

T.O. 1H-3(C)E-1

# FLIGHT MANUAL

USAF SERIES

## CH-3E AND HH-3E

HELICOPTERS

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**1 SEPTEMBER 1983**

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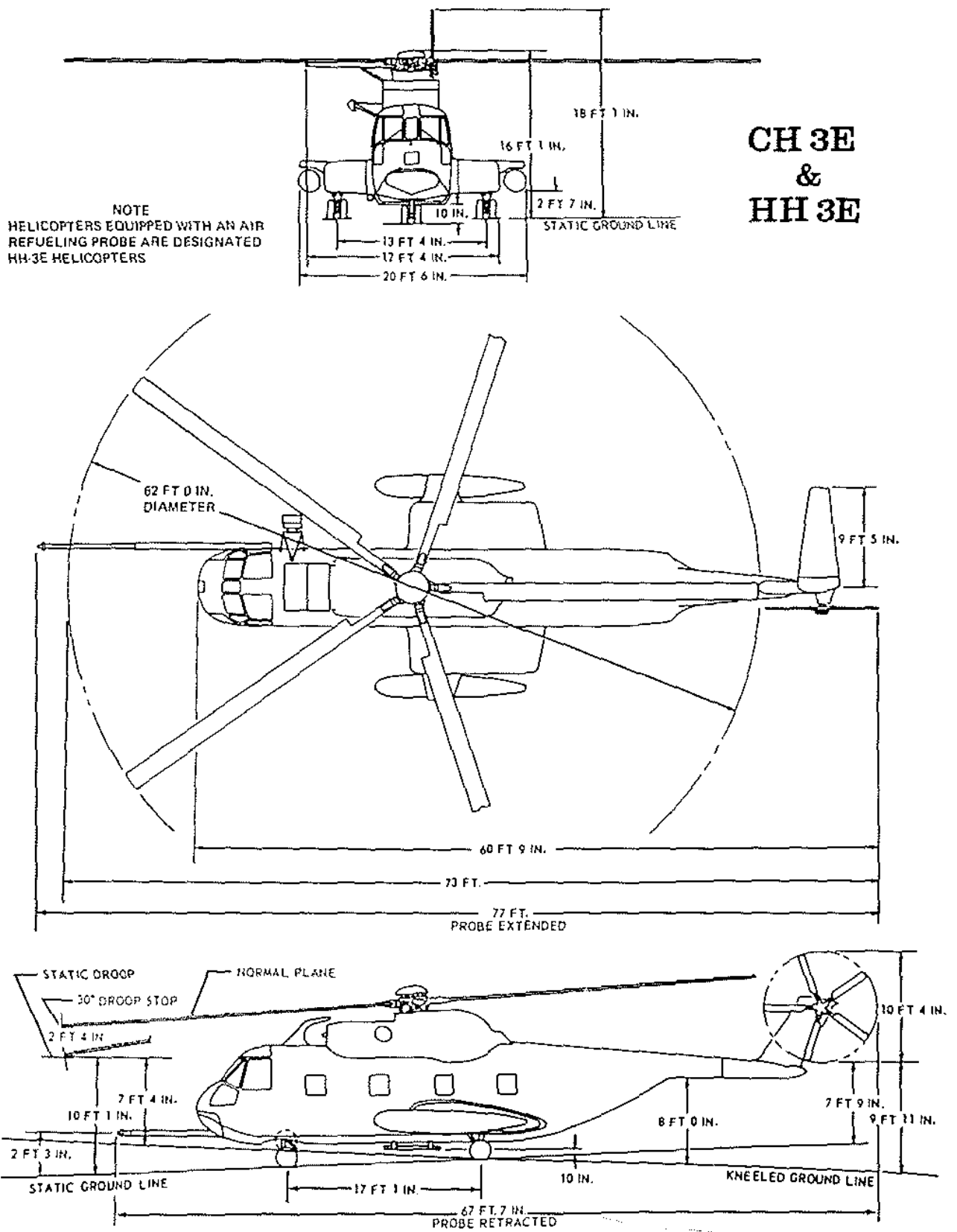


Figure 1-1. Three View and Dimensions

CODE	SERIAL NUMBERS MODEL CH-3E HELICOPTERS	CODE	SERIAL NUMBERS MODEL HH-3E HELICOPTERS
14	65-5697 THRU 65-5700	24	65-12777, 65-12780, 65-12781, 65-12783, 65-12784 AND 65-12787
15	65-12788 THRU 65-12800	25	66-13284
16	66-13285	26	66-13286
17	66-13291 THRU 66-13293 AND 66-13296	27	66-13290
18	67-14703	28	67-14704
19	67-14705	29	67-14706
20	67-14707	30	67-14708, 67-14709 AND 67-14711 THRU 67-14717
21	67-14718 THRU 67-14720	31	67-14722 THRU 67-14725
22	68-8282	32	69-5798 THRU 69-5812
23	64-14230 AND 64-14232		

### GLOSSARY OF TERMS AND ABBREVIATIONS

AC — Alternating current	INCIPIENT BLADE STALL — Blade tip stall
ACCELERATION — The rate of change of velocity	BOTTOMING — The engine is considered as bot- toming during deceleration whenever a minimum fuel flow to compression-discharge pressure condi- tion is attained.
ADF — Automatic direction finder	BUOYANCY — The upward force exerted by water on a floating or immersed body by a fluid.
AFCS — Automatic flight control system	°C — Degrees Centigrade
AIRSPEED	CAS — Calibrated airspeed
KCAS — Knots calibrated airspeed	CDI — Course deviation indicator
KIAS — Knots indicated airspeed	CENTER OF GRAVITY (CG) — The center of gravity is the point about which a helicopter would balance if suspended.
KTAS — Knots true airspeed	CG — Center of gravity
ALT — Altitude	COLLECTIVE — The increasing or decreasing of pitch on all the main rotor blades simultaneously. Also short for collective lever.
APU — Auxiliary power unit	CYCLIC — The changing of pitch of each main rotor blade individually as it makes a complete rotation or cycle. Also short for cyclic stick.
BAR ALT — Barometric altitude control	DC — Direct current
BDHI — Bearing distance heading indicator	DG — Directional gyro
BLADE TIP STALL — Beginning of blade stall. Occurs at tip of retreating blade due to its high angle of attack and low forward velocity.	
BLADE STALL — A stall that begins at the tip of the blade and works progressively inboard as the conditions which cause it increase in severity.	
FULL BLADE STALL — Blade stall that is allowed to fully develop causing loss of control and an up- ward left pitch of the helicopter.	

GLOSSARY OF TERMS AND ABBREVIATIONS (Cont)

DRAFT — The depth of water the helicopter draws or requires to float.	IN — Inches
DRAG DIVERGENCY — Beginning of blade tip stall.	INV — Inverter
DROOP — Characteristic built into speed control for speed stability and load sharing. When in the governing range steady state $N_f$ will decrease in proportion to engine load at a fixed $N_f$ setting. On this installation the droop is 8.5% $N_f$ from no load to full load conditions.	KTS — Knots
DECAY — Loss of $N_f$ beyond droop, resulting from a power requirement in excess of power available.	KVA — Kilovolt-amperes
EXCESS BUOYANCY — Buoyancy in excess of that required to float.	LAT — Latitude
°F — Degrees Fahrenheit	LB — Pound(s)
FOD — Foreign object damage	LB/GAL — Pound per gallon
FPM — Feet per minute	LB/HR — Pound per hour
FT — Feet	LOAD FACTOR — A factor representing the ratio of weight or pressure of a specified load or force to a standard weight or pressure. The load factor may represent the ratio of the total weight of the helicopter to a weight or pressure imposed by aerodynamic forces, inertia forces, or ground effect.
FT/MIN — Feet per minute	MAG — Magnetic slaved compass
GAL — Gallons	MAX -- Maximum
GCA — Ground-controlled approach	MEAN WATERLINE — The mean of the highest and lowest waterline for a given set of conditions, gross weight, sea state, etc.
GSI — Glide slope indicator	MIN -- Minutes/Minimum
GW — Gross weight	MSL — Mean sea level
HR — Hour	$N_f$ — Power turbine speed (rpm)
HYDROSTATIC ROLL ANGLE — Angle of roll when helicopter is on water.	$N_g$ — Gas generator speed
H-V — Height velocity	$N_r$ — Rotor speed (rpm)
IAS — Indicated airspeed	OAT — Free air, ambient or outside air temperature.
IBIS — Inflight blade inspection system	OGE — Out of ground effect (for the CH-3E, and HH-3E, this means hovering approximately 50 feet wheel height or higher)
IGE — In ground effect	P <sub>2</sub> — Compressor inlet total pressure

GLOSSARY OF TERMS AND ABBREVIATIONS (Cont)

$P_3$  — Compressor discharge pressure

PRESS — Pressure

PSI — Pounds per square inch

Q — Torque

R/C — Rate of climb

R/D — Rate of descent

RIGHTING MOMENT — A moment that tends to restore the helicopter to a previous position after an angular displacement on water about one of its axes.

RPM — Revolutions per minute

SEA STATE — Condition of water surface in terms of wind, wave height, wave length, etc.

SERVICE CEILING — Maximum altitude at which a rate of climb 100 FPM can be maintained.

SL — Sea level

STD DAY — Standard day atmospheric conditions

$T_2$  — Compressor inlet air temperature

OAT may be used in place of  $T_2$  in this manual as  $T_2$  is not indicated in the cockpit.

$T_5$  — Power turbine inlet temperature

TAS — True airspeed

TEMP — Temperature

TOLD — Takeoff and landing data

TOPPING — A procedure for adjusting engine fuel control to achieve engine performance at maximum operating limits.

TORQUE — Turning force or moment.

TORQUE POWER INDICATION — An indication of power input being delivered to the gear box by the engines.

TRIM ANGLE — The angle at which the helicopter's hull rests on the water.

UTI — Utility

VA — Volt amperes

VAC — Volts alternating current

WATERLINE — The line of intersection between the surface of the water and the side of the helicopter hull when the helicopter is afloat.

WAVE LENGTH — The distance between two successive wave crests.

$W_f$  — Fuel flow

$W_f/P_3$  — Ratio of weight of fuel flow to be burned to compressor discharge pressure or amount of air available for combustion and cooling.

WL — Water line

XMFR RECT — Transformer rectifier

$\frac{1}{\sqrt{\sigma}}$  — The reciprocal of the square root of density ratio, at the appropriate density altitude. The greek letter sigma ( $\sigma$ ) is used to represent the density ratio.

# 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

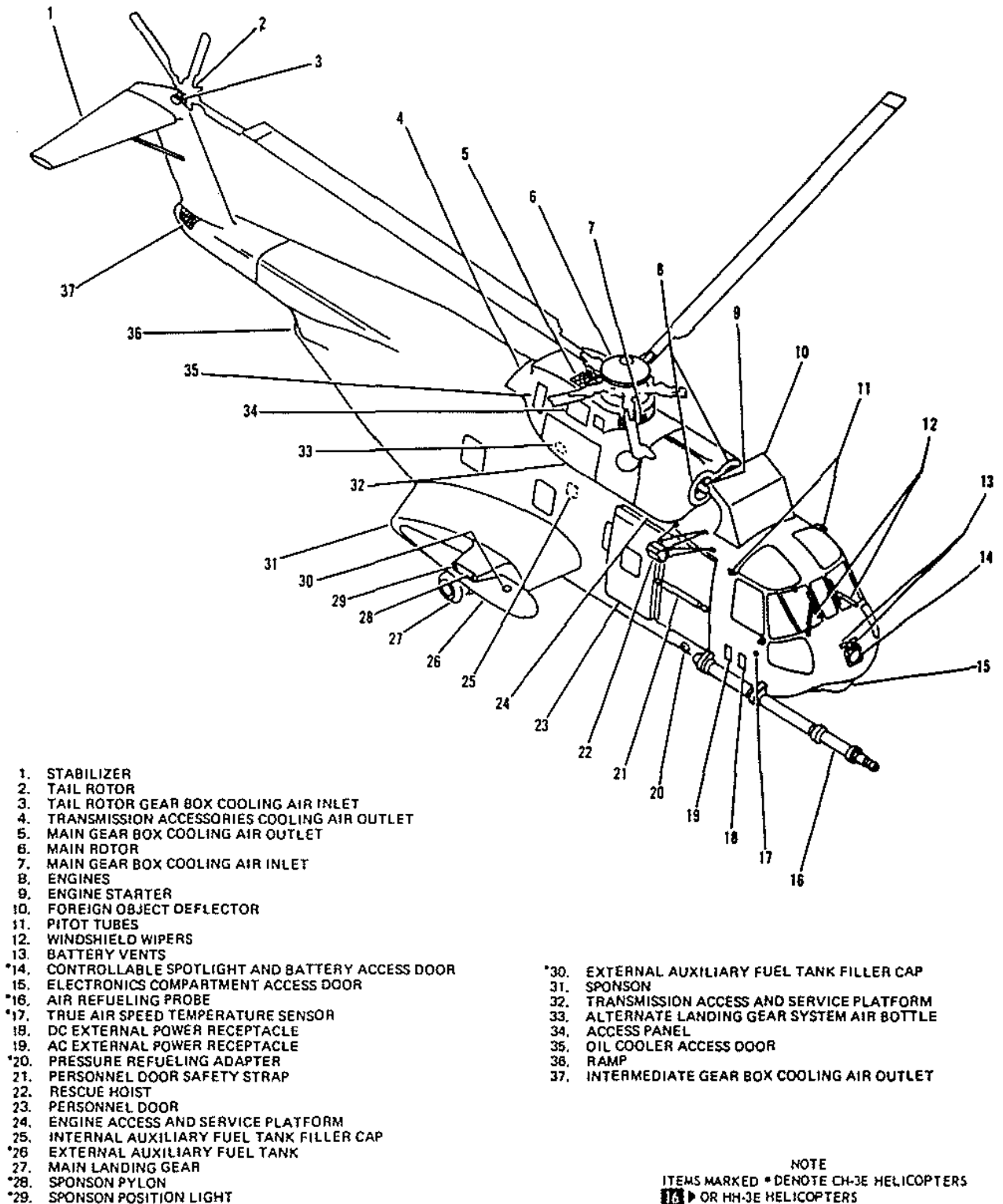
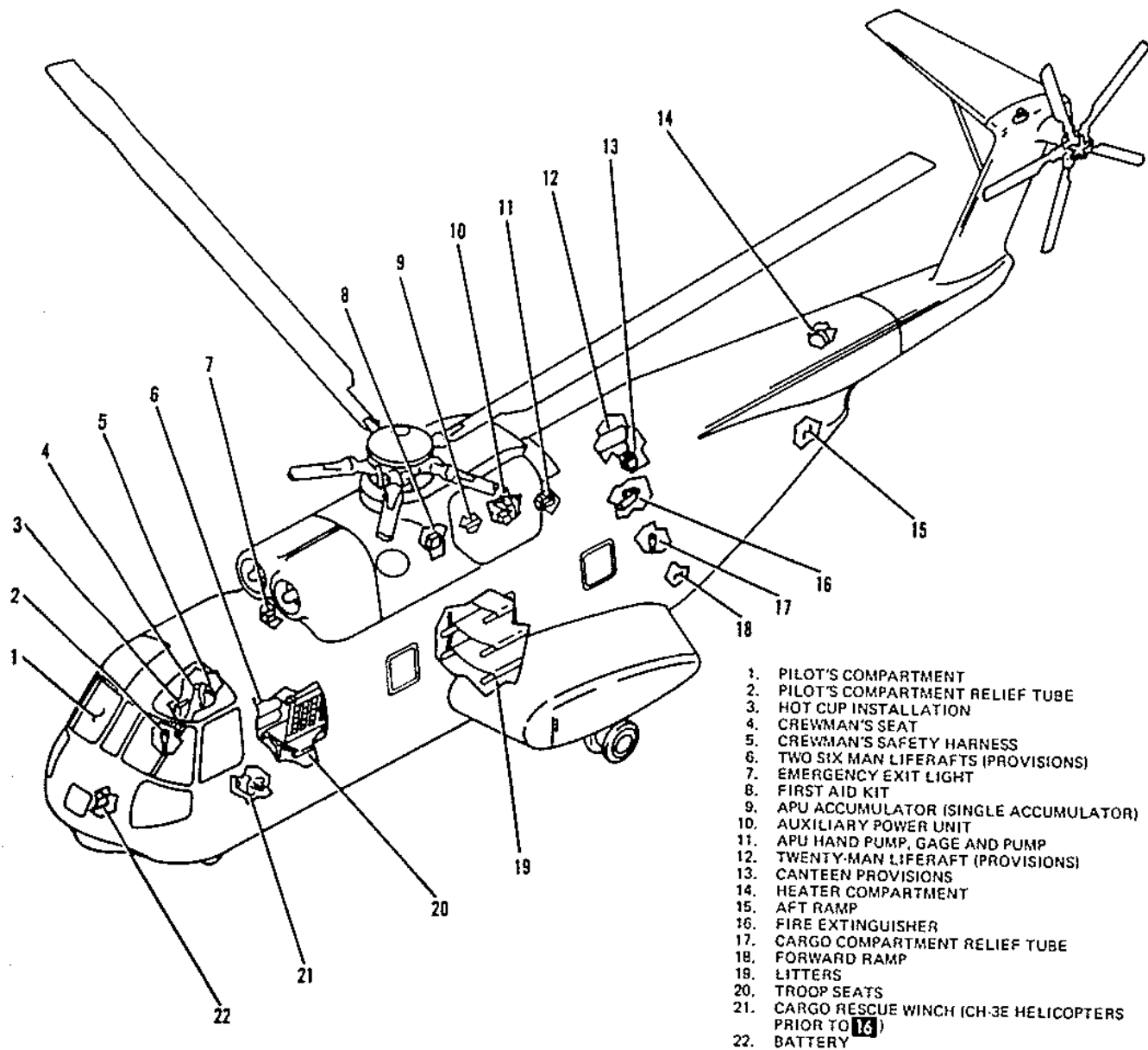
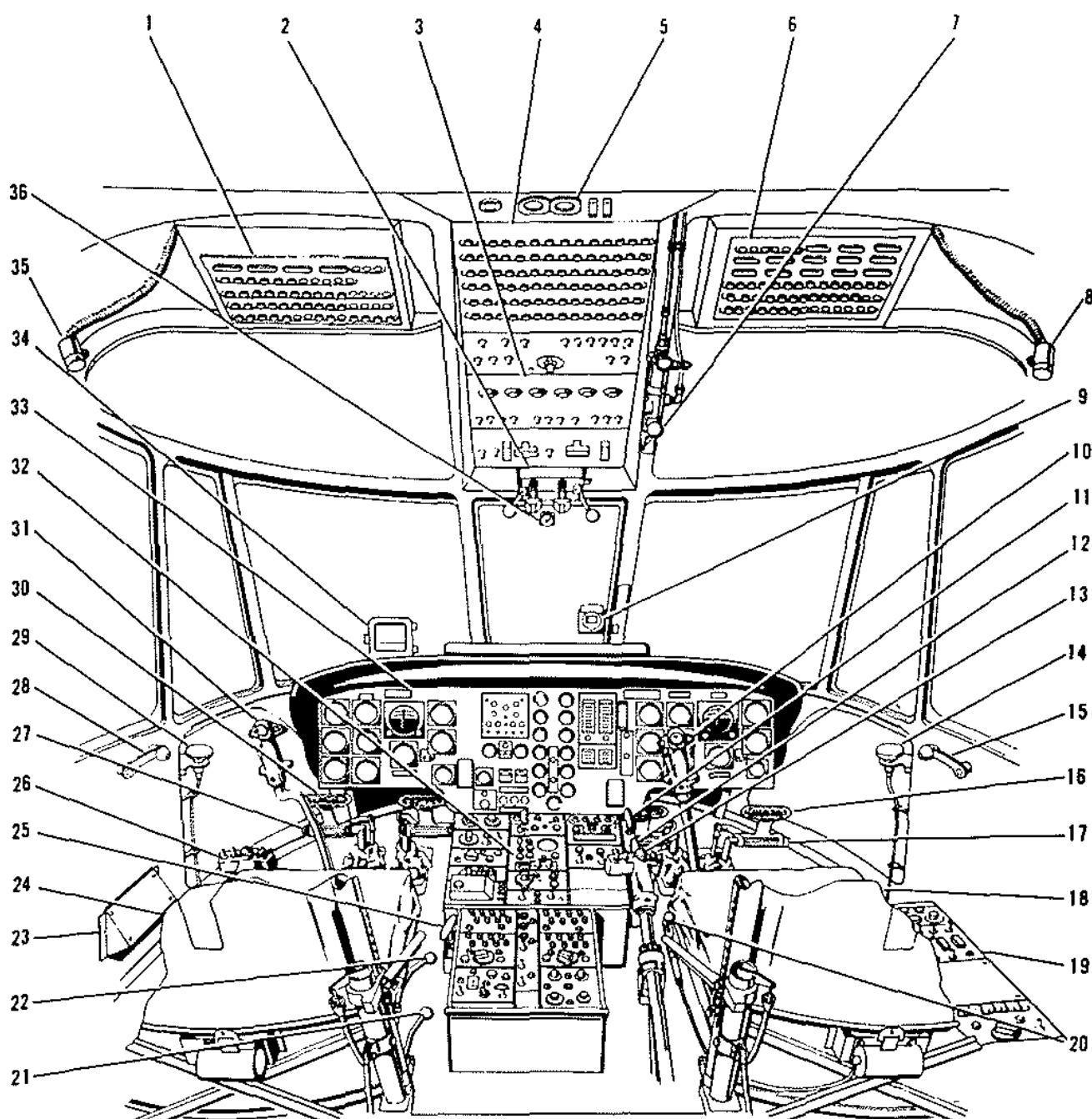


Figure 1-2. General Arrangement Exterior Diagram (Typical)



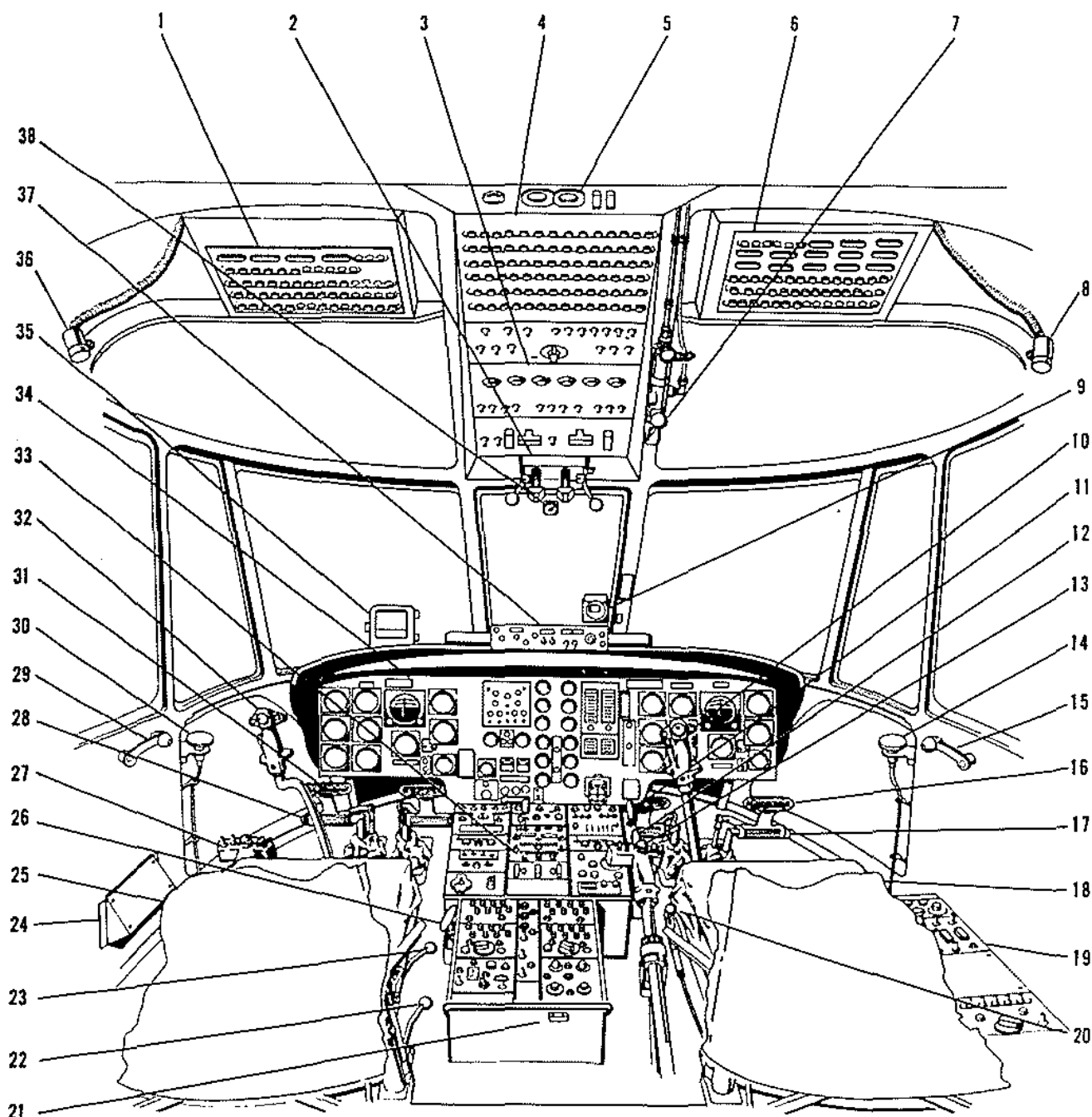
1. PILOT'S COMPARTMENT
2. PILOT'S COMPARTMENT RELIEF TUBE
3. HOT CUP INSTALLATION
4. CREWMAN'S SEAT
5. CREWMAN'S SAFETY HARNESS
6. TWO SIX MAN LIFERAFTS (PROVISIONS)
7. EMERGENCY EXIT LIGHT
8. FIRST AID KIT
9. APU ACCUMULATOR (SINGLE ACCUMULATOR)
10. AUXILIARY POWER UNIT
11. APU HAND PUMP, GAGE AND PUMP
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    | 19. PILOT'S RADIO CONSOLE                           |
| 2. ENGINE CONTROL QUADRANT                   | 20. PILOT'S SHOULDER HARNESS LOCK LEVER             |
| 3. OVERHEAD SWITCH PANEL                     | 21. COPILOT'S SEAT HEIGHT ADJUSTMENT LEVER          |
| 4. OVERHEAD DC CIRCUIT BREAKER PANEL         | 22. COPILOT'S SEAT FORWARD AND AFT ADJUSTMENT LEVER |
| 5. PILOT'S COMPARTMENT DOME LIGHT            | 23. COPILOT'S RADIO CONSOLE                         |
| 6. AC ESSENTIAL CIRCUIT BREAKER PANEL        | 24. COPILOT'S SEAT                                  |
| 7. ROTOR BRAKE LEVER                         | 25. ALTERNATE LANDING GEAR HANDLE                   |
| 8. PILOT'S SPOTLIGHT                         | 26. COPILOT'S COLLECTIVE PITCH LEVER                |
| 9. MAGNETIC COMPASS                          | 27. COPILOT'S TAIL ROTOR PEDALS                     |
| 10. PILOT'S CYCLIC STICK                     | 28. COPILOT'S WINDOW EMERGENCY RELEASE HANDLE       |
| 11. PARKING BRAKE HANDLE                     | 29. COPILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB      |
| 12. NOSEWHEEL LOCK HANDLE                    | 30. COPILOT'S TOE BRAKES                            |
| 13. PILOT'S COLLECTIVE PITCH LEVER           | 31. COPILOT'S CYCLIC STICK                          |
| 14. PILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB | 32. COCKPIT CONSOLE                                 |
| 15. PILOT'S WINDOW EMERGENCY RELEASE HANDLE  | 33. INSTRUMENT PANEL                                |
| 16. PILOT'S TOE BRAKES                       | 34. COPILOT'S SCRDLL CHECKLIST                      |
| 17. PILOT'S TAIL ROTOR PEDALS                | 35. COPILOT SPOT LIGHT                              |
| 18. PILOT'S SEAT                             | 36. FREE AIR TEMPERATURE GAGE                       |

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



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

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

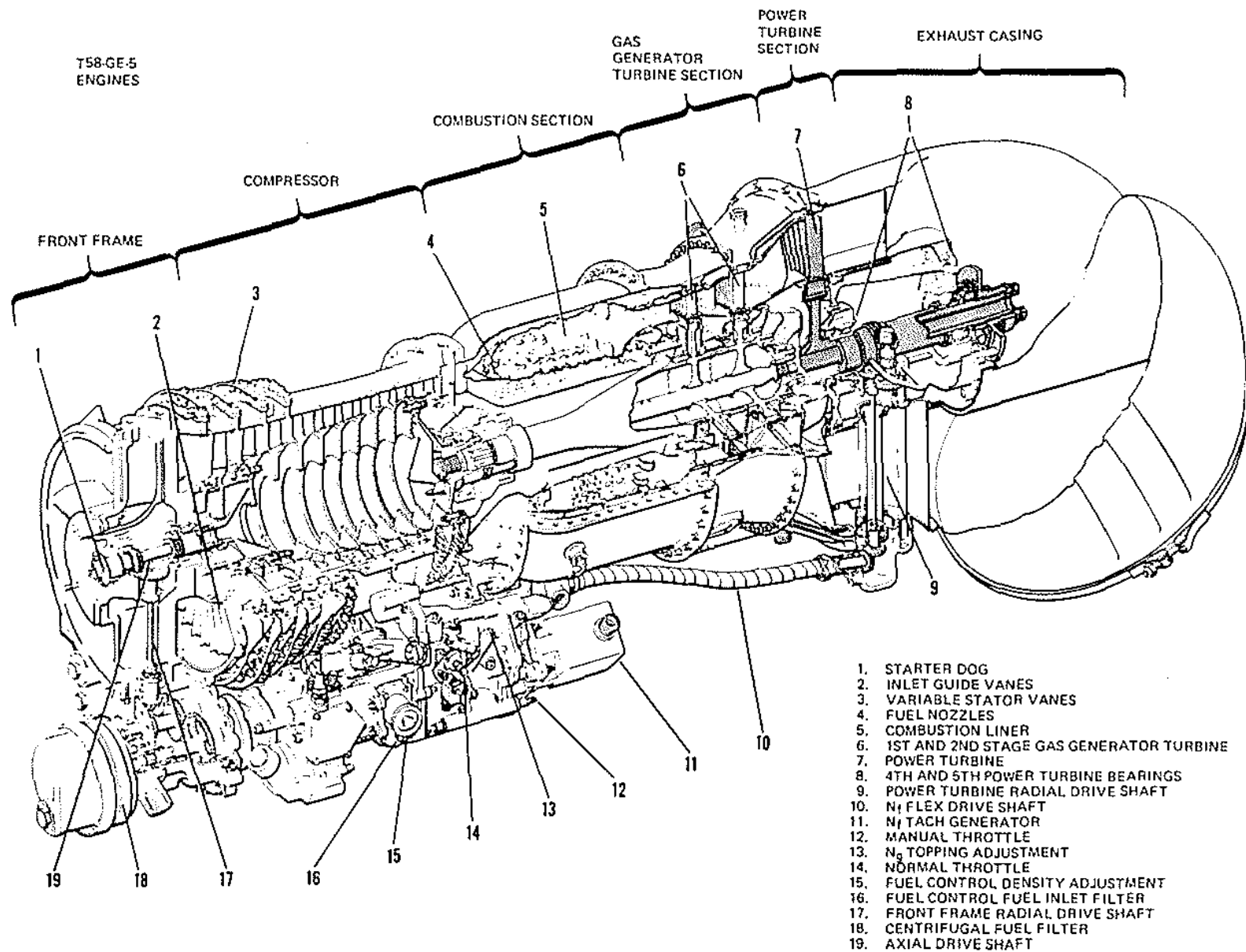


Figure 1-6. Engine Cut-Away View (Typical)

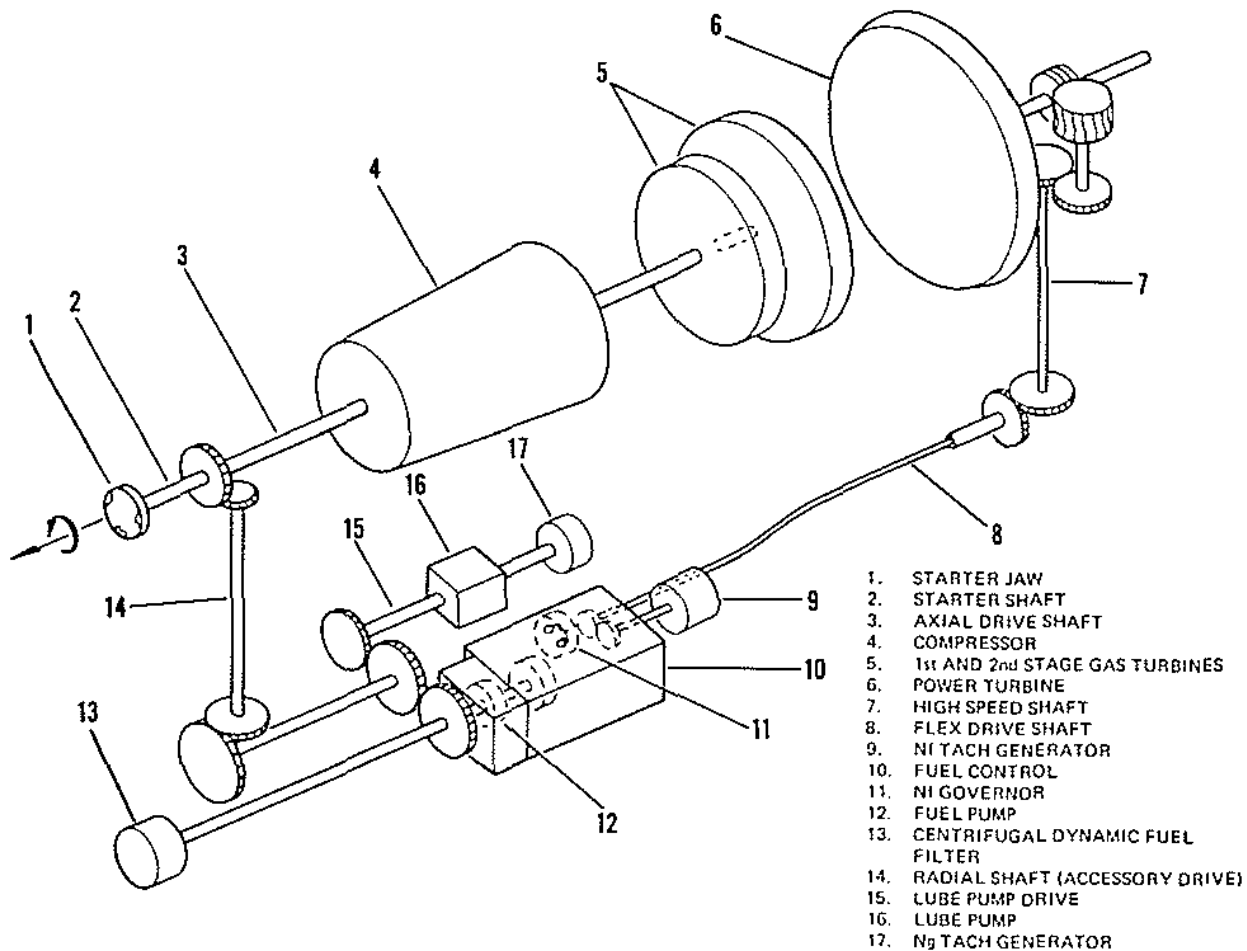


Figure 1-7. Simplified Engine Schematic

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

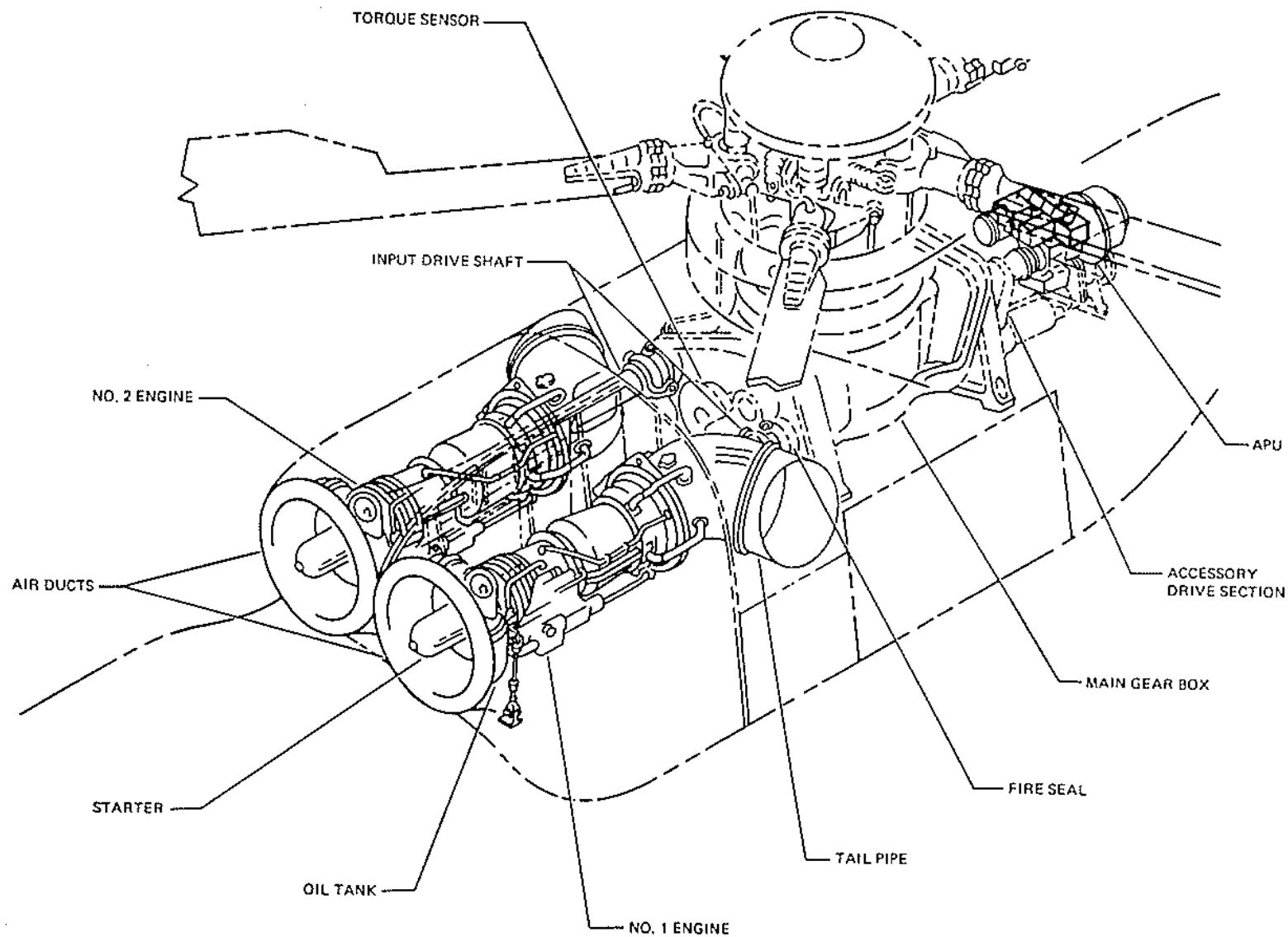


Figure 1-8. Engine, Main Gear Box, and APU Installation

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