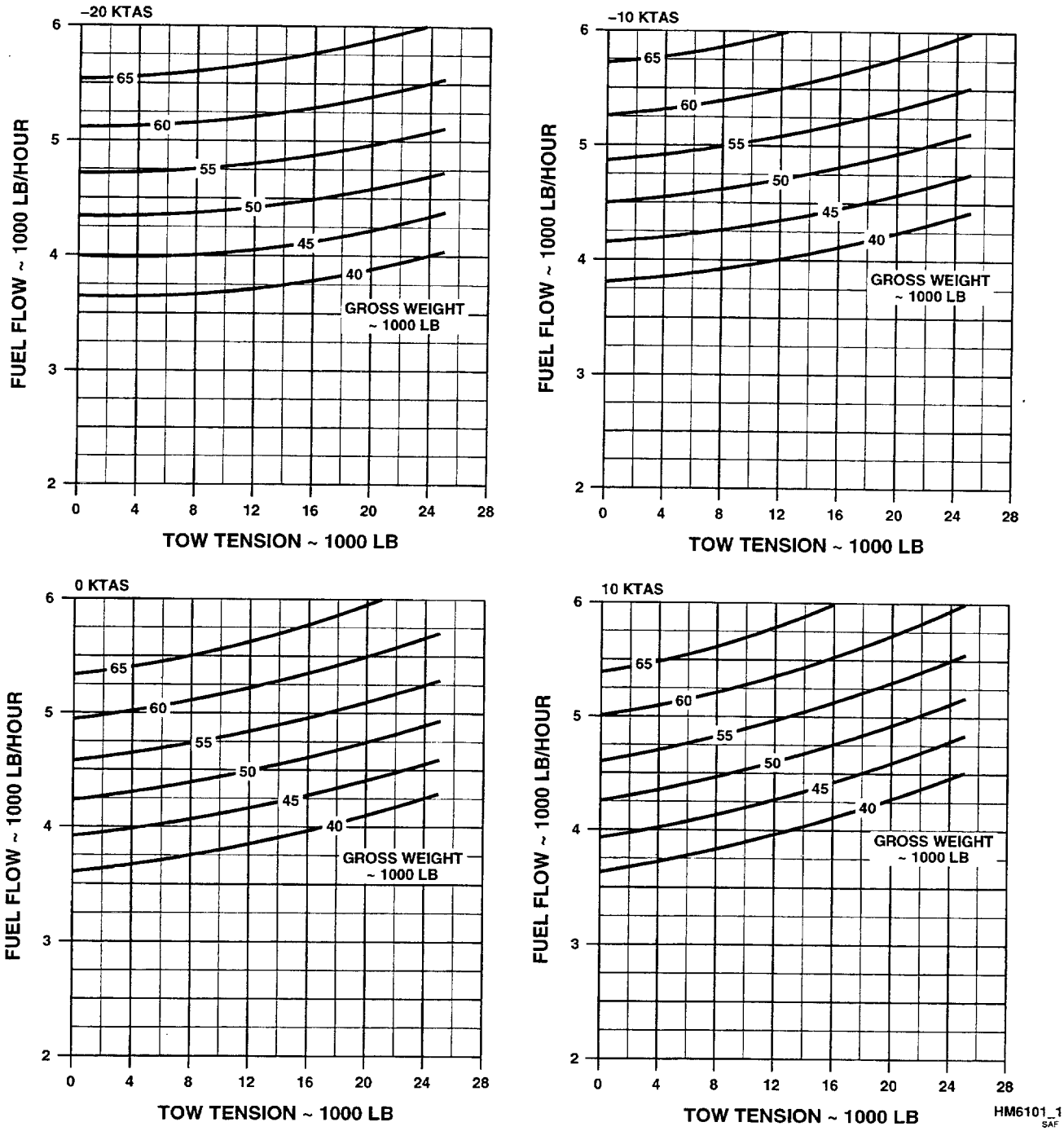


Figure 24-8. Fuel Flow for Towing - Sea Level 15°C (419 Engine) (Sheet 1 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 15° C

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

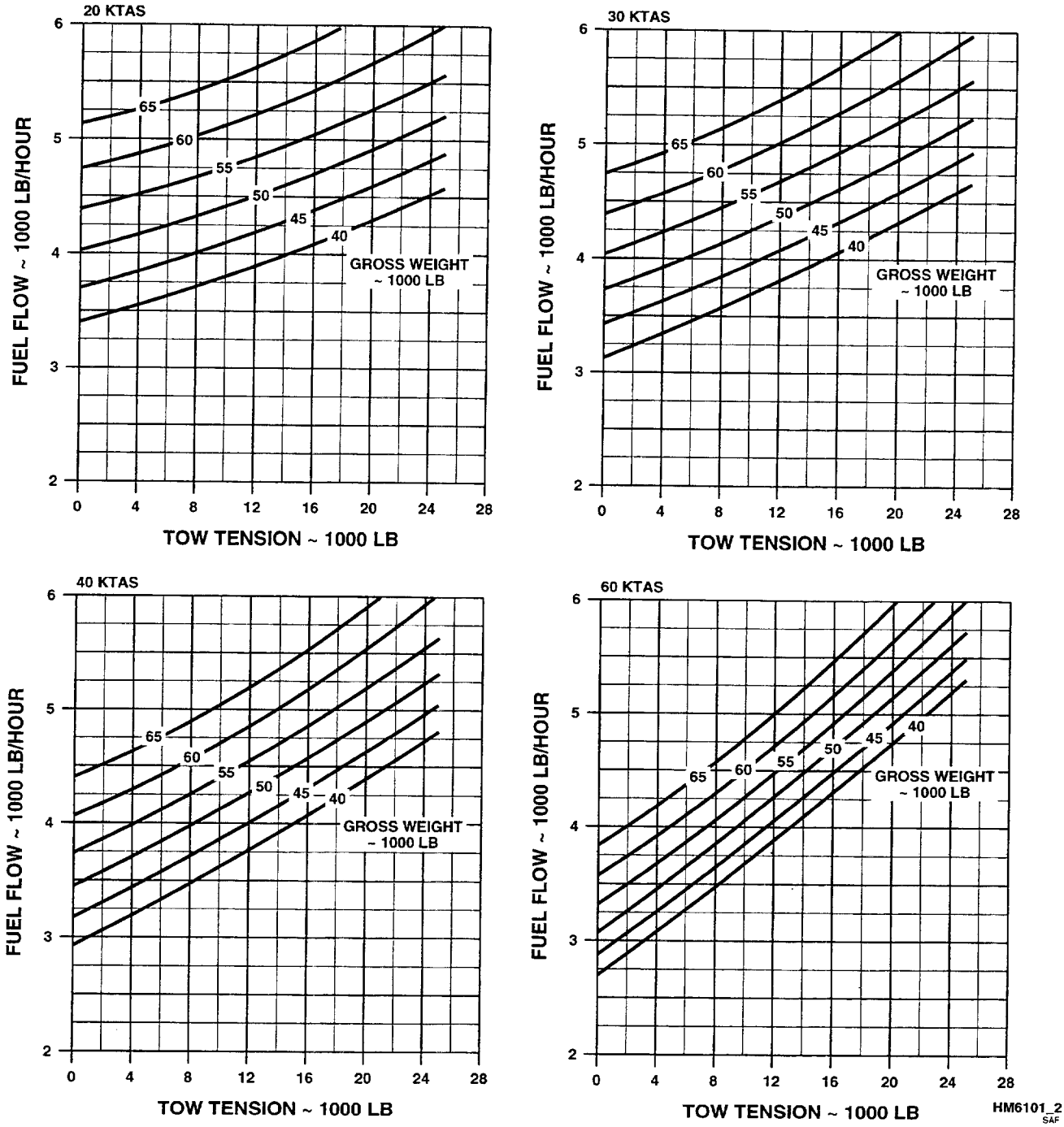


Figure 24-8. Fuel Flow for Towing - Sea Level 15°C (419 Engine) (Sheet 2 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 32° C
103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

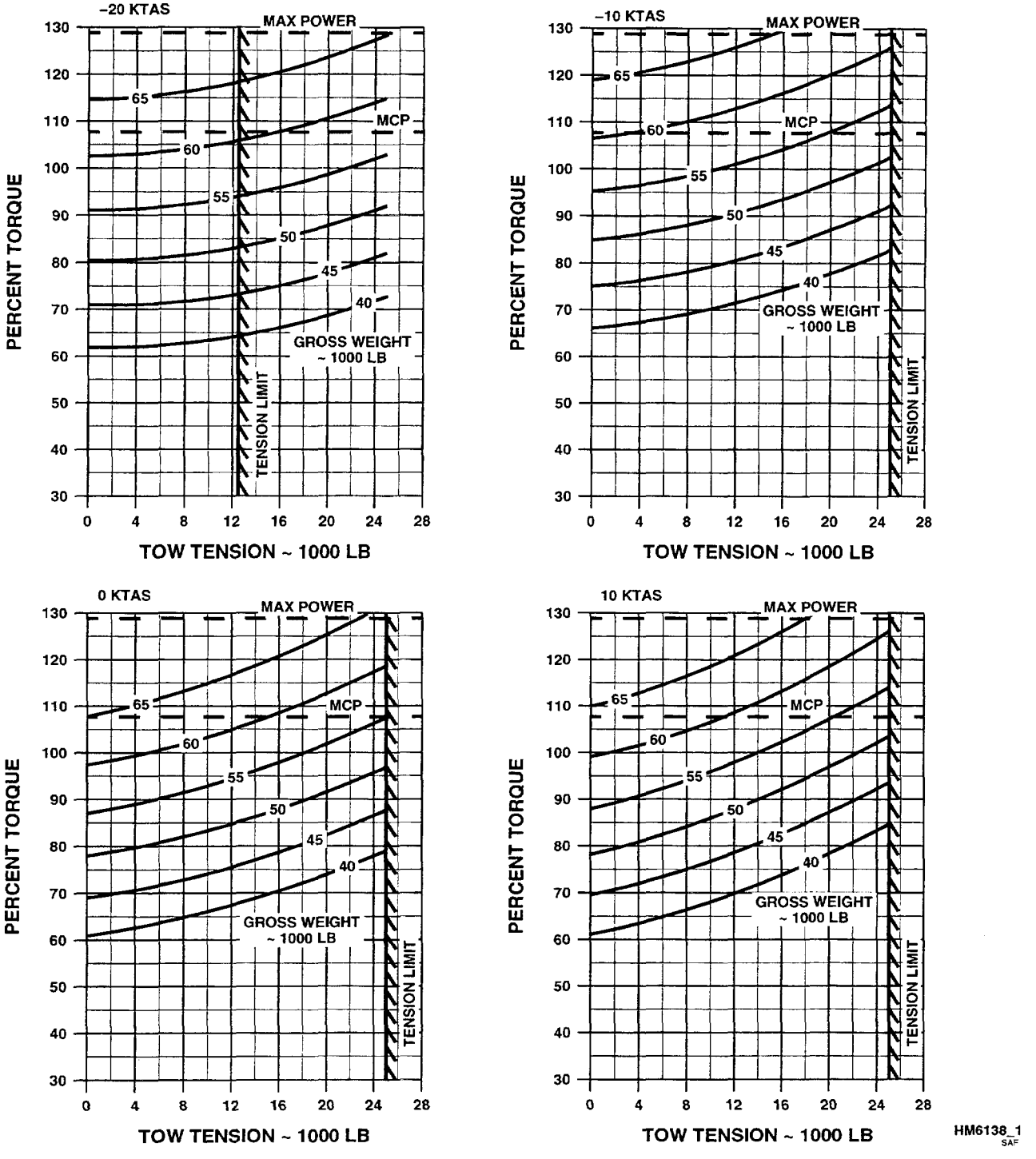


Figure 24-9. Torque Required for Towing - Sea Level 32°C (419 Engine) (Sheet 1 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 32° C
103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

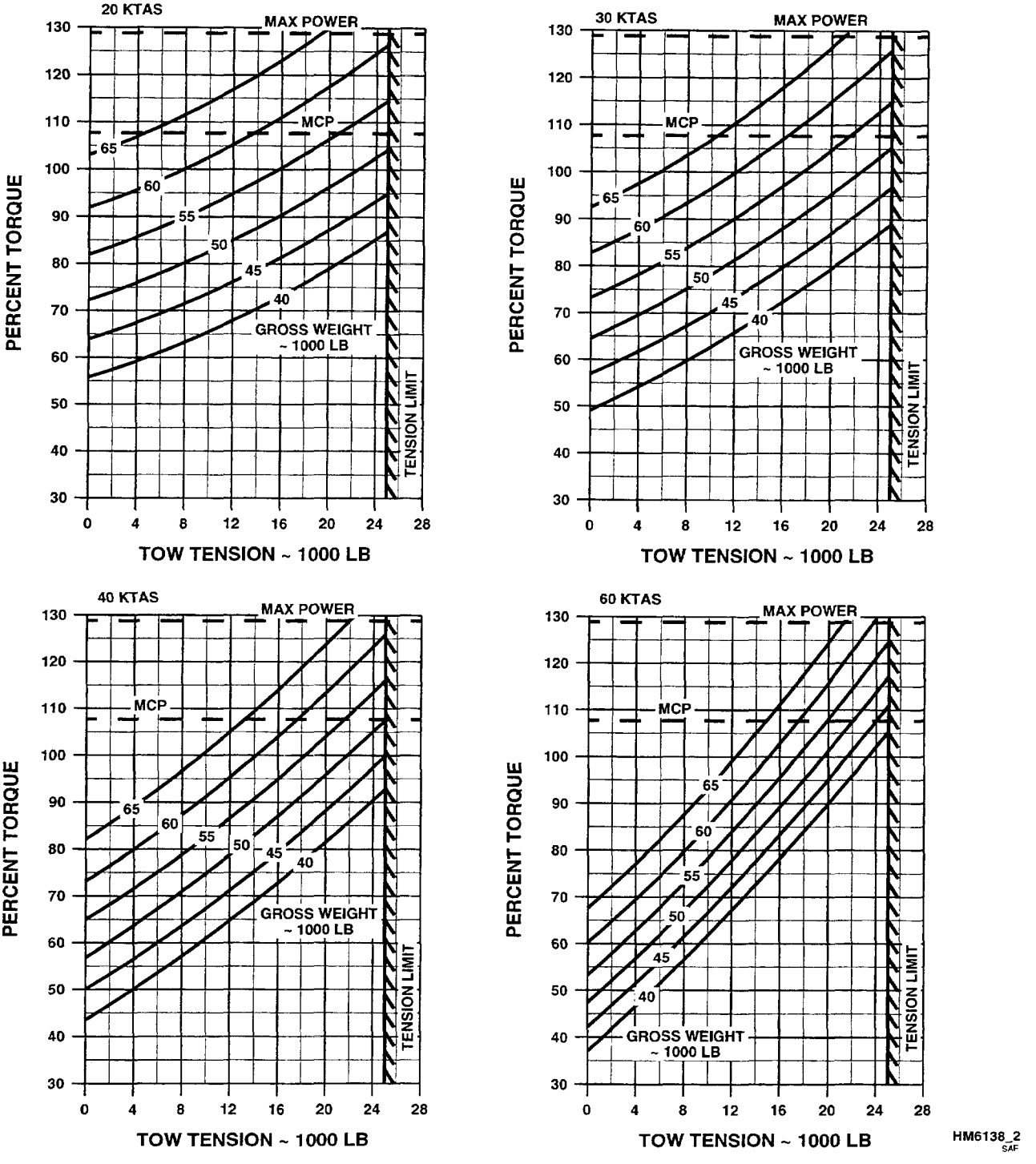


Figure 24-9. Torque Required for Towing - Sea Level 32°C (419 Engine) (Sheet 2 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 32° C

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

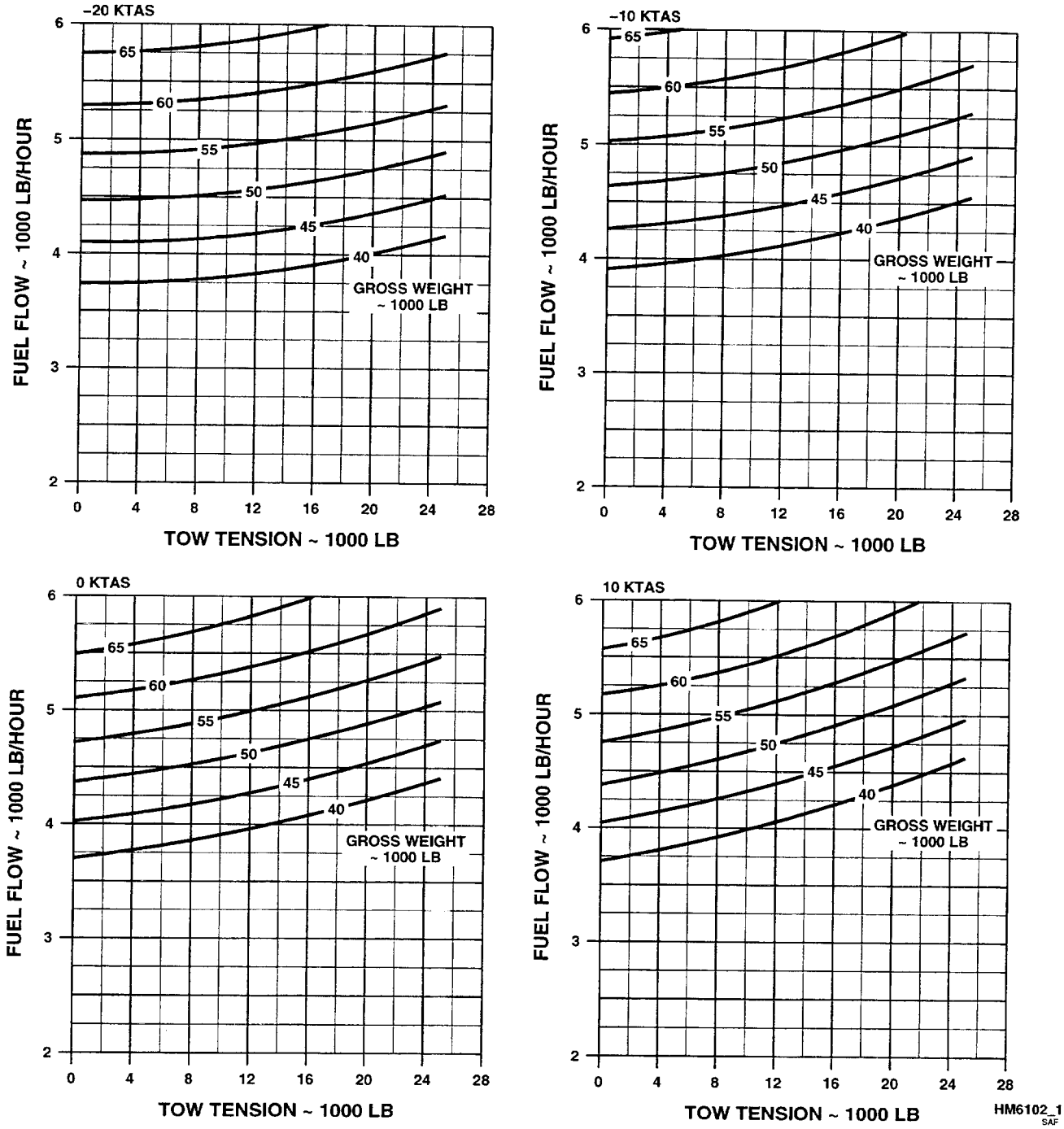


Figure 24-10. Fuel Flow for Towing - Sea Level 32°C (419 Engine) (Sheet 1 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 32° C

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

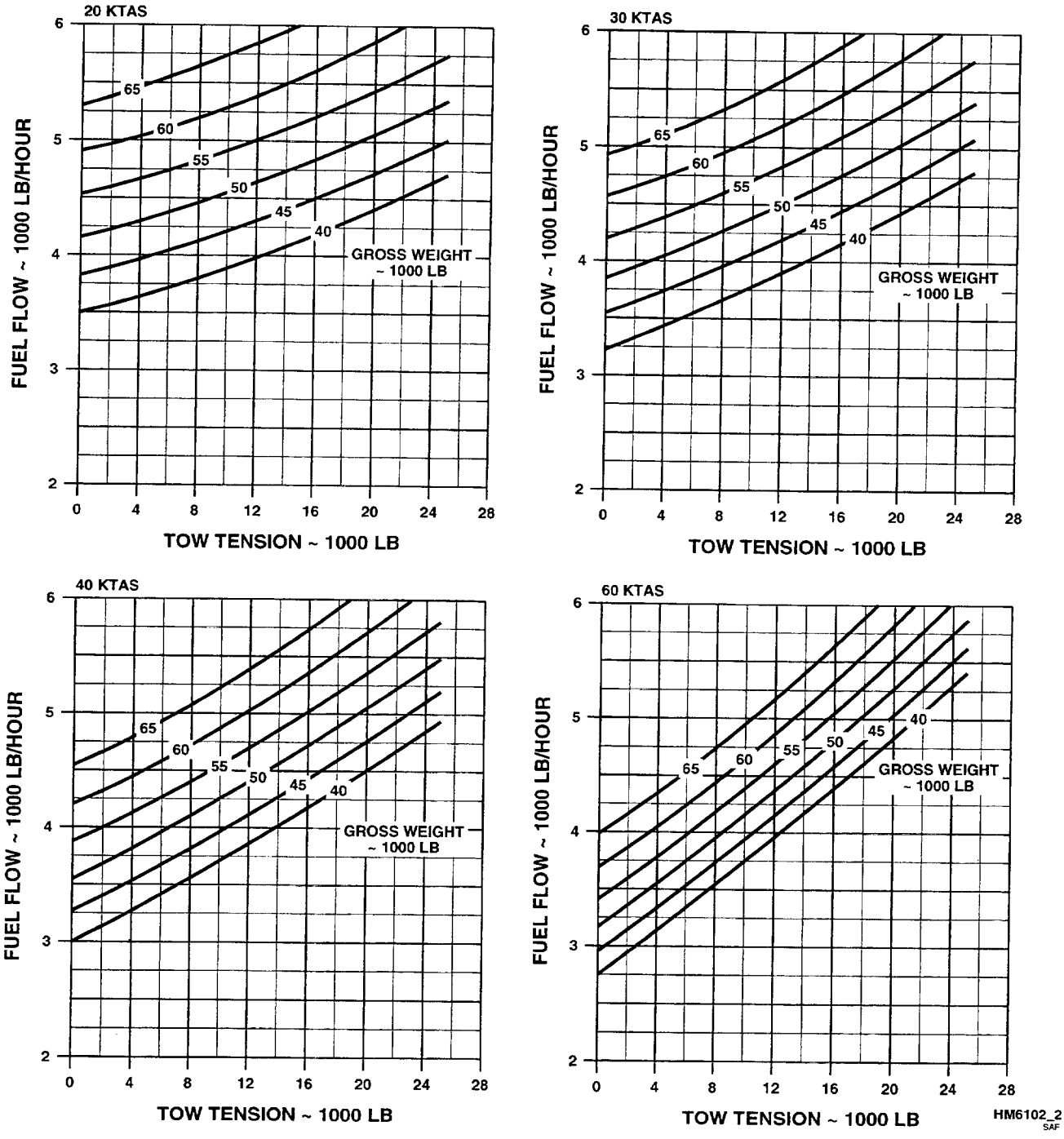


Figure 24-10. Fuel Flow for Towing - Sea Level 32°C (419 Engine) (Sheet 2 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 40° C
103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

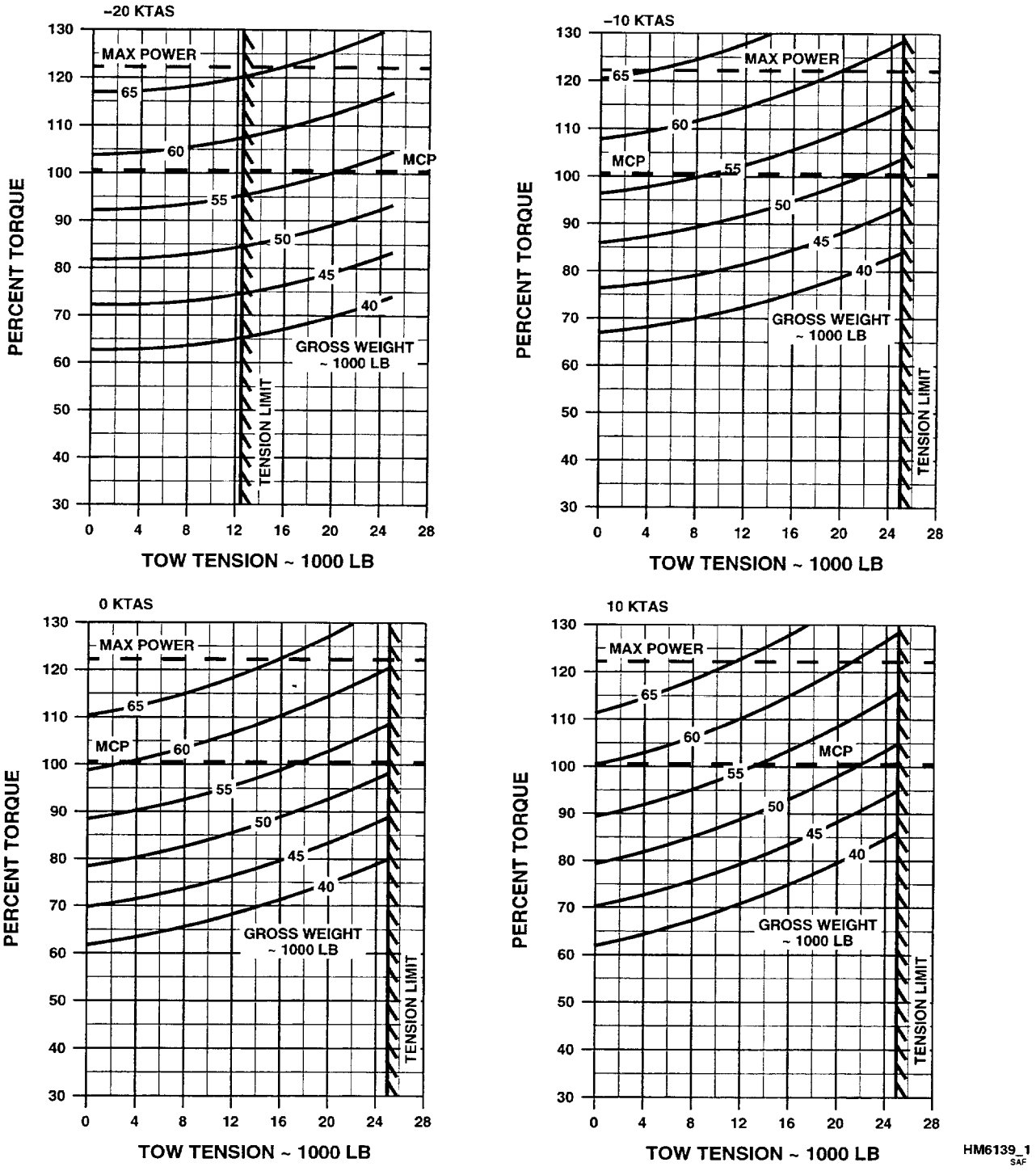


Figure 24-11. Torque Required for Towing - Sea Level 40°C (419 Engine) (Sheet 1 of 2)

TORQUE REQUIRED FOR TOWING
SEA LEVEL 40° C
103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

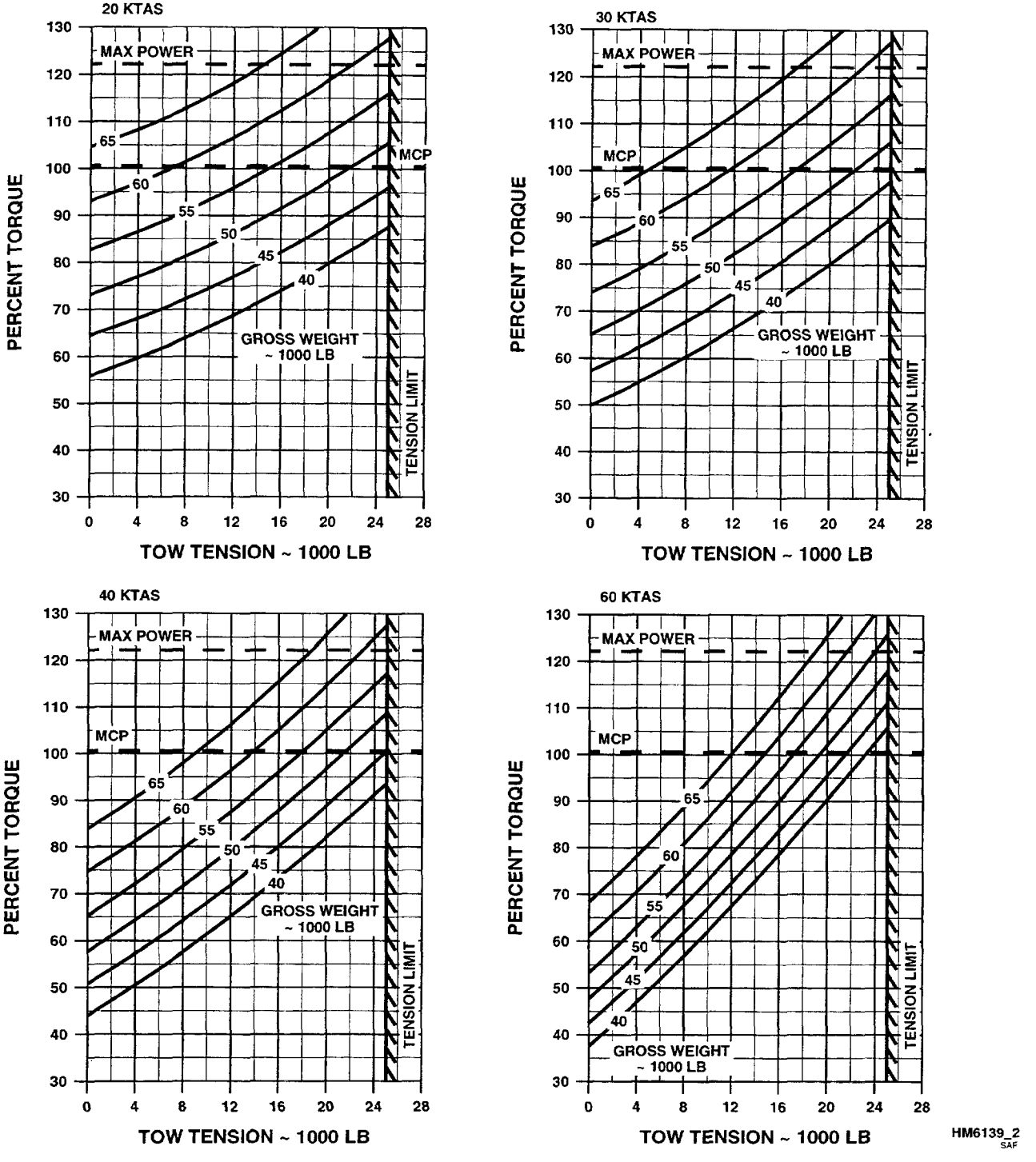


Figure 24-11. Torque Required for Towing - Sea Level 40°C (419 Engine) (Sheet 2 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 40° C

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

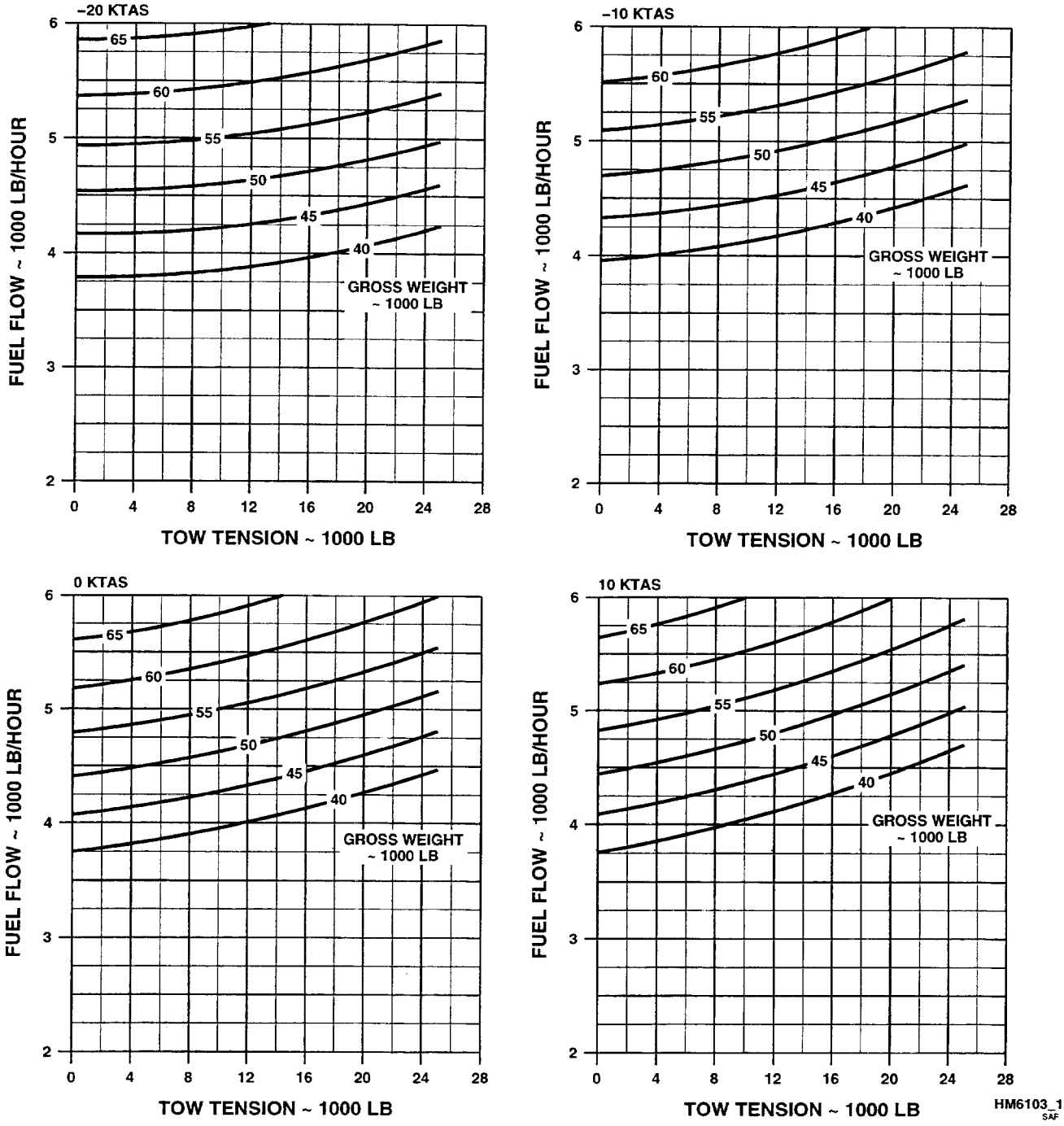


Figure 24-12. Fuel Flow for Towing - Sea Level 40°C (419 Engine) (Sheet 1 of 2)

FUEL FLOW FOR TOWING
SEA LEVEL 40° C

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

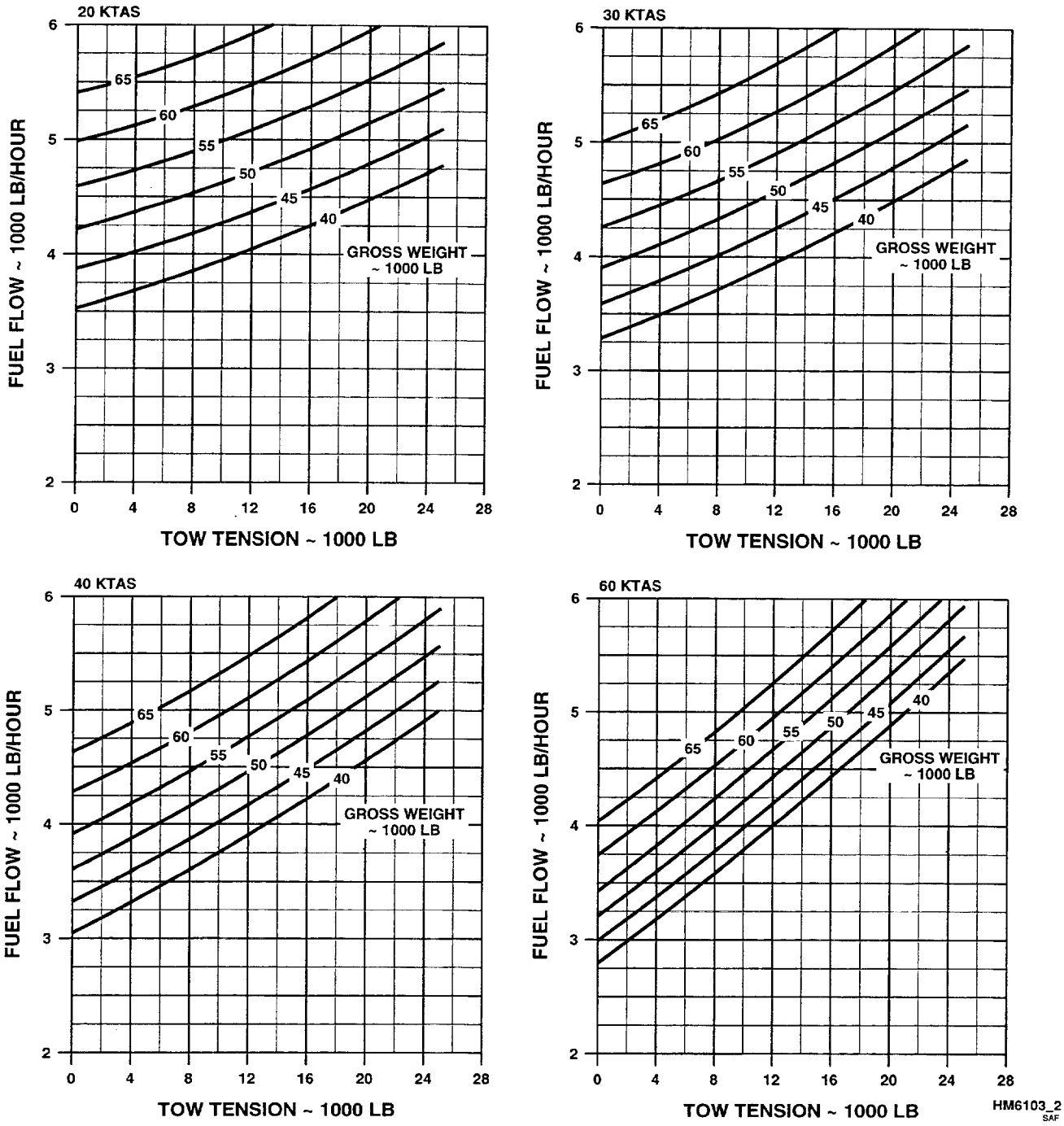


Figure 24-12. Fuel Flow for Towing - Sea Level 40°C (419 Engine) (Sheet 2 of 2)

CHAPTER 25
Emergency

25.1 HEIGHT-VELOCITY DIAGRAMS

The height velocity diagrams provide the limiting altitude and corresponding airspeed combinations for a landing following engine(s) failure. Note that with any height-velocity diagram the depicted boundary is not precise. The boundary will expand or contract depending on the nature of the emergency and the capabilities of the flight crew. Emergency landings from positions outside the height velocity envelopes assume unrestricted landing areas, and roll-on speeds up to 60 knots at high gross weights can be expected. There is significant expansion of the avoid area if the landing area is restricted. 416 engine charts are based on degraded engine performance at 100% N_r and standard day temperature at sea level. 419 engine charts are based on contingency power levels of a specification engine from 100% to 103% N_r, and standard day temperature at sea level.

25.1.1 Height-Velocity Diagram - Three-Engine Failure Chart. The height-velocity diagram - three-engine failure chart (Figure 25-1) is used the same way as Figure 25-2.

25.1.2 Height-Velocity Diagram - Dual-Engine Failure Chart. See Figure 25-2 for the 416 engine and Figure 25-3 for the 419 engine. Figure 25-3 (for the 419 engine) provides two height-velocity diagrams, one for standard-day conditions and one for hot day (39.4°C) conditions.

For example, at 60,000 pounds, determine if a safe landing can be made from 400-feet wheel height and 45 KIAS. Enter the left side of the chart at 400-feet wheel height and trace across to 45 KIAS. Note that this intersection falls outside the 60,000-pound boundary and is therefore satisfactory. However, note that this altitude speed combination is unsatisfactory for 70,000 pounds.

25.1.3 Height-Velocity Diagram - Single-Engine Failure Chart. The height-velocity diagram - single-engine failure chart (Figure 25-4 for the 416 engine and Figure 25-5 for the 419 engine) is used the same way as Figure 25-2. Figure 25-4 (for the 416 engine) also provides a diagram for 6000 feet density altitude. Figure 25-5 (for the 419 engine) provides two height-velocity diagrams, one for standard-day conditions and the other for hot day (39.4°C) conditions.

25.2 CLIMB CHARTS

The climb charts provide a means of computing the rate of climb, time to climb, horizontal distance covered, and fuel consumed for various gross weights, pressure altitudes, and temperatures. Separate climb charts are provided for both 416 engine 419 engine-equipped aircraft.

416 engine charts are based on degraded engine performance. The fuel used includes warmup and takeoff from sea level. Also included is a climb speed schedule for various pressure altitudes. A temperature scale relates the OAT at various pressure altitudes.

419 engine charts are based on specification engine performance. They are similar in operation to the climb performance charts in Chapter 21.

25.2.1 Single-Engine Climb at Maximum Power Chart (416 Engine). The single-engine climb at maximum power chart (416 engine) (Figure 25-6) provides the time to climb, horizontal distance covered, fuel consumed, and rate of climb, at various gross weight.

For example, to find the single-engine time to climb to 2000 feet pressure altitude, distance traveled, fuel consumed, rate-of-climb, and best airspeeds at 36,000 pounds gross weight and 10°C OAT, enter the bottom of the chart at 36,000 pounds. Trace up to the 2000-foot curve in the time grid, trace left to the temperature baseline, follow the influence line to 10°C, and then trace left to read time to climb: 7 minutes. Enter the distance grid at 36,000 pounds, trace up to the 2000-foot curve, trace left to the temperature baseline, follow the influence line to 10°C, and then trace left to read distance traveled: 8 miles. Enter the fuel grid at 36,000 pounds, trace up to the 2000-foot curve, trace left to the temperature baseline, follow the influence line to 10°C, and then trace left to read fuel consumed: 390 pounds. Enter the rate-of-climb grid at 36,000 pounds, trace up to the 2000-foot curve and trace left to the temperature baseline. Follow the influence lines to 10°C, then trace left to read the final rate-of-climb: 190 feet-per-minute. Enter the left side of the climb schedule grid and note best climb speed at sea level is 62 KIAS and 60 KIAS at 2000 feet.

25.2.2 Single-Engine Climb Performance - Maximum Power Charts (419 Engine). There are three single-engine climb performance charts (Figure

25-7) for the 419 engine at maximum power; one for standard temperature, as well as one each for 15° above and 30° below standard temperature. Refer to Chapter 21 for example details.

Note

- When the takeoff pressure altitude is above sea level pressure altitude, it will be necessary to determine climb data from sea level pressure altitude to the takeoff pressure altitude and from sea level pressure altitude to the cruise level pressure altitude. The difference between that data will be the appropriate data necessary to climb from takeoff pressure altitude to cruise level pressure altitude.

- If OAT at the desired pressure altitude is the same as approximate standard day temperature, use STD DAY baseline to compute time to climb, fuel used, and distance traveled. If OAT is not the same as approximate standard day temperature, compute the difference, e. g., PA (10,000 ft), OAT (-10°C), STD DAY TEMP (-5°C), subtract the difference to equal differential factor (-5°C).

25.2.3 Dual-Engine Climb Charts (416 Engine). The dual-engine climb charts (416 engine) (Figures 25-8 thru 25-11) are based on maximum and military power and provide dual engine climb data for the helicopter on cold and warm days. The charts use like factors in the same manner as the 416 engine climb charts in Part 3; therefore, explanatory text and sample problem data are not included.

25.2.4 Dual-Engine Climb Performance Charts (419 Engine). The dual-engine climb performance charts (Figure 25-12 and Figure 25-13) for the 419 engine are similar to the single-engine climb performance charts for the 419 engine, above. The charts are provided for both maximum power and military power settings. Each power setting includes three charts; one for standard temperature as well as one each for 30° above and below standard temperature.

25.3 ABILITY TO MAINTAIN LEVEL FLIGHT CHARTS

25.3.1 Single- or Dual-Engine Ability to Maintain Level Flight Chart. The single- or dual-engine ability to maintain level flight chart (Figure 25-14 for the 416 engine and Figure 25-15 for the 419 engine) provides the speed range wherein one or two-engine level flight may be maintained at various density altitudes and gross weights at a torque value the engine(s) is (are) actually producing.

For example, to determine the speed range for single engine level flight at a gross weight of 40,000 pounds, 2000 feet pressure altitude, 10° OAT and torque of 120%, proceed as follows: Enter the left side of the chart at 2000, trace right to the 40,000 pound curve, then down to the temperature base line. Follow the influence line to 10° OAT and then trace down to the airspeed base line. The airspeed read directly across is maximum endurance, 50 KIAS. Follow the airspeed influence lines above and below to 120% torque for 62 KIAS and 40 KIAS. These are the maximum and minimum airspeeds. The procedures for obtaining dual engine airspeeds are similar with the exception of the use of the dual-engine torque scale. Engine torque figures are derived from the appropriate charts in Chapter 19.

25.3.2 Single-Engine Ability to Maintain 60 Knot Level Flight at Various N_r's chart. The single-engine ability to maintain 60 knot level flight at various N_r's chart (Figure 25-16 for the 416 engine and Figure 25-17 for the 419 engine) provides the gross weight at which one-engine level flight at 60 KIAS can be maintained at various pressure altitudes, temperatures, and rotor speeds. 416 engine data is based on degraded engine performance and 419 engine data is based on specification engine performance.

For example, to find the gross weight at which level flight at 60 KIAS can be maintained, at 2000-feet pressure altitude, 10°C OAT, and 103% N_r, enter the left side of the chart at 2000 feet. Trace right to the 10°C curve, and then trace down to the rotor speed baseline. Follow the influence line to 103% N_r and then trace down and read 37,600 pounds.

25.3.3 Dual-Engine Ability to Maintain 70 Knot Level Flight at Various N_r's Chart. The dual-engine ability to maintain 70-knot level flight at various N_r's charts (Figure 25-18 for the 416 engine and Figure 25-19 for the 419 engine) are used the same way as Figure 25-16 for the 416 engine. For the 419 engine, both cold day and hot day charts are provided.

25.4 MAXIMUM RANGE/ENDURANCE CHARTS

25.4.1 Single-Engine Maximum Range, Standard Temperature Chart (416 Engine). The single-engine maximum range, standard temperature

chart (Figure 25-20) for the 416 engine is based on degraded engine military power to provide maximum range during one-engine operation. The chart is used in the same way as the range charts in Chapter 22.

25.4.2 Single-Engine Maximum Range, Standard Temperature Cold Day -30°C Chart (416 Engine). The single-engine maximum range, standard temperature cold day -30°C chart (Figure 25-21) for the 416 engine is based on degraded engine military power to provide maximum range during one-engine operation. The chart is used in the same way as the range charts in Chapter 22.

25.4.3 Single-Engine Maximum Endurance Chart (416 Engine). The single-engine maximum endurance chart (Figure 25-22) for the 416 engine provides maximum endurance for the helicopter during one-engine operation. The chart is used in the same manner as the 416 engine endurance charts in Chapter 23.

25.4.4 Single-Engine Maximum Range Bingo Profile (419 Engine). The single-engine maximum range bingo profile (Figure 25-23) for the 419 engine is used the same way as the 419 engine maximum range bingo profiles in Chapter 22. Four profiles are provided, one for standard temperature, as well as one each for 30° below, 15° below, and 15° above standard temperature.

CAUTION

Bingo profiles do not provide for reserve fuel requirements.

25.4.5 Single-Engine Maximum Endurance Bingo Profile (419 Engine). The single-engine maximum endurance bingo profile (Figure 25-24) for the 419 engine is used the same way as the 419 engine maximum endurance bingo profiles in Chapter 23. The range profile provides the range, in nautical miles and the time profile provides the time, in hours, for the amount of fuel on board.

25.5 LANDING DISTANCE

25.5.1 Single- or Dual-Engine Landing Distance Chart. The single- or dual-engine landing distance chart (Figure 25-25) provides the landing distance ground roll when pressure altitude, temperature, gross weight, and headwind component are introduced into the chart.

For example, to determine landing distance at 2000 feet pressure altitude, 28°C OAT, 50,000 pound gross weight, with a 5-knot headwind, enter the bottom of the upper left grid at 28°C. Trace up to the 2000-foot pressure altitude curve, trace across to the 50,000-pound curve in the next grid, and then trace down to the headwind grid's baseline. Follow the influence line to 6 knots and trace down to read 160-feet ground roll.

25.6 DUAL ENGINE HOVER CHART

25.6.1 Dual-Engine Ability to Hover OGE at Various N_r's. The dual-engine ability of hover OGE at various N_r's chart (Figure 25-26 for the 416 engine and Figure 25-27 for the 419 engine) provides the gross weight that the helicopter can hover out of ground effect on two engines when pressure altitude is applied to outside air temperature, rotor speed, and headwind component factors. The 416 engine chart is based on degraded engine performance and the 419 engine chart is based on specification engine performance.

For example, to find the gross weight at which a helicopter can hover out of ground effect on two engines at a pressure altitude of 2000 feet, 0°C with 105% N_r and a 20-knot headwind enter the left side of the chart at 2000 feet, trace right to 0°C and then trace down to the rotor speed baseline. Follow the rotor speed influence line up to 105% N_r then trace down to the headwind baseline and read 50,800 pounds at 0 headwind. Follow the headwind influence lines to 20 knots of headwind and read 57,500 pounds. However, since 0°C at 2000 feet is below standard temperature, the headwind effect must be reduced by 6% since the conditions of interest are 10° below standard temperature (Standard temperature at 2000 feet is 11°C). The headwind effect is 6700 pounds (57,500 pounds - 50,800 pounds). Headwind effect for the 2000 feet 11°C is 6% less or 6300 pounds. Hover capability is therefore 50,800 pounds + 6300 pounds = 57,100 pounds.

HEIGHT VELOCITY DIAGRAM
THREE ENGINE FAILURE
SEA LEVEL STANDARD TEMPERATURE
100% – 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ESTIMATED

NOTE:

IT IS ESTIMATED THAT A THREE-ENGINE FAILURE IN THE SHADED AREA LEAVES INSUFFICIENT ALTITUDE FOR THE CORRECT AUTOROTATIVE APPROACH TO AN EMERGENCY LANDING AND THAT THE SUBSEQUENT LAND BACK WILL EXCEED THE DESIGN LIMITATIONS OF THE AIRCRAFT

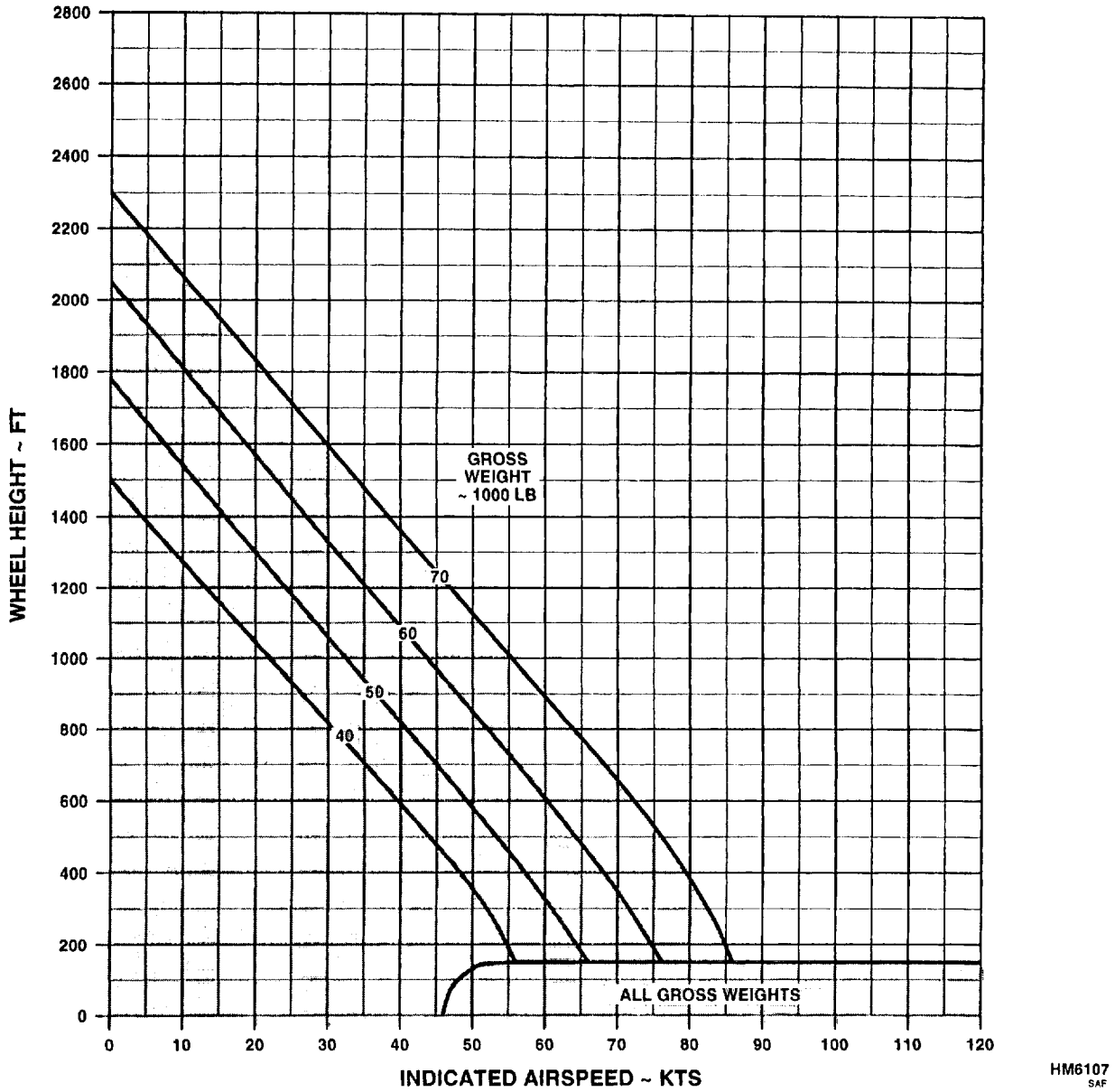


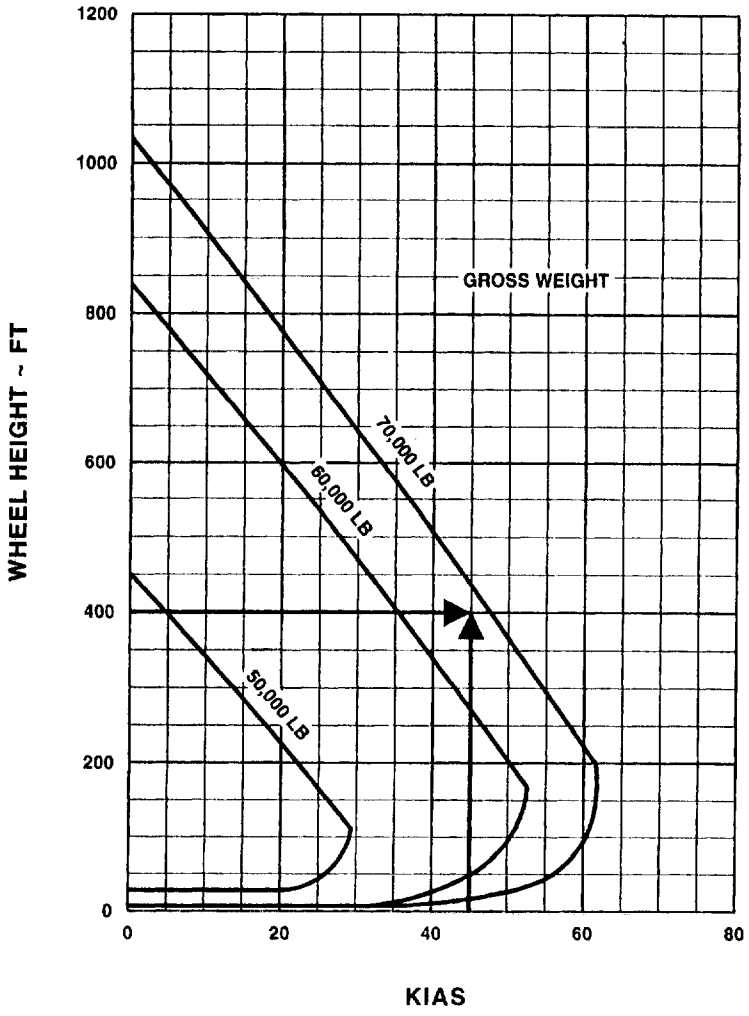
Figure 25-1. Height-Velocity Diagram, Three-Engine Failure

HEIGHT VELOCITY DIAGRAM
DUAL-ENGINE FAILURE
SEA LEVEL STANDARD TEMPERATURE
100% Nr

MODEL: MH-53E
DATA BASIS: ESTIMATED
DATA AS OF: 1 OCTOBER 1986

NOTE

IT IS ESTIMATED THAT A DUAL-ENGINE FAILURE IN THE HEIGHT ~ VELOCITY ENVELOPES SHOWN WILL PREVENT ANY CONTINUATION OF FLIGHT AND THE SUBSEQUENT LAND ~ BACK WILL EXCEED THE DESIGN LIMITATIONS OF THE AIRCRAFT.



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Figure 25-2. Height-Velocity Diagram, Dual-Engine Failure (416 Engine)

HEIGHT VELOCITY DIAGRAM
DUAL ENGINE FAILURE
CONTINGENCY POWER
2 MINUTE LIMITATION
100% – 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ESTIMATED
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTE:

IT IS ESTIMATED THAT A DUAL-ENGINE FAILURE IN THE SHADED AREA WILL EXCEED THE DESIGN LIMITATIONS OF THE AIRCRAFT DURING LANDBACK

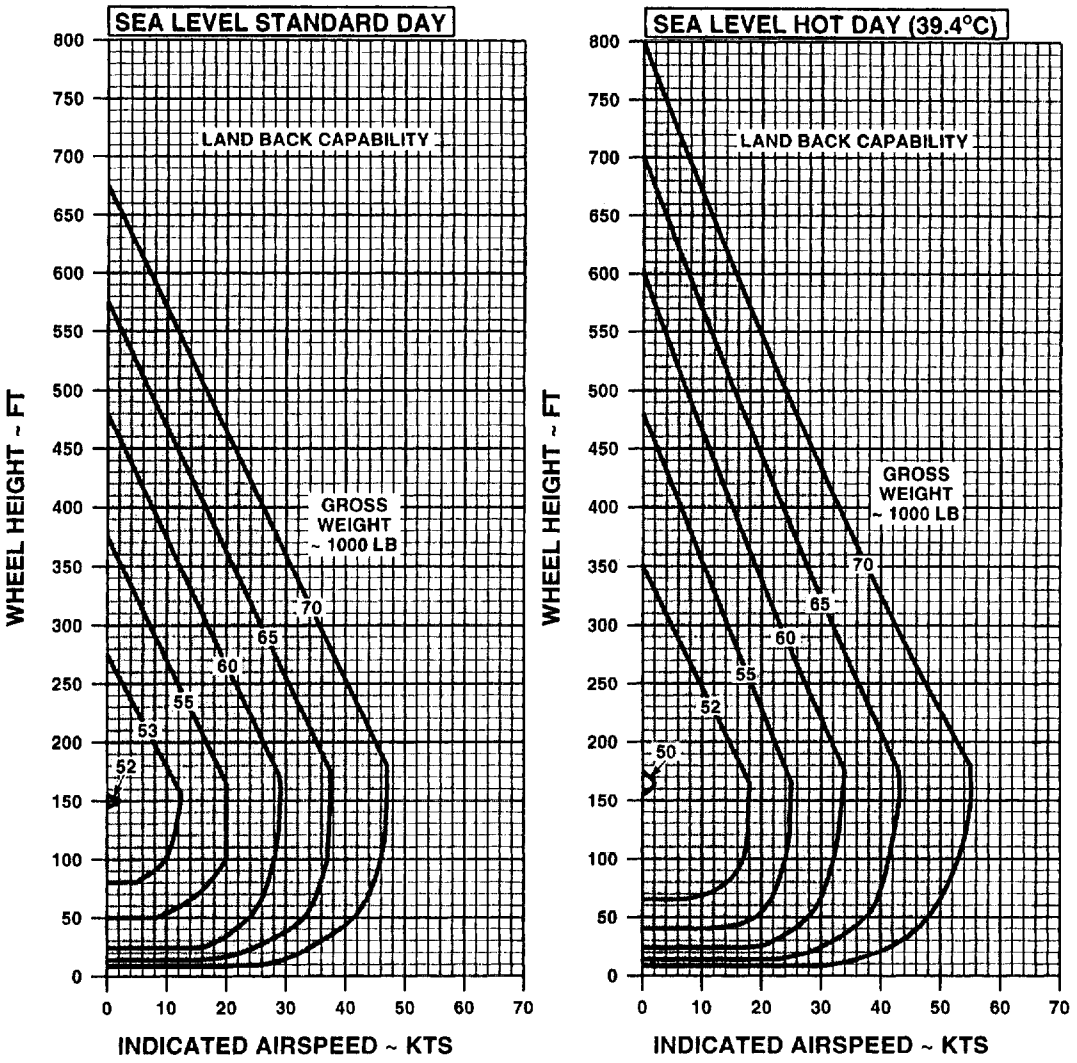


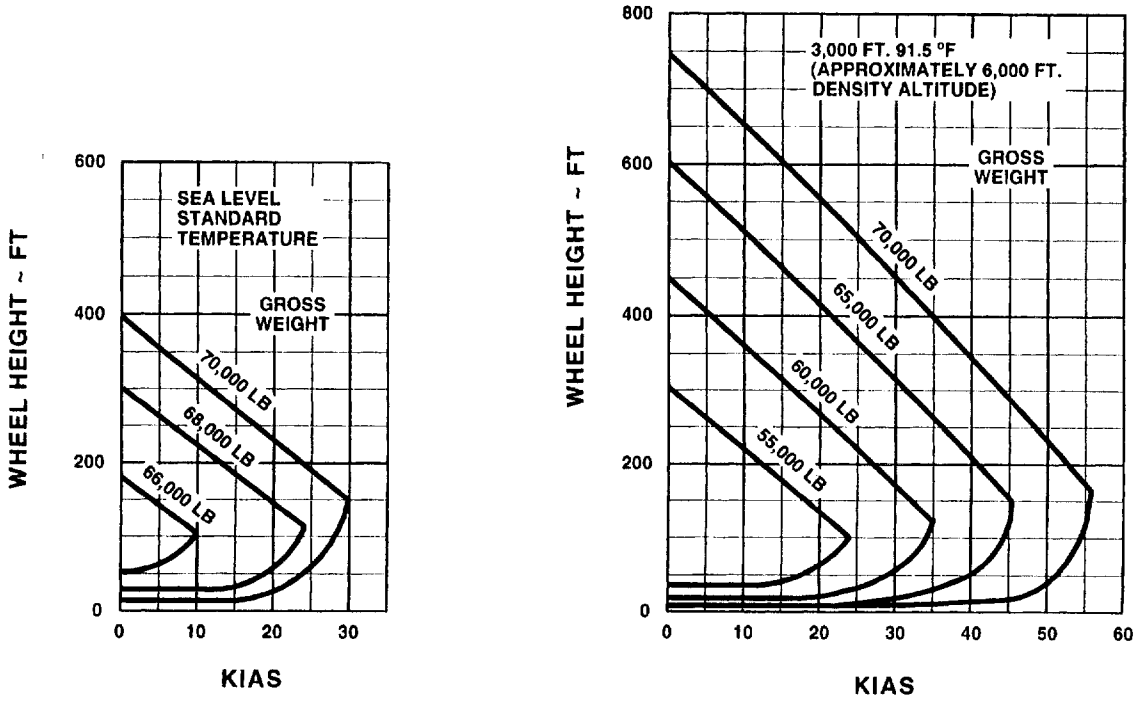
Figure 25-3. Height-Velocity Diagram, Dual-Engine Failure (419 Engine)

HEIGHT VELOCITY DIAGRAMS
SINGLE-ENGINE FAILURE
100% Nr

MODEL: MH-53E
DATA BASIS: ESTIMATED
DATA AS OF: 1 OCTOBER 1986

NOTE

CONTINUOUS FLIGHT WITHIN THE HEIGHT - VELOCITY ENVELOPES SHOWN SHOULD BE AVOIDED. IT IS ESTIMATED THAT A SINGLE ENGINE FAILURE IN THESE REGIONS WILL EXCLUDE CONTINUATION OF FLIGHT AND THE SUBSEQUENT LAND - BACK WILL EXCEED THE DESIGN LIMITATIONS OF THE AIRCRAFT.



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Figure 25-4. Height-Velocity Diagram, Single-Engine Failure (416 Engine)

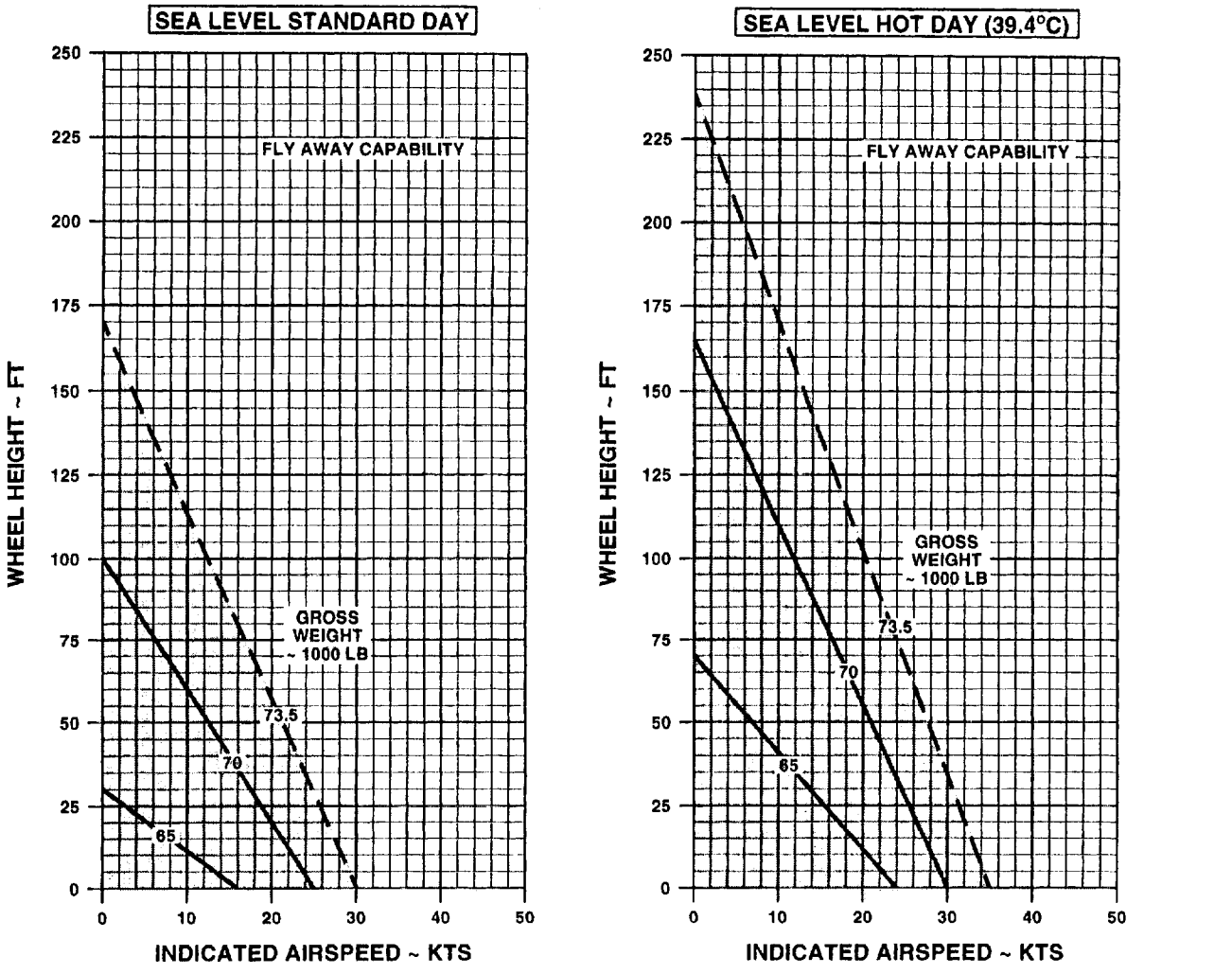
HEIGHT VELOCITY DIAGRAM
SINGLE ENGINE FAILURE
CONTINGENCY POWER
2 MINUTE LIMITATION
100% – 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ESTIMATED
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTE:

CONTINUOUS FLIGHT WITHIN THE SHADED AREA SHOWN SHOULD BE AVOIDED. IT IS ESTIMATED THAT A SINGLE ENGINE FAILURE IN THIS REGION WILL EXCLUDE CONTINUATION OF FLIGHT. LAND BACKS AT GROSS WEIGHTS UP TO 70,000 LB CAN BE CONDUCTED WITHIN THE DESIGN LIMITATIONS OF THE AIRCRAFT.



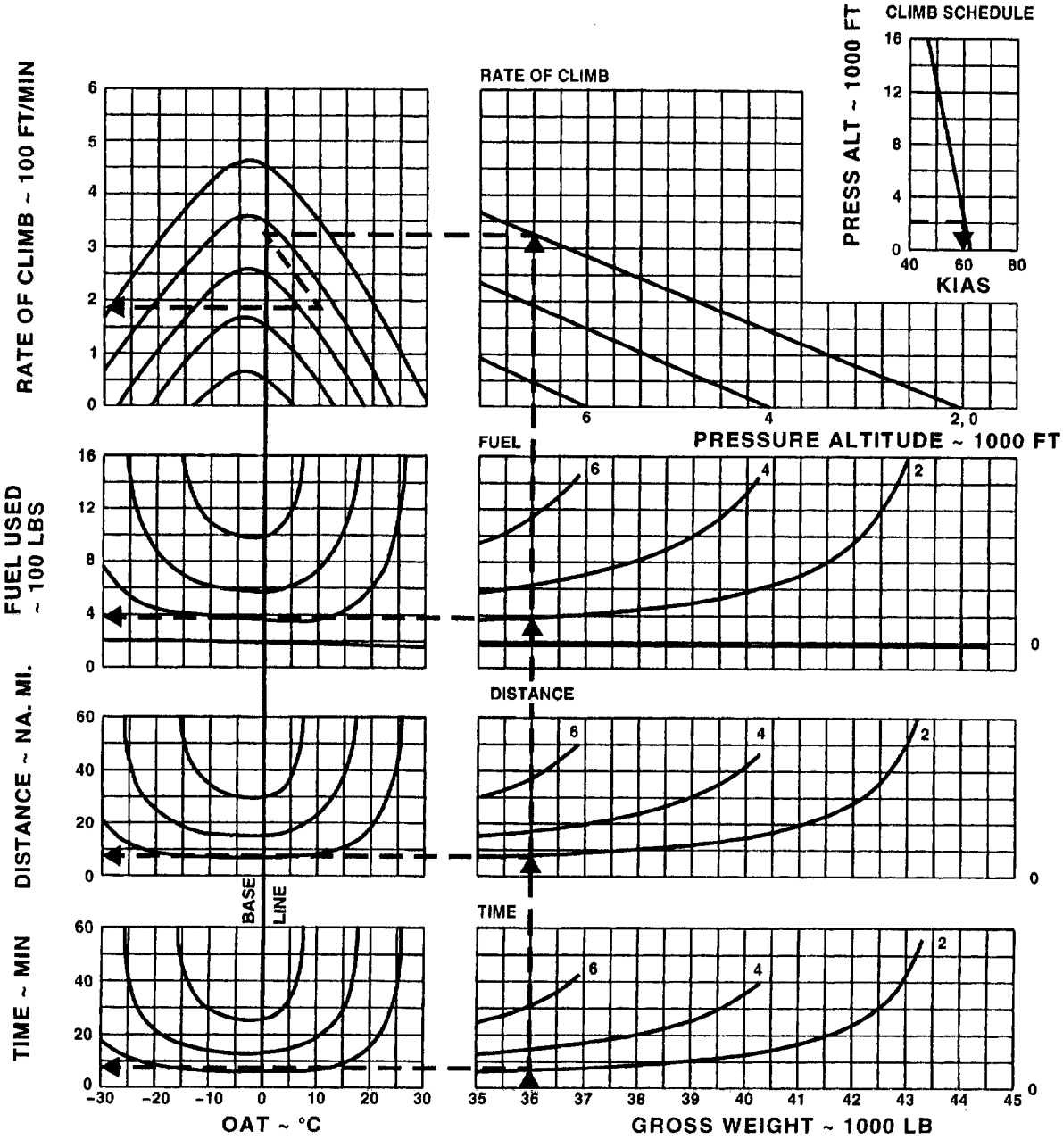
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Figure 25-5. Height-Velocity Diagram, Single-Engine Failure (419 Engine)

SINGLE-ENGINE CLIMB
773°C (T64-416) OR 792°C (T64-416A) T5 MAX PWR
10 MINUTE LIMITATION
100% Nr

MODEL: MH-53E
DATA AS OF: 1 0CTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



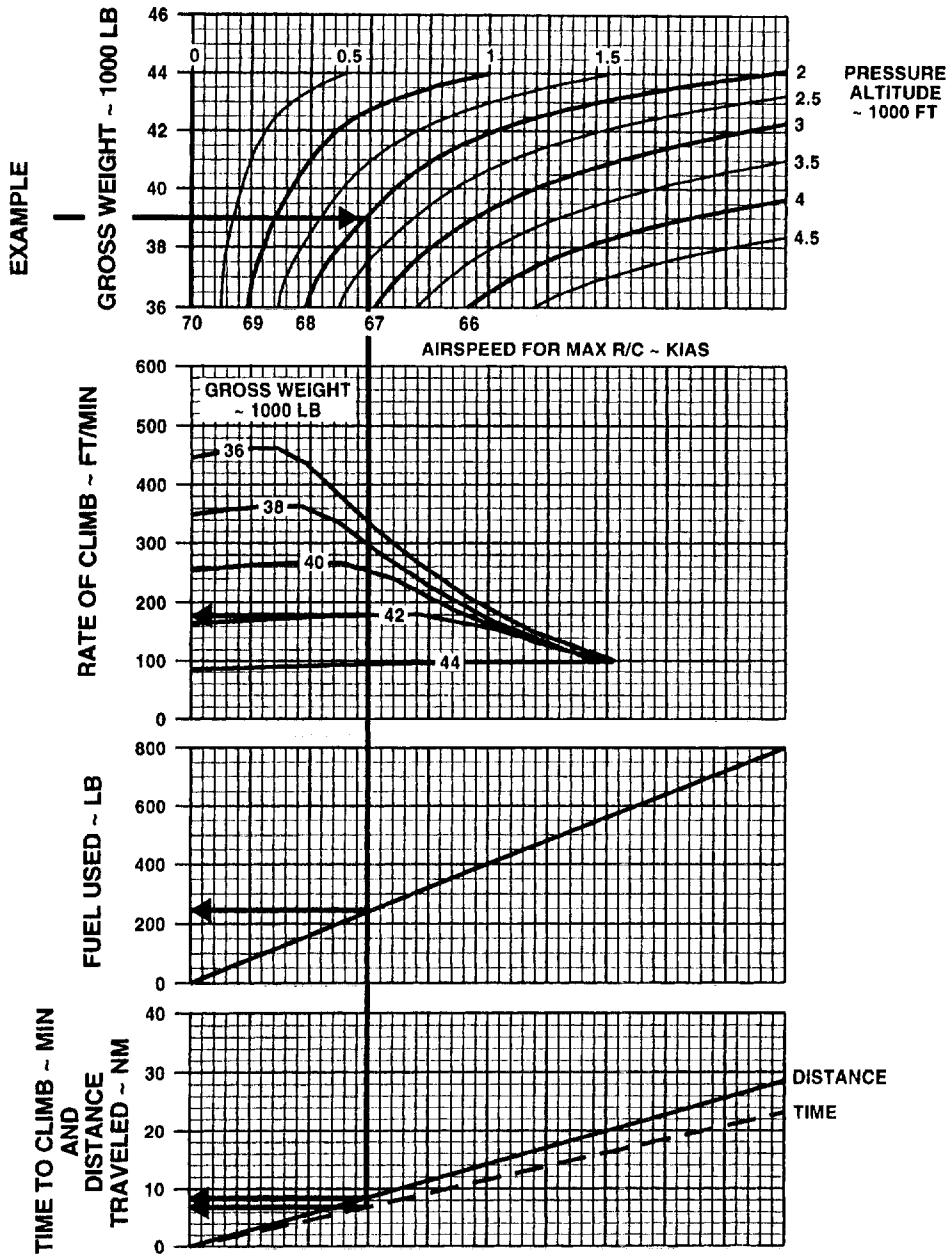
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Figure 25-6. Single-Engine Climb at Maximum Power (416 Engine)

CLIMB PERFORMANCE
SINGLE ENGINE – MAXIMUM POWER (829°C T5)
10 MINUTE (137%) TRANS LIMITATION
STANDARD TEMP –30°C, ZERO WIND, 100% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



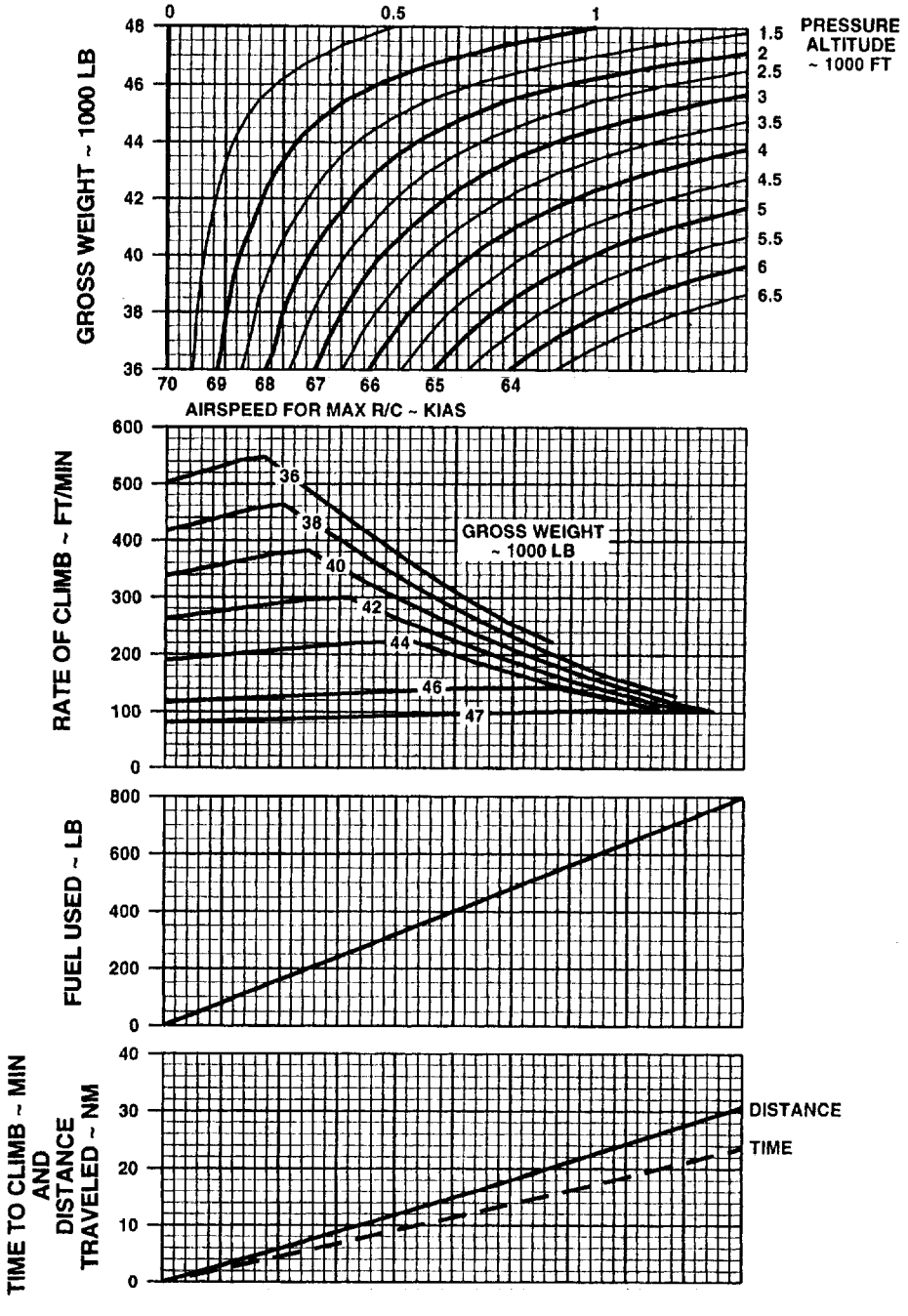
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Figure 25-7. Single-Engine Climb Performance - Maximum Power (419 Engine) (Sheet 1 of 3)

CLIMB PERFORMANCE
SINGLE ENGINE – MAXIMUM POWER (829°C T5)
10 MINUTE (137%) TRANS LIMITATION
STANDARD TEMP, ZERO WIND, 100% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 25-7. Single-Engine Climb Performance - Maximum Power (419 Engine) (Sheet 2 of 3)

CLIMB PERFORMANCE
SINGLE ENGINE – MAXIMUM POWER (829°C T5)
10 MINUTE (137%) TRANS LIMITATION
STANDARD TEMP +15°C, ZERO WIND, 100% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

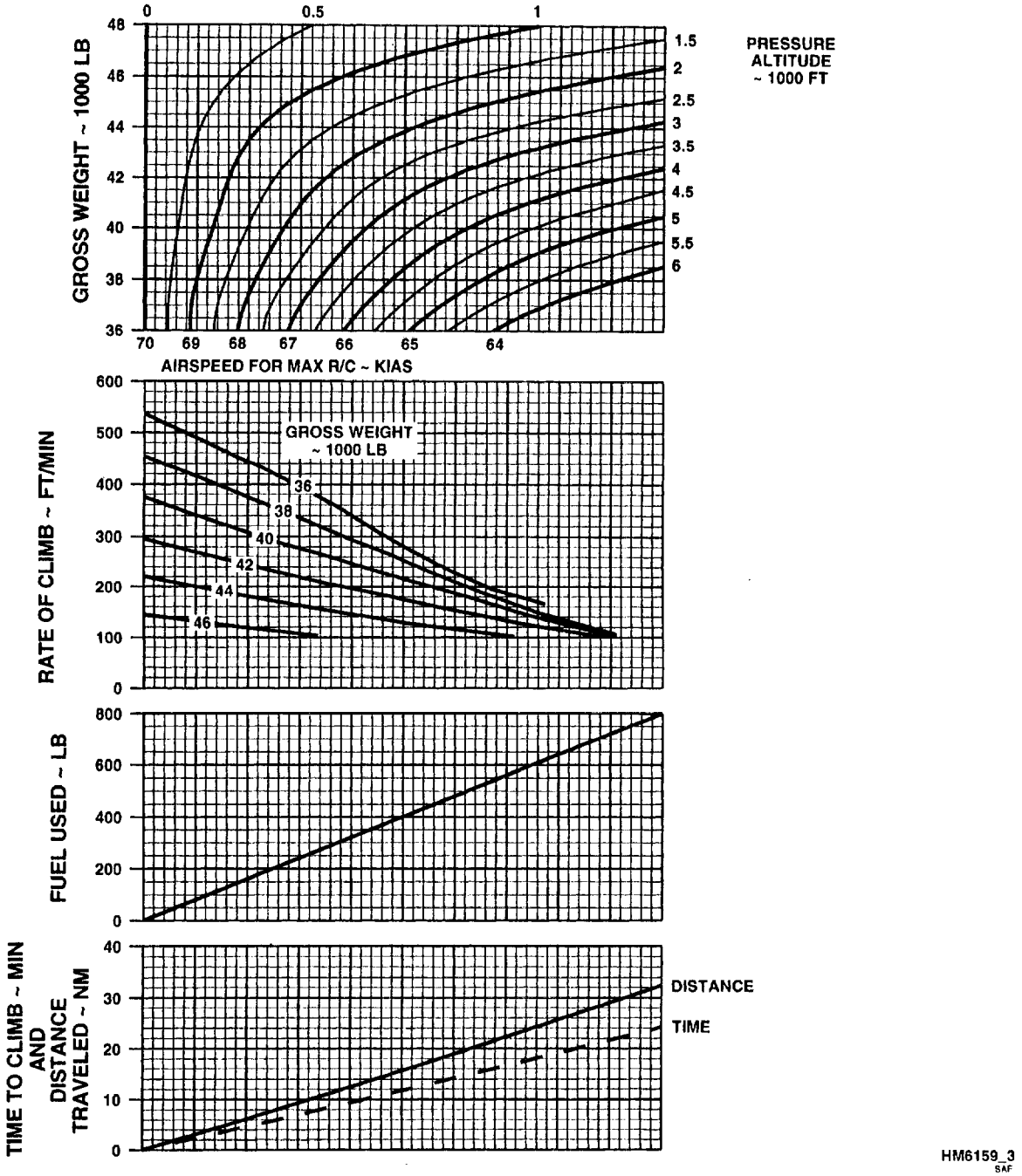


Figure 25-7. Single-Engine Climb Performance-Maximum Power (419 Engine) (Sheet 3 of 3)

DUAL-ENGINE CLIMB
773°C (T64-416) OR 792°C (T64-416A) T5 MAX PWR
10 MINUTE LIMITATION
COLD DAY
100% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

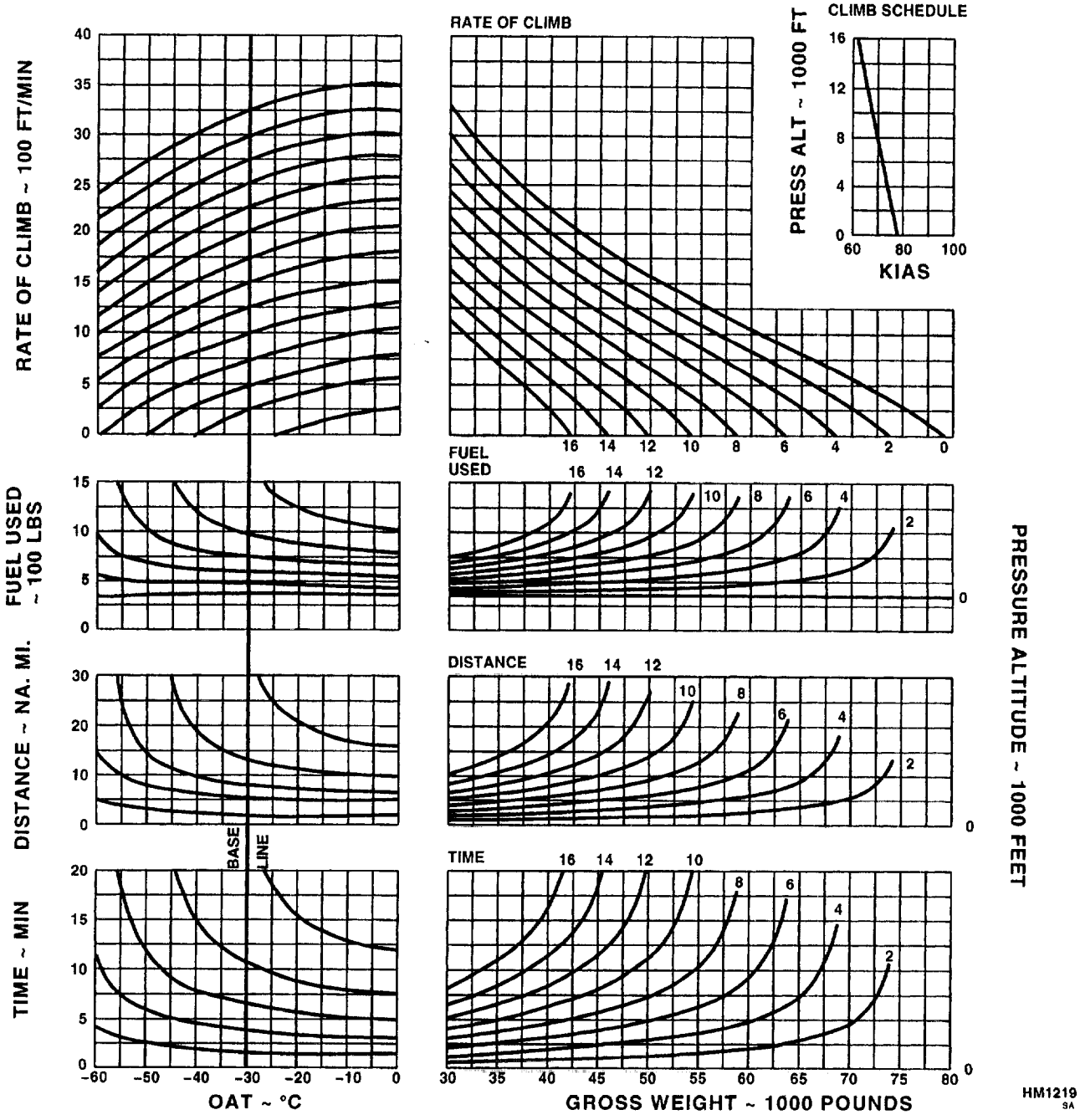


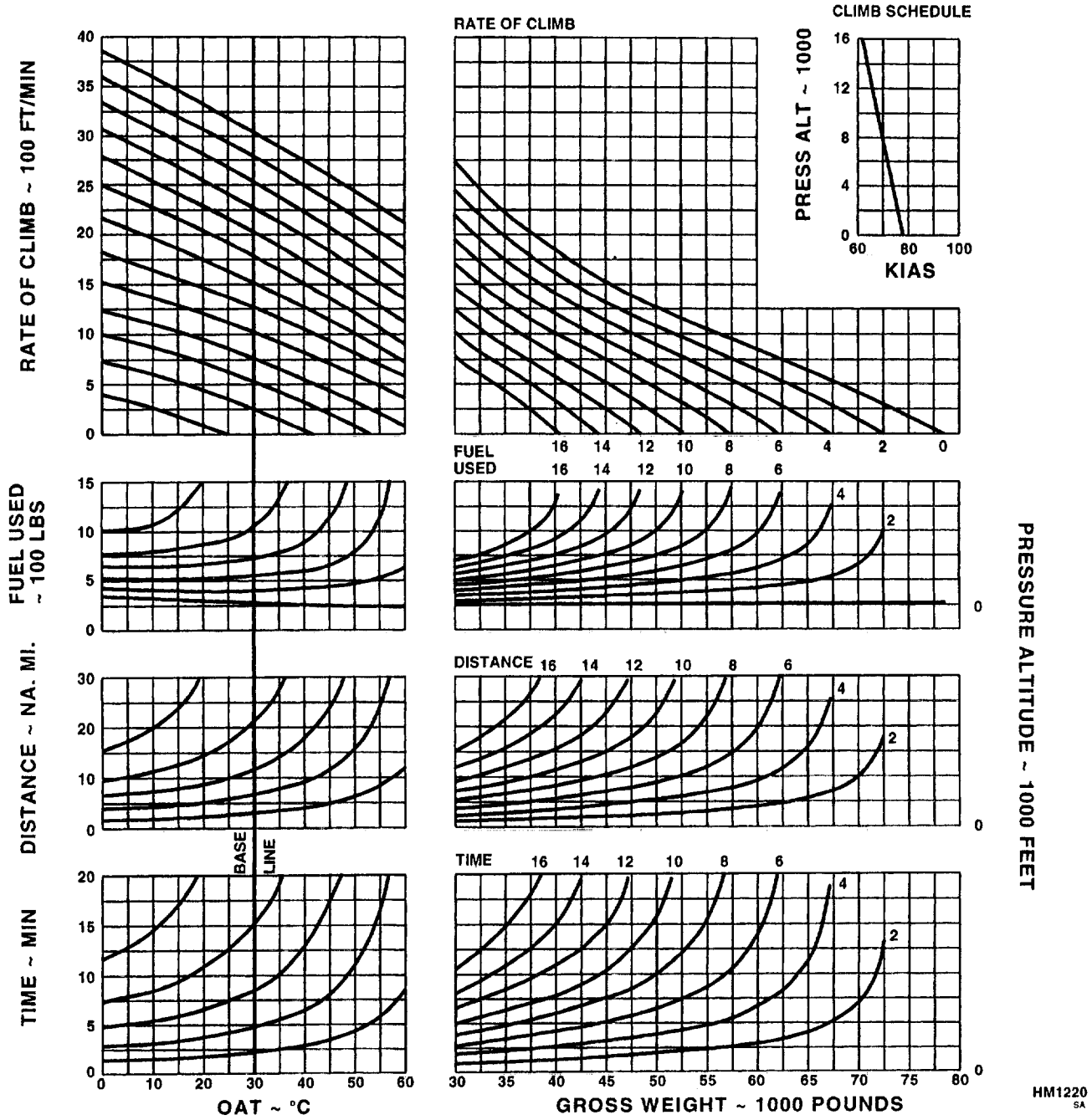
Figure 25-8. Dual-Engine Climb at Maximum Power - Cold Day (416 Engine)

DUAL-ENGINE CLIMB

773°C (T64-416) OR 792°C (T64-416A) T5 MAX PWR
10 MINUTE LIMITATION
WARM DAY
100% Nr

MODEL: MH-53E
DATA AS OF: 1 0CTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



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Figure 25-9. Dual-Engine Climb at Maximum Power - Warm Day (416 Engine)

DUAL-ENGINE CLIMB
753°C T5 MILITARY POWER
30 MINUTE LIMITATION
COLD DAY
100% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

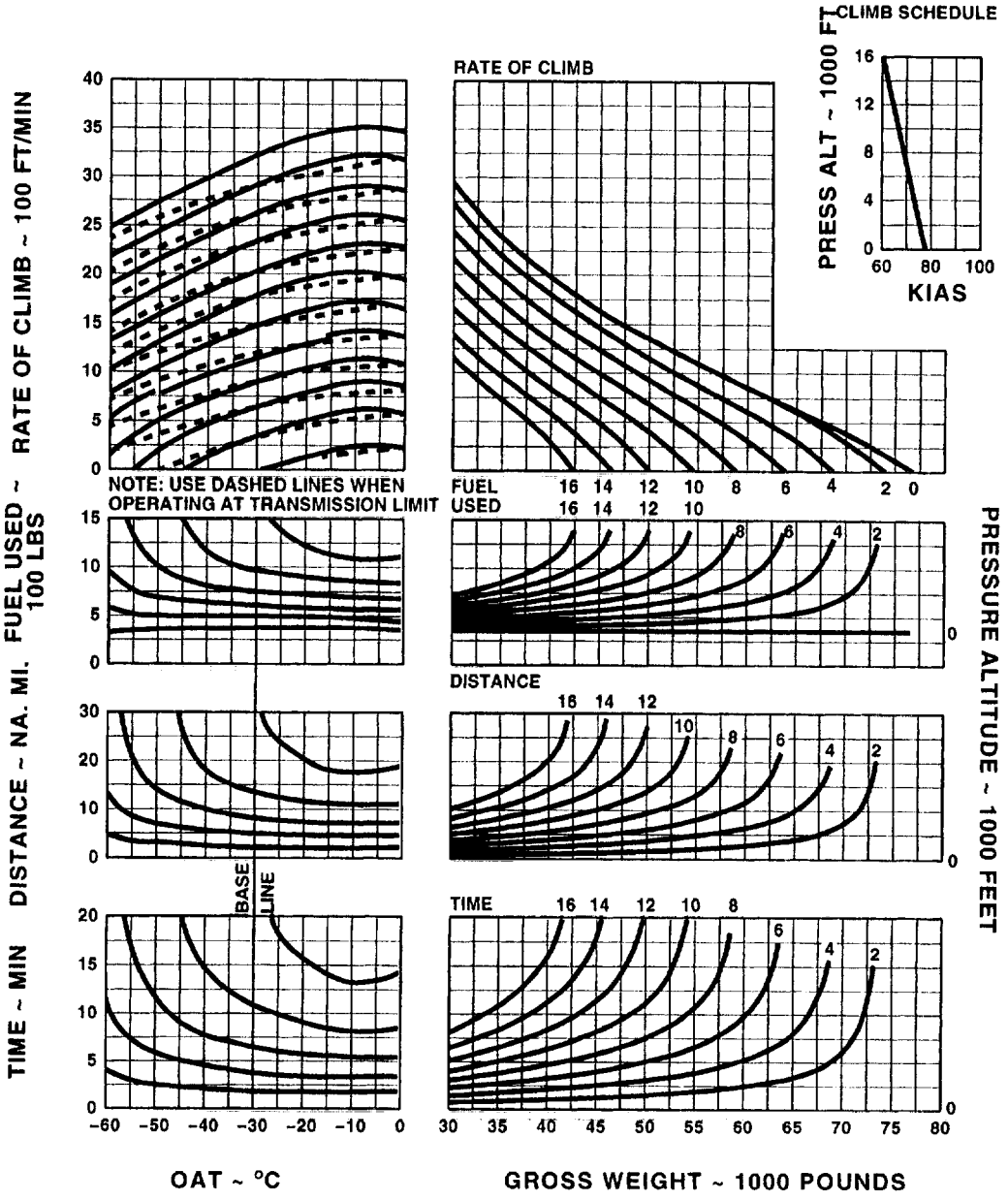


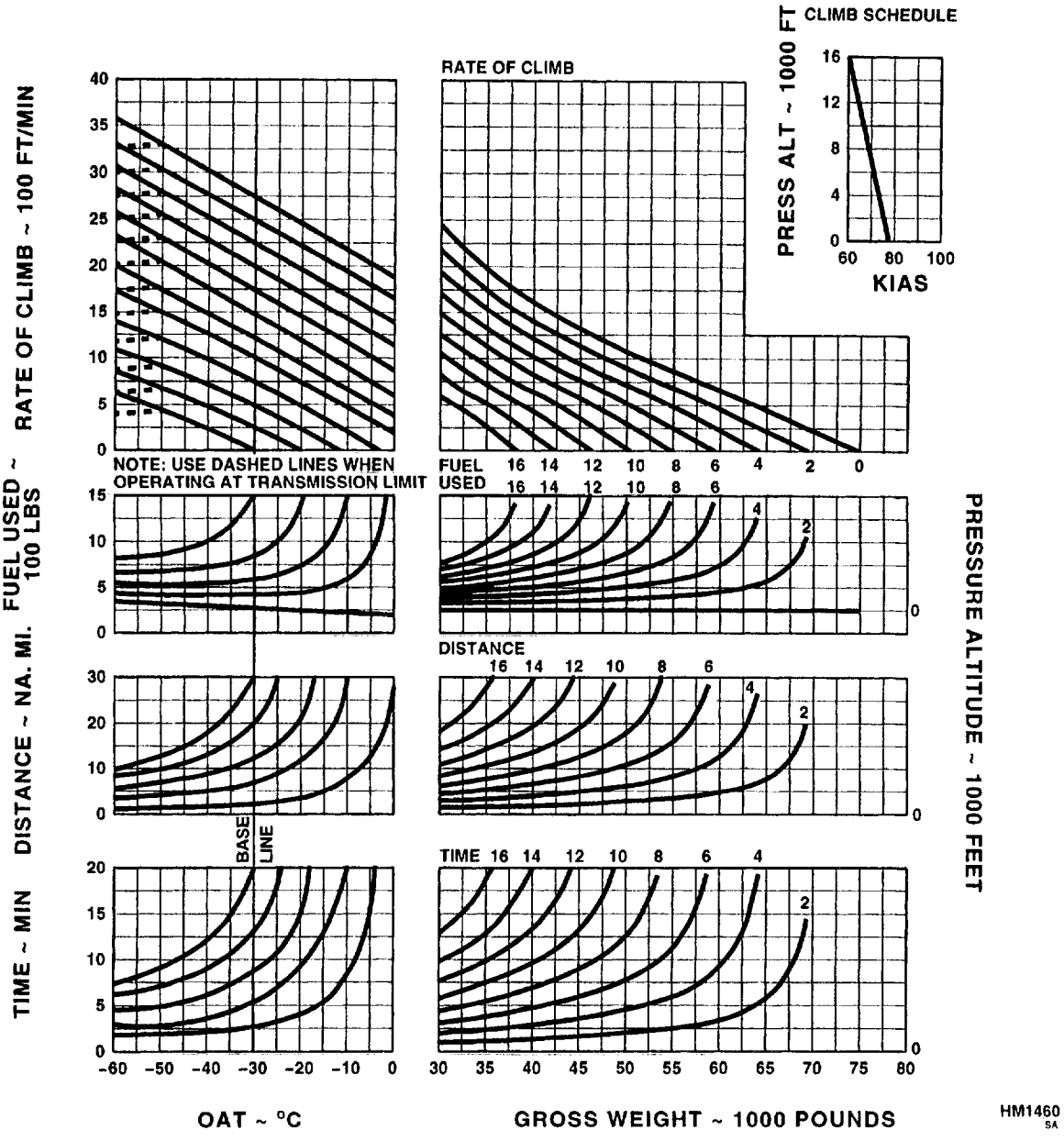
Figure 25-10. Dual-Engine Climb at Military Power - Cold Day (416 Engine)

DUAL-ENGINE CLIMB
753°C T5 MILITARY POWER
30 MINUTE LIMITATION
WARM DAY
100% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



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Figure 25-11. Dual-Engine Climb at Military Power - Warm Day (416 Engine)

CLIMB PERFORMANCE
DUAL ENGINE – MAXIMUM POWER (829°C T5)
10 MINUTE (137%) TRANS LIMITATION
STANDARD TEMP –30°C, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

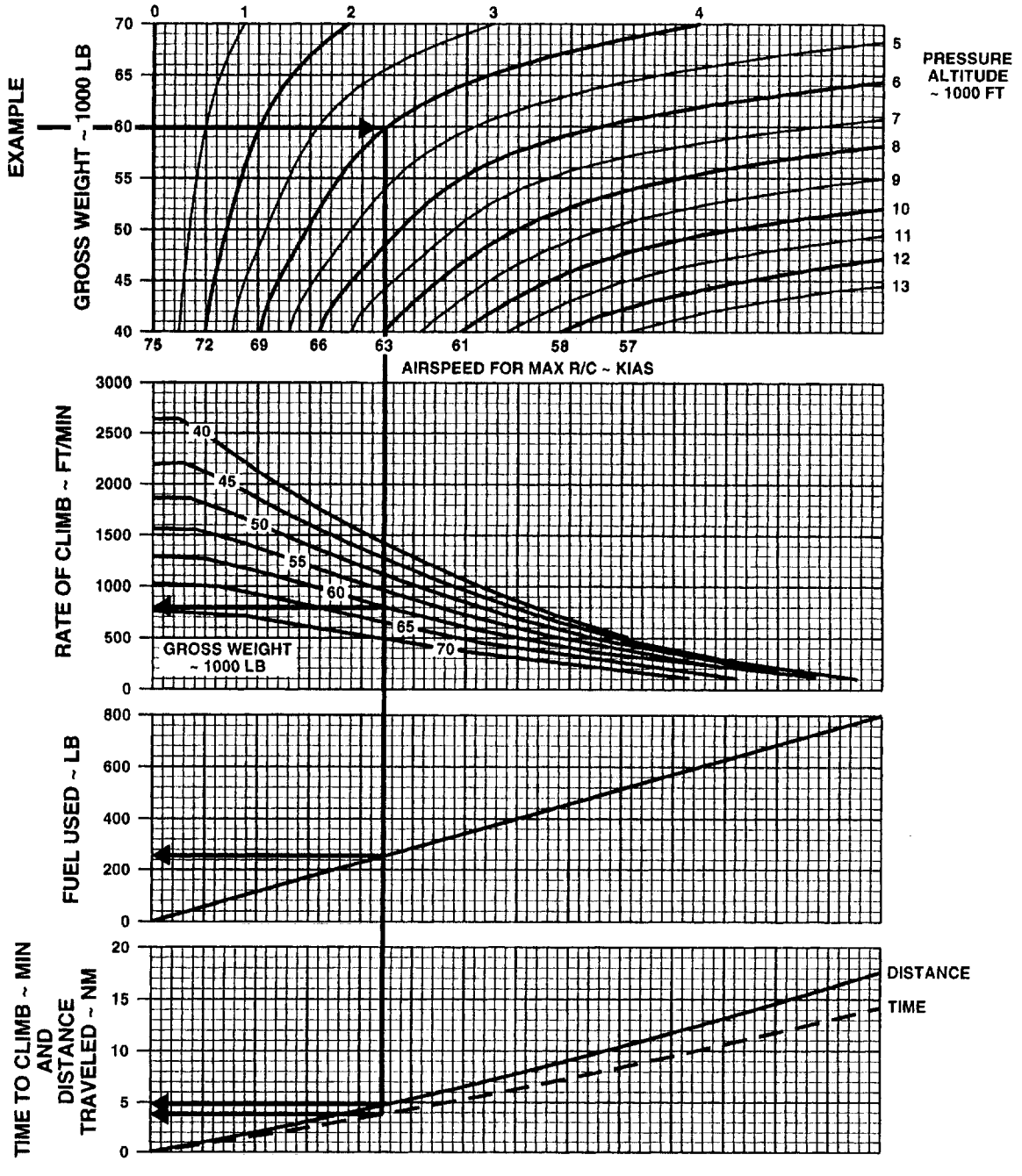
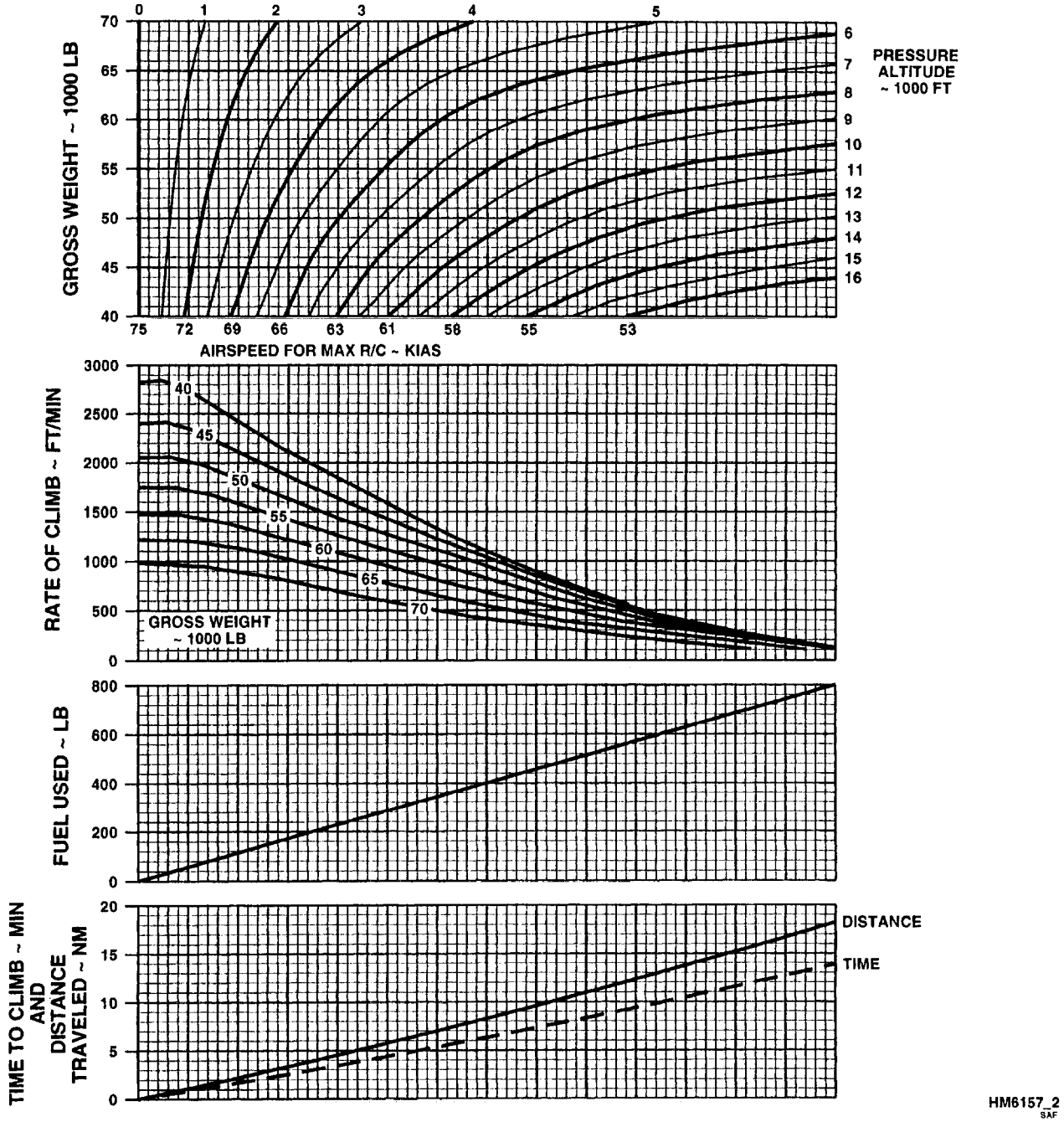


Figure 25-12. Dual-Engine Climb Performance - Maximum Power (419 Engine) (Sheet 1 of 3)

CLIMB PERFORMANCE
DUAL ENGINE – MAXIMUM POWER (829°C T5)
10 MINUTE (137%) TRANS LIMITATION
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 25-12. Dual-Engine Climb Performance - Maximum Power (419 Engine) (Sheet 2 of 3)

CLIMB PERFORMANCE
DUAL ENGINE – MAXIMUM POWER (829°C T5)
10 MINUTE (137%) TRANS LIMITATION
STANDARD TEMP +30°C, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

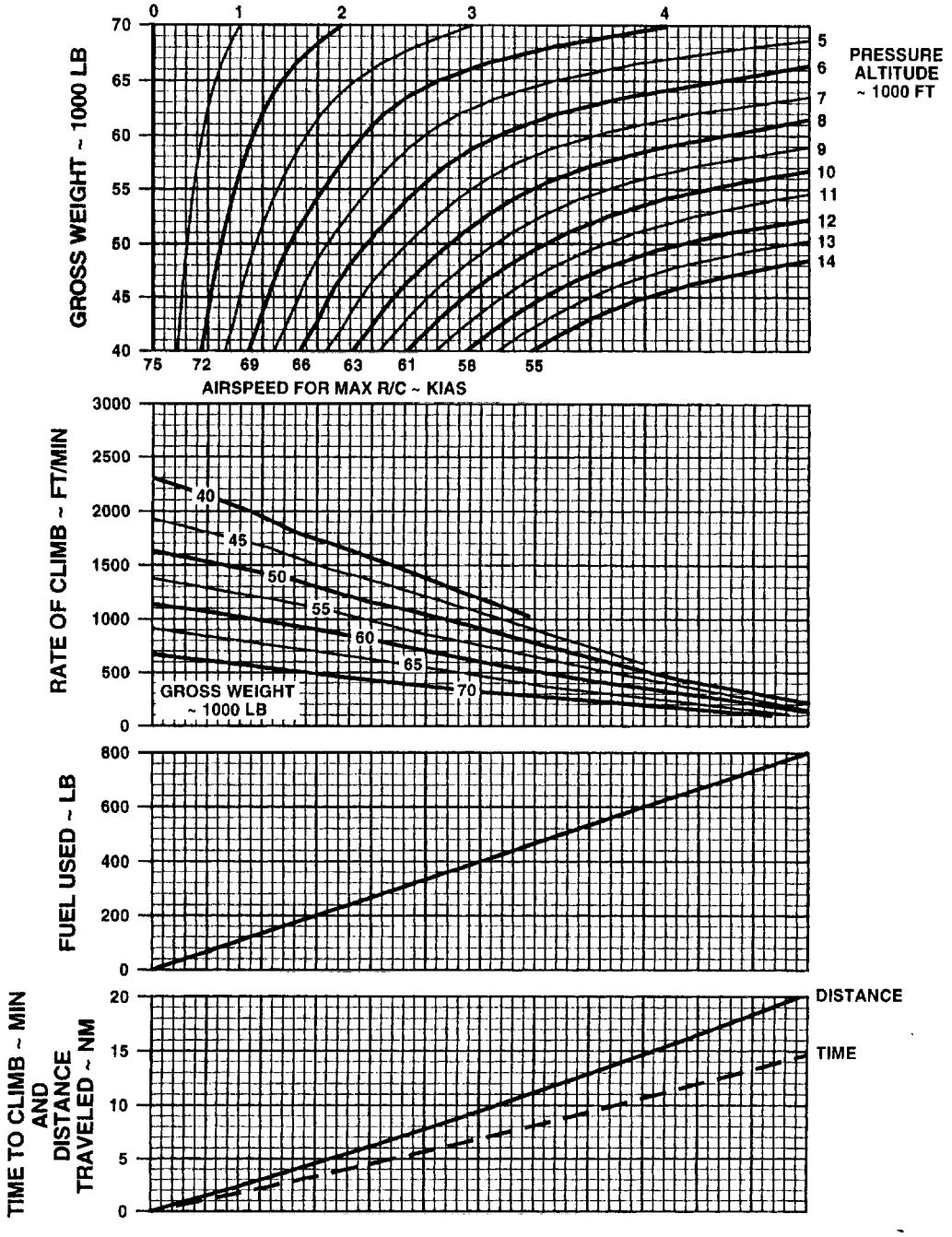


Figure 25-12. Dual-Engine Climb Performance - Maximum Power (419 Engine) (Sheet 3 of 3)

CLIMB PERFORMANCE
DUAL ENGINE – MILITARY POWER (809°C T5)
30 MINUTE (121%) TRANS LIMITATION
STANDARD TEMP –30°C, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

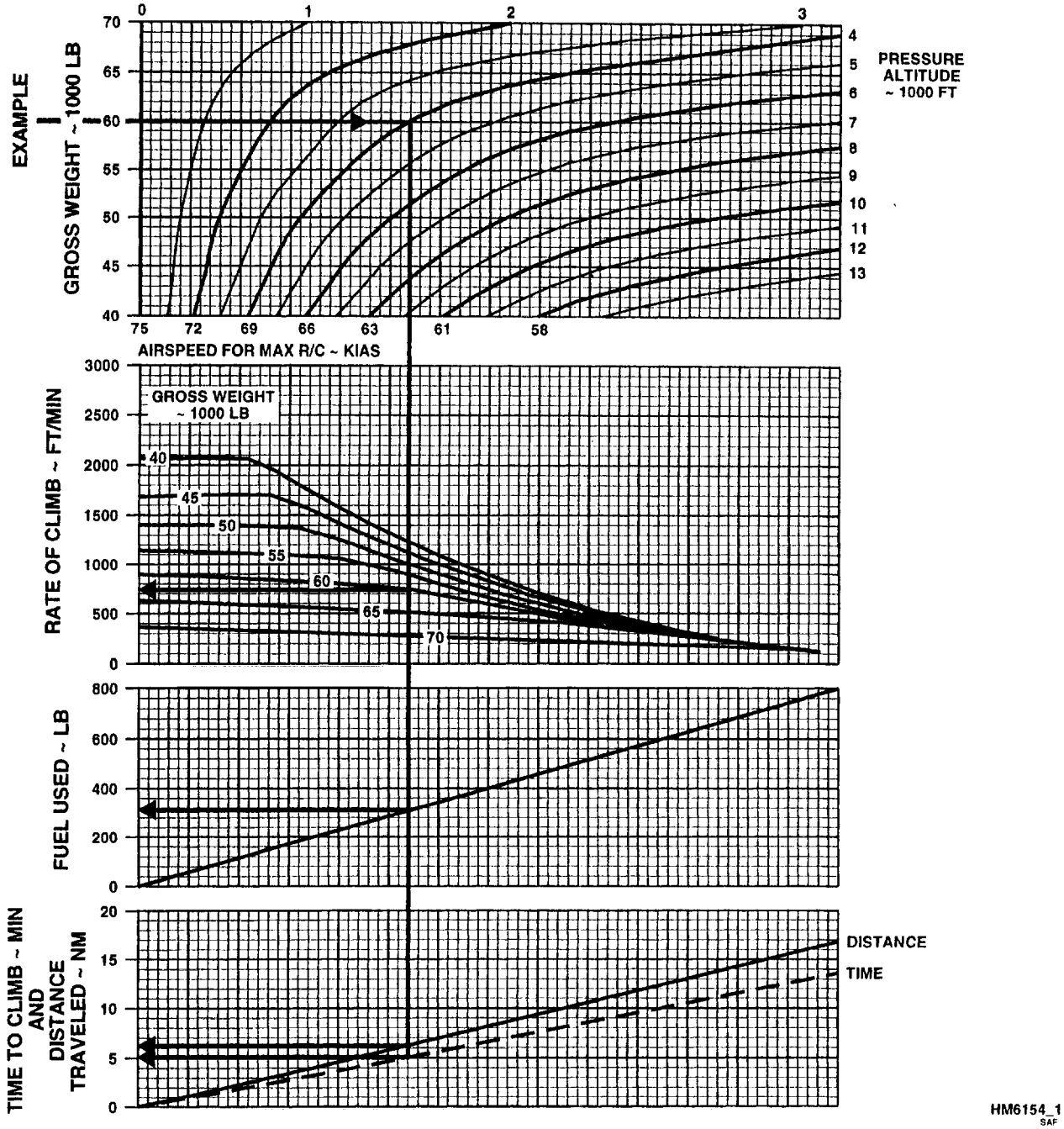


Figure 25-13. Dual-Engine Climb Performance - Military Power (419 Engine) (Sheet 1 of 3)

CLIMB PERFORMANCE
DUAL ENGINE – MILITARY POWER (809°C T5)
30 MINUTE (121%) TRANS LIMITATION
STANDARD TEMP, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

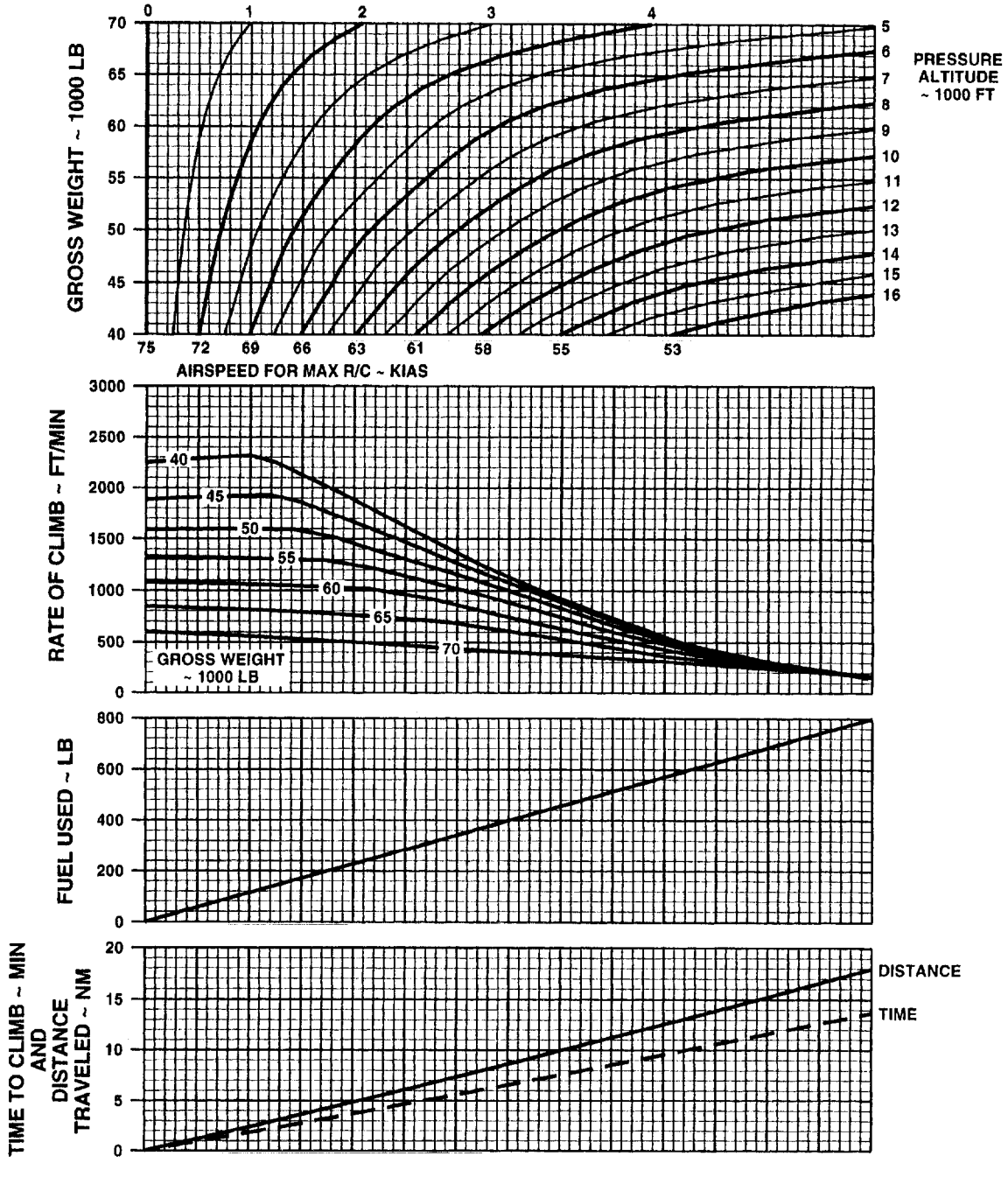


Figure 25-13. Dual-Engine Climb Performance - Military Power (419 Engine) (Sheet 2 of 3)

CLIMB PERFORMANCE
DUAL ENGINE – MILITARY POWER (809°C T5)
30 MINUTE (121%) TRANS LIMITATION
STANDARD TEMP +30°C, ZERO WIND, 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

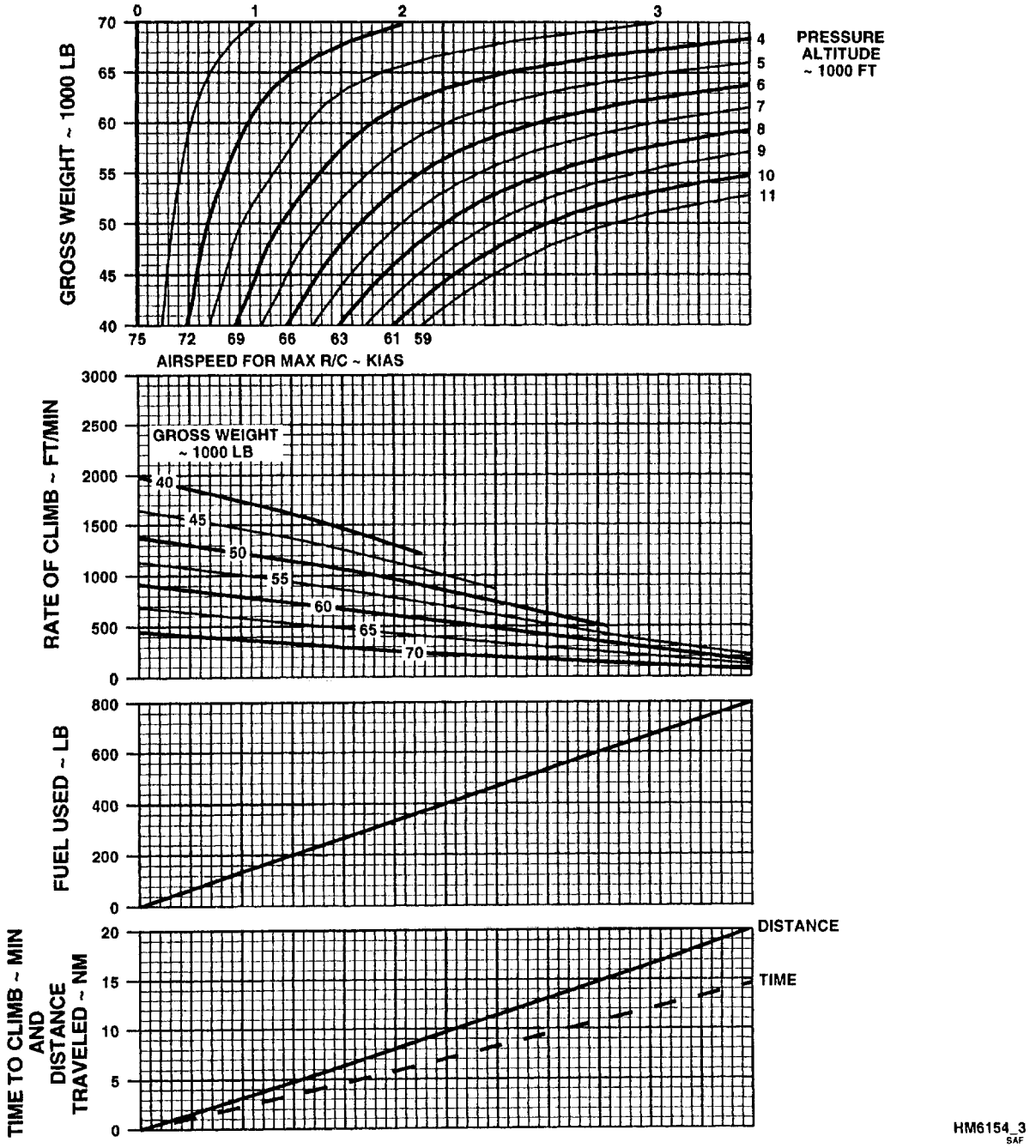


Figure 25-13. Dual-Engine Climb Performance - Military Power (419 Engine) (Sheet 3 of 3)

SINGLE OR DUAL ENGINE
ABILITY TO MAINTAIN LEVEL FLIGHT 100% NR

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

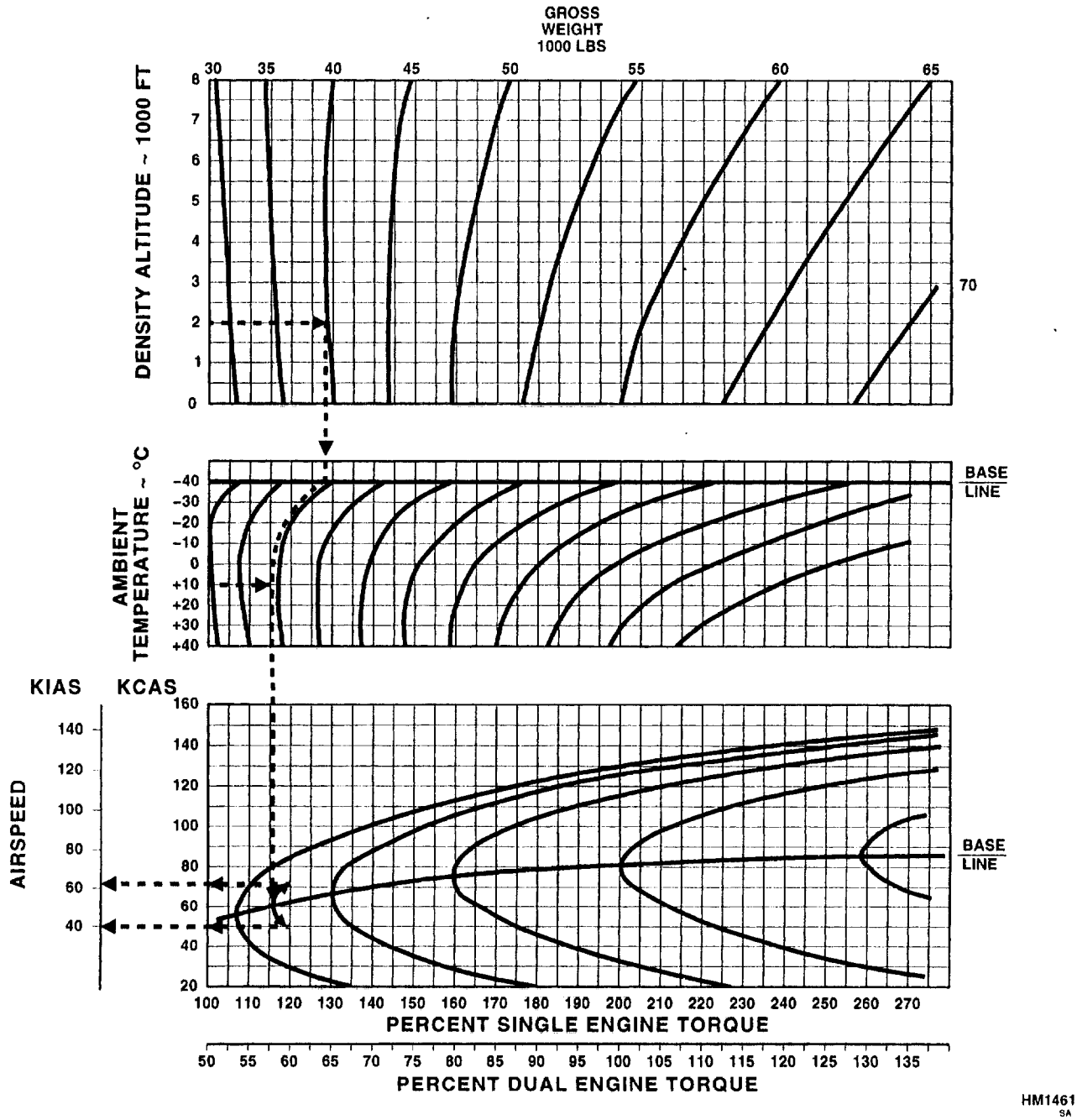


Figure 25-14. Single- or Dual-Engine Ability to Maintain Level Flight (416 Engine)

SINGLE OR DUAL ENGINE ABILITY TO MAINTAIN LEVEL FLIGHT 100% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

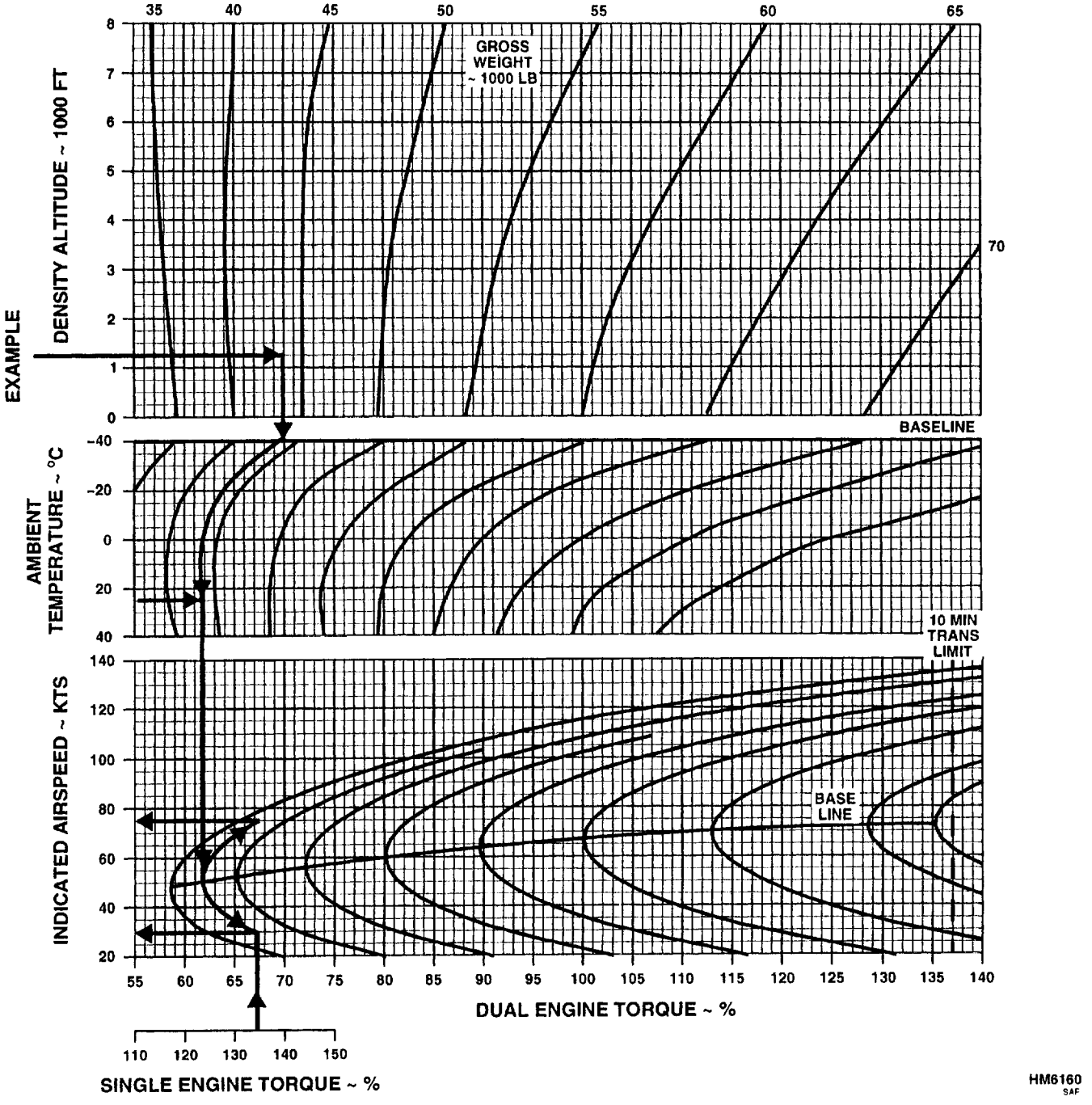


Figure 25-15. Single- or Dual-Engine Ability to Maintain Level Flight (419 Engine)

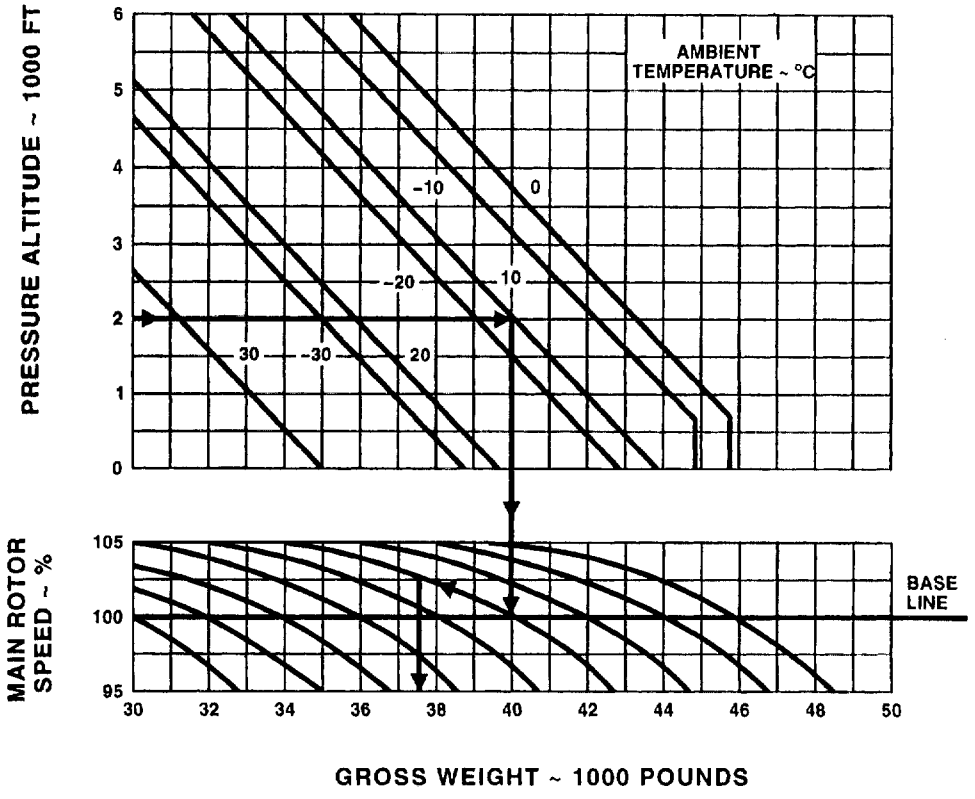
SINGLE ENGINE ABILITY TO MAINTAIN 60 KIAS LEVEL FLIGHT AT VARIOUS ROTOR SPEEDS
MAXIMUM POWER

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTE: WITHOUT EAPS INSTALLED INCREASE WEIGHT BY 500 LBS.



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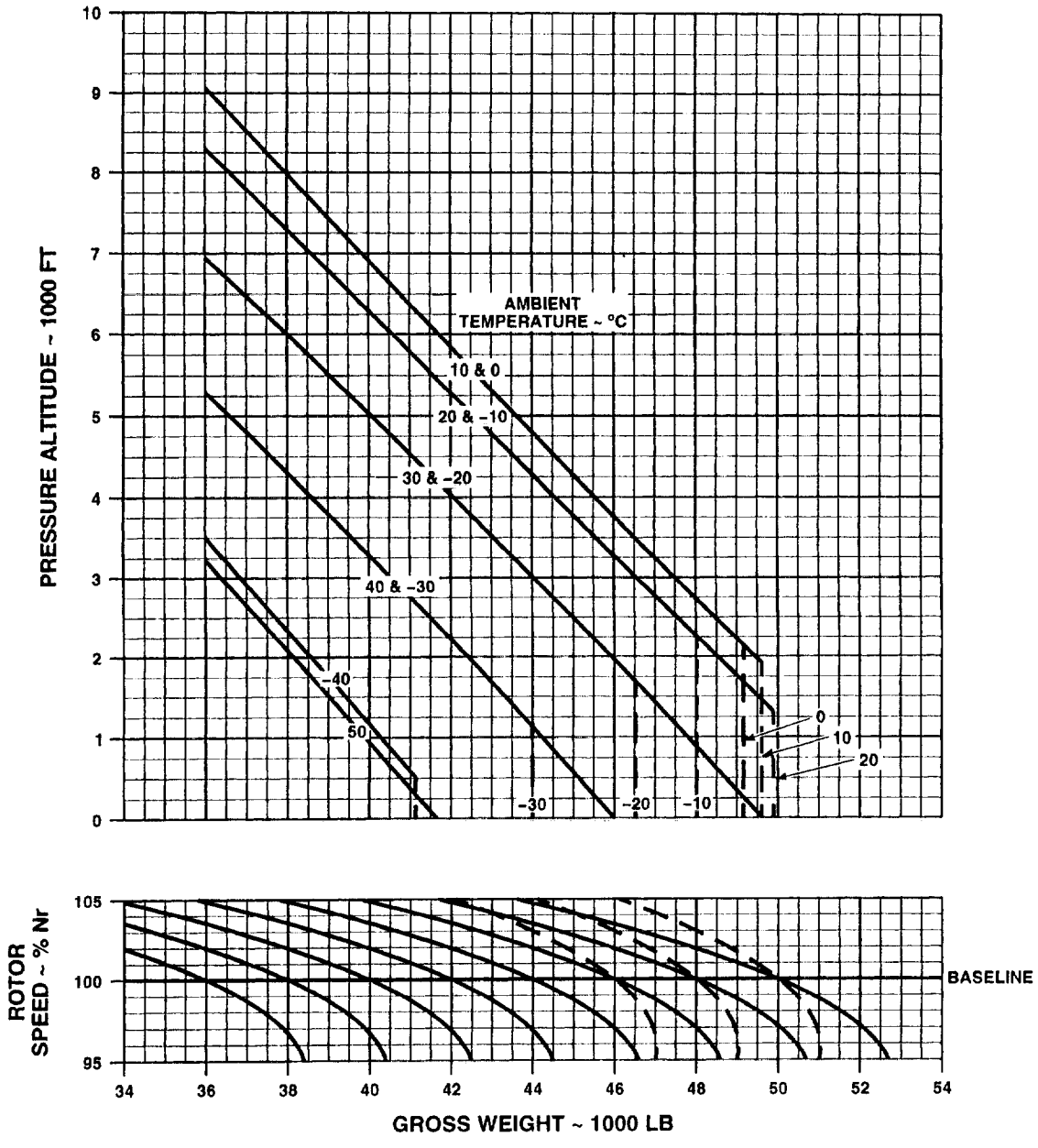
Figure 25-16. Single-Engine Ability to Maintain 60 Knot Level Flight at Various N_rs (416 Engine)

SINGLE ENGINE ABILITY TO MAINTAIN 60 KIAS LEVEL FLIGHT AT VARIOUS ROTOR SPEEDS MAXIMUM POWER (829°C T5)

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTES --- 10 MIN (137%) TRANSMISSION TORQUE RATING IN UPPER CHART
WHEN LIMITED BY TRANSMISSION RATING USE DASHED INFLUENCE LINES ON ROTOR RPM SCALE



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Figure 25-17. Single-Engine Ability to Maintain 60 Knot Level Flight at Various N_rs (419 Engine)

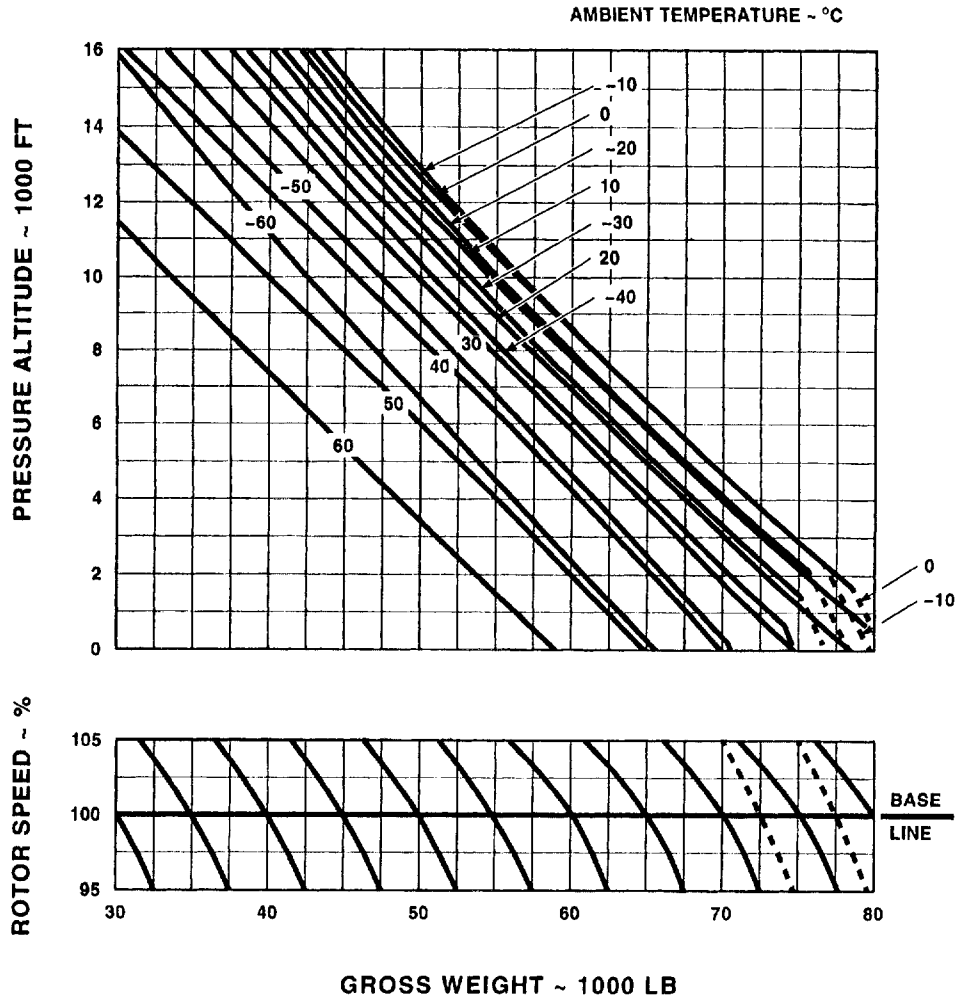
DUAL-ENGINE ABILITY TO MAINTAIN 70 KIAS LEVEL FLIGHT AT VARIOUS SPEEDS
MILITARY POWER

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES: WITHOUT EAPS INSTALLED INCREASE WEIGHT BY 500 LBS.
▪ ▬ ▪ 30 MIN TRANSMISSION TORQUE RATING IN UPPER CLASS. WHEN LIMITED BY TRANSMISSION RATING USE DASHED INFLUENCE LINES ON ROTOR RPM SCALE.



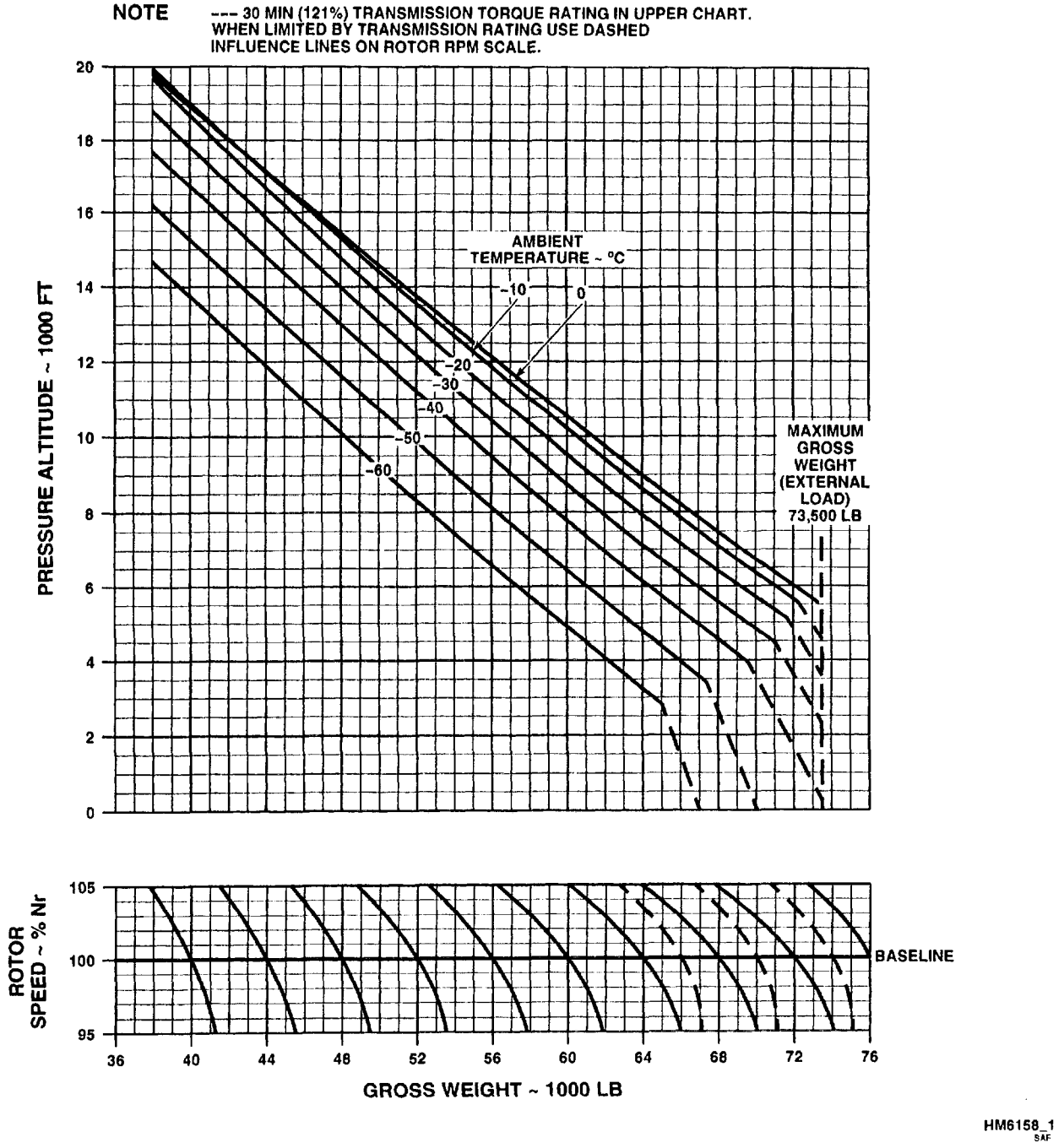
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Figure 25-18. Dual-Engine Ability to Maintain 70 Knot Level Flight at Various N_rs (416 Engine)

DUAL ENGINE ABILITY TO MAINTAIN 70 KIAS LEVEL FLIGHT AT VARIOUS ROTOR SPEEDS – COLD DAY MILITARY POWER (809°C T5)

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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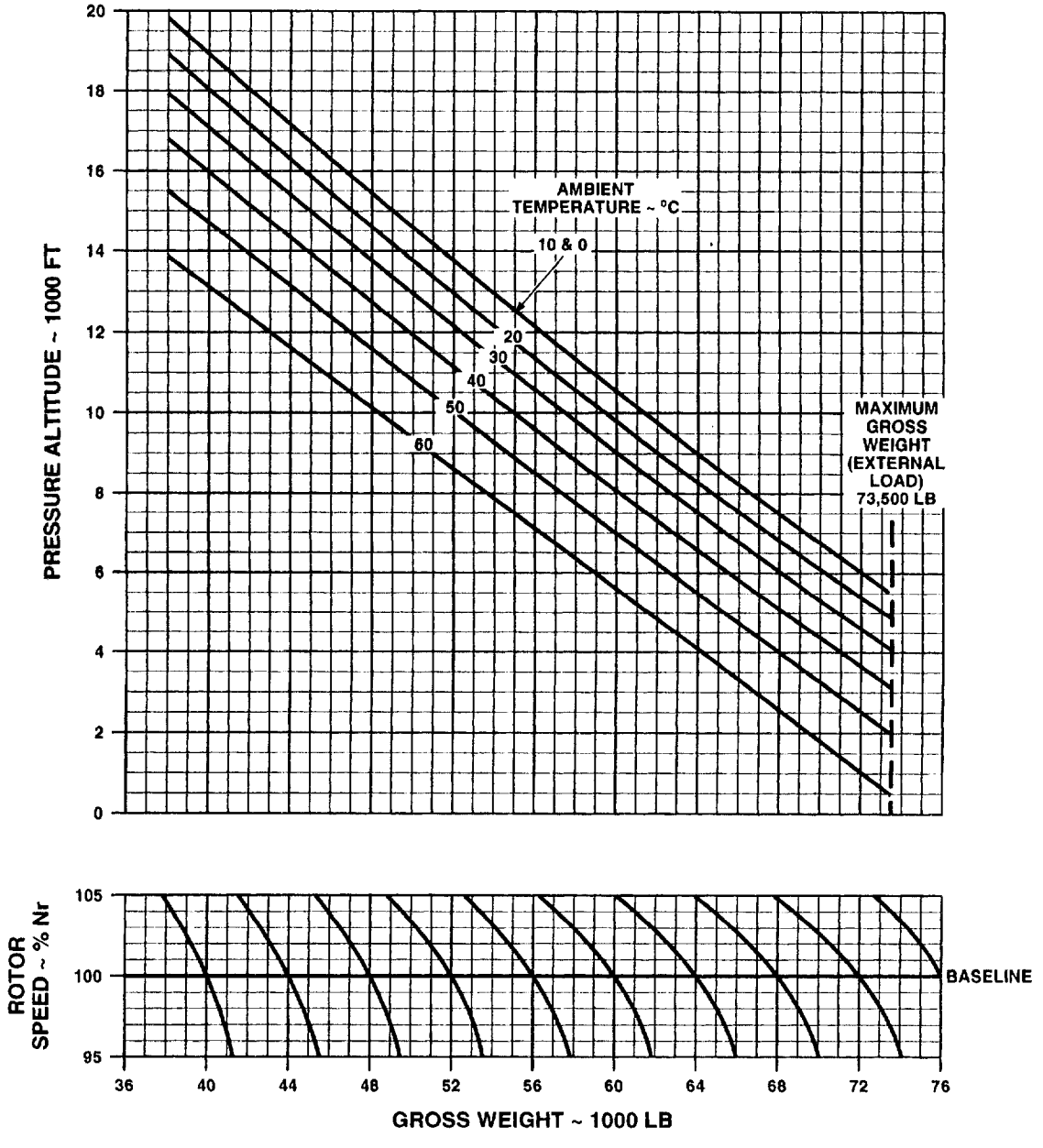
Figure 25-19. Dual-Engine Ability to Maintain 70 Knot Level Flight at Various N_rs (419 Engine) (Sheet 1 of 2)

DUAL ENGINE ABILITY TO MAINTAIN 70 KIAS LEVEL FLIGHT AT VARIOUS ROTOR SPEEDS – HOT DAY MILITARY POWER (809°C T5)

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTE 30 MIN (121%) TRANSMISSION TORQUE RATING.



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Figure 25-19. Dual-Engine Ability to Maintain 70 Knot Level Flight at Various N_rs (419 Engine) (Sheet 2 of 2)

SINGLE-ENGINE MAXIMUM RANGE
MILITARY POWER STANDARD TEMPERATURE
100% Nr

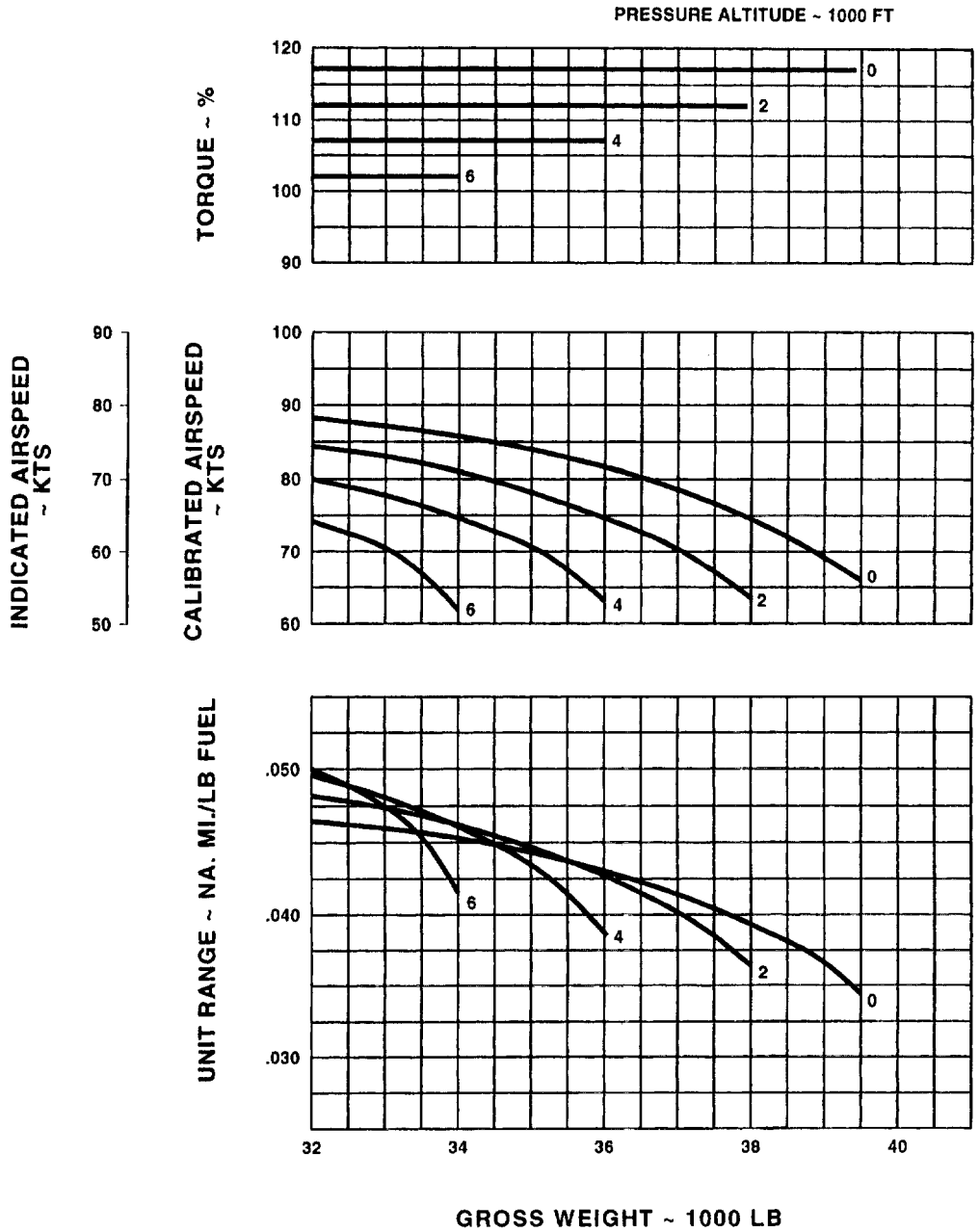
MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

STANDARD TEMPERATURE AT SEA LEVEL = 15 °C.
STANDARD TEMPERATURE AT 5000 FT = 5 °C.



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Figure 25-20. Single-Engine Maximum Range, Standard Temperature (416 Engine)

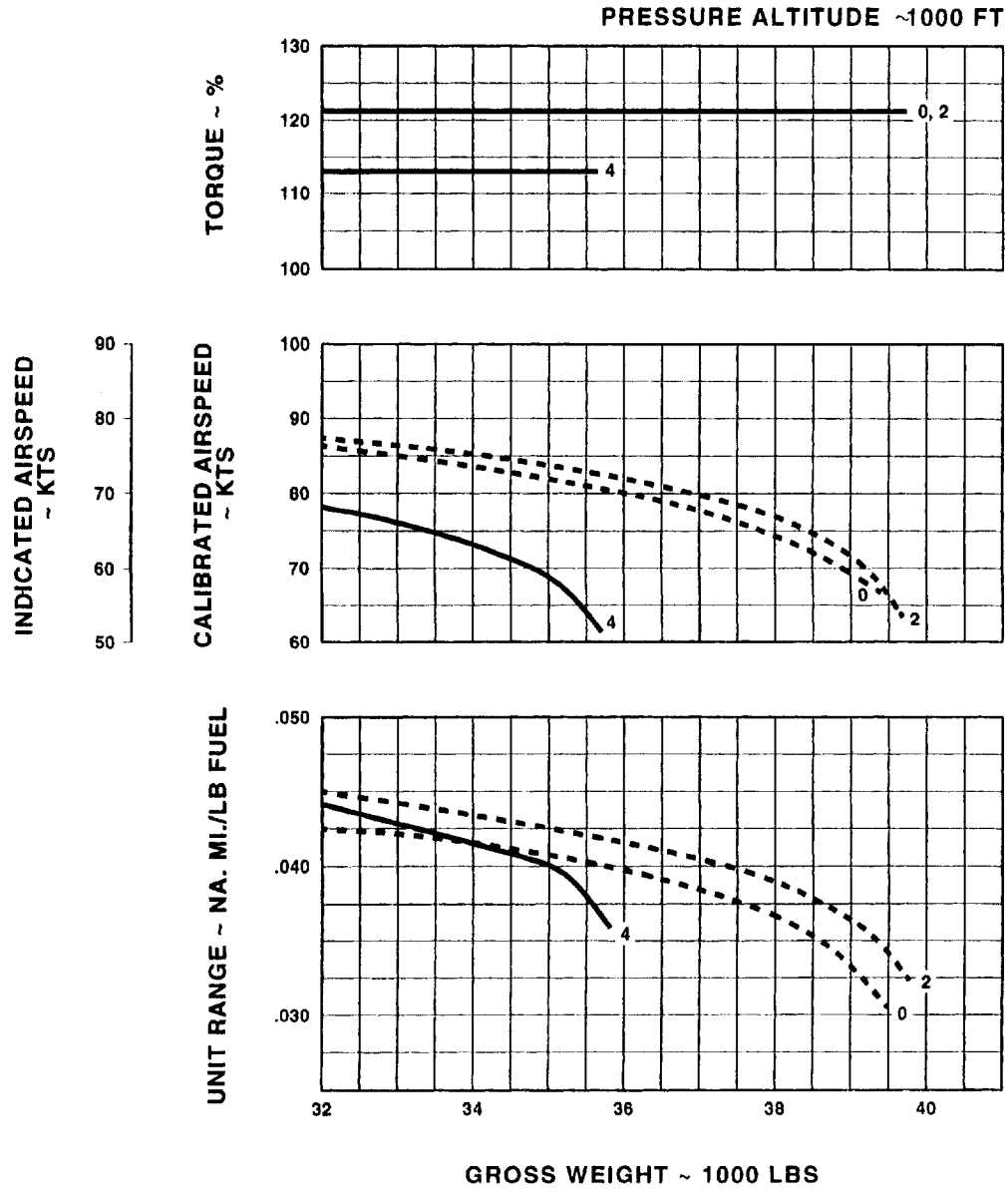
SINGLE-ENGINE MAXIMUM RANGE
STANDARD TEMPERATURE -30°C
COLD DAY
MILITARY POWER
100% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

NOTES:

- - - - 30 MINUTE TRANSMISSION TORQUE RATING
STANDARD TEMPERATURE -30°C AT SEA LEVEL = -15°C
STANDARD TEMPERATURE -30°C AT 5000 FT = -25°C



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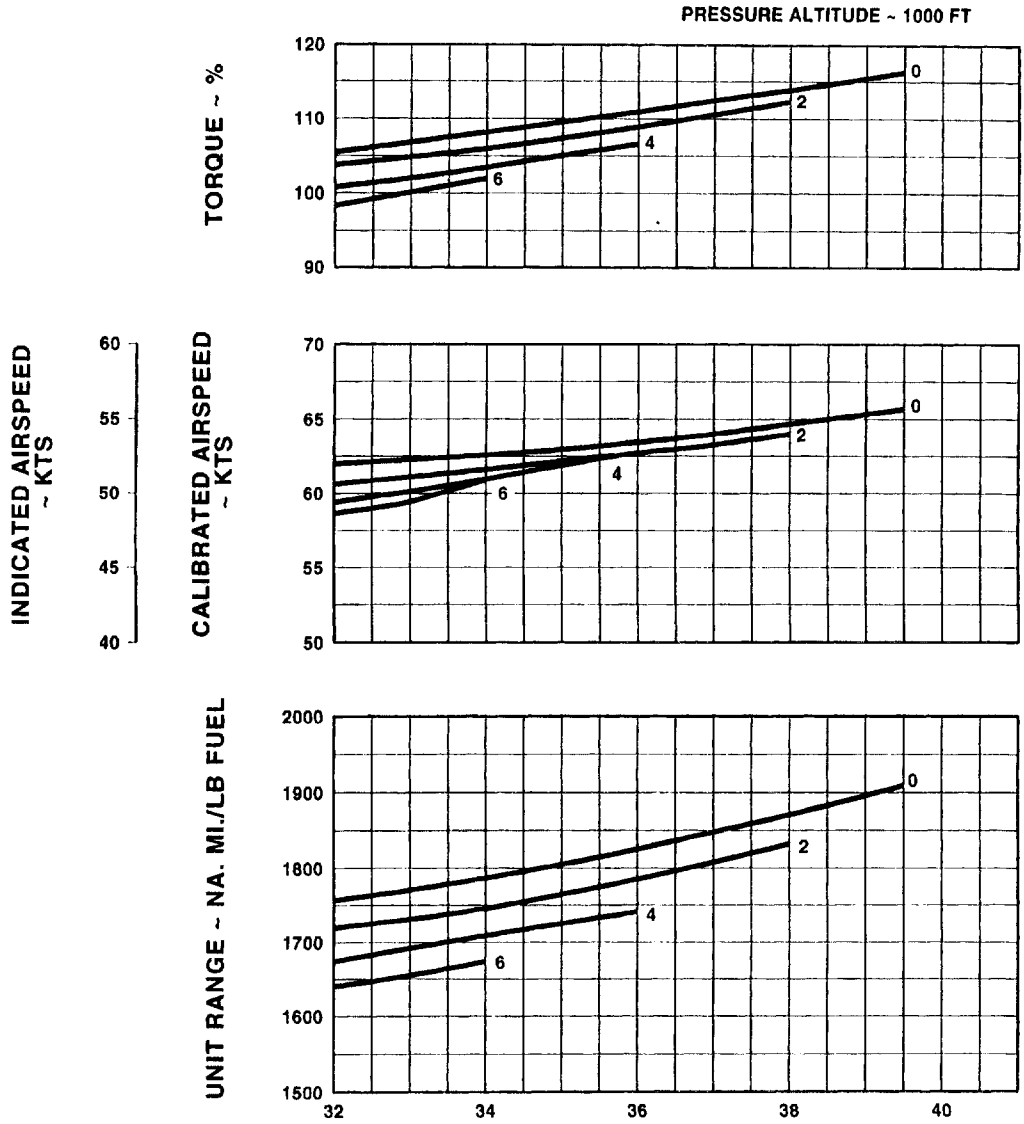
Figure 25-21. Single-Engine Maximum Range, Standard Temperature Cold Day -30°C (416 Engine)

SINGLE-ENGINE MAXIMUM ENDURANCE
STANDARD TEMPERATURE
100% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



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Figure 25-22. Single-Engine Maximum Endurance (416 Engine)

BINGO PROFILE
SINGLE ENGINE – MAXIMUM RANGE
STANDARD TEMP –30°C, ZERO WIND, 100% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL				
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	5000	4000	3000	2000	1000
	4	–22.9	1874	61	121			113	76	38
	3	–20.9	1866	62	121			113	75	38
	2	–19.0	1865	63	121			113	76	38
	1	–17.0	1869	64	121			113	75	38
39	0	–15.0	1878	64	121			110	73	37
	5	–24.9	1874	64	120				79	40
	4	–22.9	1873	66	121	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			80	40
	3	–20.9	1865	67	121				81	40
	2	–19.0	1864	68	121				81	40
	1	–17.0	1868	69	121				80	40
38	0	–15.0	1877	69	121				78	39

NOTES

1. CAUTION – NO RESERVE FUEL
2. ALL POINTS LIMITED BY MIL POWER OR 121% TORQUE

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Figure 25-23. Single-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 1 of 4)

BINGO PROFILE
SINGLE ENGINE – MAXIMUM RANGE
STANDARD TEMP –15°C, ZERO WIND, 100% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL				
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	5000	4000	3000	2000	1000
	5	-9.9	1889	66	121	208	166	125	83	42
	4	-7.9	1879	66	121	206	165	123	82	41
	3	-5.9	1876	65	121	202	162	121	81	40
	2	-4.0	1879	64	121	194	155	116	78	39
	1	-2.0	1895	64	121	190	152	114	76	38
41	0	0.0	1913	61	121	178	142	107	71	36
	6	-11.9	1854	64	118		167	125	84	42
	5	-9.9	1888	70	121		175	132	88	44
	4	-7.9	1878	70	121		174	131	87	44
	3	-5.9	1875	70	121		171	128	86	43
	2	-4.0	1878	69	121		167	125	83	42
	1	-2.0	1886	68	121		161	120	80	40
40	0	0.0	1897	64	121		151	113	76	38
	6	-11.9	1856	69	119			134	89	45
	5	-9.9	1887	73	121			137	91	46
	4	-7.9	1877	73	121			135	90	45
	3	-5.9	1874	73	121			133	89	44
	2	-4.0	1878	72	121			130	87	43
	1	-2.0	1885	71	121			126	84	42
39	0	0.0	1897	70	121			121	81	40
	7	-13.9	1774	61	113				86	43
	6	-11.9	1859	72	119	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			93	46
	5	-9.9	1886	75	121				94	47
	4	-7.9	1876	75	121				93	46
	3	-5.9	1874	75	121				91	46
	2	-4.0	1877	75	121				89	45
	1	-2.0	1885	74	121				87	44
38	0	0.0	1896	73	121				84	42

NOTES

1. CAUTION – NO RESERVE FUEL
2. ALL POINTS LIMITED BY MIL POWER OR 121% TORQUE

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Figure 25-23. Single-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 2 of 4)

BINGO PROFILE
SINGLE ENGINE – MAXIMUM RANGE
STANDARD TEMP, ZERO WIND, 100% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL				
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	5000	4000	3000	2000	1000
	5	5.1	1889	68	121	222	177	133	89	44
	4	7.1	1886	68	121	217	174	130	87	43
	3	9.1	1888	66	121	210	168	126	84	42
	2	11.0	1894	63	121	198	158	119	79	40
	1	13.0	1911	62	121	188	151	113	75	38
42	0	15.0	1938	63	121	186	149	111	74	37
	6	3.1	1840	65	118	221	177	133	88	44
	5	5.1	1888	72	121	233	186	140	93	47
	4	7.1	1885	72	121	228	182	137	91	46
	3	9.1	1887	71	121	222	178	133	89	44
	2	11.0	1893	70	121	214	171	128	86	43
	1	13.0	1904	67	121	204	163	122	81	41
41	0	15.0	1918	64	121	191	152	114	76	38
	7	1.1	1790	56	114		162	122	81	41
	6	3.1	1840	70	118		188	141	94	47
	5	5.1	1887	75	121		192	144	96	48
	4	7.1	1884	75	121		189	142	95	47
	3	9.1	1886	74	121		184	138	92	46
	2	11.0	1892	73	121		178	134	89	45
	1	13.0	1903	71	121		171	128	86	43
40	0	15.0	1917	69	121		163	122	82	41
	7	1.1	1785	67	114			142	95	47
	6	3.1	1842	73	118			147	98	49
	5	5.1	1886	78	121			148	99	49
	4	7.1	1884	77	121			146	97	49
	3	9.1	1885	77	121			142	95	47
	2	11.0	1892	76	121			138	92	46
	1	13.0	1902	74	121			133	89	44
39	0	15.0	1916	73	121			128	85	43
	8	-0.8	1721	61	110				92	46
	7	1.1	1787	71	114	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			99	50
	6	3.1	1843	76	118				101	50
	5	5.1	1885	80	121				101	51
	4	7.1	1883	79	121				99	50
	3	9.1	1885	79	121				97	49
	2	11.0	1891	78	121				94	47
	1	13.0	1902	77	121				91	46
38	0	15.0	1915	75	121				88	44

NOTES

1. CAUTION – NO RESERVE FUEL
2. ALL POINTS LIMITED BY MIL POWER OR 121% TORQUE

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Figure 25-23. Single-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 3 of 4)

BINGO PROFILE
SINGLE ENGINE – MAXIMUM RANGE
STANDARD TEMP +15°C, ZERO WIND, 100% Nr
OBTAINABLE ONLY FOR MAX RANGE PROFILE

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL				
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX RANGE KIAS	MAX RANGE TRQ	5000	4000	3000	2000	1000
	3	24.1	1888	68	120	219	175	131	88	44
	2	26.0	1910	69	121	215	172	129	86	43
	1	28.0	1923	66	121	204	163	122	82	41
42	0	30.0	1938	62	121	189	151	113	75	38
	4	22.1	1837	66	117	222	178	133	89	44
	3	24.1	1888	72	120	231	185	139	93	46
	2	26.0	1909	73	121	226	181	135	90	45
	1	28.0	1921	71	121	217	174	130	87	43
41	0	30.0	1937	69	121	207	166	124	83	41
	5	20.1	1789	64	114		182	136	91	45
	4	22.1	1837	71	117		189	142	95	47
	3	24.1	1889	76	120		192	144	96	48
	2	26.0	1908	76	121		187	140	94	47
	1	28.0	1921	74	121		180	135	90	45
40	0	30.0	1936	73	121		173	130	87	43
	6	18.1	1737	80	111			135	90	45
	5	20.1	1790	69	114			146	97	49
	4	22.1	1838	74	117			148	98	49
	3	24.1	1890	78	121			148	99	49
	2	26.0	1907	78	121			144	96	48
	1	28.0	1920	77	121			139	93	46
39	0	30.0	1935	75	121			134	89	45
	6	18.1	1738	67	111	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			99	49
	5	20.1	1790	73	114				101	51
	4	22.1	1839	77	117				101	51
	3	24.1	1890	80	121				101	50
	2	26.0	1907	80	121				98	49
	1	28.0	1919	79	121				95	48
38	0	30.0	1935	78	121				92	46

NOTES

1. CAUTION – NO RESERVE FUEL
2. ALL POINTS LIMITED BY MIL POWER OR 121% TORQUE

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Figure 25-23. Single-Engine Maximum Range Bingo Profile (419 Engine) (Sheet 4 of 4)

BINGO PROFILE
RANGE AT MAXIMUM ENDURANCE SPEED
SINGLE ENGINE
STANDARD TEMP, ZERO WIND, 100% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						AIR RANGE (NM) LBS OF FUEL				
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX END KIAS	MAX END TRQ	5000	4000	3000	2000	1000
	5	5.1	1867	58	119	195	156	117	78	39
	4	7.1	1875	59	119	192	154	115	77	38
	3	9.1	1890	59	120	189	151	113	75	38
	2	11.0	1911	59	121	185	148	111	74	37
	1	13.0	1935	59	121	179	143	107	72	36
42	0	15.0	1963	59	121	174	139	104	70	35
	6	3.1	1828	57	116	199	159	120	80	40
	5	5.1	1832	58	117	197	157	118	79	39
	4	7.1	1844	58	117	194	155	116	77	39
	3	9.1	1862	58	118	189	151	114	76	38
	2	11.0	1885	58	119	185	148	111	74	37
	1	13.0	1911	58	120	180	144	108	72	36
41	0	15.0	1939	58	120	174	139	105	70	35
	7	1.1	1790	56	114		162	122	81	41
	6	3.1	1791	57	114		161	121	81	40
	5	5.1	1800	57	114		159	119	79	40
	4	7.1	1816	57	115		156	117	78	39
	3	9.1	1836	58	116		152	114	76	38
	2	11.0	1860	58	117		148	111	74	37
	1	13.0	1887	58	118		144	108	72	36
40	0	15.0	1917	58	119		139	104	70	35
	7	1.1	1752	56	111			123	82	41
	6	3.1	1758	56	112			122	81	41
	5	5.1	1770	56	112			120	80	40
	4	7.1	1788	57	113			117	78	39
	3	9.1	1811	57	114			114	76	38
	2	11.0	1836	57	115			111	74	37
	1	13.0	1865	57	116			108	72	36
39	0	15.0	1895	57	117			104	69	35
	8	-0.8	1714	55	109				84	42
	7	1.1	1716	55	109	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			83	42
	6	3.1	1726	55	110				82	41
	5	5.1	1742	56	110				80	40
	4	7.1	1762	56	111				78	39
	3	9.1	1786	56	112				76	38
	2	11.0	1813	56	113				74	37
	1	13.0	1843	56	114				72	36
38	0	15.0	1873	56	115				69	35

NOTE

CAUTION – NO RESERVE FUEL

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Figure 25-24. Single-Engine Maximum Endurance Bingo Profile (419 Engine) (Sheet 1 of 2)

BINGO PROFILE
TIME AT MAXIMUM ENDURANCE SPEED
SINGLE ENGINE
STANDARD TEMP, ZERO WIND, 100% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

AIRCRAFT						TIME ~ HOURS LBS OF FUEL				
GW LB x 1000	PA FT x 1000	OAT °C	FUEL FLOW LB/HR	MAX END KIAS	MAX END TRQ	5000	4000	3000	2000	1000
	5	5.1	1867	58	119	2.7	2.1	1.6	1.1	0.5
	4	7.1	1875	59	119	2.7	2.1	1.6	1.1	0.5
	3	9.1	1890	59	120	2.6	2.1	1.6	1.1	0.5
	2	11.0	1911	59	121	2.6	2.1	1.6	1.0	0.5
	1	13.0	1935	59	121	2.6	2.1	1.6	1.0	0.5
42	0	15.0	1963	59	121	2.5	2.0	1.5	1.0	0.5
	6	3.1	1828	57	116	2.7	2.2	1.6	1.1	0.5
	5	5.1	1832	58	117	2.7	2.2	1.6	1.1	0.5
	4	7.1	1844	58	117	2.7	2.2	1.6	1.1	0.5
	3	9.1	1862	58	118	2.7	2.1	1.6	1.1	0.5
	2	11.0	1885	58	119	2.7	2.1	1.6	1.1	0.5
	1	13.0	1911	58	120	2.6	2.1	1.6	1.0	0.5
41	0	15.0	1939	58	120	2.6	2.1	1.5	1.0	0.5
	7	1.1	1790	56	114		2.2	1.7	1.1	0.6
	6	3.1	1791	57	114		2.2	1.7	1.1	0.6
	5	5.1	1800	57	114		2.2	1.7	1.1	0.6
	4	7.1	1816	57	115		2.2	1.7	1.1	0.6
	3	9.1	1836	58	116		2.2	1.6	1.1	0.5
	2	11.0	1860	58	117		2.2	1.6	1.1	0.5
	1	13.0	1887	58	118		2.1	1.6	1.1	0.5
40	0	15.0	1917	58	119		2.1	1.6	1.0	0.5
	7	1.1	1752	56	111			1.7	1.1	0.6
	6	3.1	1758	56	112			1.7	1.1	0.6
	5	5.1	1770	56	112			1.7	1.1	0.6
	4	7.1	1788	57	113			1.7	1.1	0.6
	3	9.1	1811	57	114			1.7	1.1	0.6
	2	11.0	1836	57	115			1.6	1.1	0.5
	1	13.0	1865	57	116			1.6	1.1	0.5
39	0	15.0	1895	57	117			1.6	1.1	0.5
	8	-0.8	1714	55	109				1.2	0.6
	7	1.1	1716	55	109	FUEL LOADING UNATTAINABLE FOR GW'S SPECIFIED			1.2	0.6
	6	3.1	1726	55	110				1.2	0.6
	5	5.1	1742	56	110				1.1	0.6
	4	7.1	1762	56	111				1.1	0.6
	3	9.1	1786	56	112				1.1	0.6
	2	11.0	1813	56	113				1.1	0.6
	1	13.0	1843	56	114				1.1	0.5
38	0	15.0	1873	56	115				1.1	0.5

NOTE

CAUTION – NO RESERVE FUEL

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Figure 25-24. Single-Engine Maximum Endurance Bingo Profile (419 Engine) (Sheet 2 of 2)

SINGLE OR DUAL ENGINE LANDING DISTANCE GROUND ROLL

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED

ENGINE: T64-GE-416/-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTE: GROUND ROLL DISTANCES WERE DETERMINED BY CONSIDERING A SINGLE OR DUAL ENGINE APPROACH ENTRY (POWER ON) AT APPROXIMATE 200 FOOT HEIGHT, 90 KIAS, 105% Nr, AT A RATE OF DESCENT OF 1000 FEET/MINUTE, AND A TOUCHDOWN SPEED OF 30 KCAS. TOTAL LANDING DISTANCE (GROUND ROLL AND AIR DISTANCE) MAY BE DETERMINED BY ADDING 700 FEET OF AIR DISTANCE FOR EACH 50 FEET OF OBSTACLE HEIGHT TO GROUND ROLL DISTANCE DETERMINED FROM THIS CHART.

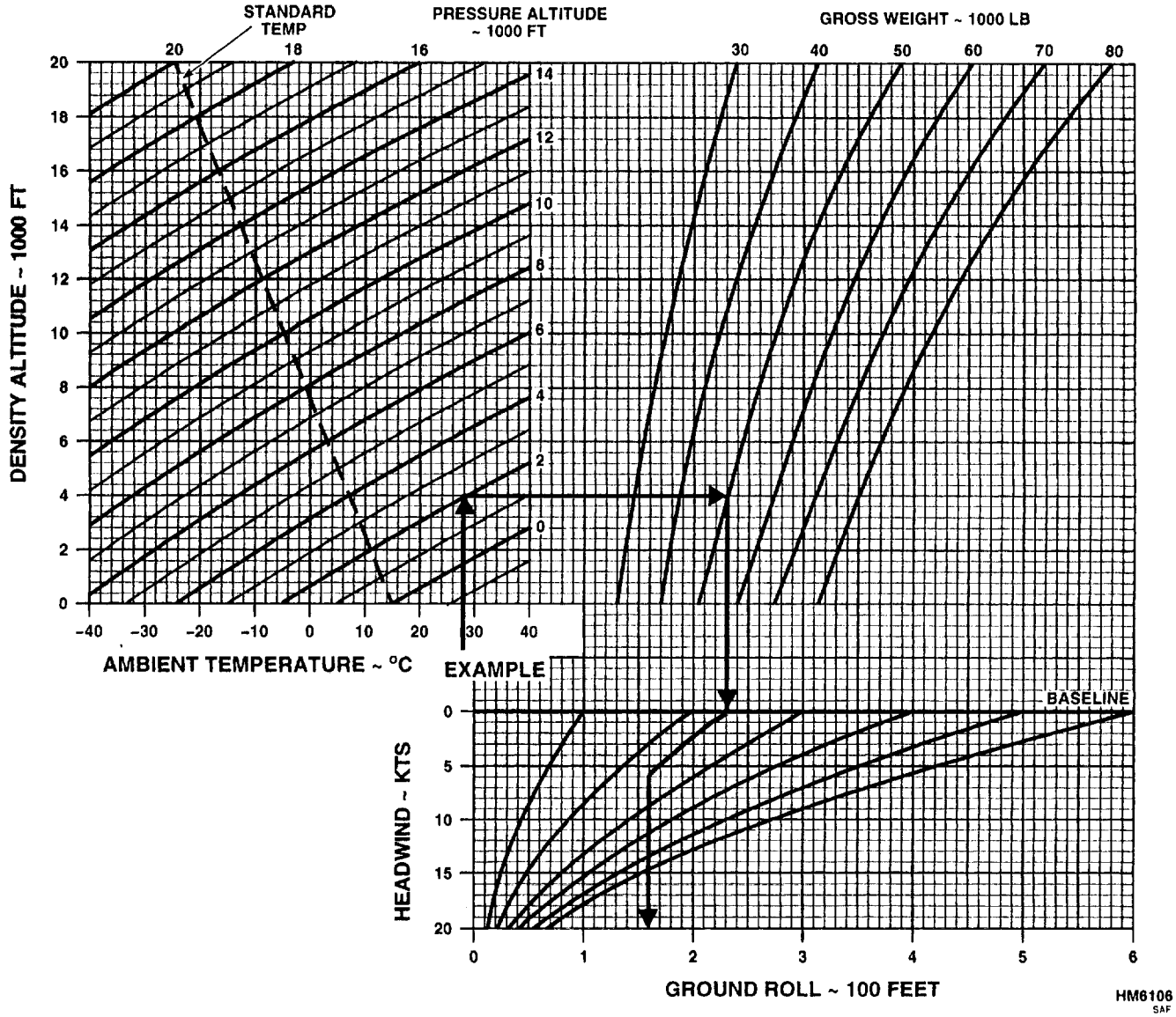


Figure 25-25. Single- or Dual-Engine Landing Distance

DUAL-ENGINE ABILITY TO HOVER OUT OF GROUND EFFECT AT VARIOUS ROTOR SPEEDS
MAXIMUM POWER

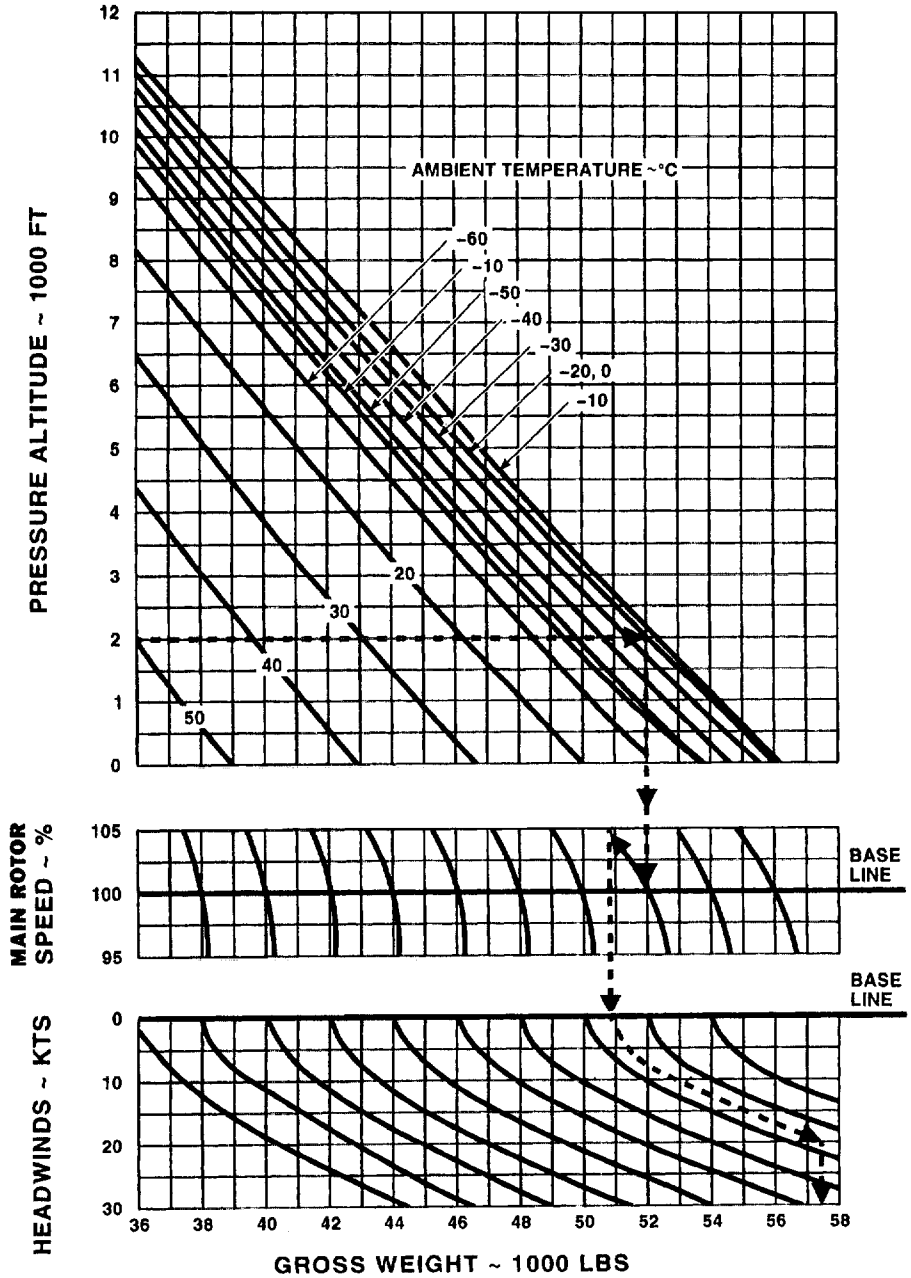
MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

CONFIGURATION: EAPS INSTALLED / EAPS DOORS CLOSED

NOTES:

INCREASE GROSS WEIGHT BY 200 LBS WITH EAPS NOT INSTALLED.
HEADWIND EFFECTS SHOWN ARE FOR STANDARD TENPERATURE. REDUCE HEADWIND EFFECTS BY 6% FOR EVERY 10 °C BELOW STANDARD TEMPERATURE.



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Figure 25-26. Dual-Engine Ability to Hover OGE at Various N_rs (416 Engine)

DUAL ENGINE ABILITY TO HOVER OUT OF GROUND EFFECT AT VARIOUS ROTOR SPEEDS MAXIMUM POWER (829 °C T5)

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS CLOSED

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

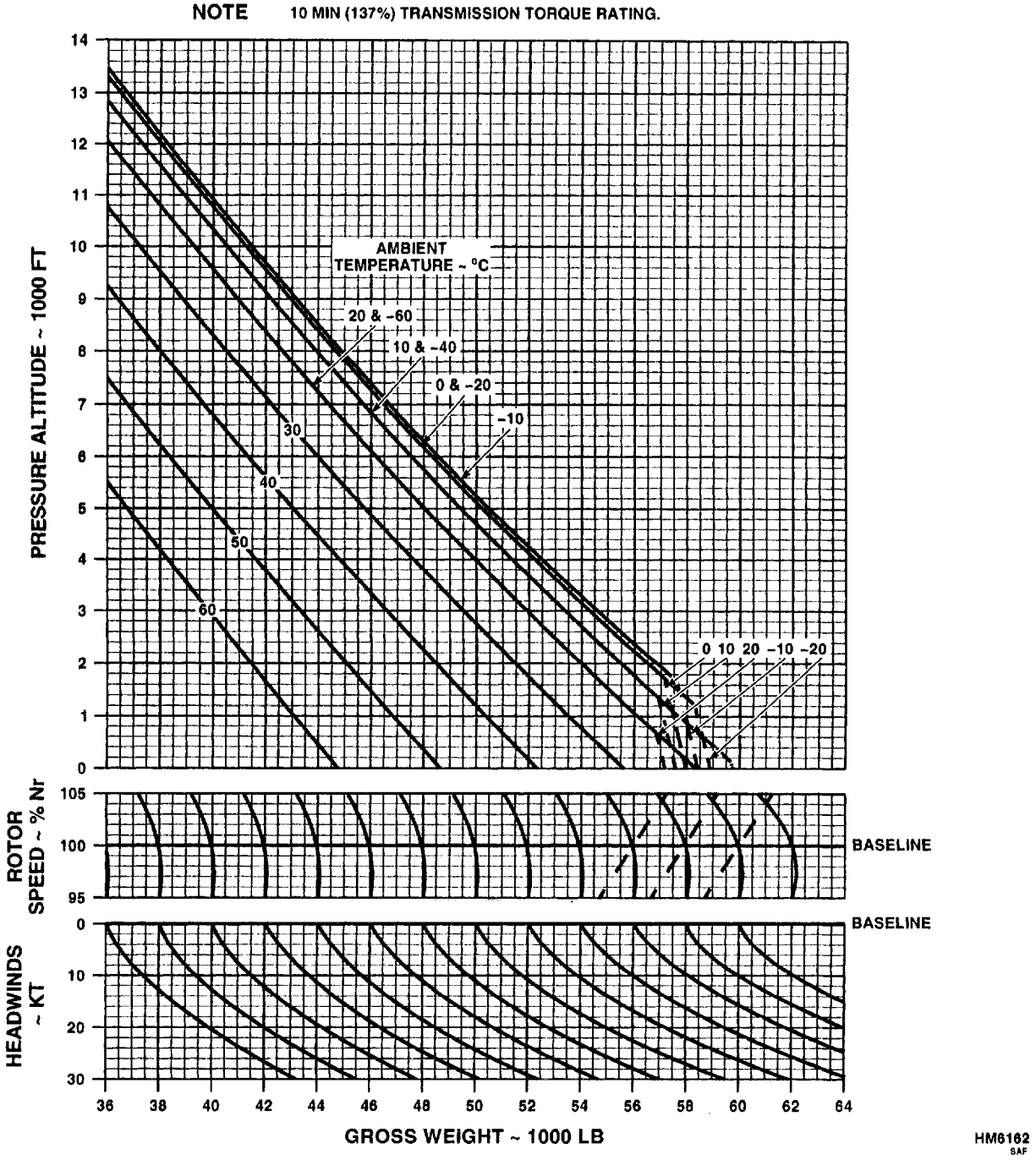


Figure 25-27. Dual-Engine Ability to Hover OGE at Various N_rs (419 Engine)

CHAPTER 26
Special

26.1 EXTERNAL LOAD DRAG CHARTS

These charts are used to determine the effect various external load shapes have on aircraft performance.

26.1.1 Increase in Drag Area Due to External Load Chart. The increase in drag area due to external load chart (Figure 26-1) is used to convert the frontal area of various shapes into drag area to be used in conjunction with the external capabilities charts.

For example, a cylinder with a frontal area of 80 square feet has a drag area of 45 square feet.

26.1.2 External Lift Capability 0 to 200 Square-Foot Drag Area, Sea Level, and 15°C. The external lift capability 0 to 200 square-foot drag area, sea level, and 15°C charts (Figures 26-2 thru 26-4 for the 416 engine and Figures 26-11 thru 26-13 for the 419 engine) provide unit range data for operations with external loads.

For example, at 60,000-pounds gross weight with an external load drag area of 40 square feet, enter the bottom of the chart at the desired KTAS, take 110 KTAS for instance and trace up to the 60,000-pound curve, then trace left and read fuel consumption .0285 nautical miles per pound of fuel.

26.1.3 External Lift Capability 0 to 200 Square-Foot Drag Area, 4000 Feet, and 7°C. The external lift capability 0 to 200 square-foot drag area, 4000 feet, and 7°C charts (Figures 26-5 thru 26-7 for the 416 engine and Figures 26-14 thru 26-16 for the 419 engine) are used the same way as Figures 26-2 thru 26-4.

26.1.4 External Lift Capability 0 to 200 Square-Foot Drag Area, Sea Level, and 35°C. The external lift capability 0 to 200 square-foot drag area, sea level, and 35°C charts (Figures 26-8 thru 26-10 for the 416 engine and Figures 26-17 thru 26-19 for the 419 engine) are used the same way as Figures 26-2 thru 26-4.

26.2 NAUTICAL MILES PER POUND OF FUEL

The nautical miles per pound of fuel chart (Figure 26-20) provides a convenient way to determine the fuel flow after the range, in nautical miles per pound of fuel, has been determined from the external lift capability charts.

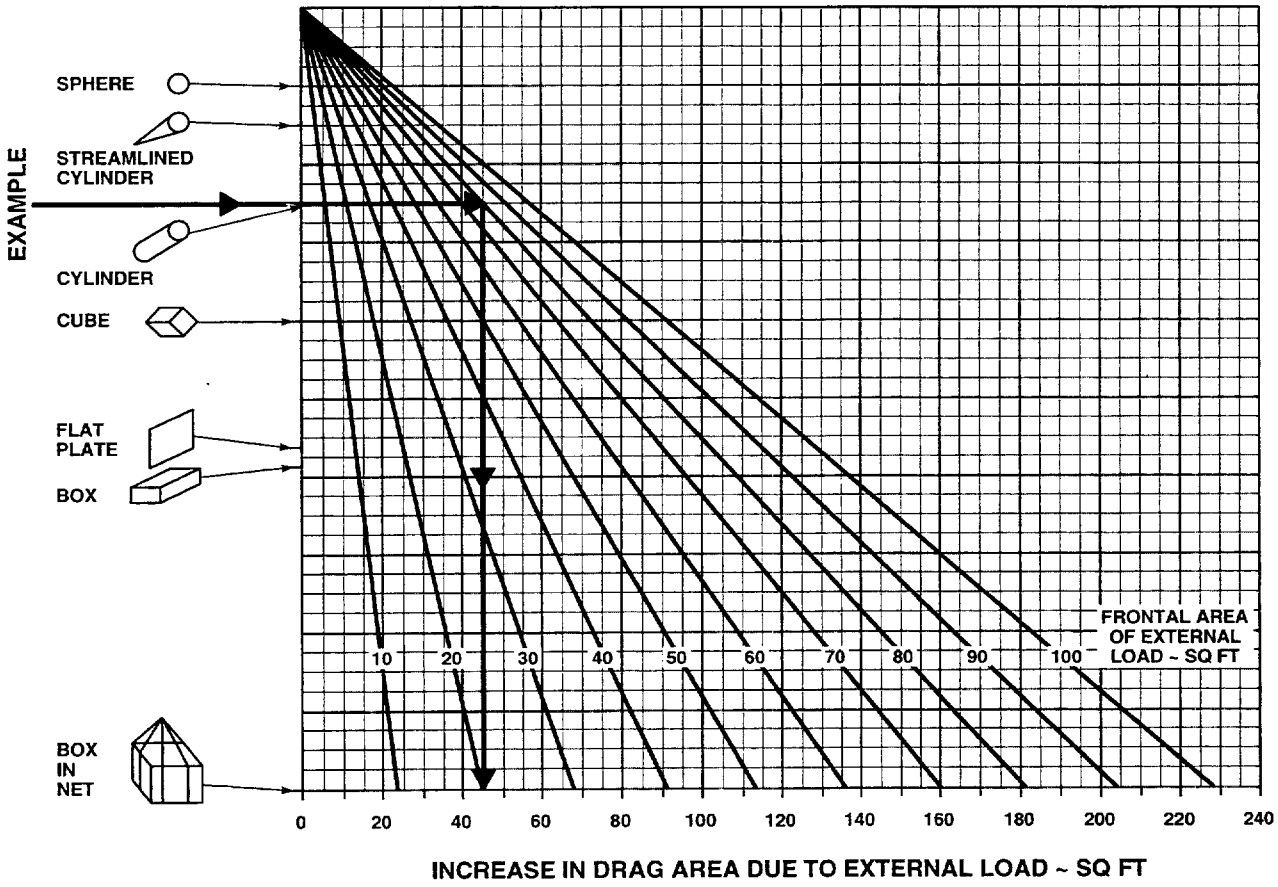
For example, after obtaining the nautical miles (in hundredths of a mile) per pound of fuel from an external lift capability chart, enter the left side of the chart at that value (0.04 nautical mile). Trace right to an appropriate TAS (140 KTAS), then down to read the fuel flow (3500 lbs/hr).

The nautical miles per pound of fuel chart can also be used in reverse to determine the range for a given amount of fuel that the helicopter can achieve for a given cruise condition on a zero wind day. The information required is the fuel flow and true airspeed as obtained from the cruise charts (Chapter 22).

INCREASE IN DRAG AREA DUE TO EXTERNAL LOAD

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: ESTIMATED
CONFIGURATION: EAPS INSTALLED

NOTE DRAG AREA INCREASE DETERMINED FROM CHART MAY BE INCREASED SIGNIFICANTLY DUE TO LOAD HANDLING CHARACTERISTICS AND SUSPENSION SLING ARRANGEMENT



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Figure 26-1. Increase in Drag Area Due to External Load

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES
SEA LEVEL STANDARD TEMPERATURE (15 °C)
103%Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

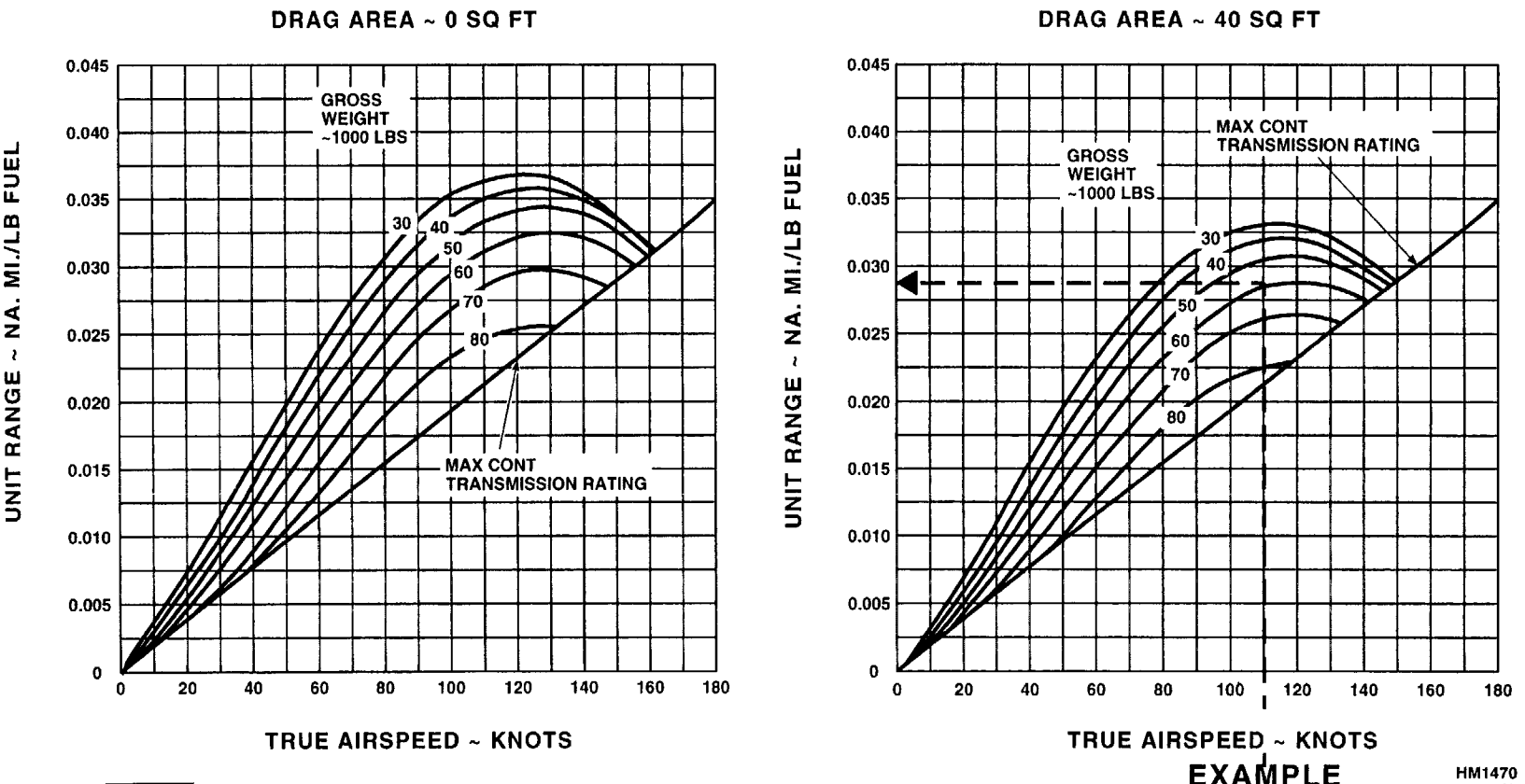


Figure 26-2. External Lift Capability 0- and 40-square-foot Drag Area, Sea Level, and 15°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES
SEA LEVEL STANDARD TEMPERATURE (15 °C)
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7LB / GAL

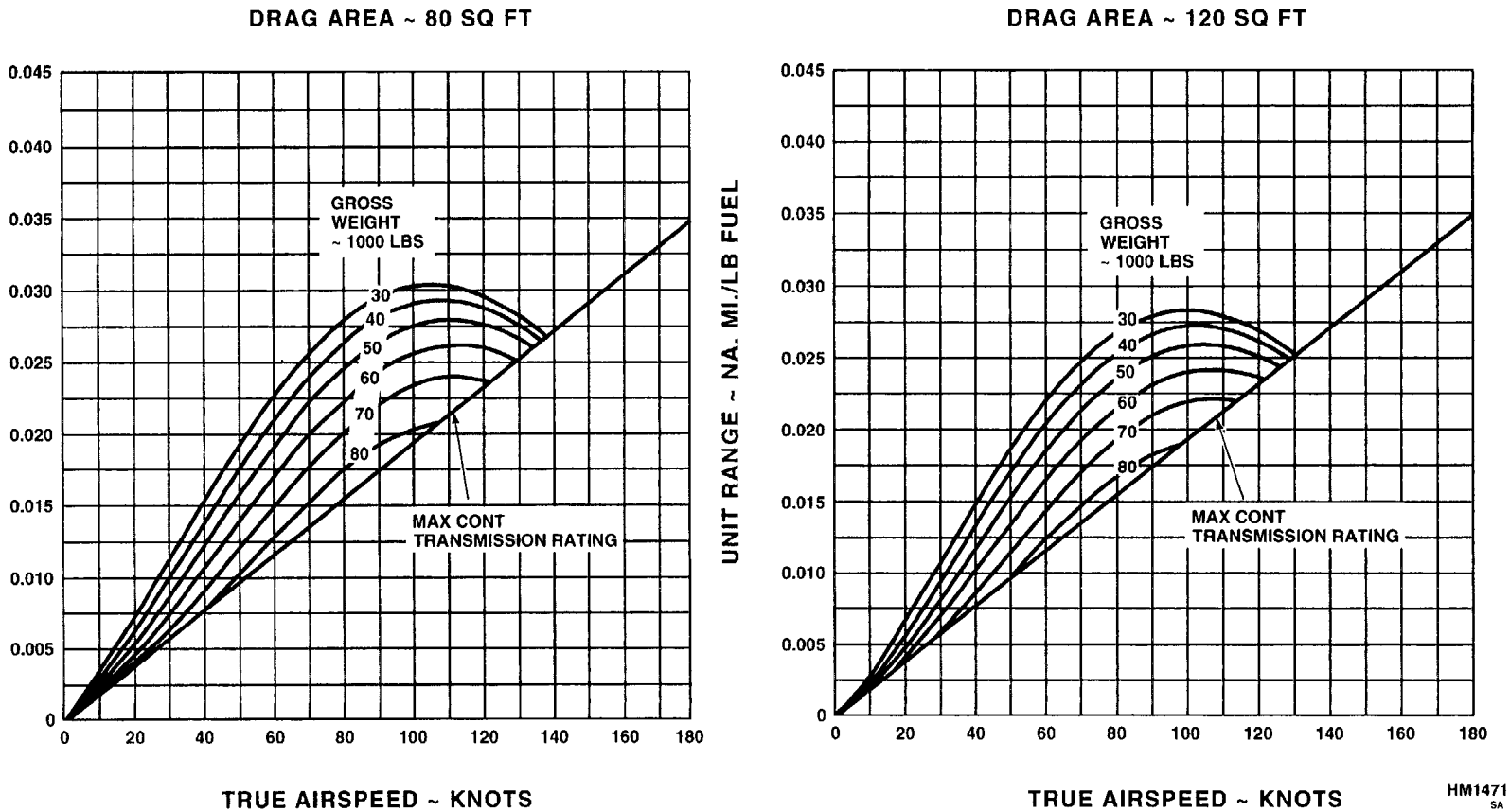


Figure 26-3. External Lift Capability 80- and 120-square-foot Drag Area, Sea Level, and 15°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES
SEA LEVEL STANDARD TEMPERATURE (15 °C)
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7LB / GAL

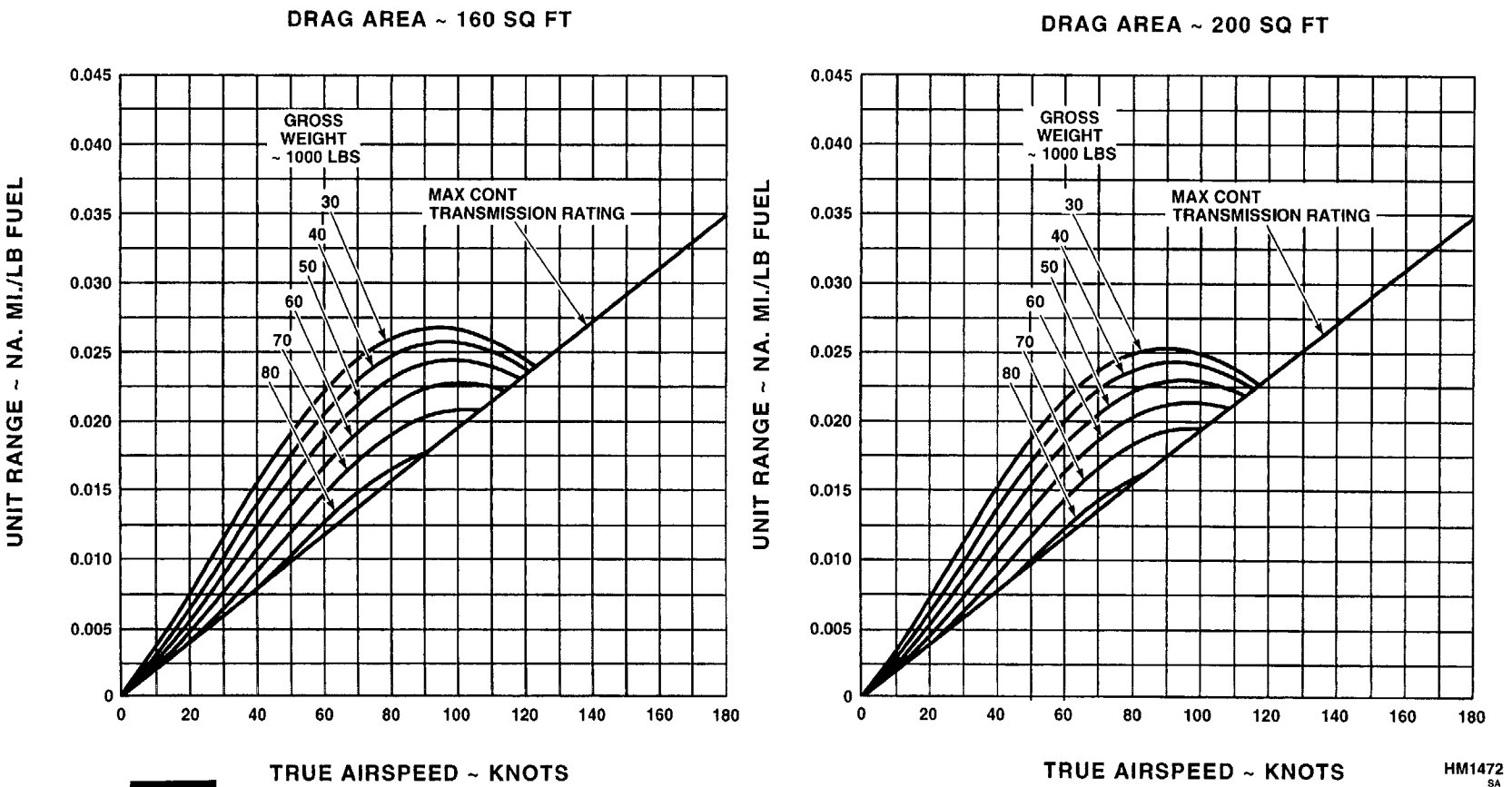


Figure 26-4. External Lift Capability 160- and 200-square-foot Drag Area, Sea Level, and 15°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES
4000 FEET STANDARD TEMPERATURE (7.1 °C)
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

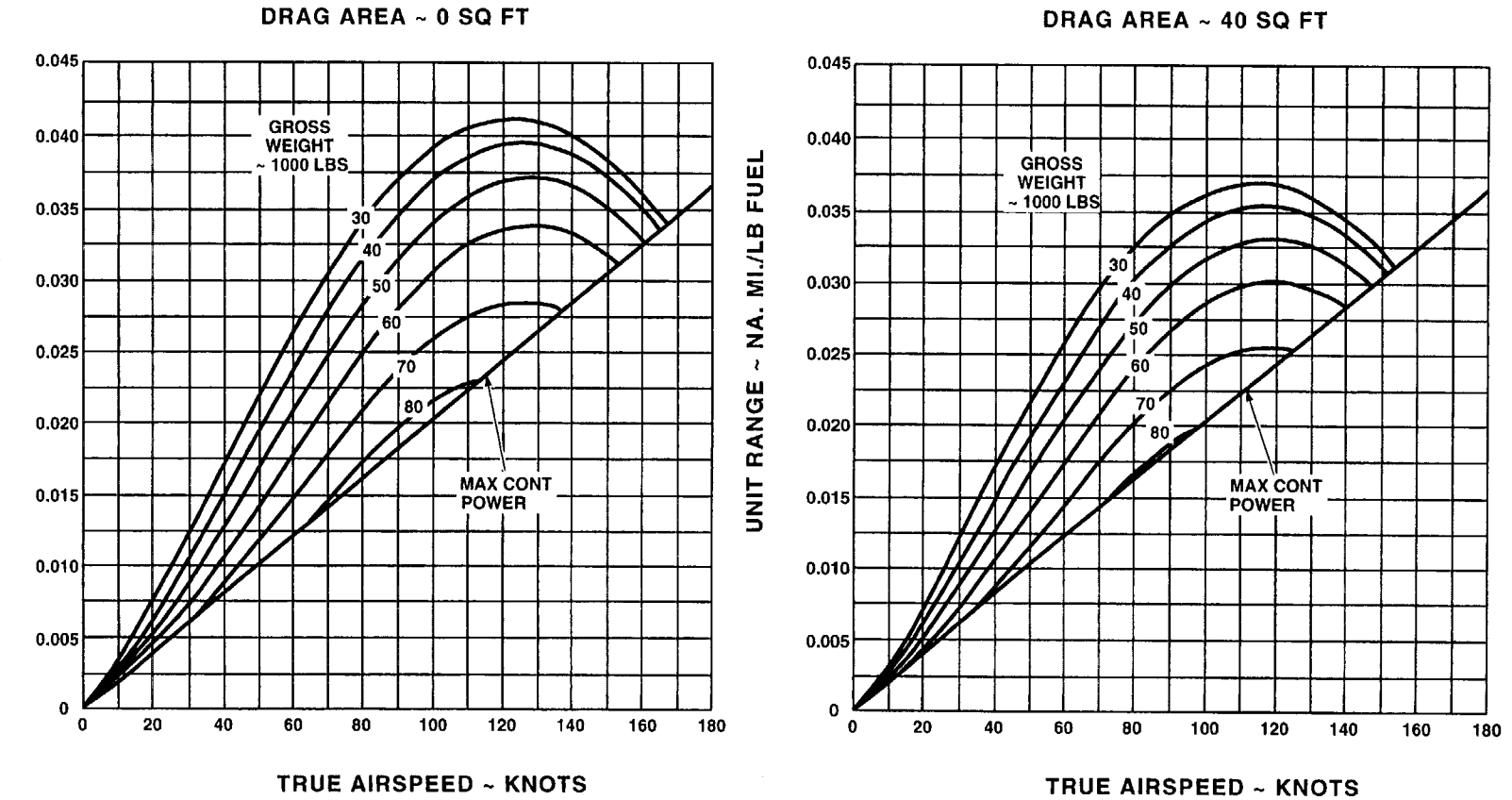


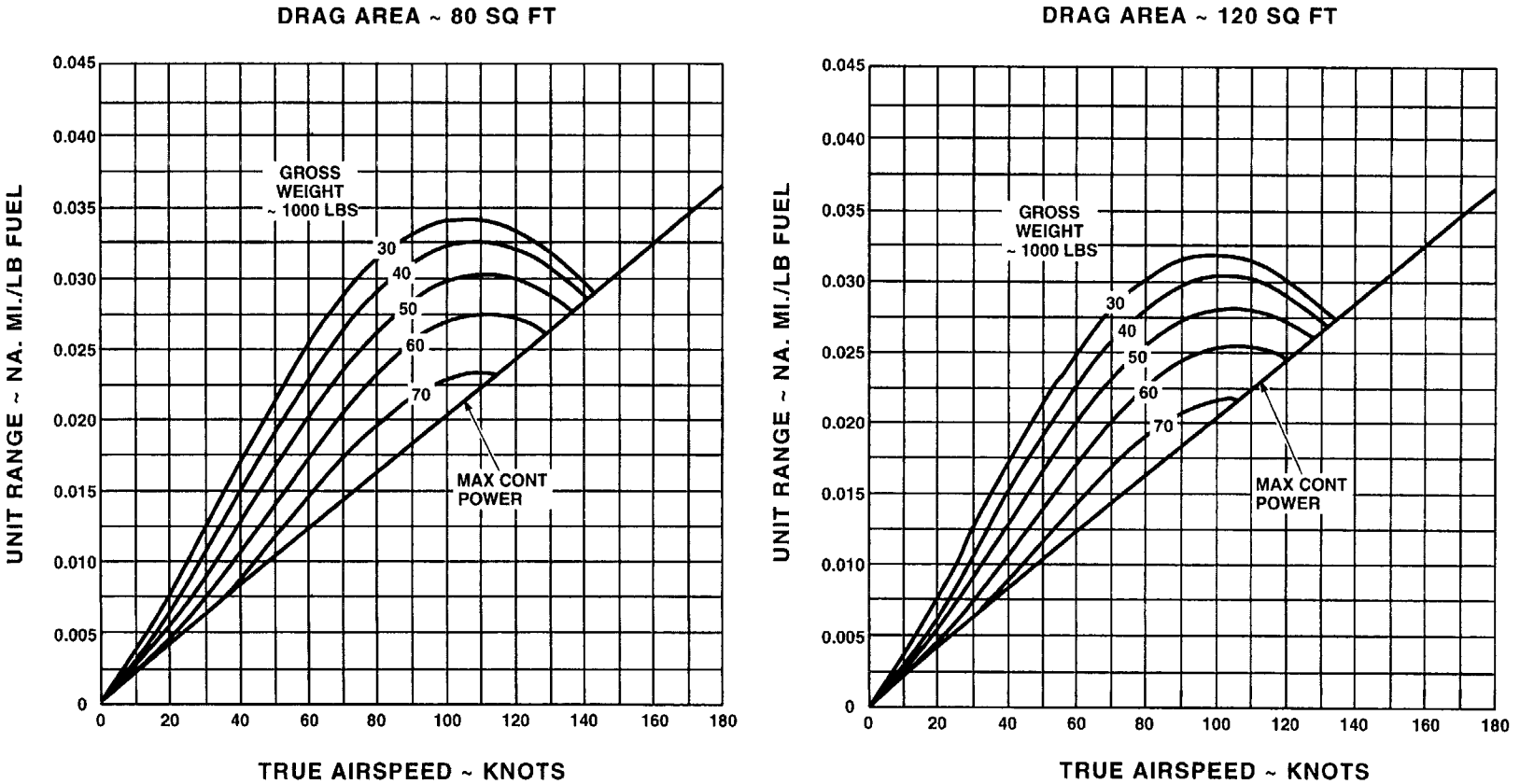
Figure 26-5. External Lift Capability 0- and 40-square-foot Drag Area, 4000 Feet, and 7°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES

4000 FEET STANDARD TEMPERATURE (7.1 °C)
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



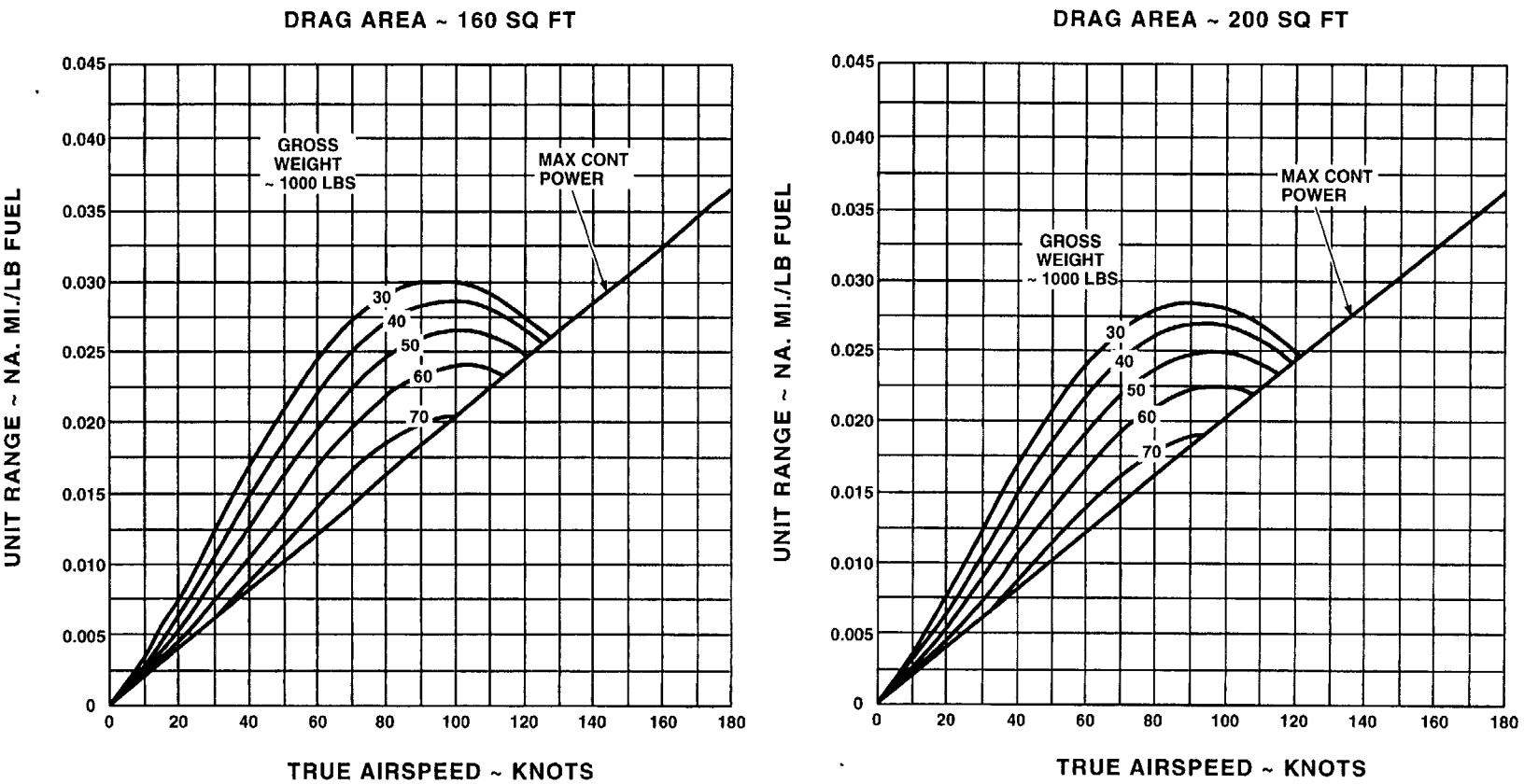
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Figure 26-6. External Lift Capability 80- and 120-square-foot Drag Area, 4000 Feet, and 7°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES
4000 FEET STANDARD TEMPERATURE (7.1 °C)
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



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Figure 26-7. External Lift Capability 160- and 200-square-foot Drag Area, 4000 Feet, and 7°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES
SEA LEVEL TEMPERATURE 35 °C
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL

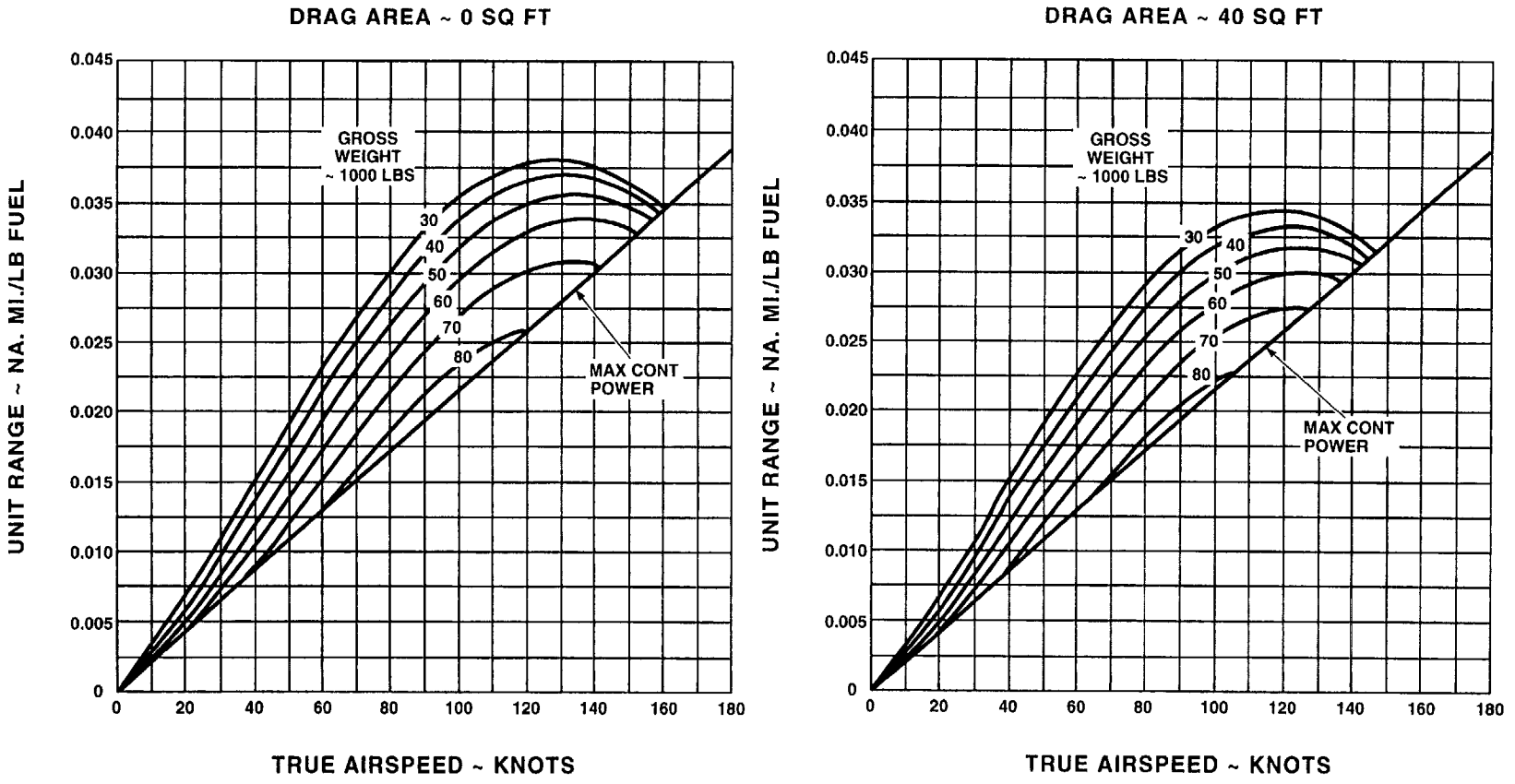


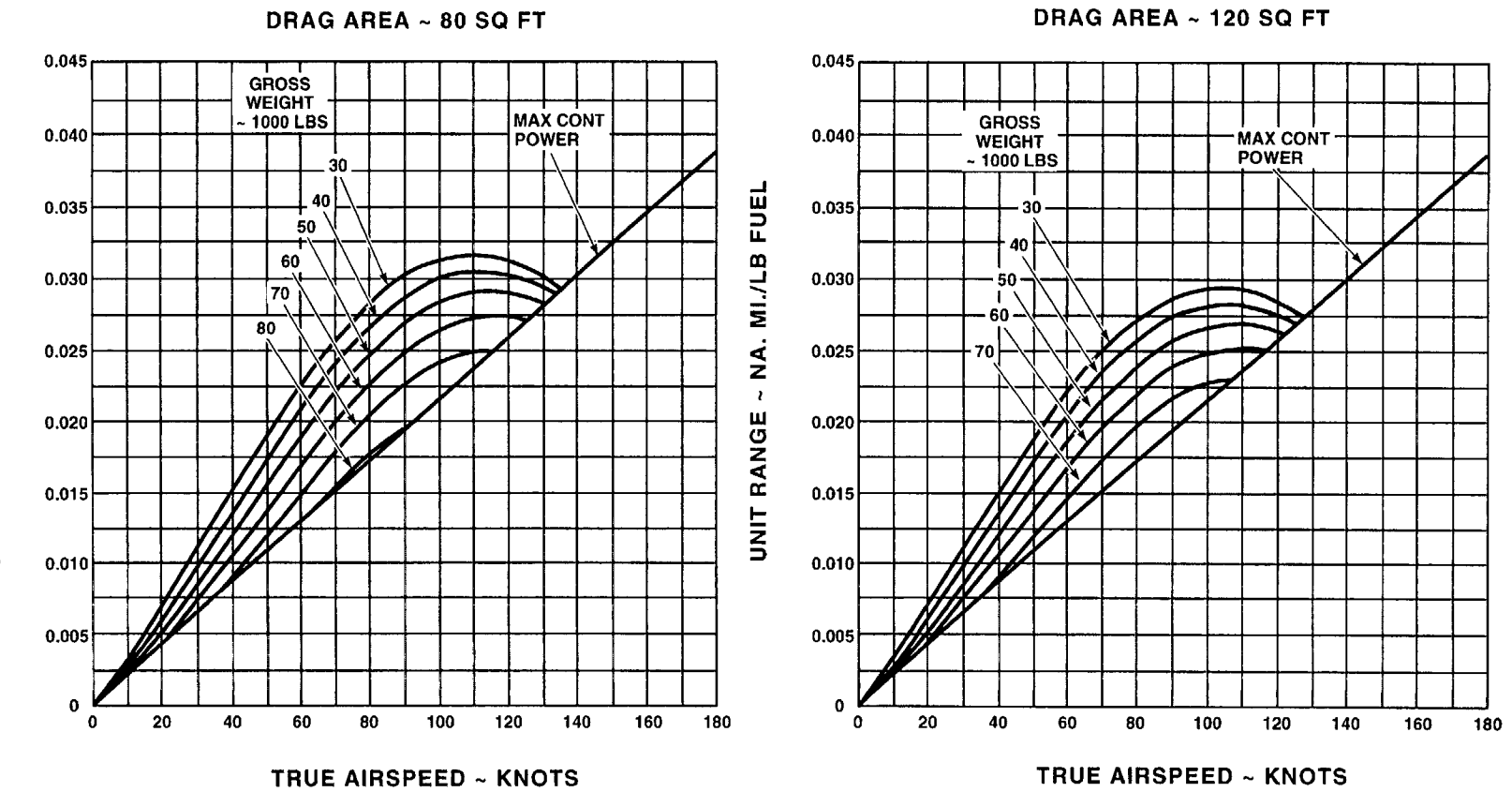
Figure 26-8. External Lift Capability 0- and 40-square-foot Drag Area, Sea Level, and 35°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES

SEA LEVEL TEMPERATURE 35 °C
103% Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



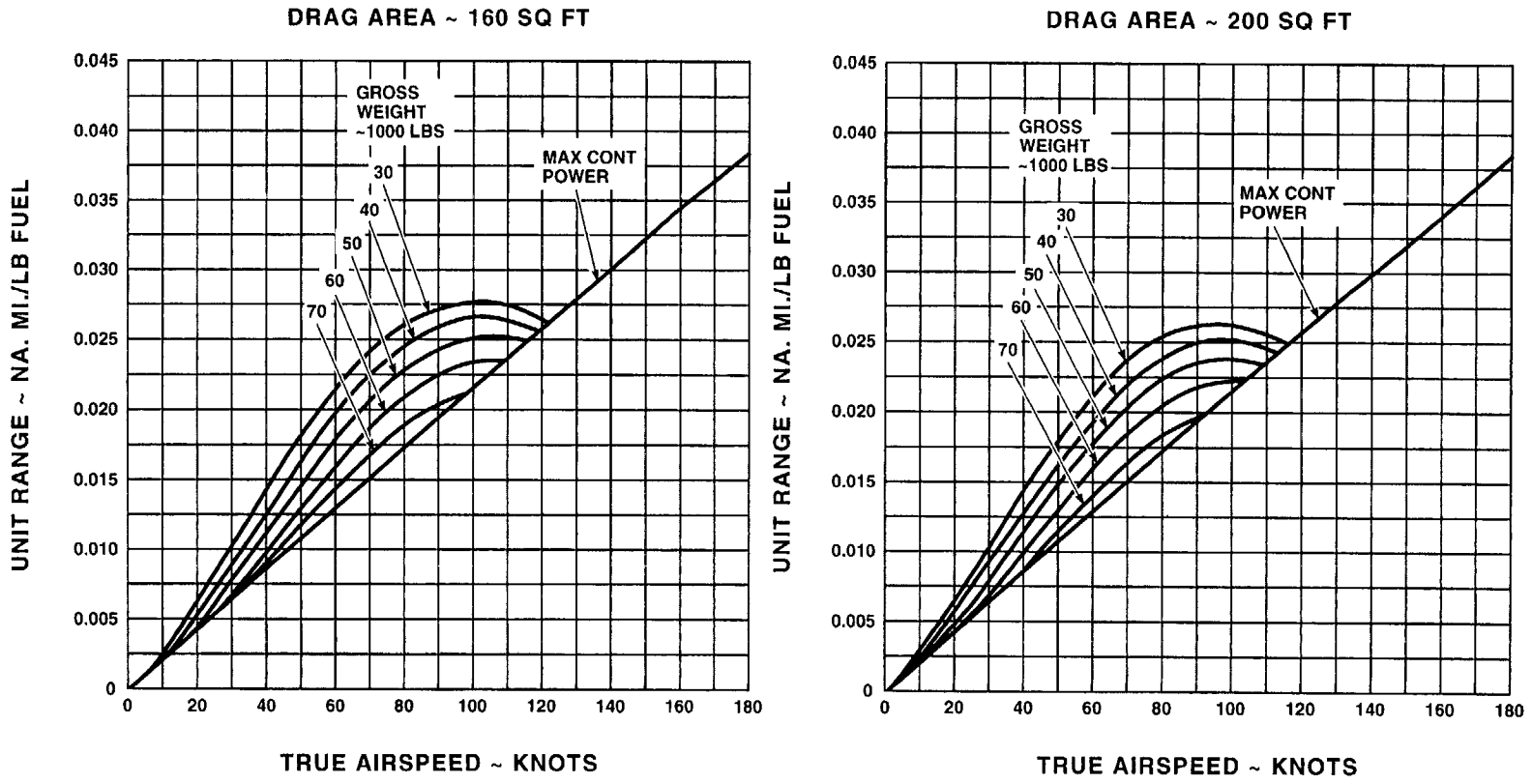
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Figure 26-9. External Lift Capability 80- and 120-square-foot Drag Area, Sea Level, and 35°C (416 Engine)

THREE-ENGINE FORWARD FLIGHT PERFORMANCE
EXTERNAL CAPABILITIES
SEA LEVEL TEMPERATURE (35 °C)
103%Nr

MODEL: MH-53E
DATA AS OF: 1 OCTOBER 1986
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS INSTALLED / EAPS DOORS OPEN

ENGINE: T64-GE-416
FUEL GRADE: JP-4 / JP-5 / JP-8
FUEL DENSITY: 6.5 / 6.8 / 6.7 LB / GAL



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Figure 26-10. External Lift Capability 160- and 200-square-foot Drag Area, Sea Level, and 35°C (416 Engine)

THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

SEA LEVEL STANDARD TEMPERATURE (15°C) 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

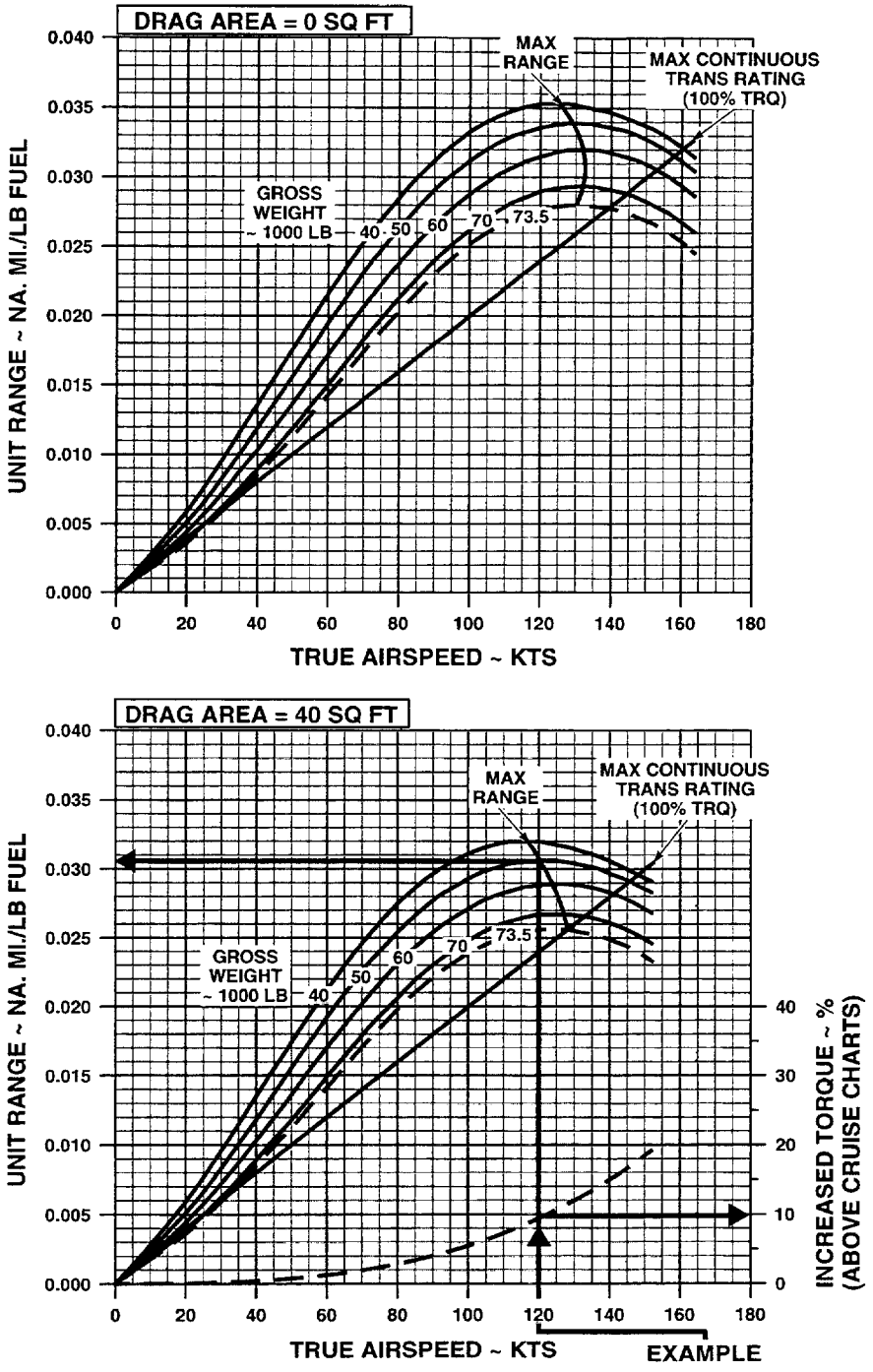


Figure 26-11. External Lift Capability 0- and 40-square-foot Drag Area, Sea Level, and 15°C (419 Engine)

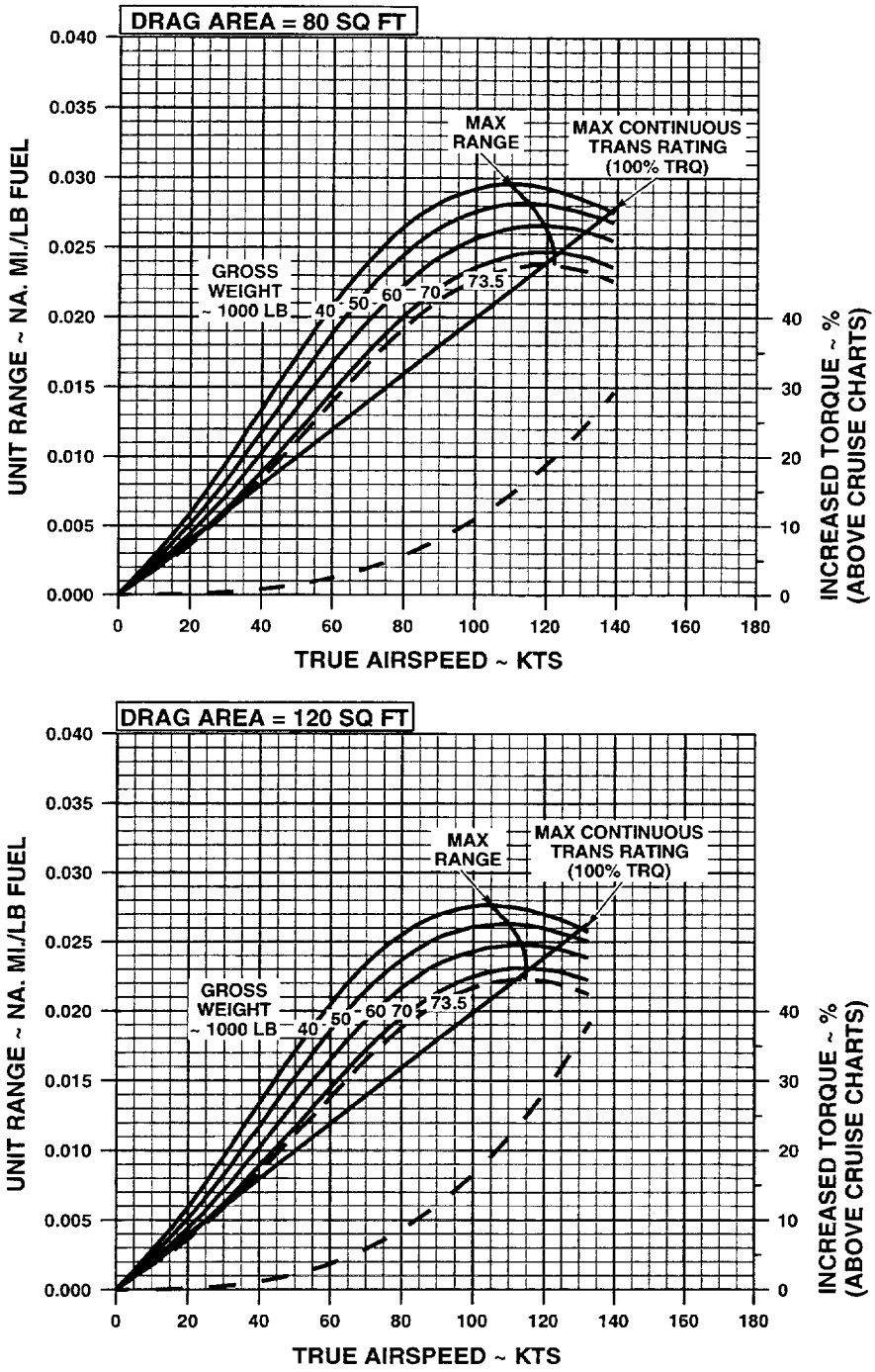
THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

SEA LEVEL STANDARD TEMPERATURE (15°C) 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 26-12. External Lift Capability 80- and 120-square-foot Drag Area, Sea Level, and 15°C (419 Engine)

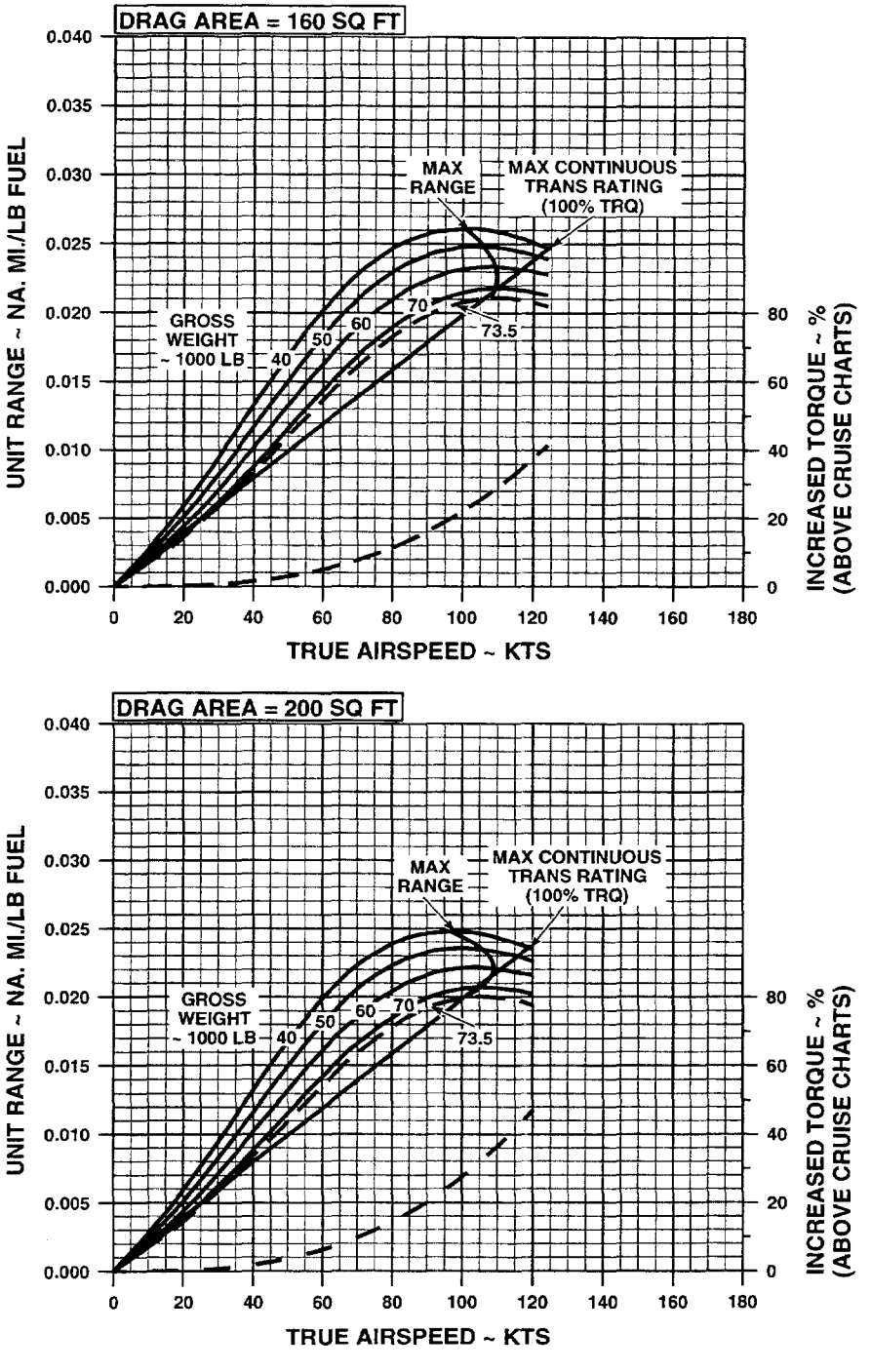
THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

SEA LEVEL STANDARD TEMPERATURE (15°C) 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 26-13. External Lift Capability 160- and 200-square-foot Drag Area, Sea Level, and 15°C (419 Engine)

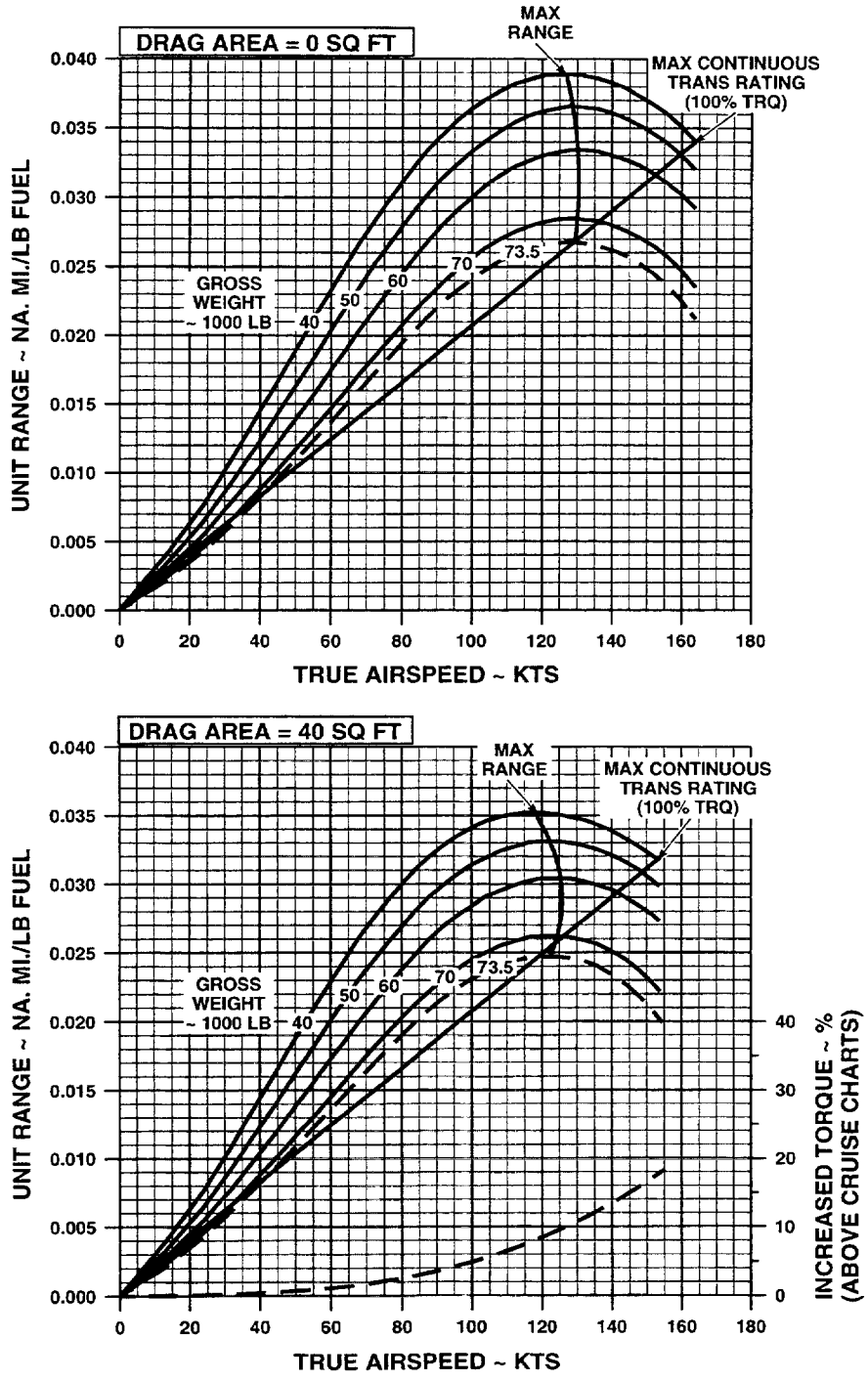
THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

4000 FT STANDARD TEMPERATURE (7.1°C) 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 26-14. External Lift Capability 0- and 40-square-foot Drag Area, 4000 Feet, and 7°C (419 Engine)

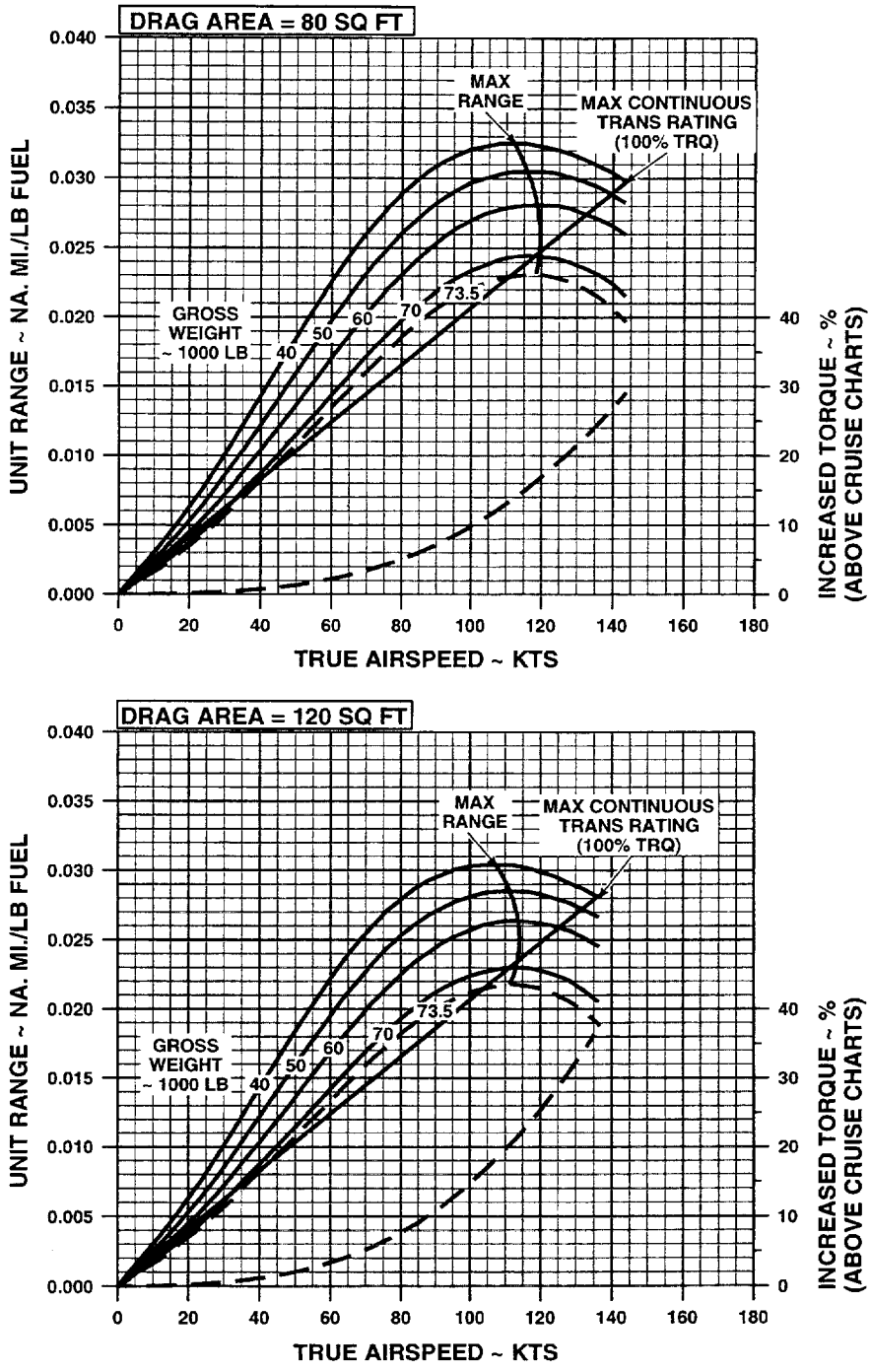
THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

4000 FT STANDARD TEMPERATURE (7.1°C) 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 26-15. External Lift Capability 80- and 120-square-foot Drag Area, 4000 Feet, and 7°C (419 Engine)

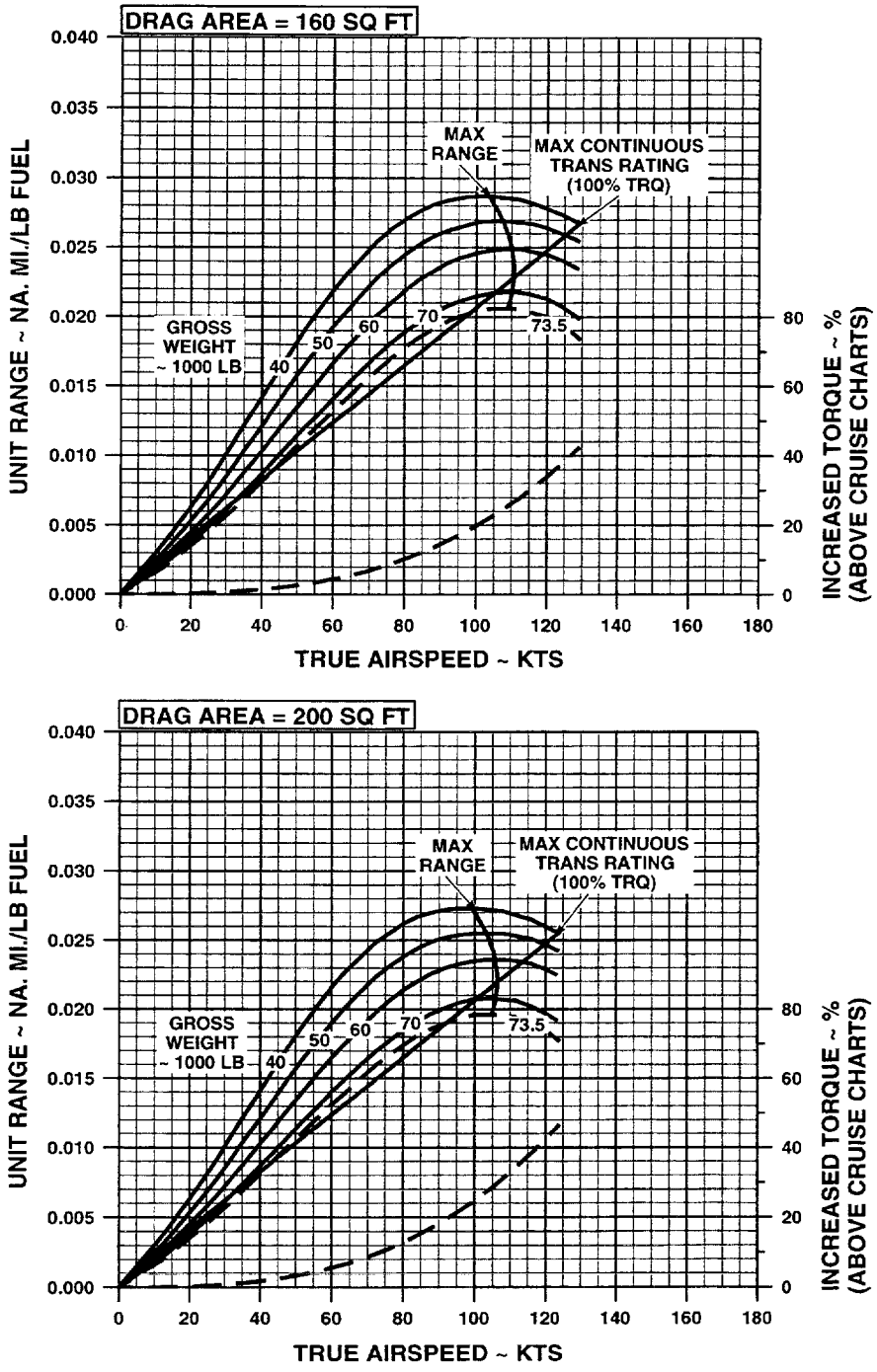
THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

4000 FT STANDARD TEMPERATURE (7.1°C) 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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SAF

Figure 26-16. External Lift Capability 160- and 200-square-foot Drag Area, 4000 Feet, and 7°C (419 Engine)

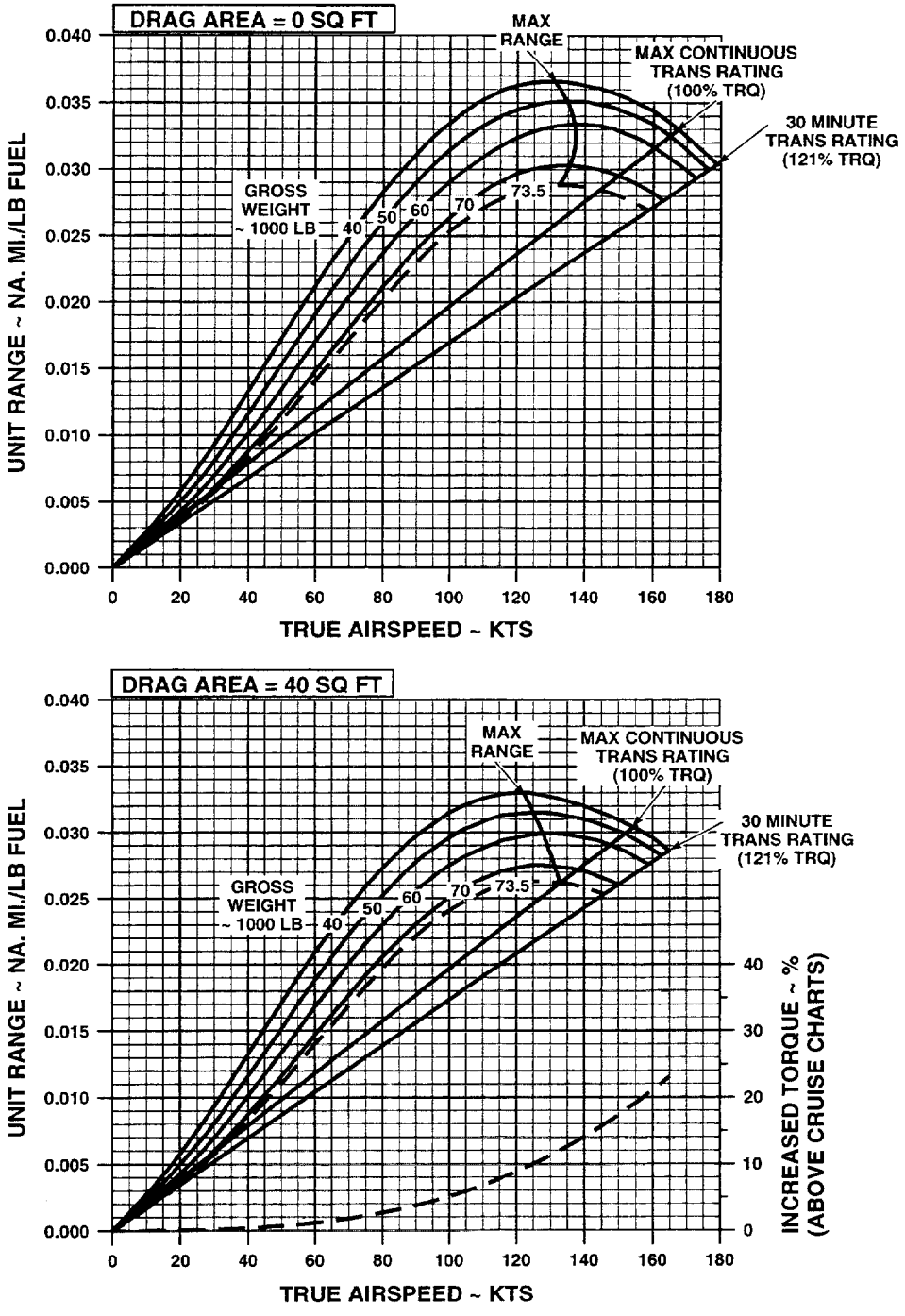
THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

SEA LEVEL TEMPERATURE 35°C 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 26-17. External Lift Capability 0- and 40-square-foot Drag Area, Sea Level, and 35°C (419 Engine)

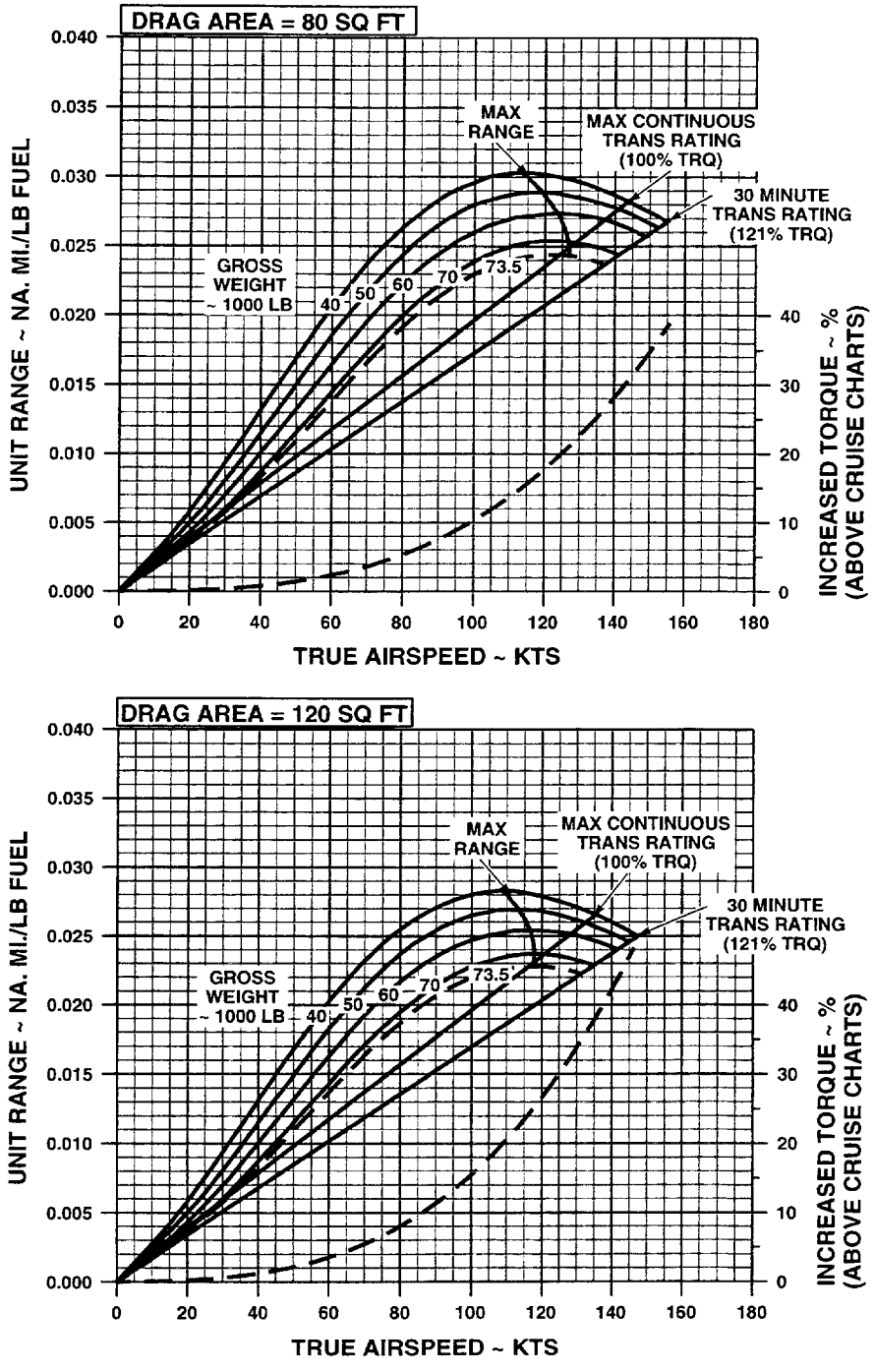
THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

SEA LEVEL TEMPERATURE 35°C 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 26-18. External Lift Capability 80- and 120-square-foot Drag Area, Sea Level, and 35°C (419 Engine)

THREE ENGINE FORWARD FLIGHT PERFORMANCE

EXTERNAL LOAD CAPABILITY FOR VARIOUS DRAG AREAS

SEA LEVEL TEMPERATURE 35°C 103% Nr

MODEL: MH-53E
DATA AS OF: MARCH 1996
DATA BASIS: FLIGHT TEST
CONFIGURATION: EAPS DOORS OPEN

ENGINE: T64-GE-419
FUEL GRADE: JP-4/JP-5/JP-8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

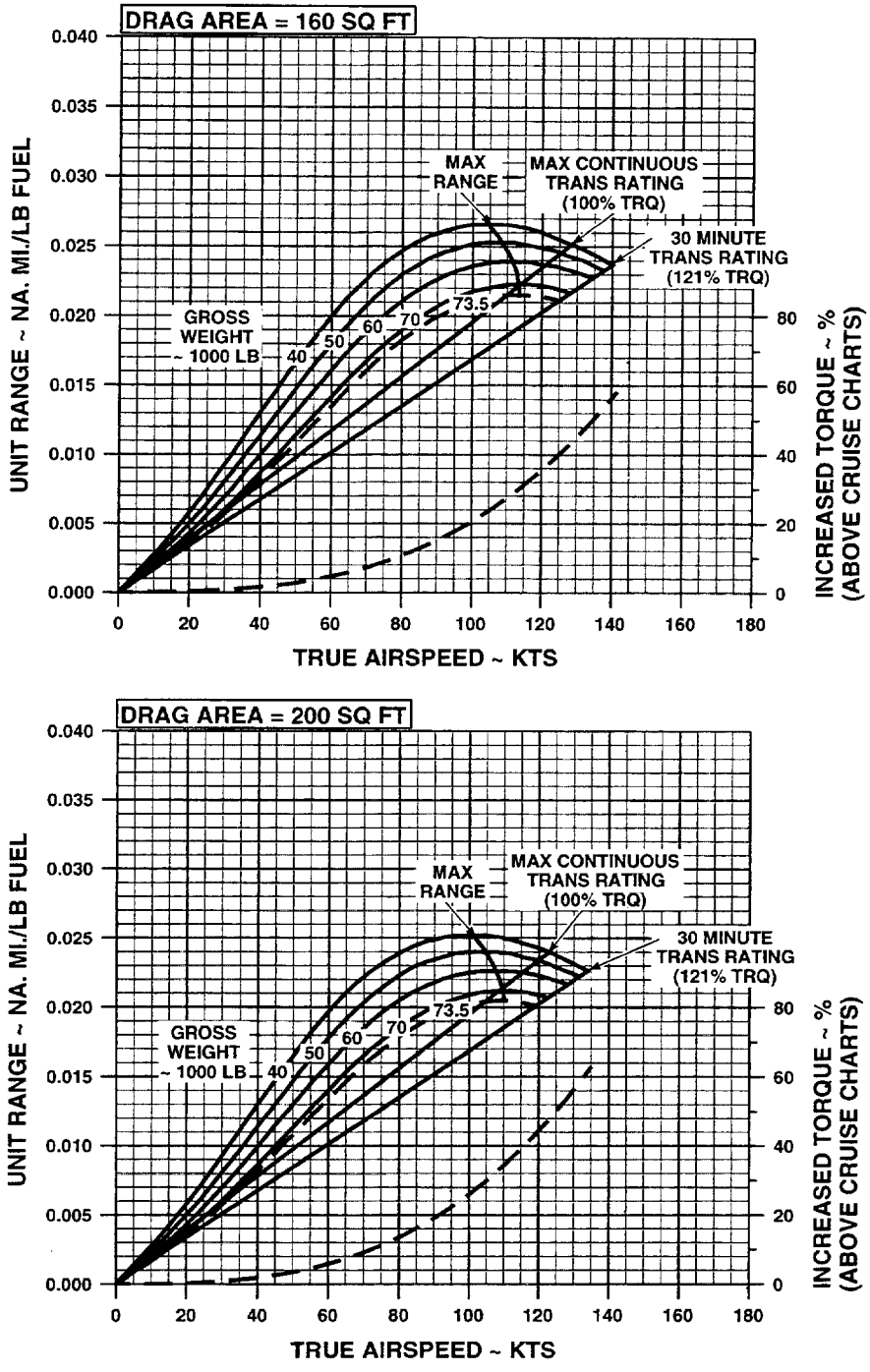
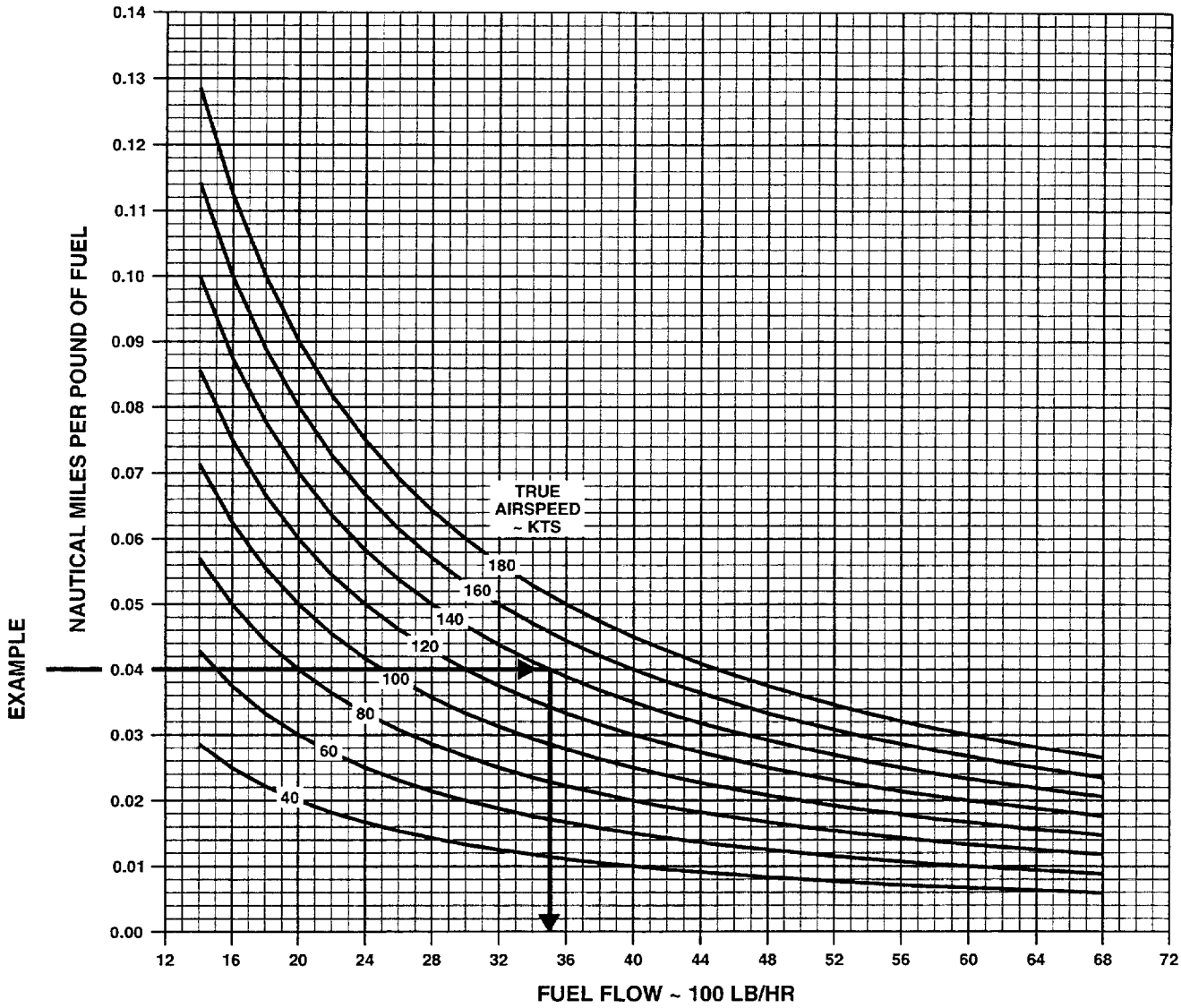


Figure 26-19. External Lift Capability 160- and 200-square-foot Drag Area, Sea Level, and 35°C (419 Engine)

NAUTICAL MILES PER POUND OF FUEL CONVERSION CHART

ZERO WIND



HM6170
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Figure 26-20. Nautical Miles per Pound of Fuel

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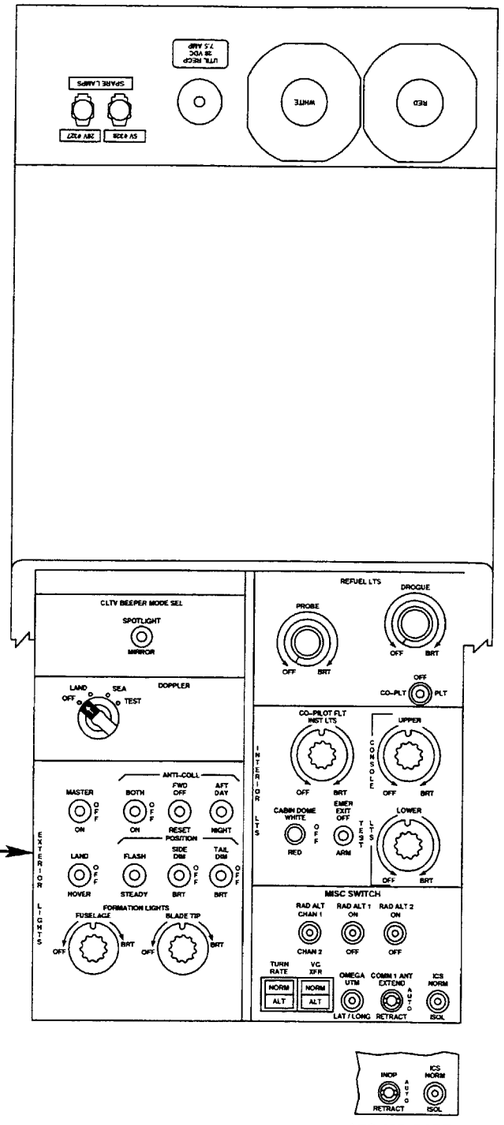
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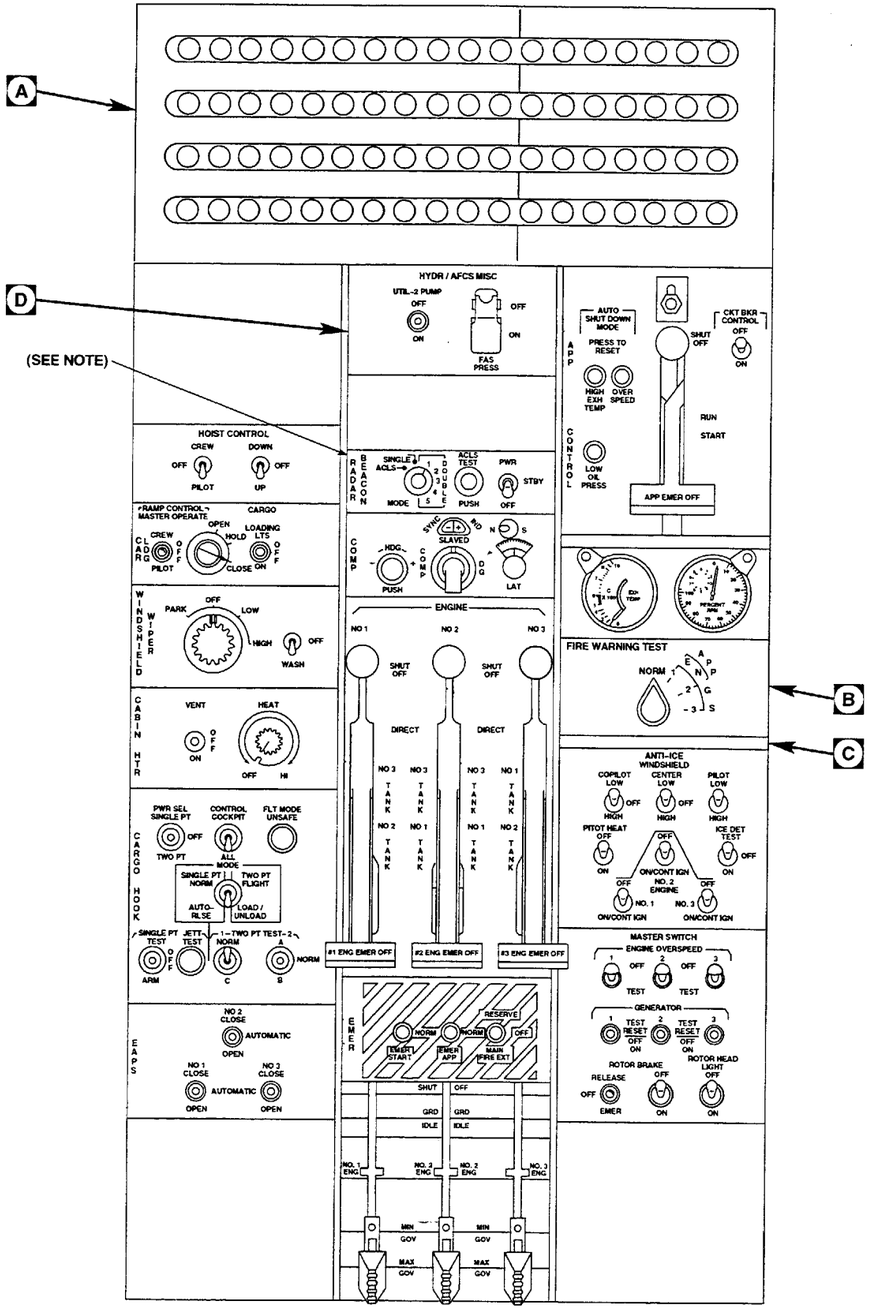
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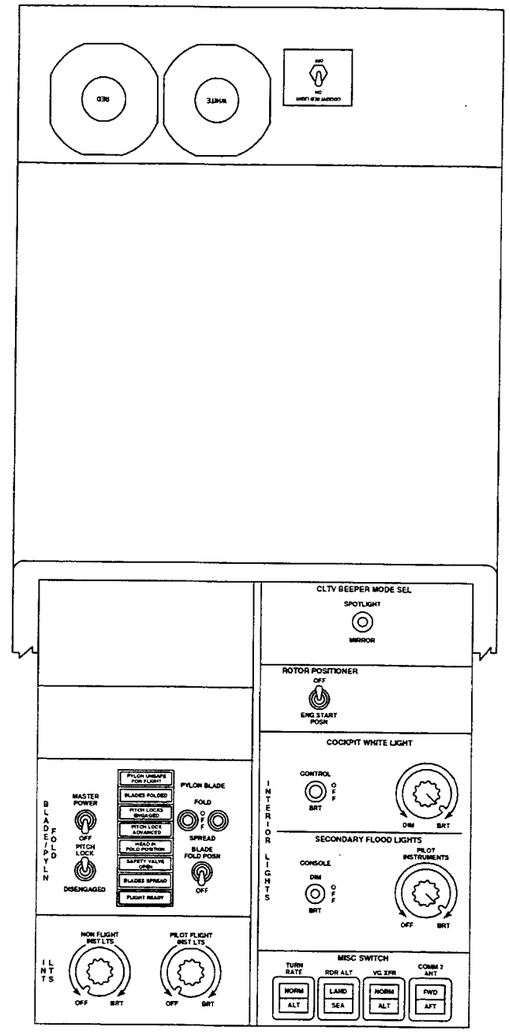
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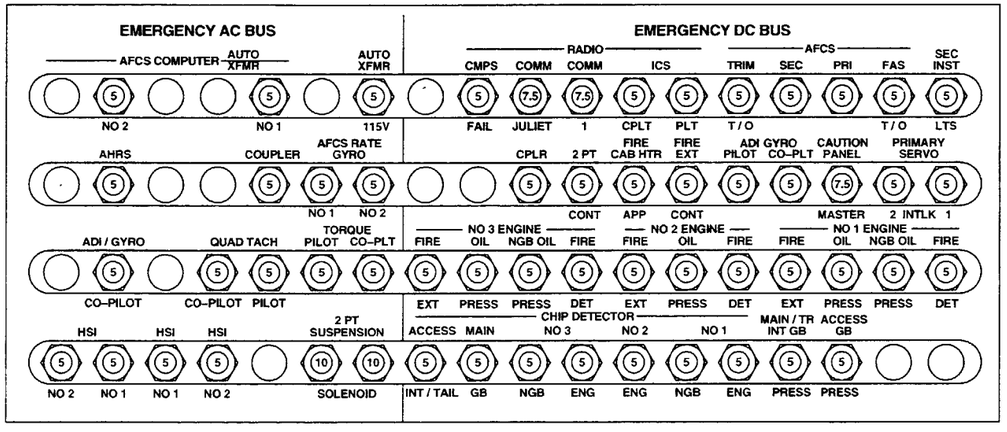


Overhead Control Panel/Circuit Breaker Panels (Sheet 1 of 2)

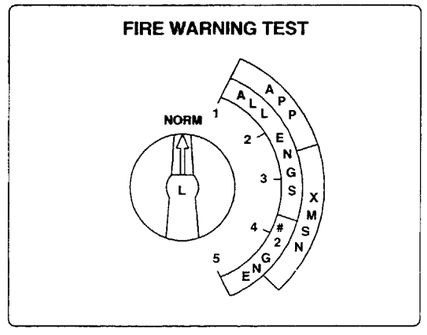


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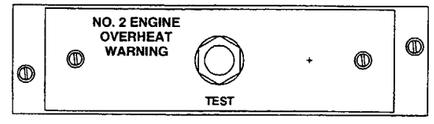


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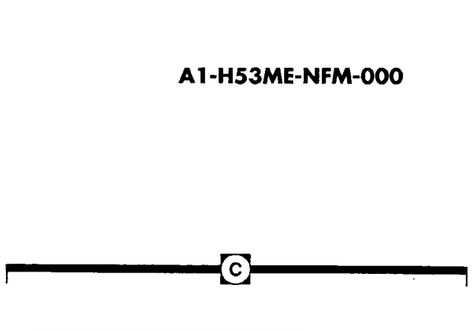
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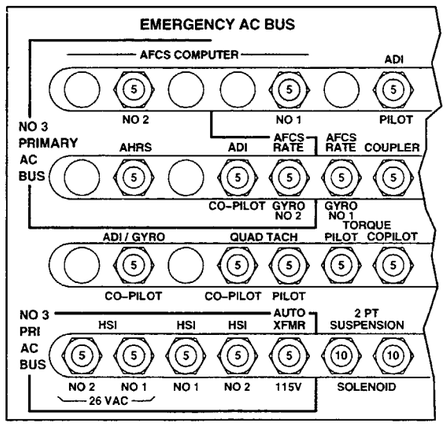


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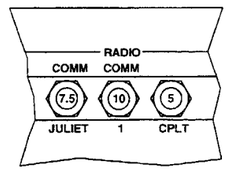
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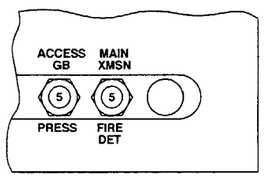
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(REPLACES HYDR / AFCS MISC PANEL ON TOP OF CENTER COLUMN. HYDR / AFCS MISC PANEL IS RELOCATED TO LOWER LEFT COLUMN.)



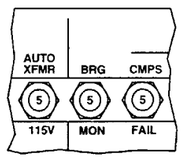
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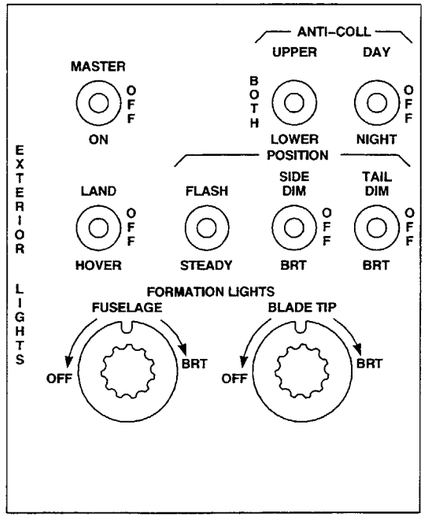
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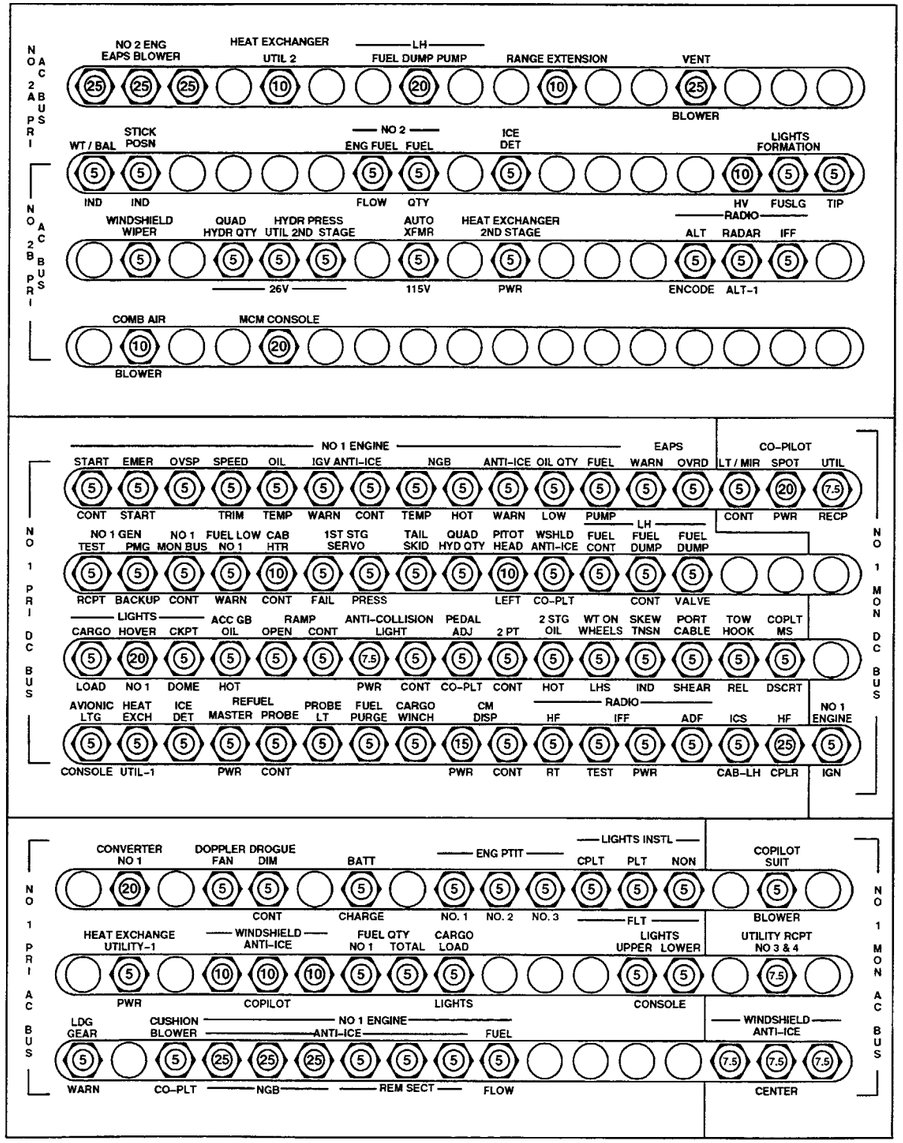
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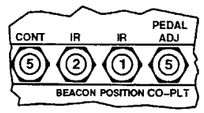


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Overhead Control Panel/Circuit Breaker Panels (Sheet 2 of 2)



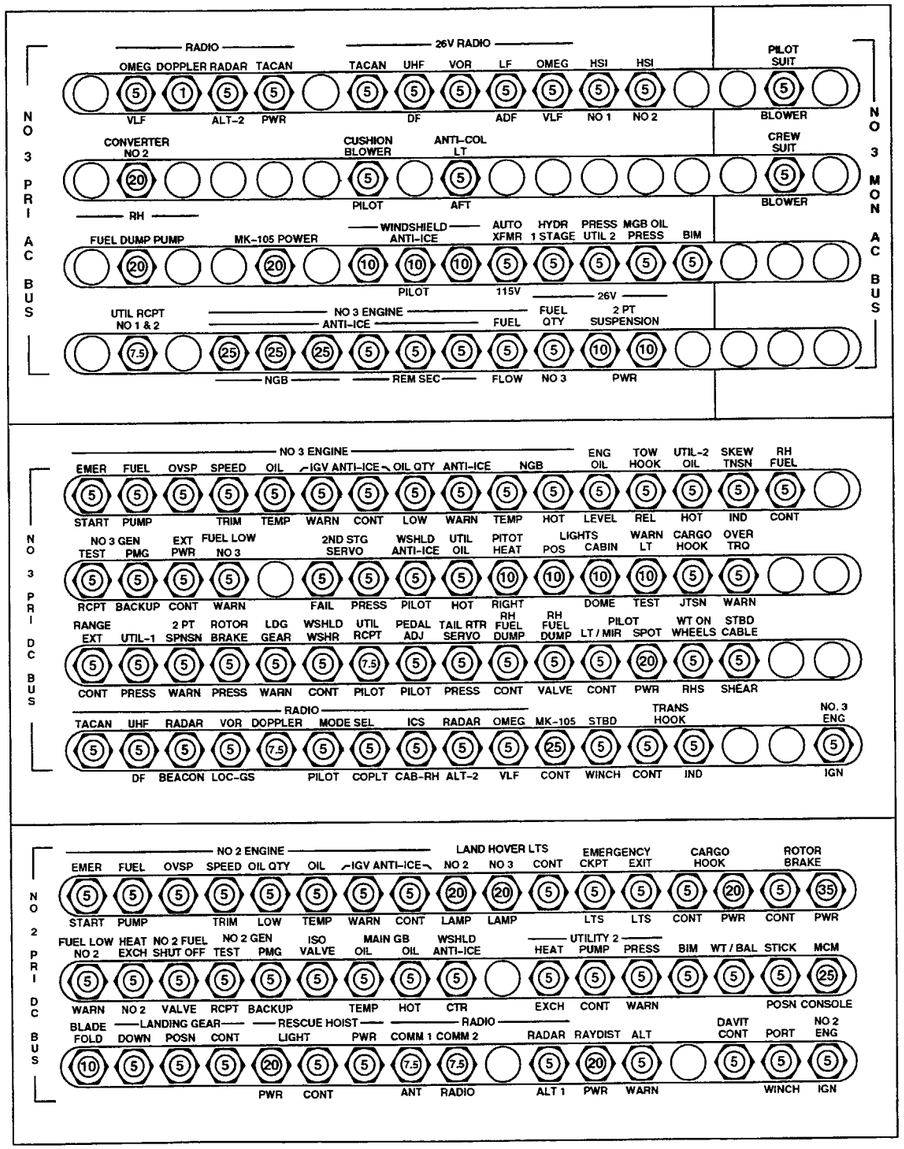


AFC 479

LEFT SIDE CABIN

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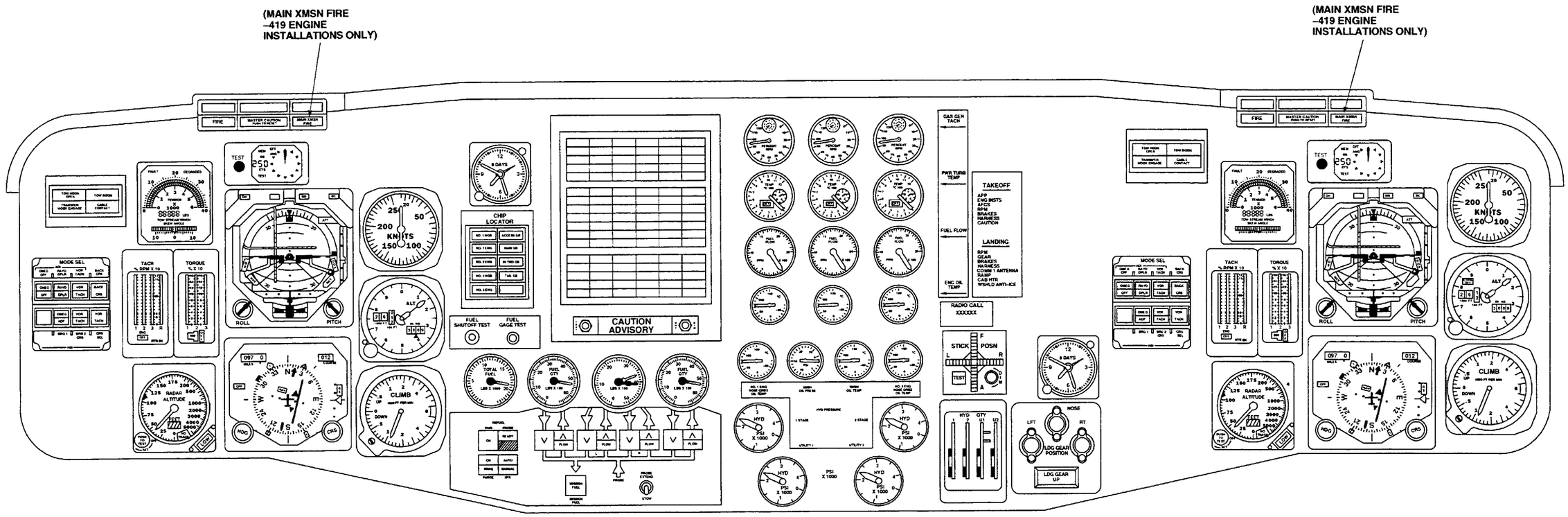
Cabin Circuit Breaker Panels (Sheet 1 of 2)



RIGHT SIDE CABIN

HM9052_2A
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Cabin Circuit Breaker Panels (Sheet 2 of 2)



INSTRUMENT PANEL

HM1480A
SA

Instrument Panel

BIM	ICE DETECTED	COMPASS FAIL	ROTOR LOCKED	ROTOR BRAKE PRESS	CHIP DETECTED
AFCS	#1 RECT	#2 RECT	#1 GEN	#2 GEN	#3 GEN
IGB OIL PRESS	———	#2 STG OIL HOT	#1 ENG FLTR BYPASS	#2 ENG FLTR BYPASS	#3 ENG FLTR BYPASS
TGB OIL PRESS	BLADE PYLON FOLD	UTILITY 1 OIL HOT	#1 ENG FUEL BOOST	#2 ENG FUEL BOOST	#3 ENG FUEL BOOST
1 STG M / R SERVO BYPAS	2 STG M / R SERVO BYPAS	UTILITY T / R PRESS	#1 ENG OIL PRESS LOW	#2 ENG OIL PRESS LOW	#3 ENG OIL PRESS LOW
1 STG T / R SERVO BYPAS	UTILITY 2 PRESS	2 STG T / R SERVO BYPAS	#1 NGB OIL PRESS	MGB OIL PRESS	#3 NGB OIL PRESS
1 STG PRESS M / R T / R	2 STG PRESS M / R	UTILITY 1 PRESS	#1 NGB OIL HOT	MGB OIL HOT	#3 NGB OIL HOT
1 STG QTY M / R T / R	2 STG QTY M / R	UTILITY 1 QTY T / R	#1 ENG OIL PRESS HIGH	#2 ENG OIL PRESS HIGH	#3 ENG OIL PRESS HIGH
C / G HOOK INOP	UTILITY 2 OIL QTY	ACC GB OIL PRESS	#1 ENG OIL QTY LOW	#2 ENG OIL QTY LOW	#3 ENG OIL QTY LOW
ALTITUDE	UTILITY 2 OIL HOT	ACC GB OIL HOT	#1 ENG ANTI ICE	TAIL ROTOR HIGH STRESS	#3 ENG ANTI ICE
TNSN / SKEW ANGLE	DOPPLER	GPWS INOP	GPWS TAC INHB	MGB AUX LUBE PUMP	ENGINE OVERTORQUE
EAPS HIGH PRESS LOSS	IFF	2 PT FLT UNARMED	#1 FUEL LOW	#2 FUEL LOW	#3 FUEL LOW
ENG STARTER ON	EXT PWR CONNECTED	RAMP OPEN	#1 IGV ANTI ICE ON	#2 IGV ANTI ICE ON	#3 IGV ANTI ICE ON
APP ON	ISOLATION VALVE OPEN	PARKING BRAKE ON	EAPS DOOR CLOSED	ROTOR BRAKE ON	ENG START HEAD POS
AUTO RELEASE ON	FWD HOOK OPEN	UTILITY 2 PUMP ON	———	PURGING	AFCS DEGRADED
SINGLE PT HOOK OPEN	AFT HOOK OPEN	———	———	COMM 1 ANT EXTENDED	———
RAD ALT 1 UNREL	———	———	———	———	RAD ALT 2 UNREL

TEST

CAUTION ADVISORY

BRT DIM

Caution/Advisory Panel

BIM	ICE DETECTED
AFCS	#1 RECT
IGB OIL PRESS	#2 ENGINE OVERHEAT

AFC 483

#2 ENG OIL QTY LOW	#3 ENG OIL QTY LOW
———	#3 ENG ANTI ICE
MGB AUX LUBE PUMP	ENGINE OVERTORQUE

AFC 440

EAPS DOOR CLOSED
———
GPWS ALERT
GPWS INOP

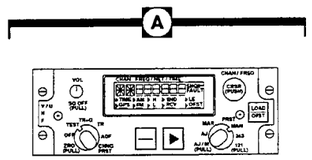
AFC 501 PT 3

DOPPLER	UTILITY 2 OIL QTY	ACC GB OIL PRESS	#1 ENG OIL QTY LOW
ALTITUDE	UTILITY 2 OIL HOT	ACC GB OIL HOT	#1 ENG ANTI ICE
TNSN / SKEW ANGLE	BEARING VIB LIMIT	BEARING TEMP DETECT	BEARING TEMP LIMIT

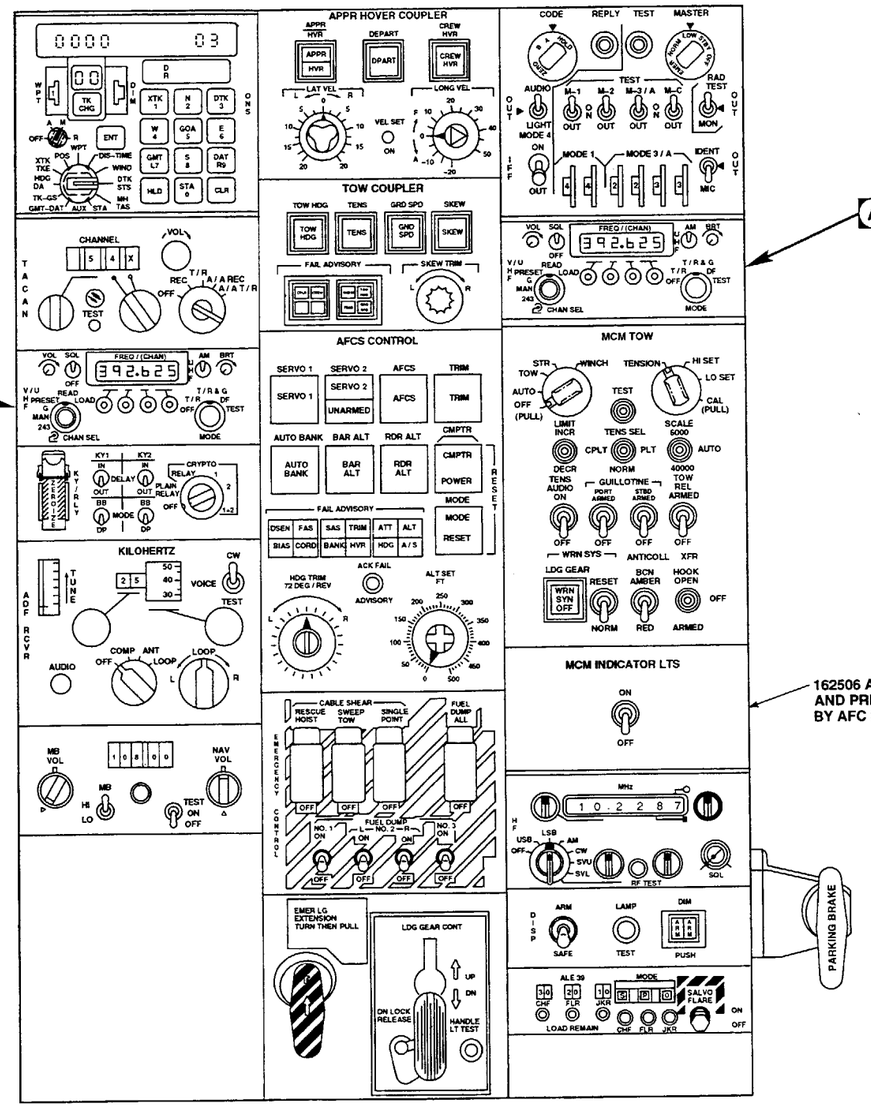
FWD HOOK OPEN	UTILITY 2 PUMP ON
AFT HOOK OPEN	GPWS INOP
C / G HOOK INOP	GPWS TAC INHB

AFC 491

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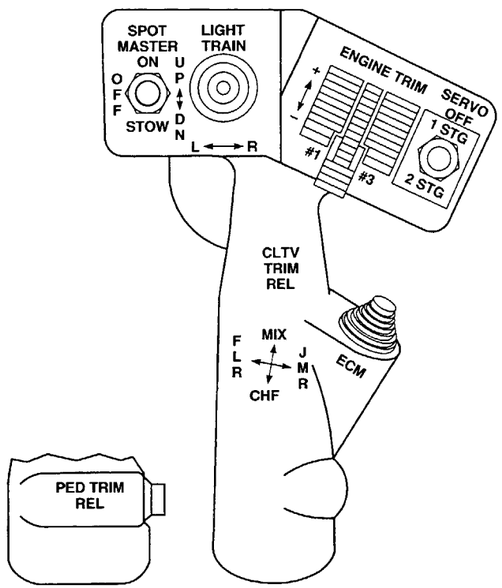


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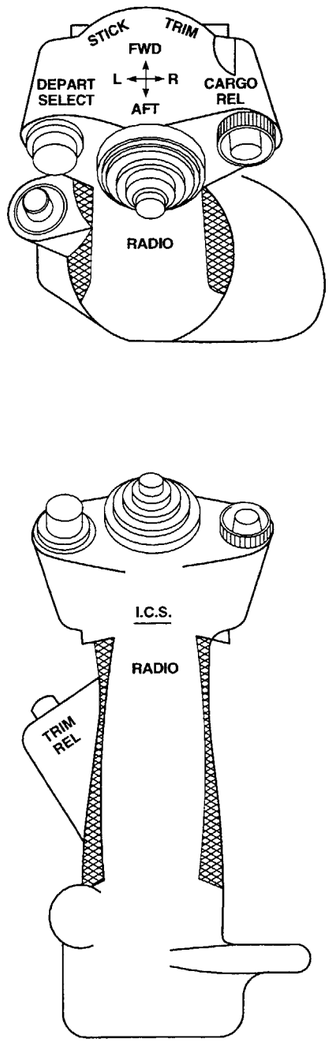


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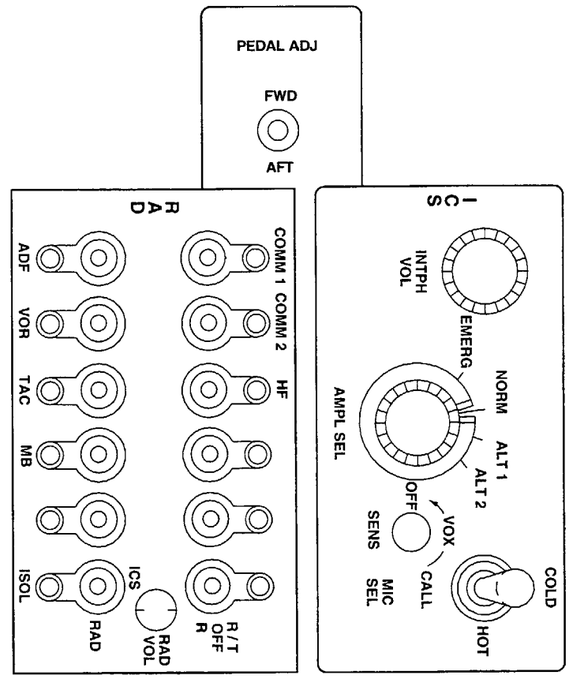
Console/Collective/Cyclic (Sheet 1 of 3)



PILOT'S COLLECTIVE GRIP



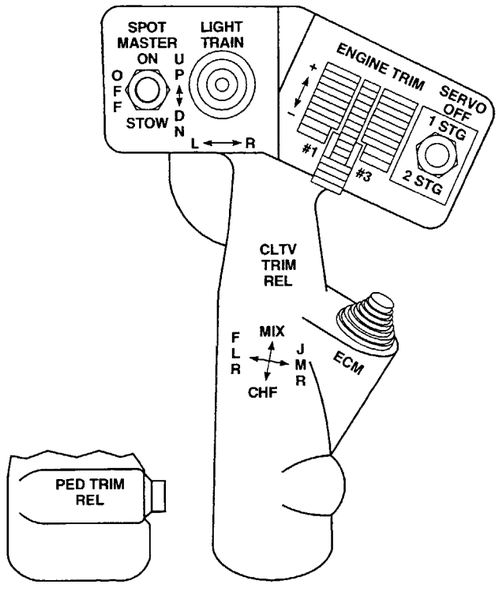
PILOT'S CYCLIC GRIP



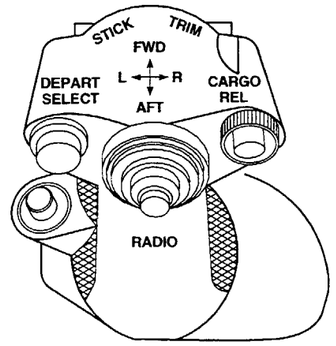
PILOT'S ICS STATION

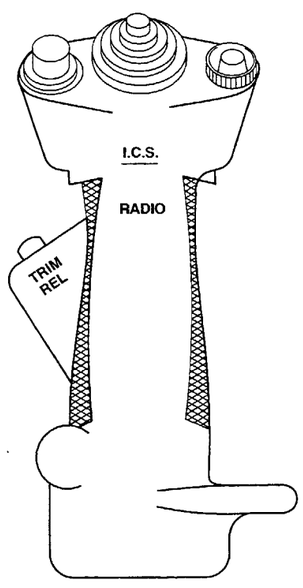
HM1488_2
SA

Console/Collective/Cyclic (Sheet 2 of 3)

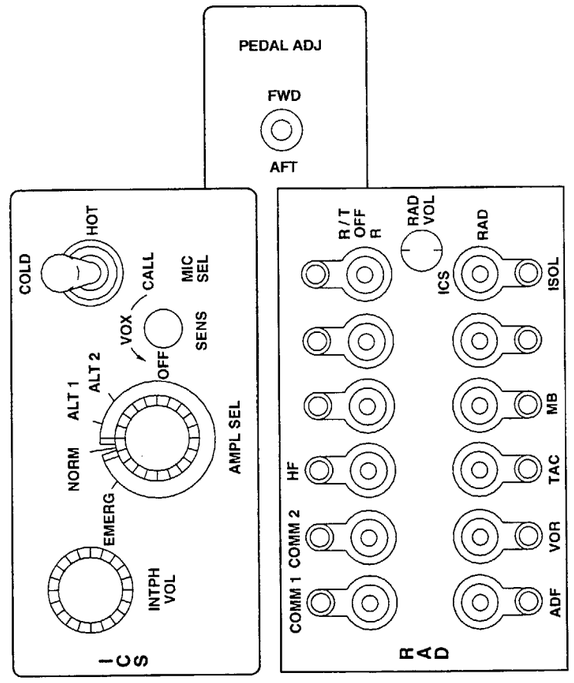


COPILOT'S COLLECTIVE GRIP





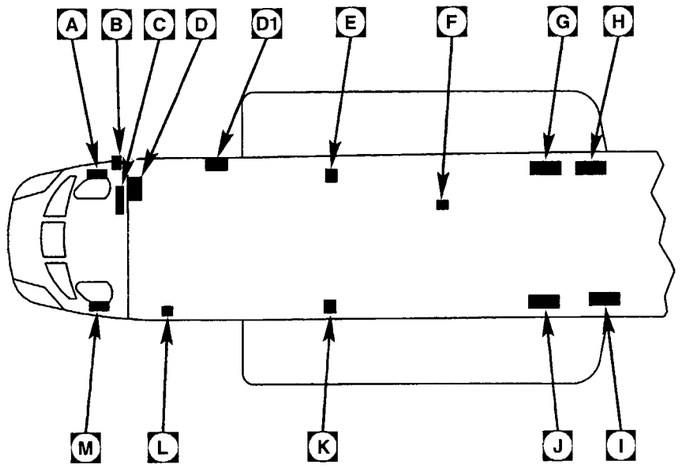
COPILOT'S CYCLIC GRIP

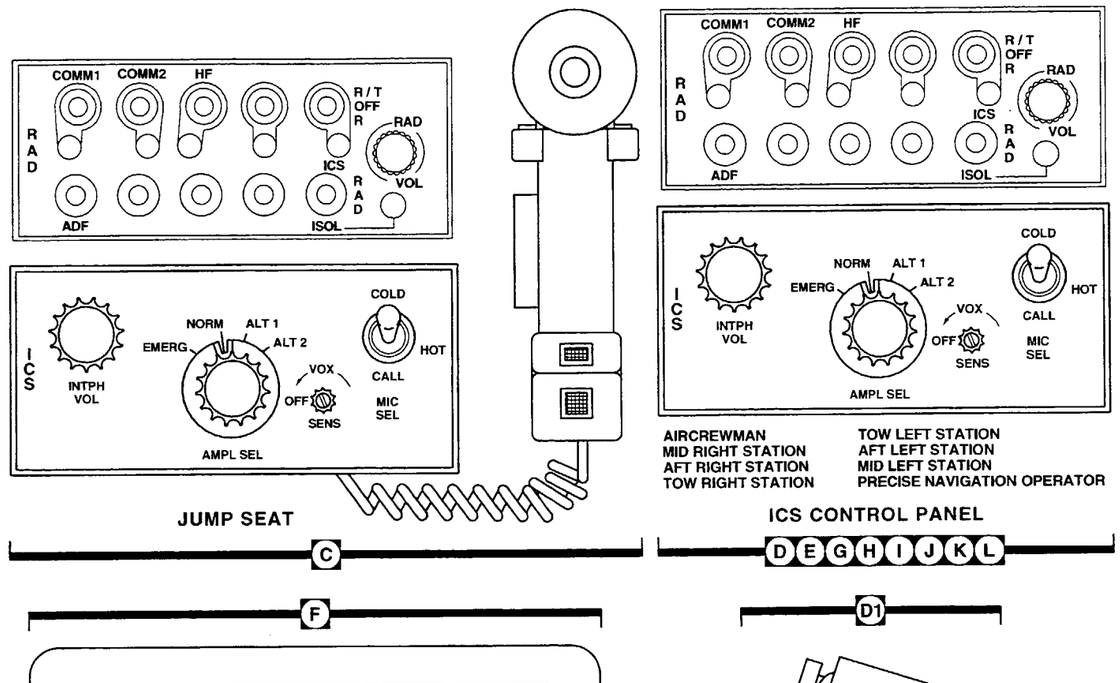


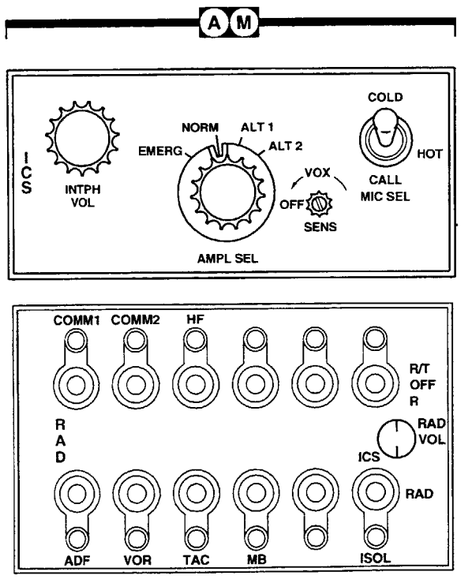
COPILOT'S ICS STATION

HM1488_1
SA

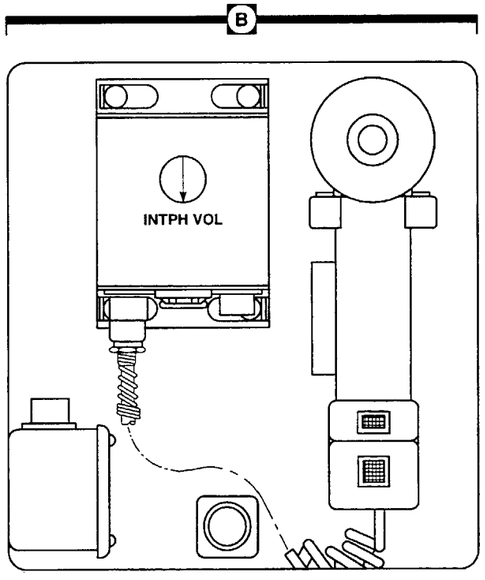
Console/Collective/Cyclic (Sheet 3 of 3)



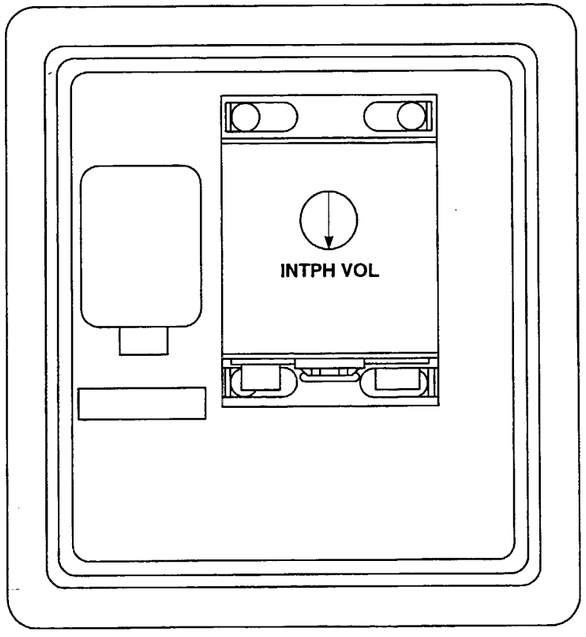




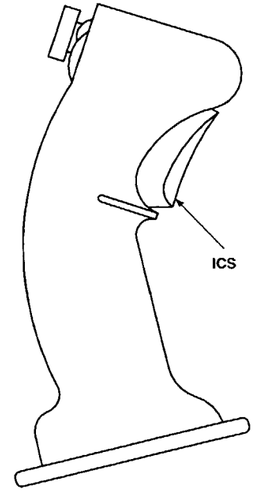
PILOT
COPILOT



EXTERNAL NOSE STATION



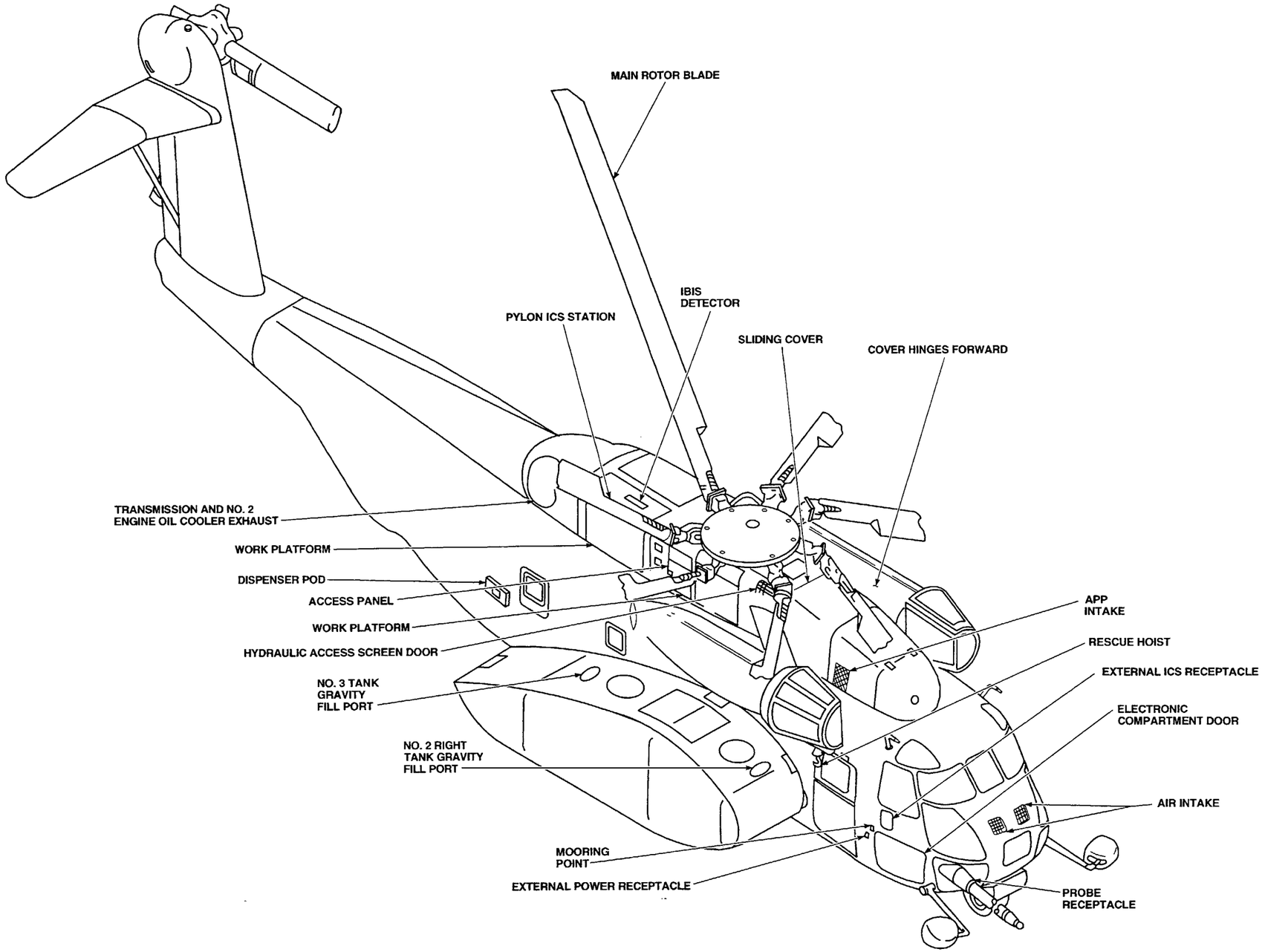
MAIN ROTOR PYLON



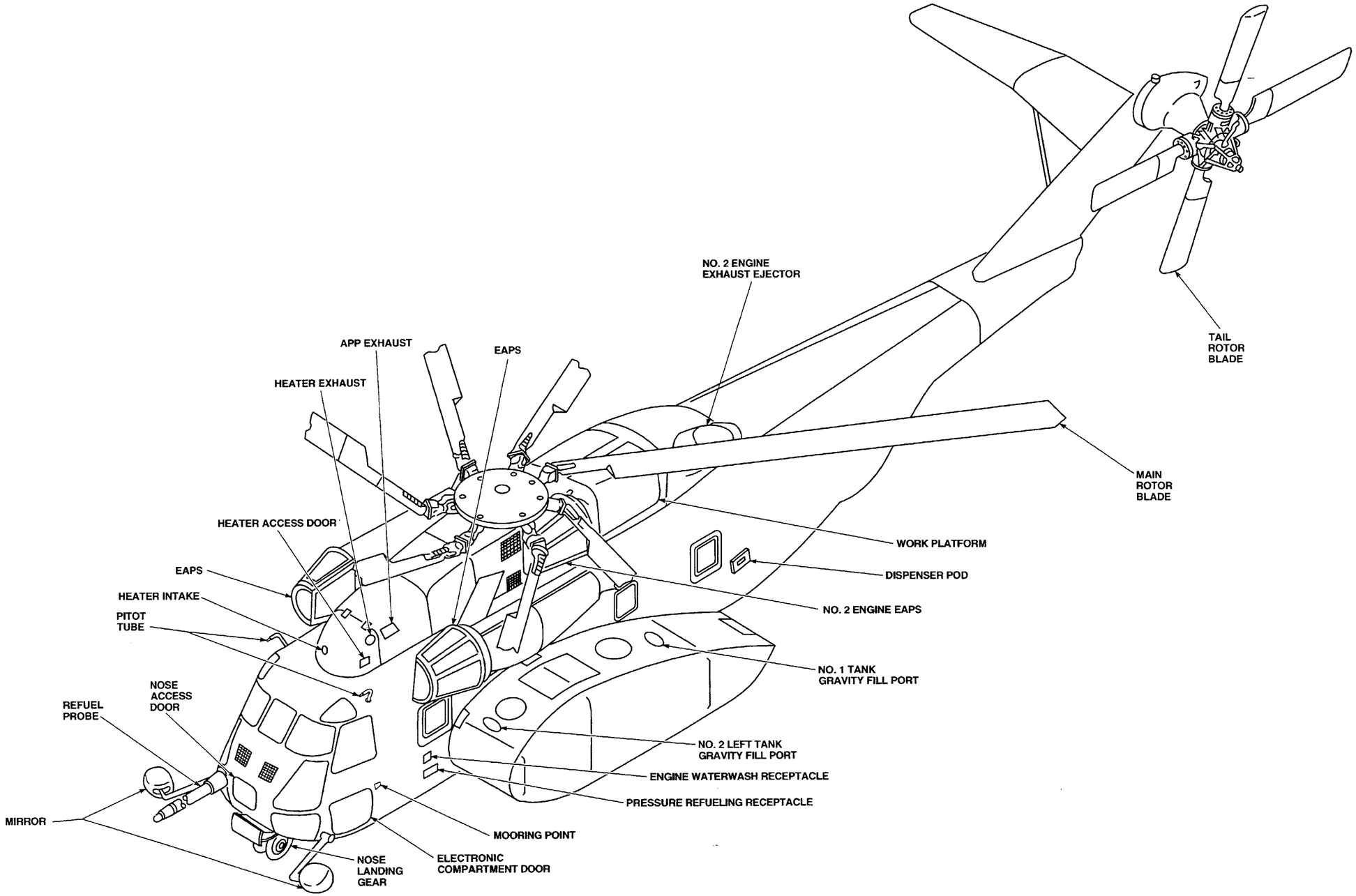
AIRCREWMAN RESCUE HOIST

HM1483
SA

ICS Control Panel

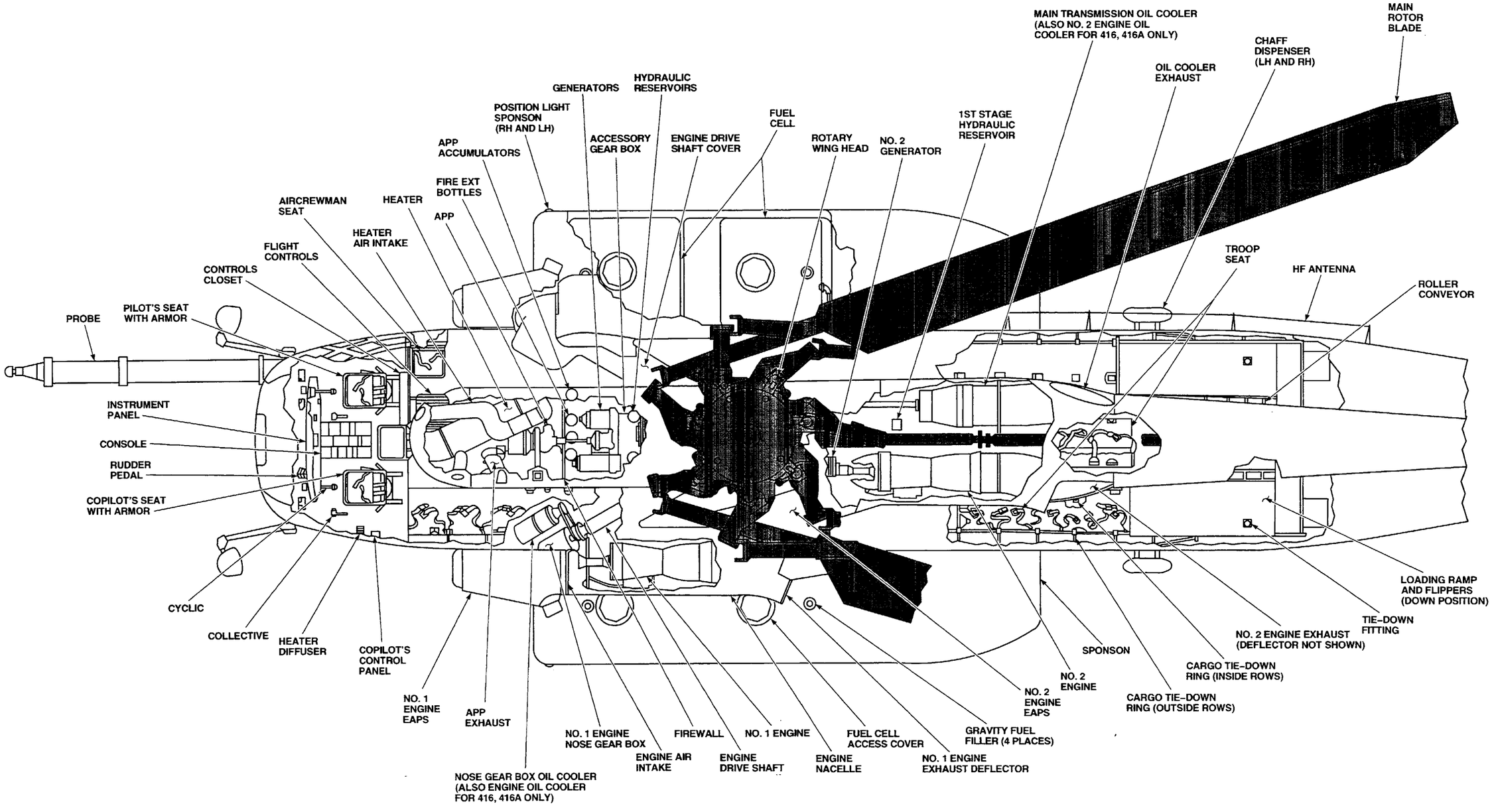


General Arrangement Diagram (Sheet 1 of 2)



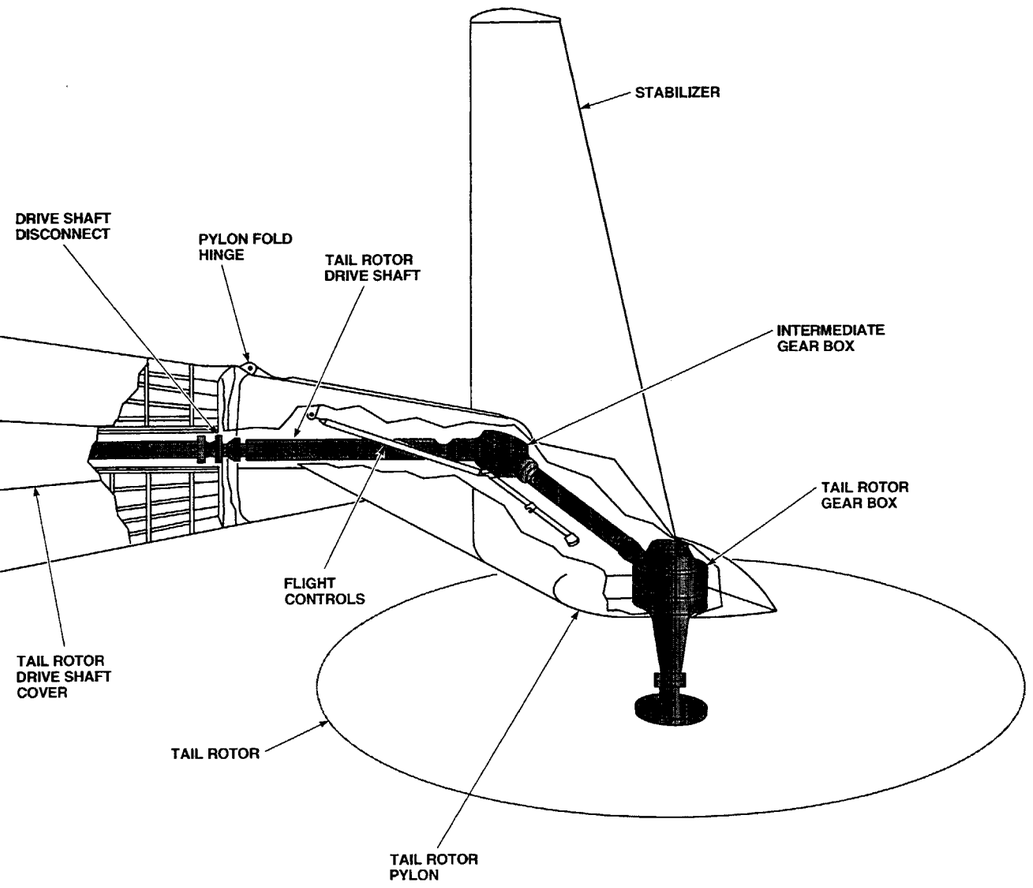
HM1485_2
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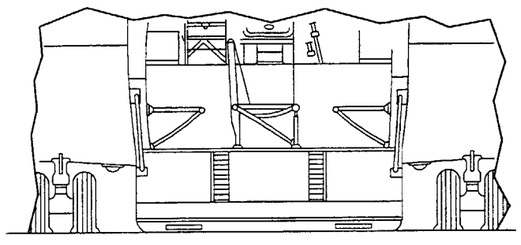
General Arrangement Diagram (Sheet 2 of 2)



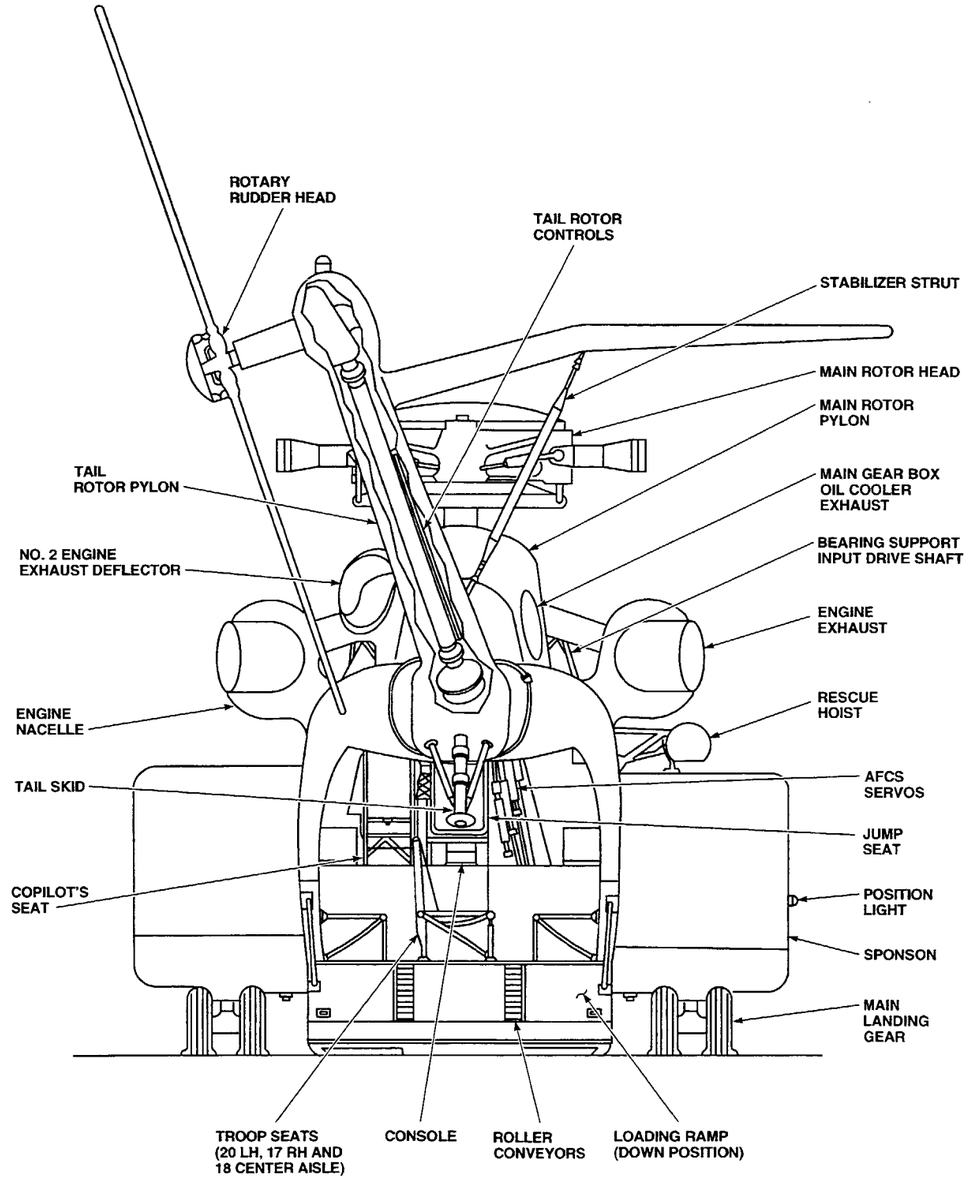
HM5420_1
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Interior Arrangement (Sheet 1 of 2)



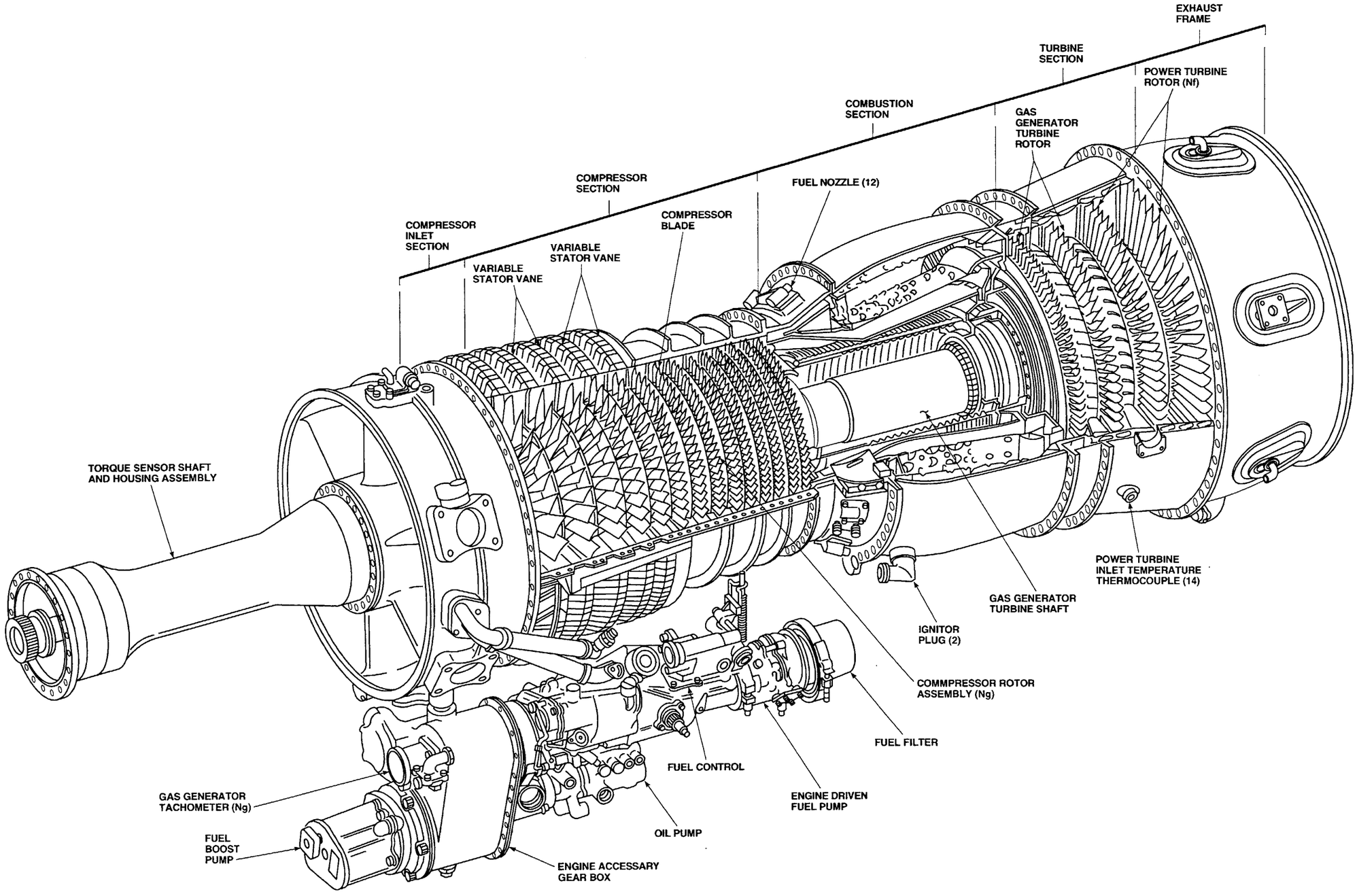


AFC 497



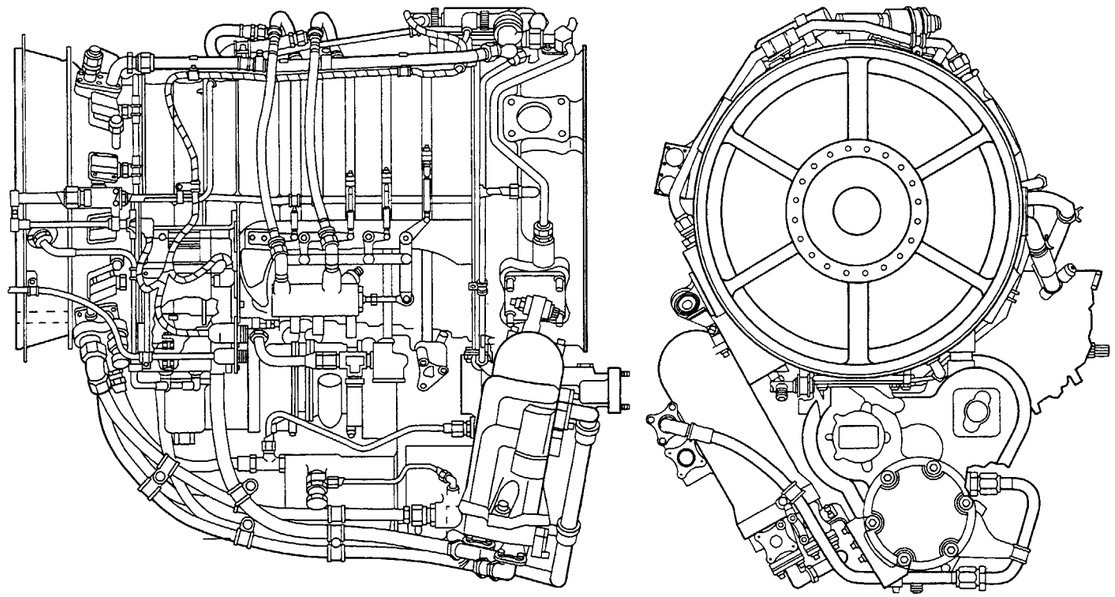
HM5420_2A
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Interior Arrangement (Sheet 2 of 2)

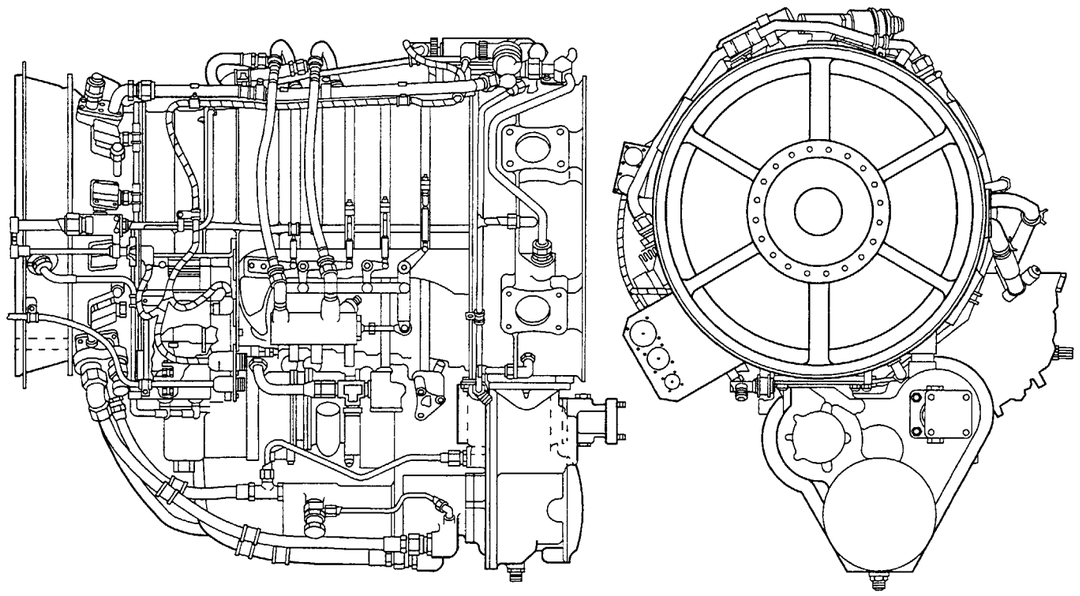


HM1479-1
SA

The Engine (Sheet 1 of 2)



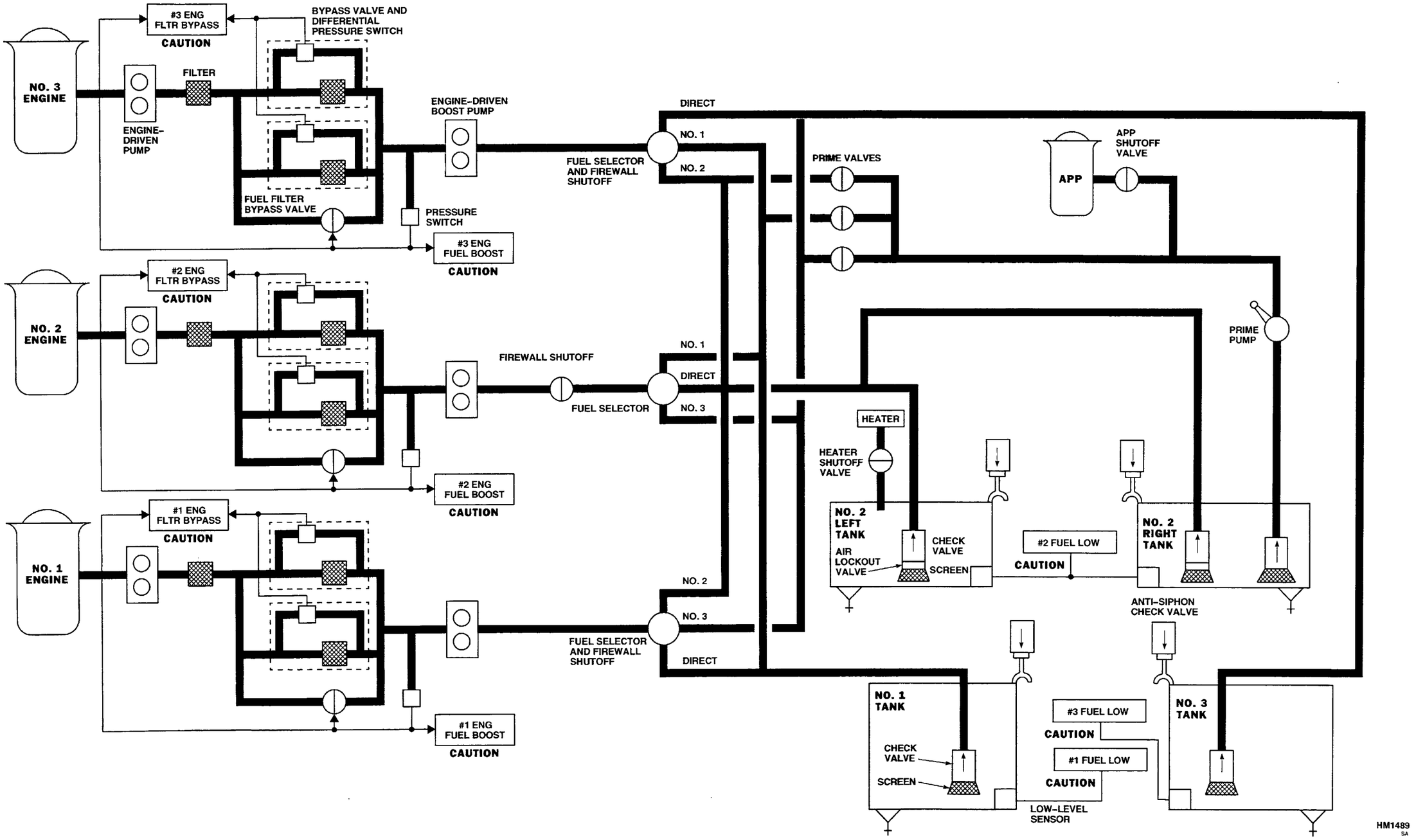
419 ENGINE



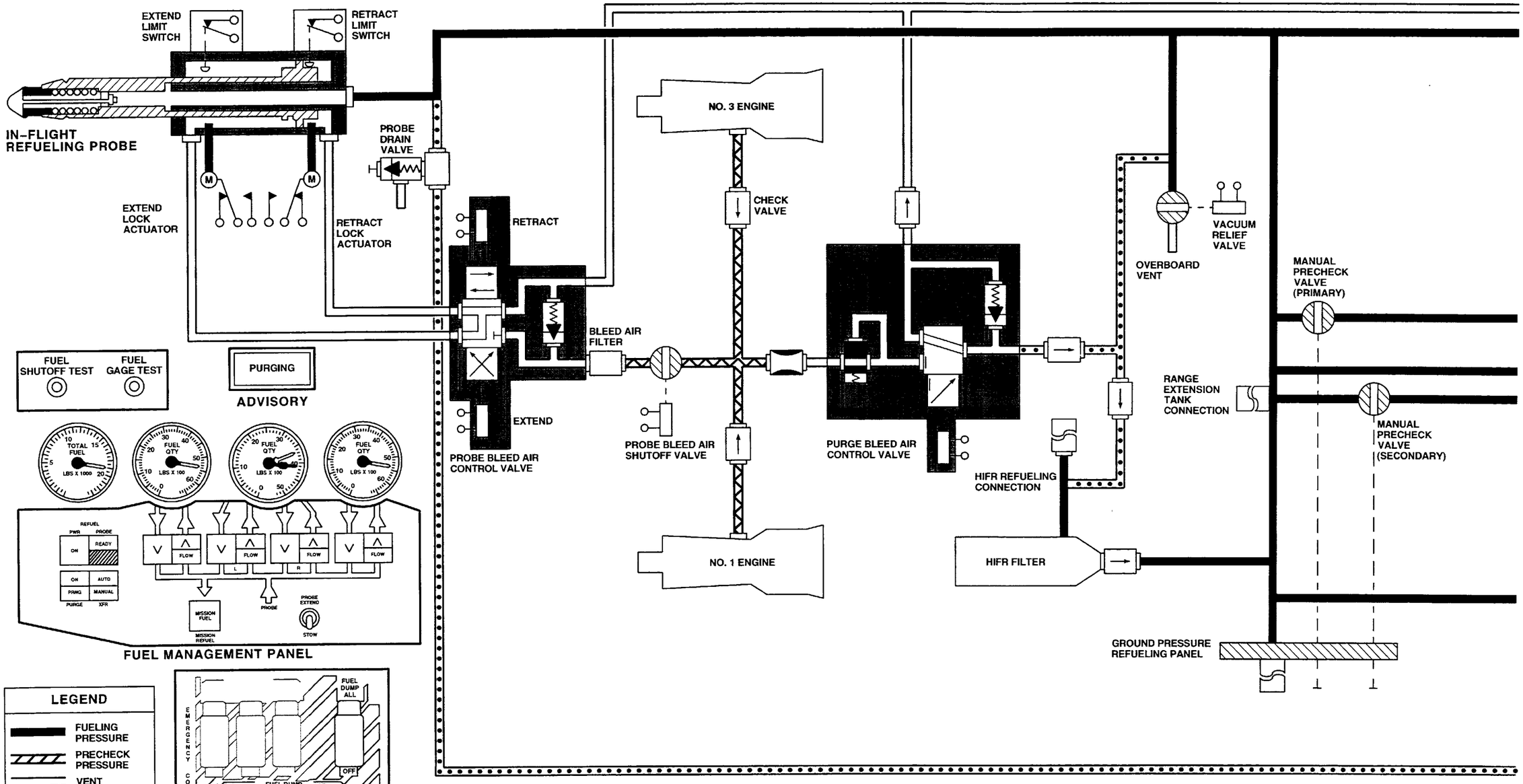
416 ENGINE

HM1479_2
5A

The Engine (Sheet 2 of 2)

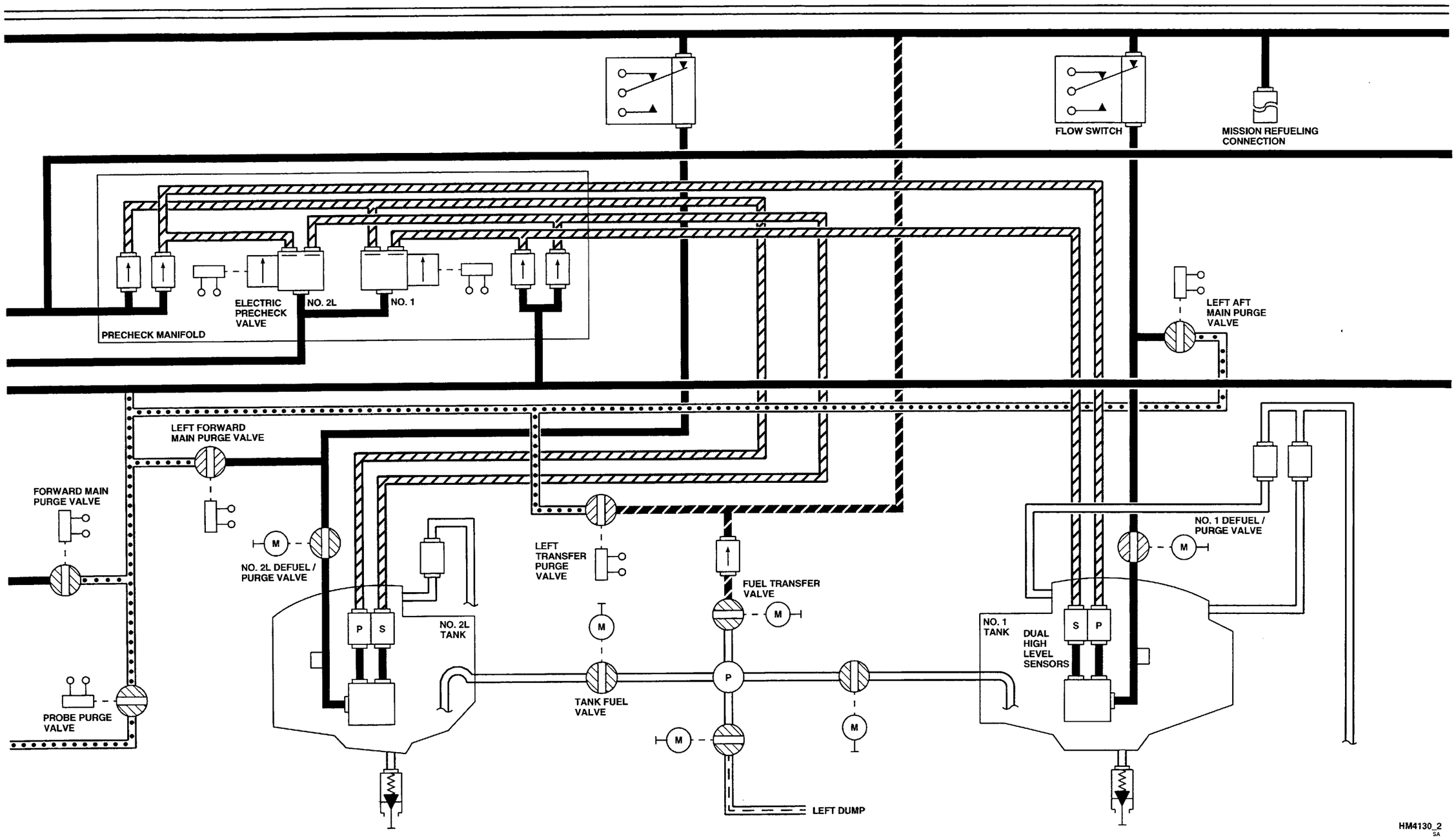


Fuel Feed System Schematic

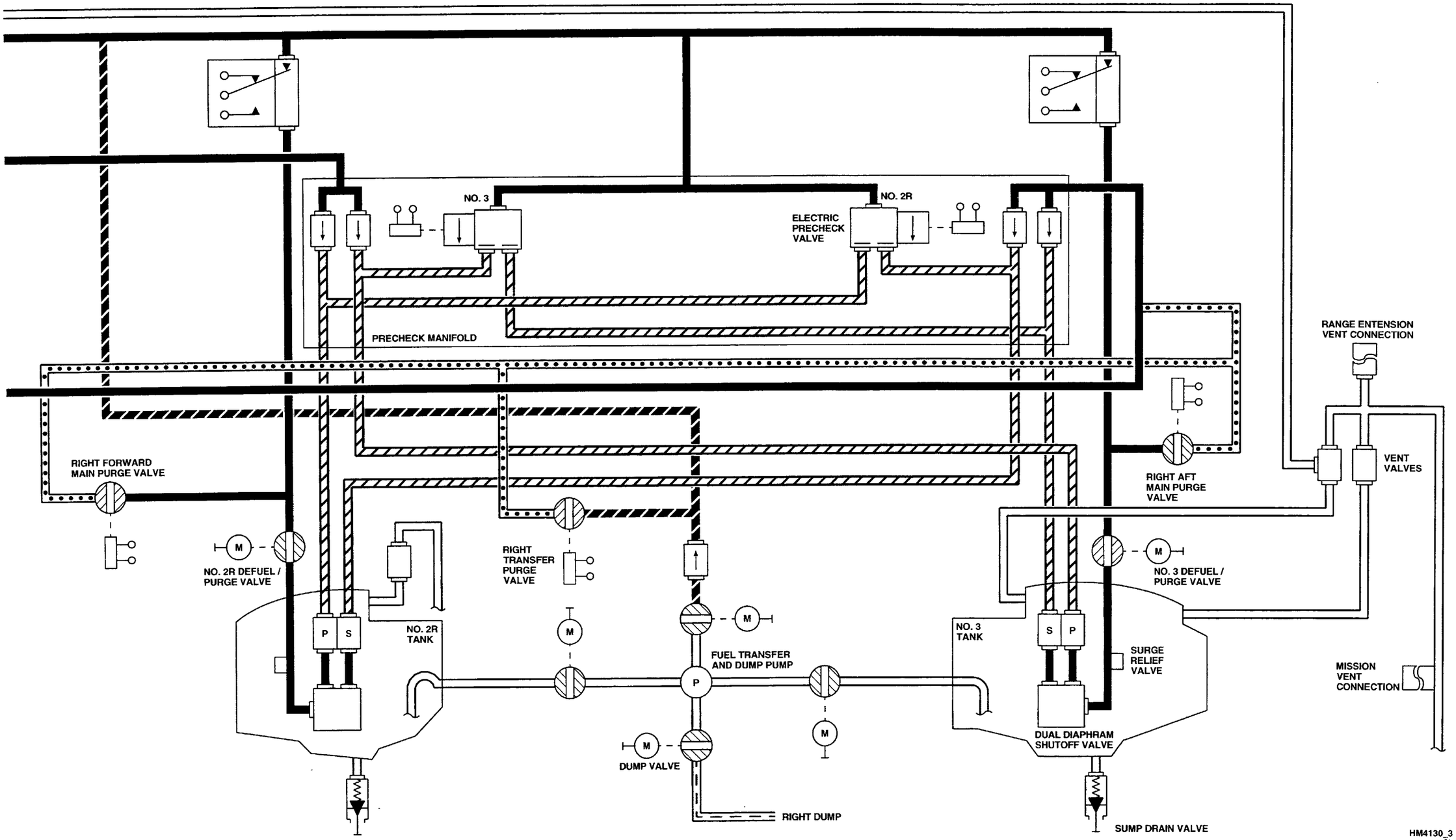


HM4130_1
SA

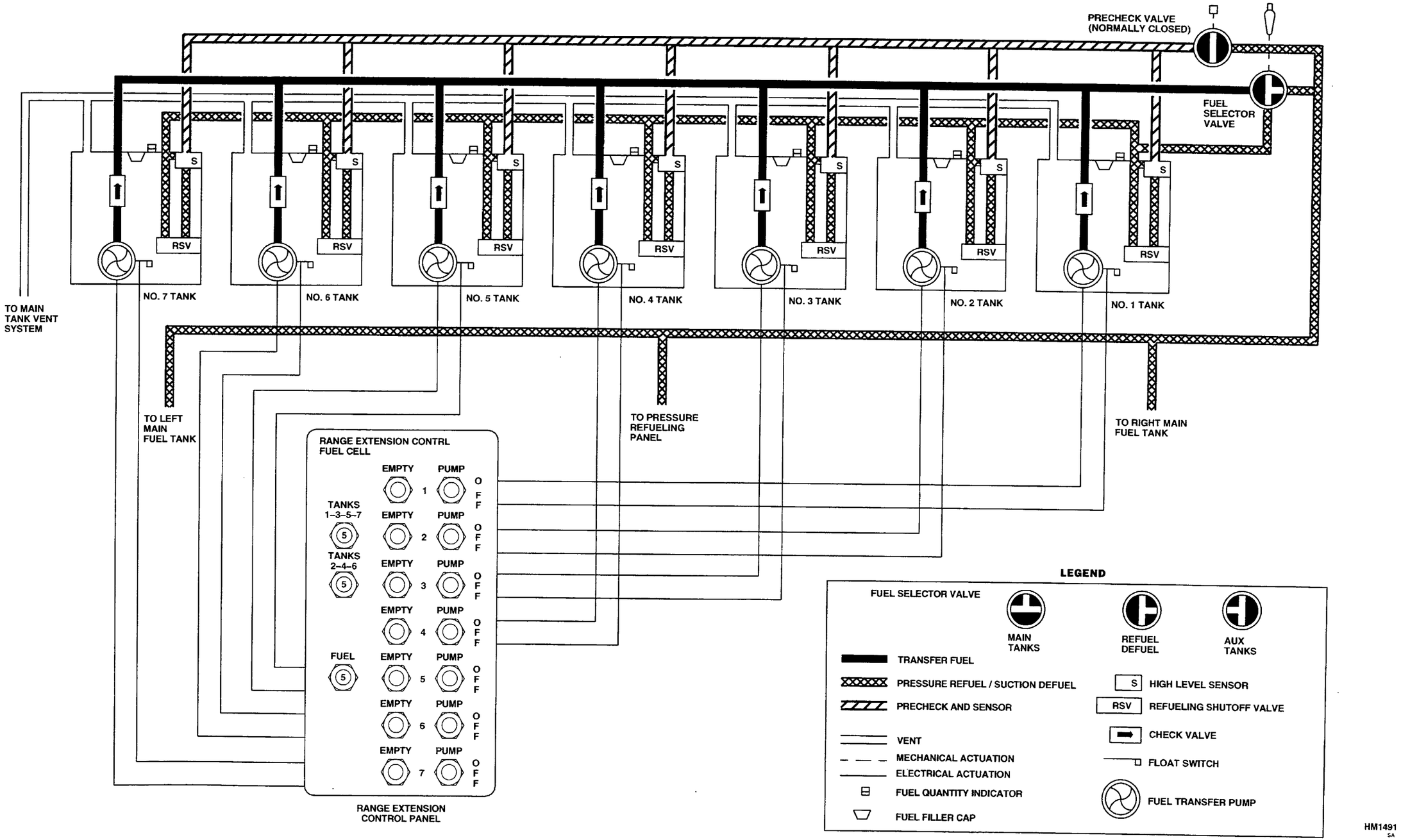
Pressure Fueling/Defueling, Transfer, Dump, and Purge Systems Schematic (Sheet 1 of 3)



Pressure Fueling/Defueling, Transfer, Dump, and Purge Systems Schematic (Sheet 2 of 3)

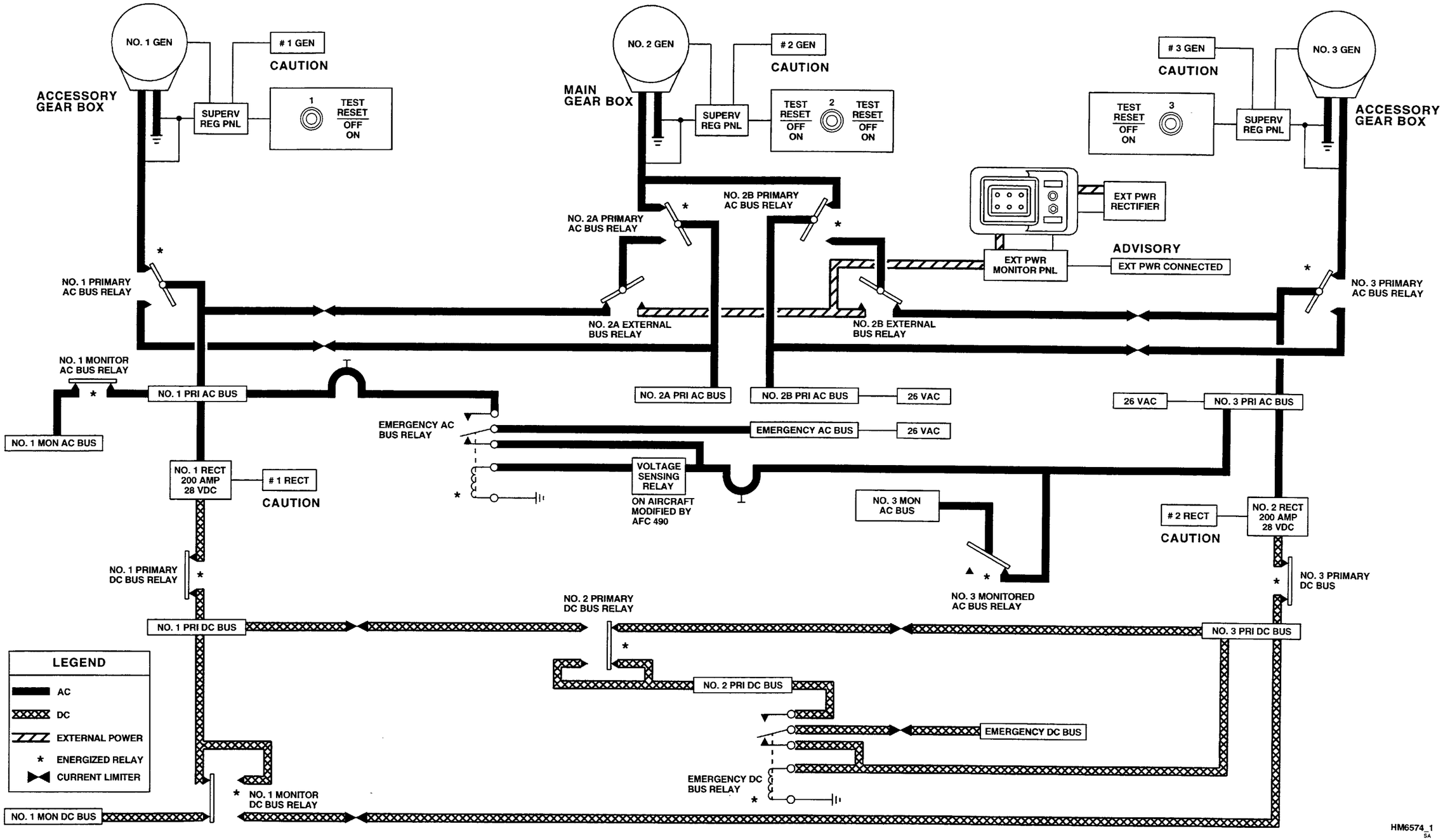


Pressure Fueling/Defueling, Transfer, Dump, and Purge Systems Schematic (Sheet 3 of 3)

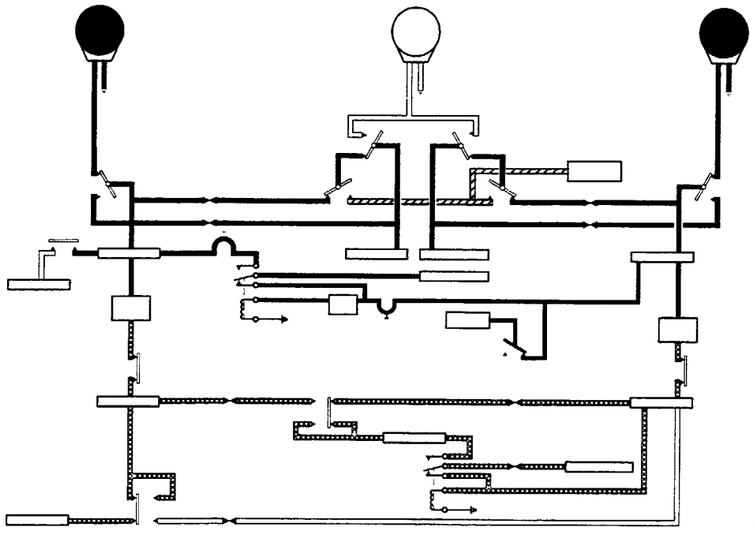


HM1491
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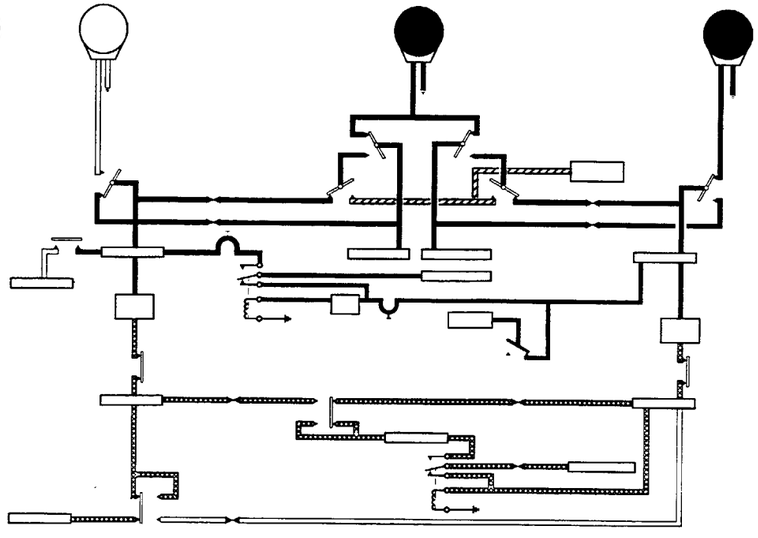
Range Extension Fuel System



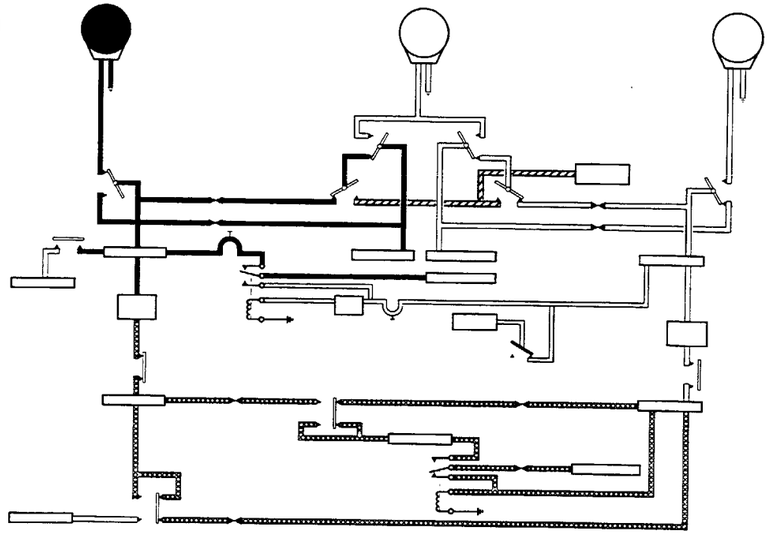
Electrical System Schematic (Sheet 1 of 2)



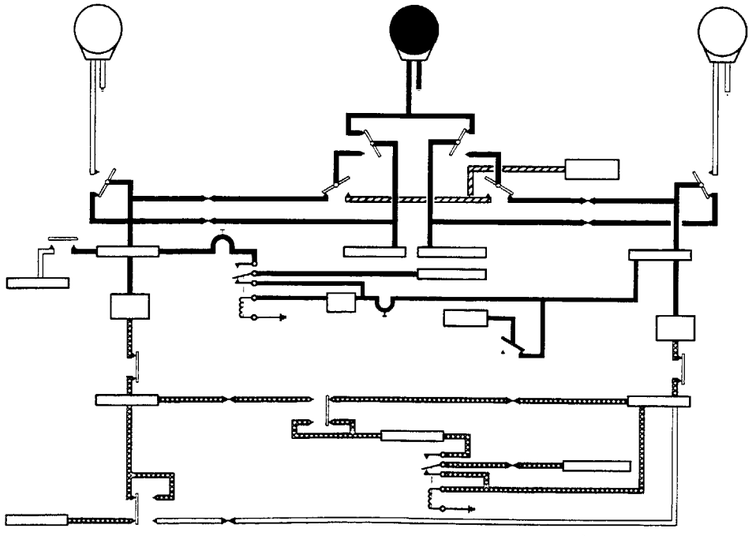
NO. 1 AND 3 GENERATORS OPERATING
ALSO APP GROUND OPERATION



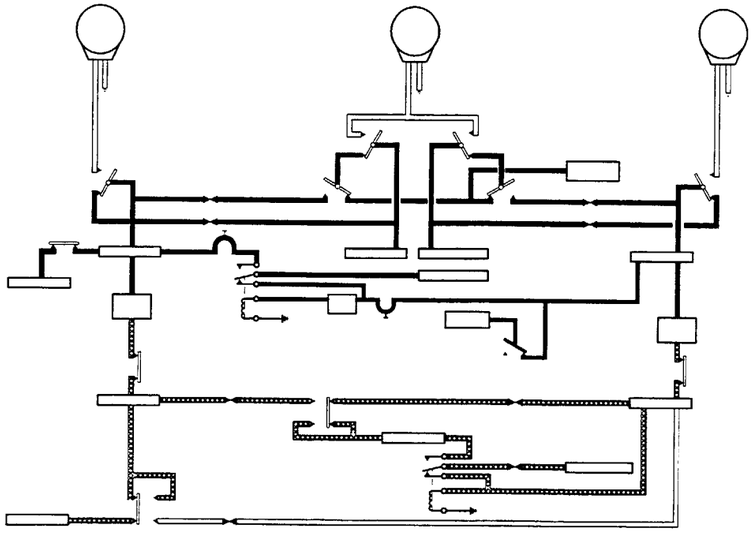
NO. 2 AND 3 GENERATORS OPERATING



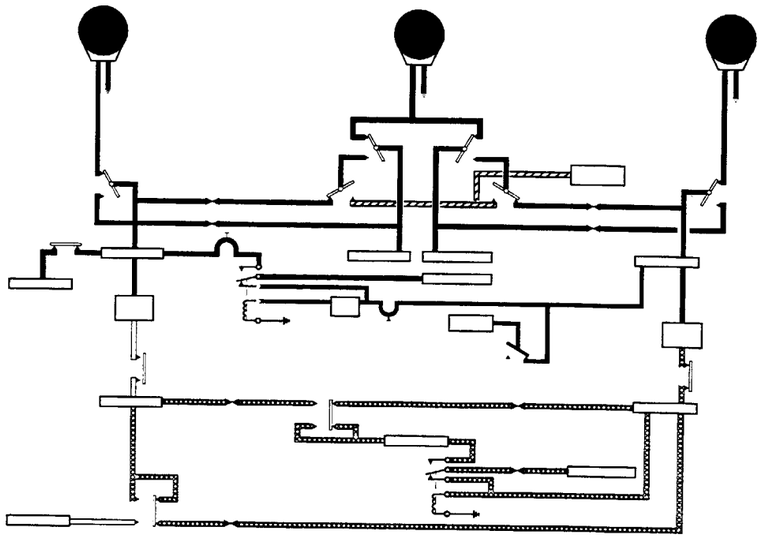
NO. 1 GENERATOR OPERATING



NO. 2 GENERATOR OPERATING



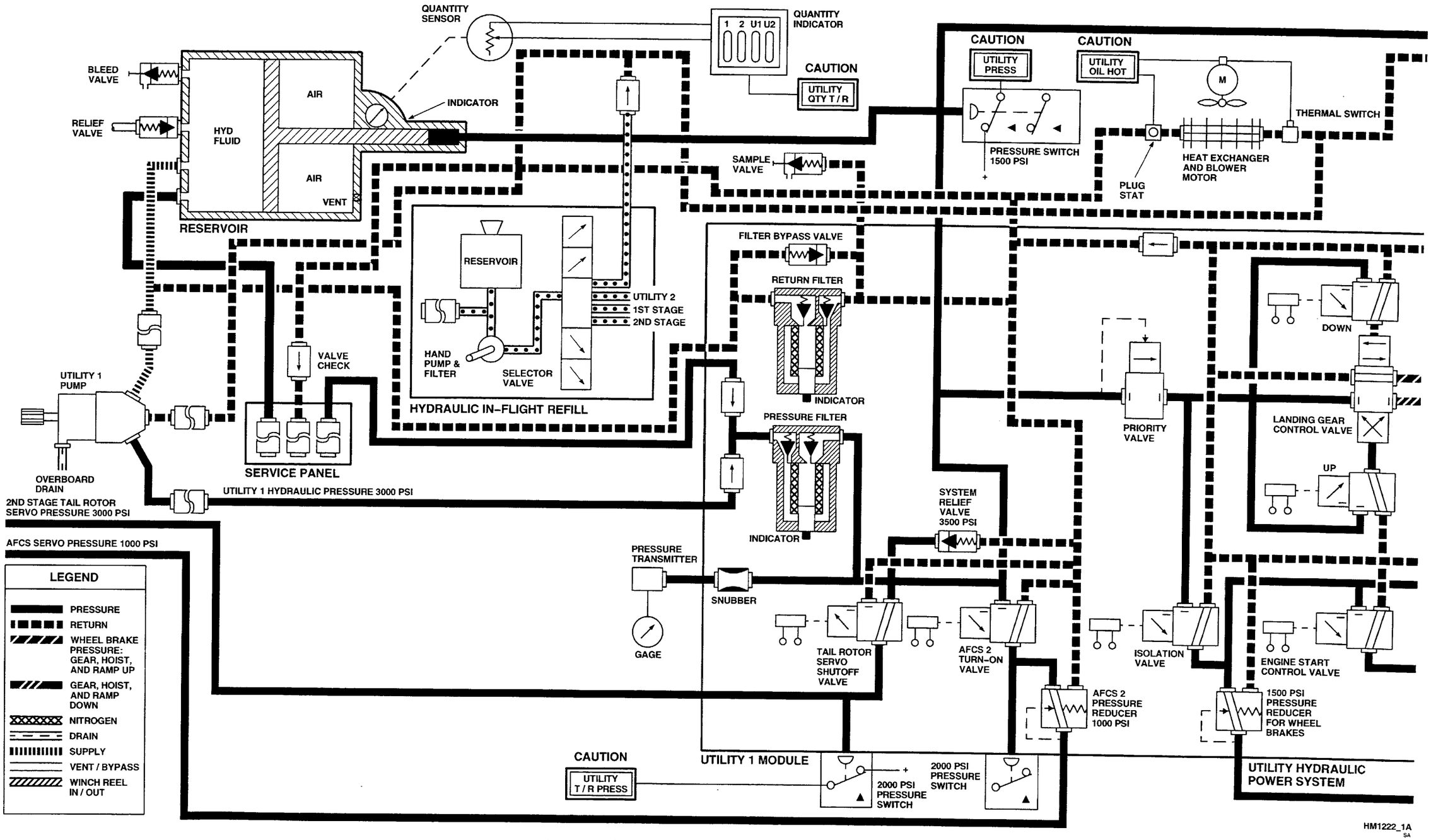
EXTERNAL POWER CONNECTED



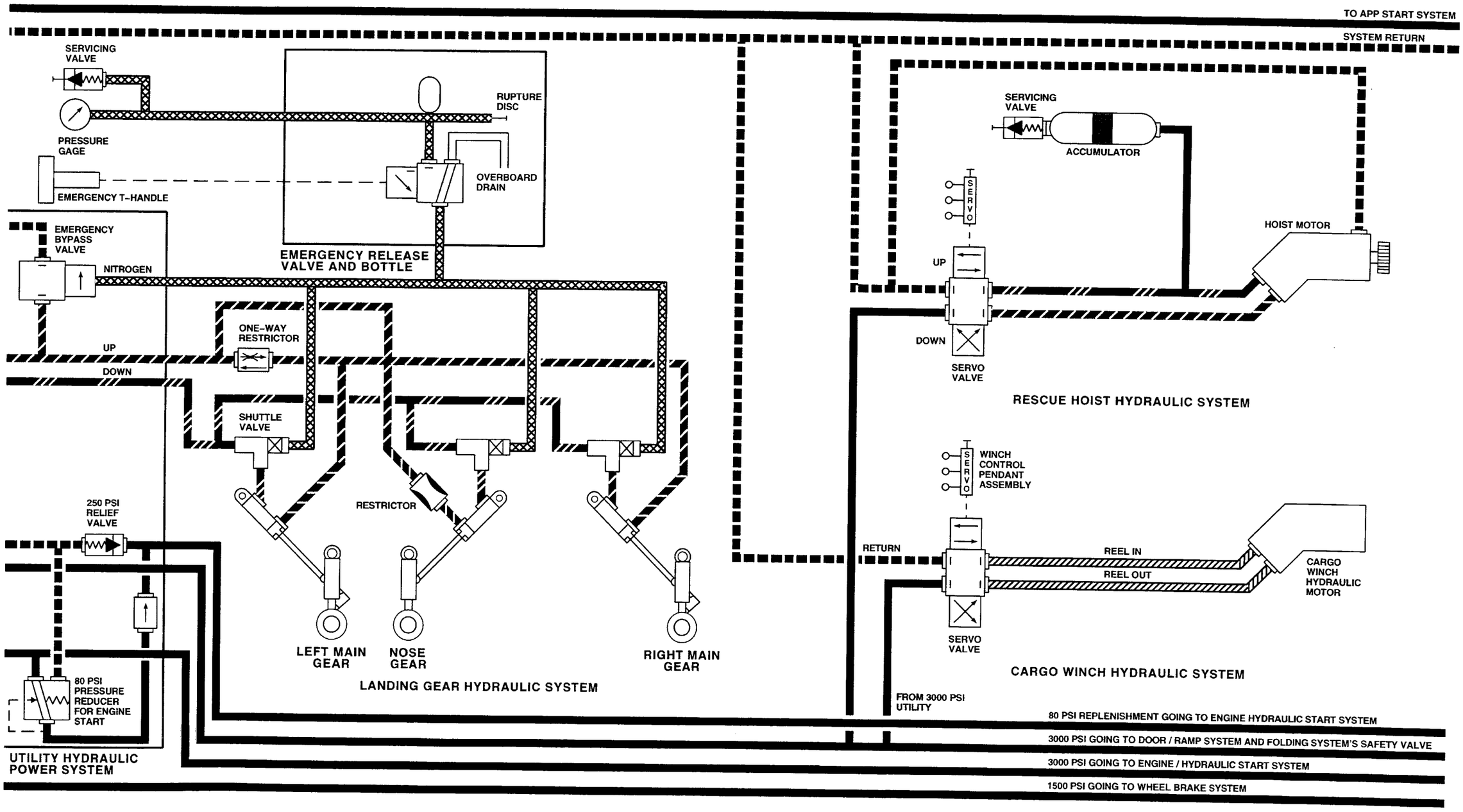
NO. 2 RECTIFIER OPERATING

HM6574_2
SA

Electrical System Schematic (Sheet 2 of 2)

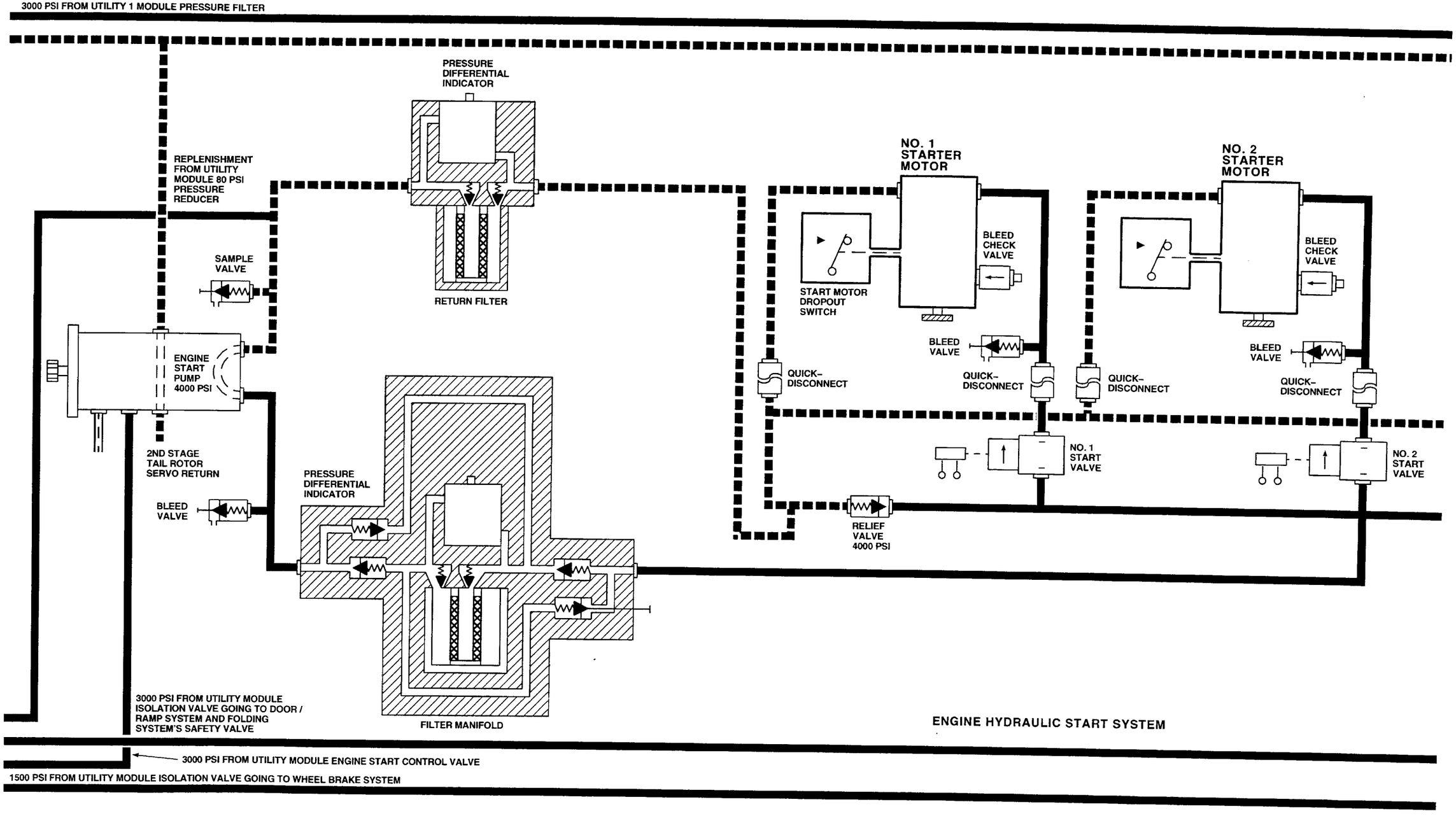


Utility 1 Hydraulic System Schematic (Sheet 1 of 6)



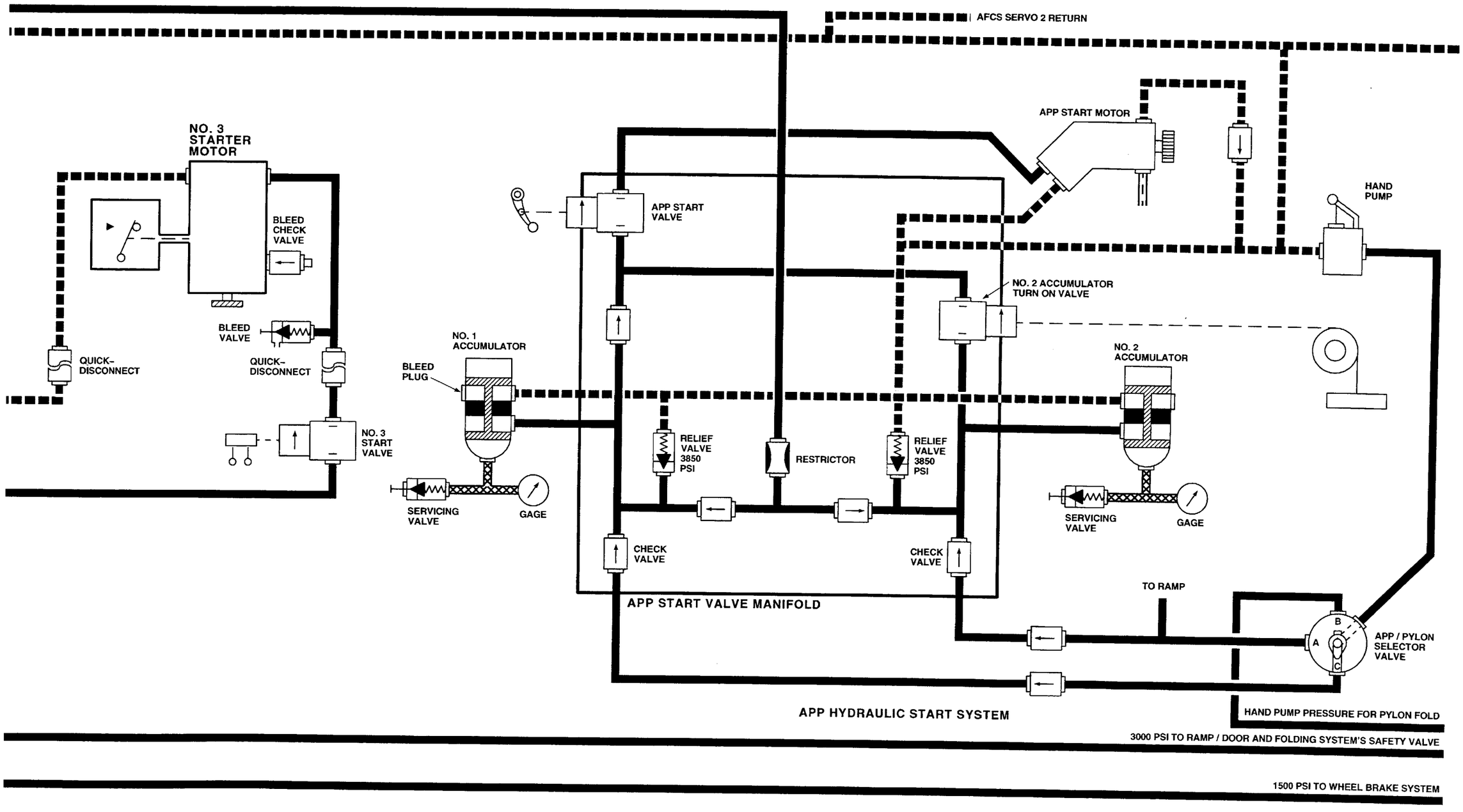
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Utility 1 Hydraulic System Schematic (Sheet 2 of 6)

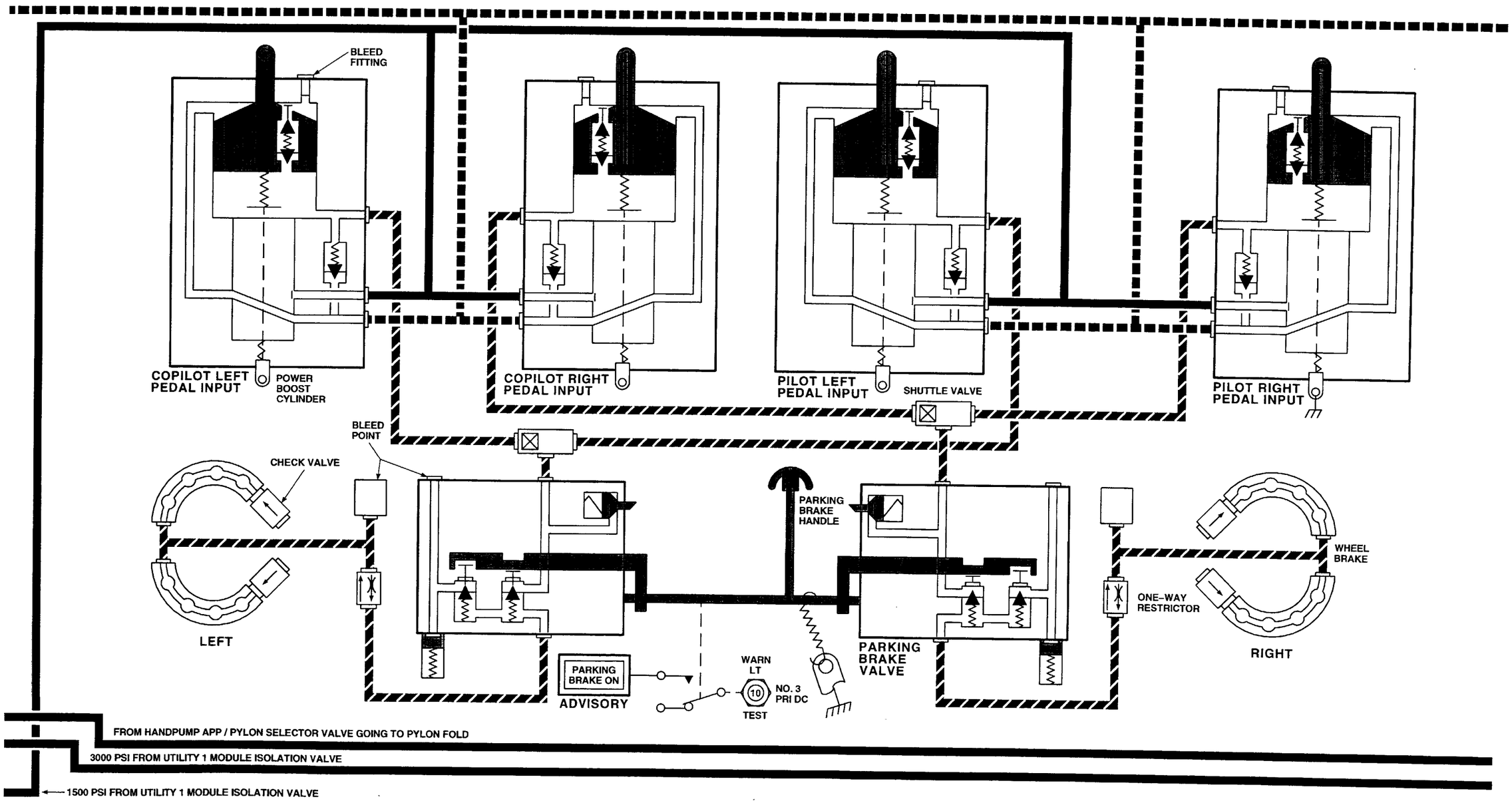


HM1222_3
SA

Utility 1 Hydraulic System Schematic (Sheet 3 of 6)

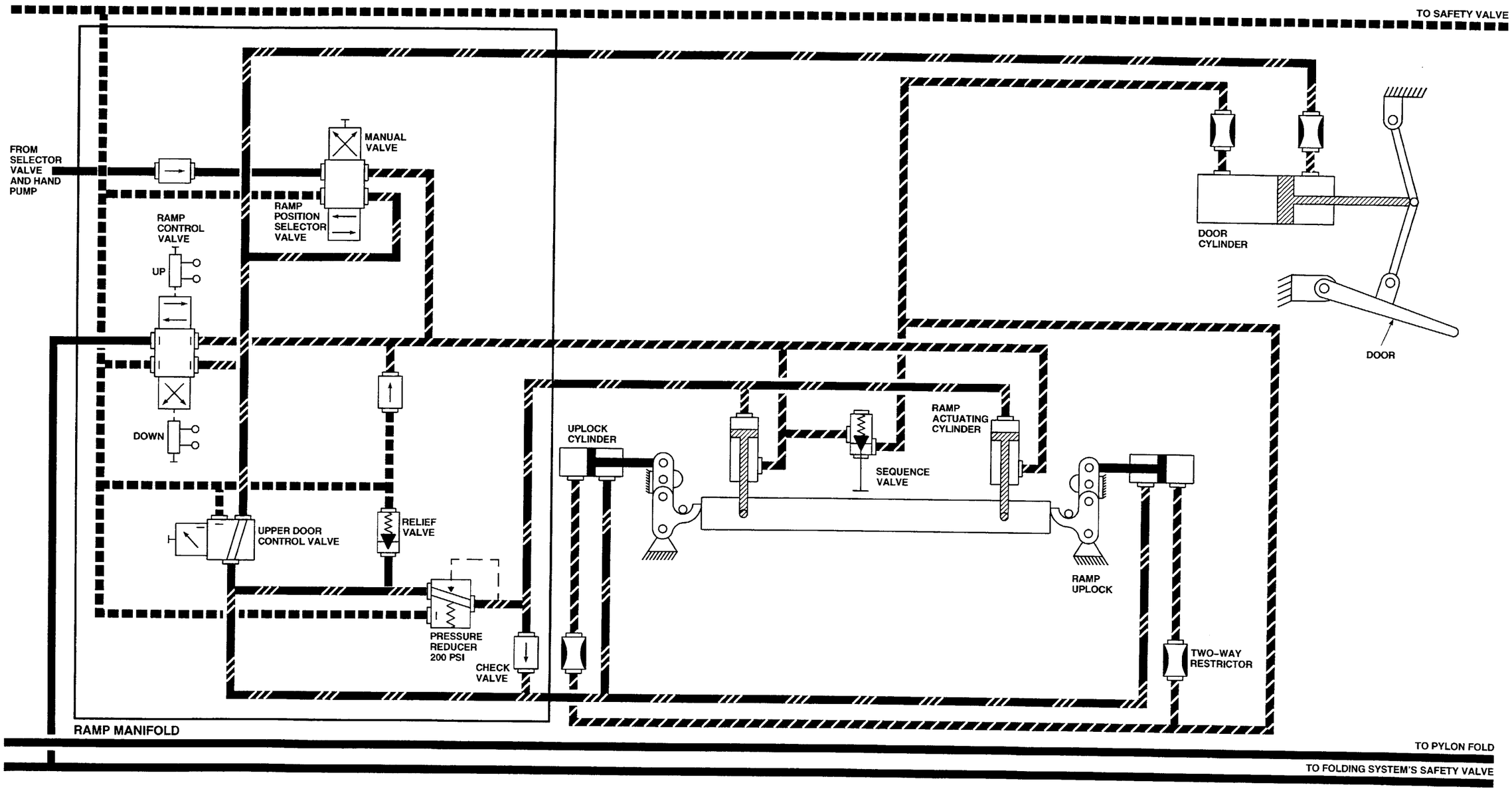


Utility 1 Hydraulic System Schematic (Sheet 4 of 6)



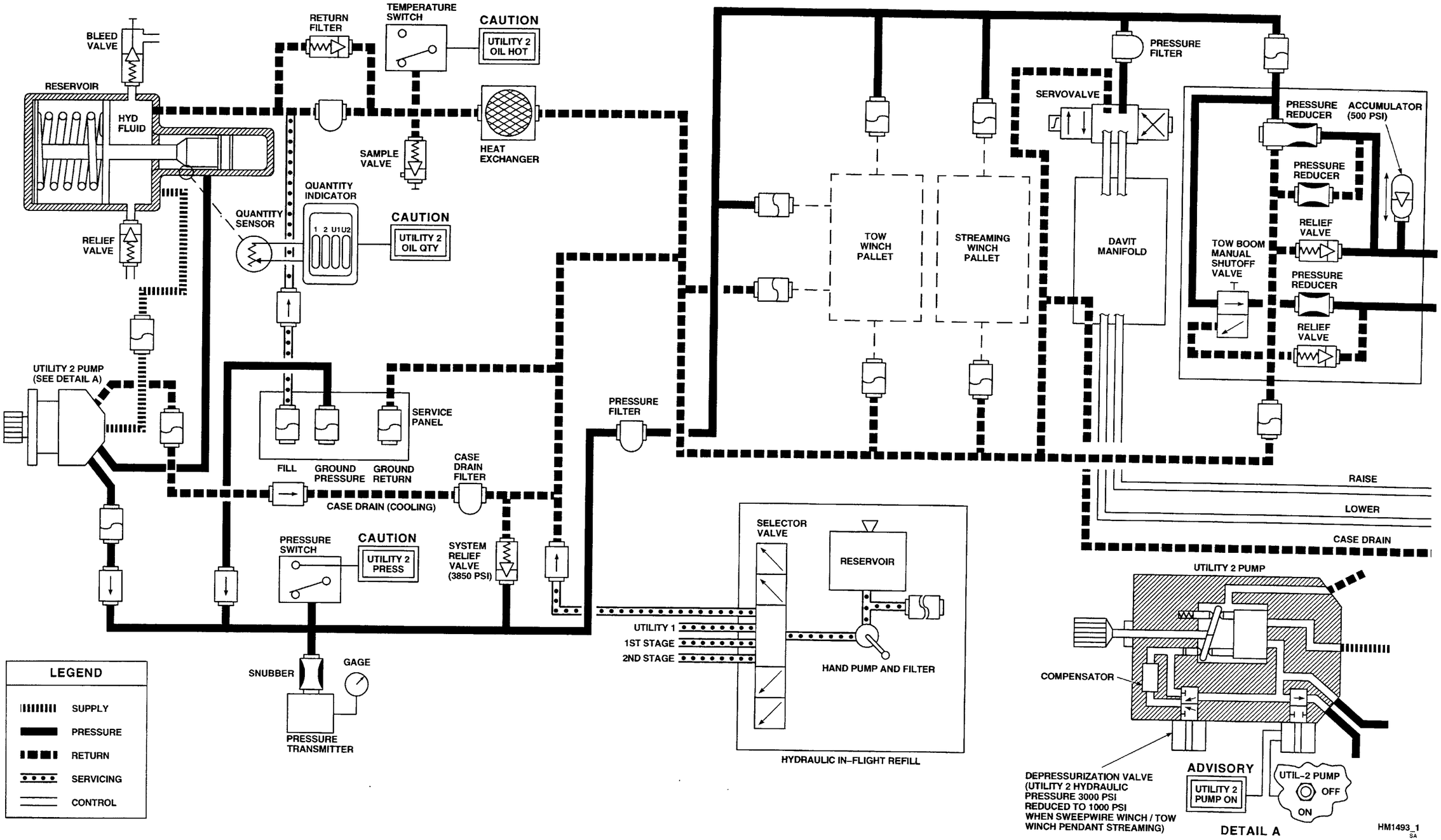
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5A

Utility 1 Hydraulic System Schematic (Sheet 5 of 6)

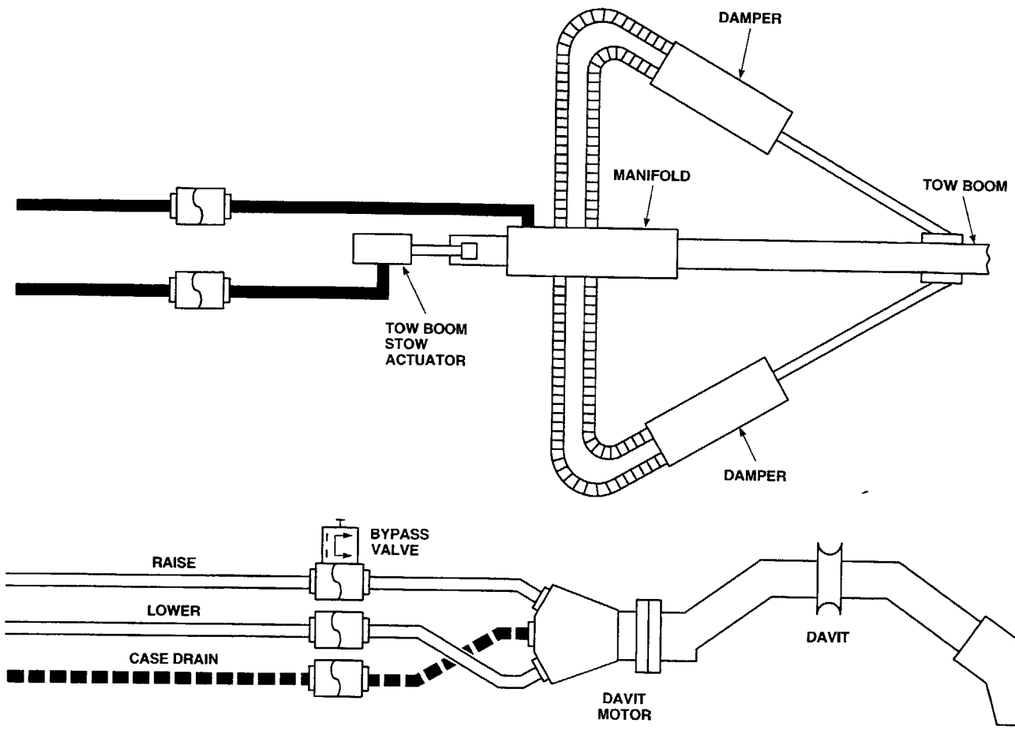


HM1222_6A
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Utility 1 Hydraulic System Schematic (Sheet 6 of 6)

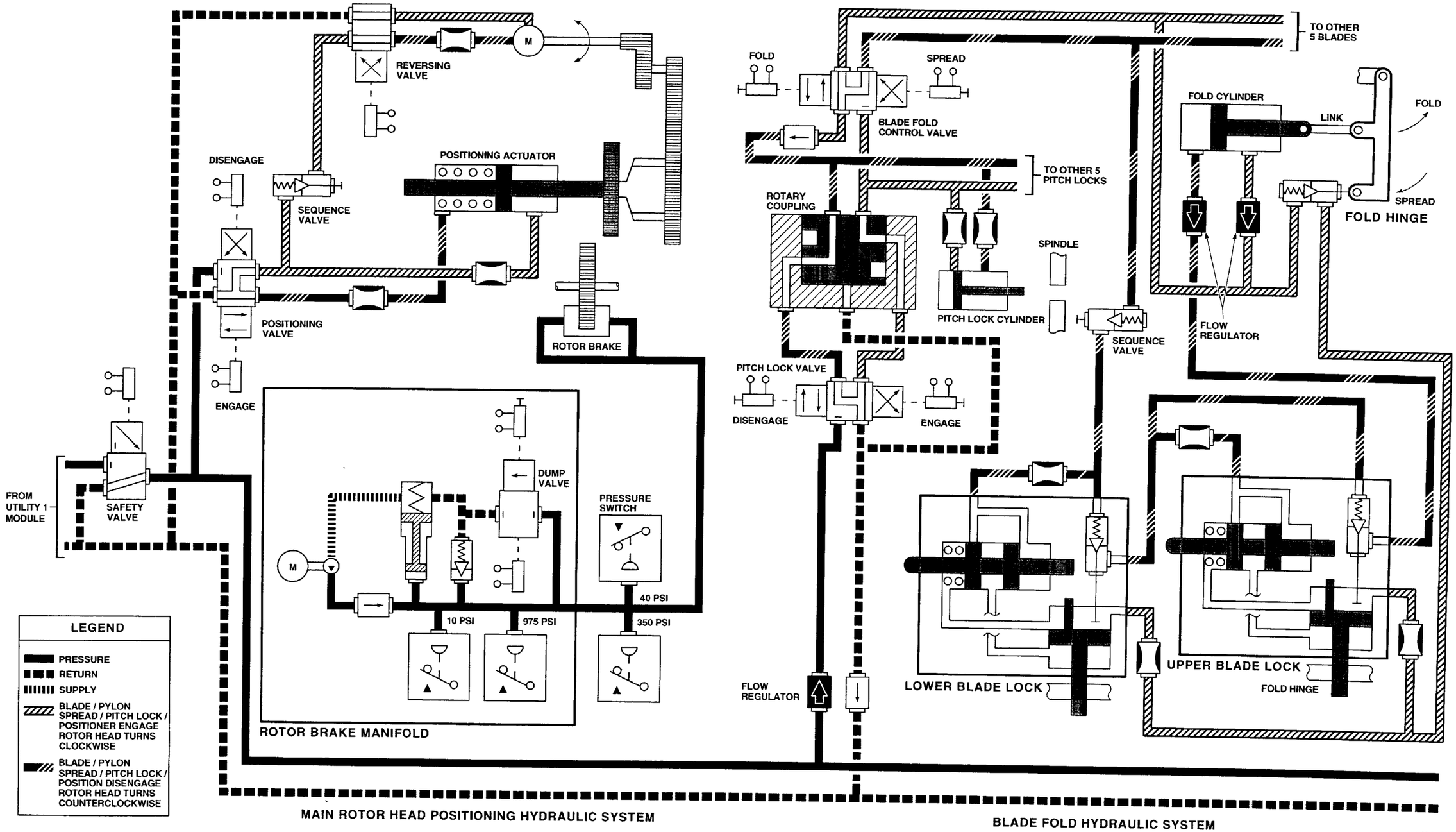


Utility 2 Hydraulic System Schematic (Sheet 1 of 2)



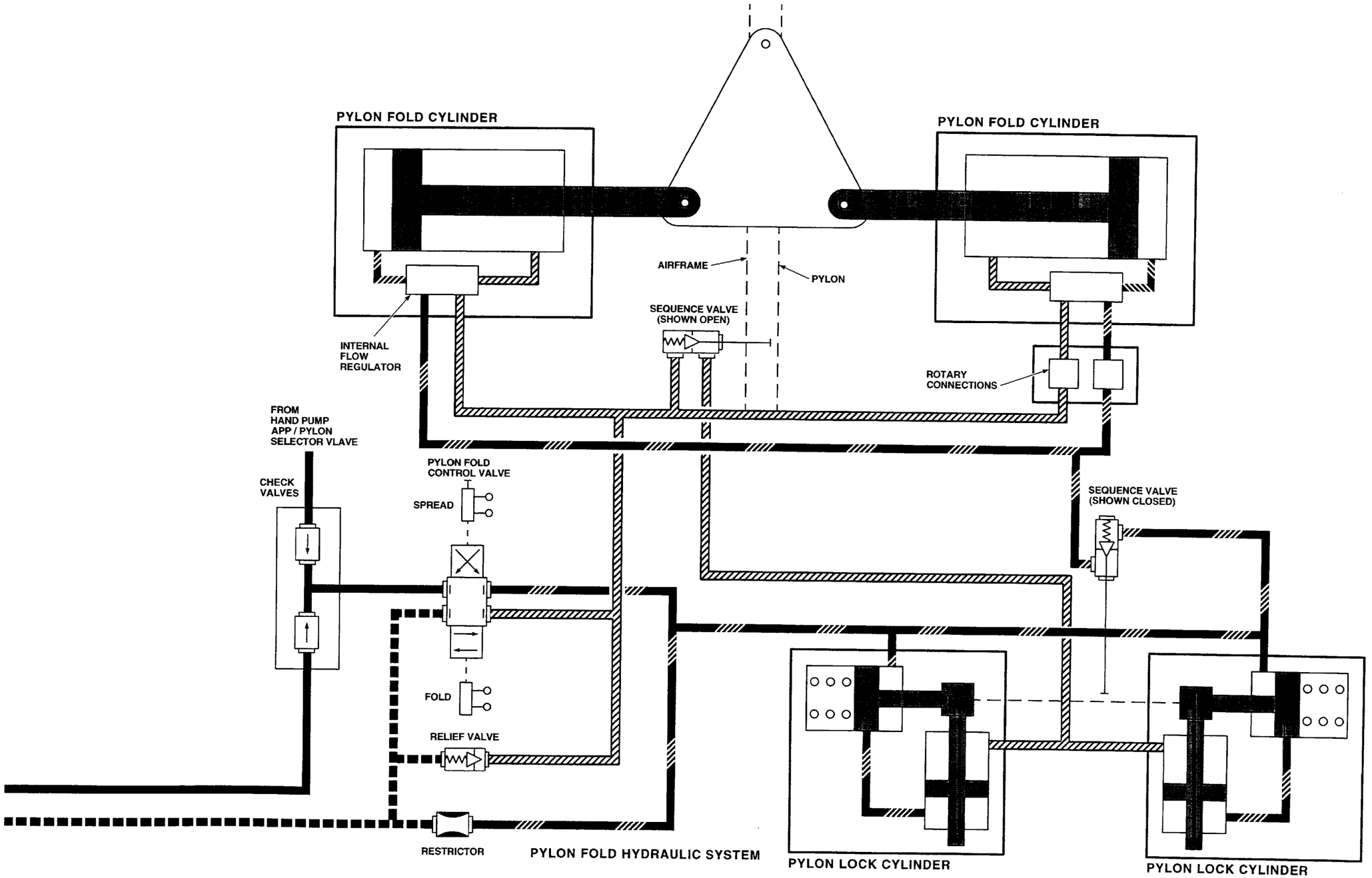
HM1493_2
SA

Utility 2 Hydraulic System Schematic (Sheet 2 of 2)



HM1494_1
SA

Blade Pylon Fold/Spread, Positioning, and Rotor Brake Hydraulic System Schematic (Sheet 1 of 2)



HM1494_2
SA

Blade Pylon Fold/Spread, Positioning, and Rotor Brake Hydraulic System Schematic (Sheet 2 of 2)

SECOND STAGE HYDRAULIC SYSTEM

2 STG QTY M/R

CAUTION

1 2 U1 U2

QUANTITY INDICATOR

QUANTITY SENSOR

CHECK RELIEF VALVE

RESERVOIR

INDICATOR

BLEED VALVE

RELIEF VALVE

2 STG OIL HOT

CAUTION

SAMPLING VALVE

SERVICE PANEL

ACCUMULATOR

SERVICING VALVE

VENT

STAT PLUG

PUMP

DRAIN

RESERVOIR

UTILITY 2

UTILITY 1

1ST STAGE

HAND PUMP & FILTER

SELECTOR VALVE

HYDRAULIC IN-FLIGHT REFILL

FILTER

M

HEAT EXCHANGER AND BLOWER MOTOR

FIRST STAGE HYDRAULIC SYSTEM

1 STG QTY M/R T/R

CAUTION

1 2 U1 U2

QUANTITY INDICATOR

QUANTITY SENSOR

CHECK RELIEF VALVE

RESERVOIR

INDICATOR

BLEED VALVE

RELIEF VALVE

PITCH LOCK ISOLATION VALVE

SAMPLING VALVE

SERVICE PANEL

ACCUMULATOR

SERVICING VALVE

VENT

PUMP

DRAIN

RESERVOIR

UTILITY 2

UTILITY 1

2ND STAGE

HAND PUMP & FILTER

SELECTOR VALVE

HYDRAULIC IN-FLIGHT REFILL

FILTER

HEAT EXCHANGER (FIN TUBE)

HM1223_1A SA

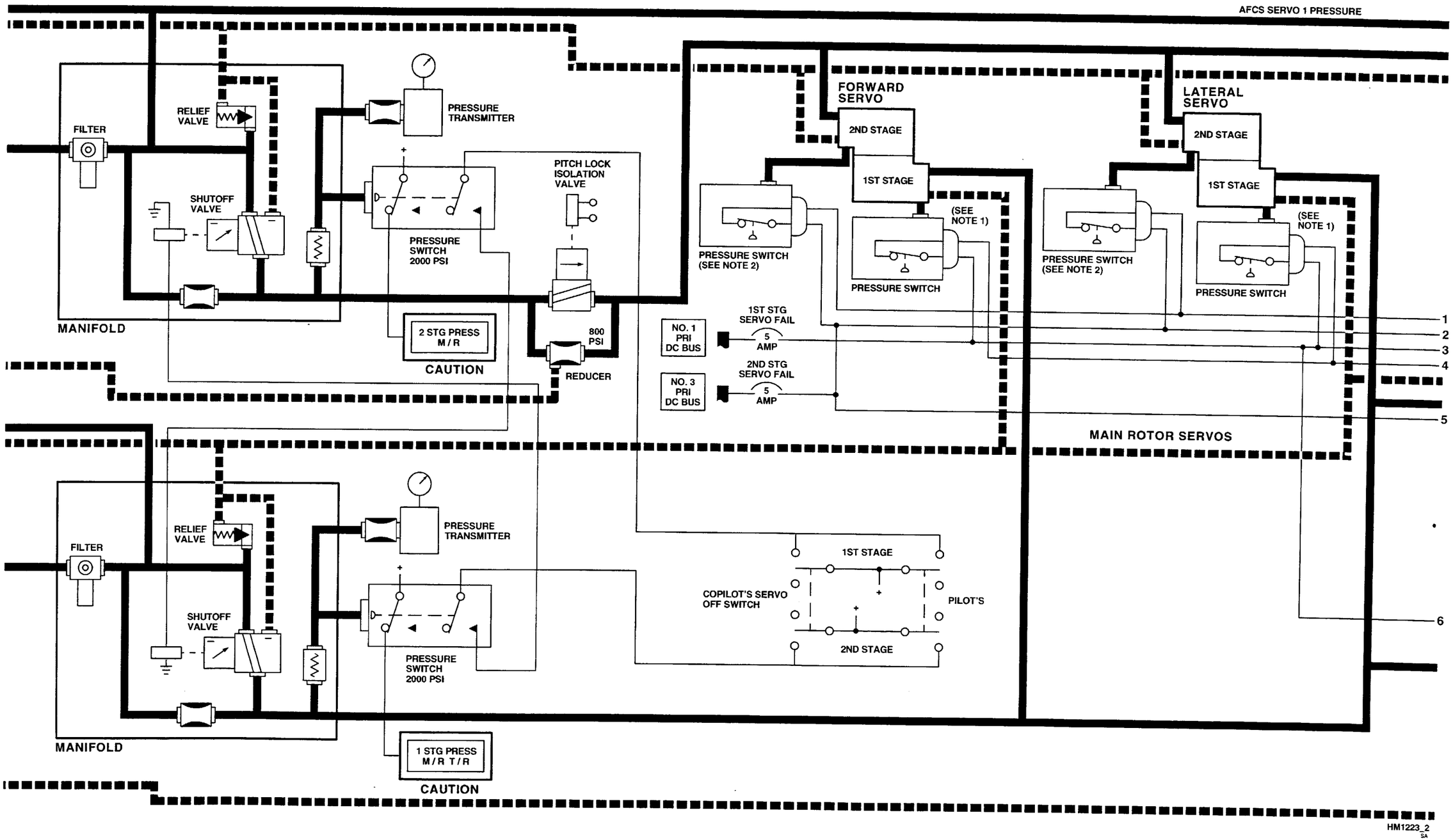
NOTES

1. A FIRST STAGE MAIN ROTOR SERVO PRESSURE SWITCH (3) OPENS WITH FIRST STAGE PRESSURE ABOVE 2000 PSI WITH NO SERVO PILOT VALVE MALFUNCTION.
2. A SECOND STAGE MAIN ROTOR SERVO PRESSURE SWITCH (3) OPENS WITH SECOND STAGE PRESSURE ABOVE 2000 PSI WITH NO SERVO PILOT VALVE MALFUNCTION.
3. FIRST STAGE TAIL ROTOR SERVO PRESSURE SWITCH OPENS WITH FIRST STAGE PRESSURE ABOVE 2000 PSI WITH NO SERVO PILOT VALVE MALFUNCTION.
4. SECOND STAGE TAIL ROTOR SERVO PRESSURE SWITCH OPENS WITH UTILITY PRESSURE ABOVE 1500 PSI WITH NO SERVO PILOT VALVE MALFUNCTION.

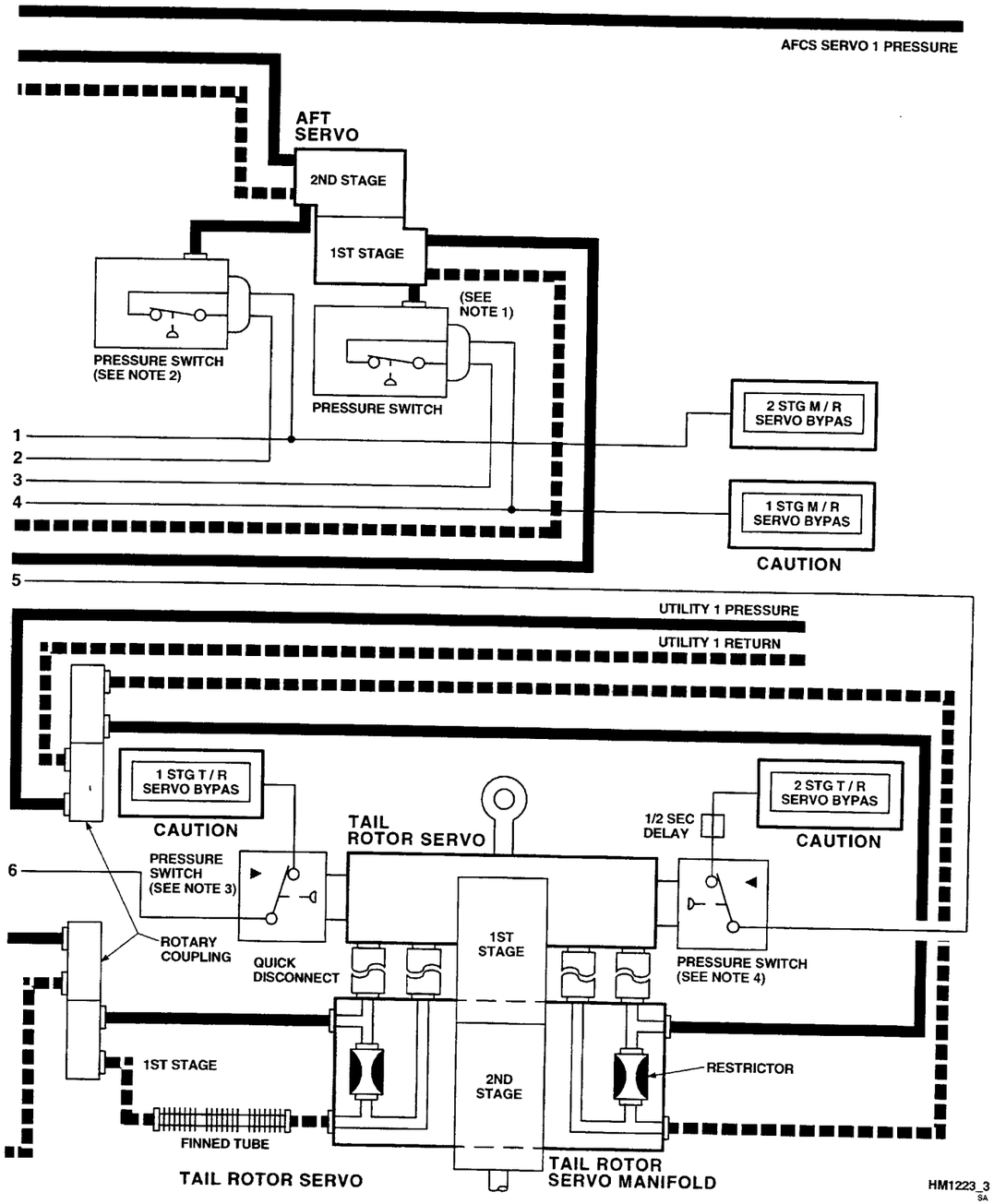
LEGEND

- PRESSURE
- RETURN
- SUPPLY
- DRAIN
- SERVICING
- \+ 28VDC

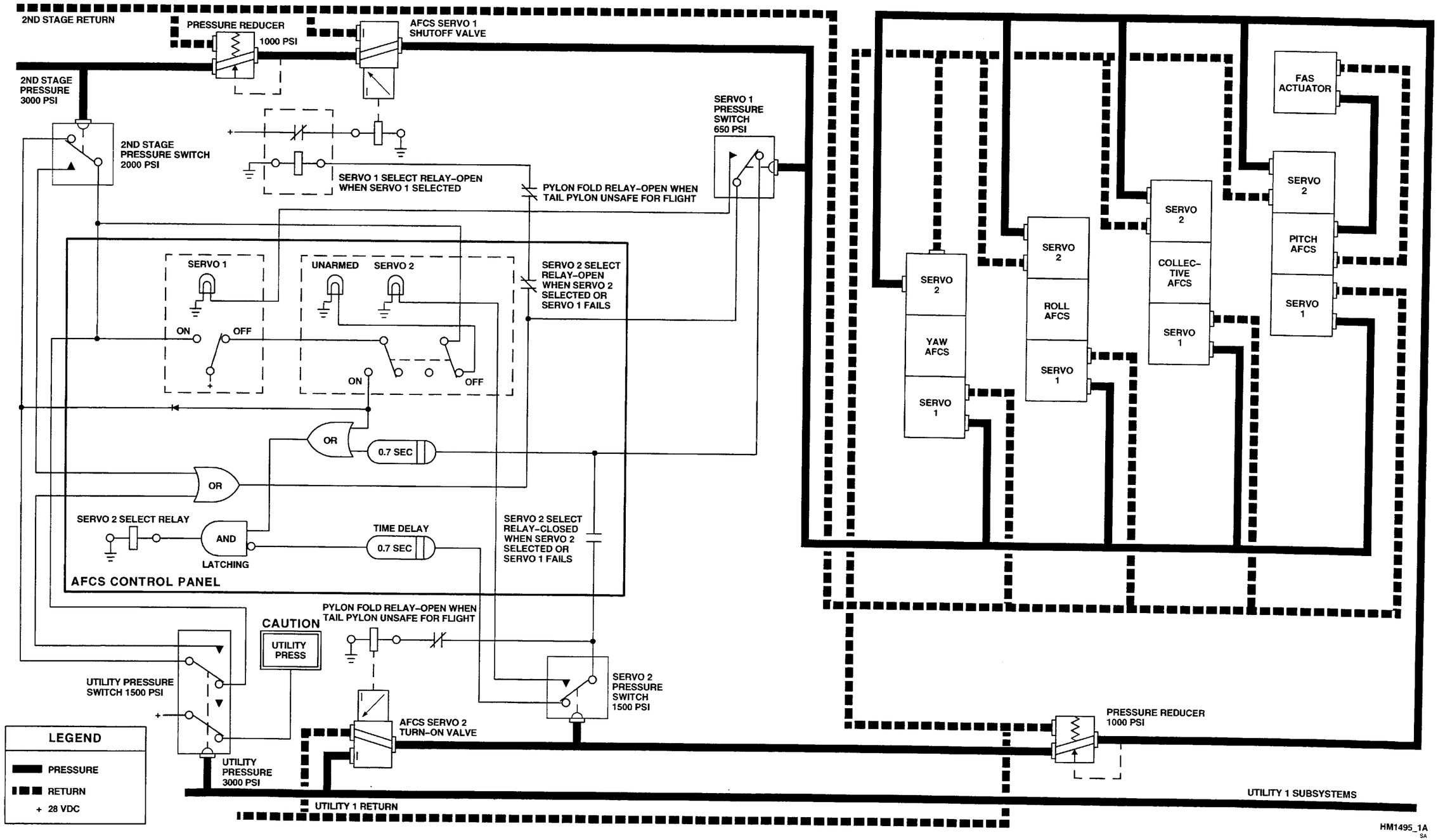
Flight Control Hydraulic System Schematic (Sheet 1 of 3)



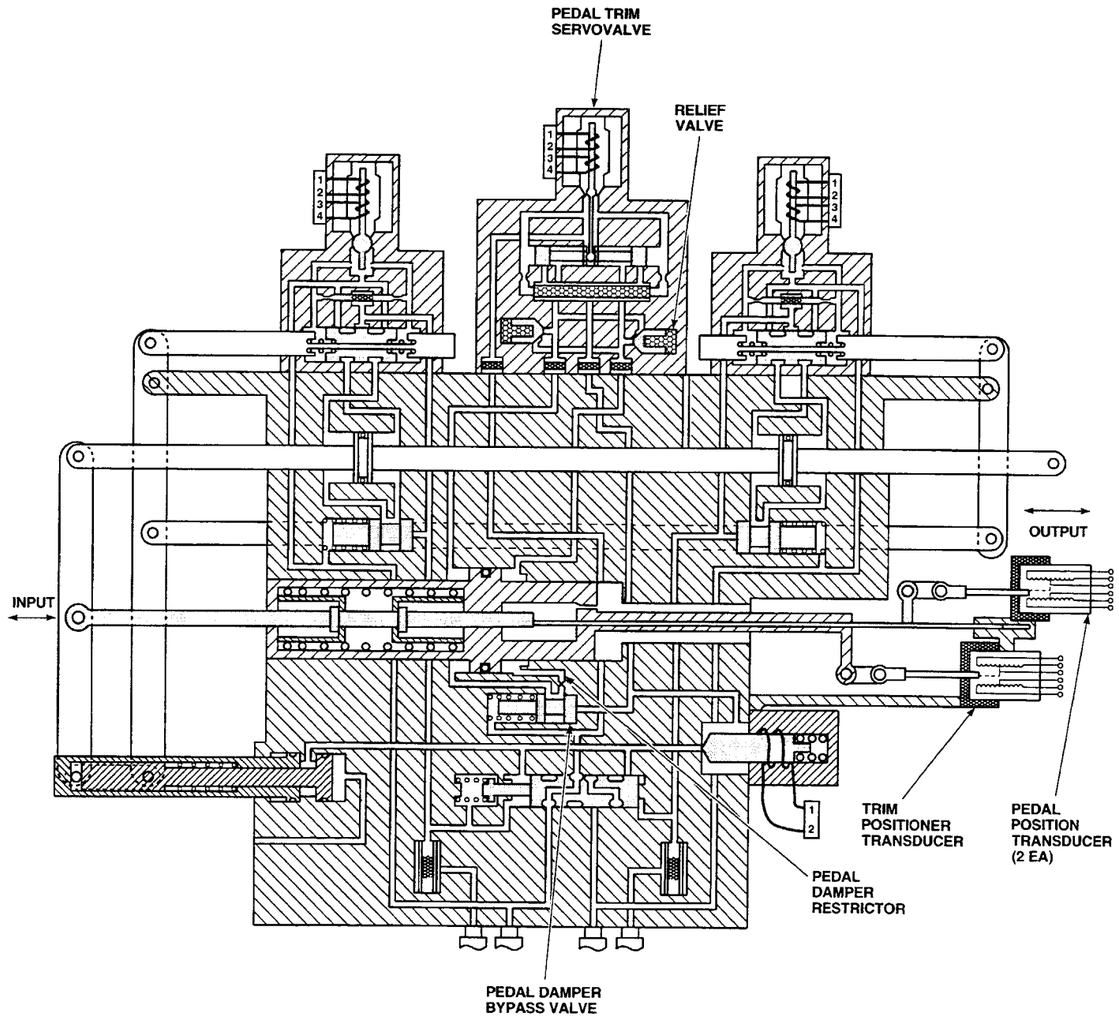
Flight Control Hydraulic System Schematic (Sheet 2 of 3)



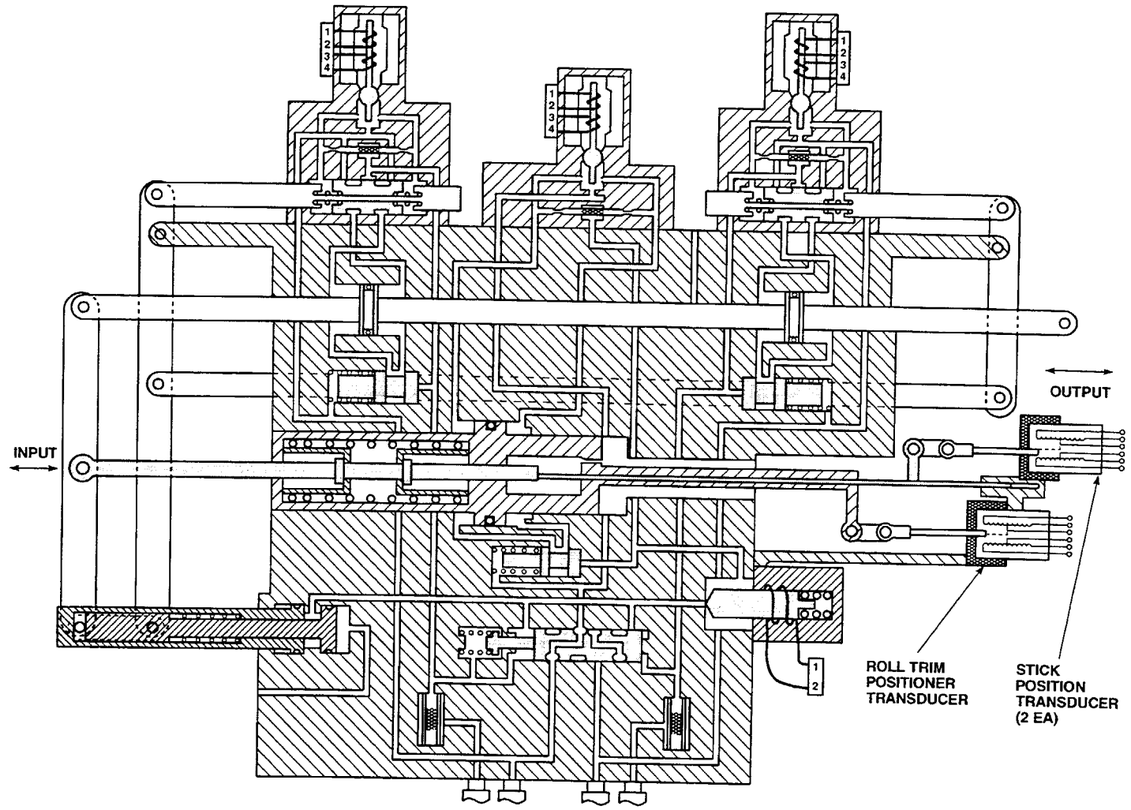
Flight Control Hydraulic System Schematic (Sheet 3 of 3)



AFCS Hydraulic System Schematic (Sheet 1 of 4)



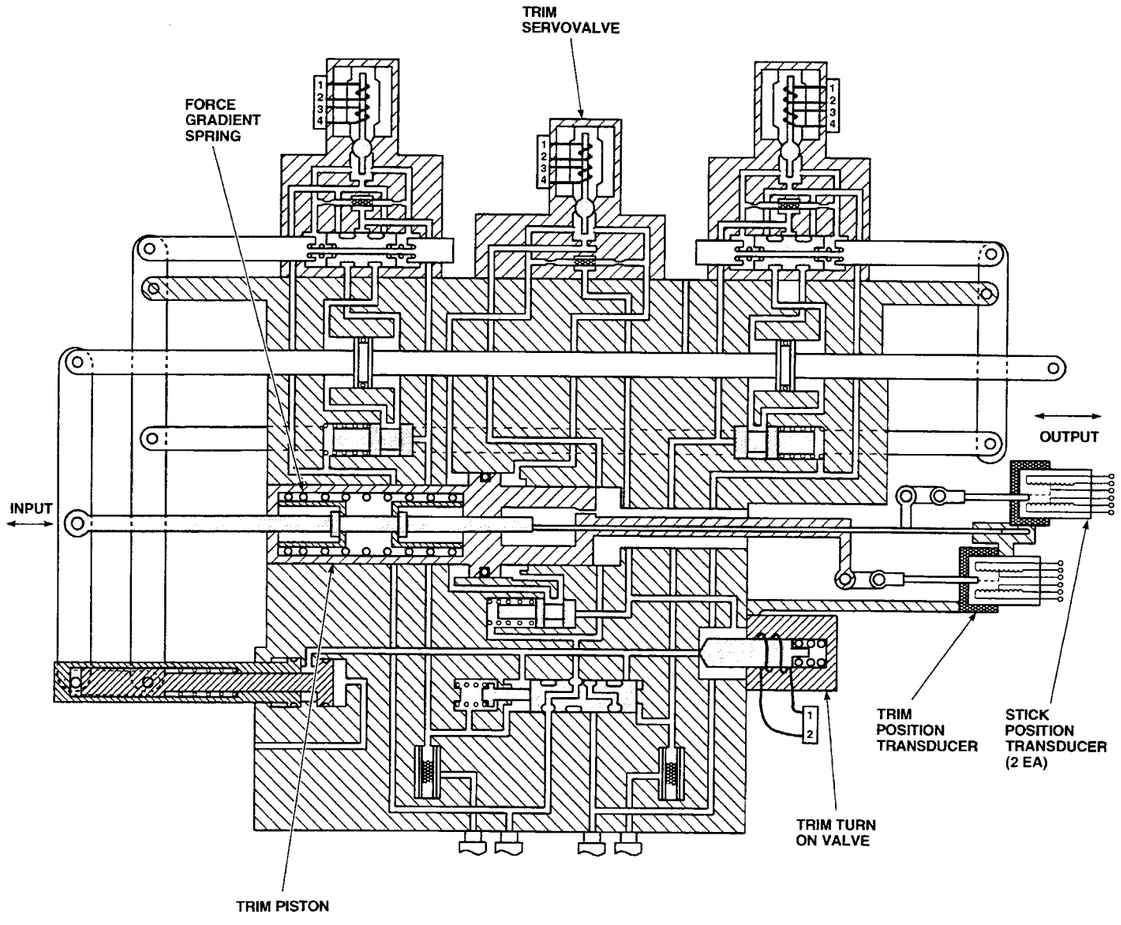
YAW AFCS SERVO HYDRAULIC SCHEMATIC



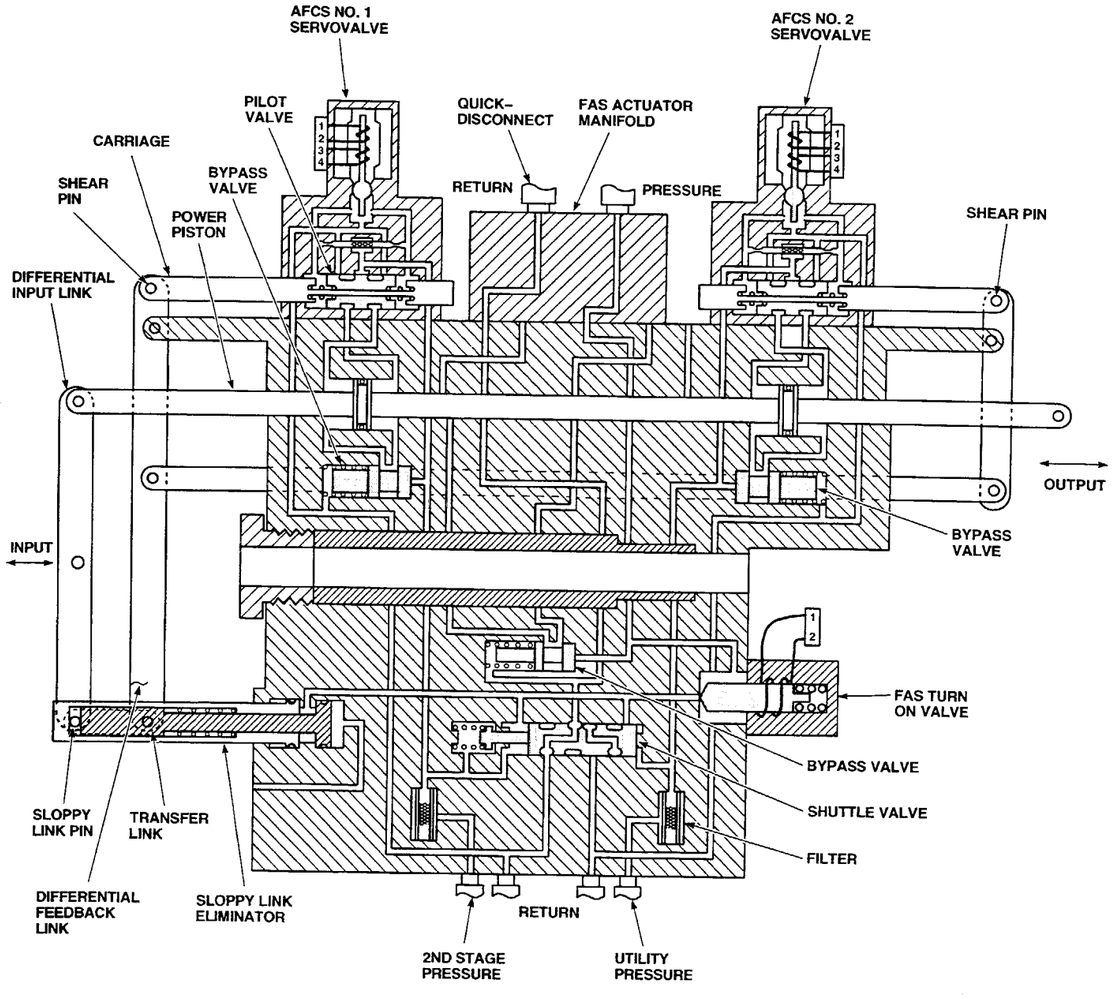
ROLL AFCS SERVO HYDRAULIC SCHEMATIC

HM1495_2
SA

AFCS Hydraulic System Schematic (Sheet 2 of 4)



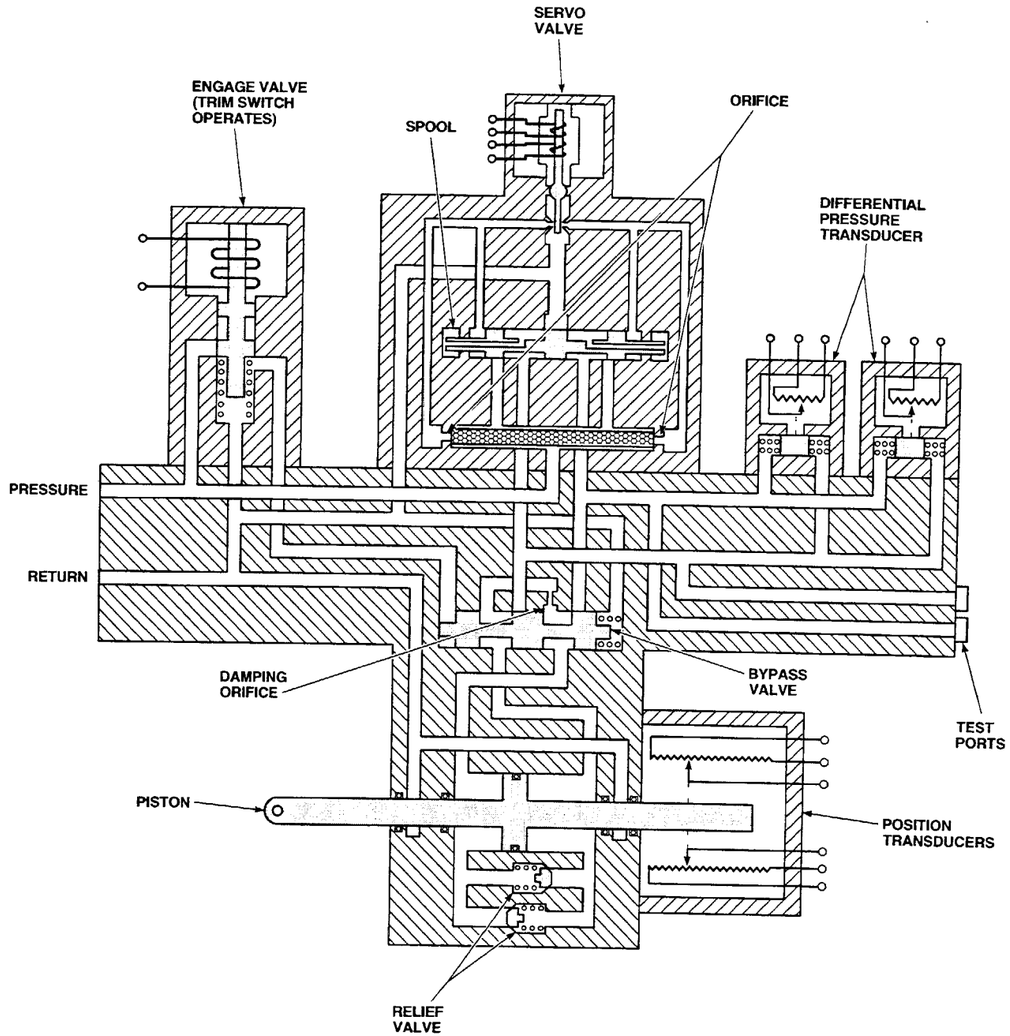
COLLECTIVE AFCS SERVO HYDRAULIC SCHEMATIC



PITCH AFCS SERVO HYDRAULIC SCHEMATIC

HM1495_3
SA

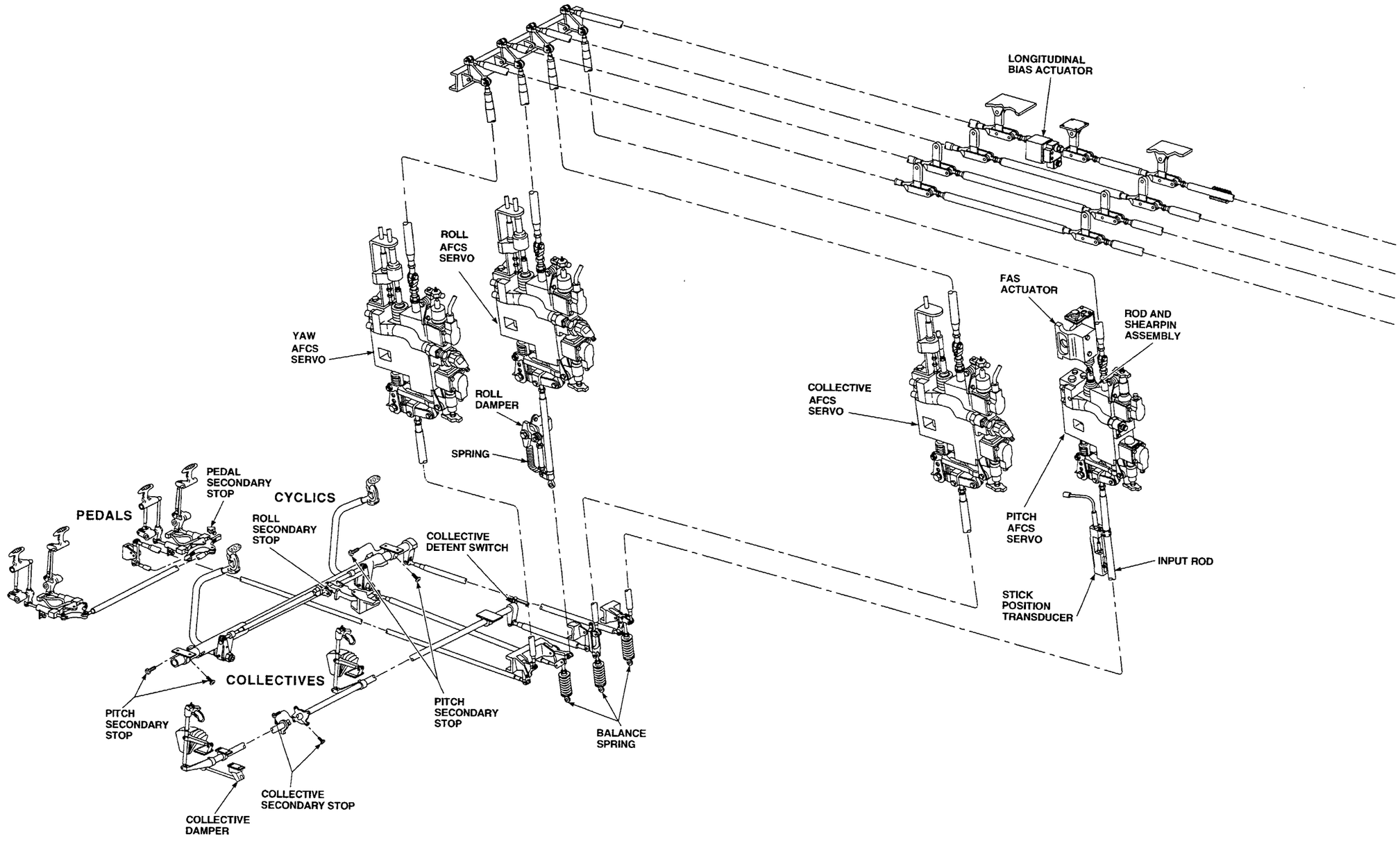
AFCS Hydraulic System Schematic (Sheet 3 of 4)



FAS ACTUATOR HYDRAULIC SCHEMATIC

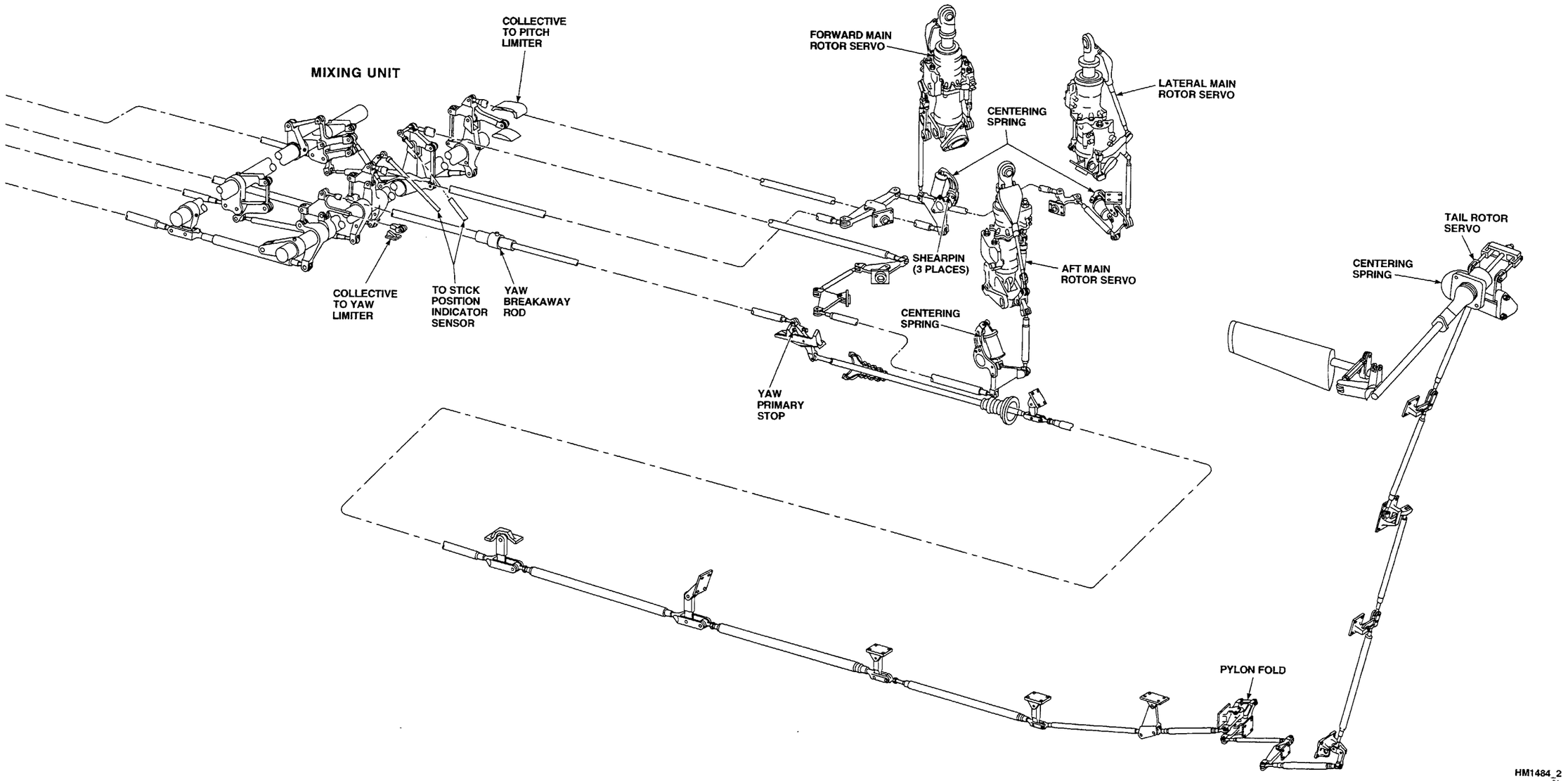
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AFCS Hydraulic System Schematic (Sheet 4 of 4)

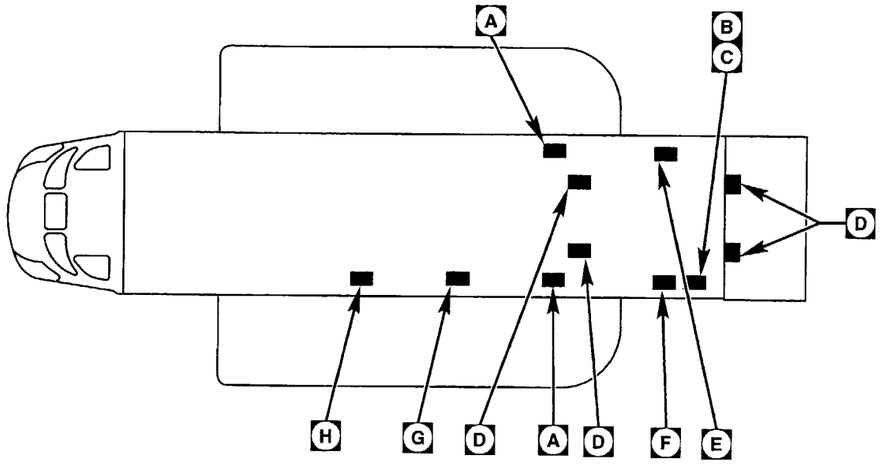


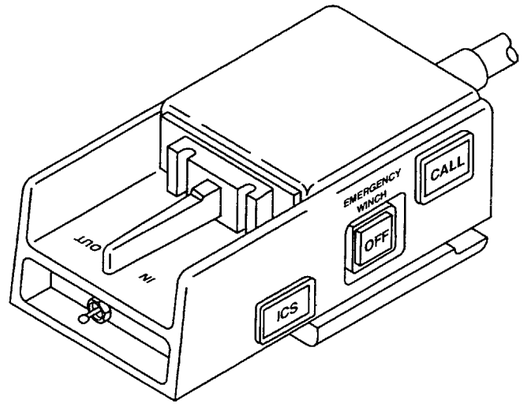
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Flight Control Schematic (Sheet 1 of 2)



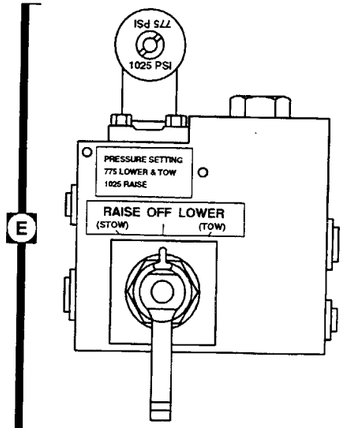
Flight Control Schematic (Sheet 2 of 2)





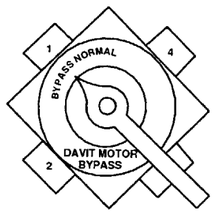
AMCM CONTROL PENDANTS

D



E

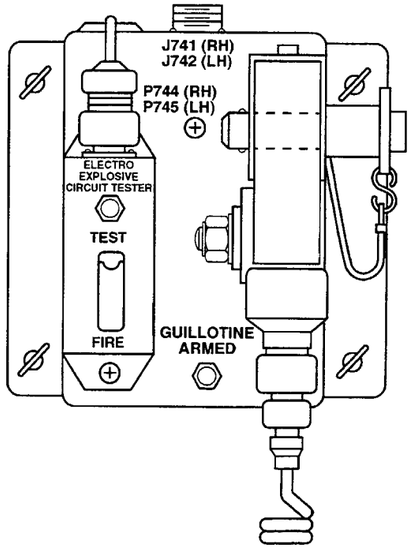
AMCM MANIFOLD



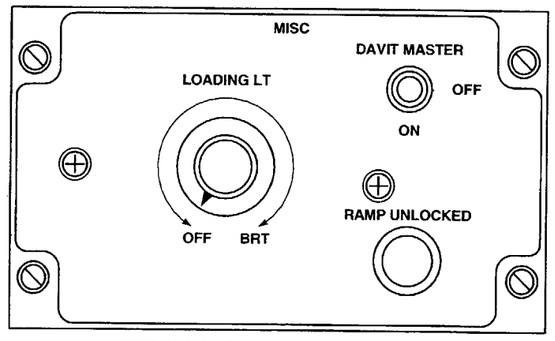
F

DAVIT MOTOR BYPASS

A

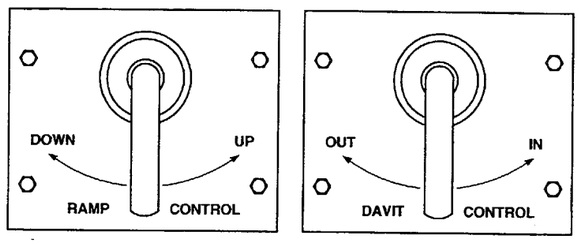


GUILLOTINE AND CIRCUIT TESTER (TWO)



B

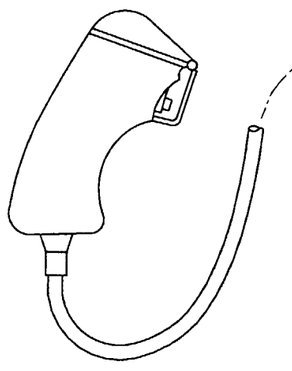
MISCELLANEOUS CONTROL PANEL



C

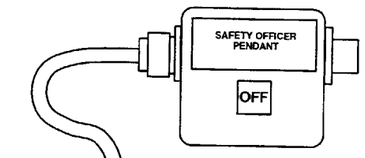
RAMP AND DAVITS CONTROL PANEL

H



SAFETY PENDANT

G



SAFETY PANEL

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COND.	PILOT ACTION	RESULTS	FOLD PANEL SWITCHES	FOLD PANEL LIGHTS	CHANGE TO CAUTION PANEL	CHANGE TO ADVISORY PANEL
			BLADE FOLD			
1.	None Aircraft Status 1. APP ON 2. No. 3 generator ON 3. Gust lock UNLOCKED 4. Rotor brake switch EMER 5. Speed levers SHUTOFF 6. Blades spread 7. Pylon spread 8. Second stage and utility pressure (2600 – 3300 psi) 9. Check droop stops and flap restrainers in	None	None Initial Status 1. Master power switch OFF 2. Pitch lock switch at DISENGAGED 3. Blade fold position switch OFF 4. Blade fold/spread switch OFF 5. Pylon fold spread switch OFF (Switches remain the same except as noted below)	1. FLIGHT READY 2. BLADES SPREAD	None Initial Status 1. MGB OIL PRESS 2. ROTOR BRAKE PRESS	None Initial Status 1. APP ON 2. ISOLATION VALVE OPEN 3. ROTOR BRAKE ON
2.	Place master power switch to POWER	Safety valve opens; hydraulic pressure is available to blade fold system	Master power switch at POWER	1. FLIGHT READY goes off 2. SAFETY VALVE OPEN goes on	BLADE PYLON FOLD goes on	No change
3.	Place blade fold position switch to BLADE FOLD POSN	1. Rotor brake pressure dumps and repumps to 40 psi 2. Rotor head drives to proper position for blade fold (No. 1 blade over aft, left side of fuselage – one position only) 3. Rotor brake repumps to 975 psi after blades are in position	1. Master power switch at POWER 2. Blade fold position switch at BLADE FOLD POSN	1. BLADES SPREAD 2. SAFETY VALVE OPEN 3. HEAD IN FOLD POSITION (After positioning sequence)	No change	ROTOR BRAKE ON light goes out during positioning and goes on after positioning sequence is complete
4.	Position cyclic and collective to light stick position indicator	Rotor head is in position for pitch locks to engage	Same as condition 3	Same as condition 3	No change	No change
5.	Place pitch lock switch to PITCH LOCK	1. Pitch locks advance 2. Second stage hydraulic gage remains normal 3. 2 STG M/R SERVO BYPAS caution light goes on	1. Master power switch at POWER 2. Blade fold position switch at BLADE FOLD POSN 3. Pitch lock switch at PITCH LOCK	1. BLADES SPREAD 2. SAFETY VALVE OPEN 3. HEAD IN FOLD POSITION 4. PITCH LOCK ADVANCED goes on as soon as any one of six pitch locks advances 5. PITCH LOCKS ENGAGED goes on after all six pitch locks are fully advanced	2 STG M/R SERVO BYPASS goes on	No change
6.	Place blade fold/spread switch to FOLD	Blades fold	1. Master power switch at POWER 2. Blade fold position switch at BLADE FOLD POSN 3. Pitch lock switch at PITCH LOCK 4. Blade fold/spread switch at FOLD	1. BLADES SPREAD light goes off 2. SAFETY VALVE OPEN 3. HEAD IN FOLD POSN 4. PITCH LOCK ADVANCED 5. PITCH LOCKS ENGAGED 6. BLADES FOLDED goes on when fully folded	No change	No change
7.	Place blade fold switch OFF	None	1. Master power switch at POWER 2. Blade fold position switch at BLADE FOLD POSN 3. Pitch lock switch at PITCH LOCK	1. SAFETY VALVE OPEN 2. HEAD IN FOLD POSN 3. PITCH LOCK ADVANCED 4. PITCH LOCK ENGAGED 5. BLADES FOLDED	No change	No change
8.	Place master power switch OFF (If pylon is to be folded immediately, leave fold master switch at ON POSN)	Safety valve remains open; pressure stays on	1. Blade fold posn switch at BLADE FOLD POSN 2. Pitch lock switch at PITCH LOCK	1. SAFETY VALVE OPEN remains on 2. HEAD IN FOLD POSN goes off 3. PITCH LOCK ADVANCED 4. PITCH LOCKS ENGAGED 5. BLADES FOLDED	No change	ROTOR BRAKE ON goes off (brake pressure remains at 975)
9.	Have crewchief lock mechanical gust lock (optional item)	Rotor head is mechanically locked in position	Same as condition 8	Same as condition 8	ROTOR LOCKED goes on	No change
			PYLON FOLD SUBSEQUENT TO BLADE FOLD			
1.	None Aircraft Status 1. APP ON 2. No. 3 generator ON 3. Rotor brake switch EMER 4. Speed levers SHUTOFF 5. Blades folded 6. Pylon spread 7. Utility press (2600–3300 psi) 8. Crewmember positioned under tail pylon with tail rotor restrainer	None	None Initial Status 1. Master power switch OFF 2. Blade fold position switch at BLADE FOLD POSN 3. Pitch lock switch at PITCH LOCK 4. Pylon and blade fold/spread switches OFF (Switches remain the same except as noted below)	1. PITCH LOCK ADVANCED 2. PITCH LOCKS ENGAGED 3. BLADES FOLDED 4. SAFETY VALVE OPEN	None	None
2.	Place master power switch to POWER	None	Master power at POWER	1. HEAD IN FOLD POSITION goes on 2. PITCH LOCKS ADVANCED 3. PITCH LOCKS ENGAGED 4. BLADES FOLDED	No change	ROTOR BRAKE ON goes on
3.	Place pylon fold/spread switch to FOLD	1. Tail rotor positioner actuator extends 2. Pylon lock pins retract, red flags extend 3. Drive shaft coupling disconnects, third red flags extends 4. Tail rotor positioner extends all the way (Tail rotor positions for minimum height)	1. Master power at POWER 2. Pylon fold/spread at FOLD	1. SAFETY VALVE OPEN 2. HEAD IN FOLD POSITION 3. PITCH LOCK ADVANCED 4. PITCH LOCKS ENGAGED 5. BLADES FOLDED 6. PYLON UNSAFE FOR FLIGHT goes on	No change	No change
4.	Place pylon fold switch OFF	None	Master power at POWER	1. SAFETY VALVE OPEN 2. HEAD IN FOLD POSITION 3. PITCH LOCK ADVANCED 4. PITCH LOCKS ENGAGED 5. BLADES FOLDED 6. PYLON UNSAFE FOR FLIGHT	No change	No change
5.	Place fold master switch OFF	None	Same as condition 1, initial status	1. HEAD IN FOLD POSITION goes off 2. PITCH LOCK ADVANCED 3. PITCH LOCKS ENGAGED 4. BLADES FOLDED 5. PYLON UNSAFE FOR FLIGHT	No change	ROTOR BRAKE ON goes off

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Blade/Pylon Fold/Spread Sequencing (Sheet 1 of 3)

COND.	PILOT ACTION	RESULTS	FOLD PANEL SWITCHES	FOLD PANEL LIGHTS	CHANGE TO CAUTION PANEL	CHANGE TO ADVISORY PANEL
			PYLON FOLD WITHOUT FOLDING BLADES			
1.	None Aircraft Status 1. APP ON 2. No. 3 generator ON 3. Gust lock UNLOCKED 4. Rotor brake EMER 5. Speed levers SHUTOFF 6. Blades spread 7. Pylon spread 8. Second stage and utility pressure (2600 – 3300 psi) 9. Crewmember positioned under tail pylon with tail rotor restrainer	None	None Initial Status 1. Master power switch OFF 2. Blade fold position switch OFF 3. Pitch lock switch at DISENGAGED 4. Pylon and blade fold/spread switches OFF 5. Switches remain the same except as noted below	1. BLADES SPREAD 2. FLIGHT READY	None Initial Status 1. MGB OIL PRESS 2. ROTOR BRAKE PRESS	None Initial Status 1. APP ON 2. ISOLATION VALVE OPEN 3. ROTOR BRAKE ON goes off
2.	Place master power switch to POWER	Safety valve opens; hydraulic pressure is available to blade fold system	Master power switch at POWER	1. FLIGHT READY goes off 2. BLADE SPREAD 3. SAFETY VALVE OPEN goes on	BLADE PYLON FOLD goes on	ROTOR BRAKE ON goes on
3.	Place pylon fold/spread switch to FOLD. As soon as blades are in position for pylon fold, pilot must stop pylon fold sequence by returning switch temporarily OFF until crewmember can restrain blades from windmilling. Return switch at fold and continue sequence	1. Rotor brake press dumps and repumps to 40 psi 2. Rotor head drives to proper position for pylon fold (Any one of seven blades over right side of aft fuselage) 3. Rotor brake repumps to 975 psi 4. Tail rotor positioner actuator extends 5. Pylon lockpins retract, red flags extend 6. Drive shaft coupling disconnects, third red flag extends 7. Tail rotor positioner fully extends; tail rotor positions for minimum height 8. AFCS SERVOS turned off	1. Master power switch at POWER 2. Pylon fold/spread switch at FOLD	1. BLADES SPREAD 2. SAFETY VALVE OPEN 3. HEAD IN FOLD POSITION goes on 4. PYLON UNSAFE FOR FLIGHT goes on	2 STG M/R PRESS M/R, 2 STG M/R SERVO BYPAS, 2 STG T/R SERVO BYPAS, and UTILITY T/R PRESS go on	ROTOR BRAKE ON light goes off during positioning and goes on after positioning sequence is complete
4.	Place pylon fold/spread switch OFF	None	Master power switch at POWER	1. BLADES SPREAD 2. SAFETY VALVE OPEN 3. HEAD IN FOLD POSITION goes off 4. PYLON UNSAFE FOR FLIGHT	No change	No change
5.	Place fold master power switch OFF	Safety valve closes; hydraulic pressure is removed from blade fold system	Same as condition 1, initial status	1. BLADES SPREAD 2. SAFETY VALVE OPEN goes off 3. PYLON UNSAFE FOR FLIGHT	No change	No change

COND.	PILOT ACTION	RESULTS	FOLD PANEL SWITCHES	FOLD PANEL LIGHTS	CHANGE TO CAUTION PANEL	CHANGE TO ADVISORY PANEL
			PYLON SPREAD (BLADES CANNOT BE SPREAD UNTIL PYLON IS IN FLIGHT POSITION)			
1.	None Aircraft Status 1. Blades and pylon folded 2. APP ON 3. No. 3 generator ON 4. Gust lock, LOCKED (Optional) 5. Rotor brake switch EMER 6. Speed levers SHUTOFF 7. Utility press (2600 – 3300 psi)	None	Initial Status 1. Master power switch OFF 2. Pitch lock switch at PITCH LOCK 3. Blade fold switch at BLADE FOLD POSN 4. Blade fold/spread switch OFF 5. Pylon fold spread switch OFF 6. Switches remain the same except as noted below	1. PITCH LOCK ADVANCED 2. PITCH LOCKS ENGAGED 3. BLADES FOLDED 4. PYLON UNSAFE FOR FLIGHT 5. SAFETY VALVE OPEN	None Initial Status 1. MGB OIL PRESS 2. ROTOR BRAKE PRESS 3. 2 STG M/R SERVO BYPASS	None Initial Status 1. APP ON 2. ISOLATION VALVE OPEN
2.	Place master power switch to POWER	None	Master power switch at POWER	1. HEAD IN FOLD POSITION goes on 2. PITCH LOCK ADVANCED 3. PITCH LOCKS ENGAGED 4. BLADES FOLDED 5. PYLON UNSAFE FOR FLIGHT	No change	ROTOR BRAKE ON goes on
3.	Place pylon fold/spread switch to SPREAD	Pylon spreads (Drive shaft coupling reconnects, lockpins extend, and flags and tail rotor positioner retracts)	1. Master power switch at POWER 2. Pylon fold/spread switch at spread	1. SAFETY VALVE OPEN 2. HEAD IN FOLD POSITION 3. PITCH LOCK ADVANCED 4. PITCH LOCKS ENGAGED 5. BLADES FOLDED 6. PYLON UNSAFE FOR FLIGHT goes out when the pylon is spread	No change	No change
4.	Place pylon fold/spread switch OFF	None	Master power switch at POWER	1. SAFETY VALVE OPEN 2. HEAD IN FOLD POSITION 3. PITCH LOCK ADVANCED 4. PITCH LOCKS ENGAGED 5. BLADES FOLDED	No change	No change
			BLADE SPREAD			
1.	None Aircraft Status 1. Blades folded 2. APP ON 3. No. 3 generator ON 4. Gust lock LOCKED (Optional) 5. Rotor brake switch EMER 6. Speed levers SHUTOFF 7. Utility press (2600 – 3300 psi) 8. Second stage pressure (2600 – 3300 psi)	None	None Initial Status 1. Master power switch ON 2. Pitch lock switch at ENGAGED 3. Blade fold position switch at BLADE FOLD POSN 4. Blade fold/spread switch OFF 5. Pylon fold/spread switch OFF (Switches remain the same except as noted below)	1. SAFETY VALVE OPEN 2. HEAD IN FOLD POSITION 3. PITCH LOCK ADVANCED 4. PITCH LOCKS ENGAGED 5. BLADES FOLDED	1. MGB OIL PRESSURE 2. ROTOR BRAKE PRESSURE 3. ROTOR LOCKED 4. 2 STG M/R SERVO BYPASS 5. 2 STG PRESS M/R AND 2 STG T/R SERVO BYPASS remains off	1. APP ON 2. ISOLATION VALVE OPEN 3. ROTOR BRAKE ON

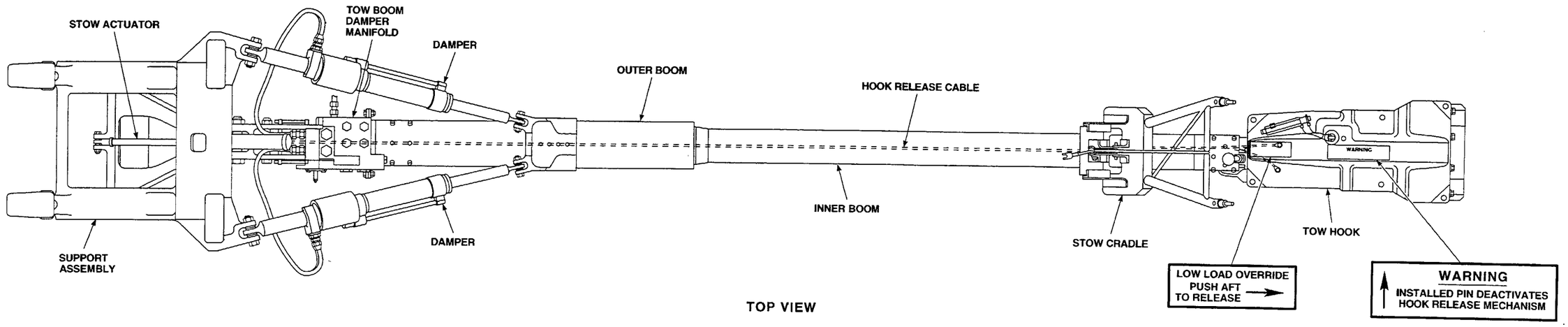
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Blade/Pylon Fold/Spread Sequencing (Sheet 2 of 3)

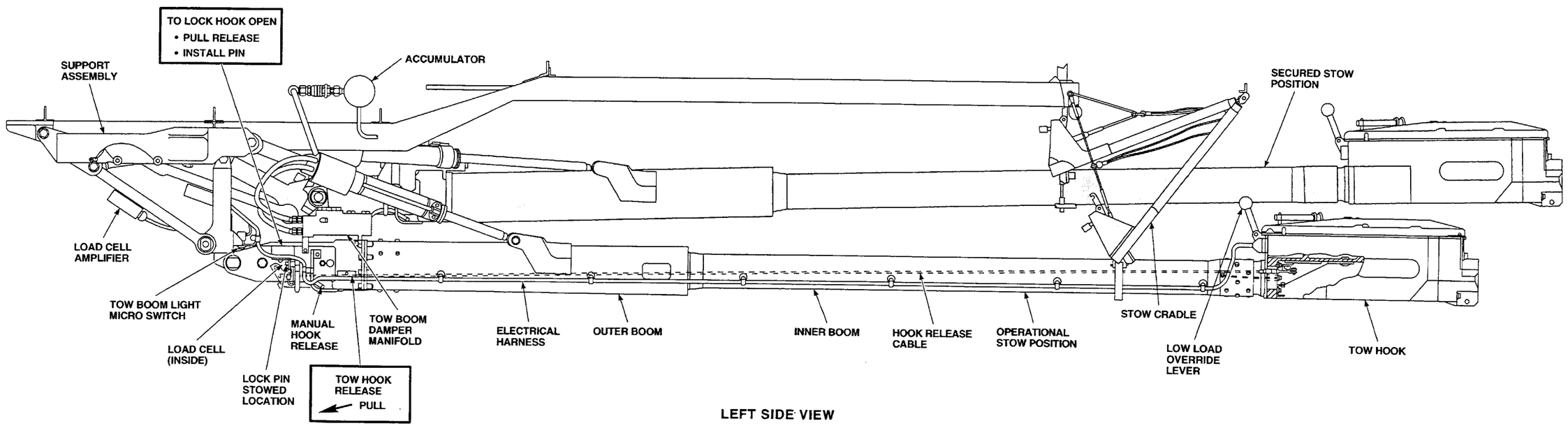
PILOT ACTION	RESULTS	FOLD PANEL SWITCHES	FOLD PANEL LIGHTS	CHANGE TO CAUTION PANEL	CHANGE TO ADVISORY PANEL
Have crewchief unlock gust lock (If applied)	Rotor head is mechanically unlocked	No change	Same as condition 1	ROTOR LOCKED goes off	No change
Place blade fold/spread switch at SPREAD	Blades spread and lock-pins go home	Blade fold/spread at SPREAD	1. SAFETY VALVE OPEN 2. HEAD IN FOLD POSITION goes off	No change	No change
Place blade fold/spread switch at OFF			1. HEAD IN FOLD POSITION goes on 2. PITCH LOCK ADVANCED 3. PITCH LOCKS ENGAGED 4. BLADES FOLDED goes off 5. BLADES SPREAD goes on when fully spread	No change	No change
Place pitch lock switch at DISENGAGED	Pitch locks retract	1. Blade fold/spread switch at OFF 2. Pitch lock switch at DISENGAGED	1. BLADES SPREAD 2. SAFETY VALVE OPEN 3. HEAD IN FOLD POSITION 4. PITCH LOCK ADVANCE goes off when all six pitch locks are retracted 5. PITCH LOCKS ENGAGED goes off as soon as one of six pitch locks retracts 6. Second stage pressure remains at normal (2600 – 3300 psi)	2 STG M/R SERVO BYPASS goes off	No change
Place blade fold position switch OFF	None	1. Blade fold/spread switch at OFF 2. Pitch lock switch at DISENGAGED 3. Blade fold position switch OFF	1. BLADES SPREAD 2. SAFETY VALVE OPEN 3. HEAD IN FOLD goes off	No change	No change
Place master switch OFF	Safety valve deenergized (Closes)	1. Blade fold/spread switch at OFF 2. Pitch lock switch at DISENGAGED 3. Blade fold position switch OFF 4. Master power switch OFF	1. BLADE SPREAD 2. FLIGHT READY goes on	BLADE PYLON FOLD goes off	No change

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Blade/Pylon Fold/Spread Sequencing (Sheet 3 of 3)



TOP VIEW



LEFT SIDE VIEW

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Tow Boom and Hook

INNER LOOP FUNCTIONS

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
SAS 1. Provides rate damping in pitch, roll and yaw 2. Provides short term dynamic stability	Pitch, roll and yaw rate gyros	Approximately ±11% in pitch, ±10 % in roll and collective, ±14% in yaw	All airspeeds	1. Will not move flight controls 2. Fail Operational for sensor, servo, or actuator malfunction 3. Weight on wheels–yaw SAS disabled
HOVER AUGMENTATION 1. Opposes aircraft acceleration along lateral and longitudal axis 2. Improves hover stability	1. Lateral and longitudinal accelerometer 2. Air data transducer	±55% within the authority of SAS function	Below 60 KIAS	1. Will not move flight controls 2. Fail Safe for sensor, servo, or actuator malfunction 3. Aircraft attitude must be between +13.3° nose up and –4.4° nose down
GUST ALLEVIATION 1. Improves aircraft stability at all airspeeds	1. Pitch and roll vertical gyros	±55% within the authority of SAS function	All airspeeds	1. Will not move flight controls 2. Fail Safe for sensor, servo, or actuator malfunction
TURN COORDINATION 1. Improves aircraft turn coordination 2. Holds ball within 1/2 ball width of center 3. Inner loop	1. Roll rate gyro 2. Lateral accelerometer 3. Air data transducer 4. Yaw trim position transducer 5. Yaw pedal position transducer	±14% yaw	Greater than 60 KIAS	1. Will not move flight controls 2. Fail Safe for sensor, servo, or actuator malfunction 3. Fail Operational for air data transducer 4. Turn coordination is engaged when: a. Cyclic trim release is depressed, or cyclic roll beep is engaged, or cyclic is displaced laterally against trim greater than 3.4% (0.3 lbs plus breakout)
CYCLIC/PEDAL/COLLECTIVE DESENSITIZATION 1. Reduces the effect of pilot induced oscillations in pitch, roll and collective 2. Reduces the effect of yaw AFCS interaction with the aircraft bending modes	1. Cylic, pedal, collective, yaw position transducers 2. Pitch, roll and yaw rate gyros	±100% of SAS authority	All airspeeds	1. Will not move flight controls 2. Fail Operational for sensor, servo, or actuator malfunction
LONGITUDINAL BIAS ACTUATOR 1. Provides a positive cyclic gradient in pitch	1. Pitch rate gyro 2. Air data transducer	±15% authority at a rate of 5.5% per second	Effective between 60 and 180 KIAS	1. Will not move flight controls 2. Fail Operational for simplex failure or gyro malfunction 3. Fail Safe for air data transducer failure, programs airspeed to 120 KIAS, and moves LBA to mid–range 4. Pitch rate gyro input interacts to dampen the fluctuating airspeed signals and improve aircraft maneuvering
CYCLIC/PEDAL/COLLECTIVE DAMPING 1. Provides pitch and roll cyclic damping 2. Provides pedal damping 3. Provides collective damping			All airspeeds	1. The FAS actuator provides cyclic pitch damping 2. The roll viscous damper provides cyclic roll damping 3. The yaw AFCS servo provides pedal damping 4. The collective viscous damper provides collective position damping 5. All dampers have shear pins or override devices

OUTER LOOP FUNCTIONS

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
COLLECTIVE TRIM 1. Holds collective at the pilots desired position	Collective trim position transducer	100% authority, 10% per second	All airspeeds	1. Fail Operational for simplex failure 2. Fail Safe for sensor malfunction 3. Pilot can override function by overpowering force gradient spring 4. Trim pushbutton must be on 5. Trim release switch allows for referencing of trim

OUTER LOOP FUNCTIONS

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
CYCLIC TRIM 1. Holds cyclic at the pilots desired position	Cyclic trim position transducer	100% authority, 5% per second	All airspeeds	1. Fail Safe for sensor or actuator malfunction 2. Pitch trim Fail Safe, roll trim Fail Operational for simplex failure 3. Pilot can override function 4. Trim pushbutton must be on 5. Trim release switch allows for referencing of trim
PEDAL TRIM 1. Holds pedal at the pilots desired position	Pedal trim position transducer	100% authority, 10% per second	All airspeeds	1. Fail Safe for sensor malfunction 2. Pilot can override function by overpowering force gradient spring. Pedal force will build to about 24 pounds depending upon side slip angle 3. Trim pushbutton must be on 4. Pedal microswitch or collective pedal trim release button allows for referencing of trim 5. Pedal microswitches affect pedal trim below 60 KIAS 6. Collective pedal trim switches affect pedal trim at all airspeeds 7. Heading hold disengaged when pedal force limiting in effect
AUTOPILOT 1. Heading bold–yaw	1. AHRS heading gyro 2. Heading trim control 3. Roll and yaw rate gyros	100% authority, 10% per second	All airspeeds	1. Moves cockpit flight controls 2. Fail Safe for sensor or actuator malfunction 3. Fail Operational for Simplex failure 4. Holds heading ± 2° 5. Heading trim control knob on AFCS control panel allows for fine trimming of heading, 3.6° per tic mark at a rate of 3° per sec 6. Autoturn is available with airspeed greater than 60 KIAS 7. Heading hold will disengage when: a. Airspeed less than 60 KIAS with feet on pedals of collective pedal trim depressed b. Airspeed greater than 60 KIAS and collective pedal trim release depressed c. Airspeed greater than 60 KIAS and cyclic trim release depressed, or cyclic roll beep engaged, or cyclic displaced laterally against trim greater than 3.4% (0.3 lbs plus breakout) d. Skew angle or Tow heading engaged 8. Heading hold reengages when: a. Bank angle is less than 2° and b. Yaw rate is less than 0.66° per second and c. Roll rate is less than 0.33° per second and d. Auto turn logic not being met
AUTOPILOT 1. Pedal force limiting	1. Pedal position transducer 2. Pedal trim position transducer		All airspeeds	1. Fail Safe for sensor malfunction 2. Allows pilot to sideslip aircraft at speeds above 60 KIAS without excessive force 3. Engaged when pedal force exceeds 2.4% pedal displacement (approx. 9 lbs plus breakout force). Pedal force is limited to 24 pounds 4. Disengages heading hold, outer loop turn coordination and skew
AUTO TURN	Lateral Accelerometer	100% authority, 10% per second	Greater than 60 KIAS	1. Fail Safe for sensor malfunction 2. Auto turn logic: a. Cyclic trim release switch depressed b. Cyclic beeper depressed c. Cyclic roll displacement greater than 3.4% from trim

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AFCS/Coupler Function Modes (Sheet 1 of 4)

OUTER LOOP FUNCTIONS

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
AUTOPILOT 1. Attitude hold–roll	Roll vertical gyro	100% authority, 7.5% per second	All airspeeds Weight off wheels	1. Moves cockpit flight controls 2. Fail Safe for sensor malfunction 3. Beeping rate 4° per second 4. Holds aircraft ±1° up to 45° and ±2° between 45° and 60° 5. Cyclic trim release button and Autobank reference attitude hold 6. Engagement of any roll coupler mode will disengage roll attitude hold 7. Beep trim will have a crisper response with engagement of any tow modes or tow tension above a set threshold 8. Roll attitude will command aircraft to wings level when: a. Autoturn disengeges (within 2° wings level) and Autobank engaged b. Heading hold is engaged and the aircraft accelerates through 60 KIAS in depart mode c. Heading hold is inhibited in approach mode due to high roll attitude and the aircraft decelerates through 60 KIAS
AUTOPILOT 1. Attitude hold–pitch	Pitch vertical gyro	100% authority, 15% per second	Below 60 KIAS All airspeeds for air data transducer failure	1. Moves cockpit flight controls 2. Fail Safe for sensor malfunction 3. Fail Operational for air data transducer malfunction 4. Beeping rate 2° per second 5. Holds aircraft ±1° 6. Cyclic trim release button references attitude hold 7. Engagement of any pitch coupler mode will disengage pitch attitude hold
AUTOPILOT 1. Airspeed hold–pitch	1. Air data transducer 2. FAS stk/dsen transducer	100% authority, 15% per second	Greater than 60 KIAS	1. Moves cockpit flight controls 2. Fail Safe for sensor malfunction 3. Beeping rate 6 KIAS per second 4. Holds airspeed ±5 KIAS up to 35° angle of bank, in calm air and unaccelerated flight. Greater than 35° angle of bank airspeed hold is faded out 5. Cyclic trim release button references airspeed hold 6. Beeped speed changes may be stopped by briefly depressing the beeper 7. For airspeed hold failure system degrades to attitude hold
AUTOBANK 1. Automatic reference of roll attitude hold	1. Yaw and Roll trim position transducer 2. Roll stick position transducer 3. Air data transducer 4. Roll rate gyro		Greater than 60 KIAS	1. Fail Safe for sensor malfunction 2. Fail Operational for air data transducer malfunction 3. If heading hold has reengaged, computers will level aircraft 4. Allows for automatic referencing of roll attitude hold at airspeeds greater than 60 KIAS 5. Autobank operates when: a. Cyclic is displaced laterally against trim greater than 3.4% (0.3 lbs plus breakout) b. Trim release is depressed
FAS–FORCE AUGMENTATION SYSTEM 1. Maneuvering force feel cue proportional to load factor	1. Pitch rate gyro 2. Air data transducer 3. Pitch trim position transducer	100% authority, 100% per second, 15% CMD limit	All airspeeds	1. Moves cockpit flight controls 2. Fail Safe for sensor malfunction 3. Fail Operational for air data transducer malfunction, FAS programs to 120 KIAS 4. Approximately 8–10 lbs/G

OUTER LOOP FUNCTIONS

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
BAR ALT–BAROMETRIC ALTITUDE HOLD 1. Provide barometric altimeter hold	1. Air data transducer 2. Vertical, lateral, longitudinal, accelerometer 3. Pitch and roll vertical gyros 4. Collective trim position transducer			1. Fail Safe for sensor malfunction 2. Holds engaged barometric altitude ±25 feet or 1% of altitude, whichever is greater, in calm air, unaccelerated flight out of ground effect 3. When engaged with climb or descent less than 500 feet per minute, altitude held to less than two significant overshoots 4. Collective trim switch will allow for temporary release and re–reference of altitude. BAR ALT pushbutton flashes 5. BAR ALT pushbutton on AFCS control panel will initiate permanent release 6. Will not engage if RAD ALT, HOVER or APPROACH/DEPART MODE is engaged
RAD ALT–RADAR ALTIMETER HOLD 1. Provide radar altimeter hold at altitude selected with the ALT SET knob up to 500 feet	1. Radar altimeter sensor 2. Rad alt select potentiometer 3. Collective trim position transducer		Greater than 200 feet limits rate of climb 960 FPM Greater than 200 feet limits rate of descent to 540 FPM Less than 200 feet limits rate of descent to 200 FPM	1. Fail Operational for one RAD ALT malfunction 2. Holds pilot's desired altitude above ground ± 7 feet or 5% of altitude, whichever is greater 3. Altitude select limited 0–500 feet 4. Collective trim release or RAD ALT pushbutton causes permanent release 5. BAR ALT HOLD will automatically engage one time if RAD ALT HOLD fails or a generator is reset 6. The RAD ALT will not engage if: a. BAR ALT, APPROACH, or DEPART mode is engaged b. RAD ALT mode has failed c. APPROACH had just been disengaged and HOVER or DEPART are not engaged and the aircraft is not in close proximity to ALT SET d. RAD ALT mode has failed
TORQUE LIMITING 1. Provides upper limit on collective stick commands if engine torque approaches 121%			All airspeeds	1. AFCS and TRIM on and one of the following engaged: APPROACH, DEPART, BAR ALT or RAD ALT

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AFCS/Coupler Function Modes (Sheet 2 of 4)

APPROACH/HOVER/DEPART COUPLER

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
APPROACH COUPLER 1. Automatic approach to hover at groundspeed and radar altitude selected with Long Vel, Lat Vel and Hvr Alt controls	1. Doppler 2. Pitch and Roll rate gyro 3. Radar altimeter 4. Lateral and longitudinal velocity set potentiometers 5. Airspeed transducer		All airspeeds	1. AFCS and TRIM engaged. Autobank and Tow coupler disengaged 2. Fail Safe for sensor malfunction 3. Moves cockpit flight controls 4. After engagement if doppler goes into memory or fails alternate approach is possible, pilot controls airspeed 5. Engagement profiles: a. On line approach descend 200 foot/min, decelerate one knot/sec b. Above line approach descend 400 foot/min, airspeed hold c. Below line approach altitude hold, decelerate one knot/sec 6. Above 60 KIAS beeping laterally will not effect deceleration profile 7. Below 60 KIAS beeping not allowed 8. All attitudes greater than 5°, induced after approach engage will be washed out when passing through 60 KIAS 9. Roll attitude greater than 5° on engagement CPLR fail advisory light illuminate 10. Pitch trim beeping at 0.2 knot per sec within 0 to 2 knot per sec decel rate 11. Rad Alt hold engages at 150 feet then descends to alt set on rad alt set knob
HOVER COUPLER 1. Provides longitudinal and lateral groundspeed control and stabilization about groundspeed set on the Long Vel and Lat Vel controls	1. Doppler 2. Pitch and Roll rate gyro 3. Radar altimeter 4. Lateral and longitudinal velocity control knobs 5. Airspeed transducer	Lateral trim ±20 knots Longitudinal trim – 50/–20 knots	Automatically groundspeed less than 2 knots Manually groundspeed less than 5 knots above long vel set pot	1. AFCS and Trim engage, Tow coupler disengaged 2. Fail Safe for sensor malfunction 3. Moves cockpit flight controls 4. Doppler cannot be in memory to select Hover 5. Beeper increments in 3 knot per second interval and is rate limited to 1 knot per second
DEPART COUPLER 1. Provides for automatic departure from hover along a predetermined profile to a cruise airspeed 100 knots and altitude of 500 feet 2. Provides for automatic departure from approach along a predetermined profile to a cruise airspeed 100 knots and altitude of 500 feet	1. Doppler 2. Pitch and Roll rate gyro 3. Radar altimeter 4. Lateral and longitudinal velocity control knobs 5. Airspeed transducer		All airspeeds Climb rate of 480 feet per minute Accelerate at 2 knot per second	1. AFCS, TRIM and Doppler engaged 2. Malfunctioning of a sensor may result in loss of AFCS function 3. Moves cockpit flight controls 4. Doppler required to initiate Depart. After engagement if doppler goes into memory or fails: a. Pitch attitude hold below 60 KIAS b. Airspeed transducer provide airspeed information above 60 KIAS 5. Departure profiles: a. From hover immediate climb at 480 feet per minute, accelerate at 2 knot per second b. From rearward flight, accelerate at 2 knot per second till groundspeed passes zero, then climb at 480 feet per minute c. From forward flight, airspeed below 60 knots and lateral velocity over ±20 knots accelerate at 2 knot per second till lateral velocity within 20 knots, then climb at 480 feet per minute d. From forward flight, airspeed above 60 knots attitude commanded to hold wings level, accelerate at 2 knot per second, climb at 480 feet per minute

APPROACH/HOVER/DEPART COUPLER

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
DEPART COUPLER (Cont.)				e. From forward flight airspeed above 100 knots, less than 500 feet attitude commanded to hold wings level, airspeed hold engage, climb at 480 feet per minute f. From forward flight, airspeed below 100 knots greater than 500 feet attitude commanded to hold wings level, altitude hold engage, accelerate at 2 knot per second 6. During departure, depressing collective trim release switch engages altitude hold, aircraft continues to accelerate to 100 knots 7. During departure, depressing cyclic trim release switch engages airspeed hold aircraft climbs to 500 feet 8. BAR ALT hold engages at radar altitude of 500 feet

TOW COUPLER FUNCTIONS

TOW HEADING HOLD (TOW HDG) 1. Provides for heading retention under tow.	1. Lateral accelerometer 2. Lateral doppler velocity 3. AHRS gyro 4. Heading trim control 5. Roll and yaw rate gyros 6. Roll vertical gyro 7. Stick/pedal desen 8. Roll trim position transducer	100% authority Heading trim control knob rate limited 1.5° per sec Roll beeper rate limited 1.5° per sec 3° per sec max either direction	Weight off wheels Tow tension greater than 400 lbs	1. AFCS and TRIM engaged. APP/HVR or Auto Bank disengaged 2. Engaging TOW HDG disengages HDG HOLD function 3. Holds heading ±3° 4. TOW HDG pushbutton depressed with less than 400 lbs, TENS light flash, tension hold armed 5. Heading trim control knob for fine trimming, 3° per tick mark, 72° per rev 6. TOW HDG temporarily released ((armed) a. Tension drop below 400 lbs for 2 sec b. Heading rate beeped with roll beeper. Will not re–engage unless cyclic trim release depressed or beeper rate beeped back through zero° per sec 7. 6 sec delay upon re–engagement with cyclic trim release or beeper 8. TOW HEADING permanently released: a. Electrical or manual Tow cable release b. TOW HDG pushbutton depressed off
TOW TENSION HOLD (TENS) 1. Provides for tow cable tension retention.	1. Longitudinal accelerometer 2. Longitudinal doppler velocity 3. Tension sensor 4. Pitch and Roll rate gyros 5. Pitch vertical gyro 6. Pitch trim position transducer 7. Pitch and Roll stick position transducer 8. Airspeed transducer 9. Stick/pedal desen	100% authority Pitch beeper rate at 10% reference tension per sec, min 300 lbs per sec	Weight off wheels Tow tension greater than 400 lbs Below 60 KIAS	1. AFCS and TRIM engaged. APP/HVR/DPART and Autobank not engaged 2. Tension ±10% or 100 lbs whichever greater 3. TENS pushbutton depressed with less than 400 lbs, TENS light flash, tension hold armed 4. Fail operational for tow tension failure 5. TOW TENSION temporarily released (armed and flashing): a. Tension drop below 400 lbs for 2 sec b. Tension rate beeped with Pitch beeper trim c. Trim release 2.5 sec delay upon re–engagement with cyclic trim release 6. TOW TENS permanently released: a. Electrical or manual Tow cable release b. GND SPD pushbutton depressed on c. TENS pushbutton depressed off

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AFCS/Coupler Function Modes (Sheet 3 of 4)

TOW COUPLER FUNCTIONS

FUNCTION	SENSORS	AUTHORITY	EFFECTIVE AIRSPEED	COMMENTS
SKEW ANGLE HOLD (SKEW) 1. Provide for cable skew angle retention under tow.	1. Skew sensor 2. Stick/pedal desen 3. Yaw rate gyro 4. Skew trim pot 5. Yaw trim position transducer 6. Yaw pedal position transducer	100% authority 20° skew angle per revolution with ±10% limit skew angle	Weight off wheels Tow tension greater than 400 lbs	1. AFCS and TRIM engaged 2. Fail Operational for one skew sensor 3. Skew Hold ±2° 4. SKEW pushbutton depressed with less than 400 lbs, SKEW light flash, Skew hold armed 5. SKEW hold temporarily released (armed and flashing): a. Tension drop below 400 lbs for 2 sec b. Collective pedal release or pedal microswitch depressed c. Skew trim dial 6. SKEW hold permanently released: a. Electrical or manual Tow cable release b. SKEW pushbutton depressed off
GROUNDSPEED HOLD 1. Provides for groundspeed retention under tow	1. Pitch rate gyros 2. Longitudinal doppler velocity 3. Longitudinal accelerometer 4. Pitch vertical gyro 5. Stick/pedal desen 6. Pitch trim position transducer 7. Pitch stick position transducer	100% authority Pitch beeper rate 3 knot per sec, rate limited 0.5 knot per sec	Below 60 KIAS	1. AFCS and TRIM engaged 2. No minimum tension required 3. Holds groundspeed ±3 knots 4. GROUNDSPEED temporarily released (armed and flashing): a. Trim release 2.5 sec delay upon re-engagement with cyclic trim release b. Groundspeed rate beeped with Pitch beeper trim 5. GROUNDSPEED permanently released: a. Electrical or manual Tow cable release b. GND SPD pushbutton depressed off c. TENS pushbutton depressed on

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AFCS/Coupler Function Modes (Sheet 4 of 4)

CONDITIONS ILLUMINATING AFCS CONTROL PANEL AND APPR/HOVER/TOW COUPLER PANEL FAIL ADVISORY LIGHTS

	TRIM	ATT	DSEN	HDG	A/S	COORD	BIAS	HVR	FAS	BANK	ALT	SAS	CPLR	SKEW	GS	TENS	TOW	CREW
Dual Pitch Rate Gyro		X	X		X		X	X	X		X	X	X		X	X		
Dual Roll Rate Gyro		X	X			X		X		X		X	X			X	X	
Dual Yaw Rate Gyro			X	X		X				X		X		X			X	
1080Y Vertical Gyro Pitch Channel		X			X			X			X		X		X	X		
1080Y Vertical Gyro Roll Channel		X						X		X	X		X				X	
AHRS Vertical Gyro Pitch Channel		X			X			X			X		X		X	X		
AHRS Vertical Gyro Roll Channel		X						X		X	X		X				X	
AHRS Directional Gyro Channel				X						X							X	
Longitudinal Accelerometer					X			X			X		X		X	X		
Lateral Accelerometer						X		X			X		X				X	
Vertical Accelerometer											X		X					
Airspeed Sensor					X	X	X	X	X	X			X					
Longitudinal Bias Actuator							X											
Bar Alt Sensor											X		X					
Rad Alt Sensor											X		X					
Doppler Sensor													X		X			
Skew Sensor														X				
Tension Sensor																X		
Rad Alt Set Pot											X		X					
Heading Trim Pot				X													X	
Skew Trim Pot														X				
Longitudinal Velocity Set Pot													X					
Lateral Velocity Set Pot													X					
Hoist Long/Lat Hvr Trim Pot																		X
Ramp Long/Lat Hvr Trim Pot																		X
FAS Delta P Transducer		X	X		X				X				X		X	X		
Pitch Trim Position XDCR		X	X		X				X				X		X	X		
Roll Trim Position XDCR		X	X							X			X				X	
Yaw Trim Position XDCR		X		X		X				X				X				
Collective Trim Position XDCR		X									X		X					
Pitch Stick Position XDCR (FAS) A/B		X	X	X	X				X				X		X	X		
Roll Stick Position XDCR A/B				X						X								
Yaw Pedal Position XDCR A/B				X		X				X				X				
Collective Stick Position XDCR A/B (CLTV 1, L, Fail)				X														
NVM Fail (Pitch Roll, Yaw CLTV)						X		X	X		X							
Coupler-in-memory													X		X			

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AFCS/Coupler Fail/Advisory Lights