SECTION I

DESCRIPTION

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THE HELICOPTER.

The model CH-3E and HH-3E helicopters are manufactured by Sikorsky Aircraft, Division of United Aircraft Corporation, Stratford, Connecticut. All model helicopters are designed for general purpose operations, and may be equipped for transport of cargo, personnel and litter patients, and air rescue and retrieval of aerial targets. HH-3E and some CH-3E helicopters are configured for search and rescue and combat aircrew recovery. Some helicopters are equipped with titanium armor plate which is installed for protection of the pilot, copilot, crewman, and vulnerable components from small arms fire. Some helicopters are also equipped with three M60 machine guns. General configuration is a single main rotor, twin turbine powered helicopter with amphibious capabilities. The fuselage is all metal, semimonocoque type construction, and is composed of the cockpit, the upper fuselage, the aft fuselage, the pylon, and the lower fuselage. The upper fuselage section contains the cargo compartment, the engine compartment, and the transmission compartment. The cargo compartment may be entered through the personnel door on the right side of the fuselage or through the ramp. Cargo compartment dimensions are 26 feet 2-1/2 inches long, of which 6 feet is ramp area, 6 feet 6 inches wide, and 6 feet high. The cargo compartment is capable of carrying 25 fully equipped troops or 15 litter patients with two attendants. The cargo compartment is also equipped with tiedown rings and skids for transport of cargo. Two gas turbine engines are mounted side by side in the engine compartment which is located above the forward portion of the cargo compartment. The engine shafts extend aft into the main gear box which is located in the transmission compartment. The main rotor assembly, to which the five rotor blades are attached, is splined to the main gear box drive shaft. An auxiliary power unit, used for checkout of equipment, cargo loading, and engine starting, is located aft of the main gear box. The aft fuselage extends from the cargo compartment to the pylon. The lower fuselage contains the electronics-radio compartment in the forward section, the retractable nose gear, and two dual cell fuel tanks. Sponsons are mounted on each side of the lower fuselage. The retractable main landing gear is mounted in the sponsons. The pylon is attached to the rear of the aft fuselage. A horizontal stabilizer is mounted on the upper right-hand side of the pylon. The intermediate gear box is installed in the lower portion of the pylon with a shaft extending upward to the tail rotor gear box at the top of the pylon. The five-bladed tail rotor is splined to the tail rotor gear box. Familiarity with the configuration of the helicopter may be obtained by referring to the exterior and interior general arrangement illustrations at the beginning of this section, and the minimum turning radius and ground clearances diagram (figure 2-4) in Section II.

FOREIGN OBJECT DEFLECTOR.

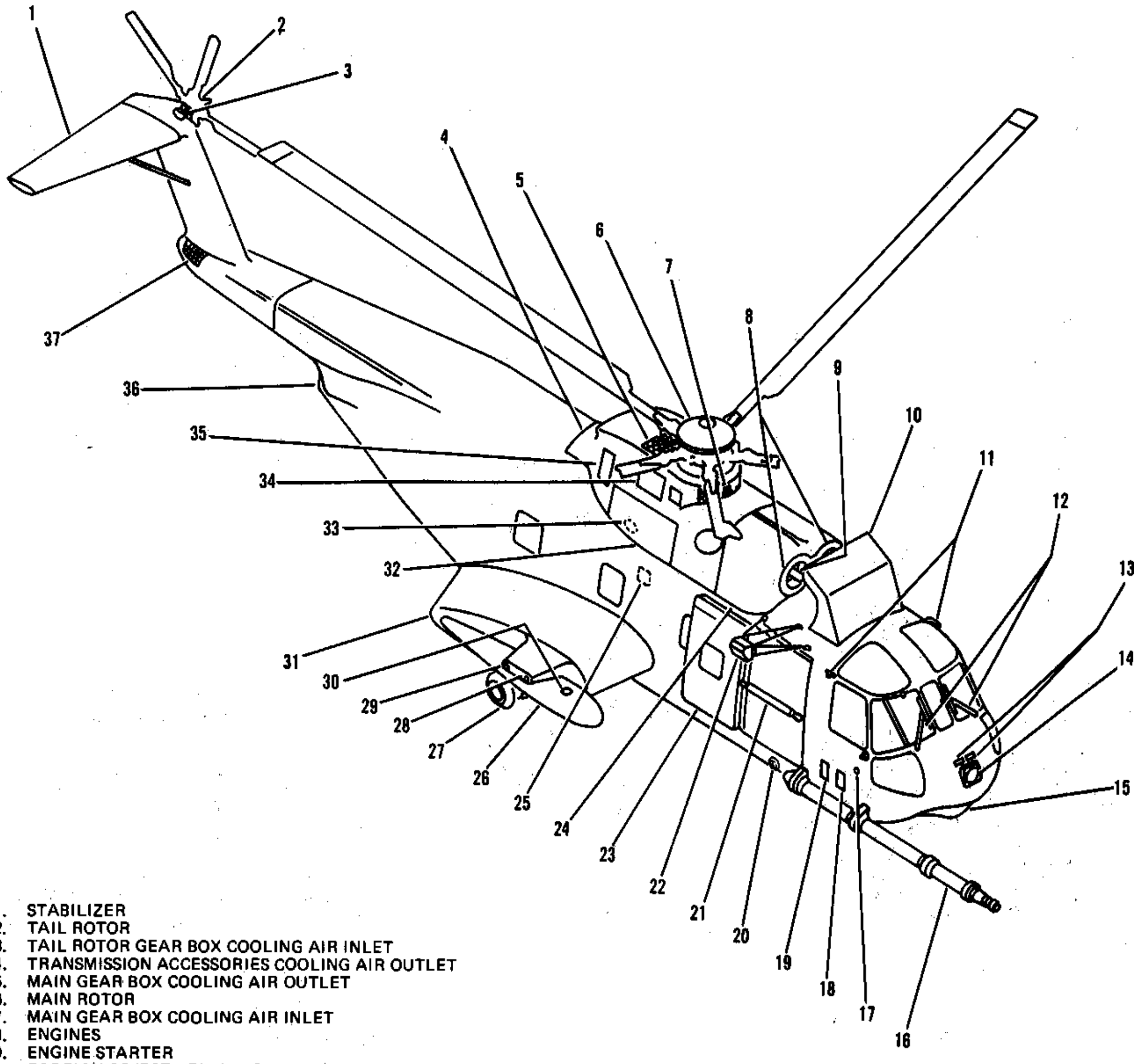
The purpose of the deflector is to inhibit ice or debris from entering the engines. A slight loss of power will result from its use.

DIMENSIONS.

Length.	
Maximum, main rotor blades extended	73 feet 0 inches
Minimum, main rotor blades removed	60 feet 9 inches
Height.	
Maximum to top of tail rotor, blade vertical	
Static	18 feet 1 inch
Kneeled	20 feet 3 inches
Minimum, tail rotor blades removed	16 feet 1 inch
Width.	
Minimum, main rotor blades removed	17 feet 4 inches
Main rotor diameter	62 feet 0 inches
Tail rotor diameter	10 feet 4 inches
Minimum Main Rotor Ground Clearance.	
(Tip clearance - forward sector)	
Static	10 feet 1 inch
Kneeled	7 feet 4 inches
Tail Rotor Ground Clearance.	
Static	7 feet 9 inches
Kneeled	9 feet 11 inches
Tail Pylon Ground Clearance.	
Static	6 feet 5 inches
Kneeled	8 feet 0 inches
Main landing gear tread.	13 feet 4 inches

ENGINES.

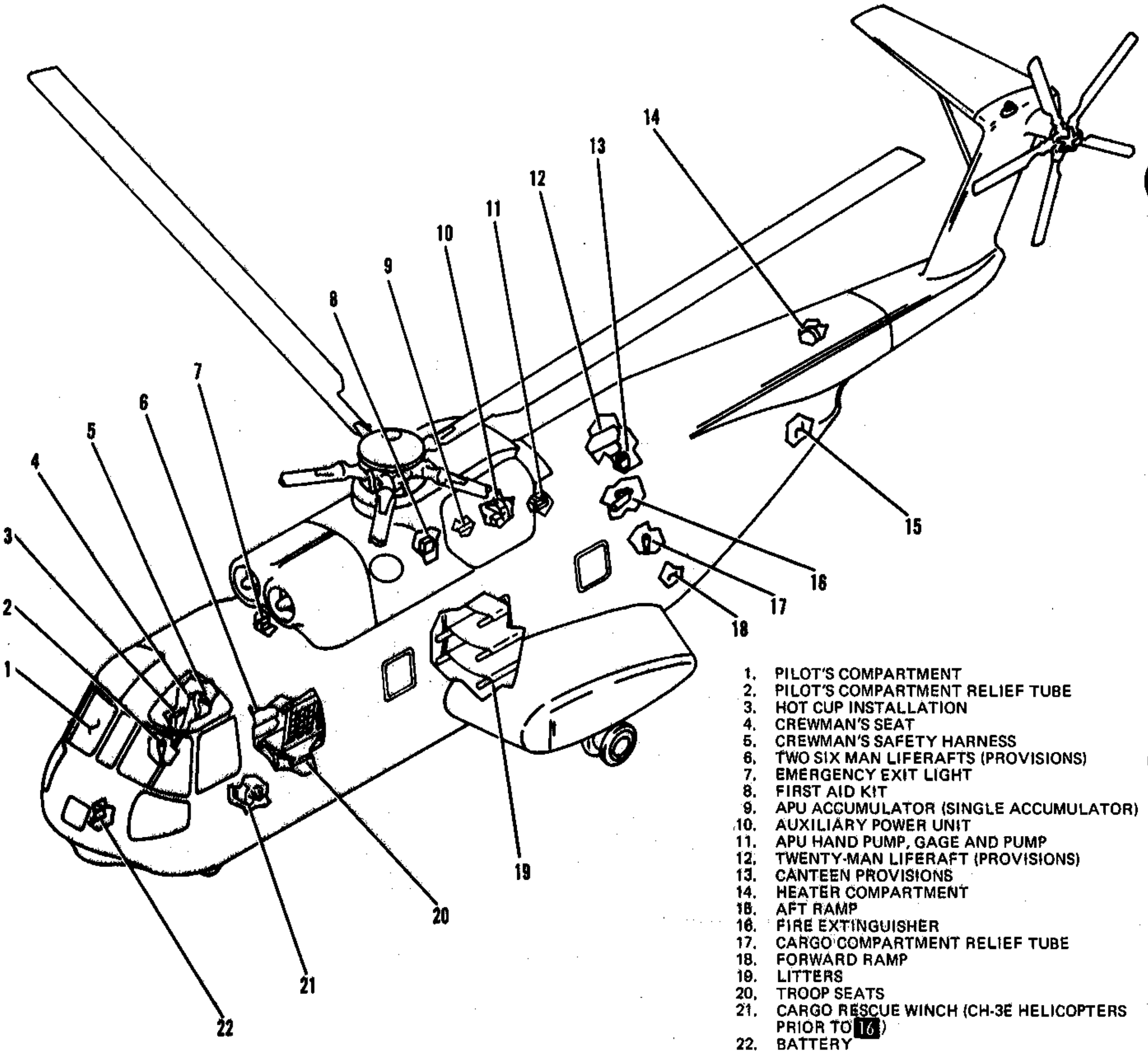
The CH-3E and HH-3E helicopters are powered by two General Electric T58-GE-5 (CT58-140-1) engines. The engines (figure 1-6) are the axial flow gas turbine turboshaft type which incorporate the free power turbine principle. The T58-GE-5 engine develops 1500 shaft horsepower. The engines are located side-by-side above the cargo compartment, forward of the main gear box. Each engine contains the following major components: an axial-flow compressor, combustion chambers, a two-stage gas generator turbine, and a single-stage power turbine that is independent of the gas generator turbine. The gas generator consists of the compressor, annular combustor, and two-stage gas generator turbine. The free turbine principle provides a constant free turbine speed output which results in a constant rotor rpm. Variations in power requirements, to maintain constant free turbine speed, are accomplished by automatic increases or decreases in gas generator speed. A hydromechanical fuel metering unit provides maximum engine performance without exceeding safe engine operating limits. In the normal operating range, power turbine speed is selected by positioning the throttle. The integrated fuel control system delivers atomized fuel in controlled amounts to the combustion chamber. Flow of fuel and air through the combustion chamber is continuous and once the mixture



1. STABILIZER
2. TAIL ROTOR
3. TAIL ROTOR GEAR BOX COOLING AIR INLET
4. TRANSMISSION ACCESSORIES COOLING AIR OUTLET
5. MAIN GEAR BOX COOLING AIR OUTLET
6. MAIN ROTOR
7. MAIN GEAR BOX COOLING AIR INLET
8. ENGINES
9. ENGINE STARTER
10. FOREIGN OBJECT DEFLECTOR
11. PITOT TUBES
12. WINDSHIELD WIPERS
13. BATTERY VENTS
*14. CONTROLLABLE SPOTLIGHT AND BATTERY ACCESS DODR
15. ELECTRONICS COMPARTMENT ACCESS DOOR
*16. AIR REFUELING PROBE
*17. TRUE AIR SPEED TEMPERATURE SENSOR
18. DC EXTERNAL POWER RECEPTACLE
19. AC EXTERNAL POWER RECEPTACLE
*20. PRESSURE REFUELING ADAPTER
21. PERSONNEL DOOR SAFETY STRAP
22. RESCUE HOIST
23. PERSONNEL DOOR
24. ENGINE ACCESS AND SERVICE PLATFORM
25. INTERNAL AUXILIARY FUEL TANK FILLER CAP
*26. EXTERNAL AUXILIARY FUEL TANK
27. MAIN LANDING GEAR
*28. SPONSON PYLON
*29. SPONSON POSITION LIGHT
*30. EXTERNAL AUXILIARY FUEL TANK FILLER CAP
31. SPONSON
32. TRANSMISSION ACCESS AND SERVICE PLATFORM
33. ALTERNATE LANDING GEAR SYSTEM AIR BOTTLE
34. ACCESS PANEL
35. OIL COOLER ACCESS DODR
36. RAMP
37. INTERMEDIATE GEAR BOX COOLING AIR OUTLET

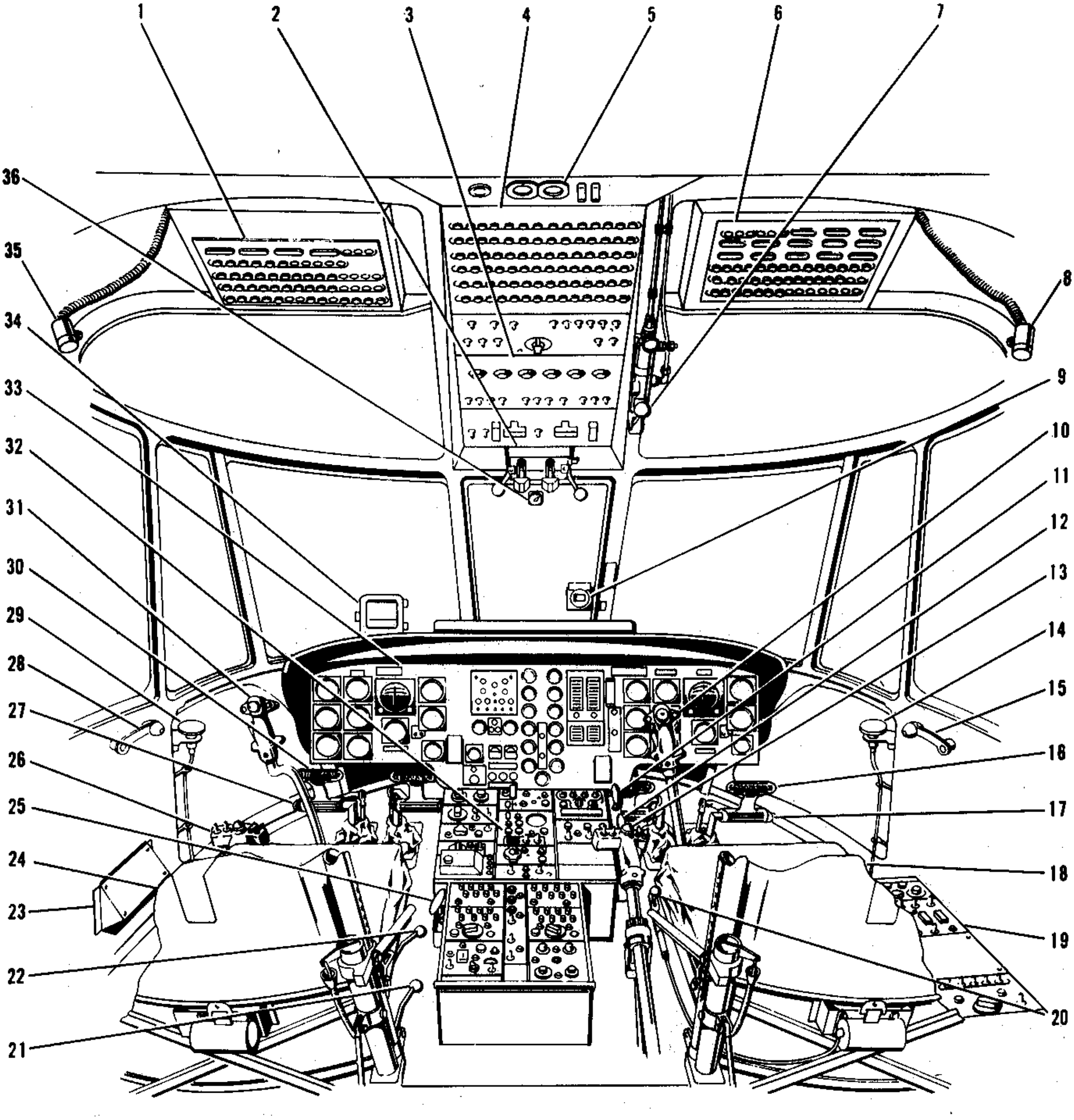
NOTE
ITEMS MARKED * DENOTE CH-3E HELICOPTERS
16 ▶ OR HH-3E HELICOPTERS

Figure 1-2. General Arrangement Exterior Diagram (Typical)



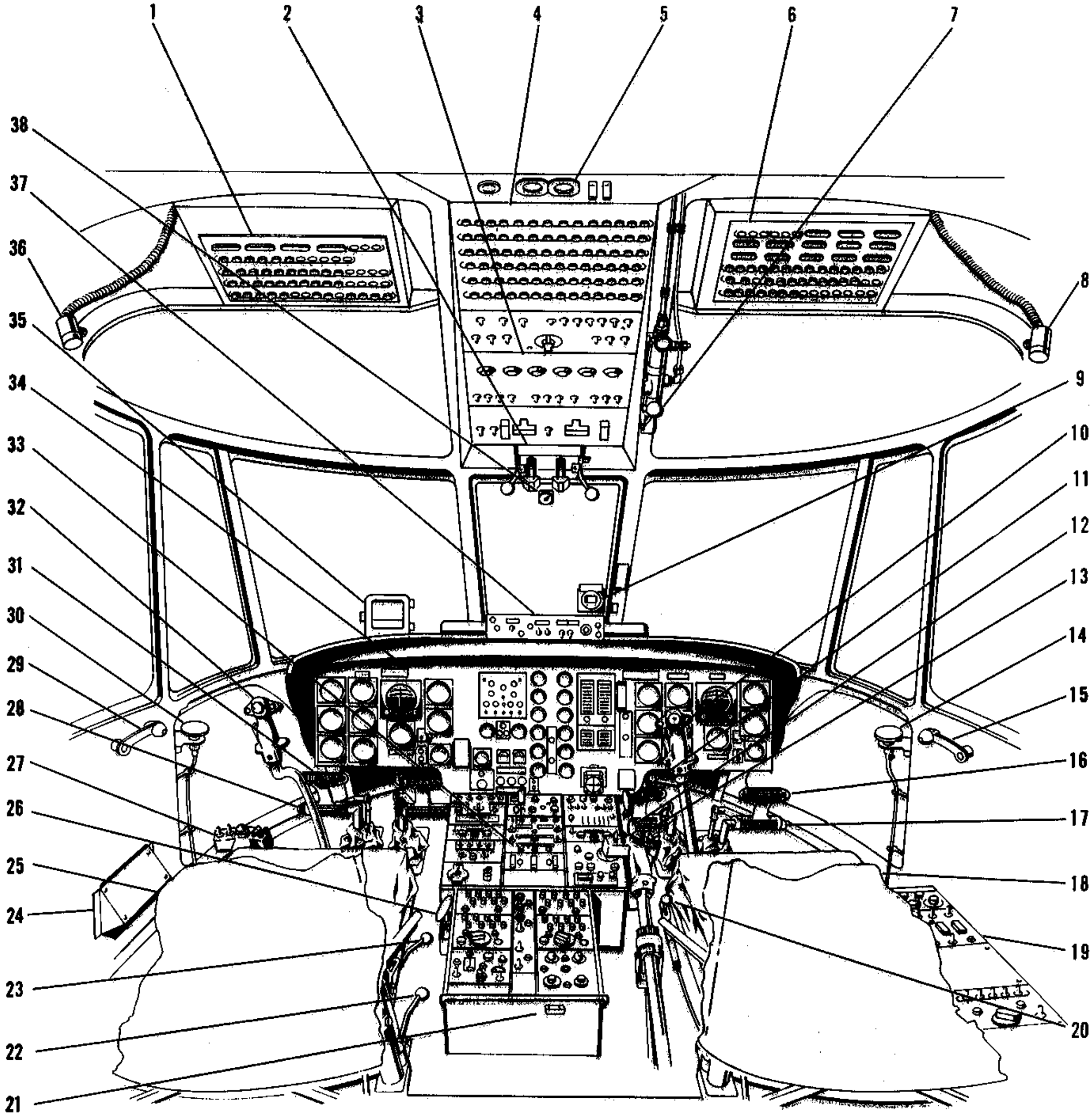
1. PILOT'S COMPARTMENT
2. PILOT'S COMPARTMENT RELIEF TUBE
3. HOT CUP INSTALLATION
4. CREWMAN'S SEAT
5. CREWMAN'S SAFETY HARNESS
6. TWO SIX MAN LIFERAFTS (PROVISIONS)
7. EMERGENCY EXIT LIGHT
8. FIRST AID KIT
9. APU ACCUMULATOR (SINGLE ACCUMULATOR)
10. AUXILIARY POWER UNIT
11. APU HAND PUMP, GAGE AND PUMP
12. TWENTY-MAN LIFERAFT (PROVISIONS)
13. CANTEEN PROVISIONS
14. HEATER COMPARTMENT
15. AFT RAMP
16. FIRE EXTINGUISHER
17. CARGO COMPARTMENT RELIEF TUBE
18. FORWARD RAMP
19. LITTERS
20. TROOP SEATS
21. CARGO RESCUE WINCH (CH-3E HELICOPTERS PRIOR TO 16)
22. BATTERY

Figure 1-3. General Arrangement Interior Diagram (Typical)



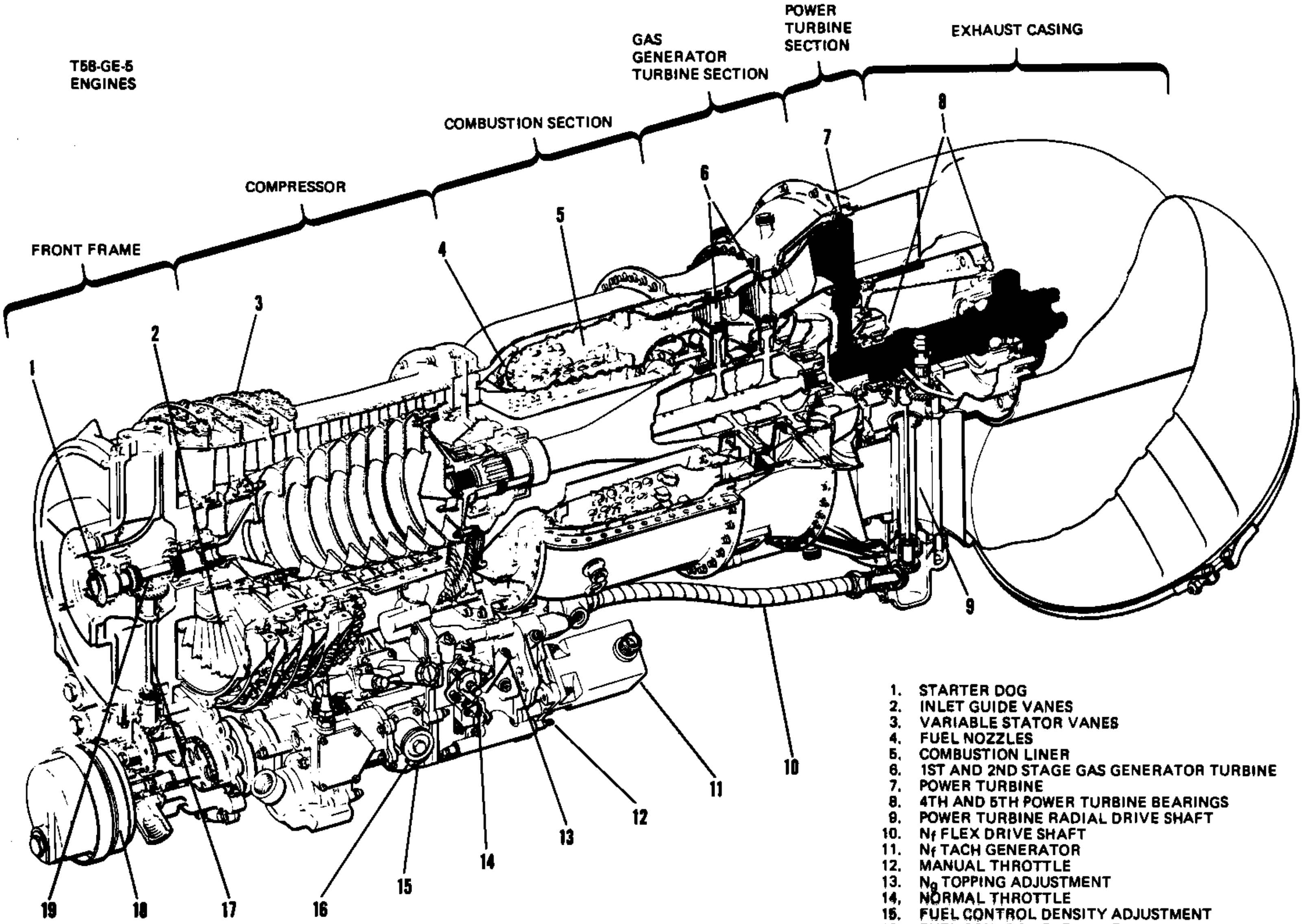
1. AC NON-ESSENTIAL CIRCUIT BREAKER PANEL
2. ENGINE CONTROL QUADRANT
3. OVERHEAD SWITCH PANEL
4. OVERHEAD DC CIRCUIT BREAKER PANEL
5. PILOT'S COMPARTMENT DOME LIGHT
6. AC ESSENTIAL CIRCUIT BREAKER PANEL
7. ROTOR BRAKE LEVER
8. PILOT'S SPOTLIGHT
9. MAGNETIC COMPASS
10. PILOT'S CYCLIC STICK
11. PARKING BRAKE HANDLE
12. NOSEWHEEL LOCK HANDLE
13. PILOT'S COLLECTIVE PITCH LEVER
14. PILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB
15. PILOT'S WINDOW EMERGENCY RELEASE HANDLE
16. PILOT'S TOE BRAKES
17. PILOT'S TAIL ROTOR PEDALS
18. PILOT'S SEAT
19. PILOT'S RADIO CONSOLE
20. PILOT'S SHOULDER HARNESS LOCK LEVER
21. COPILOT'S SEAT HEIGHT ADJUSTMENT LEVER
22. COPILOT'S SEAT FORWARD AND AFT ADJUSTMENT LEVER
23. COPILOT'S RADIO CONSOLE
24. COPILOT'S SEAT
25. ALTERNATE LANDING GEAR HANDLE
26. COPILOT'S COLLECTIVE PITCH LEVER
27. COPILOT'S TAIL ROTOR PEDALS
28. COPILOT'S WINDOW EMERGENCY RELEASE HANDLE
29. COPILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB
30. COPILOT'S TOE BRAKES
31. COPILOT'S CYCLIC STICK
32. COCKPIT CONSOLE
33. INSTRUMENT PANEL
34. COPILOT'S SCROLL CHECKLIST
35. COPILOT SPOT LIGHT
36. FREE AIR TEMPERATURE GAGE

Figure 1-4. Pilot's Compartment CH-3E (Typical)



1. AC NON-ESSENTIAL CIRCUIT BREAKER PANEL
2. ENGINE CONTROL QUADRANT
3. OVERHEAD SWITCH PANEL
4. OVERHEAD DC CIRCUIT BREAKER PANEL
5. PILOT'S COMPARTMENT DOME LIGHT
6. AC ESSENTIAL CIRCUIT BREAKER PANEL
7. ROTOR BRAKE LEVER
8. PILOT'S SPOTLIGHT
9. MAGNETIC COMPASS
10. PILOT'S CYCLIC STICK
11. PARKING BRAKE HANDLE
12. NOSEWHEEL LOCK HANDLE
13. PILOT'S COLLECTIVE PITCH LEVER
14. PILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB
15. PILOT'S WINDOW EMERGENCY RELEASE HANDLE
16. PILOT'S TOE BRAKES
17. PILOT'S TAIL ROTOR PEDALS
18. PILOT'S SEAT
19. PILOT'S RADIO CONSOLE
20. PILOT'S SHOULDER HARNESS LOCK LEVER
21. AUXILIARY FUEL TANK MANUAL RELEASE HANDLE
22. COPILOT'S SEAT HEIGHT ADJUSTMENT LEVER
23. COPILOT'S FORWARD AND AFT ADJUSTMENT LEVER
24. COPILOT'S RADIO CONSOLE
25. COPILOT'S SEAT
26. ALTERNATE LANDING GEAR HANDLE
27. COPILOT'S COLLECTIVE PITCH LEVER
28. COPILOT'S TAIL ROTOR PEDALS
29. COPILOT'S WINDOW EMERGENCY RELEASE HANDLE
30. COPILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB
31. COPILOT'S TOE BRAKES
32. COPILOT'S CYCLIC STICK
33. COCKPIT CONSOLE
34. INSTRUMENT PANEL
35. COPILOT'S SCROLL CHECKLIST
36. COPILOT SPOT LIGHT
37. PRESSURE REFUELING CONTROL PANEL
38. FREE AIR TEMPERATURE GAGE

Figure 1-5. Pilot's Compartment - HH-3E (Typical)



1. STARTER DOG
2. INLET GUIDE VANES
3. VARIABLE STATOR VANES
4. FUEL NOZZLES
5. COMBUSTION LINER
6. 1ST AND 2ND STAGE GAS GENERATOR TURBINE
7. POWER TURBINE
8. 4TH AND 5TH POWER TURBINE BEARINGS
9. POWER TURBINE RADIAL DRIVE SHAFT
10. N_f FLEX DRIVE SHAFT
11. N_f TACH GENERATOR
12. MANUAL THROTTLE
13. N_g TOPPING ADJUSTMENT
14. NORMAL THROTTLE
15. FUEL CONTROL DENSITY ADJUSTMENT
16. FUEL CONTROL FUEL INLET FILTER
17. FRONT FRAME RADIAL DRIVE SHAFT
18. CENTRIFUGAL FUEL FILTER
19. AXIAL DRIVE SHAFT

Figure 1-6. Engine Cut-Away View (Typical)

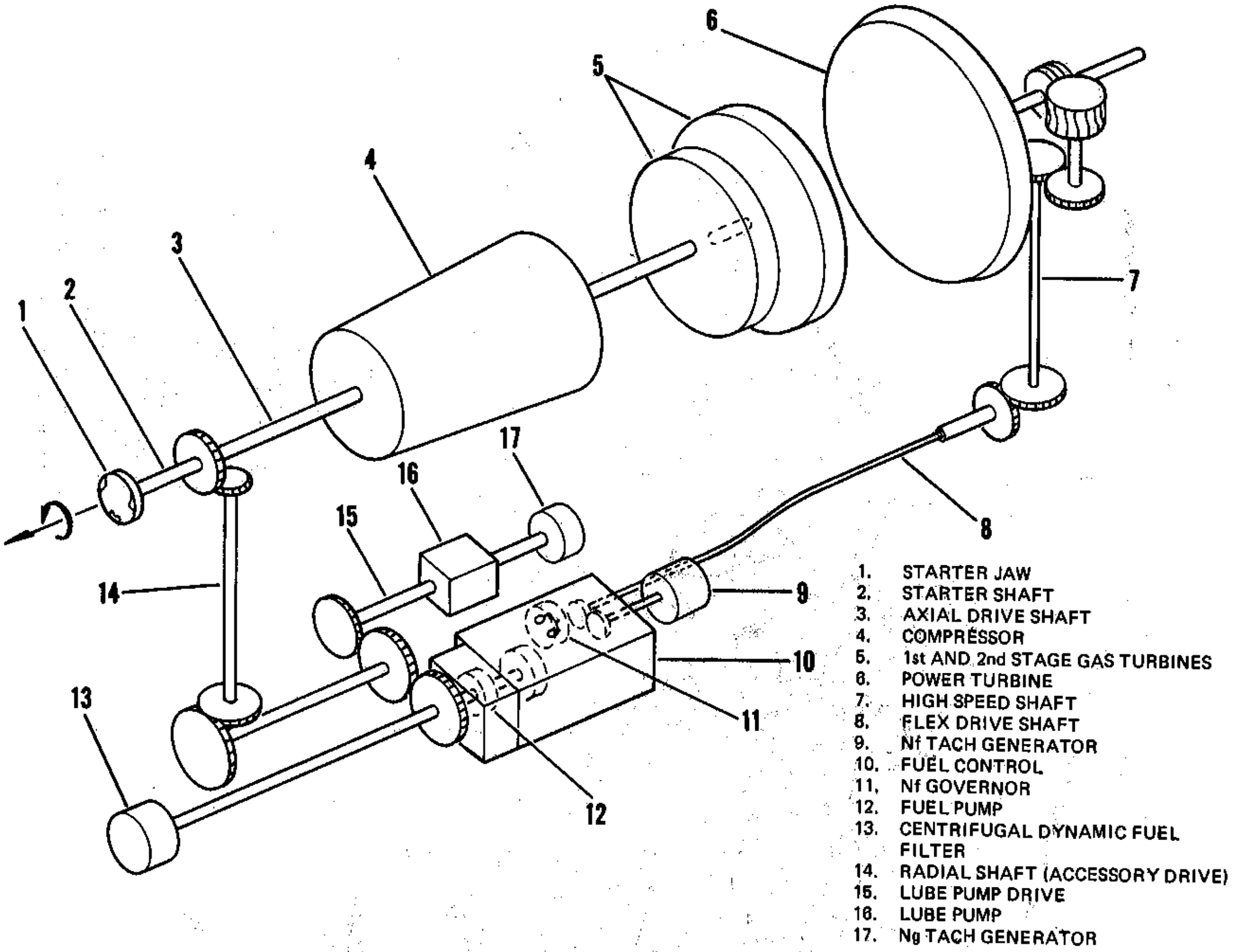


Figure 1-7. Simplified Engine Schematic

is ignited, combustion is self-sustained. Changes in air pressure, air temperature, humidity, helicopter velocity, and rotor operation all affect engine performance. The engine fuel control system automatically maintains selected power turbine speed by changing fuel flow to increase or decrease gas generator speed as required, thus regulating output power to match the load under changing conditions.

COMPRESSOR.

The ten stage compressor consists of the compressor rotor and stator. The compressor rotor is supported by the front frame section and compressor rear frame section. The stator is bolted between the front frame section and compressor rear frame. The primary purpose of the compressor is to compress air for combustion. Ambient air enters through the front frame and is directed to the compressor inlet, passes through ten stages of compression, and is directed to the combustion chambers. The inlet guide vanes (figure 1-6) and the first three stages of the stator vanes (figure 1-6) are variable and change their angular position as a function of compressor inlet temperature and gas generator speed to prevent stall of the compressor.

COMBUSTION CHAMBER.

In the combustion chamber, fuel is added to the compressed air and ignited, causing a rapid expansion of gases toward the gas generator turbine section. As the air enters the combustion section, a portion goes into the combustion chamber where it is mixed with the fuel and ignited. The remaining air forms a blanket between the outer combustion casing and the combustion liner (figure 1-6) for

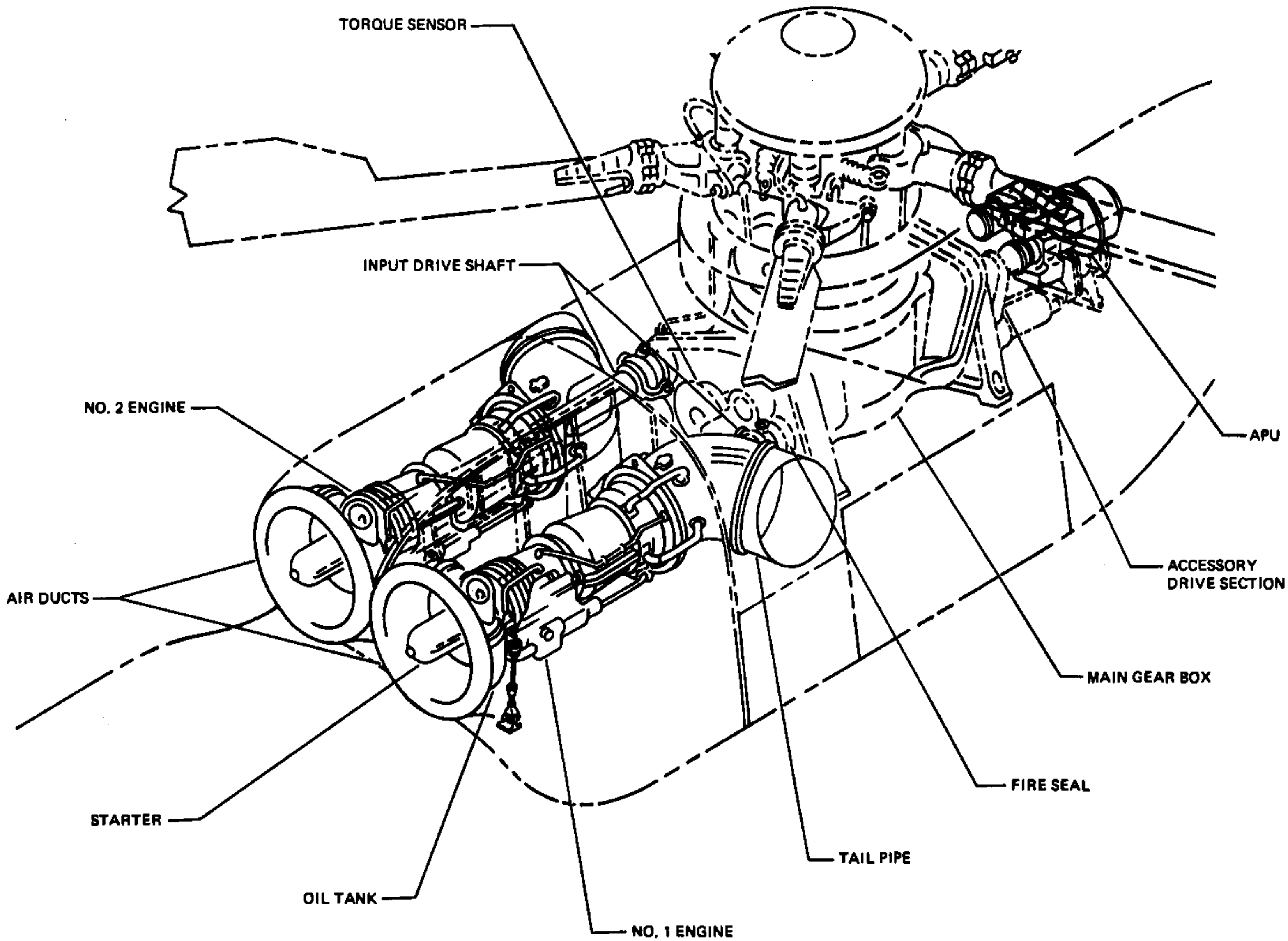


Figure 1-8. Engine, Main Gear Box, and APU Installation

cooling purposes. Once combustion is started by the two igniter plugs, it is self-sustaining. After the air has been expanded and increased in velocity by combustion, it is passed through the first-stage turbine wheel of the gas generator turbine (figure 1-6).

GAS GENERATOR TURBINE.

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

POWER TURBINE.

The power turbine (figure 1-6) is bolted to the rear flange of the second stage turbine casing. The engine utilizes the free turbine principle in which engine output power is provided by the power turbine rotor, which is mechanically independent of the gas generator rotor. This rotor derives its power from the gases which are directed to it by the gas generator turbine nozzles. Within the normal operating range, power turbine speed may be maintained or regulated independent of output power. This principle also provides more rapid acceleration because of the availability of high engine torque at low output speeds.

GAS GENERATOR SPEED (N_g).

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

FREE POWER TURBINE SPEED (N_f).

The free power turbine speed (N_f) is dependent upon engine control input shaft position and rotor load. The principal purpose of monitoring power turbine speed is to regulate fuel flow to maintain an essentially constant power turbine speed for a given engine control input shaft position To prevent destructive power turbine overspeed in the event of a loss of power turbine load, a governor within the fuel control senses power turbine speed and shuts off fuel flow to the engine at a power turbine speed of approximately 120% (N_f). Fuel flow will resume when the power turbine speed drops below the fuel shutoff speed. The engine may or may not relight.

ENGINE FUEL SYSTEM.

The engine fuel systems (figure 1-9), one for each engine, consist of an engine-driven pump, a dynamic filter, a fuel control unit, a static filter, an oil cooler, a flow divider, and a fuel manifold and associated piping. The fuel control unit is supplied fuel from the engine-driven fuel pump. Metered fuel from the engine fuel control unit is piped through an oil-fuel heat exchanger and then enters the flow divider connected directly to the fuel manifold on the engine. For normal flight, rotor speed is selected by positioning the throttles and the engine fuel controls will meter fuel to maintain the selected rotor speed.

Engine-Driven Fuel Pump.

A dual element engine-driven fuel pump, mounted on each engine, consisting of a positive displacement type gear pump and a centrifugal boost pump, is built into a single housing. Power for each pump is furnished from the engine accessory drive section by means of a splined shaft. This shaft drives the fuel pump and simultaneously acts as a link to transmit gas generator speed information to the engine fuel control unit.

Engine Fuel Control Unit.

The engine fuel control units, one located on each engine, are hydromechanical units that regulate engine fuel flow to maintain a constant selected free power turbine speed, and thus maintain a constant helicopter rotor speed. Fuel from the engine fuel pump enters the fuel control unit through the inlet and passes through the fuel filter. The fuel control has a fuel metering section and a computing section. The metering section selects the rate of flow to the combustion chambers, based on information received from the computing sections. The metering section has a metering valve and a pressure regulating valve. The pressure regulating valve maintains a constant pressure across the main metering valve by bypassing excess fuel back to the engine fuel pump inlet. The metering valve is positioned

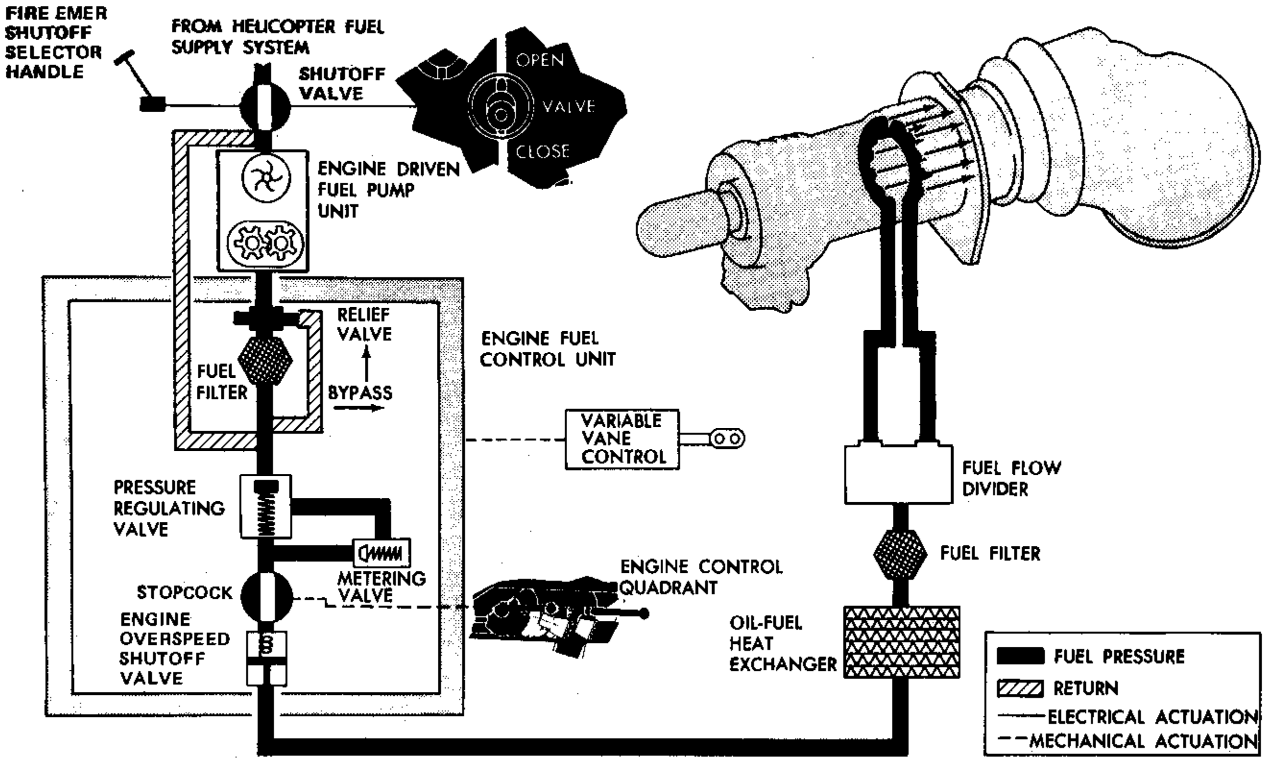


Figure 1-9. Engine Fuel System

in response to various internal operating signals, and meters fuel to the engine as a function of these integrated signals. The engine fuel control unit performs the following functions: prevents compressor stall, turbine overtemperature, rich or lean blowouts, governs gas generator idle and maximum speeds, and schedules inlet guide and stator vane positions to provide optimum compressor performance.

THROTTLES.

Two engine throttle levers marked, NUMBER 1 ENGINE and NUMBER 2 ENGINE, are located on the overhead engine control quadrant (figure 1-10). Marked positions on the overhead quadrant are SHUT-OFF, GRD IDLE, MIN GOV, and 100% SPEED. The throttles are connected directly to the fuel stopcock and indirectly to the fuel metering valve in the fuel control unit. When the throttles are in the SHUT-OFF position, fuel flow to the fuel nozzles is stopped by means of a stopcock that prevents fuel from entering the combustion chambers. The stopcock is open whenever the throttle is 6 degrees or more from the SHUT-OFF position and is closed when the throttle is 3 degrees or less from the SHUT-OFF position. The GRD IDLE position schedules fuel flow to produce a gas generator speed of approximately 56% N_g. Gas generator idle speed will vary with inlet air temperature. A detent at GRD IDLE prevents inadvertent retarding of the throttles below the idle speed of the engines. The throttles may be retarded from the detent by exerting a downward and rearward pressure on the throttle. The MIN GOV position of the throttle, 89% N_f or above, is the point where the governing range of the power turbine is entered. When the throttle is at the full forward position, the engine is producing maximum power turbine speed. Engine speed trim switches are installed on the collective pitch stick grip to provide accurate speed changes and engine synchronization, when desired. This is accomplished by moving the switches forward or aft. After rotor engagement, and with the throttles in the governing range (at or forward of the MIN GOV position), any force attempting to slow the rotor or transmission system, such as increases in collective pitch, will be sensed by the fuel control unit which will attempt to maintain constant rpm by increasing power. The throttles must be placed in the GRD IDLE or SHUT-OFF position before applying the rotor brake, for normal shutdown.

ENGINE SPEED TRIM SWITCHES (BEEPER TRIM SWITCHES).

The engine speed trim switches (beeper trim switches), located on each collective pitch lever grip (figure 1-11), are used to make adjustments to power turbine speed and for engine synchronization. The switches are marked ENG TRIM, 1 and 2, + (plus) and — (minus). The switches provide electrical power to actuators in the overhead control quadrant which are connected to the throttles. The throttles are positioned by the actuators for adjustment to the desired power turbine speed. Moving the ENG TRIM switches forward will cause increases in power turbine speed and moving the switches aft will cause decreases in power turbine speed. When the desired power turbine speed is attained, the switches are released and will return to the spring-loaded center position. Beeper trim system range is approximately 91% to 108% N_f. The ENG TRIM switches receive electrical power from the dc essential bus through circuit breakers, under the general heading ENGINE and marked SPEED TRIM, 1-ENG-2, located on the center overhead dc circuit breaker panel.

NOTE

Pilot's beeper trim switches override the copilot's switches.

EMERGENCY FUEL CONTROL LEVERS.

Two emergency fuel control levers, one for each engine, marked EMER FUEL CONTROL, are located on each side of the engine control quadrant (figure 1-10). The emergency fuel control levers operate independently and are used in case of fuel control unit failure. Each emergency fuel control lever has positive open and close stops and is connected directly by a flexible cable and linkage to the main metering valve in each engine fuel control unit. The primary function of the emergency fuel control lever is to manually override the automatic features of the fuel control. This may become necessary under some starting situations and during any fuel control malfunction that causes erratic engine operation. The emergency fuel control lever must be used with extreme caution as it has a positive influence on fuel flow and misuse can cause engine overspeed or overtemperature. The lever is mechanically connected to a cam within the fuel control which contacts the fuel metering valve. The initial position of the fuel metering valve is dependent upon the automatic features of the control as established by the setting of the throttle. The cam, when actuated by advancing the emergency fuel control lever, contacts the fuel metering valve. Once contact is established, further advancement of the emergency fuel control will manually control fuel flow, which in turn, regulates engine power output. At high power settings, considerable dead band travel will normally be encountered before the emergency fuel control contacts the metering valve lever. This will be felt as a slight restriction in control movement. When this is felt, the control will be very sensitive, and care should be taken not to exceed T_5 and N_g red lines. The emergency fuel control is unable to reduce the position of the metering valve below that called for by the throttles. Control below this point will depend upon the type of malfunction encountered. In all instances of emergency fuel control operation, it must be remembered that the throttles must not be retarded beyond the GRD IDLE position. The fuel stopcock is located downstream of the metering valve and is actuated by the throttles. Placing the throttles in the SHUT-OFF position will stop engine fuel flow, regardless of emergency fuel control lever position.

CAUTION

Rapid movement of emergency fuel control levers may induce compressor stall.

STARTING SYSTEM.

Each engine starting system (figure 1-12) is equipped with an electric starter, located on the front frame section of the engine. In addition, each system is equipped with a start bleed valve. The start bleed valve is automatically opened during the starting cycle, to direct air overboard to reduce

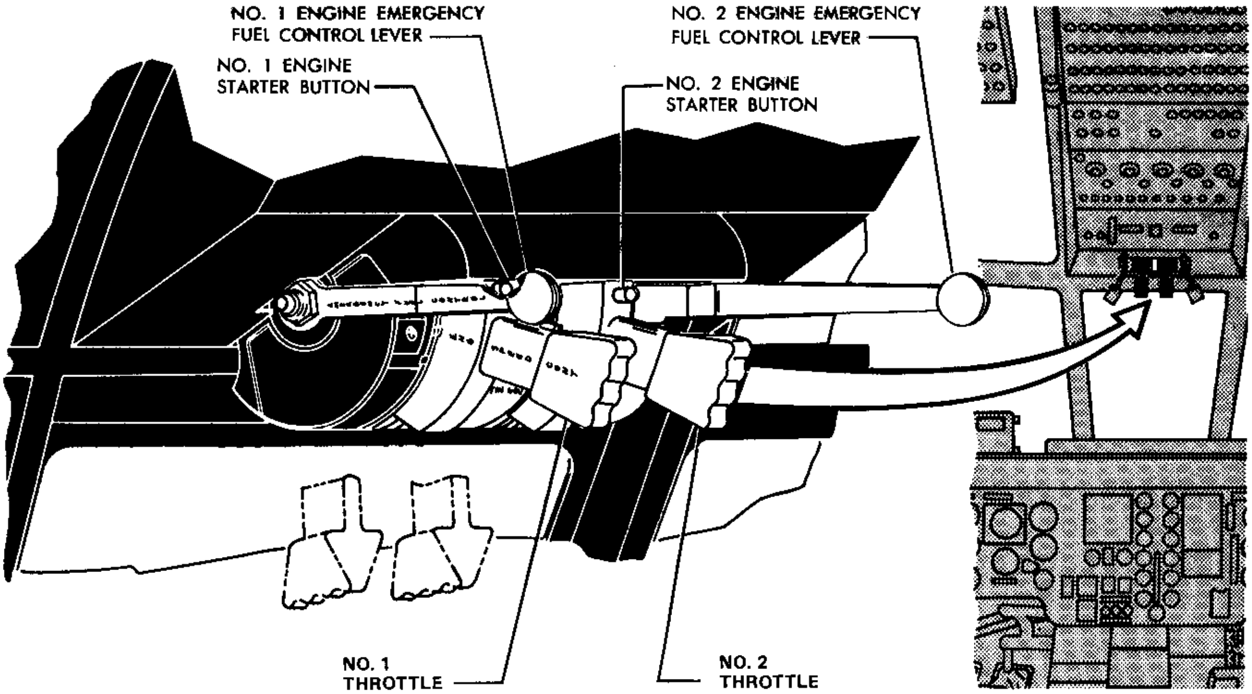


Figure 1-10. Engine Controls

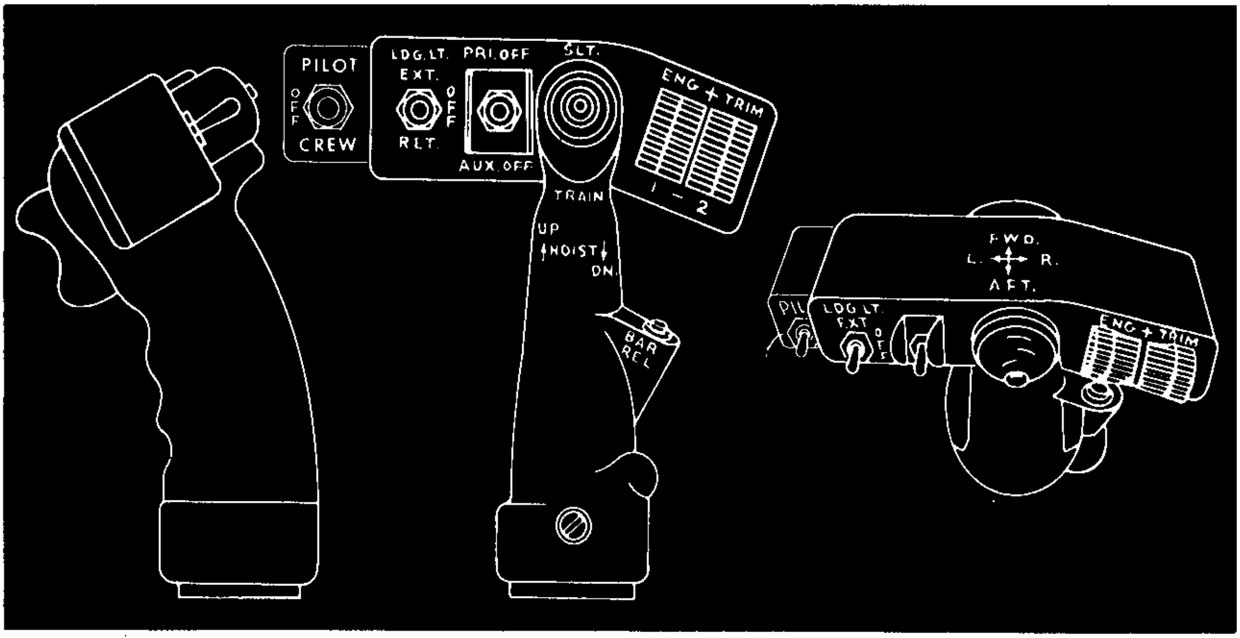


Figure 1-11. Collective Pitch Lever Grip

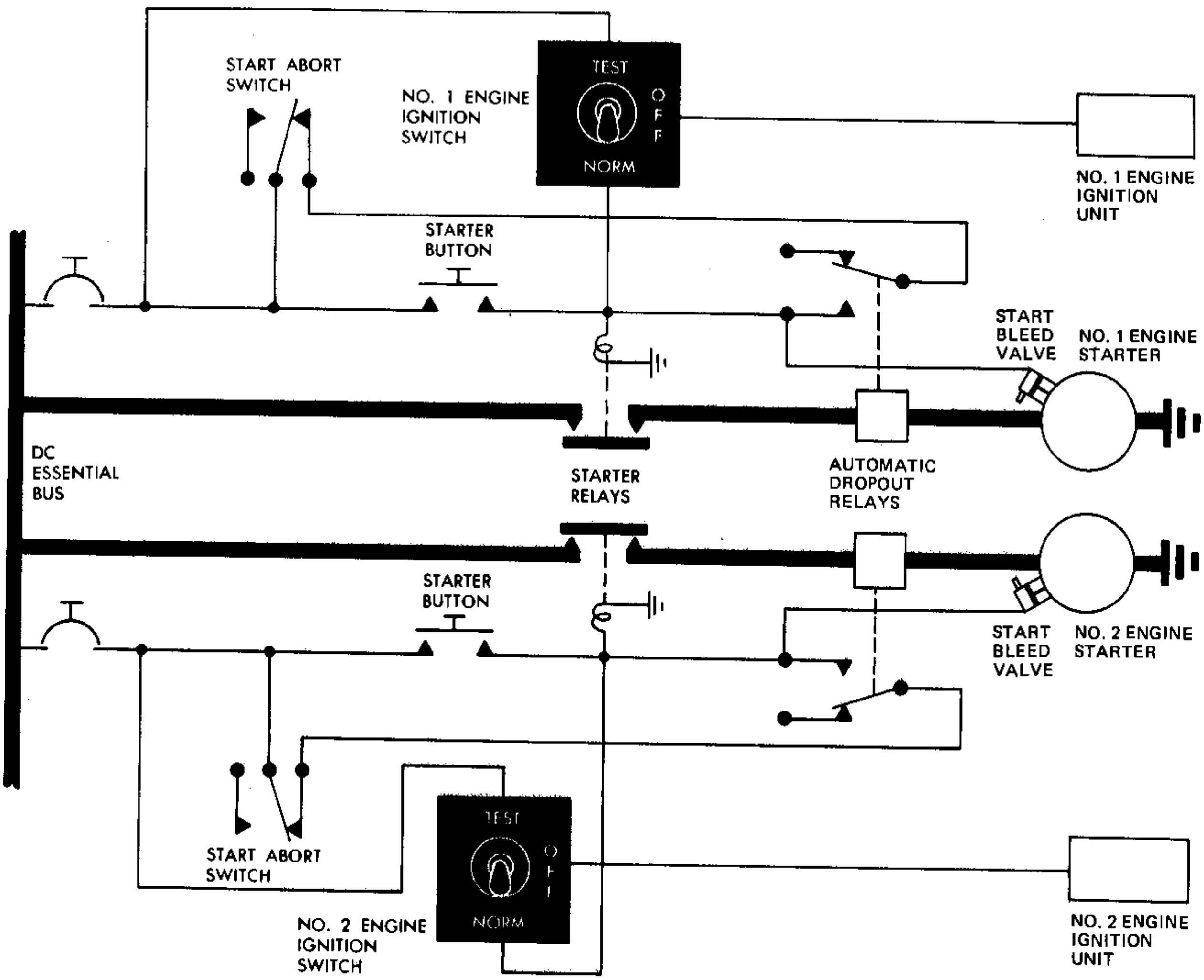


Figure 1-12. Starting System Diagram

back pressure in the compressor and lessen the possibility of engine stall, and closes after the starter has been deenergized (approximately 45 to 53%). The valve bleeds off approximately 6.7% of the compressor discharge air flow, reduces the starter drag, and allows the gas generator speed to increase faster. Engine starts are accomplished by placing the throttle in the SHUT-OFF position, placing the IGNITION switch in the NORM position, and depressing the starter button on the engine throttle. With the relay closed, power is supplied to the starter motor and the start bleed valve. When the starter button is released, a holding circuit in the starter relay, powered through the abort switch, holds the relay contacts closed until the starter amperage falls below 100 ± 15 amperes. With the starter in operation, the throttle may be advanced to the GRD IDLE position to supply the necessary fuel to the engine. After engine lite-off, starter amperage falls below 100 ± 15 amperes and the starter relay drops out. This cuts off power to the starter motor and ignition unit. A start may be aborted prior to engine lite-off by pulling down on the throttle. This opens the normally closed abort switch on the quadrant and deenergizes the starter relay coil. Power for the control circuit of the starter and ignition system is supplied by the essential dc bus at 28 volts dc through the engine starter 1-ENG-2 circuit breakers on the circuit breaker panel. The starter has a duty cycle limited to 30 seconds continuous cranking, a minimum cooling period of 3 minutes between start attempts, and a maximum of three start attempts in any 30 minute period. Before the starter can be energized, the APU must be operating or external power applied, or the battery switch ON. The engine may be motored by using the starter with the ignition switches off.

Starter Buttons.

A starter button is located on each throttle. The starter is energized by holding the engine throttle in SHUT-OFF position and momentarily depressing the starter button which energizes the starter relay and completes the circuit to the starter. After the engine starts and the starter electrical power load decreases, the starter dropout relay automatically disengages the electrical power to the starter and ignition circuit. During the engine start, starter dropout normally occurs between 45 to 53% N_g. Starter dropout can be noted by the magnetic compass swinging to its original heading and the loadmeters being energized.

Starter Abort Switch.

The starter abort switch, located in the engine control quadrant (figure 1-10) and actuated by pulling throttle down, provides the means to abort an engine start prior to engine lite-off. The abort switch interrupts electrical power for ignition and deenergizes the starter relay.

IGNITION SYSTEM.

Each engine ingition system, mounted on the engine, consists of a capacitor-discharge ignition unit, two ignitor plugs, and a control circuit. The system provides ignition for starting only; during engine operation, the flame in the combustion chamber is self-sustaining. When the switch is in the NORM position, the ignition unit operates in conjunction with the starter. When gas generator speed increases and the starter power load decreases, the automatic dropout disengages both the starter and ignition system and combustion is self-sustained. The ignition system operates on current from the dc essential bus through the starter control system.

Ignition Switches.

An ignition switch, one for each engine, located on the overhead switch panel (figure 1-13), marked IGNITION, 1-ENG-2, has marked positions TEST, OFF, and NORM. When the switch is in the NORM position with the starter engaged, the ignition unit is energized. Holding the switch in the spring-loaded TEST position energizes the ignition unit only. When the switch is placed in TEST position, a clicking noise can be heard. When the switch is in the OFF position, the ignition unit is deenergized. The throttle must be in the SHUT-OFF position before the starter and ignition systems can be energized.

TORQUEMETERS.

Two torquemeters (figure 1-14), one for the pilot and one for the copilot, are located on the instrument panel. Each dual-pointer indicator marked PERCENT TORQUE, contains two pointers, marked 1 and 2, which indicate input torque in percent of maximum engine power output of each engine. The electrically-actuated torquemeter dials, calibrated in percent torque, are graduated in increments of 5 percent from 0 to 150. The torquemeters operate on 26 volts ac and are protected by circuit breakers, marked 1 ENG 2 TORQUE SENSOR, located on the ac essential circuit breaker panel. The torquemeters indicate the amount of torque being applied to the main gear box by the engines. This knowledge serves two purposes; (1) to prevent overstressing the gear box, and (2) to monitor the power output of the engines. The torque sensing cells are located in the main gear box and are hydromechanical in nature, sensing any shift in the helical gear at the input from each engine. Oil pressure within the cells are sensed by pressure transmitters and transmitted electrically to the torquemeters.

ENGINE GAS GENERATOR (N_g) TACHOMETERS.

Two engine gas generator tachometers (figure 1-14), one for each engine, are located on the instrument panel and indicate the speed of the gas generator in percent of total rpm (N_g). Each tachometer has two dials and pointers. The outer dial and pointer indicates gas generator speed from zero to 100 percent, increments of two percent. The small vernier dial and pointer, located in the upper left-hand position of the tachometer, indicates gas generator speed from 0 to 10, in increments of 1 percent. The gas generator tachometer-generator is driven by the engine oil pump shaft. The electrical power produced by the gas generator tachometer-generator is proportional to gas generator rpm (100% N_g=26,300 gas generator rpm).

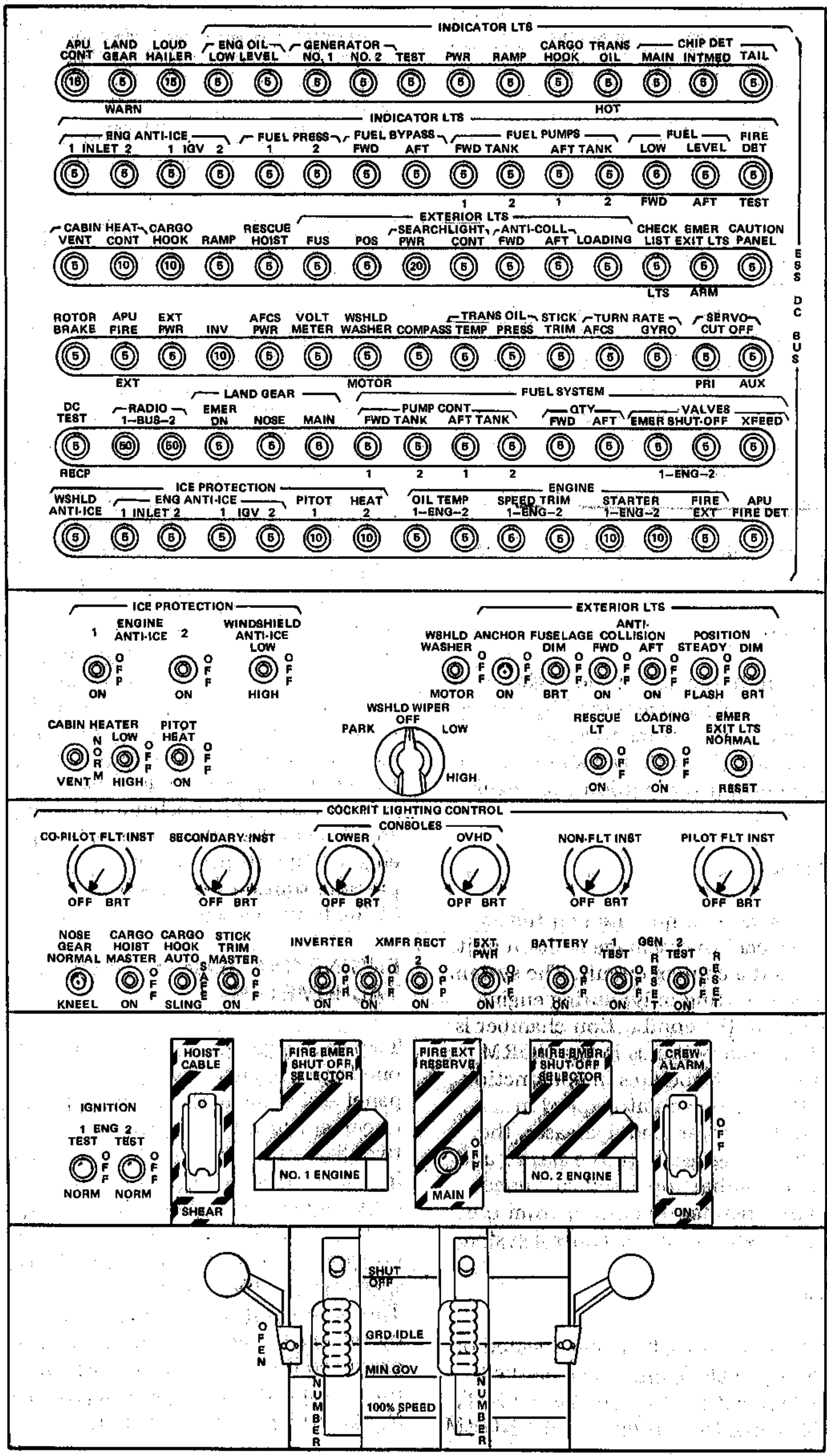
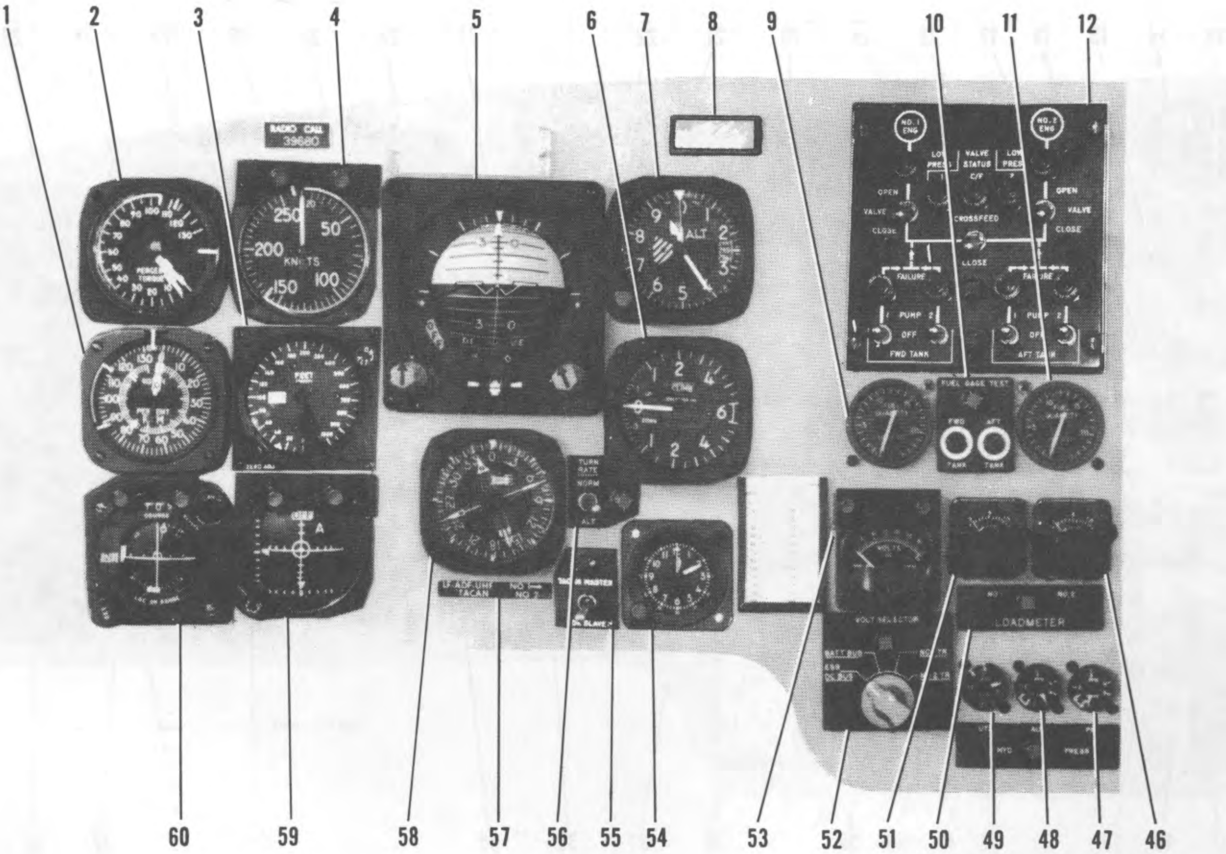
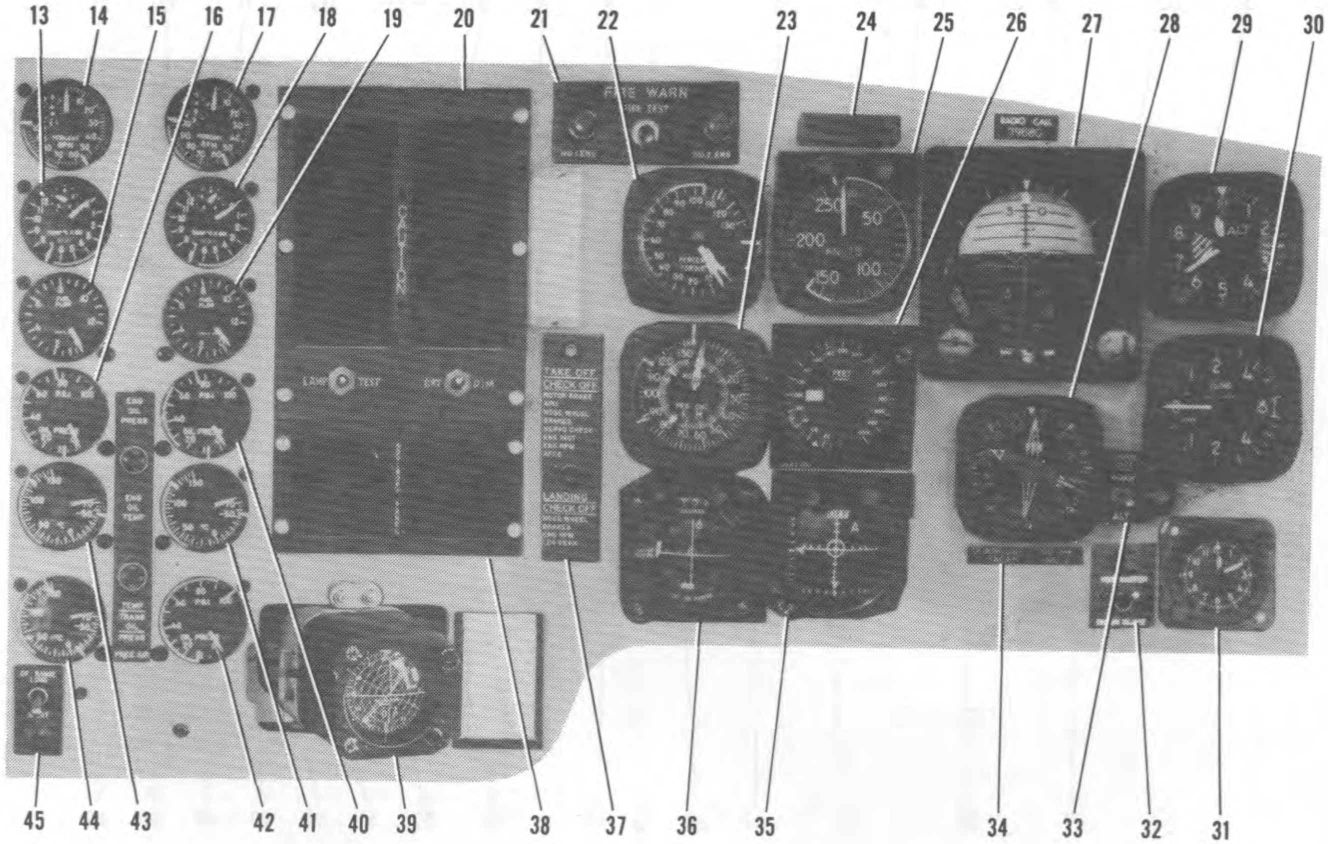


Figure 1-13. Overhead Switch Panel and Engine Control Quadrant (Typical)



1. COPILOT'S TRIPLE TACHOMETER
2. COPILOT'S TORQUEMETER
3. COPILOT'S RADAR ALTIMETER
4. COPILOT'S AIRSPEED INDICATOR
5. COPILOT'S ATTITUDE INDICATOR
6. COPILOT'S VERTICAL VELOCITY INDICATOR
7. COPILOT'S ALTIMETER
8. MASTER CAUTION LIGHT
9. FORWARD TANK FUEL QUANTITY GAGE
10. FUEL QUANTITY GAGE TEST SWITCH PANEL
11. AFT TANK FUEL QUANTITY GAGE
12. FUEL MANAGEMENT PANEL
13. NO. 1 ENGINE POWER TURBINE INLET TEMPERATURE (T_5) INDICATOR
14. NO. 1 ENGINE GAS GENERATOR (Ng) TACHOMETER
15. NO. 1 ENGINE FUEL FLOW INDICATOR
16. NO. 1 ENGINE OIL PRESSURE INDICATOR
17. NO. 2 ENGINE GAS GENERATOR (Ng) TACHOMETER
18. NO. 2 ENGINE POWER TURBINE INLET TEMPERATURE (T_5) INDICATOR
19. NO. 2 ENGINE FUEL FLOW INDICATOR
20. CAUTION LIGHT PANEL
21. FIRE WARNING LIGHTS AND TEST SWITCH PANEL
22. PILOT'S TORQUEMETER
23. PILOT'S TRIPLE TACHOMETER
24. MASTER CAUTION LIGHT
25. PILOT'S AIRSPEED INDICATOR
26. PILOT'S RADAR ALTIMETER
27. PILOT'S ATTITUDE INDICATOR
28. PILOT'S BEARING, DISTANCE, HEADING INDICATOR
29. PILOT'S ALTIMETER

Figure 1-14. Instrument Panel (Typical) (Sheet 1 of 2)



30. PILOT'S VERTICAL VELOCITY INDICATOR
31. PILOT'S CLOCK
*32. PILOT'S VOR/TACAN SELECTOR SWITCH
33. PILOT'S TURN RATE SWITCH
34. PILOT'S BDHI POINTER IDENTIFICATION DECAL
35. PILOT'S AFCS INDICATOR
36. PILOT'S COURSE INDICATOR
37. CHECK OFF LIST
38. ADVISORY LIGHT PANEL
**39. VELOCITY STEERING INDICATOR
40. NO. 2 ENGINE OIL PRESSURE INDICATOR
41. NO. 2 ENGINE OIL TEMPERATURE INDICATOR
42. TRANSMISSION OIL PRESSURE INDICATOR
43. NO. 1 ENGINE OIL TEMPERATURE INDICATOR
44. TRANSMISSION OIL TEMPERATURE INDICATOR
*45. DF RANGE SWITCH
46. NO. 2 LOAD METER
47. PRIMARY HYDRAULIC PRESSURE INDICATOR
48. AUXILIARY HYDRAULIC PRESSURE INDICATOR
49. UTILITY HYDRAULIC PRESSURE INDICATOR
50. LOAD METER IDENTIFICATION PANEL
51. NO. 1 LOAD METER
52. VOLTMETER SELECTOR PANEL
53. DC VOLTMETER
54. COPILOT'S CLOCK
*55. COPILOT'S VOR/TACAN SELECTOR SWITCH
56. COPILOT'S TURN RATE SWITCH
57. COPILOT'S BDHI POINTER IDENTIFICATION PANEL
58. COPILOT'S BEARING, DISTANCE HEADING INDICATOR
59. COPILOT'S AFCS INDICATOR
60. COPILOT'S COURSE INDICATOR

Figure 1-14. Instrument Panel (Typical) (Sheet 2 of 2)

N_f AND N_r TRIPLE TACHOMETERS.

Two triple tachometers (figure 1-14), one for the pilot and one for the copilot, are located on the instrument panel. Each tachometer contains three pointers; the pointers marked 1 and 2 indicate the power turbine speed (N_f) of the No. 1 and 2 engines, respectively, and the pointer marked R indicates the main rotor rpm. The engine tachometers are powered by their own tachometer-generators which are driven by the power turbine through a flex cable, which is routed to the fuel control on which they are mounted. The main rotor tachometer is powered by its own tachometer-generator, located on the accessory section of the gear box, and driven by the accessory gears. The tachometers are read in percent of total rpm (100% N_f=18,966 power turbine rpm and 100% N_r= 203 rotor rpm).

POWER TURBINE INLET TEMPERATURE (T_5) INDICATORS.

Two power turbine inlet temperature indicators (figure 1-14), marked PWR TURB INLET TEMP, are located on the instrument panel. The indicators are graduated in degrees Centigrade and operate from thermocouples, located forward of the power turbine in the second-stage turbine casing on each engine. The indicators are normally powered by 115 volts ac from the ac essential bus, through circuit breakers, marked TURBINE INLET TEMP 1-ENG-2, located on the ac essential circuit breaker panel. However, when the ac essential bus is not energized, the indicators are powered by 115 volts ac from the inverter. The pilot has no direct control for regulating the power turbine inlet temperatures; however, limited control for lowering these temperatures can be achieved by reducing collective pitch or power demand. The maximum power turbine inlet temperature is indirectly controlled by the gas generator maximum speed adjustment of the fuel control.

ENGINE OIL PRESSURE INDICATORS.

Two engine oil pressure indicators (figure 1-14), one for each engine, are located on the instrument panel. The indicators are powered by 26 volts ac from the inverter bus and are protected by circuit breakers, marked OIL PRESS 1-ENG-2, located on the essential circuit breaker panel. Pressure is indicated in psi.

ENGINE OIL TEMPERATURE INDICATOR.

Two engine oil temperature indicators (figure 1-14), one for each engine, are located on the instrument panel. The engine oil temperature bulb, located on each oil inlet line on the bottom of each engine oil tank transmits indications to the respective temperature indicator. The indicators are powered from the dc essential bus and are protected by circuit breakers, marked OIL TEMP 1-ENG-2, located on the overhead dc circuit breaker panel. Temperature is indicated in degrees Centigrade.

FUEL FLOW INDICATORS.

Two fuel flow indicators (figure 1-14), calibrated in pounds per hour, are located on the instrument panel. The fuel flow indicators provide indication of the fuel consumption of the engines and operate on electrical power from the ac essential bus, through circuit breakers, marked FLOW 1-ENG-2 and under the general heading FUEL, located on the ac essential circuit breaker panel.

ROTOR SYSTEMS.

The rotor systems consist of a single main rotor and an anti-torque tail rotor. Both systems are driven by the two engines through the transmission system and are controlled by the flight controls.

MAIN ROTOR SYSTEM.

The main rotor system consists of the main rotor head assembly and the rotor blades. The head assembly, mounted directly above the main gear box, consists of a hub assembly and a swashplate assembly. The hub assembly, consisting of five sleeve-spindle assemblies and five hydraulic dampers clamped between two parallel plates, is splined to the main rotor drive shaft. The root ends of the five rotor blades are attached to the sleeve-spindle assemblies which permit each blade to flap vertically, hunt horizontally, and rotate about their spanwise axis, to change the angle of incidence. Anti-flapping restrainers limit the upward movement of the blades caused by wind pressure and droop stops limit the downward position of the blades. Both are in operation when the blades are stopped or turning at low speed. When speed is increased to approximately 25 percent (50 rpm) rotor speed, centrifugal force automatically releases the anti-flapping restrainers. The droop stops release at approximately 75% (152 rpm) rotor speed. The hydraulic dampers minimize hunting movement of the blades about the vertical hinges as they rotate, prevent shock to the blades when the rotor is started or stopped, and aid in the prevention of ground resonance. The blades are constructed of aluminum allow with the exception of forged steel cuffs which attach the root ends of the blades to the sleeve-spindle assemblies on the main rotor hub. Each blade basically consists of a hollow extruded aluminum spar pressurized with nitrogen, 25 aluminum blade pockets, an aluminum tip cap, an aluminum root cap, a steel cuff, a pressure (IBIS) indicator, an air valve, and an abrasion strip. Vent holes on the underside of each pocket prevent accumulation of moisture inside the blade. Each blade is balanced statically and dynamically within tolerances that permit individual replacement of the blades. In addition, a pretrack number is stenciled on each blade to eliminate the necessity for blade tracking. Balancing and the assignment of a pretrack number is performed at time of manufacture or overhaul. The swashplate assembly consists of an upper (rotating) swashplate driven by the rotor hub and a lower stationary swashplate secured by a scissors assembly to the main gear box to prevent rotation. Both swashplates are mounted on a ballring and socket assembly which keeps them parallel at all times, but allows them to be tilted, raised, or lowered simultaneously by components of the main rotor flight control system that are connected to arms on the lower stationary swashplate. Cyclic or collective pitch changes, introduced at the stationary swashplate, are transmitted to the blades by linkage on the rotating swashplate. The main rotor hub assemblies are equipped with a bifilar absorber assembly to reduce fatigue stress and improve the overall vibration comfort level throughout the helicopter. The bifilar absorber assembly, secured to the main rotor hub, consists of a five pointed, starshaped, aluminum forging with a seventeen-pound weight attached to each star point. Each weight is enclosed by a fairing to reduce drag.

CAUTION

Should an object (door, window, inspection panel, etc.) be inadvertently lost during flight, land as soon as possible if a vibration is experienced, or as soon as practical if a vibration is not and inspect the main and tail rotor system. Possible damage may not be felt in the controls or be visually detected with rotors turning.

In-Flight Blade Inspection System (IBIS).

The In-Flight Blade Inspection System (IBIS) visibly indicates in the cockpit that the pressure in one or more main rotor blade(s) has dropped below the allowable limit (figure 1-15).

The IBIS indicator located on the back wall of the spar of each main blade contains a small radioactive source (100 micro curies strontium 90) which is completely shielded (no radiation emitted) when rotor blade is at normal pressure. When the pressure in the rotor blade drops below approximately 6 pounds, the indicator will activate, causing the radioactive source to move to an unshielded position, thereby emitting beta radiation. The detector assembly, located aft of the main rotor shaft, under the transmission cowling, detects the beta radiation and sends a signal to the signal processor. The signal processor causes the BLADE PRESS light on the caution panel to illuminate, indicating a loss of pressure in one or more of the blades. Loss of pressure in the blade spar is also indicated by the IBIS indicator located in the back wall of the spar of each main blade. The indicator has a transparent cover through which a color indication can be observed. If the pressure in the blade spar drops below the minimum permissible service pressure, the indicator will be activated and will show two red stripes. The IBIS system is failsafe, i.e., loss of 115-volt 40 hz power, failure of the detector, and/or failure of the Signal Processor will cause the BLADE PRESS light to illuminate. The system receives electrical power from the 28-volt dc essential bus and 115-volt ac essential bus and is protected by 5-amp circuit breakers located on the pilot's and copilot's circuit breaker panels.

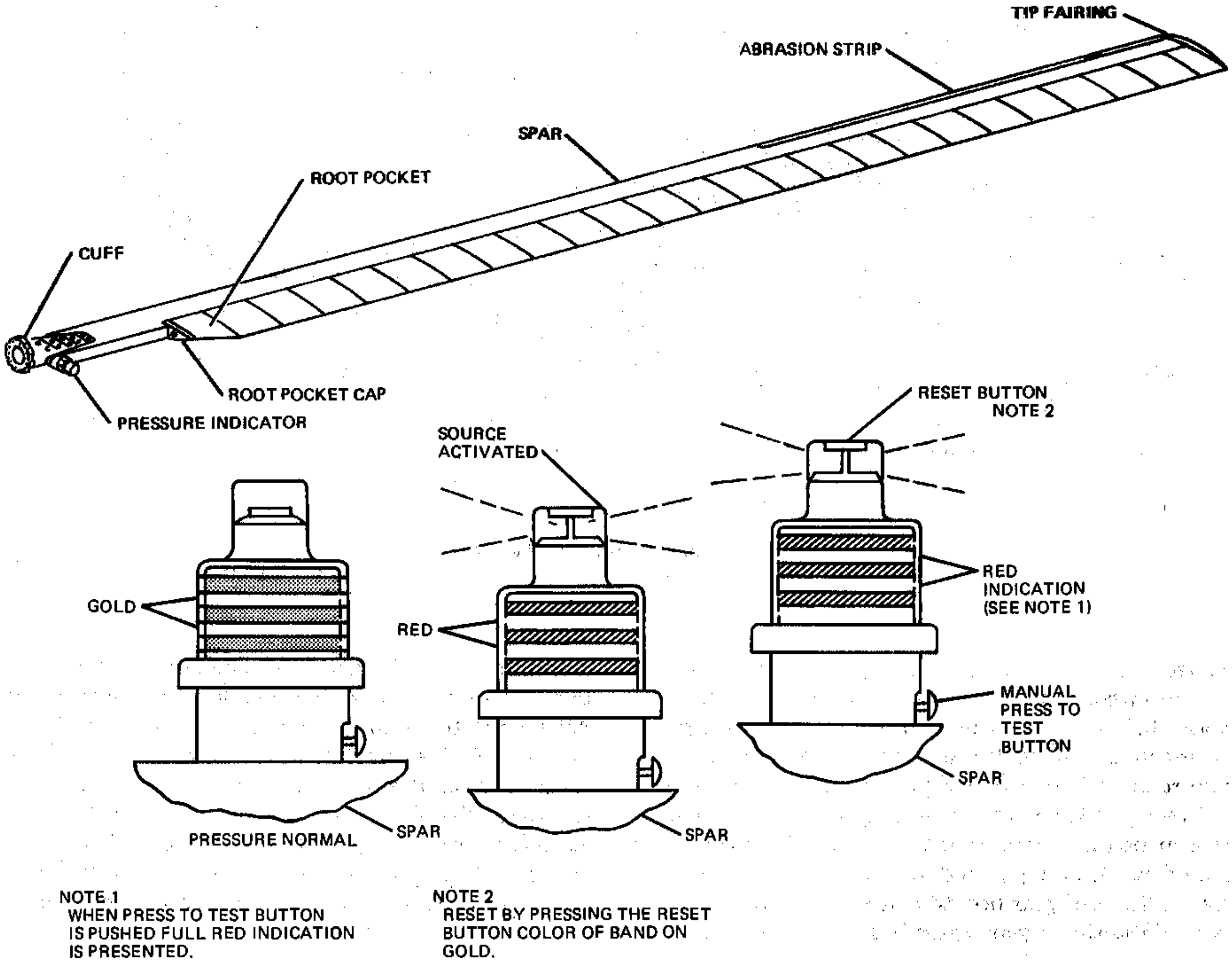


Figure 1-15. IBIS Indicator

TAIL ROTOR.

The tail rotor (figure 1-2) consists of the tail rotor assembly and tail rotor blades. The tail rotor assembly, mounted at the upper end of the pylon, consists of a tail rotor hub and the pitch-changing mechanism. The splined hub is supported and driven by the horizontal output shaft of the tail gear box. Because the tail rotor is directly geared, via transmission shafts, to the main gear box, tail rotor RPM is directly proportional to main rotor RPM. The five tail rotor blades are attached to the tail rotor hub so they are free to flap and rotate about their span-wise axis for pitch variation. The blade pitch-changing mechanism transmits tail rotor control pedal movements to the tail rotor blades through the horizontal output shaft of the tail gear box.

TRANSMISSION SYSTEM.

The transmission system (figure 1-16) consists of three gear boxes that transmit power to the main and tail rotors. The main gear box reduces engine rpm and interconnects the two engines to the rotor head. A freewheeling unit, located at each engine input to the main gear box, permits the rotor head

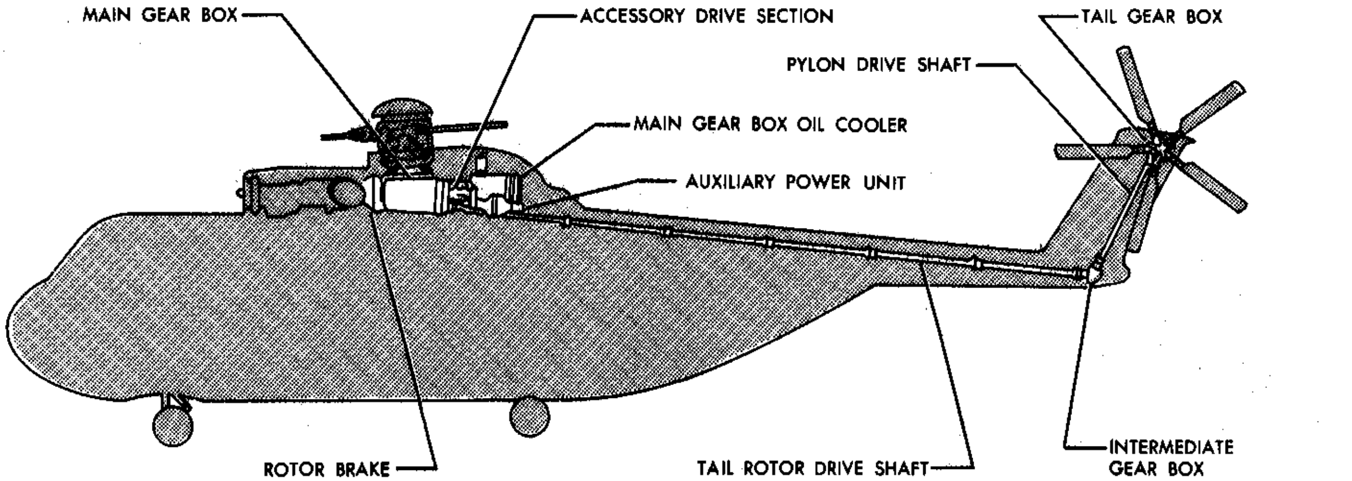


Figure 1-16. Transmission System

to autorotate without engine drag in event of engine (or engines) failure, or when engine rpm decreases below that of the rotor rpm. Engine torque is transmitted through the main gear box to the main rotor drive shaft to drive the main rotor, and aft through a tail rotor drive shaft to the intermediate gear box at the base of the pylon. From the intermediate box, a pylon drive shaft extends upward to the tail gear box to drive the tail rotor. Each of the three gear boxes has a chip detector.

MAIN GEAR BOX.

The main gear box, mounted above the cargo compartment aft of the engines, is a four-stage reduction gear system which reduces engine rpm at a ratio of approximately 93.4 to 1 for driving the rotor head. The main gear box contains a spur, helical bevel gear, and a single planetary gear stage. Shafting extends from the main gear box lower housing to the intermediate gear box and then to the tail rotor gear box to drive the tail rotor. The main gear box accessory section drives the primary, auxiliary, and utility hydraulic pumps, primary and secondary transmission lubrication pumps, torquemeter oil pump, two generators, and the N_r tachometer generator. The freewheeling capability of the tail takeoff freewheeling unit allows the APU to drive the accessory section during ground operations without turning the main rotor system. After rotor speed reaches 100% N_r, the tail takeoff freewheeling unit engages and the accessory section is driven by the main gear box. The APU clutch contains a freewheel unit that enables shutdown of the APU when the main rotor is turning. Should the tail takeoff freewheeling unit fail, the No. 1 engine N_f throughshaft will drive the accessory section whenever the No. 1 engine is running and the rotors are turning. Operation below approximately 92-96% N_f will cause illumination of the generator caution lights during ground operations.

INTERMEDIATE GEAR BOX.

The intermediate gear box, located at the base of the tail rotor pylon, contains a bevel gear direct-drive system to change direction of the shafting that transmits engine torque to the tail gear box. The intermediate gear box is splash-lubricated. Screened air outlets (figure 1-2) in the pylon fairing permit the gear box to be cooled by the rotor downwash.

TAIL GEAR BOX.

The tail gear box, located at the upper end of the tail rotor pylon, contains a bevel gear reduction-drive system to transmit engine torque to the tail rotor. The tail gear box also contains part of the pitch change linkage which extends through the hollow output shaft to the tail rotor hub. The tail gear box is splash-lubricated.

TRANSMISSION CHIP DETECTOR LIGHTS.

Three transmission chip detector lights, marked CHIP LOCATION, MAIN, INTMED, and TAIL, are located on a chip location panel on the cockpit console (figures 1-17 and 1-18). The lights provide a visual indication of metallic chips detected in the main, intermediate, or tail gear boxes. An additional chip detector sensor monitors the system in the main gear box emergency sump. The added chip detector uses the same chip detector light, electrical power source, and protective circuit breaker as the MAIN (primary) chip detector. A caution panel light, marked CHIP DETECTED, illuminates simultaneously with any one of the three lights on the cockpit console. The system operates on current from the dc essential bus and is protected by circuit breakers, marked CHIP DET, MAIN, INTMED, and TAIL, located on the overhead dc circuit breaker panel.

ROTOR BRAKE.

A hydraulically-actuated rotor brake, mounted on a brake shaft forward of the main gear box, stops the rotation of the rotor system and prevents rotation when the helicopter is parked. The rotor brake consists of a hydraulic cylinder and lever, pressure gage, hydraulic brake cylinders, and a brake disc. The rotor brake hydraulic cylinder and lever, located on the pilot's compartment ceiling, operate independently from the hydraulic systems. A spring-loaded accumulator, connected to the rotor brake hydraulic lines at the forward end of the transmission compartment, assures continuous hydraulic pressure when the rotor brake lever is applied. The rotor brake hydraulic cylinder is gravity fed with hydraulic fluid from the rotor brake reservoir. In case of a broken or leaking hydraulic line from the rotor brake reservoir, the rotor brake hydraulic cylinder contains sufficient fluid for braking the rotor system. The hydraulic brake cylinder is located on the supports attached to the main gear box. The brake disc is positioned on the main input shaft of the main gear box.

Rotor Brake Cylinder and Lever.

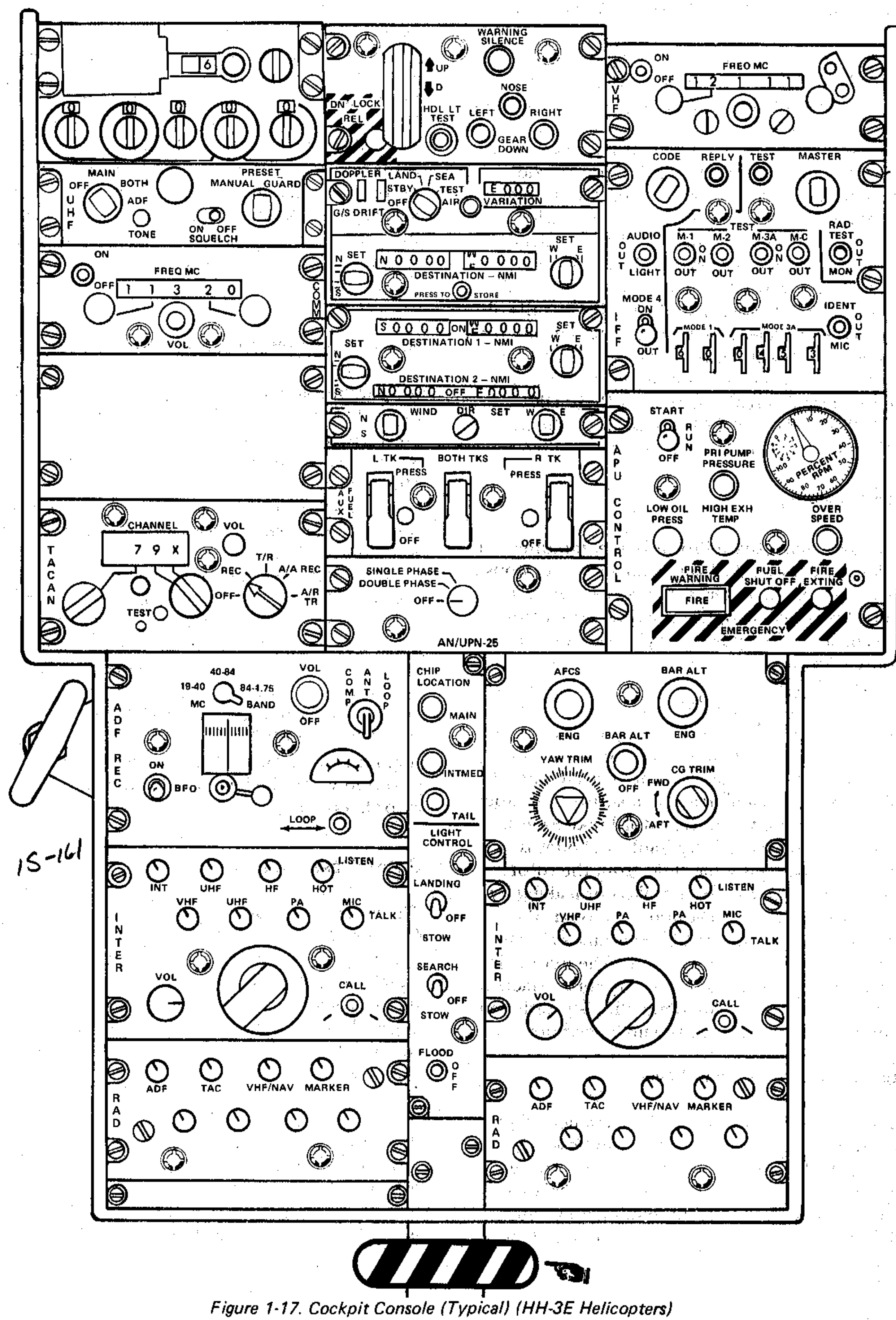
A rotor brake lever (figure 1-19) is connected directly to the rotor brake hydraulic cylinder, located on the pilot's compartment ceiling to the right and forward of the overhead switch panel. The rotor brake is applied by pulling down and pushing forward as indicated on the decal aft of the lever on the upper structure. The decal is marked TO ENGAGE ROTOR BRAKE PUSH LEVER FORWARD and has an arrow pointing forward. A spring-loaded lock, located at the forward outboard side of the cylinder, automatically locks the brake lever in the applied (forward) position if the pilot places the small handle in the horizontal (forward position). To release the rotor brake, pull out on the lockpin and swing the lever aft and up against the bottom of the cylinder until it snaps into place. The lockpin may be rendered inoperative by rotating until it remains in the OUT position.

Rotor Brake Pressure Gage.

A hydraulic actuated rotor brake pressure gage is located to the rear of the rotor brake lever (figure 1-19) on the pilot's compartment ceiling. The reading, indicated by the pointer, indicates psi x 100. A decal, marked ROTOR BRAKE PRESSURE, located adjacent to the rotor brake pressure gage, is marked to identify the operating pressure ranges of the system. The marking ACTUATING RANGE 350-500 psi identifies the system operating pressure range for normal rotor brake application. The marking ENGINE START 320 P.S.I. MIN. identifies the minimum system pressure required before starting engines to ensure the rotors will not turn with both engines operating at ground idle. The marking PARKED POSITION RANGE 250-600 P.S.I identifies the system pressure range maintained for effective rotor brake application when the helicopter is parked with the rotor brake on.

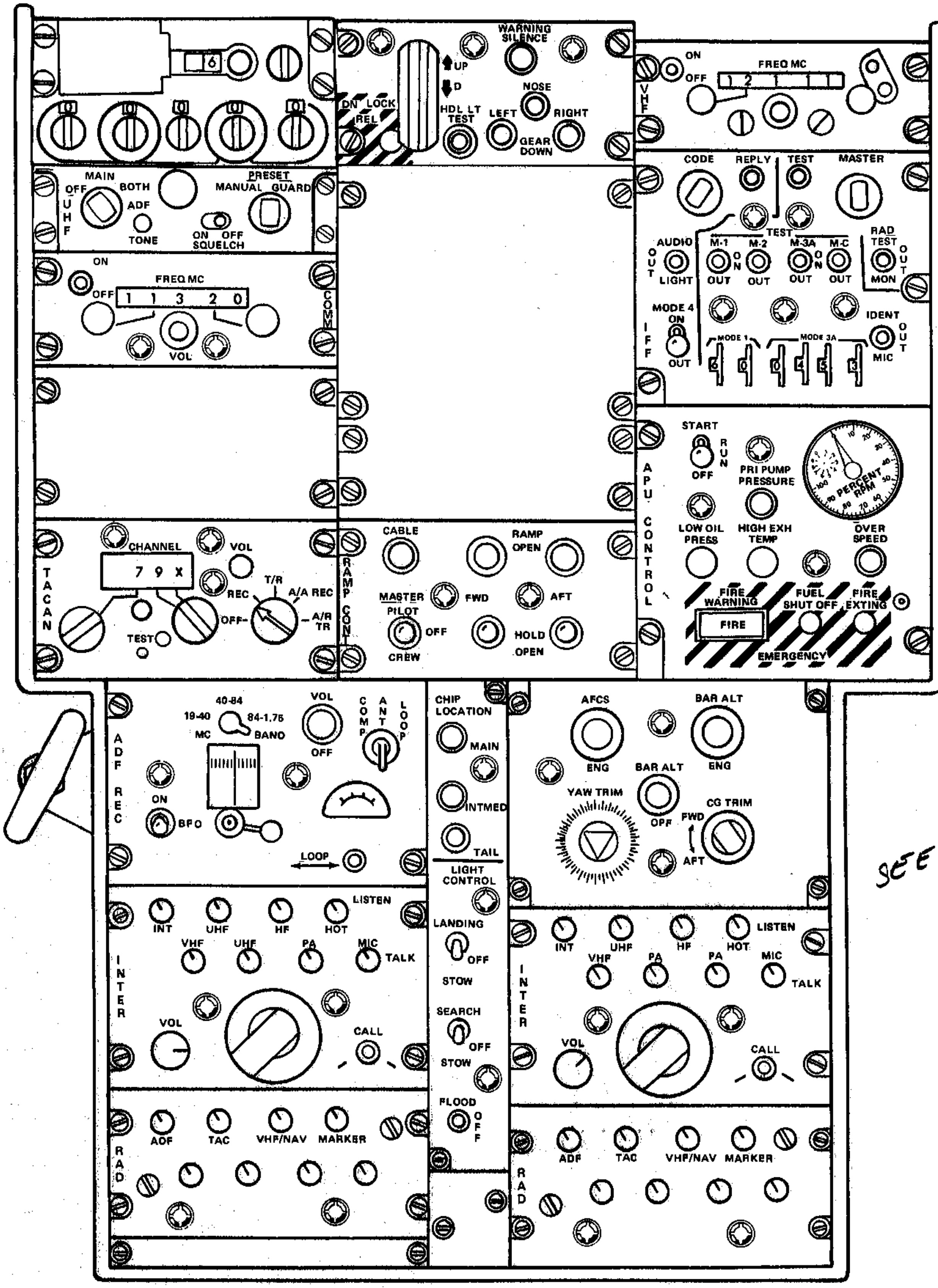
Rotor Brake Caution Light.

The rotor brake caution light, marked ROTOR BRAKE ON, is located on the caution panel (figure 1-20) on the pilot's side of the instrument panel. The light is provided as an aid in the prevention of rotor engagement while the rotor brake is engaged. Whenever the rotor brake hydraulic pressure is 10 ± 1 PSI or above, the electrical power is supplied to the dc essential bus, the caution light will go on. When the rotor brake pressure drops below 10 ± 1 PSI, the light will go out. Normally, the rotor brake off the pressure should be zero; however, after the rotor brake is released and pressure, at 10 ± 1psi or above, is trapped in the system, the caution light will remain on. If the pressure reaches 20 psi, the brake will begin to drag.



SEE 1S-161

Figure 1-17. Cockpit Console (Typical) (HH-3E Helicopters)



SEE 1S-161

Figure 1-18. Cockpit Console (Typical) ~~(CH-3E Helicopter)~~

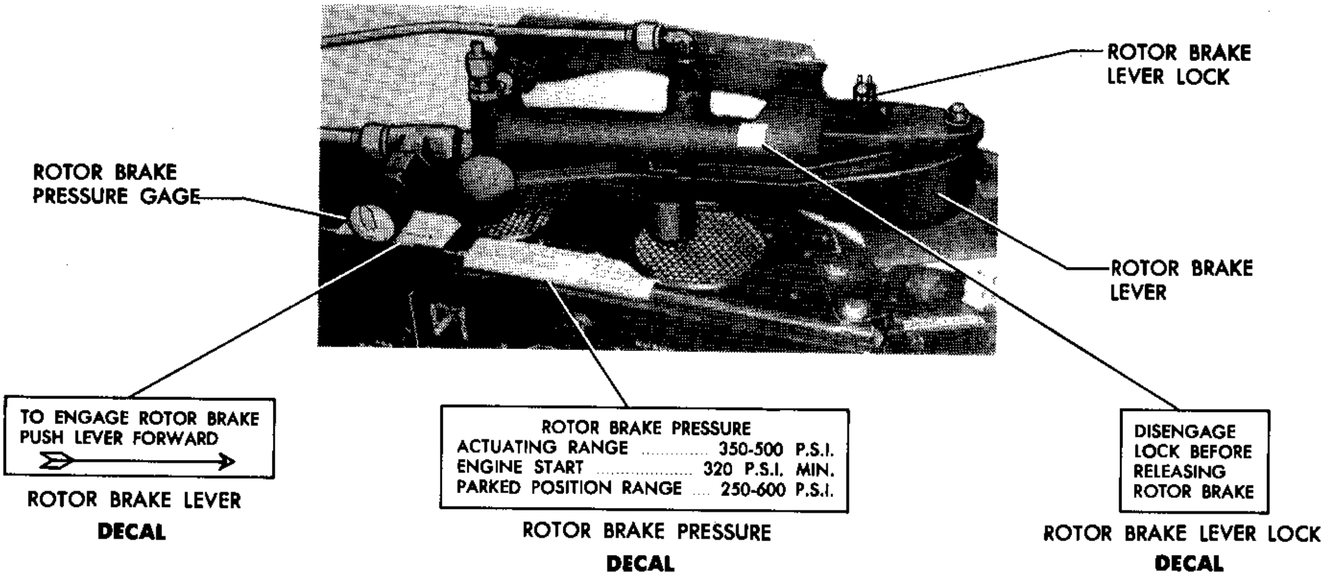


Figure 1-19. Rotor Brake Lever

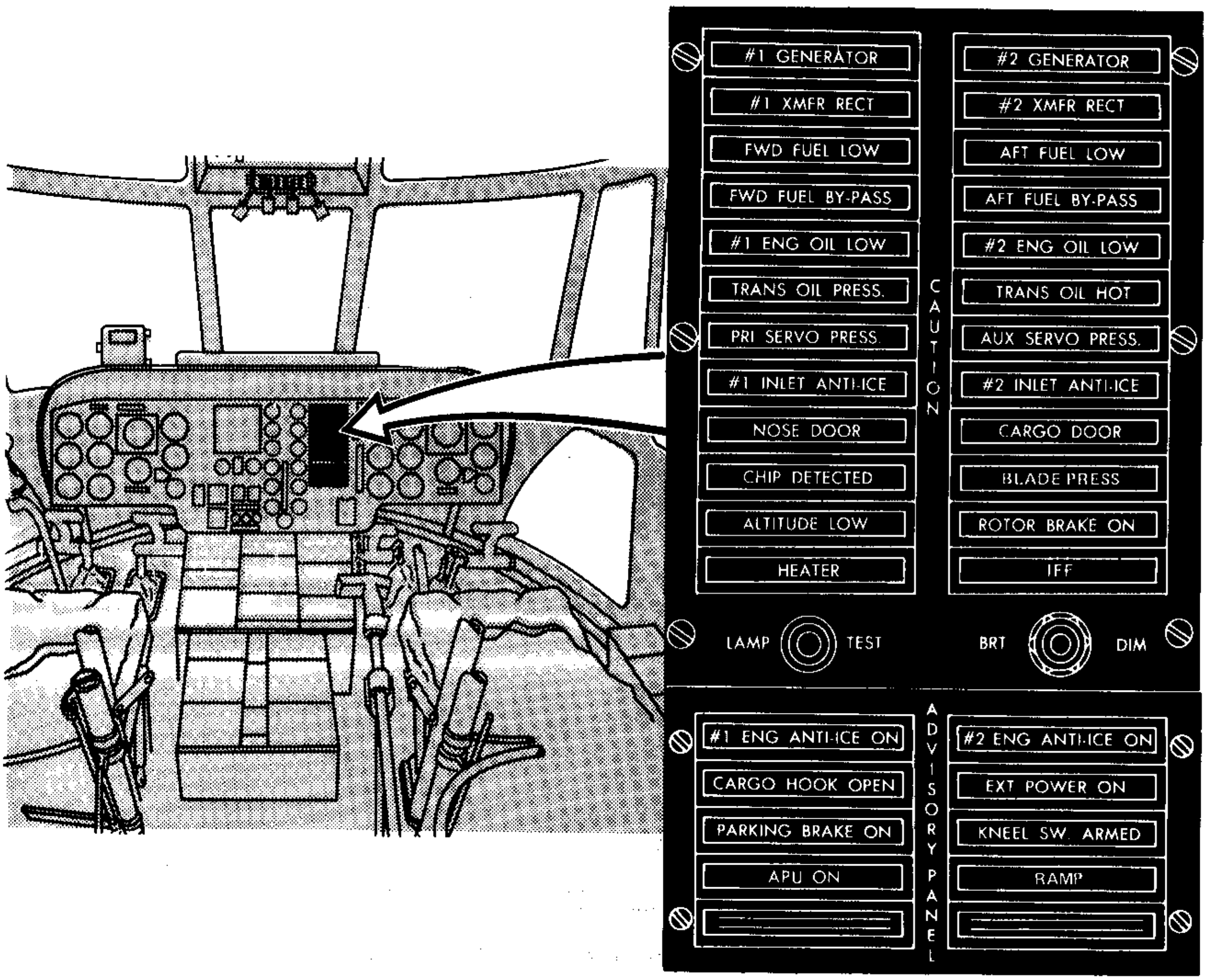


Figure 1-20. Caution and Advisory Panel (Typical)

Figure 1-21 deleted.

OIL SUPPLY SYSTEMS.

The oil supply systems consist of the engine and transmission oil systems. An auxiliary oil system is provided for those helicopters that have the internal auxiliary fuel tanks installed to augment the normal oil tank supply. HH-3E helicopters are equipped with an auxiliary oil system that differs slightly from that provided with the internal auxiliary fuel tanks. CH-3E helicopters 16 are equipped with provisions for installation of the auxiliary oil system used on the HH-3E.

ENGINE OIL SYSTEM.

Each engine has an independent oil tank and dry sump full scavenge oil system. Oil is gravity fed from the tank to the engine drive oil pump, mounted on the forward right-hand side of the engine. The pump distributes the oil, under pressure, through a filter to accessory gears and engine bearings. The oil serves both lubricating and cooling purposes and the system is completely automatic. The scavenge side of the pump returns the oil through an oil cooler to the oil tank. The oil cooler is an oil-to-fuel heat exchanger with an associated oil bypass system. The oil flow through the cooler depends on oil temperature. At low oil temperature, most of the oil bypasses the cooler. Higher oil temperatures close the bypass valve and cause the oil to flow through the cooler. Each engine oil system has a useful capacity of 2.5 US gallons of oil in a 3.5 US gallon tank (1.0 gallon expansion space). The circular tanks are located around the forward section of each engine.

NOTE

.1625 GAL

.1750 GALL

Approximate oil consumption is 1.3 and 1.4 pints per hour at normal and military power, respectively. Maximum allowable oil consumption is 1.4 pints per hour.

Engine Oil Low Level Caution System.

The engine oil low level caution system consists basically of two separate indicating systems, one for each engine. Each system is separately powered through a 5 ampere circuit breaker on the essential dc bus and has a separate caution panel light capsule marked #1 ENG OIL LOW and #2 ENG OIL LOW. A float switch is installed in each engine oil tank. If the oil level in a tank falls 0.6 gallons below full, the float switch contacts close. Closing the switch contacts completes the circuit from the essential dc bus, through the 5 amp circuit breaker and the warning light to ground, causing the light to illuminate. Power for the engine oil low level caution system is supplied by the essential dc bus system through circuit breakers, marked ENG OIL LOW LEVEL, located on the overhead control panel.

AUXILIARY OIL SYSTEMS.

Auxiliary oil systems (figure 1-22) are provided for those helicopters that have the internal auxiliary fuel tanks installed and those helicopters equipped with external auxiliary fuel tanks and an air refueling system. The requirement for an auxiliary oil system is generated primarily by the increased range realized with the auxiliary fuel tanks and the air refueling system. As both systems use the same components and operating procedures, the basic difference being the location of the auxiliary oil tank, they will be discussed under one heading. The auxiliary oil system consists of a tank, hand pump, drain valve, two directional valves, and two TANK FULL lights. The need to replenish the oil supply in the engine oil tanks is indicated by illumination of the appropriate ENG OIL LOW caution light. The appropriate engine oil tank may then be filled to the proper level by opening the applicable direction valve and operating the hand pump until the associated TANK FULL light illuminates. Continued pumping after the TANK FULL light has illuminated will cause the oil to be pumped overboard.

Auxiliary Oil Tank.

The auxiliary oil tank for helicopters equipped with the single internal auxiliary fuel tank installed is mounted on the fuel tank. If the dual internal auxiliary fuel tank system is installed, the tank is mounted on the rear tank. Those helicopters equipped with external auxiliary fuel tanks and an air refueling system have the auxiliary oil tank mounted on the right-hand side of the cargo compartment. The tank has a capacity of 2.6 US gallons and is equipped with a filler cap, drain valve, lights that indicate when the engine oil tanks are full, and the plumbing to carry tbe oil to the hand pump.

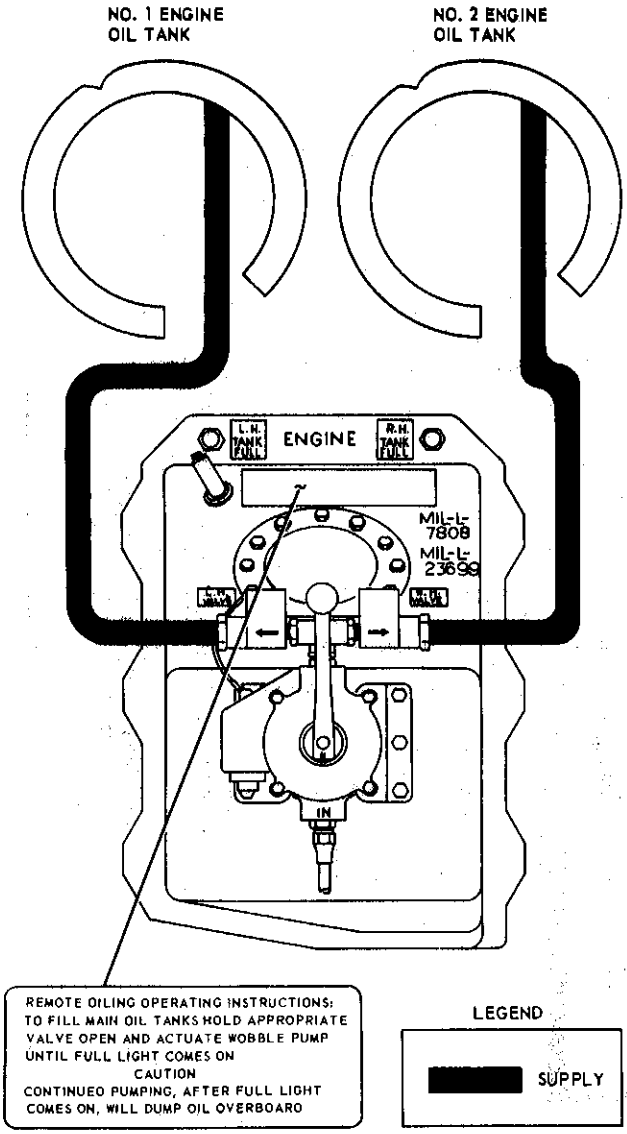


Figure 1-22. Auxiliary Oil System

Hand Pump.

The hand pump, secured to the auxiliary oil tank, is manually operated by moving the handle in a left and right direction.

Directional Valves.

The two directional valves, secured to the auxiliary oil tank, are used to direct the auxiliary oil to a selected engine oil tank. The valve marked LH VALVE directs flow to the No. 1 engine oil tank and the valve marked RH VALVE directs flow to the No. 2 engine oil tank. The valves are opened by depressing plungers that will return the valves to the closed position whenever they are released. There are no provisions for locking the valves in the open position.

Engine Oil Tank Full Indicator Lights.

The engine oil tank full indicator lights, marked LH TANK FULL and RH TANK FULL, are located on the top of the auxiliary oil tank. The lights, one for each engine oil tank, illuminate to indicate that the engine oil tank has been replenished to the full level by the auxiliary oil system. The engine oil tank full indicator lights are powered from the dc essential bus through the INDICATOR LTS PWR circuit breakers located on the overhead circuit breaker panel.

TRANSMISSION OIL SYSTEM.

Each of the three transmission system gear boxes has an individual oil system. The main gear box is pressure-lubricated and the intermediate and tail gear boxes are splash-lubricated.

MAIN GEAR BOX OIL SYSTEM.

A primary oil pump and secondary oil pump circulate oil for main gear box lubrication and cooling. The torque system oil pump is mounted tandem to the primary oil pump and is used to provide lubrication under emergency conditions. Oil is pumped from the gear box sump to an oil cooler located behind the main gear box. Cooling air enters the forward end of the main gear box fairing and is forced through the oil cooler by a blower, driven by belts from the tail rotor drive shaft. After passing through the oil cooler, the oil returns to the main gear box where it is sprayed onto the gears and bearings through jets built into the gear box castings. An oil filler is accessible from the left side of the main gear box fairing. A window in the gear box below the oil filler provides a sight check for the oil level in the main gear box. Normal servicing is 11.6 US gallons. Figure 1-23 shows the main gear box lubricating schematic diagram.

CAUTION

The oil level cannot be seen if the tank is overserviced. Excessive oil temperatures can result from an overserviced main gear box.

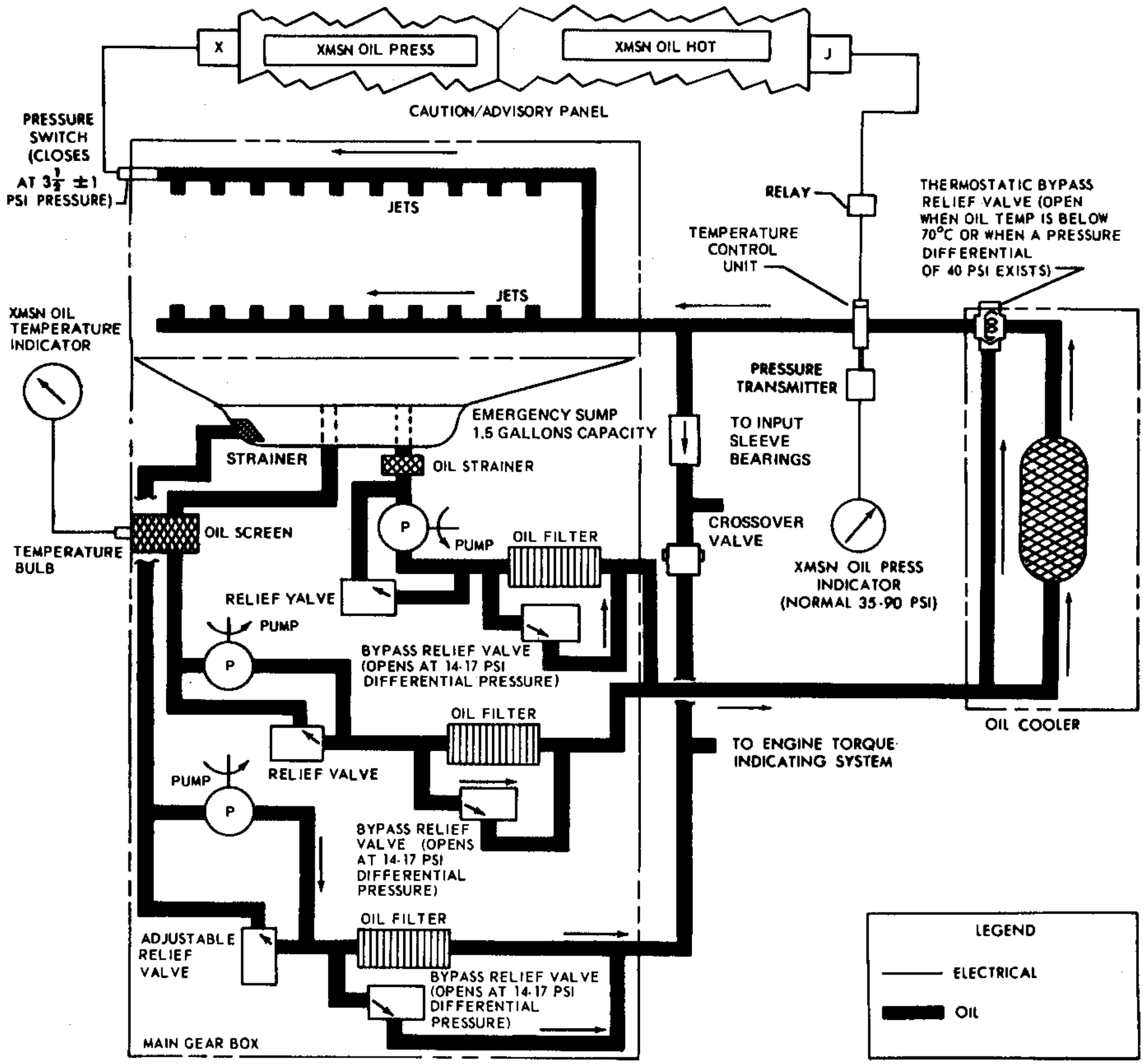


Figure 1-23. Main Gear Box - Lubricating Schematic Diagram

MAIN GEAR BOX EMERGENCY SUMP OIL SUPPLY.

An emergency sump (figure 1-24) in the bottom of the transmission provides a reserve oil supply of approximately 1.5 gallons to lubricate the input sleeve bearings in the high speed section of the main gear box. If a break occurs in the main gear box pressurized lubricating system, the main lubrication pumps will pump most oil overboard, leaving approximately 1.5 gallons in the emergency sump. As the main lubrication pressure decreases to approximately 10 PSI, a crossover valve opens, directing oil from the torquemeter pump directly to each of the four sleeve bearings in addition to providing oil to the torque indicating system.

Main Gear Box Oil Pressure Indicator and Caution Light.

The main gear box oil pressure indicator, marked TRANS OIL PRESS (figure 1-14), is located on the instrument panel. The indicator is graduated in pounds per square inch and is actuated by a pressure transmitter connected to the gear box oil inlet port. The main gear box oil pressure indicator operates on 26 volts ac from the inverter bus and is protected by a circuit breaker marked TRANS OIL PRESS, located on the ac essential circuit breaker panel. The main gear box oil low pressure caution light, marked TRANS OIL PRESS, is located on the caution panel (figure 1-20). The amber caution light operates on direct current from the essential bus and is protected by a circuit breaker, marked CAUTION PANEL, located on the overhead dc circuit breaker panel. The light will come on when the main gear box oil pressure drops below 4 psi as it enters the last oil pressure jet in the gear box.

Main Gear Box Oil Temperature Indicator and Caution Light.

The main gear box oil temperature indicator (figure 1-14), marked TEMP XMSN OIL, located on the instrument panel, is graduated in degrees Centigrade. The indicator, electrically connected to an oil temperature bulb adjacent to the main gear box oil outlet port, receives power from the dc essential bus through a circuit breaker, marked TRANS OIL TEMP, located on the overhead dc circuit breaker panel. The main gear box oil temperature caution light, marked TRANS OIL HOT, is located on the caution panel (figure 1-20). The amber caution light operates on direct current from the essential bus and is protected by a circuit breaker, marked TRANS OIL HOT, located on the overhead dc circuit breaker panel (figure 1-39). The transmission oil temperature caution light will illuminate when the transmission oil temperature reaches 120°C at the main gear box inlet port. The different locations of the temperature sensors for the indicator and caution light allow the pilot to monitor the gear box operation by means of the indicator and the oil cooler operation by means of the caution light. Thus if a malfunction occurs in the oil cooler (blockage, fan belt failure, etc), the caution light will illuminate before the gear box oil temperature rises to a hazardous level.

Intermediate and Tail Gear Box Oil Systems.

Both the intermediate and the tail gear boxes are splash-lubricated from individual sump systems. Internal spiral channels ensure oil lubrication to all bearings. An oil filler plug, and oil level sight gage are located in each gear box casting. When the oil in the intermediate gear box is at FULL on the oil level sight gage, it contains 0.2 gallons. When the oil in the tail gear box is at FULL on the oil level gage, it contains 0.4 gallons.

FUEL SUPPLY SYSTEM.

The helicopters are equipped with two independent pressure-type, fuel systems (figure 1-25) that are joined by a crossfeed system to ensure maximum fuel utilization. An auxiliary fuel system, either an internal or external fuel tank system, is provided to augment the main tank fuel supply. The internal auxiliary fuel tank system may be installed on CH-3E helicopters prior to 16 . CH-3E 16▶ and all HH-3E helicopters are equipped with external auxiliary fuel tanks. HH-3E helicopters are equipped with a ground pressure and air refueling system and CH-3E helicopters 16▶ are equipped with provisions for the ground pressure and air refueling systems. Those helicopters equipped with an auxiliary fuel system are also provided with a fuel dumping system. The component installation and procedures for supplying fuel from the main fuel tanks to the engines are the same for all model helicopters. The fuel boost pumps within each tank provide fuel to the appropriate engine and also to the fuel ejector unit within the tank. Fuel passing through the ejector unit creates a venturi effect which draws additional fuel

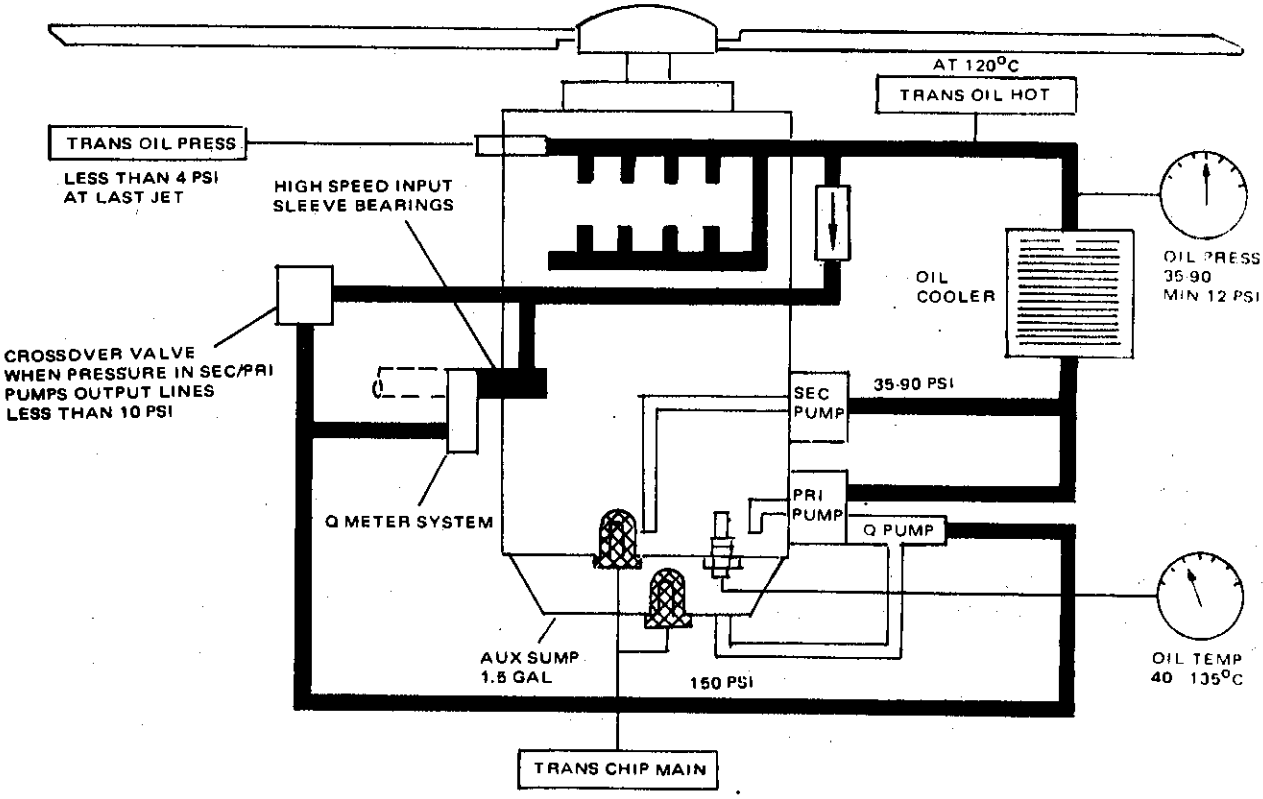


Figure 1-24. Main Transmission with Auxiliary Sump

from the tank into the ejector unit. Fuel is then pumped from the ejector unit into a collector can which surrounds the boost pumps within the fuel tank. The fuel ejector unit and boost pump arrangement provides integral fuel transfer within each tank, at all operating altitudes, and a minimum of unusable fuel. The crossfeed system is electrically controlled by a fuel crossfeed valve switch and allows fuel from both systems to be directed to one engine during single-engine operation. The fuel management panel, located on the instrument panel, controls the fuel systems. Fuel for the auxiliary power unit is supplied from the aft fuel tank, and fuel for the heater is supplied from the forward fuel tank.

FUEL TANKS.

The forward and aft main fuel tanks are located below the cargo compartment floor. The internal and

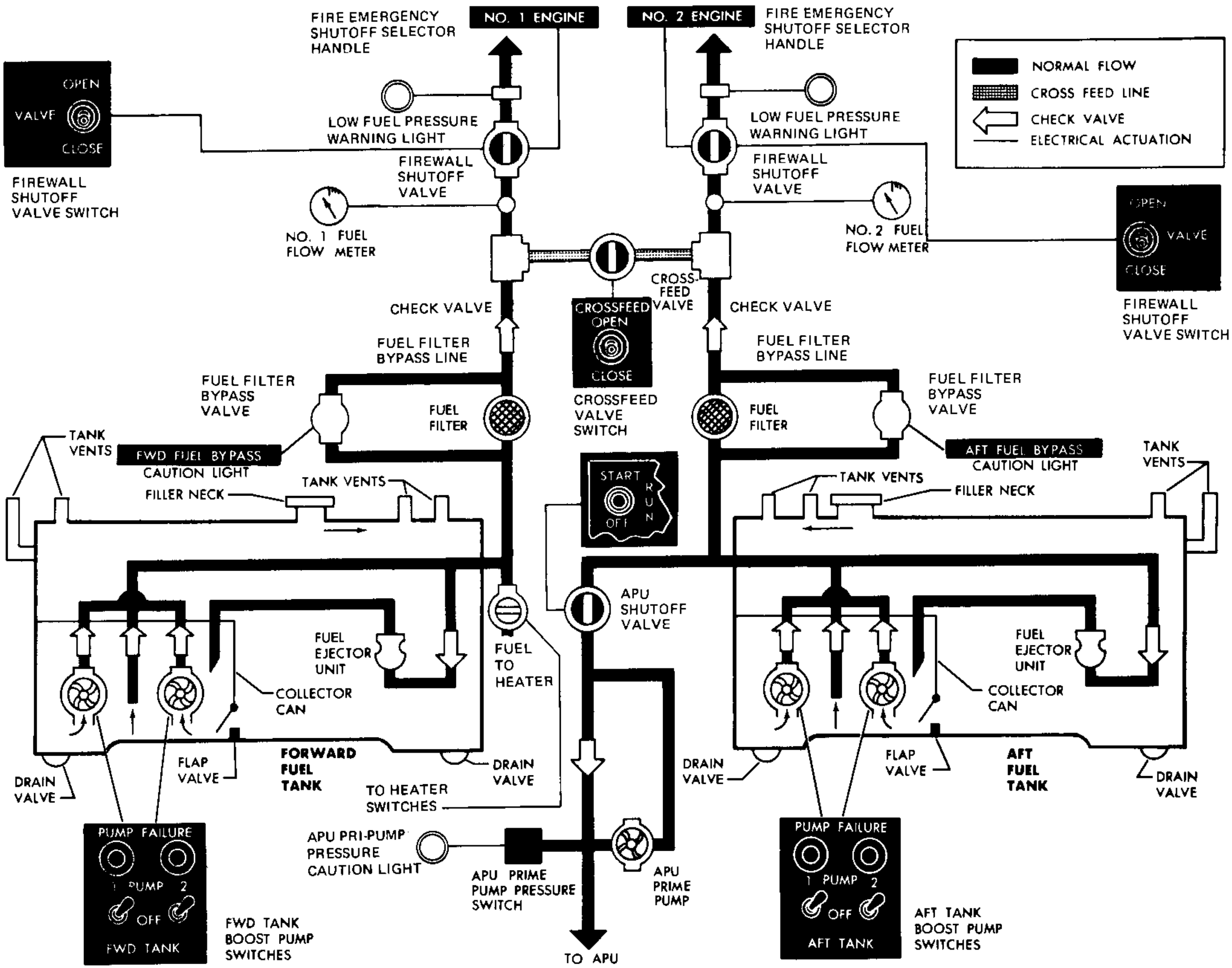


Figure 1-25. Helicopter Fuel System (CH-3E Helicopters Without External Auxiliary Tanks)

external auxiliary fuel tanks are discussed under the heading AUXILIARY FUEL SYSTEMS in this section. Each main fuel tank contains a collector can which surrounds two fuel boost pumps, a fuel ejector unit, vents, and sump drain valves. The main fuel tanks on helicopters prior to CH-3E 16 not modified by T.O. 1H-3(C)C-557 contain two bladder-type fuel cells. CH-3E 16▶ , all HH-3E, or helicopters modified by T.O. 1H-3(C)C-557, are equipped with two self-sealing type fuel cells in each main fuel tank. CH-3E and HH-3E helicopters modified by T.O. 1H-3-609 have polyurethane foam installed in the main fuel tanks. The material is 97 percent void and completely fills the internal volume of the tanks. With the foam material installed, it is impossible to have an explosion occur internally within the fuel tanks, regardless of the ignition source. It must be remembered that foam has no self-sealing capability, and its only function is to prevent internal explosion and to act as a baffle material. With foam installed the dry weight of the aircraft without external tanks is increased approximately 171 pounds. However, the gross weight is increased only 96 pounds on aircraft with external tanks and 22 pounds on aircraft without external tanks as 2.5 percent of the fuel capacity is displaced by the foam. See figure 1-30 for fuel quantity data with explosion suppression foam installed. The main fuel tanks of helicopters equipped with auxiliary fuel systems each contain a float valve. The float valves are actuated by the rising fuel in each tank to shut off the fuel from the auxiliary tanks when the main tanks are full. The float valves regulate the rate of flow from the auxiliary tanks, prevent overfilling the main tanks, and maintain a constant main fuel tank level until the auxiliary tanks are empty. The main fuel tanks of helicopters equipped with, or provisioned for, the ground pressure and refueling system are equipped with the fuel lines and components necessary to support the systems. The tank components installed in each tank for the ground pressure and air refueling systems are a pressure refueling shutoff valve, a high level shutoff sensor, and surge valves. The pressure refueling shutoff valves permit fuel flow when pressure refueling and are shut off by the high level shutoff sensors when the tanks are full. The high level shutoff sensors are actuated by the rising fuel in each tank to shut off fuel flow when the main tanks are full. The high level shutoff sensors operate during ground pressure and air inflight refueling, or when fuel is being transferred from the external auxiliary fuel tanks to the main fuel tanks. The surge valves prevent damage from pressure surges by relieving excessive pressure. The vents are routed through the cargo compartment to minimize vent icing, then to both sides of the helicopter where the cells are vented to the atmosphere. The sump drain valves are manually operated to drain water from the system. The defueling valves provide for complete drainage of the system. Both fuel tanks are gravity filled through two filler caps located on the left side of the helicopter; pressure refueled through the pressure refueling adapter, located on the lower fuselage below the entrance of the cargo compartment; the air refueling probe, located on the right side of the forward fuselage, or from the auxiliary fuel systems.

ADDED TO SEE 13-162

FUEL SHUTOFF VALVE SWITCHES.

The two fuel shutoff valve switches, marked VALVE, are located on the fuel management panel (figure 1-26). The switch, marked NO. 1 ENG with marked positions OPEN and CLOSE, controls the flow of fuel to the No. 1 engine. The switch, marked NO. 2 ENG with marked positions OPEN and CLOSE, controls the flow of fuel to the No. 2 engine. The switches control the fuel shutoff valves located on top of the cargo compartment before the engine compartment. Placing either switch in the CLOSE position shuts off the flow of fuel to the appropriate engine. The fuel shutoff valves are also actuated to the closed position when the appropriate fire emergency shutoff selector handle is pulled. The fire emergency shutoff selector handles, marked FIRE EMER SHUTOFF SELECTOR, located on the overhead control panel, arm the fire extinguisher circuit in addition to actuating the fuel shutoff valves. In the event of electrical failure, the fuel shutoff valves will remain in the last switch position energized. The fuel shutoff valves are provided with a fail safe capability. The fail safe capability prevents the valves from changing position should a possible malfunction occur whereby both the open and close circuits of the valve are energized simultaneously. The fuel shutoff valves and switches operate on current from the dc essential bus and are protected by circuit breakers marked EMER SHUTOFF 1- ENG-2 under the general headings FUEL SYSTEM and VALVES, located on the overhead dc circuit breaker panel.

FUEL CROSSFEED VALVE SWITCH.

The fuel crossfeed valve switch, marked CROSSFEED, is located on the fuel management panel (figure 1-26). The switch has marked positions

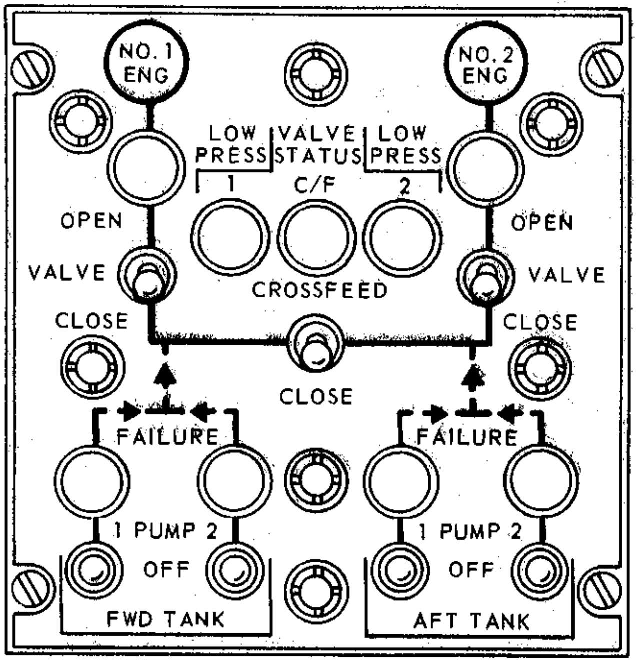


Figure 1-26. Fuel Management Panel

OPEN and CLOSE and controls the fuel crossfeed valve located on top of the cargo compartment between the two fuel systems supply lines in the crossfeed line. With the switch in the CLOSE position, the forward fuel tank supplies fuel to the No. 1 engine and the aft fuel tank supplies the No. 2 engine. When the switch is placed in the OPEN position, the crossfeed valve opens and allows fuel under pressure to be supplied from both fuel tanks to either or both engines. The crossfeed system does not transfer between tanks. The fuel crossfeed valve operates on direct current from the dc essential bus and is protected by a circuit breaker marked X FEED, under the general headings FUEL SYSTEM and VALVES, located on the overhead dc circuit breaker panel.

FUEL SHUTOFF AND CROSSFEED VALVE STATUS LIGHTS.

Valve status warning lights for each shutoff valve and the crossfeed valve are located on the fuel management panel (figure 1-26). The lights, marked 1, 2, and C/F, under the heading VALVE STATUS, illuminate to provide an indication of the status of the shutoff and crossfeed valves. The appropriate light will be illuminated when a valve is being actuated from one position to another, if a protective relay is inoperative when electrical power is applied to the helicopter, or if both the closing and opening circuits should become simultaneously energized. The valve status lights use the same power source and protective circuit as the low fuel pressure warning lights.

LOW FUEL PRESSURE WARNING LIGHTS.

Two low fuel pressure warning lights, marked #1 LOW PRESS, #2 LOW PRESS, are located on the fuel management panel (figure 1-26). The warning lights will illuminate whenever fuel pressure drops below minus 5 psi at the pressure switch, located between the fuel shutoff valve and the engine. The intensity of the lights may be varied by rotating a rheostat under the heading CONSOLES, marked LOWER, located on the overhead switch panel. The warning lights receive electrical power from the dc essential bus through circuit breakers, under the general heading INDICATOR LTS and marked FUEL PRESS 1 and 2, located on the overhead dc circuit breaker panel.

FUEL BOOST PUMPS.

Two fuel boost pumps are located in the forward end of each main fuel tank. Each tank has a No. 1 boost pump and a No. 2 boost pump, powered by separate electrical circuits. The No. 1 boost pump in each tank is powered by current from the ac essential bus, while the No. 2 boost pump in each tank is powered by current from the ac nonessential bus. Control of all boost pumps is provided by switches which operate on current from the dc essential bus. The No. 1 boost pumps are protected by circuit breakers, marked FWD TANK and AFT TANK and under the general heading No. 1 FUEL PUMP, located on the ac essential bus circuit breaker panel. The No. 2 boost pumps are protected by circuit breakers, marked FWD TANK and AFT TANK and under the general heading No. 2 FUEL PUMP, located on the ac nonessential bus circuit breaker panel. The engine may be operated using one, both or no boost pumps.

Fuel Boost Pump Switches.

Four boost pump switches, grouped according to fuel tank designations, are located on the fuel management panel (figure 1-26). The two boost pump switches for the pumps in the forward tank are marked FWD TANK 1 and 2, and those for the aft tank AFT TANK 1 and 2. The number designation, whether 1 or 2, indicates the boost pump controlled by the particular switch. Each switch has marked positions PUMP (ON) and OFF. All boost pump switches are connected to the dc essential bus through circuit breakers, marked FWD TANK 1 and 2, AFT TANK 1 and 2, under the general headings FUEL SYSTEM and PUMP CONT, located on the overhead dc circuit breaker panel. When the switches are placed in the PUMP (ON) position, dc power from the dc essential bus closes relays in the circuit between the appropriate ac essential bus and the respective boost pump. The OFF position deenergizes the relays, cutting off ac power to the respective boost pump.

Fuel Boost Pump Failure Warning Lights.

Each of the four boost pumps is provided with a pressure switch that is connected to the pressure feed line from each boost pump. The fuel pressure switches actuate the boost pump failure warning lights, marked FAILURE, located on the fuel management panel (figure 1-26), when the boost pump pressure falls below a safe operating pressure. Each boost pump is provided with an individual boost pump failure warning light located above the respective boost pump switch. The boost pump failure warning lights should illuminate and then go off when the boost pumps are first turned on, or when the boost pump switches are being tested. They are illuminated until fuel pressure is built up in the system. The pressure switches close if the boost pressure decreases to, or is below, approximately 16 1/2 psi and energizes the respective boost pump failure warning light circuit which lights the boost pump failure warning light. The boost pump pressure switches and failure warning lights operate from the dc essential bus and are protected by circuit breakers, marked FWD TANK, 1 and 2, AFT TANK, 1 and 2 and under the general headings INDICATOR LIGHTS and FUEL PUMPS, located on the overhead dc circuit breaker panel.

FUEL QUANTITY GAGES AND TEST SWITCHES.

The fuel quantity gages (figure 1-14), located on the instrument panel, indicate the fuel quantity in each tank in pounds. Fuel quantities are shown in figures 1-27, 1-28, 1-29 and 1-30. The fuel quantity indicating system may be tested by pressing the fuel gage test switches, marked FUEL GAGE TEST, FWD TANK AFT TANK, located between the fuel quantity gages on the fuel quantity gage test switch panel (figure 1-14). Pressing either button-type switch for approximately 10 seconds will induce a current reversal which causes the pointer to drop below zero. Upon release of the test switch, the normal current should cause the pointer to return to the previous reading. The test shows that the fuel quantity indicating system is operating correctly. The fuel quantity indicating system normally operates on 115 volt ac current from ac essential bus is protected by circuit breakers, marked FWD and AFT and under the general headings FUEL and QTY, located on the ac essential bus circuit breaker panel, but is operated by ac current from the inverter until the ac essential bus is energized.

FUEL LOW LEVEL CAUTION LIGHTS.

The fuel low level caution lights, marked FWD FUEL LOW and AFT FUEL LOW, located on the caution panel (figure 1-20), will illuminate when approximately 140 to 190 pounds of fuel remain in the respective fuel tank depending upon the aircraft attitude. The caution lights operate on current from the dc essential bus, through circuit breakers marked LOW LEVEL, FWD and AFT, and under the general headings INDICATOR LIGHTS and FUEL, located on the overhead dc circuit breaker panel.

FUEL FILTER BYPASS CAUTION LIGHTS.

The fuel filter bypass caution lights, marked FWD FUEL BYPASS and AFT FUEL BYPASS, are located on the caution panel (figure 1-20). The fuel filter bypass caution light will illuminate whenever the respective system filter screen has become clogged and the fuel bypasses the fuel filter of the respective fuel tank. The caution lights are tested by the master TEST button on the caution panel and operate on dc current through circuit breakers, marked FWD and AFT and under the headings INDICATOR LIGHTS and FUEL BYPASS, located on the overhead dc circuit breaker panel.

AUXILIARY FUEL SYSTEMS.

The auxiliary fuel systems consist of an internal auxiliary fuel tank system and an external auxiliary fuel tank system. The internal auxiliary fuel tank system may be installed on CH-3E helicopters

FUEL QUANTITY DATA
(JP-4)

NONSELF-SEALING TANKS

	USABLE		UNUSABLE		FULLY SERVICED	
FUEL TANKS	US GALLONS	POUNDS	US GALLONS	POUNDS	US GALLONS	POUNDS
FWD MAIN	342.0	2223.0	2.0	140 - 13.0 = 127#	344	2236.0
AFT MAIN	345.0	2242.5	1.0	140 - 6.5 133.5#	346	2249.0
TOTAL MAIN	687.0	4465.5	3.0	19.5	690	4485.0
ONE AUXILIARY TANK	437	2840.5	4.00	26.0	441	2866.5
TWO AUXILIARY TANKS	874	5681.0	8.00	52.0	882	5733.0

TOTAL USABLE FUEL	WITHOUT INTERNAL AUXILIARY TANKS	687.0 GAL.	4465.5 LB.
TOTAL USABLE FUEL	WITH ONE INTERNAL AUXILIARY TANK	1124.0 GAL.	7306.0 LB.
*TOTAL USABLE FUEL	WITH TWO INTERNAL AUXILIARY TANKS	1561.0 GAL.	10,146.5 LB.

NOTES

1. USABLE FUEL DETERMINED AT 1 DEGREE NOSEDOWN ATTITUDE.
2. FUEL DENSITY OF 6.5 LB/GAL AT STANDARD DAY TEMPERATURE.
3. THE SINGLE AUXILIARY FUEL TANK INSTALLED WEIGHS 332 POUNDS. THE DUAL AUXILIARY FUEL TANKS INSTALLED WEIGH 612 POUNDS.
   *TOTAL USABLE FUEL, WITH TWO AUXILIARY FUEL TANKS IN USE, MUST BE ADJUSTED FOR TAKEOFF GROSS WEIGHT.
4. THE INSTALLATION VARIATIONS OF EACH FUEL TANK MAY CAUSE THE TOTAL CAPACITY OF A TANK TO VARY AS MUCH AS ±3 GALLONS.

Figure 1-27. Fuel Quantity Data

DELETE FIG 1-27 AFTER COMPLIANCE
WITH TCTO 1H3-778 15-162

FUEL QUANTITY DATA
(JP-4)

SELF-SEALING TANKS

FUEL TANKS	USABLE US GALLONS	USABLE POUNDS	UNUSABLE US GALLONS	UNUSABLE POUNDS	FULLY SERVICED US GALLONS	FULLY SERVICED POUNDS
FWD MAIN	333.0	2164.5	2.0	13.0	335	2177.5
AFT MAIN	334.0	2171.0	1.0	6.5	335	2177.5
TOTAL MAIN	667.0	4335.5	3.0	19.5	670	4355.0
ONE AUXILIARY TANK	437	2840.5	4.00	26.0	441	2866.5
TWO AUXILIARY TANKS	874	5681.0	8.00	52.0	882	5733.0

TOTAL USABLE FUEL	WITHOUT INTERNAL AUXILIARY TANKS	667.0 GAL.	4335.5 LB.
TOTAL USABLE FUEL	WITH ONE INTERNAL AUXILIARY TANK	1104.0 GAL.	7176.0 LB.
*TOTAL USABLE FUEL	WITH TWO INTERNAL AUXILIARY TANKS	1541.0 GAL.	10,016.5 LB.

NOTES

1. USABLE FUEL DETERMINED AT 1-1/2 DEGREE NOSEUP ATTITUDE.
2. FUEL DENSITY OF 6.5 LB/GAL AT STANDARD DAY TEMPERATURE.
3. THE SINGLE AUXILIARY FUEL TANK INSTALLED WEIGHS 332 POUNDS. THE DUAL AUXILIARY FUEL TANKS INSTALLED WEIGH 612 POUNDS. *TOTAL USABLE FUEL, WITH TWO AUXILIARY FUEL TANKS IN USE, MUST BE ADJUSTED FOR TAKEOFF GROSS WEIGHT.
4. THE INSTALLATION VARIATIONS OF EACH FUEL TANK MAY CAUSE THE TOTAL CAPACITY OF A TANK TO VARY AS MUCH AS ±3 GALLONS.

Figure 1-28. Fuel Quantity Data

ESTIMATED
FUEL QUANTITY DATA
(JP-4)

CONFIGURED FOR EXTERNAL AUXILIARY FUEL TANK INSTALLATION

	USABLE		UNUSABLE		FULLY SERVICED	
FUEL TANKS	US GALLONS	POUNDS	US GALLONS	POUNDS	US GALLONS	POUNDS
FWD MAIN	311.02 (337.52)	2021.16 (2193.9)	3.48	22.6	314.5 (341)	2044.2 (2216.5)
AFT MAIN	313.3 (307.4)	2034.4 (1998.1)	2.60	16.9	315.9 (310)	2051.3 (2015)
TOTAL MAIN	624.32 (644.92)	4056 (4192)	6.08	39.5	630.4 (651)	4095.5 (4231.5)
AUXILIARY TANKS	386.7 (398)	2523.5 (2587)	2	13	388.3 (400)	2523.9 (2600)

TOTAL USABLE FUEL	WITHOUT EXTERNAL AUXILIARY TANKS	624.32 GAL. (644.92)	4056 LB. (4192)
TOTAL USABLE FUEL	WITH EXTERNAL AUXILIARY TANKS	1011.02 GAL. (1043.32)	6579.5 LB. (6781.6)

NOTES

1. FUEL CAPACITIES DETERMINED AT 1-1/2 DEGREE NOSEUP ATTITUDE. QUANTITIES SHOWN IN PARENTHESES ( ) ARE FOR GRAVITY REFUELING AND OTHER QUANTITIES ARE FOR PRESSURE REFUELING.
2. USABLE FUEL DETERMINED AT 1 DEGREE NOSEDOWN ATTITUDE FOR BOTH PRESSURE AND GRAVITY REFUELING.
3. FUEL DENSITY OF 6.5 LB/GAL AT STANDARD DAY TEMPERATURE
4. JP-8 FUEL DENSITY OF 6.7 LB/GAL AT STANDARD DAY TEMPERATURE.
5. THE EMPTY EXTERNAL AUXILIARY FUEL TANKS WEIGH 94 POUNDS.
6. AS THE AMOUNT OF FUEL THAT CAN BE RECEIVED IN THE AUXILIARY FUEL TANKS VARIES GREATLY DUE TO THE HIGH LEVEL SHUTOFF SENSING SYSTEM, IT WILL BE NECESSARY FOR THE PILOT TO REQUEST THE TOTAL AMOUNT OF FUEL TRANSFERRED BY THE TANKER TO DETERMINE THE TOTAL AMOUNT OF FUEL AVAILABLE. TO DATE, DATA HAS SHOWN THAT THE AMOUNT OF FUEL RECEIVED VARIES FROM 150 TO 180 GALLONS PER TANK.
7. THE INSTALLATION VARIATIONS OF EACH FUEL TANK MAY CAUSE THE TOTAL CAPACITY OF A TANK TO VARY AS MUCH AS ±3 GALLONS.

Figure 1-29. Fuel Quantity Data (Configured for Auxiliary Fuel Tank Installation)

FUEL QUANTITY DATA
(JP 4)

EXPLOSION SUPPRESSION FOAM INSTALLED

FUEL TANKS	USABLE US GALLONS	USABLE POUNDS	UNUSABLE US GALLONS	UNUSABLE POUNDS	FULLY SERVICED US GALLONS	FULLY SERVICED POUNDS
FWD MAIN	295.9 (297.9)	1923.4 (1936.4)	2.9 (10.9)	18.9 (70.8)	298.4 (319.2)	1939.6 (2075.5)
AFT MAIN	277.5 (293.0)	1803.8 (1904.5)	4.4 (14.4)	28.6 (93.6)	288.5 (321.1)	1875.3 (2087.2)
TOTAL	573.4 (590.9)	3727.2 (3840.9)	7.3 (25.3)	47.5 (164.4)	586.9 (640.3)	3814.9 (4162.7)
AUXILIARY TANKS	365.4 (347.1)	2375.1 (2256.2)	2	13	368.8 (380.0)	2397.2 (2470.0)

(No foam installed in External Auxiliary Tanks)

TOTAL USABLE FUEL	WITHOUT EXTERNAL AUXILIARY TANKS	627.2 (648.7)	4076.8 (4216.0)
TOTAL USABLE FUEL	WITH EXTERNAL AUXILIARY TANKS	1013.9 (1046.7)	6590.3 (6803.0)

NOTES

1. FUEL CAPACITIES DETERMINED AT 1-1/2 DEGREE NOSEUP ATTITUDE. QUANTITIES SHOWN IN PARENTHESES ( ) ARE FOR GRAVITY REFUELING AND OTHER QUANTITIES ARE FOR PRESSURE REFUELING.
2. USABLE FUEL DETERMINED AT 1 DEGREE NOSEDOWN ATTITUDE.
3. FUEL DENSITY OF 6.5 LB/GAL AT STANDARD DAY TEMPERATURE.
4. ONE EMPTY EXTERNAL AUXILIARY FUEL TANK WEIGHS 94 POUNDS
5. AS THE AMOUNT OF FUEL THAT CAN BE RECEIVED IN THE AUXILIARY TANKS VARIES GREATLY DUE TO THE HIGH LEVEL SHUTOFF SENSING SYSTEM, IT WILL BE NECESSARY FOR THE PILOT TO REQUEST THE TOTAL AMOUNT OF FUEL TRANSFERRED BY THE TANKER TO DETERMINE THE TOTAL AMOUNT OF FUEL AVAILABLE. TO DATE, DATA HAS SHOWN THAT THE AMOUNT OF FUEL RECEIVED VARIES FROM 150 TO 180 GALLONS PER TANK.

Figure 1-29. Fuel Quantity Data (Helicopters Modified by T.O. 1H-3-609)

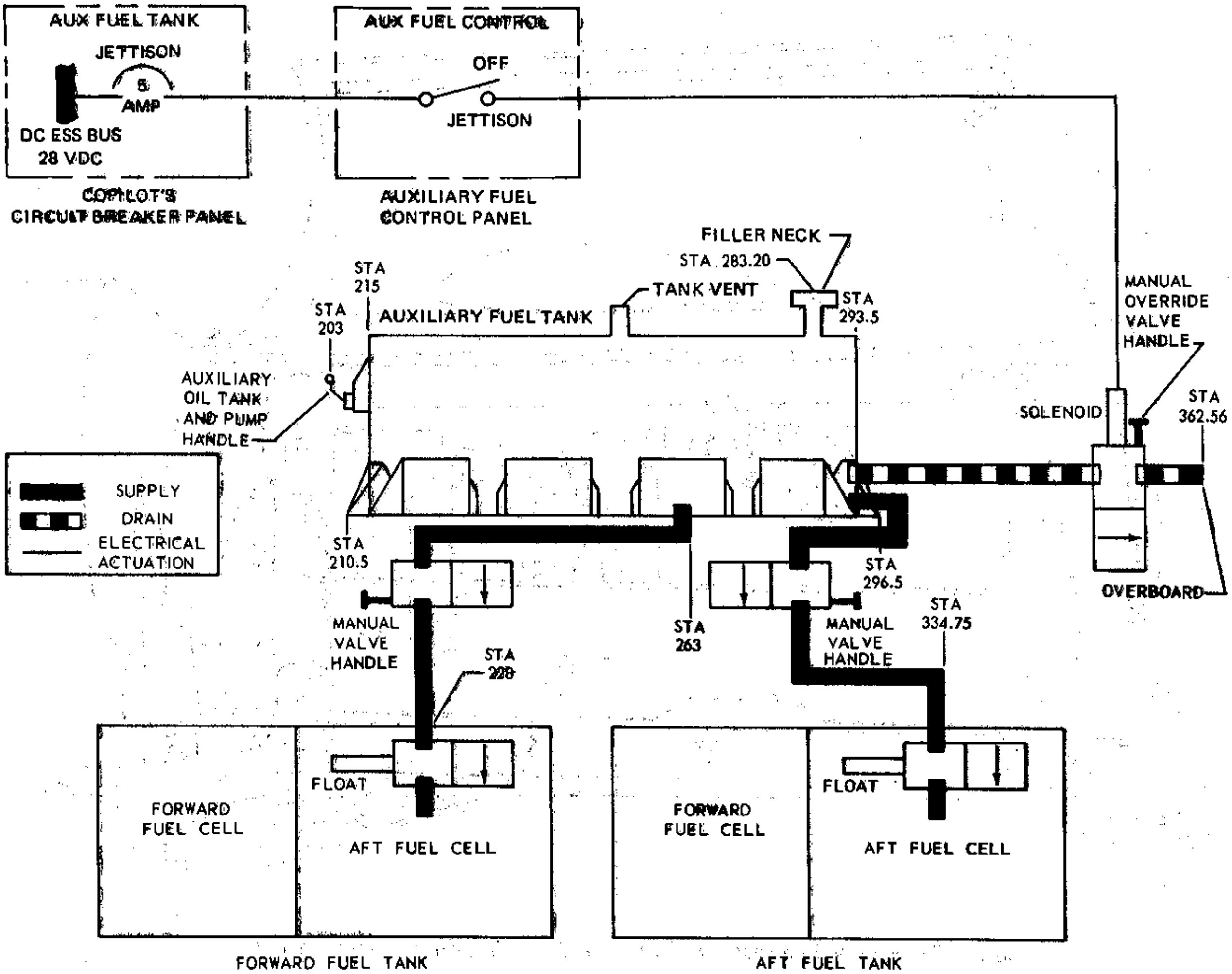


Figure 1-31. Single Internal Tank Auxiliary Fuel System Diagram

prior to 16 . CH-3E 16 and all HH-3E helicopters are equipped with the external auxiliary fuel tank system. See figures ~~1-27~~, 1-28, 1-29 and 1-30 for fuel quantity data. DELETE 1-27 AFTER COMPLIANCE WITH TCTO 1H-3-778

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Internal Auxiliary Fuel Tank System.

The internal auxiliary fuel tank system, either a single or dual tank system, may be installed to increase the range and endurance of the helicopter. The single tank auxiliary fuel system (figure 1-31) consists of a tank that is mounted on the cargo floor, float valves, an auxiliary fuel filler neck, provisions for fuel venting, and electrical provisions for fuel dumping. A fuel valve, located in each fuel transfer line, allows fuel from the auxiliary fuel tank to be gravity transferred to either or both of the main fuel tanks. The dual tank auxiliary fuel system (figure 1-33) is a combination of two single tank systems with modified plumbing and double the fuel capacity. In the dual tank installation, the forward auxiliary fuel tank is moved forward to allow an auxiliary tank to be installed over each main tank.

Internal Auxiliary Fuel Tanks.

The fiberglass internal auxiliary fuel tanks are the same for either the single or dual installation. The

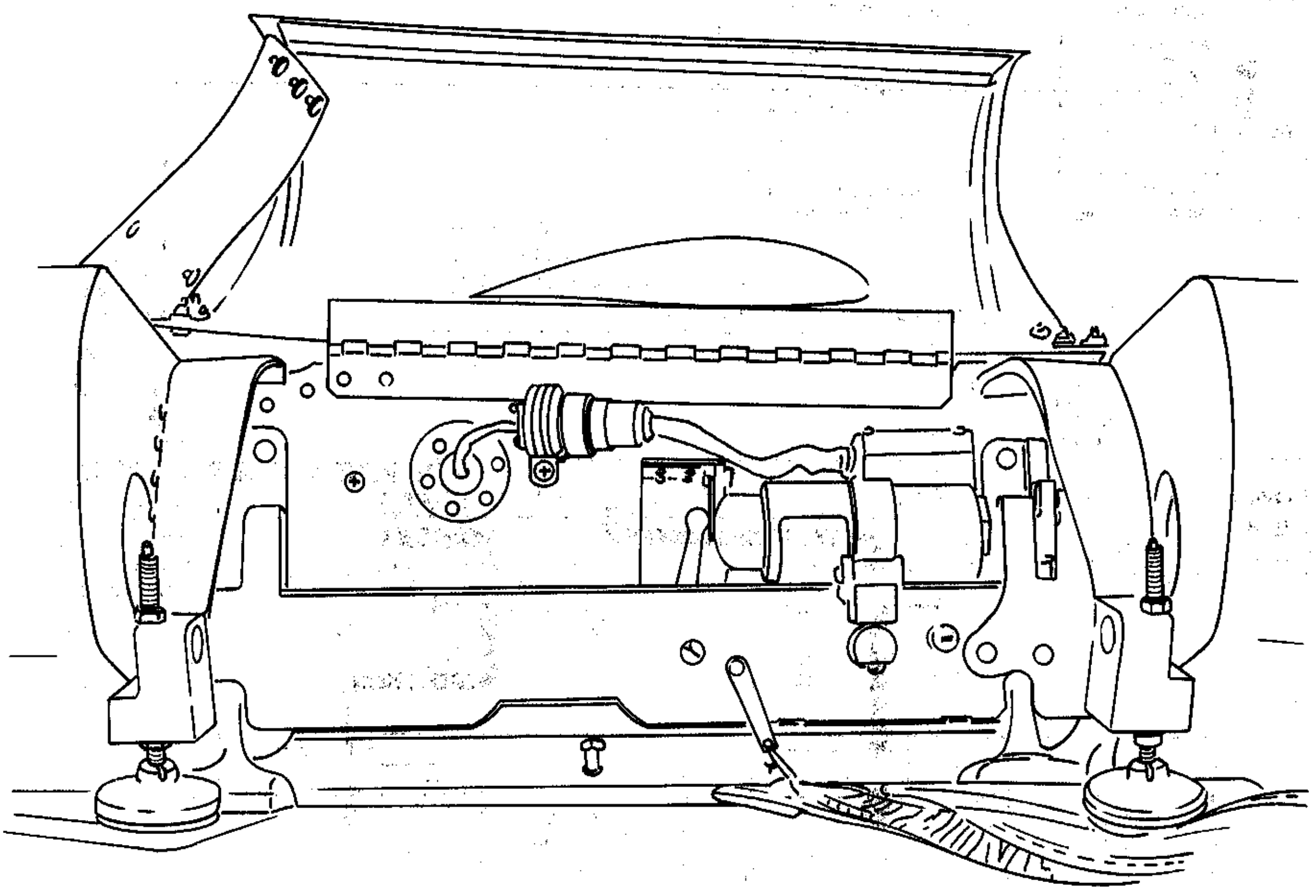

Figure 1-32. Proper External Auxiliary Fuel Tank To Bomb Shackle Installation

dual auxiliary fuel system uses two single tank systems, but only one outlet per tank. When using the single tank system, two fuel transfer lines, each equipped with a float valve, are used to supply fuel to the helicopter's forward and aft fuel tanks. When using the dual tank system, each auxiliary tank is equipped with one fuel transfer line with a float valve. The forward auxiliary fuel tank provides fuel to the helicopter's forward fuel tank and aft auxiliary fuel tank provides fuel to the helicopter's aft fuel tank. Each tank is also equipped with a fuel jettison line and dump valve. Refer to FUEL DUMPING SYSTEMS in the section for procedures to jettison internal auxiliary fuel. A single auxiliary empty fuel tank installed weighs 332 pounds while the dual auxiliary empty fuel tanks installed weigh 612 pounds. An auxiliary tank support displaces a floor area of 7 feet 2 inches by 4 feet 6 inches. The tank, or tanks, are vented to the atmosphere and are filled through an external filler cap located on the right side of the helicopter. The dual tank system is filled through the rear tank only. The auxiliary fuel tanks are secured to the cargo compartment floor tiedown rings, the single tank using 12 tiedowns and the dual tanks using 24 tiedowns.

Internal Auxiliary Fuel System Manual Shutoff Valves.

The two auxiliary fuel system manual shutoff valves located between the floor and the auxiliary fuel tank, may be opened any time auxiliary fuel is desired or required.

Float Valves.

The fuel transfer lines are equipped with a float valve which prevents overfilling of the main fuel tanks. The float valves are actuated by the rising

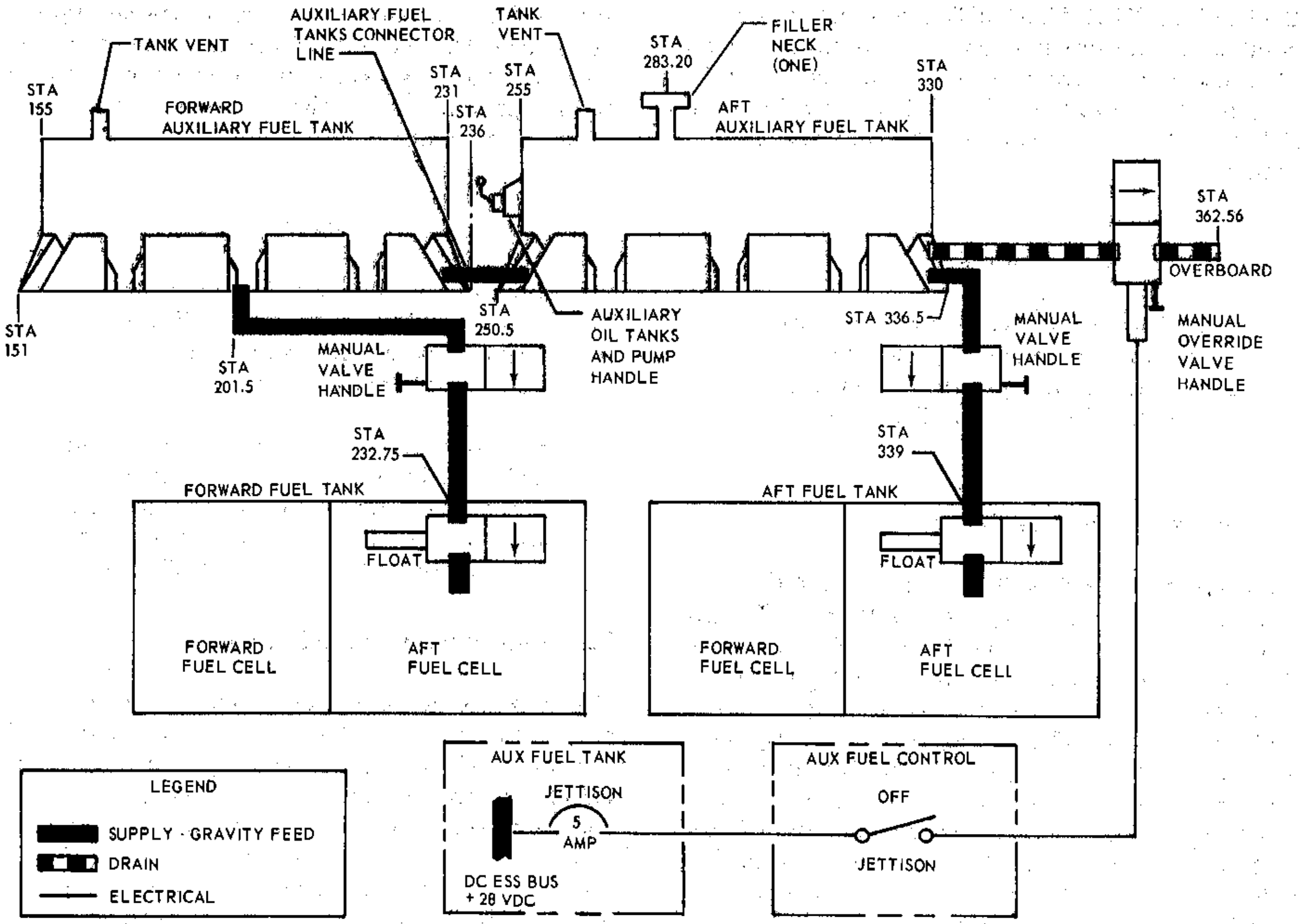

Figure 1-33. Dual Internal Auxiliary Fuel System Diagram

fuel level in the main tanks and shut off when the main tanks are full.

External Auxiliary Fuel System.
(See figure 1-35).

The external auxiliary fuel system is installed to increase the range or endurance of the helicopter. The system does not provide fuel directly to the engine, but functions to replenish fuel into the main fuel tanks. The system consists of an external auxiliary fuel tank, attached outboard of each sponson, an external auxiliary fuel tank pressurization system, a bomb rack with attaching and release mechanisms, and a control panel. The external auxiliary fuel tanks may be electrically or mechanically jettisoned. The tanks may be gravity fueled or serviced through the ground pressure and/or air refueling systems. Fuel is transferred to the main fuel tanks at a rate greater than dual engine consumption by pressurizing the auxiliary fuel tanks with engine compressor bleed air. The tanks may be simultaneously pressurized by either or both engines. The system operates on 28 volts dc from the dc essential bus. The circuit for each tank pressurization system is protected by circuit breakers, marked LH and RH and under the headings BLEED AIR and EXT AUX FUEL TANK, located on the copilot's circuit breaker panel. On CH-3E 16▶ and all HH-3E helicopters, the tank pressurization system and tank fuel valves are protected by circuit breakers, LH and RH, and under the heading FUEL MANAGE, also located on the copilot's circuit breaker panel. The jettison circuits are protected by circuit breakers, marked LH and RH, under the headings JETTISON and EXT AUX FUEL TANK, also located on the copilot's circuit breaker panel.

NOTE

The MASTER POWER switch, located on the pressure refueling panel, must be placed in the OFF position when transferring fuel from the auxiliary to main tanks.

External Auxiliary Fuel Tanks.

Each external auxiliary fuel tank (figure 1-2) weighs 94 pounds empty, has a capacity of 200 gallons, and is interchangeable for use on either sponson pylon. The tanks, one mounted outboard of each sponson pylon, are attached to bomb racks and stabilized by sway braces. When properly installed, the release lever is positioned at an angle toward the electrical solenoid. The manual release striker plate will be positioned between the release lever and the electrical solenoid. The electrical solenoid will be in the cocked position with approximately one inch of solenoid plunger showing. (See figure 1-32.) The mounting attitude of the tanks provides expansion space while refueling in a normal ground attitude as well as maximum usable fuel during cruise. The tanks may be individually or simultaneously jettisoned electrically, and simultaneously jettisoned by the mechanical release handle. Self-sealing quick disconnects are provided at each tank line to seal off the appropriate line when the tanks are jettisoned. The tanks are pressurized by engine compressor bleed air to force the fuel into the main fuel tanks and are refueled through filler caps located on the top of the tanks. When pressure exceeds approximately 13 psi, the tanks are vented through pressure relief valves in the compressor air inlet line. When the auxiliary fuel tanks are empty, compressor bleed air will continue to flow through the auxiliary fuel tanks into the main fuel tanks, where it is vented out the main fuel tank vents until the bleed air shutoff valves are closed. The bleed air shutoff valves may be closed when the auxiliary tanks are empty, as indicated by decreasing main fuel tank levels on the fuel quantity indicating system. Each auxiliary fuel tank is equipped with a thermistor and tank vent valve. The thermistors operate in conjunction with the ground pressure and air refueling systems to indicate when the tanks are full and to then close the auxiliary tank fuel valves.

NOTE

- The external auxiliary fuel tank pressurization should be turned off when tanks are empty to prevent any possible loss of engine performance.
- External auxiliary fuel tanks are not self-sealing or bulletproof and constitute a potential hazard when exposed to small arms fire, and should be jettisoned, particularly when containing unusable fuel.

Fuel Tank Pressurization System.

The auxiliary fuel tanks are pressurized by engine compressor bleed air. The pressurization systems contain check valves, a pressure regulator, shutoff valves, and pressure relief valves. The crossfeed configuration permits both tanks to be simultaneously pressurized by either or both engines. The pressure regulator maintains a pressure of 10 psi to the shutoff valves when either or both engines are operating. Opening the shutoff valves will permit the compressor bleed air to pressurize respective tanks. The pressure relief valve will vent excessive pressures above 13 psi (input compressor air on accumulated tank pressures) overboard. Each shutoff valve is equipped with a vent to relieve all tank pressure when the valve is closed. The shutoff valves are controlled by switches, located on the auxiliary fuel control panel.

Auxiliary Fuel Control Panel.

The auxiliary fuel control panel, located on the cockpit console (figure 1-18), contains all switches for operation of the pressurization system and electrically jettisoning the external auxiliary fuel tanks. The switches that are appropriate to the left tank are under the general heading L TK, and the switches that are appropriate to the right are under the general heading R TK. The respective pressurization switches, with marked positions PRESS and OFF, control the pressurization shutoff valves and auxiliary tank fuel valves. Placing a pressurization switch in the PRESS position will open the appropriate shutoff valve permitting the respective tank to be pressurized and simultaneously open the auxiliary tank fuel valve permitting fuel to transfer to the main tanks. When a switch is placed in the OFF position the bleed air shutoff valve and auxiliary tank fuel valve is closed. The three guarded switches, all marked JETTISON, are used to electrically jettison the auxiliary fuel tanks. When the switch under the general heading L TK is actuated, the left auxiliary fuel tank will be electrically released. When the switch under the general heading R TK is actuated, the right auxiliary fuel tank will be electrically released. Actuating the switch under the general heading BOTH TKS will simultaneously electrically release both tanks.

Auxiliary Fuel Tank Manual Release Handle.

The manual release handle, located on the cockpit console (figure 1-17), is actuated to simultaneously mechanically release both external auxiliary fuel tanks.

NOTE

It may require up to 65 pounds of force to release the external auxiliary fuel tanks. A total pull of 2¼ inches is required.

FUEL DUMPING SYSTEMS.

The fuel dumping systems consist of an internal auxiliary fuel tank dumping system, a manually controlled fuel dumping system, and a rapid fuel dumping system.

Internal Auxiliary Fuel Tank Dumping System.

Those CH-3E helicopters prior to 16 equipped with internal auxiliary fuel tanks, have the capability of dumping auxiliary fuel at a rate of approximately 560 pounds per minute in level flight. Each auxiliary fuel tank is equipped with a fuel jettisoning (dump) line and an electrically operated dump valve that has a manual override. The dump valve is activated by movement of a toggle switch located on the auxiliary fuel control panel. Fuel is dumped through a dump port, located at station 326 in the right sponson, and exits from the lower rear.

Auxiliary Fuel Jettison (Dump) Switch.

The toggle type auxiliary fuel jettison switch, marked JETTISON and OFF, is located on the auxiliary fuel tank control panel on the cockpit console (figure 1-17). When the switch is placed in the JETTISON position, fuel is dumped overboard through the dump valve. The jettison switch is powered from the dc essential bus through a circuit breaker marked JETTISON and under the general heading AUX FUEL CONTROL, located on the dc circuit breaker panel above the copilot.

Manually Controlled Fuel Dumping System.

Helicopters modified by T.O. 1H-3-505 are equipped with a manually controlled fuel dumping system which permits fuel to be dumped from the forward main fuel tank at a rate of 150 pounds per minute in level flight from 70 knots to V max knots, during descents through full autorotation at 100 knots, and during water taxi. The system consists of manual fuel close line and dump valves, located in the cargo compartment, plus some additional hosing. The dump hosing extends up from the tank through the cargo compartment and out through the outboard tail end of the right sponson. The manual fuel dump system must be used in conjunction with the boost pumps and crossfeed system. All boost pumps must be ON, the crossfeed OPEN, and engines operating, before fuel dumping can be attempted.

CAUTION

The manual fuel dumping system will dump the entire fuel load from the forward tank if not monitored. The system uses the existing fuel boost pumps in the forward tank and does not provide the protection of 500 pounds reserve in each tank that the rapid fuel dumping system provides.

NOTE

When the manual fuel dump system valve is in operation, fuel boost pump failure lights and fuel filter bypass lights may illuminate. This is a normal condition caused by a drop in prime fuel pressure and the resultant pressure differential across the fuel filters. The fuel boost pump failure lights should go out when the fuel pressure stabilizes upon releasing the manual fuel dump valve.