DCS DIGITAL COMBAT SIMULATOR

UH-1H HUEY

FLIGHT MANUAL

Bell Helicopter
A Textron Company
OFFICIAL LICENSED PRODUCT
68-7213-35445

BST

THE FIGHTER COLLECTION

Eagle Dynamics

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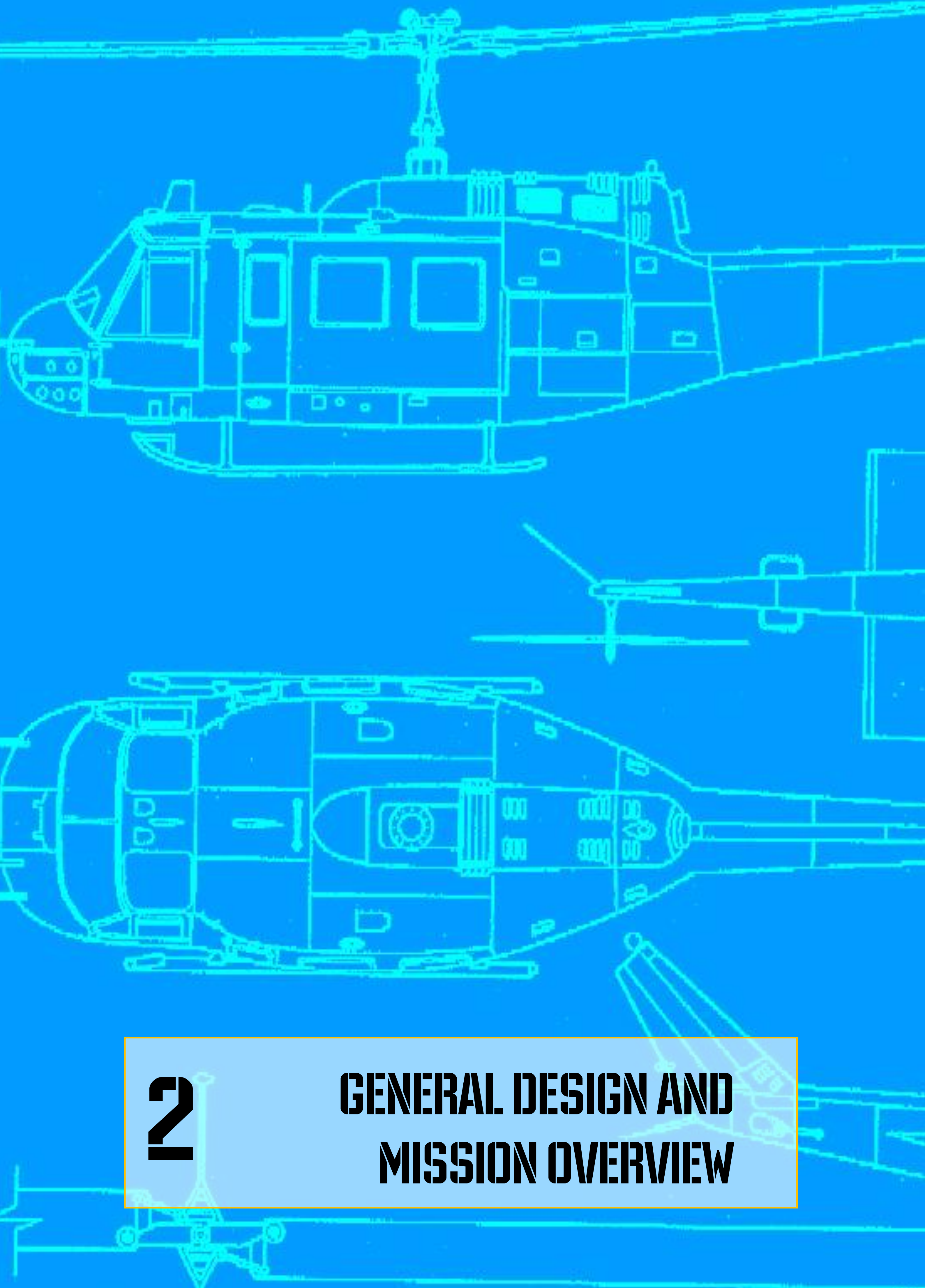
1. HELICOPTER HISTORY

Note. This section is under construction

In our game you can carry out performances missions on model UH-1H.



2 GENERAL DESIGN AND MISSION OVERVIEW

2. GENERAL DESIGN AND MISSION OVERVIEW

2.1. General Description and mission overview

The UH-1H is a single engine, single rotor helicopter. Primary mission capability of the helicopter is air movement of supplies and personnel. Secondary missions include SASO[1], air assault, and C2[2] operations under day, night, visual, and instrument conditions.

In DCS: UH-1H Huey, the helicopter can be operated in the following variants:

a) Combat transport – delivery of troops and/or materiel. Up to 11 combat troops can be transported and deployed.

b) Air assault – armed air assault employing a variety of weapon systems (see chapter 8).

The helicopter can be employed either from prepared airfields or Forward Area Rearming/Refueling Point (FARP) helipads.

The crew includes the pilot in the right-hand seat, copilot in the left-hand seat and one or two door gunners.

[1] SASO – stability and support operations – military activities during peacetime and conflict that do not necessarily involve armed clashes between two organized forces.
[2] C^2 – command and control

2.2. Primary specifications UH-1H

2.2.1. Specifications table

A. AIRCRAFT	**UNIT**	**UH-1H**
B. NORMAL CREW	per acft	2
C. OPERATIONAL CHARACTERISTICS		
(1) Max allowable gross	lbs / kg	9.500 / 4.309
(2) Basic weight	lbs / kg	5.914 / 2.683
(3) Useful load	lbs / kg	4.368 / 1.981
(4) Payload/Normal mission	lbs / kg	2.900 / 1.315
(5) Fuel capacity internal/external	lbs/gal // kg/l	1.358/209 // 633/791
(6) Fuel consumption rate	lbs/gal/h // kg/l/h	550/84 // 250/318
(7) Normal cruise speed	kts / km/h	90–120 / 160–220
(8) Endurance at cruise (Plus 30 min reserve)	hrs+min	2+15
(9) Grade of fuel	octane	JP 4/5
D. PASSENGER CAPACITY		
(1) Troops seats	ea	11
(2) Total capacity with crew	ea	13
(3) Litters and ambulatory	ea	13
E. EXTERNAL CARGO		6
(1) Maximum recommended	lbs / kg	4.000 / 1.814
(2) Rescue hoist capacity	lbs / kg	300 / 136
F. DIMENSIONS		
(1) Length — fuselage	ft-in / m	40'7" / 12,38
(2) Length — blades unfolded	ft-in / m	57'1" / 17,41
(3) Length — blades folded	ft-in / m	NA
(4) Width — blades folded	ft-in / m	8'7" / 2,62
(5) Width — tread	ft-in / m	8'7" / 2,62
(6) Height — extreme	ft-in / m	14'6" / 4,42
(7) Diameter — main rotor	ft-in / m	48'3" / 14,71
(8) Diameter — tail rotor	ft-in / m	8'6" / 2,59
(9) Wing span	ft-in / m	NA
G. CARGO DOOR		
(1) Dimensions — width x height	ft-in / m	74"x48" / 1,88x1,22
(2) Location — side of fuselage	side of fus.	left & right
H. CARGO COMPARTMENT		
(1) Floor — above ground	in / m	24 / 0,61
(2) Usable length	in / m	92 / 2,34
(3) Floor width	in / m	96 / 2,44
(4) Height (clear of obstructions)	in / m	49 / 1,24
(5) Maximum cargo space	cu ft / cu m	220 / 6,24
I. WEAPONS		M21

Note. The composite rotor blades provide a 6% improvement in the UH-1H's hovering capability and a 5 to 8 percent reduction in fuel flow in forward flight.

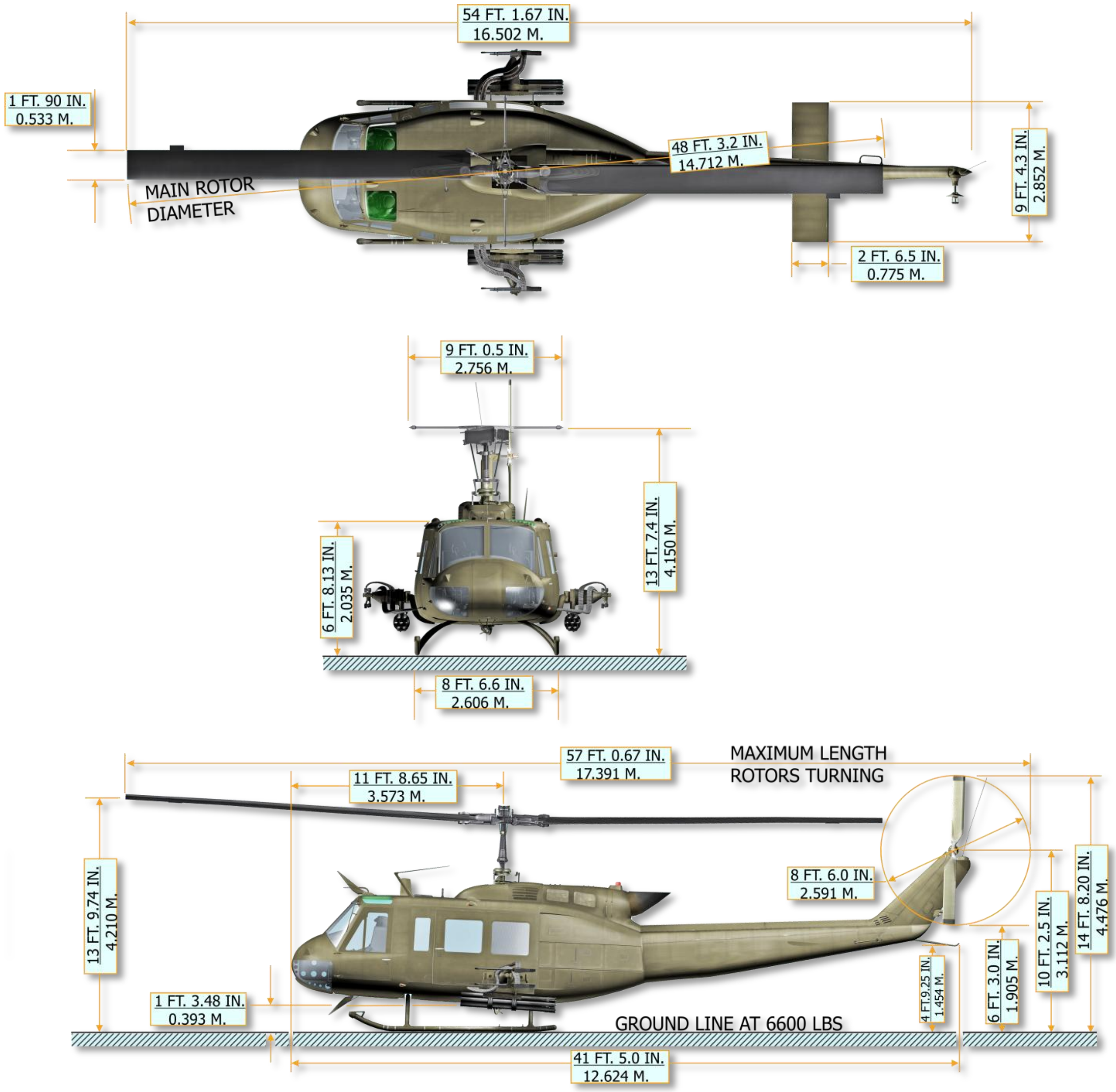
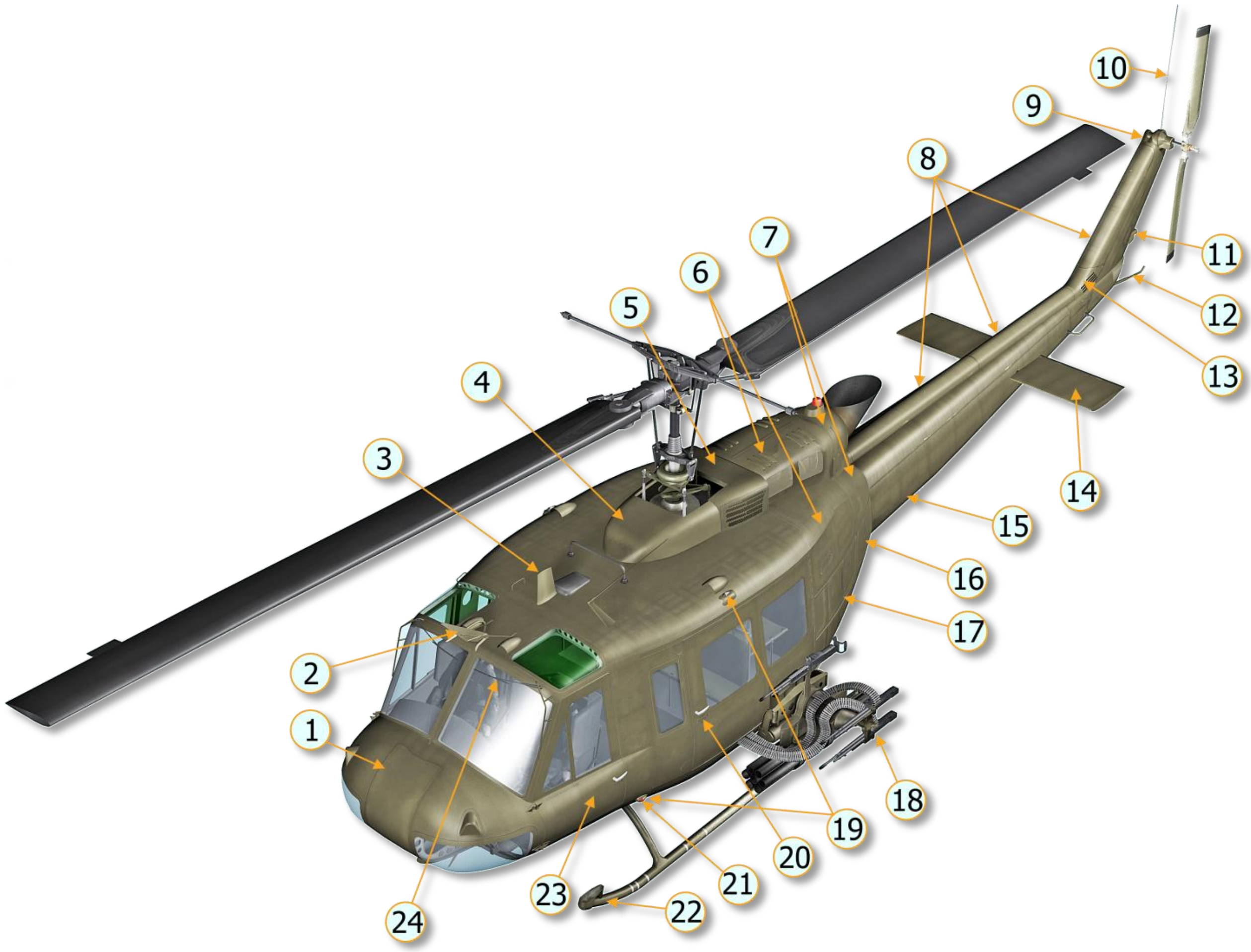


Figure 2.1. UH-1H helicopter dimensions.

2.3. General Assembly Diagram



1. Radio compartment and fwd battery location access door
2. Wire-Strike Protection System (WSPS) upper cutter
3. VHF/UHF antenna
4. Transmission fairing
5. Engine intake fairing
6. Engine cowling
7. Tailpipe fairing
8. Driveshaft covers
9. 90 degree gearbox
10. FM communications antenna No.1
11. Aft position light (NVG)
12. Tail skid
13. 42 degree gearbox
14. Synchronized elevator
15. Tail boom
16. Electrical compartment access door
17. Aft radio compartment access doors
18. M21 armament sub-system
19. Position light (NVG)
20. Sliding cargo door
21. Position light (Red)
22. Landing gear
23. Copilot door
24. WSPS windshield deflector

Figure 2.2. General assembly of the UH-1H (top-left-front).

1. VHF navigation (Omni) antenna
2. Synchronized elevator
3. Anti-collision light
4. FM homing antenna No.1
5. Loop (ADF) antenna
6. Position light (White)
7. Position light (Red)
8. FM communications antenna No.2 (mission antenna)
9. VHF/UHF antenna
10. Pitot tube
11. Pilot door
12. M21 Armament subsystem
13. Position lights (Green upper and lower)
14. Heater compartment access door
15. Oil cooler fan access door
16. Stabilizer bar

Figure 2.3. General assembly of the UH-1H (top-right-front).

1. Radar warning antenna, FWD
2. FM communications antenna No.2 (mission antenna)
3. IR exhaust suppressor
4. Radar warning antenna, AFT
5. Radar altimeter antennas (optional)
6. Oil cooler IR shield
7. DC external plug
8. Cargo suspension hook
9. WSPS lower cutter
10. Position lights (NVG)

Figure 2.4. General assembly of the UH-1H (below-left-behind).

2.4. Engine and Related Systems

2.4.1. Description of the engine

The power system of the UH-1H consists of a single Textron Lycoming T53-L-13B turboshaft engine with a maximum output power of 1100 kW/1400 hp.

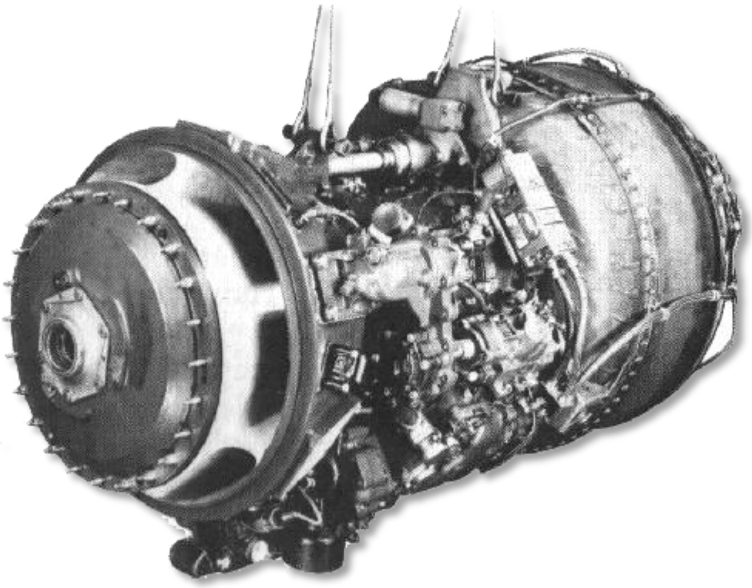
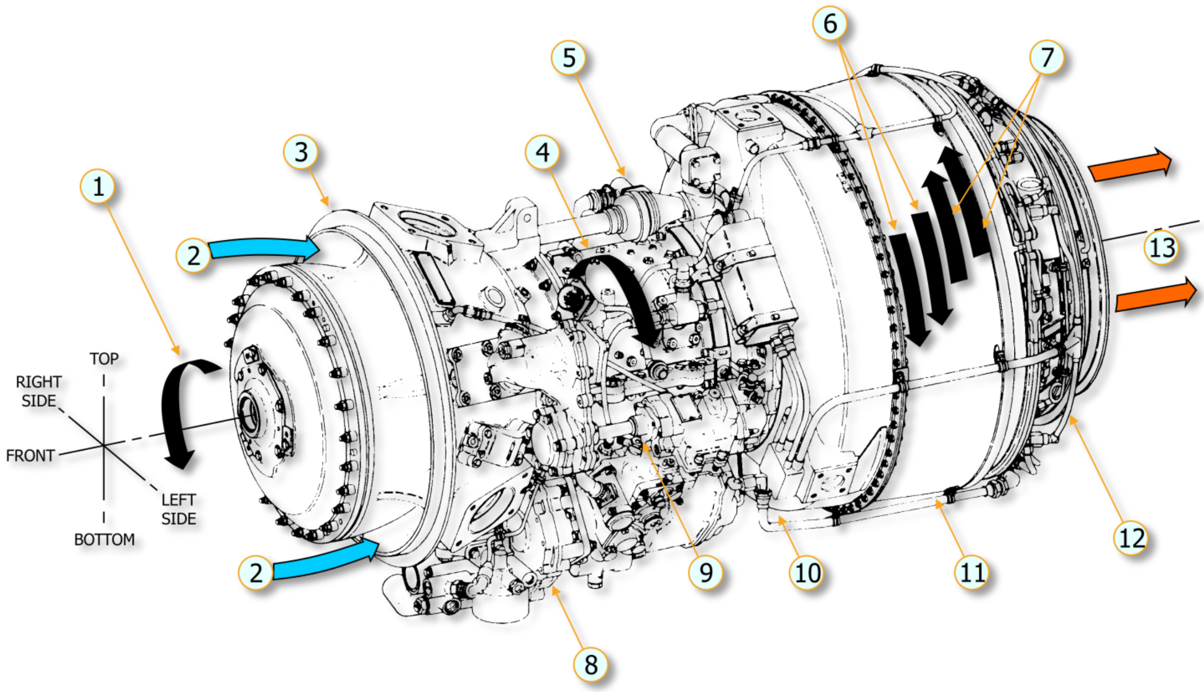


Figure 2.5. The T53-L-13B engine.



1. Rotation of output gearshaft
2. Air inlet
3. Air inlet section
4. Rotation of compressor rotor
5. Hot air solenoid valve
6. Rotation of gas producer turbine rotors
7. Rotation of power turbine rotors
8. Accessory drive gearbox
9. Compressor section
10. Diffuser section
11. Combustion section
12. Exhaust section
13. Rear exhaust

Figure 2.6. Internal layout of the T53-L-13B engine (1 of 2).

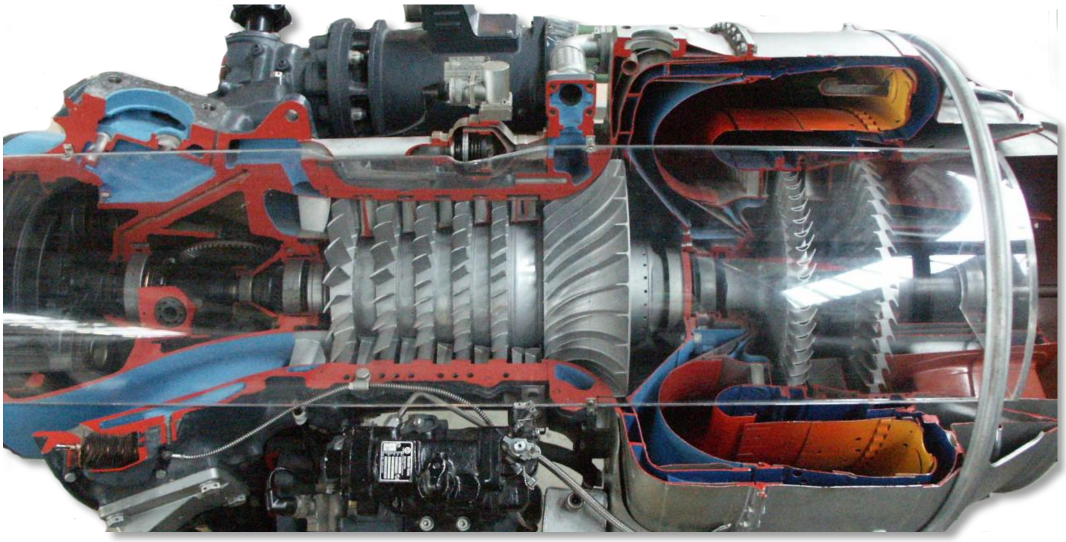


Figure 2.7. Internal layout of the T53-L-13B engine (2 of 2).

Lycoming T53-L-13B specifications:

Power Rating, shp	1400
Air consumption, lbs/s kg/s	13 6
Compression Ratio	7,2:1 @ 25,600 rpm
Specific Fuel Consumption, lbs/shp/h kg/shp/h	0.58 0,263
Burner: reverse flow annular, fuel nozzles	22
Dimensions Engine, inch / mm	
diameter	22.99 / 584
length	47.6 / 1209
Weight lbs / kg	549 / 249
Rated revolutions power turbine, /min	22.000
Rated revolutions driveshaft, /min	6600
Rated Torque Output at full power	1,200 lb/ft @ 6,640 rpm
Peak Torque Output	1,700 lb/ft @ 1,800 rpm
Turbine entry temperature, °C	938
Compressor	
axial	5 stage
centrifugal	1 stage

2.4.2. Engine Fuel Control System

A. Engine Mounted Components

The fuel control assembly is mounted on the engine. It consists of a metering section, a computer section and an overspeed governor.

(1) The *METERING SECTION* (#4 in Figure 2.8) is driven at a speed proportional to N1 speed. It pumps fuel to the engine through the main metering valve or if the main system falls through the emergency metering valve which is positioned directly by the twist grip throttle.

Figure 2.8. Engine Mounted Components.

1. Droop Compensator
2. Governor Actuator
3. Overspeed Governor
4. Metering and Computer Section (Fuel Control Unit or FCU)

(2) The *COMPUTER SECTION* (also #4 in Figure 2.8) determines the rate of main fuel delivery by biasing main metering valve opening for N1 speed, inlet air temperature and pressure, and throttle position. It also controls the operation of the compressor air bleed and operation of the variable inlet guide vanes.

(3) The *OVERSPEED GOVERNOR* (#3 in Figure 2.8) is driven at a speed proportional to N2 speed. It biases the main metering valve opening to maintain a constant selected N2 rpm.

B. Power Controls (Throttles)

Rotating the pilot or copilot twist grip-type throttle to the full open position (Figure 2.9) allows the overspeed governor to maintain a constant rpm.

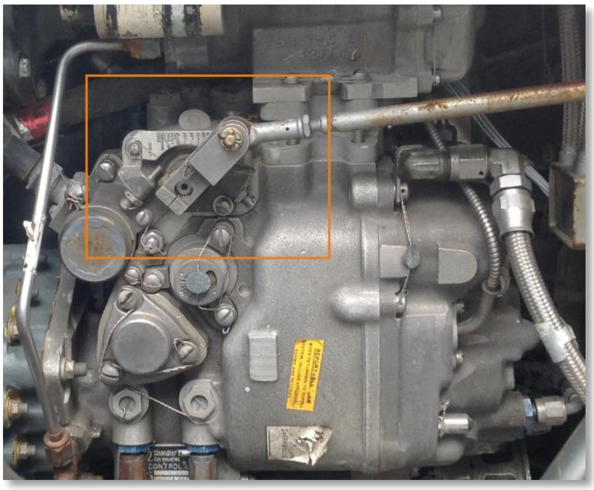


Figure 2.9. FCU. Throttle full open position.

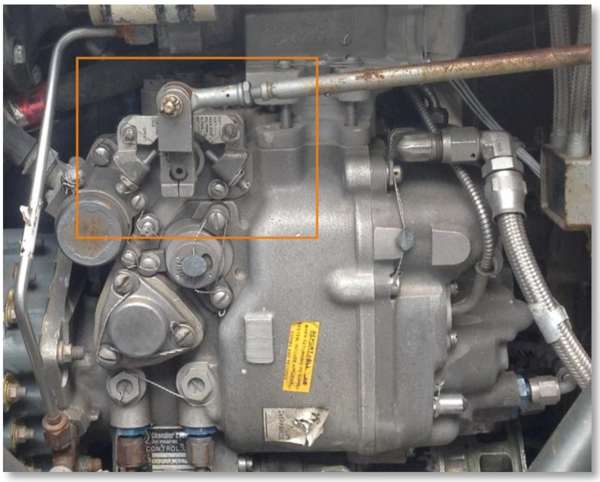


Figure 2.10. FCU. Throttle closed position (idle).

Rotating the throttle toward the closed position (Figure 2.10) will cause the rpm to be manually selected instead of automatically selected by the overspeed governor. Rotating the throttle to the fully closed position (Figure 2.11) shuts off the fuel (not implemented in DCS: UH-1H).

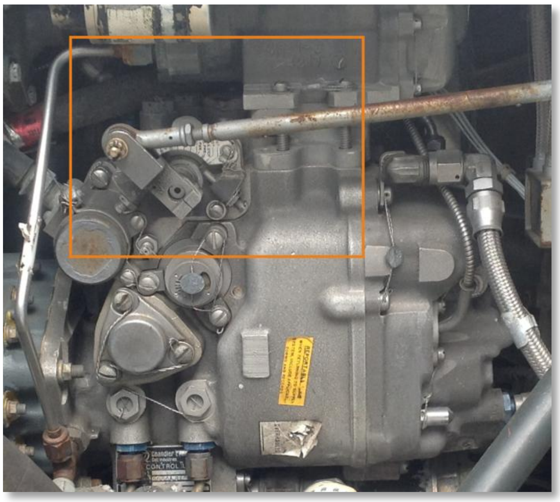


Figure 2.11. FCU. Throttle full closed position.

An idle stop is incorporated in the throttle to prevent inadvertent throttle closure. To bypass the idle detent, press the IDLE REL switch and close the throttle (not implemented in DCS: UH-1H).

C. Governor switch

The GOV switch is located on the ENGINE control panel. AUTO position permits the overspeed governor to automatically control the engine rpm with the throttle in the full open position. The EMER position permits the pilot or copilot to manually control the rpm. Because automatic acceleration, deceleration, and overspeed control are not provided with the GOV switch in the EMER position, control movements must be smooth to prevent compressor stall, overspeed, over-temperature, or engine failure.

Note. If GOV switch is in EMER position and throttle is full opened, main rotor rpm can exceed the limit, so pilot should control engine and rotor rpm manually by rotating the throttle twist grip.

2.4.3. Engine Oil Supply System

The system consists of an engine oil tank with deaeration provisions, thermostatically controlled oil cooler with bypass valve, pressure transmitter and pressure indicator, low pressure warning switch and indicator (see Caution Lights Panel), sight gauges and oil supply return vent and breather lines. Pressure for engine lubrication and scavenging of return oil are provided by the engine mounted and engine driven oil pump.

2.4.4. Governor RPM Switch

The pilot and copilot GOV RPM INCR/DECR switches are mounted on a switch box attached to the end of the collective pitch control lever (Figure 4.6). The switches are a three-position momentary type and are held in INCR (up) position to increase the power turbine (N2) speed or DECR (down) position to decrease the power turbine (N2) speed. Electrical power for the circuit is supplied from the 28 VDC essential bus and is protected by a circuit breaker marked GOV CONT.

2.4.5. Droop Compensator

A droop compensator (#1 in Figure 2.8) maintains engine rpm (N2) as power demand is increased by the pilot. The compensator is a direct mechanical linkage between the collective stick and the speed selector lever on the N2 governor. No crew controls are provided or required. The compensator will hold N2 rpm to 6600 rpm when properly rigged. Droop is defined as the speed change in engine rpm (N2) as power is increased from a no-load condition. It is an inherent characteristic designed into the governor system. Without this characteristic instability would develop as engine output is increased resulting in N1 speed overshooting or hunting the value necessary to satisfy the new power condition.

2.4.6. Engine Instrument and Indicators

All engine instruments and indicators are mounted in the instrument panel and the pedestal.

a) Torquemeter Indicator. The torquemeter indicator is located in the center area of the instrument panel and is marked TORQUE PRESS.

b) Exhaust Gas Temperature Indicator. The exhaust gas temperature indicator is located in the center area of the instrument panel and is marked EXH TEMP.

c) Dual Tachometer. The dual tachometer is located in the center area of the instrument panel and indicates both the engine and main rotor rpm.

d) Gas Producer Tachometer. The gas producer indicator is located in the right center area of the instrument panel and is marked PERCENT.

e) Oil Temperature Indicator. The engine oil temperature indicator is located in the center area of the instrument panel and is marked ENGINE OIL.

f) Oil Pressure Indicator. The engine oil pressure indicator is located in the center area of the instrument panel and is marked OIL.

g) Oil Pressure Caution Light. The ENGINE OIL PRESS caution light is located in the pedestal mounted CAUTION panel. The light is connected to a low pressure switch. When pressure drops below approximately 25 psi, the switch closes an electrical circuit causing the caution light to illuminate. The circuit receives power from the 28 VDC essential bus and is protected by the circuit breaker marked CAUTION LIGHTS.

h) Engine Chip Detector Caution Light. A magnetic plug is installed in the engine. When sufficient metal particles accumulate on the magnetic plug to complete the circuit, the ENGINE CHIP DET segment illuminates. The circuit receives power from the 28 VDC essential bus and is protected by the circuit breaker marked CAUTION LIGHTS. On helicopters equipped with ODDS, the chip detector which is connected to the caution light is part of the external oil separator.

i) Engine Ice Detector. The ice detector system (ENGINE ICE DET caution light) is not connected.

j) Engine Icing Caution Light. The ENGINE ICING segment of the caution panel.

k) Engine Inlet Air Caution Light. The ENGINE INLET AIR segment of the caution panel will illuminate when the inlet air filter becomes clogged. Power is supplied from the 28 VDC bus and protection is provided by the CAUTION LIGHT circuit breaker. (Not implemented in DCS: UH-1H)

l) Failure of either fuel pump element will close an electrical circuit illuminating the caution light. The system receives power from the 28 VDC essential bus and is protected by a circuit breaker marked CAUTION LIGHTS. One type of switch used on some aircraft will illuminate the caution light until normal operating pressure is reached. This momentary lighting does not indicate a pump element failure.

m) Emergency Fuel Control Caution Light. The emergency fuel control caution light is located in the pedestal-mounted caution panel. The illumination of the worded segment GOV EMER is a reminder to the pilot that the GOV switch is in the EMER position. Electrical power for the circuit is supplied from the 28 VDC bus and is protected by a circuit breaker marked CAUTION LIGHTS.

n) Fuel Filter Caution Light. The FUEL FILTER caution light is located in the pedestal-mounted caution panel or a press to test light is located on the instrument panel. A differential pressure switch is mounted in the fuel line across the filter. When the filter becomes clogged, the pressure switch senses this and closes contacts to energize the caution light circuit. If clogging continues, the fuel bypass opens to allow fuel to flow around the filter. The circuit receives power from the 28 VDC essential bus and is protected by a circuit breaker marked CAUTION LIGHTS. (Not implemented in DCS: UH-1H)

2.5. Power Train System

The power train is a system of shafts and gearboxes through which the engine drives the main rotor, tail rotor, and accessories, such as the DC generator and the hydraulic pump. The system consists of (Figure 2.12) a main driveshaft, a main transmission, which includes input and output drives, and the main rotor mast, and a series of driveshafts with two gearboxes through which the tail rotor is driven.

A. Transmission

The main transmission is mounted forward of the engine and coupled to the power turbine shaft at the cool end of the engine by the main driveshaft. The transmission is basically a reduction gearbox, used to transmit engine power at a reduced rpm to the rotor system. A freewheeling unit is incorporated in the transmission to provide a quick-disconnect from the engine if a power failure occurs. This permits the main rotor and tail rotor to rotate in order to accomplish a safe auto-rotational landing. The tail rotor drive is on the lower aft section of the transmission. Power is transmitted to the tail rotor through a series of driveshaft and gearboxes. The rotor tachometer generator, hydraulic pump, and main DC generator are mounted on and driven by the transmission. A self-contained pressure oil system is incorporated in the transmission. The oil is cooled by an oil cooler and turbine fan. The engine and transmission oil coolers use the same fan. The oil system has a thermal bypass capability. An oil level sight glass, filler cap, and magnetic chip detector are provided. A transmission oil filter is mounted in a pocket in the upper right aft corner of sump case, with inlet and outlet ports through internal passages. The filter incorporates a bypass valve for continued oil flow if screens become clogged. The transmission external oil filter is located in the cargo-sling compartment on the right side wall, and is connected into the external oil line. On helicopters equipped with ODDS[1], a full flow debris monitor with integral chip detector replaces the integral oil filter. A bypass valve is incorporated, set to open at a set differential pressure to assure oil flow if filter element should become clogged.

Normal revolution (min^{-1}): main rotor (mast): 324, tail rotor: 1782.

[1] ODDS – Oil Debris Detection System – ODDS improves oil filtration and reduces nuisance chip indications caused by normal wear particles on detector gaps. When a chip gap is bridged by conductive particles, a power module provides an electrical pulse which burns away normal wear particles.

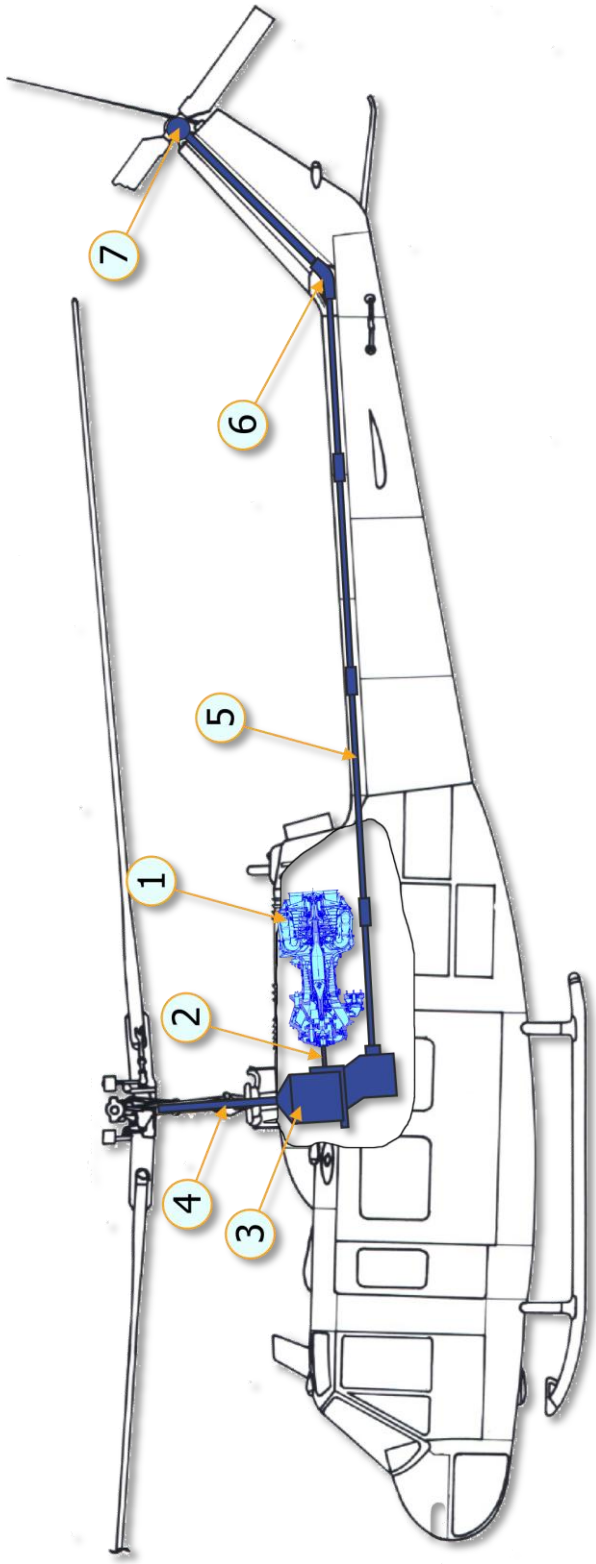


Figure 2.12. Power Train Diagram

1. Engine
2. Main Driveshaft (6600 RPM)
3. Transmission
4. Mast (324 RPM)
5. Tail Rotor Driveshafts
6. Intermediate Gearbox (42°)
7. Tail Rotor Gearbox (90°, 1782 RPM)

B. Gearboxes

Intermediate Gearbox 42 Degree. The 42 degree gearbox is located at the base of the vertical fin. It provides 42 degree change of direction of the tail rotor driveshaft. The gearbox has a self-contained wet sump oil system. An oil level sight glass, filler cap, vent and magnetic chip detector are provided.

Tail Rotor Gearbox 90 Degree. The 90 degree gearbox is located at the top of the vertical fin. It provides a 90 degree change of direction and gear reduction of the tail rotor driveshaft. The gearbox has a self-contained wet sump oil system. An oil level sight glass, vented filler cap and magnetic chip detector are provided.

C. Driveshafts

Main Driveshaft. The main driveshaft connects the engine output shaft to the transmission input drive quill.

Tail Rotor Driveshaft. The tail rotor driveshaft consists of six driveshaft and four hanger bearing assemblies. The assemblies and the 42 degree and 90 degree gearboxes connect the transmission tail rotor drive quill to the tail rotor. To **Figure 2.12. Power Train Diagram**

D. Indicators and Caution Lights

a) Transmission Oil Pressure Indicator. The TRANS OIL pressure indicator is located in the center area of the instrument panel. It displays the transmission oil pressure in psi. Electrical power for the circuit is supplied from the 28 VAC bus and is protected by the XMSN circuit breaker in the AC circuit breaker panel.

b) Transmission Oil Pressure Low Caution Light. The XMSN OIL PRESS segment in the CAUTION panel will illuminate when the transmission oil pressure drops below about 30 psi. The circuit receives power from the essential bus. Circuit protection is supplied by the CAUTION LIGHTS circuit breaker.

c) Transmission Oil Temperature Indicator. The transmission oil temperature indicator is located in the center area of the instrument panel. The indicator displays the temperature of the transmission oil in degrees Celsius. The electrical circuit receives power from the essential bus and is protected by the TEMP IND ENG XMSN circuit breaker in the DC breaker panel. This is a wet bulb system dependent on fluid for valid indication.

d) Transmission Oil Hot Caution Light. The XMSN OIL HOT segment in the CAUTION panel will illuminate when the transmission oil temperature is above 110°C (230°F). The circuit receives power from the essential bus and is protected by the CAUTION LIGHTS circuit breaker. This is a wet bulb system dependent on fluid for valid indication.

e) Transmission and Gearbox Chip Detector:

(1) Chip Detector Caution Light. Magnetic inserts are installed in the drain plugs of the transmission sump, 42 degree gearbox and the 90 degree gearbox. On helicopters equipped with ODDS, the transmission chip gap is integral to a full-flow debris monitor. When sufficient metal particles collect on the plugs to close the electrical circuit, the CHIP DETECTOR segment in the CAUTION panel will illuminate. A self-closing, spring-loaded valve in the chip detectors permits the magnetic probes to be removed without the loss of oil. The circuit is powered by the essential bus and protected by the CAUTION LIGHTS circuit breaker.

(2) Chip Detector Switch. A CHIP DET switch is installed on a pedestal mounted panel. The switch is labeled BOTH, XMSN, and TAIL ROTOR and is spring-loaded to the BOTH position. When the CHIP DETECTOR segment in the CAUTION panel lights up, position the switch to XMSN, then TAIL ROTOR to determine the trouble area. CHIP DET caution light will remain on when a contaminated component is selected. The light will go out if the non-contaminated component is selected.

2.6. Cockpit layout

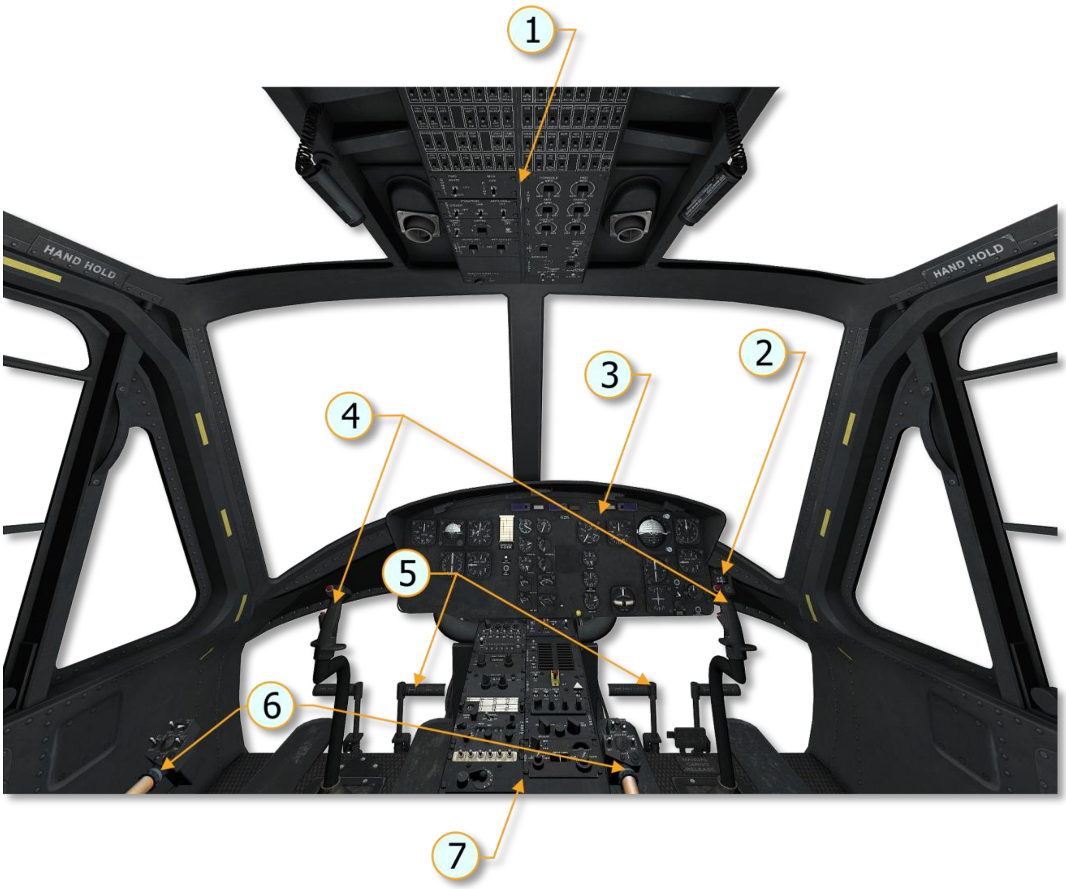


Figure 2.13. UH-1H cockpit layout.

1. Overhead Console
2. Standby Compass
3. Instrument Panel
4. Cyclic Control System
5. Tail Rotor Control System
6. Collective Control System
7. Pedestal Panel

NOTES

3 HELICOPTER AERODYNAMICS

3. HELICOPTER AERODYNAMICS

3.1.1. The Forces That Act On a Helicopter

Weight (G) and drag (Q) act on a helicopter as they do on any aircraft; however, lift (T_y) and thrust (T_x) for a helicopter are obtained from the main rotor (T_{rotor}). In a very basic sense, the helicopter's main rotor does what wings and a propeller do for a fixed-wing aircraft. Moreover, by tilting the main rotor, the pilot can make the helicopter fly to either side, forward, or backwards.

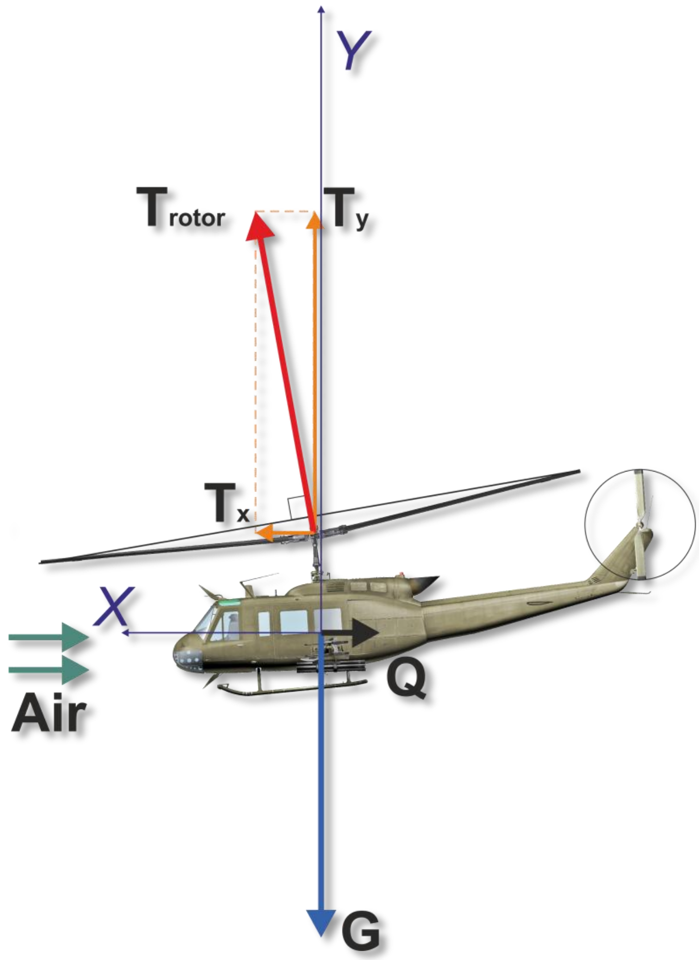


Figure 3.1. Forces Acting on a Helicopter

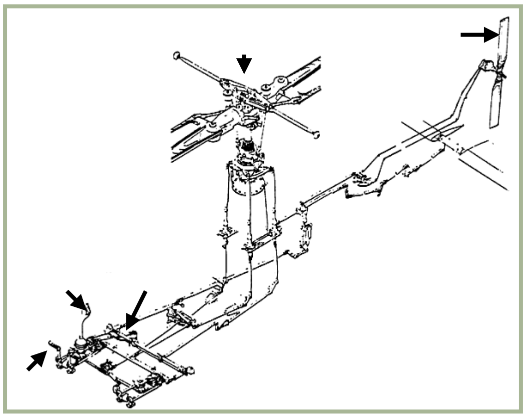


Figure 3.2. Helicopter Controls

3.1.2. Controls

The sketch in Figure 3.2 shows the main rotor, cyclic and collectives, anti-torque pedals, and anti-torque rotor. Basically, the cyclic control is a mechanical linkage used to change the pitch of the main rotor blades. Pitch change is accomplished at a specific point in the plane of rotation to tilt the main rotor disc. Most current military helicopters now have hydraulic assistance in addition to the mechanical linkages. The collective changes the pitch of all the main rotor blades equally and simultaneously. The anti-torque pedals are used to adjust the pitch in the anti-torque rotor blades to compensate for main rotor torque.

3.1.3. Velocity

A helicopter's main rotor blades must move through the air at a relatively high speed in order to produce enough lift to raise the helicopter and keep it in the air. When the main rotor reaches required takeoff speed and generates a great deal of torque, the anti-torque rotor can negate fuselage rotation.

The helicopter can fly forward, backward, and sideways according to pilot control inputs. It can also remain stationary in the air (hover) with the main rotor blades developing enough lift to hover the helicopter.

3.1.4. Torque

The torque problem is related to a helicopter's single-main-rotor design. The reason for this is that the helicopter's main rotor turns in one direction while the fuselage wants to turn in the opposite direction. This effect is based on Newton's third law that states "To every action there is an opposite and equal reaction." The torque problem on single-rotor helicopters is counteracted and controlled by an anti-torque (tail) rotor.

On coaxial helicopters, the main rotors turn in opposite directions and thereby eliminate the torque effect.

3.1.5. Anti-torque Rotor

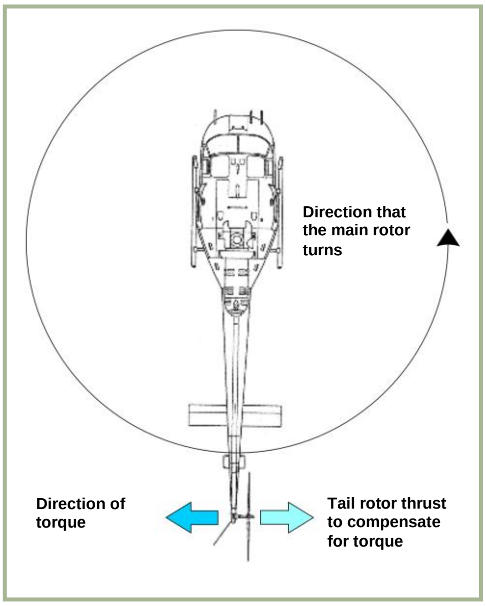


Figure 3.3. Tail rotor and thrust

Figure 3.3 shows the direction of travel of the main rotor, the direction of torque of the fuselage, and the location of the anti-torque (tail) rotor.

An anti-torque rotor located on the end of a tail boom provides torque compensation for single-main-rotor helicopters. The tail rotor, driven by the engine at a constant speed, produces thrust in a horizontal plane opposite to the torque reaction developed by the main rotor.

3.1.6. Gyroscopic Precession

The result of applying force against a rotating body occurs at 90° in the direction of rotation from where the force is applied. This effect is called gyroscopic precession and it is illustrated in Figure 3.4. For example: if a downward force is applied at the 9 o'clock position in the diagram, then the result appears at the 6 o'clock position as shown. This will result in the 12 o'clock position tilting up an equal amount in the opposite direction.

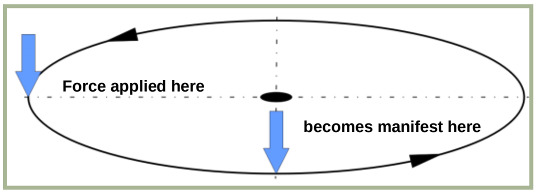


Figure 3.4. Gyroscopic Precession

Figure 3.5 illustrates the offset control linkage needed to tilt the main rotor disc in the direction the pilot inputs with the cyclic. If such a linkage were not used, the pilot would have to move the cyclic 90° to the right of the desired direction. The offset control linkage is attached to a lever extending 90° in the direction of rotation from the main rotor blade.

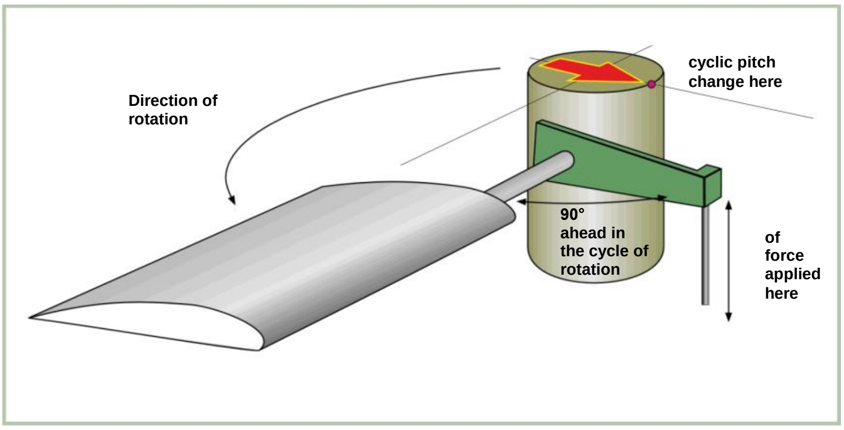


Figure 3.5. Offset Control Linkage

3.1.7. Dissymmetry of Lift

The area within the circle made by the rotating blade tips of a helicopter is known as the disc area or rotor disc. When hovering in still air, lift generated by the rotor blades is equal within all parts of the disc. Dissymmetry of lift is the difference in lift that exists between the advancing half of the disc and the retreating half; this is created by horizontal flight and/or wind.

When a helicopter is hovering in still air, the tip speed of the advancing blade is approximately 600 feet per second (~ 183 m/s) and the tip speed of the retreating blade is the same. Dissymmetry of lift is created by the movement of the helicopter in forward flight. The advancing blade has the combination of blade speed velocity and that of the helicopter's forward airspeed. The retreating blade however loses speed in proportion to the forward speed of the helicopter.

Figure 3.6 illustrates dissymmetry of lift and shows the arithmetic involved in calculating the differences between the velocities of the advancing and retreating blades. In the figure, the helicopter is moving forward at a speed of 50 m/s, the velocity of the rotor disc is equal to approximately 180 m/s, and the advancing blade speed is 230 m/s. The speed of the retreating blade is 130 m/s. This speed is obtained by subtracting the speed of the helicopter (50 m/s) from the tip speed of 180 m/s. As can be seen from the difference between the advancing and retreating blade velocities, a large speed and lift variation exists.

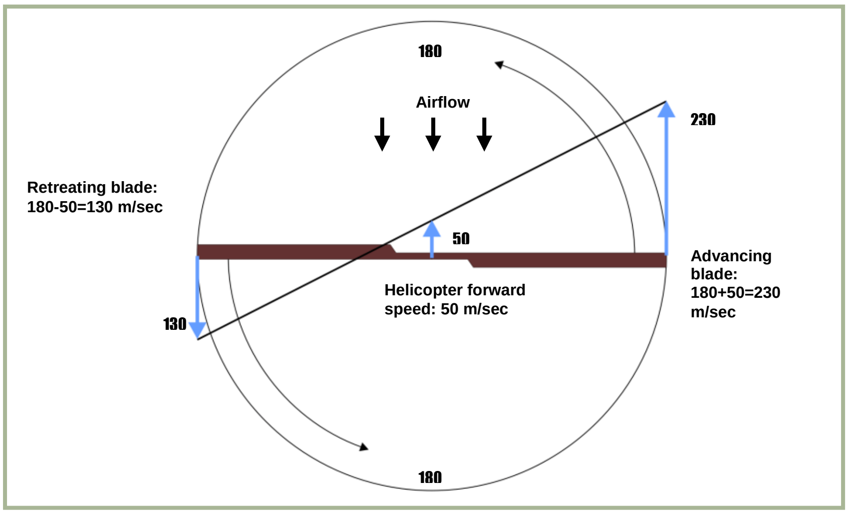


Figure 3.6. Dissymmetry of Lift. (ROTATIONAL VELOCITY) ± (HEL FORWARD SPEED) = (AIRSPEED OF BLADE).

Cyclic pitch control, a design feature that permits changes in the angle of attack during each revolution of the rotor, compensates for the dissymmetry of lift. As the forward speed of the helicopter is increased, the pilot must apply more and more cyclic to hold a given rotor disc attitude. The mechanical addition of more pitch to the retreating blade and less to the advancing blade is continued throughout the helicopter's range.

3.1.8. Retreating Blade Stall

Figure 3.7 illustrates the tendency of a helicopter's retreating blades to stall in forward flight. This is a major factor in limiting a helicopter's maximum forward airspeed. Just as the stall of a fixed wing aircraft wing limits the low-airspeed flight envelope, the stall of a rotor blade limits the high-speed potential of a helicopter. The airspeed of a retreating blade slows down as forward airspeed is increased. The retreating blade must produce an amount of lift equal to that of the advancing blade, as shown in Figure 3.8. As the airspeed of the retreating blade is decreased with forward airspeed, the blade angle of attack must be increased to equalize lift throughout the rotor disc area. As this angle of attack is increased, the blade will eventually stall at some high, forward airspeed as shown in Figure 3.9.

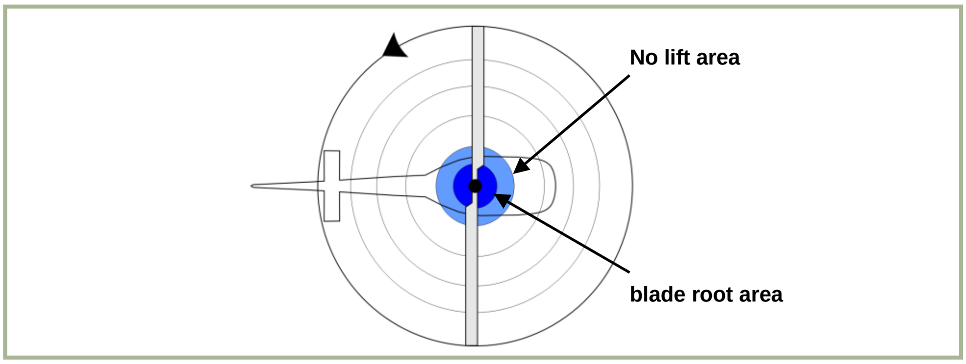


Figure 3.7. Hovering Lift Pattern

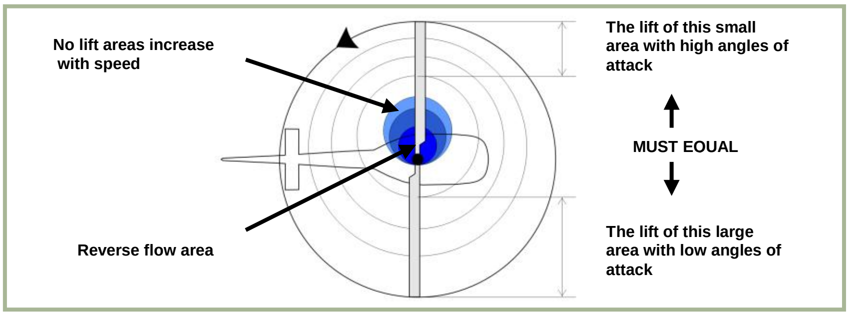


Figure 3.8. Normal Cruise Lift Pattern

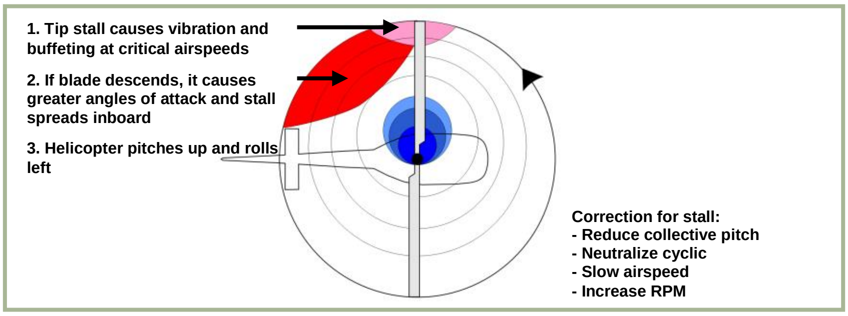


Figure 3.9. Lift Pattern at Critical Airspeed

Upon entry into a retreating blade stall, the first noticeable effect is vibration of the helicopter. This vibration is followed by the helicopter's nose lifting with a rolling tendency. If the cyclic is held forward and the collective is not reduced, the stall will become aggravated and the vibration will increase greatly. Soon thereafter, the helicopter may become uncontrollable.

3.1.9. Settling With Power (Vortex Ring State)

Settling with power is a condition of powered flight when the helicopter settles into its own main rotor downwash; this is also known as Vortex Ring State.

Conditions conducive to settling with power include a vertical, or nearly vertical, descent of at least 300 feet per minute with low forward airspeed. The rotor system must also be using some of the available engine power (from 20 to 100%) with insufficient power available to retard the sink rate. These conditions occur during approaches with a tailwind or during formation approaches when some aircraft are flying in the downwash of other aircraft.

Under the conditions described above, the helicopter may descend at a high rate that exceeds the normal downward induced flow rate of the inner blade sections. As a result, the airflow of the inner blade sections is upward relative to the disk. This produces a secondary vortex ring in addition to the normal tip vortex. The secondary vortex ring is generated at about the point on the blade where airflow changes from up to down. The result is an unsteady turbulent flow over a large area of the disk that causes loss of rotor efficiency, even though power is still applied.

This graphic shows induced flow along the blade span during normal hovering flight:

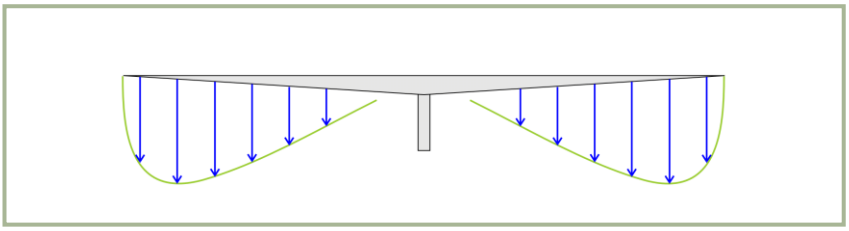


Figure 3.10. Induced Flow Velocity During Hovering Flight

The downward velocity is highest at the blade tip where blade airspeed is highest. As blade airspeed decreases towards the center of the disk, downward velocity is less. Figure 3.11 shows the induced airflow velocity pattern along the blade span during a descent conducive to settling with power:

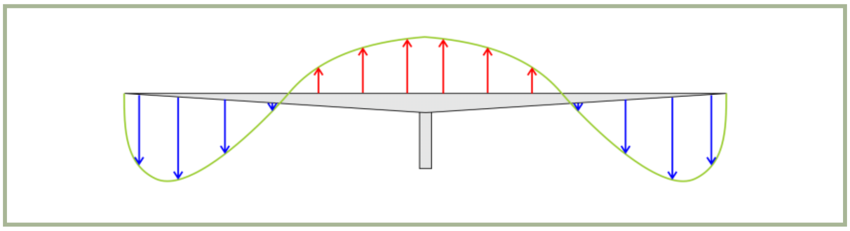


Figure 3.11. Induced Flow Velocity During Vortex Ring State

The descent is so rapid that induced flow at the inner portion of the blades is upward rather than downward. The upward flow caused by the descent can overcome the downward flow produced by blade rotation. If the helicopter descends under these conditions, with insufficient power to slow or stop the descent, it will enter a vortex ring state:

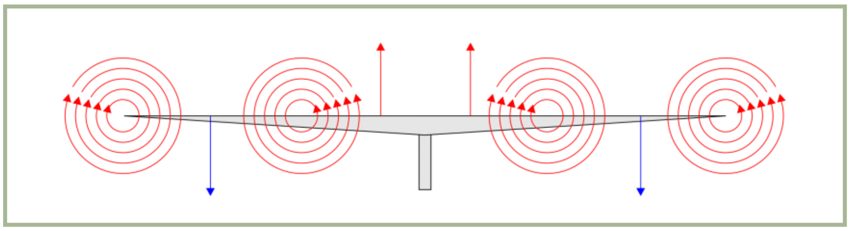


Figure 3.12. Vortex Ring State

During a vortex ring state, roughness and loss of control is experienced because of the turbulent rotational flow on the blades and the unsteady shifting of the flow along the blade span.

Power settling is an unstable condition, and if allowed to continue, the sink rate will reach sufficient proportions for the flow to be entirely up through the rotors. This can result in very high descent rates. Recovery may be initiated during the early stages of power settling by putting on a large amount of excess power. This excess power may be sufficient to overcome the upward flow near the center of the rotor disc. If the sink rate reaches a higher rate, power will not be available to break this upward flow and thus alter the vortex ring state of flow.

Normal tendency is for pilots to recover from a descent by application of collective pitch and power. If insufficient power is available for recovery, this action may aggravate power settling and result in more turbulence and a higher rate of descent. Recovery can be accomplished by lowering collective pitch and increasing forward speed (pushing the cyclic forward). Both of these methods of recovery require sufficient altitude to be successful.

3.1.10. Hovering

A helicopter hovers when it maintains a constant position over a point on the ground, usually a few feet above the ground. To hover, a helicopter's main rotor must supply lift equal to the total weight of the helicopter, including crew, fuel, and if applicable, passengers, cargo, and armaments. The necessary lift is generated by rotating the blades at high velocity and increasing the blade angle of attack.

When hovering, the rotor system requires a large volume of air upon which to work. This air must be pulled from the surrounding air mass; this is an expensive maneuver that takes a great deal of engine horsepower. The air delivered through the rotating blades is pulled from above at a relatively high velocity, forcing the rotor system to work in a descending column of air.

The main rotor vortex and the recirculation of turbulent air add resistance to the helicopter while hovering. Such an undesirable air supply requires higher blade angles of attack and an expenditure of more engine power and fuel. Additionally, the main rotor is often operating in air filled with abrasive materials that cause heavy wear on helicopter parts while hovering in the ground effect.

3.1.11. Ground Effect

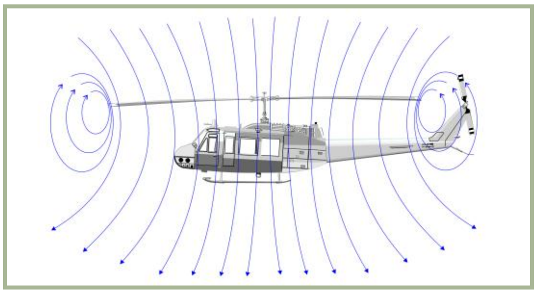


Figure 3.13. Airflow When Out of Ground Effect

Ground effect is a condition of improved performance found when hovering near the ground. The best height is approximately one-half the main rotor diameter. Figure 3.13 shows "out of ground effect" and 3.14 shows "in ground effect".

The improved lift and airfoil efficiency while operating in ground effect is due to the following effects:

First, and most importantly, the main rotor-tip vortex is reduced. When operating in the ground effect, the downward and outward airflow reduces the vortex. A vortex is an airflow rotating around an axis or center.

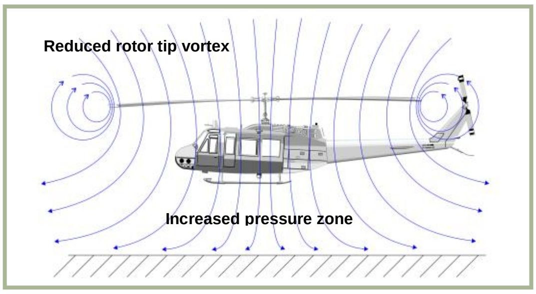


Figure 3.14. Airflow When In Ground Effect

This makes the outward portion of the main rotor blade more efficient. Reducing the vortex also reduces the turbulence caused by recirculation of the vortex.

Second, the airflow angle is reduced as it leaves the airfoil. When the airfoil angle is reduced, the resultant lift is rotated slightly forward; this makes the angle more vertical. Reduction of induced drag permits lower angles of attack for the same amount of lift and it reduces the power required to rotate the blades.

3.1.12. Translational Lift

The efficiency of the hovering rotor system is improved by each knot of incoming wind gained by forward motion of the helicopter or by a surface headwind. As the helicopter moves forward, fresh air enters in an amount sufficient to relieve the hovering air-supply problem and improve performance. At approximately 40 km/h, the rotor system receives enough free, undisturbed air to eliminate the air supply problem. At this time, lift noticeably improves. This distinct change is referred to as translational lift. At the instant of translational lift, and as the hovering air supply pattern is broken, dissymmetry of lift is created. As airspeed increases, translational lift continues to improve up to the speed that is used for best climb.

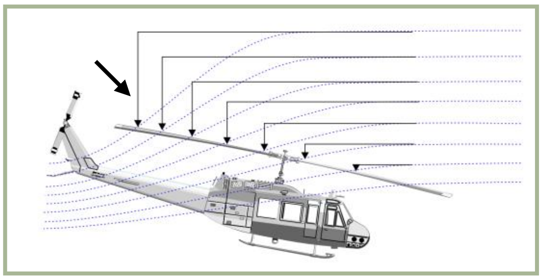


Figure 3.15. Translational lift

In forward flight, air passing through the rear portion of the rotor disc has a higher downwash velocity than the air passing through the forward portion. This is known as transverse flow effect and is illustrated in figure 3.15. This effect, in combination with gyroscopic precession, causes the rotor to tilt sideward and results in vibration that is most noticeable on entry into effective translation.

3.1.13. Autorotation

If engine power fails, or other emergencies occur, autorotation is a means of safely landing a helicopter. The transmission in a helicopter is designed to allow the main rotor to turn freely in its original direction when the engine stops. Figure 3.16 illustrates how the helicopter is allowed to glide to earth and by using the main rotor rpm, make a soft landing.

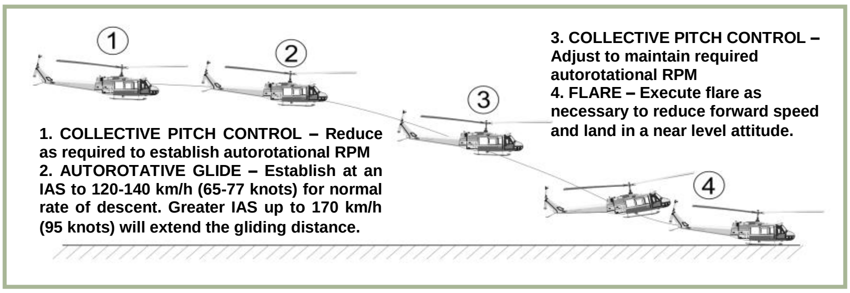


Figure 3.16. Approach to Landing, Power Off

The rotor blade autorotative driving region is the portion of the blade between 25 to 70 percent radius, as shown in Figure 3.17, blade element B. Because this region operates at a comparatively high angle of attack, the result is a slight but important forward inclination of aerodynamic forces. This inclination supplies thrust slightly ahead of the rotating axis and tends to speed up this portion of the blade during autorotation.

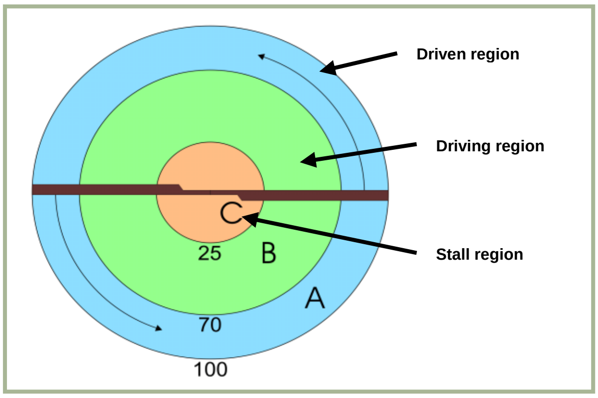


Figure 3.17. The Rotor Blade Autorotative Regions

The blade area outboard of the 70 percent circle is known as the propeller or driven region. Analysis of blade element A: the aerodynamic force inclines slightly behind the rotating axis. This inclination causes a small drag force that tends to slow the tip portion of the blade. Rotor rpm stabilizes, or achieves equilibrium, when autorotative force and antiautorotative force are equal.

The blade area inboard of the 25% circle is known as the stall region because it operates above its maximum angle of attack. This region contributes considerable drag that tends to slow the blade.

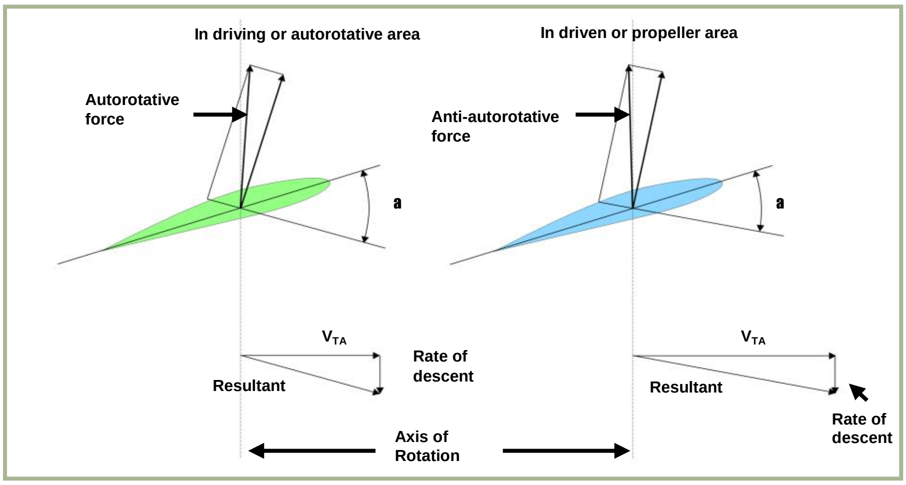


Figure 3.18. Autorotation Blade Forces

All helicopters carry an operator's manual that has an airspeed versus altitude chart similar to the one shown in Figure 3.19. The shaded areas on this chart must be avoided. This area is referred to as the "dead man's curve" and "avoid curve". The proper maneuvers for a safe landing during engine failure cannot be accomplished in these areas.

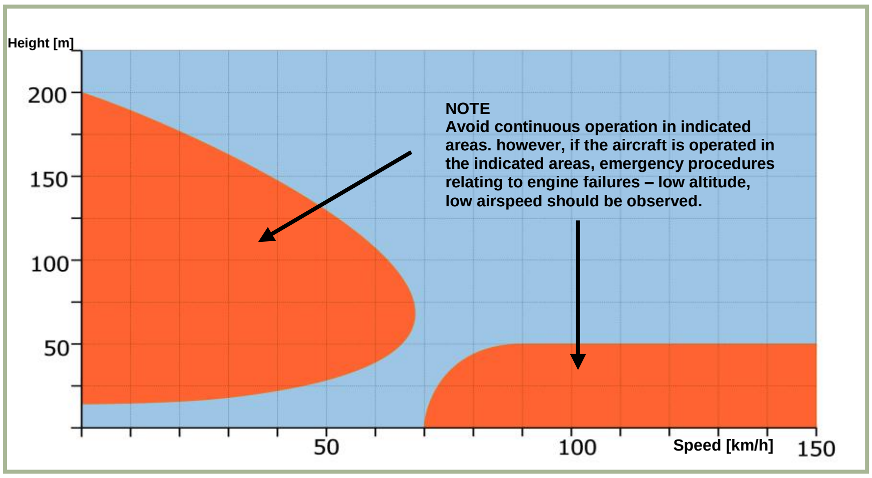


Figure 3.19. Height-Velocity Diagram

3.1.14. Summary

Weight, lift, thrust, and drag are the four forces acting on a helicopter. The cyclic for directional control, the collective pitch for altitude control, and the anti-torque pedals to compensate for main rotor torque are the three main controls used in a helicopter.

Torque is an inherent problem with single-main-rotor helicopters. Gyroscopic precession occurs at approximately 90° in the direction of rotation from the point where the force is applied. Dissymmetry of lift is the difference in lift that exists between the advancing and retreating halves of the rotor disc.

Settling with power can occur when the main rotor system is using from 20 to 100 percent of the available engine power, and the horizontal velocity is under 10 knots. At a hover, the rotor system requires a great volume of air upon which to generate lift. This air must be pulled from the surrounding air mass. This is a costly maneuver that takes a great amount of engine power.

Ground effect provides improved performance when hovering near the ground at a height of no more than approximately one-half the main rotor diameter. Translational lift is achieved at approximately 18 knots, and the rotor system receives enough free, undisturbed air to improve performance. At the instant translational lift is in effect and the hovering air-supply pattern is broken, dissymmetry of lift is created. Autorotation is a means of safely landing a helicopter after engine failure or other emergencies. A helicopter transmission is designed to allow the main rotor to turn freely in its original direction if the engine fails.

4 FLIGHT CONTROL SYSTEM

4. FLIGHT CONTROL SYSTEM

The flight control system is a hydraulically-assisted positive mechanical type, actuated by conventional helicopter controls. Complete controls are provided for both pilot and copilot. The system includes a cyclic system, collective control system, tail rotor system, force trim system, synchronized elevator, and a stabilizer bar.

4.1. Cyclic Control System

The system is operated by movement of the cyclic control stick (Figure 4.1).

1. Force trim switch
2. Radio ICS switch
3. Armament fire control switch
4. Cargo release switch
5. Hoist switch

Figure 4.1. Cyclic Control stick.

Moving the stick in any direction will produce a corresponding movement of the helicopter which is a result of a change in the plane of rotation of the main rotor. The pilot cyclic contains the force trim switch, radio ICS switch, armament fire control switch, cargo release switch and the hoist switch. Desired operating friction can be induced into the control stick by hand tightening the friction adjuster.

A. Synchronized Elevator. The synchronized elevator is located on the tail boom. It is connected by control tubes and mechanical linkage to the fore-and-aft cyclic system. Fore-and-aft movement of the cyclic control stick will produce a change in the synchronized elevator attitude. This improves controllability within the center of gravity (cg) range (Figure 4.2..Figure 4.4).

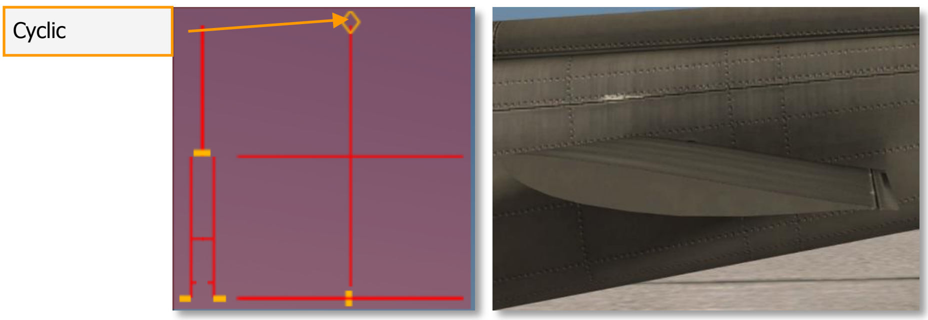


Figure 4.2. Position of the synchronized elevator when cyclic is fully forward (angle +5.40 degrees regarding the construction line of helicopter).

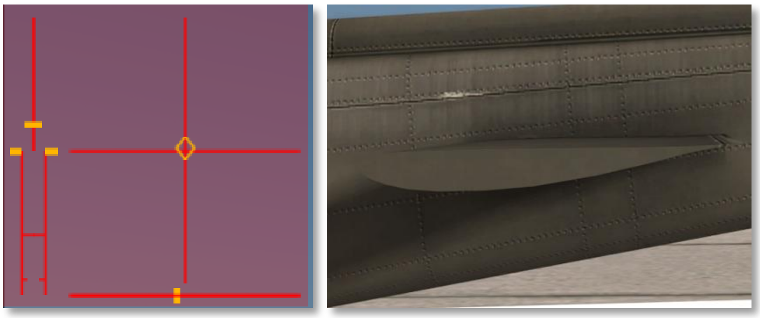


Figure 4.3. Position of the synchronized elevator when cyclic is neutral (angle -4.70 degrees).

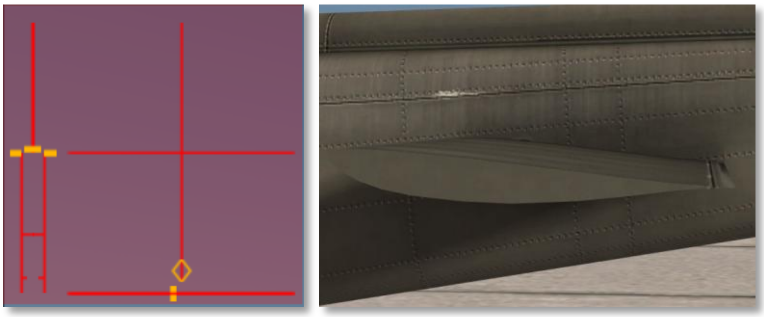


Figure 4.4. Position of the synchronized elevator when cyclic is fully back (angle +1.28 degrees).

Position of the synchronized elevator with respect to the longitudinal axis of the fuselage:

Cyclic Position	Angle	
mm	rad	degree
-163,8 (fully back)	0,0224	1,28
-152,5	0,0174	1,00
-127,0	0,0	0,00
-101,6	-0,0192	-1,10
-76,2	-0,0384	-2,20
-50,8	-0,0541	-3,10
-25,4	-0,069	-3,95
0,0	-0,0820	-4,70
25,4	-0,0850	-4,87
50,8	-0,0803	-4,60
76,2	-0,0628	-3,60
101,6	-0,03	-1,72
127,0	0,0035	0,20
152,5	0,0593	3,40
163,8 (fully forward)	0,0942	5,40

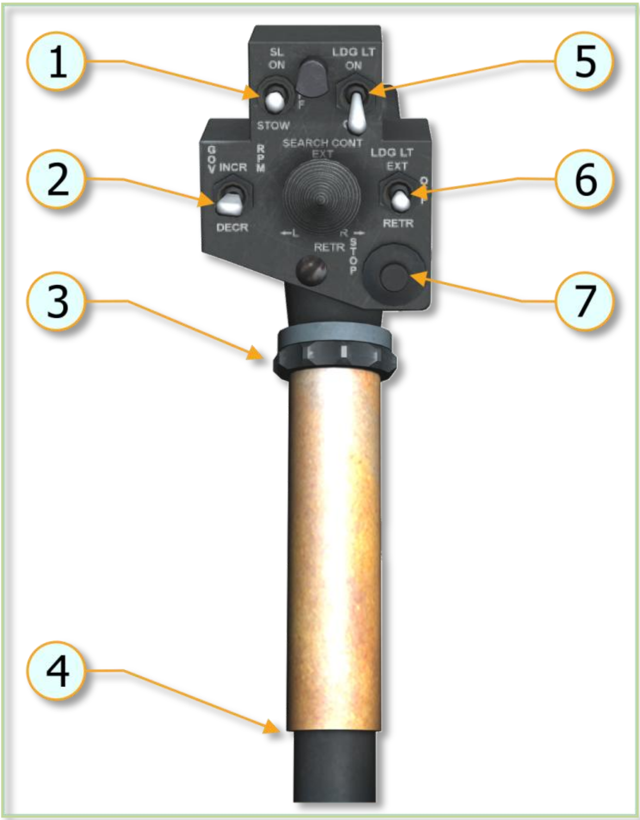
B. Stabilizer Bar. The stabilizer bar is mounted on the main rotor hub trunnion assembly in a parallel plane, above and at 90 degrees to the main rotor blades (Figure 4.5).

Figure 4.5. Stabilizer bar.

The gyroscopic and inertial effect of the stabilizer bar will produce a damping force in the rotor rotating control system and thus the rotor. When an angular displacement of the helicopter/mast occurs, the bar tends to remain in its trim plane. The rate at which the bar rotational plane tends to return to a position perpendicular to the mast is controlled by the hydraulic dampers. By adjusting the dampers, positive dynamic stability can be achieved, and still allow the pilot complete responsive control of the helicopter.

4.2. Collective Control System

The collective pitch control lever controls vertical flight (Figure 4.6).



1. Searchlight switch
2. Governor RPM switch
3. Throttle friction adjuster
4. Throttle
5. Landing light ON/OFF switch
6. Landing light extend/retract switch
7. Starter switch (only for this game)[1]

Figure 4.6. Collective Control stick.

The amount of lever movement determines the angle of attack and lift developed by the main rotor, and results in ascent or descent of the helicopter: When the lever is in the full down position, the main rotor is at minimum pitch.

[1] In reality this button is the "engine idle stop release switch" and does not have "engine start" functionality.

When the lever is in the full up position, the main rotor is at maximum pitch. Desired operating friction can be induced into the control lever by hand-tightening the friction adjuster. A grip-type throttle and a switch box assembly are located on the upper end of the collective pitch control lever. The pilot switch box contains the starter switch, governor rpm switch, engine idle stop release switch, and landing light/searchlight switches. A collective lever down lock is located on the floor below the collective lever. The copilot collective lever contains only the grip-type throttle, governor rpm switch, and starter switch when installed. The collective pitch control system has built-in breakaway (friction) force to move the stick up from the neutral (center of travel) position of eight to ten pounds with hydraulic boost ON.

4.3. Tail Rotor Control System

The tail rotor control system is operated by pilot/copilot anti-torque pedals. Pushing a pedal will change the pitch of the tail rotor blades, resulting in directional control. Pedal adjusters are provided to adjust the pedal distance for individual comfort. A force trim system is connected to the directional controls.

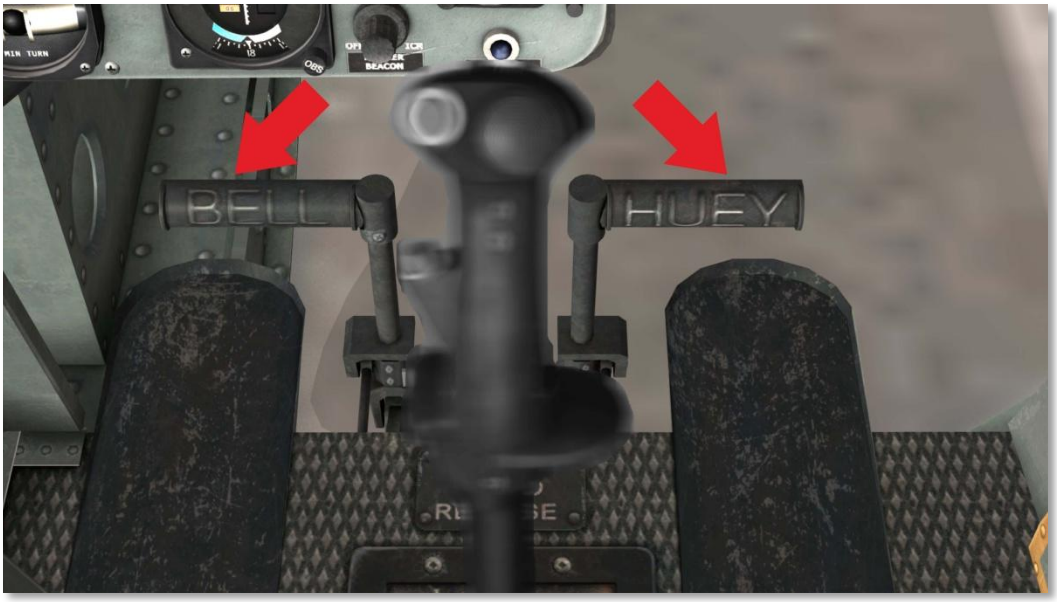


Figure 4.7. Anti-torque pedals.

4.4. Force Trim System

Force centering devices are incorporated in the cyclic controls and directional pedal controls. These devices are installed between the cyclic stick and the hydraulic servo cylinders, and between the anti-torque pedals and the hydraulic servo cylinder. The devices furnish a force gradient or "feel" to the cyclic control stick and anti-torque pedals. A FORCE TRIM ON/OFF switch is installed on the miscellaneous control panel to turn the system on or off.

Figure 4.8. FORCE TRIM ON/OFF switch.

These forces can be reduced to zero by pressing and holding the force trim push-button switch on the cyclic stick grip (Figure 4.9) or moving the force trim switch to OFF.

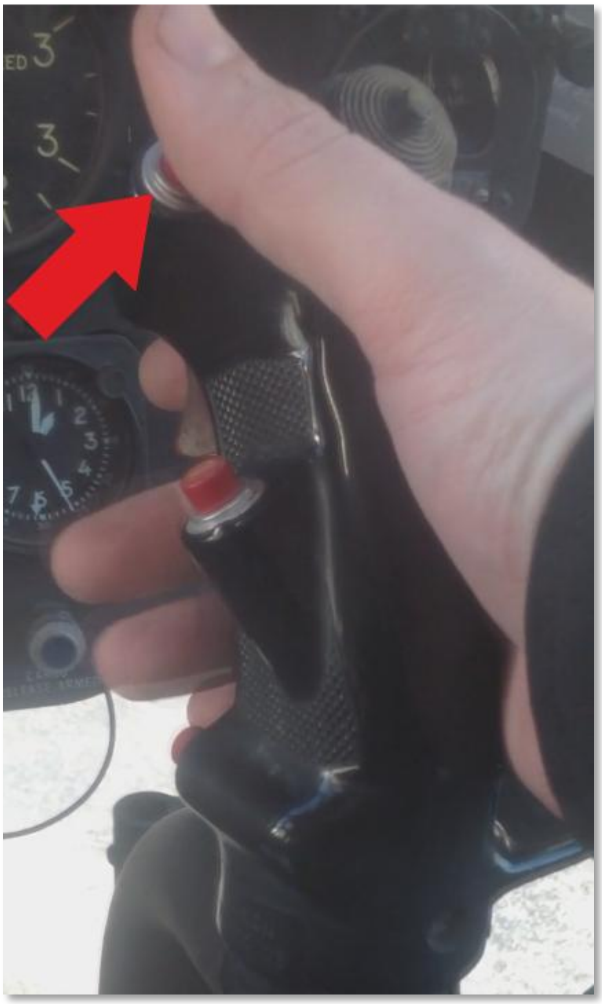


Figure 4.9. Force trim push-button switch on the cyclic stick grip.

5 COCKPIT INSTRUMENTS & CONTROLS

5. COCKPIT INSTRUMENTS AND CONTROLS

5.1. Instrument Panel

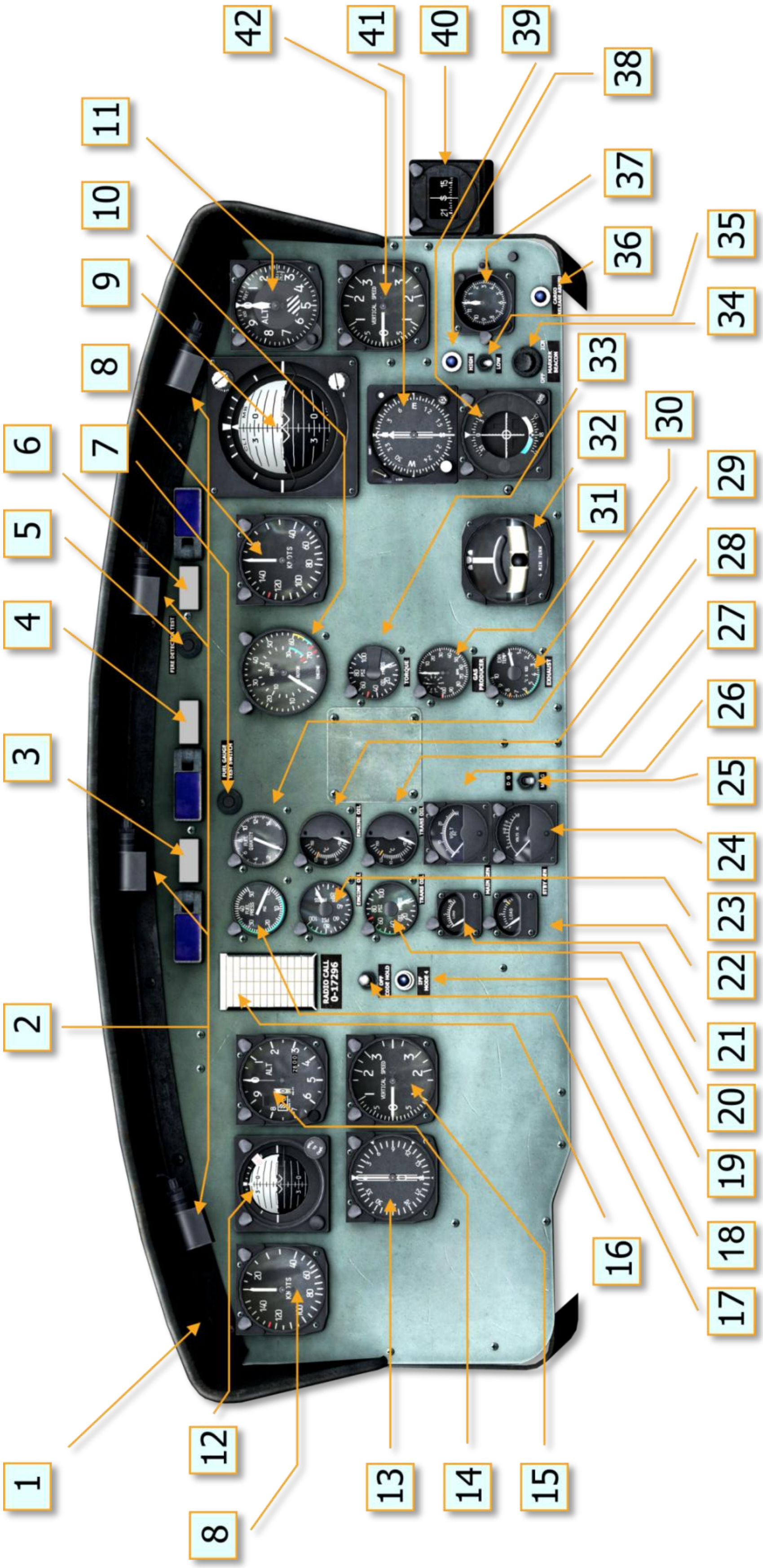


Figure 5.1. UH-1H instrument panel.

1. Glareshield
2. Secondary lights
3. Master caution
4. RPM warning light
5. Fire detector test switch
6. Fire warning indicator light
7. Fuel gauge test switch
8. Airspeed indicator
9. Attitude indicator
10. Dual tachometer
11. Altimeter indicator (AAU-31/A)
12. Attitude indicator
13. Radio compass indicator
14. Altimeter indicator (AAU-32/A)
15. Vertical velocity indicator
16. Compass correction card holder
17. Fuel pressure indicator
18. IFF code hold switch
19. IFF code hold light
20. Transmission oil pressure indicator
21. Main generator loadmeter
22. Standby generator loadmeter
23. Engine oil pressure indicator
24. AC voltmeter
25. Compass slaving switch
26. DC voltmeter
27. Transmission oil temperature indicator
28. Engine oil temperature
29. Fuel quantity indicator
30. Exhaust gas temperature indicator
31. Gas producer tachometer indicator
32. Turn and slip indicator
33. Torquemeter indicator
34. Marker beacon volume control
35. Marker beacon Sensing Switch
36. Cargo release armed light
37. Clock
38. Marker beacon light
39. Course deviation indicator
40. Magnetic compass
41. Radio compass indicator
42. Vertical velocity indicator

Figure 5.1. UH-1H instrument panel description.

5.1.1. Master Caution System

NOTE Aircraft are equipped with NVG compatibility devices, flip-filters (not implemented in DCS: UH-1H) for the "Master Caution", "Low RPM", and "Fire Warning" indicators. These filters must be flipped over away from the indicators during visual flight conditions. A slide drawer filter is also provided for the caution panel. This filter must be stowed in the pedestal stowing position when not being used for NVG flight. To stow, lift the front end of the filter to the vertical position and allow the filter to gently slide into the vertical cavity in the pedestal above the caution panel.

a) NVG Flight Conditions.

(1) Follow all procedures used for visual flight conditions, except the "Master Caution", "Low RPM", and "Fire Warning" flip-filters and "Caution Panel" slide drawer filter must be placed over the indicators.

(2) Flip instrument panel indicator filters over indicators and press lightly in place to avoid light leakage around edges.

(3) Gently pull the slide drawer filter up from stowed position until it is at the top vertical position and place it over the caution panel.

b) Master Caution Indicator. The master caution indicator light on the instrument panel will illuminate when fault conditions occur. This illumination alerts the pilot and copilot to check the caution panel for the specific fault condition.

c) Caution panel. The CAUTION panel is located on the pilot side of the pedestal (Figure 5.2). Worded segments illuminate to identify specific fault conditions. The worded segments are readable only when the light illuminates. When a light illuminates, flickers or full illumination, it indicates a fault condition. Refer to Caution Lights Panel for explanation of the fault conditions.

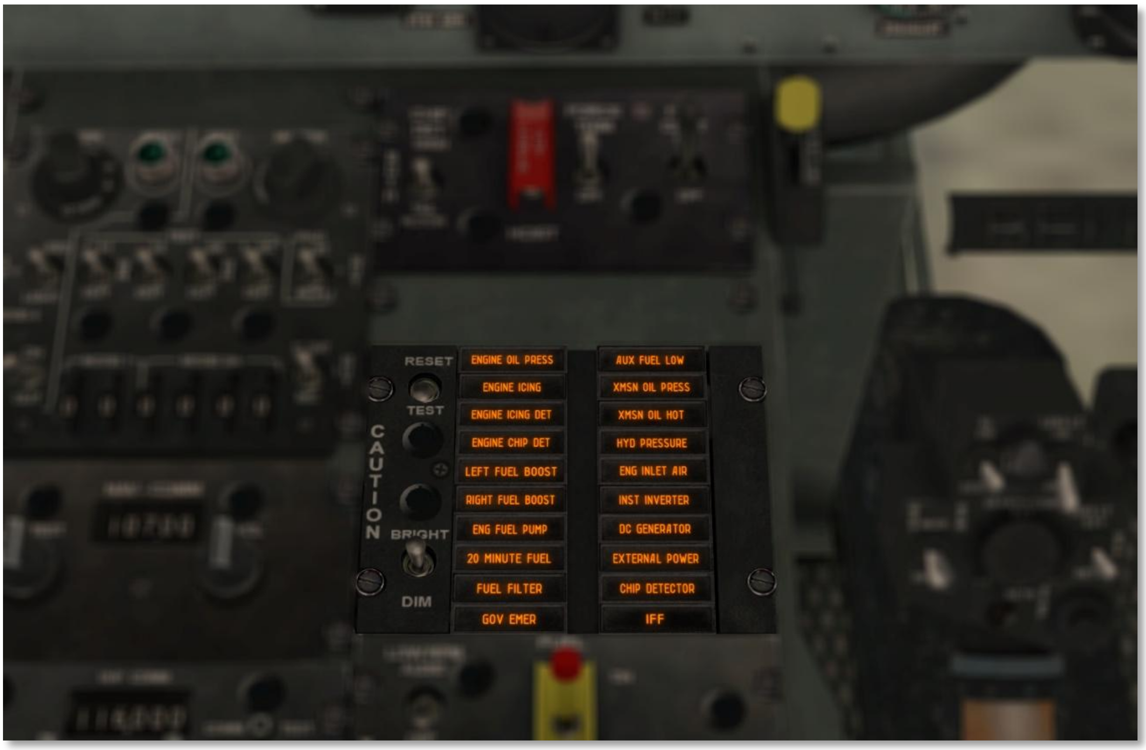


Figure 5.2. CAUTION panel location.

d) Electrical Power. Electric power for the master caution system is supplied from the essential bus. Circuit protection is provided by the CAUTION LIGHTS circuit breakers.

5.1.2. RPM High-Low Limit Warning System (4, Figure 5.1)

The rpm high-low limit warning system provides the pilot with an immediate warning of high and low rotor or engine rpm. Main components of the system are a detector unit, warning light and audio signal circuit, low RPM AUDIO/OFF switch, and electrical wiring and connectors. The warning light and audio warning signal systems are activated when any one of the following rpm conditions exist:

a) Warning light only:

(1) For rotor rpm of 329-339 (High Warning).

(2) For rotor rpm of 300-310 (Low Warning).

(3) For engine rpm of 6100-6300 (Low Warning).

(4) Loss of signal (circuit failure) from either rotor tachometer generator or power turbine tachometer generator.

b) Warning light and audio warning signal combination:

(1) For rotor rpm of 300-310 and engine rpm of 6100-6300 (Low Warning).

(2) Loss of signal (circuit failure) from both rotor tachometer generator and power turbine tachometer generator.

c) Rotor Tachometer Generator and Power Turbine Tachometer Generator. The rotor tachometer generator and power turbine tachometer generator both send signals to the high-low rpm warning light and audio warning circuits. When only the warning light is energized, determine the cause of indication by checking the torquemeter and cross referencing other engine instruments. A normal indication signifies that the engine is functioning properly and that there is a tachometer generator failure or an open circuit to the warning system rather than an actual engine failure. Electrical power for system operation is supplied by the 28 VDC essential bus.

d) High-Low Limit RPM Warning Light. The high-low warning light is located on the instrument panel. This light illuminates to provide a visual warning of low rotor rpm, low engine rpm or high rotor rpm.

e) LOW RPM AUDIO/OFF Switch. The LOW RPM AUDIO/OFF switch is on the engine control panel. When in the OFF position, the switch prevents the audio warning signal from functioning during engine starting. Current production helicopters use a spring-loaded switch. When the switch has been manually turned off for engine starting, it will automatically return to the AUDIO position when normal operating range is reached.

5.1.3. Fire Detector Warning System (5, 6, Figure 5.1).

A FIRE warning light is located in the upper right section of the instrument panel. The FIRE DETECTOR TEST switch (press to test) is located to the left of the fire warning light.

Excessive heat in the engine compartment causes the FIRE light to illuminate. Pressing the press-to-test switch also causes the light to illuminate. Electric power for the circuit is supplied from the 28 VDC essential bus and is protected by the FIRE DET circuit breaker. Back to instrument panel

5.1.4. Airspeed indicator (8, Figure 5.1)

The pilot and copilot airspeed indicators display indicated airspeed (IAS) in knots. The gauge is graduated from 0 to 150 knots in either 5 or 10 knot increments depending on the airspeed. The indicator is red lined at 124 knots.

Note. Indicated airspeeds are unreliable below 20 knots due to rotor downwash

5.1.5. Attitude Indicators (9, 12, Figure 5.1)

Figure 5.3. Attitude Indicator (AI) copilot (left) and pilot (right).

The Attitude Indicator (AI) provides your primary instrument indication of aircraft pitch, roll and yaw in relation to an artificial horizon represented on a sphere. Back to instrument panel

A. Copilot Attitude Indicator

The copilot attitude indicator is located in the copilot section of the instrument panel. It is operated by 115 VAC power supplied by the inverter. Circuit protection is provided by the COPILOT ATTD circuit breakers in the AC circuit breaker panel. In a climb or dive exceeding 27 degrees of pitch, the horizontal bar will stop at the top or bottom of the case and the sphere then becomes the reference. The copilot attitude indicator may be caged manually by pulling the PULL TO CAGE knob smoothly away from the face of the instrument to the limit of its travel and then releasing quickly.

Note. The copilot attitude indicator shall be caged only in a straight and level attitude. The caging knob shall never be pulled violently.

B. Pilot Attitude Indicator.

The pilot attitude indicator is located on the pilot section of the instrument panel. The indicator displays the pitch and roll attitude of the helicopter. An OFF warning flag in the indicator is exposed when electrical power to the system is removed. However, the OFF flag will not indicate internal system failure. The attitude indicator has an electrical trim in the roll axis in addition to the standard pitch trim. The attitude indicator is operated by 115 VAC power, supplied by the inverter. Circuit protection is provided by the PILOT ATTD circuit breakers in the AC circuit breaker panel.

5.1.6. Dual tachometer (10, Figure 5.1)

The dual tachometer is located in the center area of the instrument panel and indicates both the engine and main rotor rpm. The tachometer inner scale (2) is marked ROTOR and the outer scale (1) is marked ENGINE. Synchronization of the ENGINE and ROTOR needles indicates normal operation of helicopter. The indicator receives power from the tachometer generators mounted on the engine and transmission. Connection to the helicopter electrical system is not required. Back to instrument panel

Back to Engine Instrument and Indicators

1. Revolutions of power turbine (outer scale, x100)

2. Revolutions of main rotor (inner scale, x10)

5.1.7. Altimeter Indicator (AAU-31/A)(11, Figure 5.1)

A. Description

The AAU-31/A pneumatic counter-drum-pointer altimeter is a precision pressure altimeter. Pressure altitude is displayed by a 100-foot drum and a single pointer indicating hundreds of feet on a circular scale, with 50' center markings. Below an altitude of 10,000 feet, a diagonal warning symbol will appear on the 10,000-foot counter.

A barometric pressure setting knob is provided to set the desired altimeter setting in inches of Mercury (inHg). A DC powered vibrator operates inside the altimeter whenever aircraft power is on.

B. Normal operation

The altimeter indicates pneumatic altitude reference to the barometric pressure level as selected by the pilot. A vibrator, powered by the DC essential bus, is contained in the altimeter and requires a minimum of one minute warmup prior to checking or setting the altimeter.

C. Abnormal operation

If the altimeter's internal vibrator becomes inoperative due to internal failure or DC power failure, the pointer and drum may momentarily hang up when passing from "9" through "0" (climbing) or from "0" through "9" (descending). This hang-up will cause lag, the magnitude of which will depend on the vertical velocity of the aircraft and the friction in the altimeter. Pilots should be especially watchful for this type of failure when the minimum approach altitude lies within the "8" – "1" part of the scale (800-1100, 1800-2100, etc.). Back to instrument panel

5.1.8. Radio compass indicator (copilot)

The copilot's Radio Compass Indicator is a repeater of the pilot's indicator, described below.

5.1.9. Radio Compass Indicator (41, Figure 5.1)

A. Description

A radio magnetic indicator is installed in the pilot instrument panel. A second radio magnetic indicator (not shown) is installed in the copilot's instrument panel. The copilot indicator is a repeater type instrument similar to the pilot indicator except that it has no control knobs. The moving compass card on both indicators displays the gyromagnetic compass heading. The number 1 pointer on the indicators indicate the bearing to the NDB or course to the VOR station. The number 2 pointer indicates the VOR course to the station.

B. Operation

(1) INV switch – MAIN or STBY.

(2) Radio magnetic indicator (pilot only) – Check power failure indicator is not in view.

SLAVED GYRO MODE.

(3) COMPASS switch – MAG (see 5.1.19).

(4) Synchronizing knob – Center (Null) annunciatior.

(5) Magnetic heading – Check.

FREE GYRO MODE.

(6) COMPASS switch – DG (see 5.1.19).

(7) Synchronizing knob – Set heading.

(8) Annunciator – Center position and then does not change (Annunciator is de-energized in the free gyro (DG) mode).

C. Inflight operation.

Set the COMPASS switch to MAG or DG as desired for magnetically slaved or free gyro mode of operation. Free gyro (DG) mode is recommended when flying in latitudes higher than 70 degrees. Back to instrument panel

When operated in the slaved (MAG) mode, the system will remain synchronized during normal flight maneuvers. During violent maneuvers the system may become unsynchronized, as indicated by the annunciator moving off center. The system will slowly remove all errors in synchronization, however, if fast synchronization is desired, turn the synchronizing knob in the direction indicated by the annunciator until the annunciator is centered again.

When operating in the free gyro (DG) mode, periodically update the heading to a known reference by rotating the synchronizing knob.

Back to instrument panel

5.1.10. Altimeter indicator (AAU-32/A) (14, Figure 5.1)

A. Description

The AAU-32/A pneumatic counter-drum-pointer altimeter is a self-contained unit which consists of a precision pressure altimeter combined with an altitude encoder. The display indicates and the encoder transmits. Simultaneously, pressure altitude is displayed on the altimeter by a 10,000-foot counter, a 1,000-foot counter and a 100-foot drum. A single pointer indicates hundreds of feet on a circular scale, with 50-foot center markings. Below an altitude of

10,000 feet, a diagonal warning system will appear on the 10,000-foot counter. A barometric pressure setting knob is provided to set the desired altimeter setting in inches of Mercury (inHg).

(not implemented in DCS: UH-1H) A DC powered vibrator operates inside the altimeter whenever the aircraft power is on. If DC power to the altitude encoder is lost, a warning flag placarded CODE OFF will appear in the upper left portion of the instrument face indicating that the altitude encoder is inoperative and that the system is not reporting altitude to ground stations. The CODE OFF flag monitors only the encoder function of the altimeter. It does not indicate transponder condition. The AIMS altitude reporting function may be inoperative without the AAU-32/A CODE OFF flag showing, In case of transponder failure or improper control settings It is also possible to get a "good" MODE C test on the transponder control with the CODE OFF flag showing. Display of the CODE OFF flag only indicates an encoder power failure or a CODE OFF flag failure. In this event, check that DC power is available and that the circuit breakers are in. If the flag is still visible, radio contact should be made with a ground radar site to determine whether the AIMS altitude reporting function is operative, and the remainder of the flight should be conducted accordingly.

B. Normal Operation

The AIMS altimeter circuit breaker should be closed prior to flight, the Mode C switch (M-C) on the transponder control should be switched to ON for altitude reporting during flight. The AAU-32/A altimeter indicates pneumatic altitude reference to the barometric pressure level as selected by the pilot. At ambient pressure, altimeters should agree with ±70 feet of the field elevation when the proper barometric pressure setting is set in the altimeter. A red flag marked CODE OFF is located in the upper left portion of the altimeters face. In order to supply Mode C information to the IFF transponder, the CODE OFF flag must not be visible. A vibrator, powered by the DC essential bus, is contained in the altimeter and requires a minimum of one minute warm-up prior to checking or setting the altimeter.

C. Abnormal Operation

If the altimeter's internal vibrator becomes inoperative due to internal failure or DC power failure, the pointer and drum may momentarily hang up when passing from "9" through "0" (climbing) or from "0" through "9" (descending). This hang-up will cause lag, the magnitude of which will depend on the vertical velocity of the aircraft and the friction in the altimeter. Pilots should be especially watchful for this type failure when the minimum approach altitude lies within the "8" – "1" part of the scale (800-1100, 1800-2100, etc).

If the CODE OFF flag is visible, the DC power is not available, the circuit breaker is not in, or there is an internal altimeter encoder failure.

It the altimeter indicator does not correspond within 70 feet of the field elevation (with proper local barometric setting) the altimeter needs rezeroing or there has been an internal failure.

If the baroset knob binds or sticks, abnormal force should not be used to make the setting as this may cause internal gear failure resulting in altitude errors. Settings can sometimes be made by backing off and turning at a slower rate. Back to instrument panel

5.1.11. Vertical velocity indicator (15, 42, Figure 5.1)

The VVI displays rate of climb or descent in increments of feet per minute. The scale is in increments of 1000 feet per min.

Back to instrument panel

5.1.12. Fuel Pressure Indicator (17, Figure 5.1)

Reading of the instrument: 5 to 35 PSI normal.

The Fuel Pressure indicator displays the pounds per square inch (PSI) pressure of the fuel being delivered by the boost pumps from the fuel cells to the engine. The indicator is graduated from 0 to 50 PSI in single PSI increments.

The circuit receives power from the 28 VAC bus and is protected by the FUEL PRESSURE circuit breaker in the AC circuit breaker panel.

5.1.13. IFF code hold switch

Not implemented.

5.1.14. IFF code hold light

Not implemented.

5.1.15. Transmission oil pressure (20, Figure 5.1)

Reading of the instrument: 30 PSI minimum, 40-60 PSI continuous, 70 PSI maximum.

The TRANS OIL pressure indicator is located in the center area of the instrument panel. It displays the transmission oil pressure in pounds per square inch (PSI).

Electrical power for the circuit is supplied from the 28 VAC bus and is protected by the XMSN circuit breaker in the AC circuit breaker panel.

Back to instrument panel

5.1.16. DC Loadmeters (Main and Standby) (21, 22, Figure 5.1)

Two direct current loadmeters are mounted in the lower center area of the instrument panel. The MAIN GEN loadmeter indicates the percentage of main generator rated capacity being used. The STBY GEN loadmeter indicates the percentage of standby generator rated capacity being used. The loadmeters will not indicate percentage when the generators are not operating.

Reading of the instrument: Main generator 1.0 to 1.25 transient, standby generator 1.0 maximum (red).

5.1.17. Engine oil pressure indicator (23, Figure 5.1)

Back to Engine Instrument and Indicators

The Engine Oil Pressure indicator is located in the center area of the instrument panel and is marked OIL PRESS. The indicator receives pressure indications from the engine oil pressure transmitter and provides readings in pounds per square inch (PSI).

The circuit receives electrical power from the 28 VAC bus and circuit protection is provided by the ENG circuit breaker in the AC circuit breaker panel.

Reading of the instrument: 25 PSI minimum – engine idle (red), 80 to 100 PSI normal (green), 100 PSI maximum (red).

5.1.18. AC voltmeter (24, Figure 5.1)

Back to instrument panel

The AC voltmeter is mounted on the center area of the instrument panel. The AC voltage output from the inverter (main or spare) is indicated on this instrument. The voltage indicated on any of the three selected positions should be 112 to 118 VAC.

5.1.19. Compass slaving switch (25, Figure 5.1)

COMPASS switch – DG / MAG:

DG – providing Free gyro mode, MAG – providing Slaved gyro mode. (see 5.1.9)

5.1.20. DC voltmeter (26, Figure 5.1)

The DC voltmeter is located in the center area of the instrument panel and is labeled VOLT DC. Direct current voltage is indicated on the voltmeter as selected by the VM switch in the overhead console.

5.1.21. Transmission oil temperature indicator (27, Figure 5.1)

Transmission oil temperature: maximum 110°C.

The transmission oil temperature indicator is located in the center area of the instrument panel. The indicator displays the temperature of the transmission oil in degrees Celsius.

The electrical circuit receives power from the essential bus and is protected by the TEMP IND ENG & XMSN circuit breaker in the DC circuit breaker panel. This is a wet bulb system dependent on fluid for valid indication.

Back to instrument panel

5.1.22. Engine oil temperature (28, Figure 5.1)

Back to Engine Instrument and Indicators

The Engine Oil Temperature indicator is located in the center area of the instrument panel and is marked ENGINE OIL. The temperature of the engine oil at the engine oil inlet is indicated in degrees Celsius.

The maximum temperature is 93°C below 30°C FAT, 100°C at 30°C FAT and above.

Power to operate the circuit is supplied from the 28 VDC essential bus. Circuit protection is provided by the TEMP IND ENG & XMSN circuit breaker.

5.1.23. Fuel Quantity Indicator (29, Figure 5.1)

The Fuel Quantity indicator is located in the upper center area of the instrument panel. This instrument continuously indicates the quantity of fuel in pounds. The indicator is connected to three fuel transmitters mounted in the fuel cells. Two are mounted in the right forward cell and one in the center aft cell. Indicator readings shall be multiplied by 100 to obtain fuel quantity in pounds.

Electrical power for operation is supplied from the 115 VAC system and is protected by circuit breaker FUEL QTY in the AC circuit breaker panel.

5.1.24. Exhaust gas temperature indicator (30, Figure 5.1)

Back to instrument panel

Back to Engine Instrument and Indicators

The exhaust gas temperature indicator is located in the center area of the instrument panel and is marked EXH TEMP. The indicator receives temperature indications from the thermocouple probes mounted in the engine exhaust diffuser section. The temperature indications are in degrees celsius. The system is electrically self-generating.

The indicator is marked as follows:

- 400°C to 610°C Continuous (green)
- 610°C to 625°C 30 Minutes (red)
- 625°C maximum 30 Minutes
- 625°C to 675°C 10 Second Limit for Starting and Acceleration
- 675°C to 760°C 5 Second Limit for Starting and Acceleration

- 760°C Maximum gas temperature (red)

5.1.25. Gas Producer Tachometer Indicator (31, Figure 5.1)

The maximum rpm of the gas producer turbine speed is 101.5 percent (red).

Back to Engine Instrument and Indicators

The gas producer indicator is located in the right center area of the instrument panel and is marked RPM GAS PRODUCER. The indicator displays the rpm of the gas producer turbine speed in percent. This system receives power from a tachometer generator which is geared to the engine compressor. A connection to the helicopter electrical system is not required.

5.1.26. Turn and slip indicator (32, Figure 5.1)

Back to instrument panel

The turn and slip indicator displays the helicopter slip condition, direction of turn and rate of turn. The ball displays the slip condition. The pointer displays the direction and rate of the turn.

To maintain coordinated flight, the pilot uses the pointer to maintain heading, while using the anti-torque pedals to counteract any slip and keep the ball centered. Remember, to maintain coordinated flight, "step on the ball."

5.1.27. Torquemeter Indicator (33, Figure 5.1)

Back to Engine Instrument and Indicators

The torquemeter indicator is located in the center area of the instrument panel and is marked OIL PRESS. The indicator is connected to a transmitter which is part of the engine oil system. The torquemeter indicates torque in pounds per square inch (PSI) of torque imposed upon the engine output shaft. The indicator is marked with the maximum torque limit for each engine as reflected by the individual engine Data Plate Torque (50 PSI in this case).

The torquemeter receives power from the 28 VAC bus and is protected by a circuit breaker marked TORQUE in the AC circuit breaker panel.

5.1.28. Marker beacon volume control

Turns the set on/off and adjusts audio signal volume.

5.1.29. Marker beacon sensing switch (35, Figure 5.1)

The marker beacon sensing switch controls the sensitivity of the marker beacon receiver between HIGH and LOW settings.

5.1.30. Cargo release armed light (36, Figure 5.1)

This light illuminates when the CARGO RELEASE switch is set to ARM.

5.1.31. Clock (37, Figure 5.1)

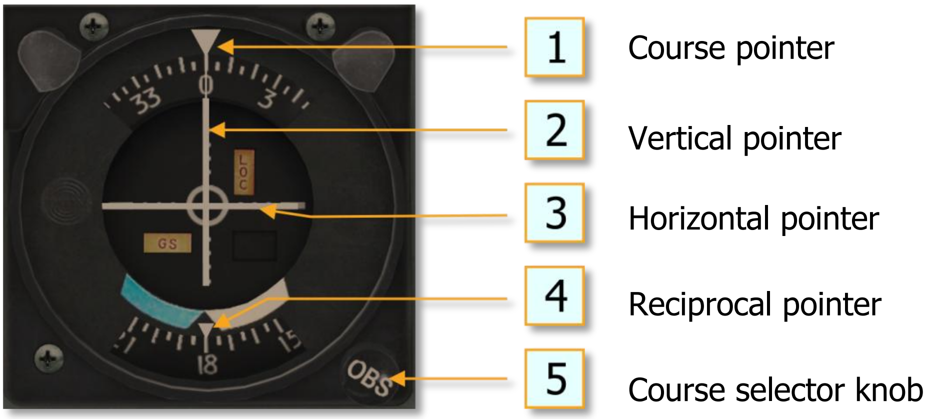
Back to instrument panel

Standard clock. The time can be adjusted by left-clicking over the adjust knob to pull it out and rotating the mouse wheel over it to set the time.

5.1.32. Marker beacon light

The marker beacon light flashes when the marker beacon receiver is operating and the aircraft is passing over a ground marker transmitter.

5.1.33. Course deviation indicator (39, Figure 5.1)



A. Description.

The Navigation Receiver set provides reception on 200 channels, with 50 kHz spacing between 108.0 and 126.95 MHz. This permits reception of the VHF omnidirectional range (VOR) between 108.0 and 117.95 MHz. The Localizers are received on odd-tenth MHz, between 108.0 and 112.0 MHz and energized as selected. Both VOR and Localizer are received aurally through the interphone system. The VOR is presented visually by the course indicator and the number 2 pointer on the bearing indicator and the localizer is presented visually by the vertical needle on the course deviation indicator (CDI). When the R-1963/ARN Glideslope/Marker Beacon Receiver is installed, the glide slope frequency is selected by tuning an associated localizer frequency on the control panel.

B. Controls and Functions.

CONTROL/INDICATOR	FUNCTION
VOL control	Controls receiver audio volume.
Power switch	Turns primary power to the radio set and to the R-1963/ARN Marker Beacon/Glideslope Receiver ON or OFF. Allows for accuracy of Course Deviation Indicators and Marker Beacon indicator lamp in the TEST position.
Whole megahertz channel selector knob	This is the control knob on the left side. It is used to select the whole megahertz number of the desired frequency.
Fractional megahertz channel selector knob	This is the control knob on the right side. It is used to select the fractional megahertz number of the desired frequency.

Back to instrument panel

C. Operation.

(1) Function switch – PWR.

(2) RECEIVERS NAV switch – ON.

(3) Frequency – Select.

(4) VOL – Adjust.

INDICATOR	FUNCTION
OFF vertical	Disappears when FM homing circuits are functioning properly. Remains in view when FM homing circuits are not functioning properly.
OFF horizontal flag	Disappears when homing circuits are functioning properly. Remains in view when FM homing circuits are not functioning properly. NOTE: Do not use if either OFF flag is in view.
Horizontal pointer	Indicates strength of FM homing signal being received. Deflects downward as signal strength decreases.
Vertical (reciprocal) pointer	Indicates when pointer is centered that helicopter is flying directly toward or away from the station. Deflection of the pointer indicates the direction (right or left) to turn to fly to the station.

5.1.34. Standby magnetic compass (40, Figure 5.1)

The standby (magnetic) compass is mounted in a bracket at the center right edge of the instrument panel. A deviation in magnetic compass indications will occur when the landing light, searchlights, or pitot heat are turned on.

Back to instrument panel

5.1.35. Radar Altimeter - AN/APN-209 (not implemented in DCS: UH-1H)

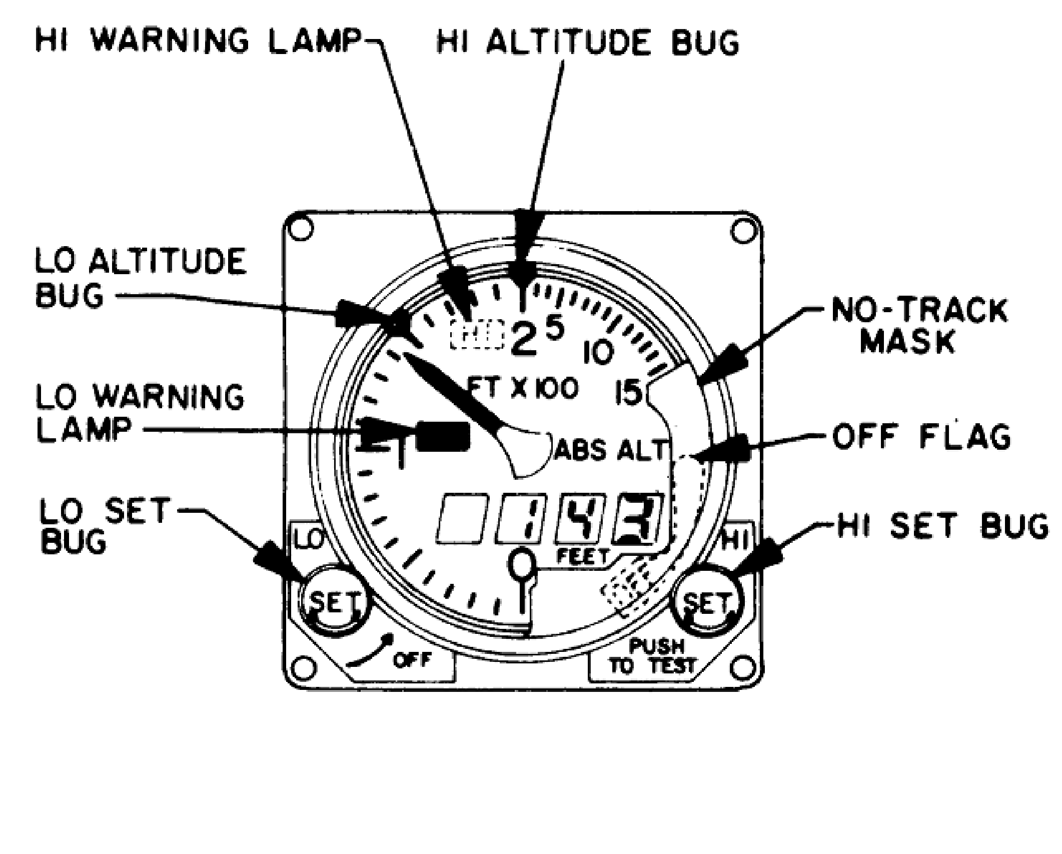


Figure 3-27. AN/APN-209 Radar Altimeter (V)

(Not implemented in DCS: UH-1H)

5.2. Pedestal Control Panels

5.2.1. Miscellaneous Control Panel

Hydraulic Control switch. When set to ON, pressure is supplied to the hydraulic servo system. When set to OFF, the solenoid valve is closed and no pressure is supplied to the servo system.

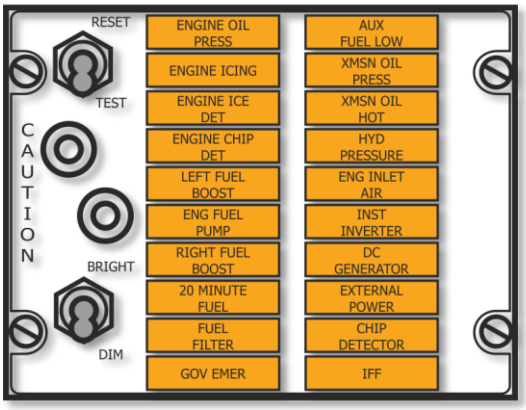
Force Trim switch. Turns the force trim system ON/OFF.

Cable Cut switch. Used for emergency release of the hoist cable.

CHIP DET (DETECTOR) SWITCH. The switch is labeled BOTH, XMSN, and TAIL ROTOR and is spring-loaded to the BOTH position. When the CHIP DETECTOR segment in the caution panel lights up, position the switch to XMSN, then TAIL ROTOR to determine the trouble area. CHIP DET caution light will remain on when a contaminated component is selected. The light will go out if the non-contaminated component is selected.

5.2.2. Caution Lights Panel

The Caution Lights Panel is subsystem of the Master Caution System.



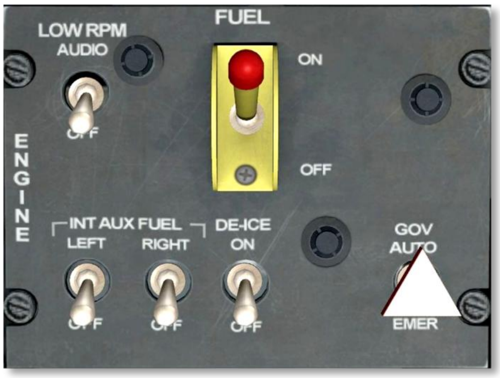
ENGINE OIL PRESS	Engine oil pressure below 25 psi
*ENGINE ICING	Engine Icing detected
*ENGINE ICE DET	Not connected
ENGINE CHIP DET	Metal particle in engine oil
LEFT FUEL BOOST	Left fuel boost pump inoperative
RIGHT FUEL BOOST	Right fuel boost pump inoperative
ENG FUEL PUMP	Engine fuel pump inoperative
20 MINUTE	Fuel quantity about 170 lbs
FUEL FILTER	Fuel filter Impending bypass (not implemented in DCS: UH-1H)
*GOV EMER	Governor switch in emergency position
AUX FUEL LOW	Auxiliary fuel tank empty
XMSN OIL PRESS	Transmission oil pressure below 30 psi
XMSN OIL HOT	Transmission oil temperature above 110°C
HYD PRESSURE	Hydraulic pressure Low
*ENGINE INLET AIR	Engine air filter clogged (not implemented in DCS: UH-1H)
INST INVERTER	Failure of inverter
DC GENERATOR	DC Generator failure
EXTERNAL POWER	External power access door open
CHIP DETECTOR	Metal particles present in 42° or 90° gearbox or main transmission
*IFF	IFF System inoperative

Back to Engine Instrument and Indicators

A. Bright-Dim Switch. The BRIGHT-DIM switch on the CAUTION panel permits the pilot to manually select a bright or dimmed condition for all the individual worded segments and the master caution indicator. The dimming switch position will work only when the pilot instrument lights are on. The master caution system lights will be in bright illumination after each initial application of electrical power, when the pilot instrument lights are turned OFF, or a loss of power from the DC essential bus occurs.

B. Reset-Test Switch. The RESET-TEST switch on the CAUTION panel enables the pilot to manually reset and test the master caution system. Momentarily placing the switch in the RESET position, extinguishes and resets the master caution indicator light so it will again illuminate should another fault condition occur. Momentarily placing the switch in TEST position will cause the illumination of all the individually worded segments and the master caution indicator. Only the lamp circuitry is tested; the condition circuitry is not. Testing of the system will not change any particular combination of fault indications which might exist prior to testing. The worded segments will remain illuminated as long as fault condition or conditions exist, unless the segment is rotated.

5.2.3. Engine Control Panel



Main FUEL switch. The switch is protected from accidental operation by a spring-loaded toggle head that must be pulled up before switch movement can be accomplished. When the switch is in the ON position, the fuel valve opens, the electric boost pump(s) are energized and fuel flows to the engine. When the switch is in the OFF position, the fuel valve closes and the electric boost pump(s) are de-energized (see also 6.1.1).

Electrical power for circuit operation is supplied by the 28 VDC essential bus and is protected by circuit breakers FUEL VALVES, LH BOOST PUMP and RH BOOST PUMP.

LOW RPM AUDIO switch. This switch enables/disables the Low RPM audio warning tone, which operates in conjunction with the Low RPM warning light. When enabled, the audio tone is heard under the following conditions:

a) For rotor rpm of 300-310 and engine rpm of 6100-6300 (Low Warning).

b) Loss of signal (circuit failure) from both rotor tachometer generator and power turbine tachometer generator.

GOV (GOVERNOR) SWITCH. AUTO position permits the overspeed governor to automatically control the engine rpm with the throttle in the full open position. The EMER position permits the pilot or copilot to manually control the rpm (see Engine Fuel Control System). To CAUTION LIGHTS PANEL

The governor circuit receives power from the 28 VDC essential bus and is protected by the GOV CONT circuit breaker.

ENGINE DE-ICE SWITCH. Engine de-ice is a bleed air system. In the ON position, bleed air is directed through the engine inlet to provide protection. Use of this system will result in reduced available engine power. In the event of DC electrical failure or when the DE-ICE ENG circuit breaker is out, de-ice is automatically ON.

System power is provided by the DC essential bus and protected by the ANTI-ICE ENG circuit breaker.

INTERNAL FUEL TRANSFER SWITCHES. (NOT IMPLEMENTED IN DCS: UH-1H) Two switches marked INT AUX FUEL LEFT/RIGHT are mounted on the ENGINE control panel. Placing the switches to the forward position energizes the auxiliary fuel system. Fuel is transferred to the main fuel cells. An overfill limit switch is installed in the main fuel tank to prevent the auxiliary fuel pumps from overfilling the main fuel cells.

Power is supplied by the DC essential bus and protected by the FUEL TRANS PUMP circuit breaker.

5.3. Overhead Console

The location of the controls and circuit breakers installed in the overhead console is depicted in Figure 5.4.

Figure 5.4. Overhead Console.

NOTES

6 HELICOPTER SYSTEMS

6. HELICOPTER SYSTEMS

6.1. Helicopter fuel system

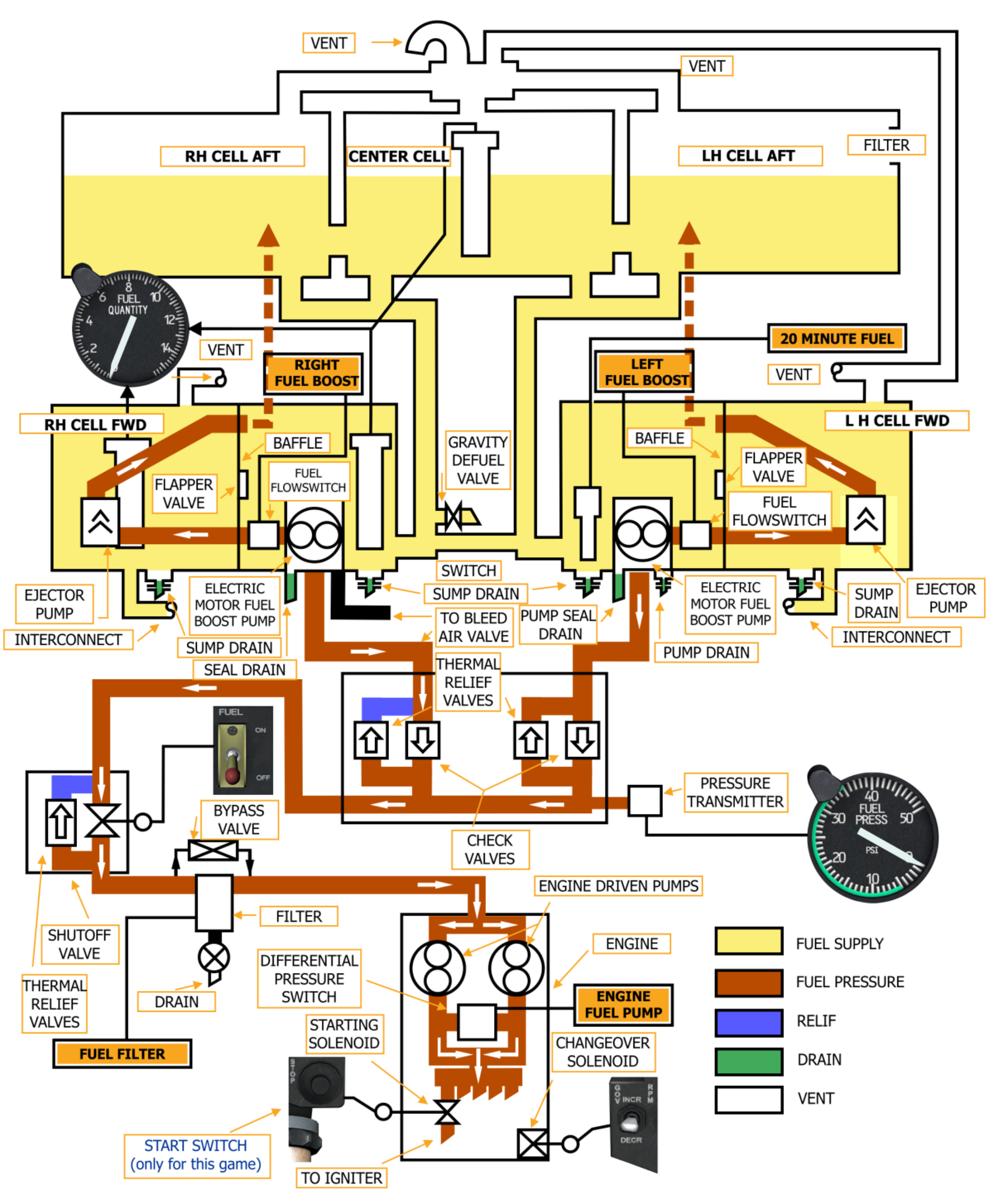


Figure 6.1. Fuel system schematic.

6.1.1. Controls and Indicators

A. Fuel Switches. The fuel system switches consist of a main fuel switch:

a) Main Fuel Switch. The FUEL MAIN ON/OFF switch is located on the pedestal-mounted ENGINE panel. The switch is protected from accidental operation by a spring-loaded toggle head that must be pulled up before switch movement can be accomplished. When the switch is in the ON position, the fuel valve opens, the electric boost pump(s) are energized and fuel flows to the engine. When the switch is in the OFF position, the fuel valve closes and the electric boost pump(s) are de-energized. Electrical power for circuit operation is supplied by the 28 VDC essential bus and is protected by circuit breakers FUEL VALVES, LH BOOST PUMP and RH BOOST PUMP.

b) Fuel Control. Fuel flow and mode of operation is controlled by switches on the pedestal-mounted engine control panel. The panel contains the MAIN FUEL ON/OFF and GOV AUTO/EMER switch. The switch over to emergency mode is accomplished by retarding the throttle to idle or off position and positioning the GOV AUTO/EMER switch to the EMER position. In the EMER position fuel is manually metered to the engine, with no automatic control features, by rotating the throttle twist grip.

B. Fuel Quantity Indicator. The fuel quantity indicator is located in the upper center area of the instrument panel. This instrument is a transistorized electrical receiver which continuously indicates the quantity of fuel in pounds. The indicator is connected to three fuel transmitters mounted in the fuel cells. Two are mounted in the right forward cell and one in the center aft cell. Indicator readings shall be multiplied by 100 to obtain fuel quantity in pounds. Electrical power for operation is supplied from the 115 VAC system and is protected by circuit breaker FUEL QTY in the AC circuit breaker panel.

C. Fuel Gauge Test Switch. The FUEL GAUGE TEST switch (7, Figure 5.1) is used to test the fuel quantity indicator operation. Pressing the switch will cause the indicator pointer to move from the actual reading to a lesser reading. Releasing the switch will cause the pointer to return to the actual reading. The circuit receives power from the 115 VAC system and is protected by a circuit breaker marked FUEL QTY in the AC circuit breaker panel.

D. Fuel Pressure Indicator. The fuel pressure indicator displays the PSI pressure of the fuel being delivered by the boost pumps from the fuel cells to the engine. The circuit receives power from the 28 VAC bus and is protected by the FUEL PRESSURE circuit breaker in the AC circuit breaker panel.

E. Fuel Quantity Low caution Light. The 20 MINUTE FUEL caution light will illuminate when there is approximately 185 (130 to 240) pounds remaining. The illumination of this light does not mean a fixed time period remains before fuel exhaustion, but is an indication that a low fuel condition exists. Electrical power is supplied from the 28 VDC essential bus. The CAUTION LIGHTS circuit breaker protects the circuit.

F. Fuel Boost Pump Caution lights. The LEFT FUEL BOOST and RIGHT FUEL BOOST caution lights will illuminate when the left/right fuel boost pumps fail to pump fuel. The circuits receive power from the 28 VDC essential bus. Circuit protection is provided by the CAUTION LIGHTS, RH FUEL BOOST PUMP and LH FUEL BOOST PUMP circuit breakers.

6.1.2. Auxiliary Fuel System (Not implemented in DCS: UH-1H)

Complete provisions have been made for installing an auxiliary fuel equipment kit in the helicopter cargo passenger compartment. Two crashworthy bladder type tanks can be installed on the aft bulkhead and transmission support structure. This allows the helicopter to be serviced with an additional 300 U.S. gallons of fuel.

A. Internal Fuel Transfer Switches. Two switches marked INT AUX FUEL LEFT/RIGHT are mounted in the ENGINE control panel. Placing the switches to the forward position energizes the auxiliary fuel system. Fuel is transferred to the main fuel cells. An overfill limit switch is installed in the main fuel tank to prevent the auxiliary fuel pumps from overfilling the main fuel cells. Power is supplied by the DC essential bus and protected by the FUEL TRANS PUMP circuit breaker.

B. Auxiliary Fuel Low Caution light. An AUX FUEL LOW caution light is provided to indicate when the auxiliary fuel tanks are empty. The light will illuminate only when the fuel transfer switches are in the forward position, and the auxiliary tanks are empty. The circuit receives power from the 28 VDC essential bus and is protected by the CAUTION LIGHTS circuit breaker.

6.2. Electrical system

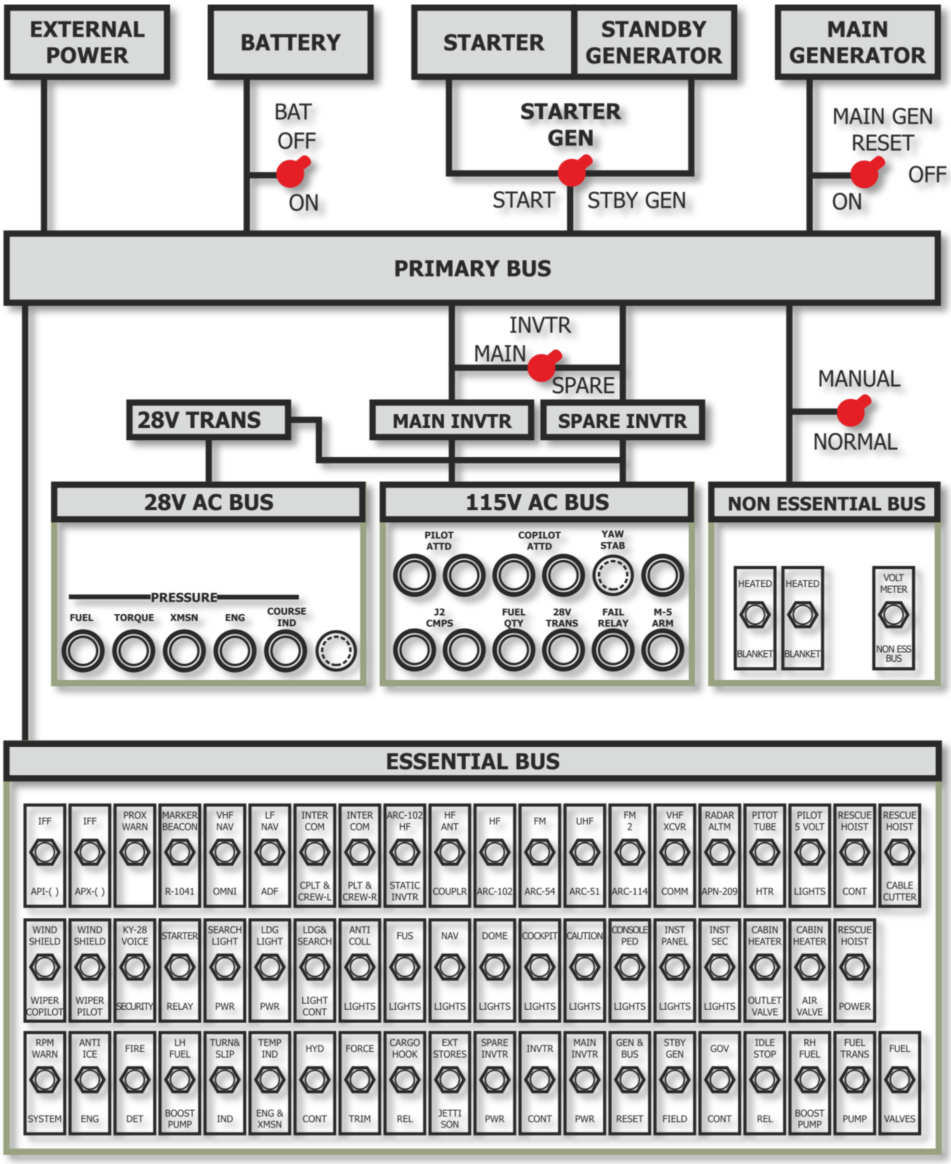


Figure 6.2. Electrical system schematic.

6.2.1. DC and AC Power Distribution

Figure 6.2.. Figure 6.4 depicts the general schematic of the DC and AC power distribution system. The DC power is supplied by the battery, main generator, standby starter-generator, or the external power receptacle. The 115 VAC power is supplied by the main or spare inverters. The 28 VAC power is supplied by a transformer which is powered by the inverter.

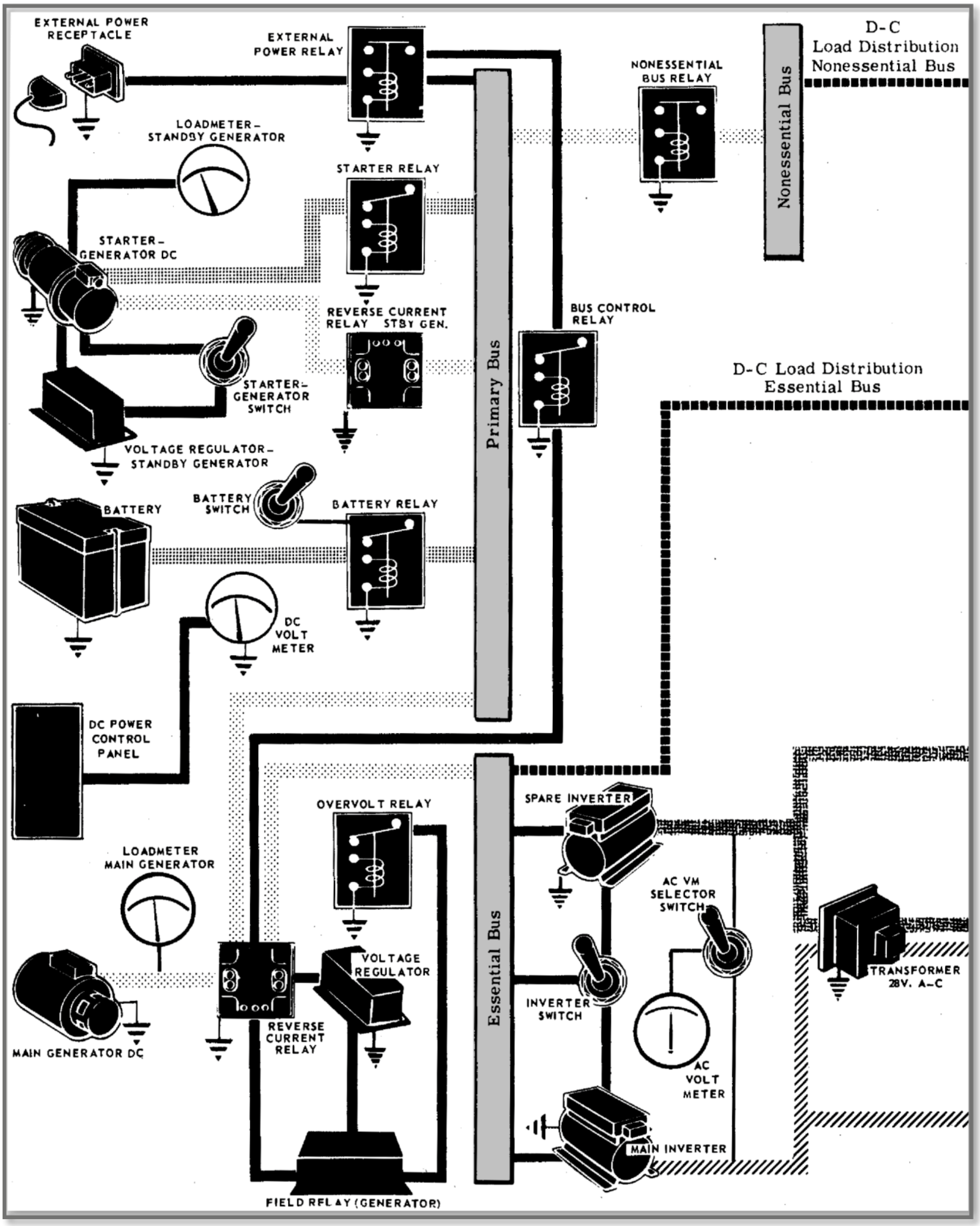


Figure 6.3. Electrical Schematic Diagram.

28 VOLT DC ESSENTIAL BUS

- Generator & Bus Reset
- Main Inverter Power
- Inverter Control
- Spare Inverter Power
- Starter Relay
- Ignition System & Ignition Solenoid
- Fuel & Oil Valves
- Left Fuel Boost Pump
- Right Fuel Boost Pump & Transfer Pump
- Idle Stop Release (not implemented in DCS: UH-1H)
- Governor Control
- Cargo Hook Release (not implemented in DCS: UH-1H)
- Fire Detection
- Windshield Wiper
- Engine Anti-Ice
- Utility Lights
- Dome Lights
- Force Trim
- Hydraulic Control
- Instrument Section Lights
- Turn & Slip Indicator
- Instrument Panel Lights
- Temperature Indicator - Engine & Transmission
- Console & Pedestal Lights
- Navigation Lights
- Caution Lights
- Anti-Collision Light
- Landing Light Power
- Search Light Power
- Landing & Search Light Control
- AN/APX-72 transponder set (not implemented in DCS: UH-1H)
- VHF Receiver AN/ARC-134
- VHF Transmitter AN/ARC-134
- UHF Transceiver AN/ARC-51BX
- FM Transceiver AN/ARC-131
- Intercom C-1611/AIC
- J-2 Compass
- Bleed Air
- Heater Control
- Heater Power
- Radio Compass Receiver AN/ARN-83
- Omni Receiver AN/ARN-82
- Marker Beacon Receiver R-1963/ARN
- Pitot Tube Heater

115 VOLT AC MAIN INVERTER

- AC Failure Relay
- Fuel Quantity Indicator & Tank Unit
- Attitude Indicator - Pilot
- Attitude Indicator - Copilot
- J-2 Compass

115 VOLT AC SPARE INVERTER

- AC Failure Relay
- Fuel Quantity Indicator & Tank Unit
- Attitude Indicator - Pilot
- Attitude Indicator - Copilot
- J-2 Compass

28 VOLT AC

- Course Indicator
- Torque Pressure Instruments
- Transmission Oil Pressure Transmitter & Indicator
- Engine Oil Pressure Transmitter & Indicator
- Fuel Pressure Transmitter & Indicator

28 VOLT DC NON ESSENTIAL BUS

- Non Essential Bus Voltmeter
- Heated Blankets

Figure 6.4. DC and AC Power Distribution Diagram.

6.2.2. DC Power Supply System

The DC power supply system is a single conductor system with the negative leads of the generator grounded in the helicopter fuselage structure. The main generator voltage will vary from 27 to 28.5 depending on the average ambient temperature. In the event of a generator failure the nonessential bus is automatically de-energized. The pilot may override the automatic action by positioning the NON-ESS BUS switch on the DC POWER control panel to MANUAL ON.

6.2.3. DC Power Indicators and Controls

Figure 6.5. Overhead console AC and DC POWER panel.

A. Main Generator Switch The MAIN GEN switch (Figure 6.5) is on the overhead console DC POWER panel. In the ON position the main generator supplies power to the distribution system. The RESET position is springloaded to the OFF position. Momentarily holding the switch to RESET position will reset the main generator. The OFF position isolates the generator from the system. The circuit is protected by the GEN & BUS RESET in the DC circuit breaker panel.

B. Battery Switch The BAT switch is located on the DC POWER control panel. ON position permits the battery to supply power and also to be charged by the generator. The OFF position isolates the battery from the system.

C. Starter-Generator Switch The STARTER GEN switch is located on the DC POWER control panel. The START position permits the starter-generator to function as a starter. The STBY GEN position permits the starter-generator to function as a generator.

D. Nonessential Bus Switch. The NON-ESS BUS switch is located on the DC POWER control panel. The NORMAL ON position permits the nonessential bus to receive DC power from the main generator. MANUAL ON position permits the nonessential bus to receive power from the standby generator when the main generator is off line.

E. DC Voltmeter Selector Switch The VM switch is located on the DC POWER control panel. The switch permits monitoring of voltage being delivered from any of the following; BAT, MAIN GEN, STBY GEN, ESS BUS, and NON-ESS BUS.

F. DC Voltmeter. The DC voltmeter is located in the center area of the instrument panel and is labeled VOLT DC. Direct current voltage is indicated on the voltmeter as selected by the VM switch in the overhead console.

G. DC Loadmeters-Main and Standby. Two direct current loadmeters are mounted in the lower center area of the instrument panel. The MAIN GEN loadmeter indicates the percentage of main generator rated capacity being used. The STBY GEN loadmeter indicates the percentage of standby generator rated capacity being used. The loadmeters will not indicate percentage when the generators are not operating.

H. DC Circuit Breaker Panel. The DC circuit breaker panel is located in the overhead console. In the "pushed in" position the circuit breakers provide circuit protection for DC equipment. In the "pulled out" position the circuit breakers deenergize the circuit. In the event of an overload the circuit breaker protecting that circuit will "pop out". Each breaker is labeled for the particular circuit it protects. Each applicable breaker is listed in the paragraph descanting the equipment it protects.

6.2.4. AC Power Supply System

Alternating current is supplied by two inverters (Figure 6.2). They receive power from the essential bus and are controlled from the AC POWER control panel (Figure 6.5).

Inverters. Either the main or spare inverter (at the pilots option) will supply the necessary 115 VAC to the distribution system. The inverters also supply 115 VAC to the 28 Volt AC transformer which in turn supplies 28 VAC to the necessary equipment. Circuit protection for the inverters is provided by the MAIN INVTR PWR and SPARE INVTR PWR circuit breakers.

6.2.5. AC Power Indicators and Controls

A. Inverter Switch. The INVTR switch is located on the AC POWER control panel in the overhead console. The switch is normally in the MAIN ON position, to energize the main inverter. In the event of a main inverter failure, the switch can be positioned to SPARE ON to energize the spare inverter. Electrical power to the INVTR switch is supplied from the essential bus. Circuit protection is provided by the INVTR CONT circuit breaker.

B. AC Failure Caution Light. The INST INVERTER caution light will illuminate when the inverter in use fails or when the INVTR switch is in the OFF position.

C. AC Voltmeter Selector Switch. The AC PHASE VM switch is located on the AC POWER control panel. The switch is used to select any one of the three phases of the 115 VAC three-phase current for monitoring on the AC voltmeter. The three positions on the switch are: AB, AC, and BC. Each position indicates that respective phase of the 115 VAC on the AC voltmeter.

D. AC VOLTMETER. The AC voltmeter is mounted on the center area of the instrument panel (Figure 5.1). The AC voltage output from the inverter (main or spare) is indicated on this instrument. The voltage indicated on any of the three selected positions should be 112 to 118 VAC.

E. AC CIRCUIT BREAKER PANEL. The AC circuit breaker panel is located on the right side of the pedestal panel. The circuit breakers in the "pushed in" position provide circuit protection for the equipment. The breakers in the "pulled out" position de-energize the circuit. The breakers will pop out automatically in the event of a circuit overload. Each breaker is labeled for the particular circuit it protects. Each applicable breaker is listed in the paragraph describing the equipment it protects.

6.3. Hydraulic system

DESCRIPTION. The hydraulic system is used to minimize the force required by the pilot to move the cyclic, collective and pedal controls. A hydraulic pump, mounted on and driven by the transmission supplies pressure to the hydraulic servos. The hydraulic servos are connected into the mechanical linkage of the helicopter flight control system. Movement of the controls in any direction causes a valve, in the appropriate system, to open and admit hydraulic pressure which actuates the cylinder, thereby reducing the force-load required for control movement. Irreversible valves are installed on the cyclic and collective hydraulic servo cylinders to prevent main rotor feedback to the cyclic and collective in the event of hydraulic system malfunction.

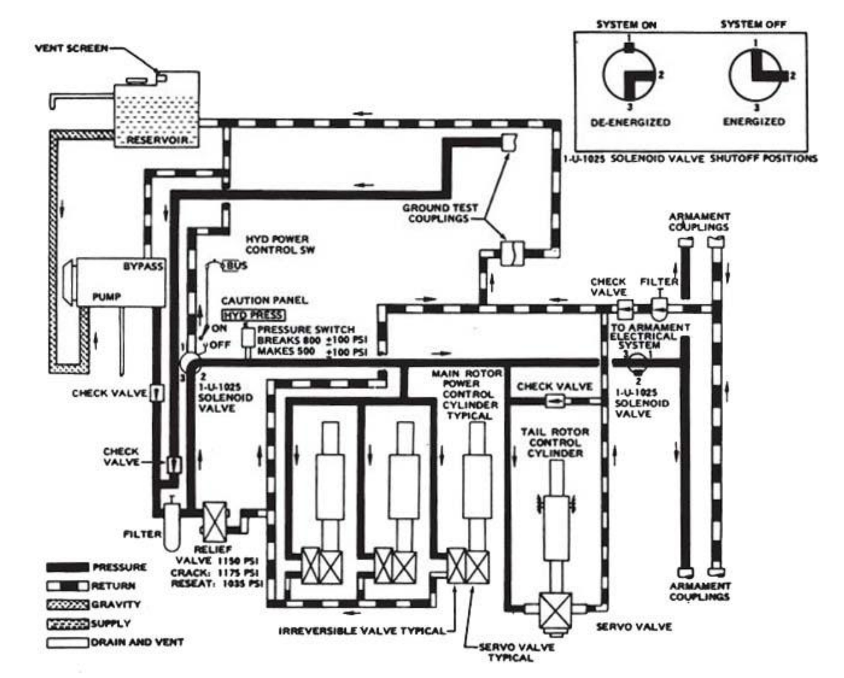


Figure 6.6. Hydraulic system schematic.

CONTROL SWITCH. The hydraulic control switch is located on the miscellaneous panel. The switch is a two-position toggle type labeled HYD CONTROL ON/OFF. When the switch is in the ON position, pressure is supplied to the servo system.

When the switch is in the OFF position, the solenoid valve is closed and no pressure is supplied to the system. The switch is a fail-safe type. Electrical power is required to turn the switch off.

HYDRAULIC PRESSURE CAUTION LIGHT. Low hydraulic system pressure will be indicated by the illumination of HYD PRESSURE segment on the caution panel. Moderate feedback forces will be noticed in the controls when moved.

Electrical power for hydraulic system control is supplied by the 28 VDC essential bus. The circuit is protected by the HYD CONT circuit breaker.

6.4. DE-ICE

Engine de-ice is a bleed air system activated by the DE-ICE switch on the ENGINE control panel. In the ON position bleed air is directed through the engine inlet to provide the protection. Power losses caused when the system is on (auto increase rpm gas producer at 3..5%). In the event of DC electrical failure or when the DE-ICE ENG circuit breaker is out, de-ice is automatically ON. System power is provided by the DC essential bus and protected by the ANTI-ICE ENG circuit breaker.

6.5. Game autopilot

Note. To simplify the use of helicopter-carried weapons when occupying other crew members' positions (copilot, door gunners), helicopter is under control of a virtual pilot. This mode is implemented as an autopilot. The game autopilot has three operation modes: ATTITUDE HOLD, LEVEL FLIGHT, ORBIT.

ATTITUDE HOLD – autopilot maintains all flight parameters that have been established right before turning on the autopilot (roll, pitch, direction, without stabilization of altitude and speed);

LEVEL FLIGHT – autopilot maintains speed, direction and altitude. If on autopilot start time there was non-zero bank angle, it gets reduced to zero;

ORBIT – autopilot maintains constant turns with a roll of 13° at a constant speed without descending. If on autopilot start time there was a greater bank angle – it gets reduced down to 13°. If existing speed does not allow for such turn without descend, then speed gets lowered to the maximum speed at which the helicopter flies without descending.

DCS: UH-1H includes a special weapon systems and autopilot status indicator on the right side of the screen to help quickly assess the status of your weapon systems and autopilot modes, as well as get quick hints of the keyboard commands required to operate them. The display can be turned on and off by pressing [LCTRL+LSHIFT+H]. See Figure 6.7, Figure 6.8.

Figure 6.7. Location of autopilot and weapon status indicators on screen.

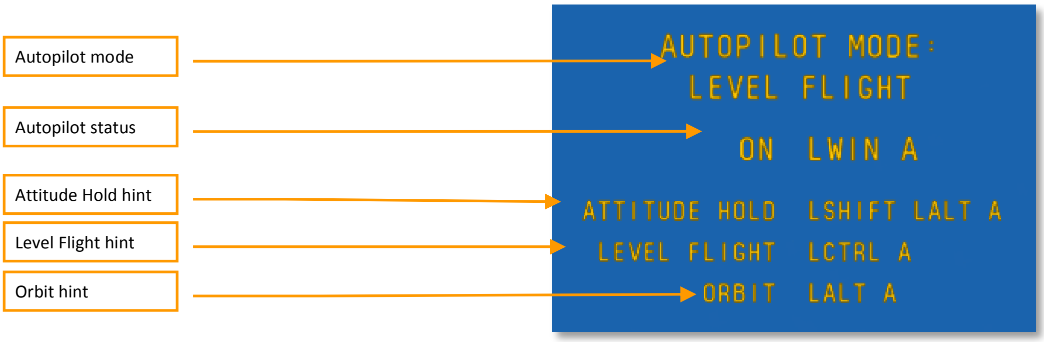


Figure 6.8. Autopilot status indicator

Autopilot mode.	Displays the currently selected autopilot mode (ATTITUDE HOLD/LEVEL FLIGHT/ORBIT).
Autopilot status.	Displays the status of the autopilot (ON/OFF) and the default keyboard command used to change it.
Attitude Hold hint.	Displays the default keyboard commands used to selected ATTITUDE HOLD autopilot mode.
Level Flight hint.	Displays the default keyboard commands used to selected LEVEL FLIGHT autopilot mode.
Orbit hint.	Displays the default keyboard commands used to selected ORBIT autopilot mode.

When autopilot is ON, a white mark indicates the position of the autopilot's control stick (virtual second pilot), see Figure 6.9.

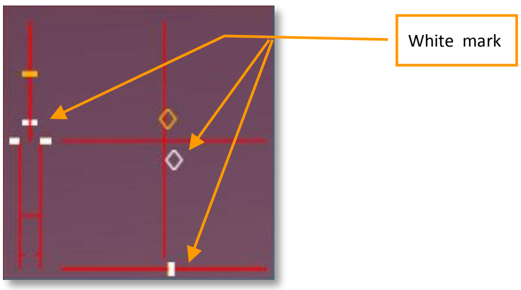


Figure 6.9 Indication of autopilot's control stick position.

NOTES

7 RADIO COMMUNICATIONS & NAVIGATION EQUIPMENT

7. RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT

7.1. Radio communications equipment

The radio communications equipment of the UH-1H includes:

- C-1611/AIC Signal Distribution Panel
- AN/ARC-51BX UHF Radio Set
- AN/ARC-134 VHF Radio Set
- AN/ARC-131 FM Radio Set
- AN/APX-72 Transponder Set

7.1.1. C-1611/AIC Signal Distribution Panel

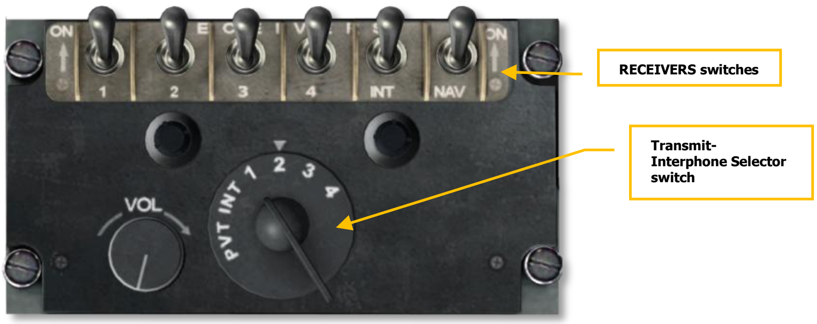


Figure 7.1.1. C-1611/AIC Signal Distribution Panel

A. Description

The Signal Distribution Panel amplifies and controls the distribution of audio signals applied to or from each headset-microphone, to or from communication receivers and transmitters, from navigation receivers, intercommunication between crewmembers, and for monitoring the communication and navigation receivers singly or in combination. In addition the C-1611/AIC panel permits the operator to control four receiver-transmitters. A private interphone line is also provided.

When the selector switch is in the PVT (private) position, it provides a hot line (no external switch is used) to any station in the helicopter which also has PVT selected. A HOT MIC switch is also provided on the C-1611/AIC control panel at the medical attendant's station to permit hand-free intercommunications with Transmit-Interphone Selector in any position. Up to four C-1611/AIC units may be installed. One each of the units are installed for the pilot and copilot, and two are installed in the crew/passenger compartment of the crew. All four of the C-1611/AIC units are wired to provide interphone operations for the crew, and full transmit and receive facilities for all communication and navigation equipment.

B. Operation

(1) Transmit interphone selector switch – as desired.

(2) RECEIVERS switches – as desired.

(3) Microphone switches – as desired.

(4) VOL control – Adjust.

CONTROL	FUNCTION
RECEIVERS switches: 1 (FM) – AN/ARC-131 FM radio set 2 (UHF) – AN/ARC-51BX UHF radio set 3 (VHF) – AN/ARC-134 VHF radio set 4 (#2 FM/HF)	Turns audio from associated receiver ON or OFF. *IN GAME POSITION "2" IS DEFAULT*
INT switch	ON position enables operator to hear audio from the interphone.
NAV switch	ON position enables operator to monitor audio from the navigation receiver.
VOL control	Adjusts audio on receivers except NAV receivers.
Transmit-interphone selector switch	Positions 1 (FM), 2 (UHF), 3 (VHF), 4 (#2 FM/HF) and INT permits INT or selected receiver-transmitter to transmit and receive. The cyclic stick switch or foot switch must be used to transmit. PVT position keys interphone for transmission.

7.1.2. AN/ARC-51BX UHF Radio Set

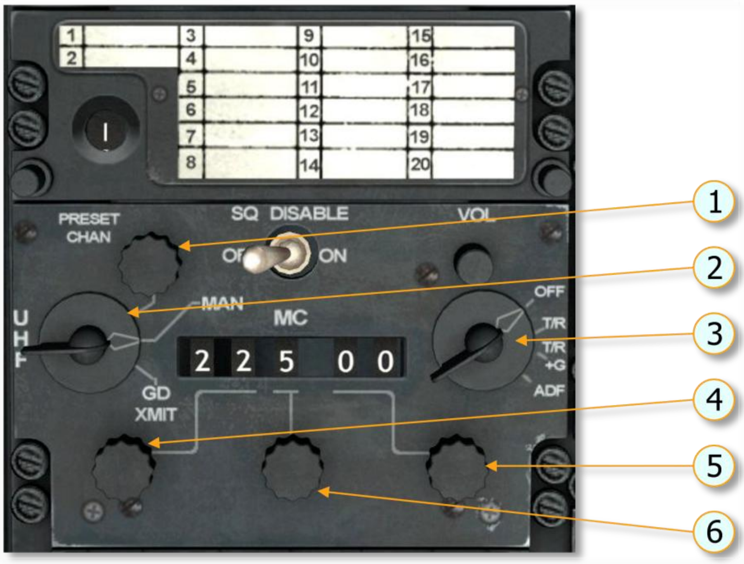


Figure 7.2.2 UHF Control Panel C-6287/ARC-51BX

1. Preset channel control
2. Mode selector
3. Function select switch
4. 10 Megahertz control
5. 0.05 Megahertz control
6. 1 Megahertz control

A. Description

The Radio Set provides two way communications in the UHF (225.0 to 399.9 MHz) band. The set located at the left side of the pedestal, tunes in 0.05 MHz increments and provides 3500 channels. The set also permits 20 preset channels and monitoring of the guard channel. Transmission and reception are conducted on the same frequency.

B. Operation

(1) UHF function select switch – T/R (T/R+G as desired).

(2) UHF mode selector switch – PRESET CHAN.

(3) RECEIVERS switch No. 2 – ON.

(4) Channel – Select.

NOTE. An 800-cps audio tone should be heard during channel changing cycle.

(5) SQ DISABLE switch – OFF.

(6) VOL – Adjust.

(7) Transmit-interphone selector switch – No. 2 position.

C. Emergency Operation

(1) UHF mode switch – GD XMIT.

(2) UHF function switch – T/R+G.

CONTROL/INDICATOR	FUNCTION
Function select switch	Applies power to radio set and selects type of operation as follows: OFF position - Removes operating power from the set. T/R position - Transmitter and main receiver ON. T/R + G position - Transmitter, main receiver and guard receiver ON. ADF position – Energizes the UHF-DF system when installed.
VOL control	Controls the receiver audio volume.
SQ DISABLE switch	In the ON position, squelch is disabled. In the OFF position, the squelch is operative.
Mode Selector	Determines the manner in which the frequencies are selected as follows: PRESET CHAN position – Permits selection of one of 20 preset channels by means of preset channel control. MAN position – Permits frequency selection by means of megacycle controls. GD XMIT position – Receiver-transmitter automatically tunes to guard channel frequency (243.00 MHz).
Preset channel control	Permits selection of any one of 20 preset channels.
Preset channel indicator	Indicates the preset channel selected by the preset channel control.
Ten Megahertz control	Sets the first two digits (or ten-megahertz number).
One Megahertz control	Sets the third digit (or one-megahertz number).
Five-hundredths Megahertz control	Sets the fourth and fifth digits (or 0.05 megahertz number).

7.1.3. AN/ARC-134 VHF Radio Set

Figure 7.1.3 VHF Control Panel C-7197/ARC-134

1. Frequency indicator
2. Communication test switch
3. Off/power switch
4. Volume control
5. Kilohertz selector
6. Megahertz selector

A. Description

The AN/ARC-134 VHF radio set transmits and receives on the same frequency. The panel (labeled VHF COMM) is located on the left side of the pedestal. The set provides voice communications in the VHF range of 116.000 through 149.975 MHz on 1360 channels spaced 25 kHz apart.

B. Operation

(1) OFF/PWR switch – PWR. Allow set to warm up.

(2) Frequency – set as desired.

(3) RECEIVERS switch No. 3 – ON.

(4) Volume – adjust as desired. If signal is not audible with VOL control fully clockwise, press COMM TEST switch to unsquelch circuits.

(5) Transmit-interphone selector switch – No. 3 position.

(6) OFF/PWR switch – OFF.

C. Emergency Operation

Select guard frequency (121.500 MHz).

CONTROL/INDICATOR	**FUNCTION**
OFF/PWR switch	Turns power to the set ON or OFF.
VOL control	Controls the receiver audio volume.
COMM-TEST switch	Turns squelch on or off.
Megahertz control	Selects the whole number part of the operating frequency.
Kilohertz control	Selects the decimal number part of the operating frequency.

7.1.4. AN/ARC-131 FM Radio Set

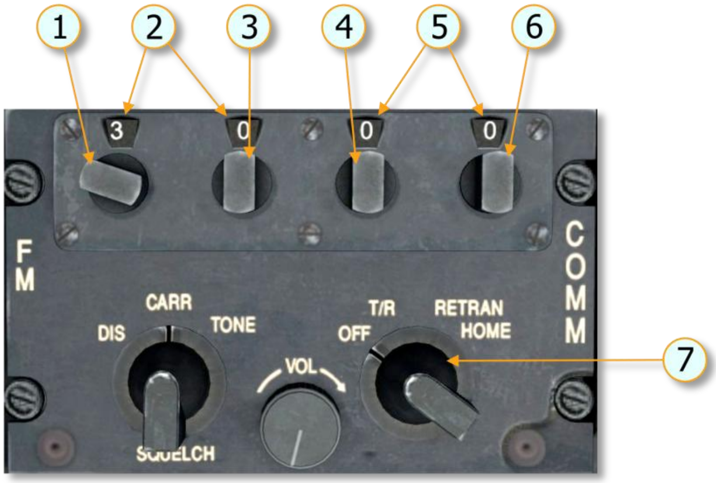


Figure 7.1.4 FM Radio Set Control Panel AN/ARC-131

1. Tens megahertz digit frequency selector
2. Frequency indicators
3. Units megahertz digit frequency selector
4. Tenths megahertz digit frequency selector
5. Frequency indicators
6. Hundredths megahertz digit frequency selector
7. Mode control switch

A. Description

The FM radio set consists of a receiver-transmitter, remote control panel unit, communication antenna and a homing antenna. The radio set provides 920 channels spaced 50 kHz apart within a frequency range of 30.00 to 75.95 MHz. Circuits are included to provide transmission sidetone monitoring. The control panel is located on the pedestal. Homing data is displayed by the course indicator on the instrument panel. A channel changing tone should be heard in the headset while the radio set is tuning. When the tone stops, the radio set is tuned. Operation in DIS position is possible; however flags on the course deviation indicator will be inoperative. When the first FM radio set is in the homing mode, the homing indicator may deflect left or right of on course indication while the second FM radio set is keyed.

B. Operation

Depending on the settings of the control panel controls, the radio set can be used for the following types of operation: two-way voice communication and homing.

Two Way Voice Communication.

(1) Mode control switch – T/R (allow two minute warm up).

(2) Frequency – Select.

(3) RECEIVERS No. 1 switch – ON.

(4) VOL control – Adjust.

(5) SQUELCH control – Set for desired squelch mode.

(6) TRANS selector switch – No. 1.

HOMING OPERATION.

(1) Mode control switch – HOME.

(2) Frequency – Adjust to frequency of selected homing station.

(3) SQUELCH control may be set to CARR or TONE, however, the carrier squelch is automatically selected by an internal contact arrangement on HOME position.

(4) Fly helicopter toward the homing station by heading in direction that causes homing course deviation indicator right-left vertical pointer to position itself in the center of the indicator scale. To ensure that the helicopter is not heading away from the homing station, change the heading slightly and note that the course deviation indicator vertical pointer deflects in direction opposite that of the turn.

C. Retransmit Operation

Start the equipment and proceed as follows for retransmit operation:

(1) Mode controls (both control units) – RETRAN.

(2) SQUELCH controls (both control units) – Set as required. Do not attempt retransmit operation with SQUELCH controls set to DIS. Both controls must be set to CARR or TONE. To operate satisfactorily, the two radio sets must be tuned to frequencies at least 3 MHz apart.

(3) Frequency adjust (both control units) for the desired operation.

D. Stopping Procedure

Mode control switch – OFF.

CONTROL/INDICATOR	FUNCTION
Mode control switch (four-position switch)	
OFF	Turns off primary power.
T/R (transmit/receive)	Radio set operates in normal communication mode (reception). (Aircraft transmit switch must be depressed to transmit.)
RETRAN (retransmit)	Radio set operates as a two-way relay station. (Two radio sets are required set at least 3 MHz apart.)
HOME	Radio set operates as a homing facility. (Requires a homing antenna and indicator.)
VOL control	Adjusts the audio output level of the radio set.
SQUELCH switch (three-position rotary switch)	
DIS (disable)	Squelch circuits are disabled.
CARR (carrier)	Squelch circuits operate normally in presence of any carrier.
TONE	Squelch opens (unsquelches) only on selected signals

	(signals containing a 150-cps tone modulation).
Frequency indicator	
Tens megahertz frequency selector	Selects the tens megahertz digit of the operating frequency.
Units megahertz frequency selector	Selects the units megahertz digit of the operating frequency.
Tenths megahertz frequency selector	Selects the tenths megahertz digit of the operating frequency.
Hundredths megahertz frequency selector	Selects the hundredths megahertz digit of the operating frequency.
Frequency indicator	Displays the operating frequency of the radio set.

7.1.5. AN/APX-72 Transponder Set (not implemented in DCS: UH-1H)

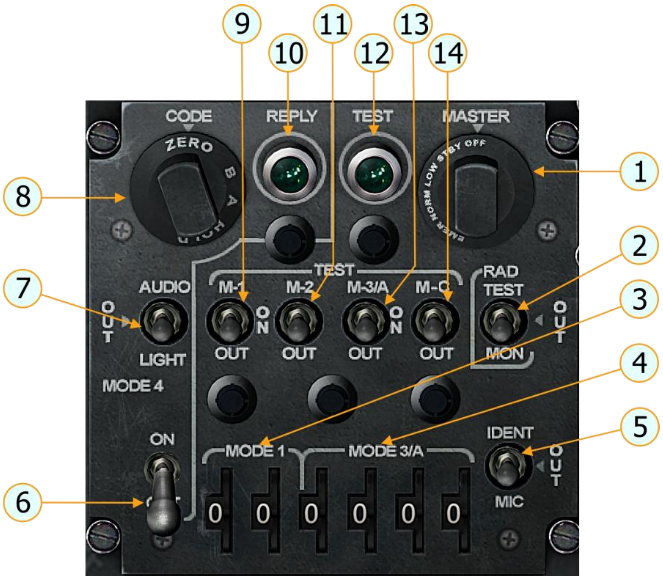


Figure 7.1.5 AN/APX-72 Transponder Set

The AN/APX-72 provides radar identification capability.
This system is not modeled in DCS: UH-1H.

7.2. Radio Navigation Equipment

The radio navigation equipment of the UH-1H includes:

- AN/ARN-82 VHF Navigation Set
- AN/ARN-83 ADF Set
- ID-998/ASN Radio Magnetic Indicator (RMI)
- ID-1347/ARN-82 Course Deviation Indicator (CDI)

7.2.1. AN/ARN-82 VHF Navigation Set

Figure 7.2.1 Navigation Control Panel AN/ARN-82

A. Description

The Navigation Receiver set provides reception on 200 channels, with 50 kHz spacing between 108.0 and 126.95 MHz. This permits reception of the VHF omnidirectional range (VOR) between 108.0 and 117.95 MHz. The Vocalizers are received on odd-tenth MHz, between 108.0 and 112.0 MHz and energized as selected. Both VOR and localizer are received aurally through the interphone system. The VOR is presented visually by the course indicator and the number 2 pointer on the bearing indicator and the localizer is presented visually by the vertical needle on the CDI. When the R-1963/ARN Glideslope/Marker Beacon Receiver is installed, the glideslope frequency is selected by tuning an associated localizer frequency on the control panel.

B. Operation

(1) Function switch – PWR.

(2) RECEIVERS NAV switch – ON.

(3) Frequency – Select.

(4) VOL – Adjust.

CONTROL/INDICATOR	FUNCTION
VOL control	Controls receiver audio volume.
Power switch	Turns primary power to the radio set and to the R-1963/ARN Marker Beacon/Glideslope Receiver ON or OFF. Allows for accuracy of Course Deviation Indicators and Marker Beacon Indicator lamp in the TEST position.
Whole megahertz channel selector knob	This is the control knob on the left side. It is used to select the whole megahertz number of the desired frequency.
Fractional megahertz channel selector knob	This is the control knob on the right side. It is used to select the fractional megahertz number of the desired frequency.

7.2.2. AN/ARN-83 ADF Set

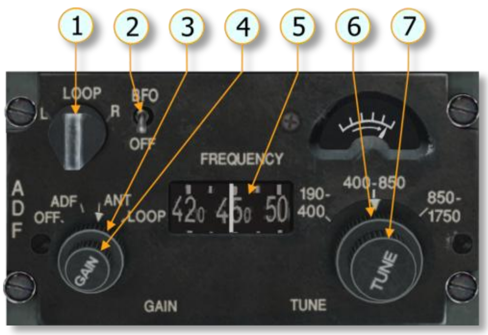


Figure 7.2.2. Direction Finder Control Panel ARN-83

1. Loop L/R switch
2. BFO switch
3. Mode selector switch
4. GAIN control
5. Frequency dial
6. Band selector switch
7. TUNE control Tuning meter

A. Description

The Automatic Direction Finder set provides radio aid to navigation within the 190 to 1750 kHz frequency range. In automatic operation, the set presents continuous bearing information to any selected radio station and simultaneously provides aural reception of the station's transmission. In manual operation, the operator determines the bearing to any selected radio station by controlling the aural null of the directional antenna. The set may also be operated as a receiver.

B. Operation

a) Automatic Operation.

(1) RECEIVERS NAV switch – ON.

(2) Mode selector switch – ADF.

(3) Frequency – Select.

(4) Volume – Adjust.

b) Manual Operation.

(1) Mode selector switch – LOOP.

(2) BFO switch – ON.

(3) LOOP L/R switch – Press right or left and rotate loop for null.

CONTROL/INDICATOR	FUNCTION
Band selector switch	Selects the desired frequency band.
TUNE control	Selects the desired frequency.
Tuning meter	Facilitates accurate tuning of the receiver.
GAIN control	Controls receiver audio volume.
Mode selector switch	Turns set OFF and selects ADF, ANT and LOOP modes of operation.
LOOP L/R switch	Controls rotation of loop left or right.
BFO switch	Turns BFO on or off.

8 ARMAMENT

8. ARMAMENT

The armament system of the DCS: UH-1H consists of the M23 and M21 subsystems. This chapter includes description of armament subsystems. See also chapter 10 for COMBAT EMPLOYMENT description.

8.1. M23 Armament Subsystem

8.1.1. M23 Armament Subsystem description

The M23 armament subsystem is attached to the external stores hardpoint fittings on both sides of the helicopter (Figure 8.1). The M-60D flexible 7.62 millimeter machine guns are free pointing but limited in traverse, elevation, and depression by cam surfaces and stops on pointless and pintle post assemblies of the two mount assemblies on which the machine guns are mounted. An ejection control bag is latched to the right side of each M60D machine gun to hold the spent cases, unfired rounds and links. Cartridges travel from ammunition box and cover assemblies to M60D machine gun through flexible chute and brace assemblies (machine gun).

Figure 8.1. The flexible 7.62 millimeter machine guns M60D on the right board

8.1.2. M23 Armament Subsystem Firing Procedures

To use the side door M-60D machines guns of the M23 armament system, simply press [3] or [4] until you are in the position of the desired side door gunner.

To aim the gun, press [LAlt+C] to enable mouse pan control mode. Once turned on, you can aim the gun using the mouse and fire by pressing [Space]. Note, you can use the mouse wheel to zoom the view in and out, as well as adjust the 3D position of the view by holding the mouse wheel down while moving the mouse.

When you switch to a gunner's position, an autopilot mode turns on to maintain the helicopter's flight path. The autopilot can be turned on and off manually by pressing [LWIN+A]. When you are in a door gunner's position, the helicopter will maintain the flight path set as the cockpit position was switched.

8.2. M21 Armament Subsystem Description

The M21 armament subsystem consists of two M134 6x barrel 7.62mm high rate machine guns and two 7-tube (M158) or 19-tube (M159) 2.75 inch aircraft rocket launchers.

Note: M158: 7-tube launcher; M158A1 was identical to LAU-68/A; M159: 19-tube launcher; M159A1 was identical to LAU-61/A.

Figure 8.2. Elements of M21 subsystem assembly on the left side of the UH-1.

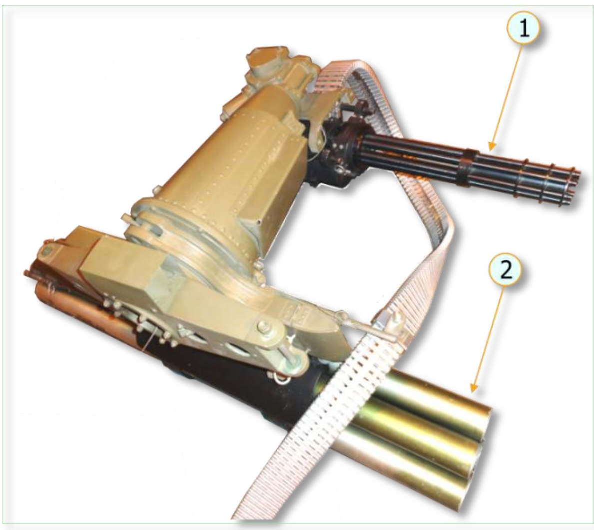


Figure 8.3. M134 (1) and M158 (2) in assembly

8.2.1. High rate of fire M134 7.62 automatic machine guns

a) Flexible, using gunner's flexible sighting station.

b) Stowed using the XM60 infinity sight and the firing on the cyclic control stick.

Figure 8.4. M134

8.2.2. 2.75-inch folding fin aerial rockets (FFAR) M158

a) Pair-single rocket from each launcher.

b) Ripples of 2, 3, 4, 5, 6, or 7 pairs of rockets.

The weapon subsystem functions satisfactorily in all coordinated helicopter positions or attitudes and within helicopter speed range of 0 to 140 knots.

Rocket launchers can be jettisoned in case of in-flight emergency.

The weapon subsystem has a high degree of accuracy when both guns are boresighted or harmonized to converge at 1000 meters and the rocket launchers are boresighted to converge rocket fires at 1250 meters.

The UH-1H can employ a wide variety of 2.75 inch Hydra 70 rockets using either the XM158 seven-tube launchers or XM159 19-tube launchers. The Hydra 70 has evolved into a wide array of air-to-surface aerial rockets. All of the 2.75 inch Folding Fin Aerial Rockets (FFAR) in this simulation use the MK66 rocket motor. FFAR rockets are an area effect weapon and are certainly not a precision attack weapon. Common targets for most of the rocket warheads include un-armored or lightly armored targets and they can be useful as a suppression weapon.

Figure 8.2.2 FFAR

Figure 8.5. 2.75 inch FFAR Warhead Types

2.75 inch rockets that the UH-1H can use include the following warheads:

- **MK5**. High explosive anti-tank warhead.
- **MK61**. Inert warhead practice rocket.
- **M151**. Anti-personnel fragmentation warhead.
- **M156**. White phosphorus smoke warhead.
- **M274**. Training smoke marker.
- **M257**. Parachute-retarded illumination flare.

Due to limited accuracy, it is best to ripple fire explosive warhead FFARs, but generally smoke and illumination FFAR are fired as singles.

Characteristics of 2.75 inch FFAR

Average Length	1.2 m
Average Weight	8.4 kg (+ 2.7 kg for HE warhead)
Diameter	2.75 inch
Average Range	3,400 m
Rockets per pod	7
Motor	Mk 66
Motor burn range	397 m
Motor burn time	1.05 – 1.10 sec
Motor average thrust	1,330 – 1,370 lbs
Launch velocity	148 fps

8.2.3. The weapon subsystem data

Characteristic		**7.62 automatic guns**	**2.75-inch FFAR** (with M158)
Maximum effective range, m		1000	2500
Minimum safe slant range, m		100	300
Maximum range, m		3450	9300 with new motor and 10-pound warhead
Ammunition capacity		6400	14
Weight of round, lbs / g		0.053 / 24	
Rate of fire		normal – 2400 shots per minute (both)	6 pairs per second
		high - 4000 shots per minute. (one gun at a time)	
Muzzle velocity, feet per second		2500	90
Weight, lbs / kg		1108.06 / 503	
Flexible limits	Up	+10°	–
	Down	-85°	–
	Inboard	12°	–
	Outboard	70°	–
Length of burst, sec		3	–

8.2.4. M21 armament controls

With gun mounts in the stow position, the electric drive assembly motor will only receive enough voltage to drive the gun at a rate of 2400 shots per minute. When moving the mounts through the field of deflection, one mount must stop at its inboard limit. Upon reaching the inboard limit, the gun will cease to fire and the opposite gun will accelerate to 4000 shots per minute; therefore, with both guns operational, the constant rate of fire is 4800 rounds per minute. This rate can be reduced to 2400 rounds per minute by selecting one gun (left or right) with the GUN SELECTOR switch on the control panel.

Figure 8.6. M21 Armament control panel.

Use the rocket PAIR SELECTOR switch for the selection of one to seven pairs of rockets.

An electrical JETTISON switch for the rocket launchers.

A rocket RESET switch to reset the rack and support assembly firing switches.

XM60E1 INFINITY SIGHT (NOT IMPLEMENTED IN DCS: UH-1H). The pilot uses the XM60/XM60E1 infinity sight to aim the rockets and the stowed automatic guns. When the sight is not in use, it may be stowed near the helicopter's ceiling in front of the pilot.

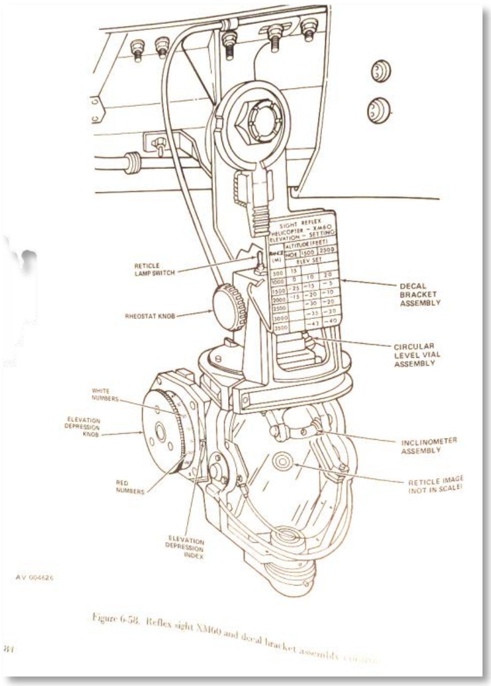


Figure 8.7. XM60/XM60E1 Reflex Sight (not implemented in DCS: UH-1H)

8.3. M21 Armament Subsystem Procedures

8.3.1. Automatic gun Firing Procedures

The gunner (copilot) can fire the 7.62mm subsystem automatic guns from the stow or flexible position, while the pilot can only fire the subsystem from the stow position.

A. STOW MODE. The guns may be stowed in a predetermined position and fired as a fixed weapon by the gunner (copilot) or the pilot. This permits straight-ahead firing in an emergency by use of the firing switch on the pilot's or gunner's cyclic stick. To fire the automatic guns in the stow position, the armament selector switch is moved to 7.62 and the OFF-SAFE-ARMED switch to ARMED.

(1) Stow fire by the pilot. The pilot uses the XM60 infinity sight for stow fire by turning the elevation depression knob until the sight reticle pipper coincides with the strike of the bullets.

(2) Stow fire by gunner (copilot). There is no sight for stow fire at the gunner's station; however, the gunner (copilot) may provide his own reference marks on the wind shield. To verify his constant head position, he fires a few rounds and places a line on the windshield that coincides with the observed strike of the bullets. He can place a dot or a circle on the line to coincide with the center of bullet strike.

B. Flexible Mode. For flexible mode operation the gunner's procedure is to:

(1) Disengage the sighting station from its stowed position, grasp the control handle, and pull down outboard.

(2) Move the reticle lamp switch either forward or aft of the center off position to illuminate the reticle lamp.

(3) Turn the rheostat knob to set reticle light intensity at desired level.

(4) Depress the actuator bar on the control handle to transfer firing voltage from the cyclic stick firing switches to the control handle trigger switch. Then by moving the sighting station, the gun may be electrically aimed and fired.

Note. Whenever the actuator bar is released, control is returned to the stowing potentiometers and mounts are driven immediately to the stowed position. Simultaneously, electrical power is transferred from the control handle trigger to the cyclic stick firing switches.

Figure 8.8. Sighting station – reticle pattern

Figure 8.9. Sighting station. Demo FLEXIBLE MODE (1 of 2)

Figure 8.10. Sighting station. Demo FLEXIBLE MODE (2 of 2)

8.3.2. Rocket Firing Procedures

The 2.75-inch rocket launchers are fixed to the support assembly and can only be fired from the stow position. When the armament selector switch is positioned at 2.75, the primary subsystem mode is rocket firing by means of cyclic stick firing switches. However, automatic gun firing can still be accomplished by using the flexible sighting station. While firing rockets, the automatic gun firing will be interrupted as long as the cyclic stick firing switch is depressed. Rocket firing procedures are as follows:

A. Before Takeoff.

1. Close the 7.62mm, rocket jettison, and XM60 sight circuit breakers.

2. Position the OFF-SAFE-ARMED switch to SAFE and check to see that the green SAFE indicator light illuminates.

3. Position the armament selector switch to 7.62. This will prevent accidental rocket firing before takeoff.

4. Check to ensure that the rocket PAIR SELECTOR switch is indicating zero pairs.

5. Depress the RESET switch to reset the firing switch on each rack and support assembly.

6. Conduct an operational check of the XM60/XM60E1 infinity sight as follows:

a) Depress the locking lever to disengage the sight from the stow indent, then swing the sight outboard and down from its stowed position until the locking lever engages the operate indention.

b) Move the reticle lamp switch either forward or aft of the center off position to illuminate the reticle lamp.

c) Turn the rheostat knob to set reticle light intensity to desired level.

d) Set desired scale reading at the fixed index scale on the sight.

B. After Takeoff.

7. Prepare for firing by setting the armament selector to 2.75 and the rocket PAIR SELECTOR switch to the desired number of rocket pairs to be fired.

8. Position the OFF-SAFE-ARMED switch to ARMED and check to see that the SAFE indicator light goes out and the ARMED indicator light illuminates.

9. Using the sight reticle pipper as a reference aiming point, acquire the target by flying a target collision course, changing the attitude of the helicopter as necessary to align the sight reticle on the target.

10. When the proper sight picture has been developed, fire the rockets by depressing the firing switch on the cyclic control stick.

11. After firing position the ...

a) OFF-SAFE-ARMED switch to SAFE.

b) Armament selector to 7.62.

c) Rocket PAIR SELECTOR to zero pairs.

12. Before helicopter shutdown, position the OFF-SAFE-ARMED switch to OFF and then open all armament circuit breakers.

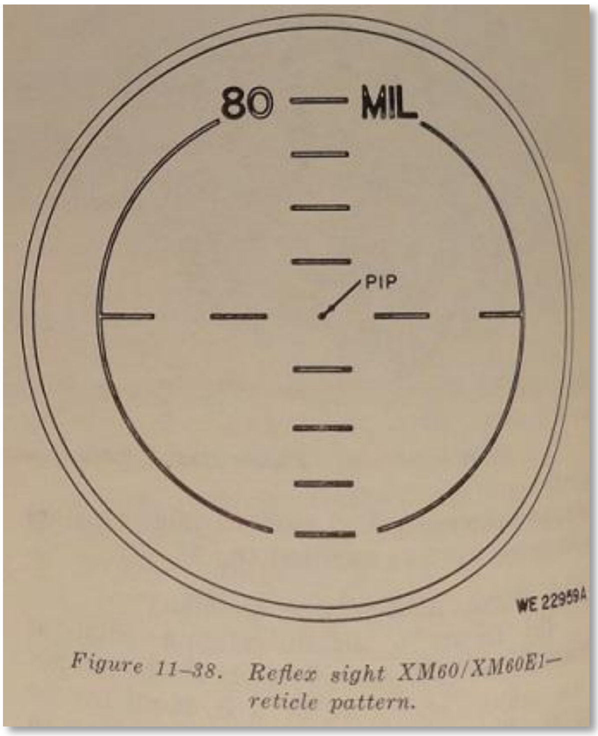


Figure 8.11. Reflex sight XM60 – reticle pattern (not implemented in DCS: UH-1H)

8.3.3. Rocket Emergency Procedures

Jettisoning can be safely accomplished during hovering, climbing, and level flight in the speed range from zero to 100 knots, and during autorotation and descending flight up to 80 knots. To jettison ...

a) Lift the red switch guard to break copper safety wire on the launcher jettison switch.

b) Push launcher jettison switch forward and check support assemblies to ensure that jettison is complete.

9 FLIGHT PREPARATION & FLIGHT

9. FLIGHT PREPARATION AND FLIGHT

9.1. Starting Engine

AUTO START ENGINE [LWIN+Home].

9.1.1. Before Starting Engine

1. Overhead switches and circuit breakers – Set as follows:
   a) DC circuit breakers – in, except for armament and special equipment.
   b) DOME LT switch – As required.
   c) AC POWER switches – Set as follows:
      (1) PHASE switch – AC [LShift+R].
      (2) INVTR switch – OFF [LShift+I].
   d) DC POWER switches – Set as follows:
      (1) MAIN GEN switch – ON and cover down [LShift+Q].
      (2) VM selector – ESS BUS [LShift+H].
      (3) NON-ESS BUS switch – As required.
      (4) STARTER GEN switch – START [LShift+X].
      (5) BAT switch – ON [LShift+P].
2. Ground power unit – Connect for GPU start.
3. FIRE warning indicator light – Test [RCtrl+T].
4. Center pedestal switches – Set as follows:
   a) Avionics equipment – Off; set as desired.
   b) External stores jettison handle – Check safe tied.
   c) DISP CONTROL panel – Check ARM/STBY/SAFE switch is SAFE [RShift+RAlt+L]; check that JETTISON switch [LAlt+J] is down and covered.
   d) GOV switch – AUTO [G].
   e) DE-ICE switch – OFF [I].
   f) FUEL switches – Set as follows:
      (1) MAIN FUEL switch – ON [F].
      (2) All other switches – OFF.
   g) Caution panel lights – TEST [LAlt+R] and RESET [R].
   h) HYD CONT switch – ON [LAlt+I].
   i) FORCE TRIM switch – ON [LAlt+U].
   j) CHIP DET switch – BOTH [LAlt+G].

5. Flight controls – Check freedom of movement through full travel: center cyclic and pedals; collective pitch full down.

6. Altimeters – Set to field elevation

FOR PILOT: pressure decrease – [RCtrl+B];

pressure increase – [RShift+B];

FOR COPILOT: pressure decrease – [LCtrl+B];

pressure increase – [LShift+B];

9.1.2. Starting Engine

1. Ignition key lock switch – ON (not implemented in DCS: UH-1H).

2. Throttle – Set for start [PgDwn push 3-4s]. Position the throttle as near as possible (on decrease side) to the engine idle (no "idle stop" position in this simulation).

3. Engine – Start as follows:

a) Start switch[1] (only for this simulation) – press and hold [Home]; note start time.

Note. DC voltmeter indication. Battery starts can be made when voltages less than 24 volts are indicated, provided the voltage is not below 14 volts when cranking through 10 percent N1 speed.

b) Main rotor – Check that the main rotor is turning as N1 reaches 15 percent. If the rotor is not turning, abort the start.

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[1] In reality this button is the "engine idle stop release switch" and does not have "engine start" functionality.

c) Start switch – Release at 40 percent N1 or after 40 seconds, whichever occurs first.

d) Throttle – Slowly advance past the engine idle stop to the engine idle position. Manually check the engine idle stop by attempting to close the throttle (not implemented in DCS: UH-1H).

e) N1 68 to 72 percent. Hold a very slight pressure against the engine idle stop during the check. A slight rise in N1 may be anticipated after releasing pressure on throttle.

Note. The copilot attitude indicator should be caged and held momentarily as inverter power is applied.

4. INVTR switch – MAIN ON [LShift+U].
5. Engine and transmission oil pressures – Check.
6. GPU – Disconnect.

9.1.3. Engine Runup

1. Avionics – On.
2. STARTER GEN switch – STBY GEN [LShift+X].
3. Systems – Check as follows:

   a) FUEL.

   b) Engine.

   c) Transmission.

   d) Electrical.

      (1) AC – 112 to 118 Volts.

      (2) DC – 27 to 28.5 Volts.

4. RPM – 6600. As throttle is increased, the low rpm audio and warning light should be off at 6100 to 6300 rpm.

9.2. Take-off and hover

9.2.1. Before Take-off

Immediately prior to take-off the following checks shall be accomplished:

1. RPM – 6600.
2. Systems – Check engine, transmission, electrical and fuel systems indications.
3. Avionics – As required.

9.2.2. Takeoff to hover

Note. During take-off and at any time the helicopter skids are close to the ground, negative pitch attitudes (nose low) of 10° or more can result in ground contact of the WSPS lower cutter tip. Forward cg, high gross weight, high density altitude, transitional lift setting, and a tailwind increase the probability of ground contact.

A. Required

a) Pretakeoff check completed prior to beginning maneuver.

b) Vertical ascent.

c) Constant heading.

d) Stabilize at a 3-foot hover.

B. Recommendations for aircraft control during takeoff

Neutralize the cyclic control stick. Observe the view ahead and outside the cockpit. Use the area about 15-20 feet in front of the helicopter for visual reference, moving your view side to side. Slowly move the collective up until the helicopter lifts off the ground and establish a hover at an altitude of approximately 3 feet. Typically the toes of the skids will lift first, followed by the right skid, and lastly the left skid.

One of the more difficult elements of a takeoff is maintaining the takeoff heading and attitude, while minimizing deviation from the takeoff point over the ground and maintaining a vertical ascent. As the collective is raised, the helicopter will experience changes in balance, requiring the pilot to be prepared to perform the following control inputs to compensate:

a) increased thrust of the main rotor and reduced ground friction on the skids will result in a right yaw tendency, requiring measured input on the LEFT anti-torque pedal (about 1/4 – 1/3 of its movement range) to increase thrust of the tail rotor and balance the yaw tendency to maintain heading;

b) increased thrust of the tail rotor and reduced ground friction on the skids will produce a tendency for the helicopter to slide right, requiring measured input of the cyclic to the LEFT (about 1/6 – 1/5 of its movement range) to displace the thrust vector of the main rotor to the left to compensate the increased tail rotor thrust and prevent any side slipping motion of the helicopter;

c) in addition to the above, as the helicopter lifts off the ground, it will have a tendency to nose down due to the displacement of the main rotor plane or motion relative to the longitudinal axis of the helicopter, requiring a measured PULL of the cyclic (about 1/6 – 1/5 of its movement range) to displace the thrust vector of the main rotor backward and prevent any nose down and forward movement of the helicopter;

d) once free from ground contact and balanced on the main rotor axis in flight, the helicopter will have a tendency to pitch up (nose up), resulting in backward movement of the helicopter and requiring a measured PUSH on the cyclic (approximately back to the neutral position) to displace the thrust vector of the main rotor forward and prevent any backward movement of the helicopter.

After liftoff is accomplished, maintain the helicopter heading and attitude in a straight vertical ascent to approximately 3 feet of altitude. Stabilize at this altitude by a slight lowering of the collective (1/10 – 1/20 of its movement range), while at the same time reducing the left pedal input (about 1/6 – 1/8 of its movement range) and the left cyclic input (by about 1/8 – 1/10 of its movement range) (see Figure 9.1..Figure 9.3).

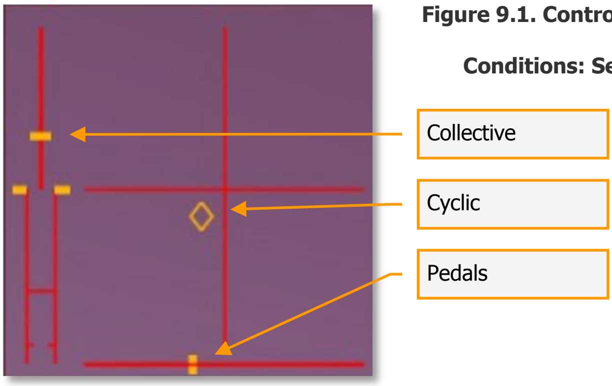


Figure 9.1. Control positions for balancing helicopter during hover.
Conditions: Sea level, FAT +15°C, empty (7260 lbs).

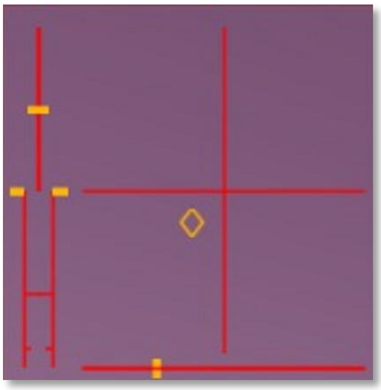


Figure 9.2. Control positions for balancing helicopter during hover.
Conditions: Sea level, FAT +15°C, weight 9500 lbs.

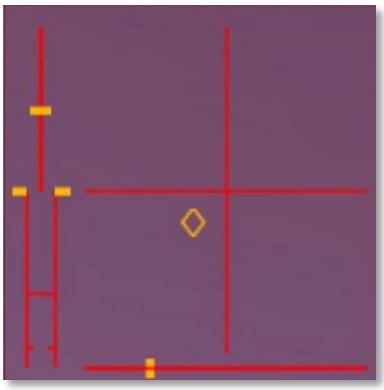


Figure 9.3. Control positions for balancing helicopter during hover.
Conditions: Sea level, FAT +40°C, weight 9500 lbs.

When attempting a hover, remember that the UH-1H is not equipped with any automated flight control systems. This means that all forward/back and left/right tendencies need to be corrected with measured input of the cyclic, performed in short, smooth, and most importantly – returned movements. To aid with timely control inputs in the initial stages, remember to quickly glance left and right outside the cockpit ahead of the helicopter. To simplify the control problem, minimize movement of the collective, as any collective adjustments require coordinated inputs of the cyclic and pedals to maintain balance in flight.

9.2.3. Hovering turns

A. Required

a) Altitude at constant 3-foot hover.

b) Remain over pivot point.

c) Constant rate of turn (maximum rate of turn of 360° in 15 seconds is recommended for training).

B. Recommendations for implementation

Prior to initiating the turn, look toward the side of the turn to ensure the area is free of obstacles to avoid a possible collision. Slightly depress the corresponding pedal (1/10 – 1/8 of its movement range). Attain a desired rate of yaw. Once the desired rate of yaw is attained, lessen the pedal input (return to a position of 1/15 – 1/20 of its movement range). A well executed turn should be performed around or near the main rotor vertical axis.

Maintaining the center point of the turn, altitude and yaw rate can be difficult, requiring the pilot to be prepared to perform the following control inputs to compensate for control instability:

a) Due to the unbalanced nature of forces and moments during a hovering turn, the helicopter will not turn exactly over the main rotor vertical axis, but with a small radius of turn (30 – 50 feet), requiring cyclic control input in addition to pedal input to control the turn.

b) When initiating a LEFT hovering turn, the pilot first adds left pedal, which increases tail rotor thrust and produces a slight bank to the right (1 – 3°) and slip to the right. Slight LEFT cyclic (1/8 – 1/10 of its movement range) is required to compensate for these tendencies and maintain the turning center point near the main rotor vertical axis. In addition, the transfer of power to the tail rotor produces a reduction in main rotor RPM (by 3 – 5 RPM) in the initial moments after input of the left pedal (when left pedal input is significant), leading to a slight loss of altitude (0.5 – 1.5 ft). It may take the engine governor up to 2 – 4 seconds to compensate and return the main rotor RPM to its starting value, at which point the helicopter may experience a slight climb rate (depending on the rate of yaw and available engine power). The climbing tendency occurs due to the increased velocity of the main rotor blades when combined with the helicopter's own rate of yaw relative to the surrounding air. The extent of all of the dynamic tendencies described depends on the aggressiveness of pedal input and the established rate of yaw.

c) When initiating a RIGHT hovering turn, the pilot first adds right pedal, which decreases tail rotor thrust and produces a slight bank to the left (1 – 3°) and slip to the left. Slight RIGHT cyclic (1/8 – 1/10 of its movement range) is required to compensate for these tendencies and maintain the turning center point near the main rotor vertical axis. In addition, the transfer of power away from the tail rotor produces an increase in main rotor RPM (by 3 – 5 RPM) in the initial moments after input of the right pedal (when right pedal input is significant), leading to a slight increase of altitude (0.5 – 1.5 ft). It may take the engine governor up to 4 – 5 seconds to compensate and return the main rotor RPM to its starting value, at which point the helicopter may experience a slight sink rate (depending on the rate of yaw and rotor RPM). The sinking tendency occurs due to decreased velocity of the main rotor blades when the helicopter's rate of yaw is subtracted from the combined velocity relative to the surrounding air. The extent of all of the dynamic tendencies described depends on the aggressiveness of pedal input and the established rate of yaw.

When performing hovering turns, the pilot has to continuously use measured cyclic control to balance the dynamic tendencies in bank and pitch, making small, but frequent adjustments of approximately 1/5 – 1/2 inch once to twice per second and use measured pedal input to maintain a desired rate of yaw.

When performing a hover at maximum takeoff weight, in conditions of high altitude or high temperatures, when the main rotor cannot rise past 314 RPM at an altitude of 3 ft (which indicates the engines are operating at maximum power), a left turn will invariably lead to a loss of altitude, because the added power transferred to the tail rotor will be impossible to compensate to maintain main rotor RPM. On the other hand, a right turn will slightly unload the tail rotor and transfer power to the main rotor, providing an additional 3 – 5 RPM and producing a climb rate. This peculiarity of conventional helicopters is often employed by pilots operating in extreme conditions where performance is very limited, such as the hot and humid climate of Vietnam and mountains of Afghanistan.

9.2.4. Sideward flight

A. Required

a) Altitude at constant 3-foot hover.

b) 90-degree clearing turn in direction of sideward flight.

c) Constant rate of movement (not to exceed 5 knots).

d) Flightpath perpendicular to heading.

B. Recommendations for implementation

To initiate sideward flight, slightly add cyclic (1/10 – 1/8 of its movement range) in the desired direction. Maintain heading using the pedals, altitude using collective control, and monitor airspeed visually by watching the ground.

Maintaining heading and altitude can be difficult, requiring the pilot to be prepared to perform the following control inputs to compensate for control instability:

a) The helicopter will tend to weathervane into the direction of flight, requiring measured pedal input in the opposite direction (1/10 – 1/8 of its movement range) to maintain heading.

b) The tilt of the main rotor relative to the ground will reduce the vertical lift component, resulting in a loss of altitude and requiring increased collective to maintain altitude.

c) To stop the helicopter at a desired point, set the cyclic control to the opposite side (1/8 – 1/6 of its movement range) approximately 4 – 8 ft ahead of the desired stopping point. As speed is reduced, return the cyclic to a near hovering position.

When performing sideward flight, the pilot has to continuously use measured cyclic control to balance the dynamic tendencies in bank and pitch, making small, but frequent adjustments of approximately 1/5 – 1/2 inch once to twice per second and use measured pedal input to maintain heading perpendicular to the direction of flight. Aggressive inputs of the cyclic will require similarly aggressive inputs of the collective and pedals to maintain coordinated flight.

9.2.5. Rearward flight

1. Required

a) Altitude at constant 3-foot hover.

b) 90-degree clearing turn in direction of sideward flight.

c) Constant rate of movement (not to exceed 5 knots).

d) Flightpath of 180° to heading.

2. Recommendations for implementation

To initiate rearward flight, increase collective (1/10 – 1/8 of its movement range) and simultaneously slightly pull back the cyclic control (1/10 – 1/8 of its movement range). Use the pedals to maintain heading and the collective to maintain altitude. Monitor speed by looking at the ground and control heading by finding a visual landmark.

Maintaining heading and altitude can be difficult, requiring the pilot to be prepared to perform the following control inputs to compensate for control instability:

a) the helicopter will tend to weathervane into the direction of flight, resulting in a continual "waving" of the tail up to 10 – 15°, requiring measured and more frequent than normal pedal input (1/10 – 1/8 of its movement range) to prevent the tail from yawing more than ±5°;

b) the tilt of the main rotor relative to the ground will reduce the vertical lift component, resulting in a loss of altitude and requiring increased collective to maintain altitude;

c) as reverse speed reaches 8 – 10 knots, the nose will begin to rise as a result of the increased airflow over the synchronized elevator pushing the tail down. Compensate for this with a slight adjustment of the cyclic forward;

d) to stop the helicopter at a desired point, set the cyclic control to the opposite side (1/8 – 1/6 of its movement range) approximately 6 – 8 ft ahead of the desired stopping point. As speed is reduced, return the cyclic to a near hovering position.

When performing rearward flight, the pilot has to continuously use measured cyclic control to compensate the dynamic tendencies in bank and pitch, making small, but frequent adjustments of approximately 1/5 – 1/2 inch once to twice per second and use measured pedal input to maintain heading.

9.2.6. Landing from hover

A. Required

1. Constant heading.
2. Vertical descent.

B. Recommendations for aircraft control during landing

To initiate a landing from a hover, slowly reduce collective (1/10 – 1/8 of its movement range) while simultaneously compensating for a left yaw tendency with input of the right pedal. Typically the left skid will make ground contact first, followed by the right skid, and then the skid toes.

Maintaining heading, vertical approach path and preventing any slippage can be difficult, requiring the pilot to be prepared to perform the following control inputs to compensate for control instability when lowering the collective and when contacting the ground:

a) The helicopter will have a tendency to yaw left due to decreased thrust of the main rotor, requiring a measured input of the RIGHT pedal (1/8 – 1/6 of its movement range) to reduce the tail rotor thrust and compensate the yaw tendency.

b) Decreased thrust of the tail rotor will produce a tendency for the helicopter to slide left (due to the left component of the main rotor thrust vector present in a hovering state), requiring measured input of the cyclic to the RIGHT (about 1/6 – 1/5 of its movement range) to reduce the left component of the main rotor thrust vector and compensate the reduced tail rotor thrust to prevent any side slipping motion of the helicopter.

c) As the helicopter nears the ground, ground effect will result in a reduced sink rate or a stabilized altitude, requiring an additional slight reduction of the collective control (1/10 – 1/8 of its movement range) to "push through" the ground effect and continue the descent. As before, reduction of the collective requires additional input on the pedals to maintain heading and cyclic to prevent slippage.

d) Upon ground contact, the fuselage will take on a ground attitude, which will move the thrust vector of the main rotor forward, resulting in a tendency of the helicopter to slide forward, requiring a measured pull of the cyclic BACK (1/6 – 1/5 of its movement range) to prevent any forward skid.

During the approach, the aggressiveness of cyclic and pedal input should be progressively reduced, but the frequency increased (up to 2 – 2.5 inputs per second on the cyclic).

After ground contact, continue to operate the controls smoothly until collective control is minimized.

When performing a vertical descent from an altitude of 15 ft or higher, ensure a sink rate less than 8.3 ft/sec (500 ft/min). A sink rate greater than 8.3 ft/sec can result in a vortex ring state (VRS), during which the sink rate can rise uncontrollably within 1 – 2 seconds up to 2000 ft/min, which will lead to a hard landing and possible damage or destruction of the helicopter.

9.2.7. Normal takeoff

To perform a normal takeoff, first look ahead approximately 100 – 150 feet. Carefully push the cyclic forward by 1/10 – 1/8 of its movement range to set a pitch angle of -4 – -6°. Because of the forward shift of the thrust vector of the main rotor, its vertical component will be reduced, leading to a loss of altitude. To compensate for this, raise the collective by approximately 1 – 1.5°.

Transitional maneuvers involving acceleration or deceleration produce balance changes in all axes, which require the pilot to control the pitch and roll using the cyclic, and control yaw and heading using the pedals.

Maintaining heading, pitch, and preventing any slippage can be difficult, requiring the pilot to be prepared to perform the following control inputs to compensate for control instability:

WHEN SPEED REACHES 15 – 20 KNOTS, THE HELICOPTER WILL DEMONSTRATE THE FOLLOWING TENDENCIES:

a) "float" and nose down (due to increasing main rotor thrust as it moves from axial to oblique flow, as well as the increasing aerodynamic force, pointed downward, of the synchronized elevator), requiring a forward push of the cyclic to "nudge" the nose down and maintain a constant pitch angle.

b) left roll (due to increasing dissymmetry of lift, which sinks the main rotor cone leftward), requiring a measured right input of the cyclic to prevent any rolling.

WHEN SPEED REACHES 25 – 30 KNOTS, THE HELICOPTER WILL DEMONSTRATE THE FOLLOWING TENDENCIES:

c) left yaw (due to increasing tail rotor thrust as oblique flow increases, as well as the increasing aerodynamic force, pointed rightward, of the vertical stabilizer), requiring a reduced input of the left pedal by 1/15 – 1/10 of its movement range to maintain heading. The reduced thrust of the tail rotor will unbalance the rolling moments and lead to a slight left roll, requiring measured input of the cyclic to the right to compensate for the roll.

WHEN SPEED REACHES 40 KNOTS, THE HELICOPTER WILL DEMONSTRATE THE FOLLOWING TENDENCIES:

d) Left roll (due to the continuing increase in the dissymmetry of lift), requiring a measured input of the cyclic to the right by about 1/10 – 1/8 of its movement range.

As helicopter airspeed increases, the dissymmetry of lift increases as well (advancing blades on the right side flap upward while retreating blades on the left side flap downward due to reduced lift as a result of lower retreating blade airspeed), producing an increasing leftward drop of the main rotor cone and requiring increasing input of the cyclic to the right to compensate. However, the cyclic input is minimized by the specially-designed vertical stabilizer, which is canted to produce a rightward rolling moment with increasing airspeed.

When approaching 120 knots (at low altitudes), the dissymmetry of lift begins to approach critical values as the retreating blades on the left side (270 – 300° from the longitudinal axis) begin to approach retreating blade stall conditions, leading to spontaneous left rolling. Such a condition requires a reduction in airspeed by a slight pull of the cyclic back (about 1/10 – 1/8 of its movement range).

Note.

Maximum Performance.

A take-off that demands maximum performance from the helicopter may be necessary because of various combinations of heavy helicopter loads, limited power and restricted performance due to high density altitudes, barriers that must be cleared and other terrain features. The decision to use either of the following take-off techniques must be based on evaluation of the conditions and helicopter performance. The copilot (when available) can assist the pilot in maintaining proper rpm by calling out rpm and torque power changes, thereby allowing the pilot more attention outside the cockpit.

A. Coordinated Climb. Align the helicopter with the desired take-off course at a stabilized hover altitude of approximately three feet (skid height). Apply forward cyclic pressure smoothly and gradually, while simultaneously increasing collective pitch to begin coordinated acceleration and climb. Adjust pedal pressure as necessary to maintain the desired heading. Maximum torque available should be applied (without exceeding helicopter limits) as the required attitude is established that will permit safe obstacle clearance. The climb out is continued at that attitude and power setting until the obstacle is cleared. After the obstacle is cleared, adjust helicopter attitude and collective pitch as required to establish a climb at the desired rate of climb and airspeed. Continuous coordinated application of control pressures is necessary to maintain a trimmed heading, flight path, airspeed, and rate of climb. This technique is desirable when OGE hover capability exists. Take-off may be made from the ground by positioning the cyclic control slightly forward of neutral prior to increasing collective pitch.

B. Level Acceleration. Align the helicopter with the desired take-off course at a stabilized hover altitude of approximately three feet (skid height). Apply forward cyclic pressure smoothly and gradually while simultaneously increasing collective pitch to begin acceleration at approximately 3 to 5 feet (skid height). Adjust pedal pressure as necessary to maintain the desired heading. Maximum torque available should be applied (without exceeding helicopter limits) prior to accelerating through effective translational lift. Additional forward cyclic pressure will be necessary to allow for level acceleration to the desired climb airspeed. Approximately five knots prior to reaching the desired climb airspeed, gradually release forward cyclic pressure and allow the helicopter to begin a constant airspeed climb to clear any obstacles. Care must be taken not to decrease airspeed during the climb out since this may result in the helicopter descending. After the obstacle is cleared, adjust helicopter attitude and collective pitch as required to establish a climb at the desired rate of climb and airspeed. Continuous coordinated application of control pressures is necessary to maintain a trimmed heading, flight path, airspeed and rate of Climb. Take-off may be made from the ground by positioning the cyclic control slightly forward of neutral prior to increasing collective pitch.

C. Comparison of Techniques.

Where the two techniques yield the same distance over a fifty-foot obstacle, the coordinated climb technique will give a shorter distance over lower obstacles and the level acceleration technique will give a shorter distance over obstacles higher than fifty feet. The two techniques give approximately the same distance over a fifty-foot obstacle when the helicopter can barely hover OGE. As hover capability is decreased, the level acceleration technique gives increasingly shorter distances than the coordinated climb technique.

In addition to the distance comparison, the main advantages of the level acceleration technique are:

(1) It requires less or no time in the Avoid area of the height-velocity diagram;

(2) Performance is more repeatable since reference to attitude, which changes with loading and airspeed, is not required;

(3) At the higher climb out airspeeds (30 knots or greater), reliable indicated airspeeds are available for accurate airspeed reference from the beginning of the climb out, therefore minimizing the possibility of descent.

The main advantage of the coordinated climb technique is that the climb angle is established early in the take-off and more distance and time are available to abort the take-off if the obstacle cannot be cleared. Additionally, large attitude changes are not required to establish climb airspeed.

Slingload.

The slingload take-off requiring maximum performance (when OGE hover is not possible) is similar to the level acceleration technique, except the take-off is begun and the acceleration made above 15 feet. Obstacle heights include the additional height necessary for a 15-foot sling load.

9.3. Climb

After take-off, select the speed necessary to clear obstacles. When obstacles are cleared, adjust the airspeed as desired (60 knots are recommended at sea level) at or above the maximum rate of climb airspeed. Figure 9.4 shows control positions for balancing the helicopter during climb.

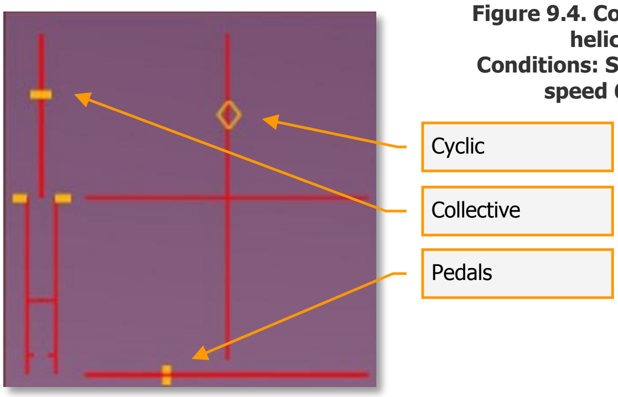


Figure 9.4. Control positions for balancing helicopter during climb.
Conditions: Sea level, FAT +15°C, empty, speed 60 knots, torque max.

9.4. Cruise

When the desired cruise altitude is reached, adjust power as necessary to maintain the required airspeed (80 - 90 knots are recommended at sea level). Figure 9.5 shows control positions for balancing the helicopter during level flight.

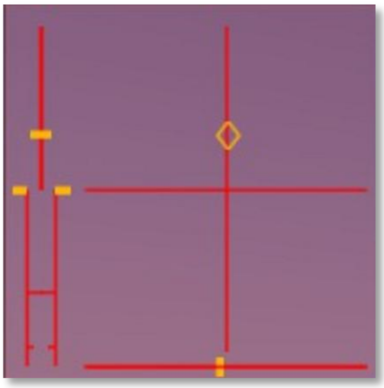


Figure 9.5. Control positions for balancing helicopter during level flight. Conditions: Sea level, FAT +15°C, empty, speed 90 knots.

9.5. Descent and landing

When preparing for landing, the approach should be planned so that descent and deceleration is performed against the wind or with a crosswind from the right.

Descent

From a starting altitude of 400 – 450 ft, plan for an approach distance of 4500 – 5000 ft to the landing hover point. As experience builds, the approach distance can be reduced to 3500 – 4000 ft. When flying a visual approach pattern, the turn to final should be started when the touchdown point is approximately 15 - 20° off the nose of the helicopter and performed with a bank of 15 - 20° to start (Figure 9.6) the final approach at approximately 80 knots.

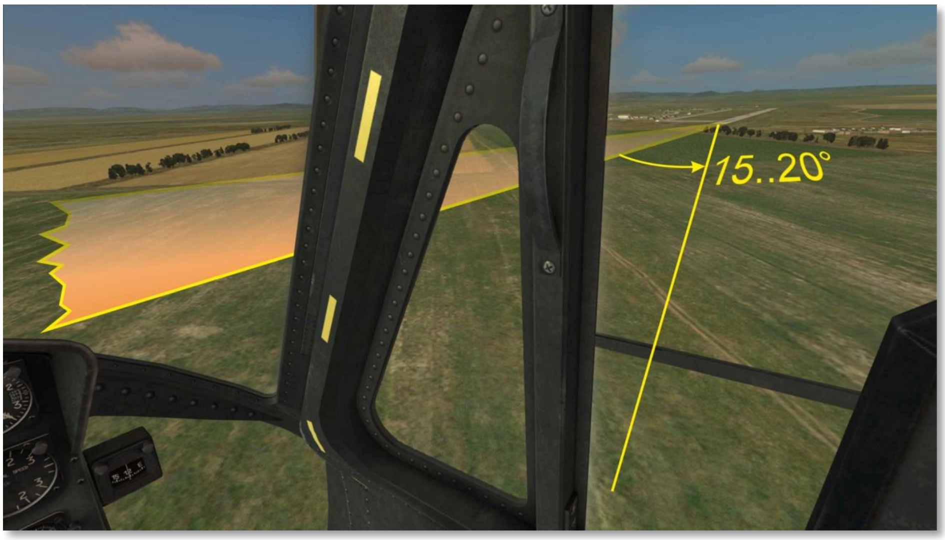


Figure 9.6. Lining up for final approach.

When descending for a landing, the glideslope can be approximated according to the following guidelines:

Descent parameters			
Distance	**4500 - 4000 ft (1500 m)**	**3000 ft (1000 m)**	**1500 ft (500 m)**
Speed [knots]	80	60	40..30
Altitude [ft]	500..450	350..300	200..150
Descent [ft/min]	300..500	400..600	200..300

After completing the turn to final approach, set up and control the descent. As the collective is lowered and the rate of descent reaches 500 – 600 ft/min, the airflow dynamics over the elevator will tend to drop the nose down and increase airspeed. To counteract this, pull the cyclic back about 1/8 – 1/6 of its movement range. Figure 9.7 shows control positions for balancing the helicopter during descent.

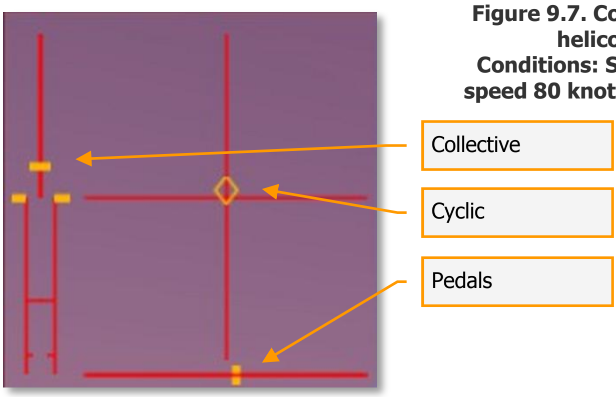


Figure 9.7. Control positions for balancing helicopter during descent. Conditions: Sea level, FAT +15°C, empty, speed 80 knots, rate of descent 800 ft/min.

Maintain the glideslope by controlling the position of the landing point on the canopy of the cockpit. If the landing point "crawls" upward on the canopy, the glideslope is too steep and the approach will be short of the desired point. To counteract this, raise the collective slightly to reduce the rate of descent. If the landing point "crawls" downward on the canopy, the glideslope is too shallow and the approach will overshoot the landing point. To counteract this, reduce collective slightly to increase the rate of descent, but maintain it under 800 ft/min. If a greater rate of descent is necessary to enter the glideslope, but the distance to the landing point is less than 2500 ft, abort the approach and execute a go-around for a second attempt.

Special considerations for decelerations.

Set pitch to +2 - +3° with a slight pull of the cyclic, simultaneously lowering the collective to maintain the desired rate of descent. The approximate rate of deceleration is recommended as follows: for every 50 ft of altitude, the airspeed should drop by 7 – 10 knots. Keep in mind however; the rate of deceleration depends on the pitch angle and entry speed. For example, for the same pitch angle, the rate of deceleration from 80 down to 50 knots is considerably lower (approximately 15 seconds) than the rate of deceleration from 50 knots down to 10 – 15 knots (approximately 5 – 7 seconds). This requires a slight adjustment of the cyclic forward (about 1/10 – 1/20 of movement range) with a corresponding increase in collective to prevent a "sinking" of the helicopter.

During decelerations, the helicopter will demonstrate the following tendencies:

a) From 80 down to 55 – 50 knots, the deceleration is normal and the helicopter flies down the glideslope toward the touchdown point smoothly and predictably, requiring little to no adjustment in power;

b) After passing through 55 – 50 knots, the helicopter undergoes a change in dynamics, requiring greater engine power as airspeed is reduced in order to maintain the desired rate of descent. If power is not applied by raising the collective as airspeed is reduced, the helicopter will begin to "sink", increasing the rate of descent to above 1000 ft/min, which can result in an entry into a vortex ring state (VRS) at airspeeds of 10 – 15 knots, leading to a possible crash.

Rapid decelerations achieved by a large pull of the cyclic and drop of the collective should be avoided at airspeeds of 60 – 20 knots. Doing so can lead to a rapid increase in rotor RPM due to increased airflow over the main rotor, which can produce a number of negative consequences: engine governor reduces engine power to compensate for increased rotor RPM; once airspeed reaches 25 – 20 knots, the helicopter tends to "sink", requiring a rapid increase in collective to prevent an uncontrolled descent; the engine is incapable of providing the power required to maintain rotor RPM at the increased collective setting rapidly enough; the increased collective setting combined with an underpowered regime of the engine results in rotor underspeed (below 314 RPM); the helicopter begins a spontaneous descent the pilot is unable to stop; a right yaw tendency may also appear as torque increases with increased engine RPM and tail rotor effectiveness is reduced with lower rotor RPM.

In summary: the pilot has a margin of error when flying a landing approach where he can deviate somewhat from the guidelines described above. However this margin is reduced as the free air temperature (FAT) is raised, helicopter weight is increased, and the pressure altitude of the landing site is increased.

Landing from a Hover (see 9.2.6)

Run-on Landing

A run-on landing may be used during emergency conditions of hydraulic power failure, some flight control malfunctions, and environmental conditions. The approach is shallow and flown at an airspeed that provides safe helicopter control. Airspeed is maintained as for normal approach except that touchdown is made at an airspeed above effective translational lift. After ground contact is made, slowly decrease collective pitch to minimize forward speed. If braking action is necessary, the collective pitch may be lowered as required for quicker stopping.

9.6. Engine Shutdown

AUTOSTOP ENGINE: [LWIN+End].

1. Throttle Engine idle for two minutes ([PgDown] for min position throttle).
2. FORCE TRIM switch ON.
3. STARTER GEN switch START [LShift+X].
4. Throttle – Off (engine shutdown in this way is not done yet).
5. Center Pedestal switches Off:
   a) FUEL [F] (in this game, the engine stops).
   b) Avionics.
6. Overhead switches Off:

a) INVTR [LShift+I].

b) PITOT HTR [RAlt+P].

c) LTS: Navigation lights [RCtrl+L], Landing light [RCtrl+,], Search light [RAlt+;].

d) MISC (switches of miscellaneous Control Panel).

e) INST LTG.

f) BAT [LShift+P].

7. Ignition key lock switch. Remove key as required (not implemented in DCS: UH-1H)

9.7. Autorotation. Practical part

An autorotation (theory – see 3.1.13) is used to land the helicopter in a variety of situations where normal flight control becomes impossible. Among these may be a malfunction or complete failure of the engine, tail rotor system, tail rotor drive system, or other problems requiring minimizing torque from the main rotor. The UH-1H has excellent autorotation characteristics, which helps perform autorotation landings safely. This is made possible by the low disc loading of the main rotor – from 3.90 lbs/ft² (19 kg/m²) for an empty helicopter up to 5.24 lbs/ft² (25.5 kg/m²) for a fully loaded helicopter[1], as well as a heavy main rotor that carries a lot of inertia and potential energy. Here is how these factors were described by the UH-1 pilot Robert Mason in his book, Chickenhawk:

"The heavy, thudding noise of the main rotors – the characteristic wop-wop-wop sound – was caused by their huge size, 48 feet from tip to tip, and a 21-inch chord (width). With ballast weights at each blade tip, the whirling rotor system had tremendous inertia. The IP demonstrated this inertia with a trick that only a Huey could do. On the ground at normal rotor speed (330 rpm) he cut the power, picked the machine up to a four-foot hover, turned completely around, and set it back on the ground. Incredible! Any other helicopter would just sit there, not rising an inch, while the rotors slowed down. These big metal blades with the weights in the tips would serve me well in Vietnam. Their strength and inertia allowed them to chop small tree branches with ease".

Because of these design features, learning to perform autorotation landing on the Huey is considerably easier than on most other helicopter types.

A. Transitioning to autorotation

Typically the need to perform an autorotation arises suddenly while the pilot is focused on flight tasks not directly related to managing the power system. For example these might be: conducting visual scanning, maintaining formation, weapons employment, etc. Experience has shown that it can take from 2 to 5 seconds between a system malfunction and the start of corrective actions by the pilot. A safe autorotation landing begins with a timely recognition of the problem and immediate, appropriate control actions to transition into autorotation.

[1] As a comparison, the disc loading of the AH-64D is 5.95 lbs/ft² (29 kg/m²) for an empty helicopter and 11.61 lbs/ft² (56.7 kg/m²) when fully loaded.

The greatest RPM drop occurs in cases of a complete engine failure during level flight with velocity above 80 knots or climb. A corrective control lag of 2-5 seconds can result in rotor RPM dropping to 280. In such cases, immediately perform the following steps:

a) Restore the rotor RPM by lowering the Collective all the way down. If speed is above 70 knots, pull the Cyclic back to increase rotor RPM using the energy of the oncoming airflow, but maintain above 50 knots by adjusting the Cyclic forward as necessary.

b) If transitioning from a hover at an altitude of 400 ft or greater, accelerate to 60 – 80 knots. At lower altitudes, make an effort to gain airspeed, but consider that accelerating and decelerating the helicopter will require short and accurate adjustments of the Collective and there is little room for error in control input.

c) When reducing airspeed, control heading using the pedals.

d) Maintain rotor RPM between 310 - 340 by carefully raising the Collective (1/10 – 1/20 of movement range) to reduce RPM and lowering it to increase RPM. Do not exceed 340 RPM.

e) Maintain a glide speed of 60 – 90 knots.

f) If in the transition to autorotation there is insufficient Cyclic pull range to affect the required pitch change necessary to maintain rotor RPM, increase Collective by 1/6 – 1/5 of its movement range. This will increase pitch authority. Once the desired glide speed of 60 – 90 knots is reached, the Collective can be reduced again in order to maintain main rotor RPM.

B. Autorotation descent

Descent parameters (airspeed and rotor RPM) for an autorotation landing are planned based on the desired goals of the pilot as determined before initiating autorotation – either to maintain a minimum rate of descent or maximum glide distance.

Figure 9.8 displays control positions for balancing the helicopter during autorotation.

Minimum Rate of Descent. Minimum rate of descent is achieved using a glide speed of 55 – 65 knots (indicated). The rate of descent at these airspeeds should be 1400 – 1800 ft/min, while the glide distance should be 4.3 – 3.4x altitude. This descent can be used when altitude is greater than 1200 ft, and the pilot will be making an attempt to restart the engine in the air (so long as this is not forbidden), see 11.1.3.

Maximum Glide Distance. Maximum glide distance is achieved using a glide speed of 80 – 90 knots (indicated). The rate of descent at these airspeeds should be 1600 – 2400 ft/min, while the glide distance should be 5.3 – 3.6x altitude. This descent can be used when the landing point is at a considerable distance from the current position.

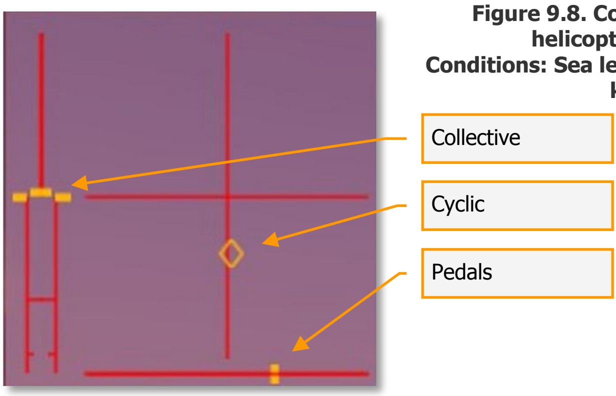


Figure 9.8. Control positions for balancing helicopter during autorotation. Conditions: Sea level, FAT +15°C, empty, speed 70 knots, 320 RPM.

The rate of descent depends primarily on rotor RPM and to a lesser degree on helicopter weight. Rotor RPM, in turn, depend on the position of the Collective. If the Collective is set to minimum (down), rotor RPM will be 320 – 340 and the rate of descent will be close to maximum. With a slightly raised position of the Collective so that rotor RPM is 295 – 320, the rate of descent will be close to minimum.

As you can see, the higher rotor RPM correspond to higher rates of descent.

With increased helicopter weight, the rate of descent increases slightly: the difference in the rates of descent between an empty and fully loaded helicopter is +200 – 300 ft/min, if all else is equal.

C. Autorotation landing

Below will be described one of the methods that can be used for an autorotation landing. It is not the only possible method.

Choose a landing point that provides 300 – 500 ft of clear glidepath from any obstacles 100 ft or lower. Perform the following steps:

a) Maintain 80 – 70 knots and 300 – 320 RPM until reaching an altitude of 200 – 150 ft. The rate of descent should be 2000 – 1700 ft/min. Keep in mind that approximately 12 – 15 seconds will pass between passing through 200 ft and landing;

b) (t = 0 sec) from an altitude of 200 – 150 ft slowly (3 – 4 seconds) (Figure 9.9) pull the Cyclic back to set a pitch angle of +15 – 20° while (Figure 9.10):

(1) (t = +4 sec) rotor RPM will increase slightly (up to 330 – 340);

(2) rate of descent will decrease;

(3) the helicopter may slide slightly left due to increased tail rotor lift;

(4) any left sliding tendency should be corrected with slight right Cyclic adjustment (1/8 – 1/10 of movement range). Keep in mind that during an autorotation landing, the helicopter will generally be balanced with a slight right bank (Figure 9.11) – the slower the airspeed, the greater right bank (up to 1 – 3°).

Figure 9.9. Position of the cockpit before changing the pitch.

Figure 9.10. Position of the cockpit after changing the pitch.

Figure 9.11. Bank of the helicopter during speed reduce.

c) (t = +6 sec) focus eyes on the landing point;

d) (t = +6 – 7 sec) from an altitude of 100..80 ft or when passing through 40 – 35 knots on the airspeed indicator (typically accompanied by a "sinking" of the helicopter), smoothly adjust the Cyclic forward (within about 3 – 4 sec) to set a landing pitch angle (from +15 – 20° to +4 – 6°) while simultaneously increasing Collective for the first time from its lowered position to 1/5 – 1/3 of its movement range within approximately 1 – 1.5 sec while:

   (1) (t = +9 sec) main and tail rotor RPM will begin to drop, producing a left turning tendency, up to 10°;

   (2) correct the left turning tendency by increasing right pedal by approximately 1/4 – 1/3 of its movement range, while slightly increasing right Cyclic to compensate for any left slide;

e) (t = +10 – 15 sec) as the ground is nearer and based on the rate of descent increase collective once more up to 1/2 – 2/3 of its movement range within 3 – 4 sec. Be careful to prevent the helicopter from nosing over upon touchdown;

f) the helicopter will touch down and possibly continue to roll for another 5 – 10 ft before coming to a stop.

WARNING! Never "yank" the collective all the way up! This can cause the helicopter to "float" up and enter a short hover at an altitude of 15 – 20 ft, before rotor RPM drops toward 200 and less, resulting in a drop down to the ground with a high sink rate and likely damage.

After touchdown, if the forward speed is excessive, pull the Cyclic back approximately 1/3 – 1/2 of its movement range to slow the helicopter using the main rotor. Once the helicopter is stopped, return the Cyclic to neutral and carefully (within 2 – 3 sec) lower the Collective all the way down.

NOTES

10 COMBAT EMPLOYMENT

10. COMBAT EMPLOYMENT

This chapter includes a description of UH-1H combat employment, see also chapter 8 for ARMAMENT description.

As described in chapter 8, in addition to the two M60D door gunner machine guns, the UH-1H can be armed with two XM158 rocket pods with 7 70mm unguided rockets each (or XM159 pods with 19 rockets each) and two M134 6-barrel Gatling type Miniguns with 5400 rounds total. Unless noted otherwise, the remainder of the chapter will assume a standard combat load of 2xXM158 + 2xM134.

When learning to fly and employ the weapon systems, it is recommended that you enable the WEAPON STATUS indicator in the Options/Special/UH-1H page of the game menu Figure 10.1..Figure 10.3 (remove/display WEAPON STATUS indicator together in hint AUTOPILOT MODE from/on the screen [LShift+LCtrl+H]).

Figure 10.1. Location of the WEAPON STATUS indicators.

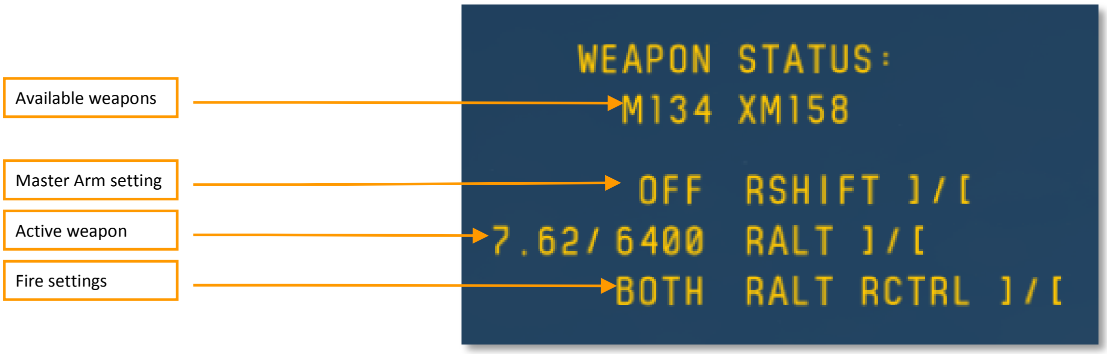


Figure 10.2. Weapon systems status indicator: OFF (not firing), 7.62 (M134 active weapon), 6400 (current balance cartridges), BOTH (fire simultaneously from two guns).

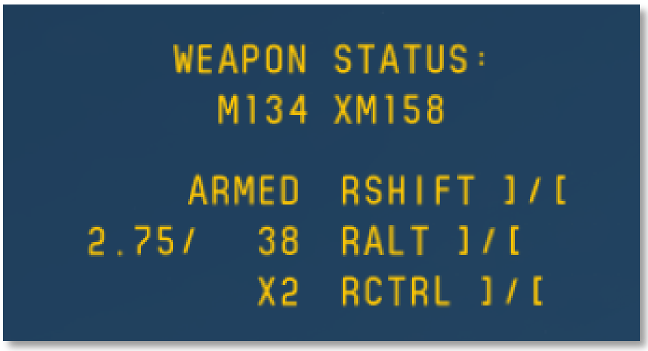


Figure 10.3. Weapon systems status indicator: ARMED (ready to open fire), 2.75 (XM158 active weapon), 38 (current balance rockets), X2 (two rockets from each launcher when you press the button once).

A. Flight control

When the helicopter is loaded with the standard combat load, the center of gravity (CG) shifts forward. This results in a greater amount of stick back pressure (pull) required by during takeoff and hover (1/3 – 1/4 of its movement range). Similarly, balanced forward flight is established with approximately 1/3 – 1/4 less forward stick than usual.

B. Cockpit procedures

Weapon systems are turned on prior to entering the combat area.

EMPLOYING THE XM158 (XM159) WEAPON SYSTEM (ROCKETS):

a) Select the desired cockpit position (pilot or copilot) – [1], [2];

b) Select "2.75" on the armament control panel – [RALT+[ ];

c) Set the desired number of rocket pairs to be fired on the armament control panel (1 to 7 from each launcher) – [RCTRL+]] and [RCTRL+[ ];

d) Establish coordinated flight with minimizing descent (climb) and by minimizing sideslip (center the ball), which will maximize accuracy of fire;

e) Turn on the aiming sight – [M]. If playing as pilot (right side), a virtual aiming reticle will appear (Figure 10.4). If playing as copilot (left side), the flexible sight will move down and the sight reticle will appear (Figure 8.9);

f) Turn on the MASTER ARM switch – [RSHIFT+]] twice.

The helicopter is now prepared for rocket employment.

Figure 10.4. Virtual aiming reticle.

When autopilot is engaged, the "Autopilot: ON" indication is added to the Weapons Status Indicator.

When playing as copilot (left side) and Flexible Mode is active, the autopilot is engaged automatically. This is designed to simulate the pilot maintaining the helicopter's attitude while the player operates the weapon system. The autopilot can be manually turned on and off with the [LWIN+A] key. The autopilot engages whenever the following conditions are true:

a) Flexible Mode is active;

b) The OFF-SAFE-ARMED switch is in the ARMED position.

Whenever the autopilot is engaged, the "Autopilot: ON" indication is added to the Weapons Status Indicator.

EMPLOYING THE M134 WEAPON SYSTEM (MINIGUNS):

a) Select the desired cockpit position (pilot or copilot) – [1], [2];

b) Select "7.62" on the armament control panel – [RALT+]];

c) Set the gun selector on the armament control panel to LEFT, RIGHT, or ALL as desired – [RAlt+RCtrl+]], [RAlt+RCtrl+[ ];

d) Turn on the aiming sight – [M]. If playing as pilot (right side), a virtual aiming reticle will appear. If playing as copilot (left side), the flexible sight will move down and the sight reticle will appear;

e) Turn on the MASTER ARM switch – [RSHIFT+]] twice (see above). The helicopter is now prepared for employment of the M134 miniguns.

When flying as copilot (left side) and Flexible Mode is active, the guns can be aimed by rotating and tilting the aiming sight using either keyboard commands [,], [.], [/], [;] or the mouse, if mouse-look is enabled [LALT+C].

C. Lining up, aiming, and firing

Attempt to enter the target area undetected by maintaining nap-of-the-earth flight to the target area and avoid known air defense positions. When approaching to within 9000-8000 ft of the target, climb to acquire the target. The climb can be performed either by pulling the cyclic to raise the nose to a pitch angle of 10-15° or by increasing collective to gain altitude while maintaining pitch angles. The latter method is preferable as it maintains the target in view in front of the helicopter, prevents an increase of the helicopter's silhouette for enemy defenses, and minimizes loss of airspeed in the climb. After completing the climb, confirm the target's location and maneuver the helicopter to face the target.

When lining up on the target from a horizontal turn, begin leveling out of the turn at an angle to the target approximately equal to the angle of bank in the turn. I.e. when performing a turn with 40° of bank, begin to level out of the turn when the target is approximately 40° off the nose. Further:

a) Once leveled out of the turn toward the target, maintain level flight at an airspeed of 80-100 knots and establish coordinated flight by minimizing sideslip (center the ball), which will maximize accuracy of fire;

b) When employing rockets, place the aiming reticle over the target at a range of 6000 ft using the cyclic, open fire at a range of 5000-3000 ft.

c) When employing the M134 miniguns, place the aiming reticle over the target at a range of 3000 ft, open fire at a range of 2500-1500 ft.

When firing the M134 miniguns in STOW mode or 2.75 rockets while continuing to manually fly the helicopter, a slight recoil force (70 kg) will produce a pitching down tendency. For long bursts, anticipate the recoil by aiming 0,5..1 pipper widths ABOVE the target.

D. Attack completion

When weapon fire is complete, perform an aggressive turn away from the target and reduce altitude while accelerating to maximum airspeed (110-120 knots). To minimize the probability of damage from enemy fire, perform defensive maneuvering by alternating left and right turns of approximately 40-50° for 4-5 seconds until the target is at a range of 3000-4000 ft.

Repeat attack passes as required.

When the attack is complete, set MASTER ARM to OFF and return to base.

11 EMERGENCY PROCEDURES

11. EMERGENCY PROCEDURES

11.1.1. Definition Of Emergency Terms

For the purpose of standardization the following definitions shall apply:

a) The term LAND AS SOON AS POSSIBLE is defined as executing a landing to the nearest suitable landing area without delay. The primary consideration is to assure the survival of occupants.

b) The term LAND AS SOON AS PRACTICABLE is defined as executing a landing to a suitable airfield, heliport, or other landing area as the situation dictates.

c) The term AUTOROTATE is defined as adjusting the flight controls as necessary to establish an autorotational descent (See 3.1.13 and 9.7).

(1) COLLECTIVE ADJUST as required to maintain rotor RPM.

(2) PEDALS ADJUST as required.

(3) THROTTLE ADJUST as required.

(4) AIRSPEED ADJUST as required.

d) The term EMER SHUTDOWN is defined as engine stoppage without delay.

(1) THROTTLE – OFF.

(2) FUEL switches – OFF.

(3) BAT switch – OFF.

CAUTION. The maximum engine torque available for any ambient condition will be reduced by 6 to 8 PSI when the GOV AUTO/EMER switch is placed in the EMER position.

e) The term EMER GOV OPNS is defined as manual control of the engine RPM with the GOV AUTO/EMER switch in the EMER position. Because automatic acceleration, deceleration, and overspeed control are not provided with the GOV switch in the EMER position, throttle and collective coordinated control movements must be smooth to prevent compressor stall, overspeed, overtemperature, or engine failure.

(1) GOV switch – EMER.

(2) Throttle – adjust as necessary to control RPM.

(3) Land as soon as possible.

11.1.2. Engine Malfunction – Partial or Complete Power Loss

A. Indications

The indications of an engine malfunction, either a partial or a complete power loss, are:

a) change in engine and transmission noise;

b) left yaw (up to 10..15°);

c) drop in engine rpm, drop in rotor rpm;

d) low rpm audio alarm, illumination of the rpm warning light;

e) descent of helicopter.

B. Flight characteristics

a) Control response with an engine inoperable is similar to a descent with power.

b) Airspeed above the minimum rate of descent values will result in greater rates of descent and should only be used as necessary to extend glide distance (see 9.7).

c) Airspeeds below minimum rate of descent airspeeds will increase rate of descent and decrease glide distance.

d) Should the engine malfunction during a left bank maneuver, right cyclic input to level the aircraft must be made simultaneously with collective pitch adjustment. If the collective pitch is decreased without a corresponding right cyclic input, the helicopter will pitch down and the roll rate will increase rapidly, resulting in a significant loss of altitude.

WARNING. Do not close the throttle. Do not respond to the rpm audio and/or warning light illumination without first confirming engine malfunction by one or more of the other indications. Normal indications signify the engine is functioning properly and that there is a tachometer generator failure or an open circuit to the warning system, rather than an actual engine malfunction.

C. Partial power condition

Under partial power conditions, the engine may operate relatively smoothly at reduced power or it may operate erratically with intermittent surges of power. In instances where a power loss is experienced without accompanying power surging, the helicopter may sometimes be flown at reduced power to a favorable landing area. Under these conditions, the pilot should always be prepared for a complete power loss. In the event a partial power condition is accompanied by erratic engine operation or power surging, and flight is to be continued, the GOV switch may be moved to the EMER position and throttle adjusted in an attempt to correct the surging condition. If flight is not possible, close the throttle completely and complete an autorotational landing.

D. Complete power loss

a) Under a complete power loss condition, delay in recognition of the malfunction, improper technique or excessive maneuvering to reach a suitable landing area reduces the probability of a safe autorotational landing. Flight conducted within the caution area of the height-velocity chart exposes the helicopter to a high probability of damage despite the best efforts of the pilot:

(1) in altitude (skid height above ground) 10..430 feet and velocity about 0 knots (hovering);

(2) in altitude (skid height above ground) about 100 feet and velocity below 50 knots;

(3) in altitude (skid height above ground) below 15 feet and velocity above 60 knots;

b) From conditions of low airspeed and low altitude, the deceleration capability is limited, and caution should be used to avoid striking the ground with the tail rotor. Initial collective reduction will vary after an engine malfunction dependent upon the altitude and airspeed at the time of the occurrence. For example, collective pitch may not need to be decreased when an engine failure occurs at a hover in ground effect; whereas, during cruise flight conditions, altitude and airspeed are sufficient for a significant reduction in collective pitch, thereby, allowing rotor rpm to be maintained in the safe operating range during autorotational descent. At high gross weights, the rotor may tend to overspeed and require collective pitch application to maintain the rpm below the upper limit. Collective pitch should never be applied to reduce rpm below normal limits for extending glide distance because of the reduction in rpm available for use during autorotational landing.

11.1.3. Engine Restart – During Flight

After an engine failure in flight, resulting from a malfunction of fuel control unit, an engine start may be attempted. Because the exact cause of engine failure cannot be determined in flight, the decision to attempt the start will depend on the altitude and time available, rate of descent, potential landing areas, and crew assistance available. Under ideal conditions approximately one minute is required to regain powered flight from time the attempt start is begun. If the decision is made to attempt an in-flight start:

1. Throttle – OFF.
2. STARTER GEN switch – START.
3. FUEL switches – ON.
4. GOV switch – EMER.
5. Attempt start.

(1) Starter switch – Press.

(2) Throttle – Open slowly to 6400 to 6600 rpm as N1 passes through 8%. Control rate of throttle application as necessary to prevent exceeding EGT limits.

(3) Starter Switch – Release as N1 passes through 40%. After the engine is started and powered flight is reestablished, continue with manual control. Return the STARTER GEN switch to STANDBY.

6. Land as soon as possible.

11.1.4. Engine Overspeed

Engine overspeed will be indicated by a right yaw, rapid increase in both rotor and engine rpm, rpm warning light illuminated, and an increase in engine noise. An engine overspeed may be caused by a malfunctioning N2 governor or fuel control. Although the initial indications of high N2 rpm and rotor rpm are the same in each case, actions that must be taken to control rpm are distinctly different. If the N2 governor malfunctions, throttle reduction will result in a corresponding decrease in N2 rpm. In the event of a fuel control malfunction, throttle reduction will have no effect on N2 rpm. If an overspeed is experienced:

a) Collective – Increase to load the rotor in an attempt to maintain rpm below the maximum operating limit.

b) Throttle – Reduce until normal operating rpm is attained. Continue with manual throttle control. If reduction of throttle does not reduce rpm as required:

WARNING. Land even if manual throttle corrects the overspeed since there is a chance of an impending engine failure due to the debris generated by the initial N2 failure.

c) EMER GOV OPNS

11.1.5. Transmission Oil – Hot or Low Pressure

If the transmission oil temperature XMSN OIL HOT caution light illuminates, limits on the transmission oil temperature gauge are exceeded; XMSN OIL PRESS caution light illuminates, or limits on the transmission oil pressure gauge are exceeded (low or high):

a) Land as soon as possible.

b) EMER SHUTDOWN – After landing.

WARNING. Do not close throttle during this emergency procedure. Descent and landing must be made with normal engine operating RPM.

Should transmission oil pressure drop to zero psi, a valid cross reference cannot be made with the oil temperature indicators. The oil temperature gauge and transmission oil hot warning lights are dependent on fluid for valid indications.

11.1.6. Tail Rotor Malfunctions

Because of the many different malfunctions that can occur, it is not possible to provide a solution for every emergency. The success in coping with the emergency depends on quick analysis of the condition.

11.1.7. Complete Loss of Tail Rotor Thrust

This situation involves a break in the drive system, such as a severed driveshaft, wherein the tail rotor stops turning or tail rotor controls fail with zero thrust

A. Indications.

a) In-Flight.

(1) Pedal input has no effect on helicopter trim.

(2) Nose of the helicopter turns to the right (left sideslip).

(3) Roll of fuselage along the longitudinal axis.

(4) Nose down tucking will also be present.

WARNING. At airspeeds below 30 to 40 knots, the sideslip may become uncontrollable, and the helicopter will begin to revolve on the vertical axis (right or left depending on power, gross weight, etc.).

b) Hover.

Helicopter heading cannot be controlled with pedals.

B. Procedures.

a) In-Flight.

(1) If aircraft is uncontrollable.

(2) If safe landing area is not immediately available and powered flight is possible, continue flight to a suitable landing area at or above minimum rate of descent airspeed. Degree of roll and sideslip may be varied by varying throttle and/or collective.

CAUTION. The flare and the abrupt use of collective will cause the nose to rotate left, but do not correct with throttle. Although application of throttle will result in rotation to the right, addition of power is a very strong response measure and is too sensitive for the pilot to manage properly at this time. DO NOT ADD POWER AT THIS TIME. Slight rotation at time of impact at zero ground speed should not cause any real problem.

(3) If landing area is suitable, touchdown at a ground speed above effective translational lift utilizing throttle as necessary to maintain directional control.

(4) If landing area is not suitable for a run-on landing, a minimum ground run autorotation must be performed: enter autorotation descent (throttle off), start to decelerate at about 75 feet altitude so that forward ground speed is at a minimum when the helicopter reaches 10 to 20 feet, execute the touchdown with a rapid collective pull just prior to touchdown in a level attitude with minimum ground speed.

b) Hover.

AUTOROTATE.

11.1.8. Loss of Tail Rotor Effectiveness

This is a situation involving a loss of effective tail rotor thrust without a break in the drive system. The condition is most likely to occur at a hover or low airspeed as a result of one or more of the following.

a) Out-of-ground effect hover.
b) High pressure altitude/high temperature.
c) Adverse wind conditions.
d) Engine/rotor rpm below 6600/324.
e) Improperly rigged tail rotor.
f) High gross weight.

A. Indications

The first indication of this condition will be a slow starting right turn of the nose of the helicopter which cannot be stopped with full left pedal application. This turn rate will gradually increase until it becomes uncontrollable or, depending upon conditions, the aircraft aligns itself with the wind.

B. Procedures

Lower collective to regain control and as recovery is effected adjust controls for normal flight.

11.1.9. Main Driveshaft Failure

A failure of the main driveshaft will be indicated by a left yaw (this is caused by the drop in torque applied to the main rotor), increase in engine rpm, decrease in rotor rpm, low rpm audio alarm (unmodified system), and illumination of the rpm warning light. This condition will result in complete loss of power to the rotor and a possible engine overspeed. If a failure occurs:

a) Autorotate.
b) EMER SHUTDOWN.

11.1.10. Fire During Flight

If the fire light illuminates and/or fire is observed during flight, prevailing circumstances (such as VFR, IMC, night, altitude, and landing areas available), must be considered in order to determine whether to execute a power-on, or a power-off landing.

a) Power-On.
   (1) Land as soon as possible.
   (2) EMER SHUTDOWN after landing.
b) Power-Off.
   (1) Autorotate.
   (2) EMER SHUTDOWN.

11.1.11. Hydraulic Power Failure

Hydraulic power failure will be evident when the force required for control movement increases; a moderate feedback in the controls when moved is felt, and/or the HYD PRESSURE caution light illuminates. Control movements will result in normal helicopter response. In the event of hydraulic power failure:

a) Airspeed – Adjust as necessary to attain the most comfortable level of control movements.

b) HYD CONT circuit breaker – Out.

If hydraulic power is not restored:

c) HYD CONT circuit breaker – In.

d) HYD CONT switch – OFF.

e) Land as soon as practicable at an area that will permit a run-on landing with power. Maintain airspeed at or above effective translational lift until touchdown.

11.1.12. Control Stiffness

A failure within the irreversible valve may cause extreme stiffness in the collective or two of the four cyclic control quadrants. If the failure is in one of the two cyclic irreversible valves, caution is necessary to avoid over controlling between the failed and operational quadrants.

a) HYD CONT switch – OFF then ON.

Check for restoration of normal flight control movements.

Repeat as necessary.

If control response is not restored:

b) HYD CONT switch – OFF if normal operation is not restored.

c) Land as soon as practicable at an area that will permit a run-on landing with power. Maintain airspeed at or above effective translational lift until touchdown.

11.1.13. Flight Control Servo Hardover

a) Cyclic hardover is caused by a sequencing valve failure within the irreversible valve on either or both cyclic servos. Cyclic servo hardover will cause the cyclic to move full right forward, full left rear, full left forward, or full right rear.

b) Collective hardover is caused by a sequencing valve failure within the irreversible valve on the collective servo. The collective will move to the full up or full down position.

c) A failure of any flight control servo may render the helicopter uncontrollable unless the following action is taken.

    (1) HYD CONT switch – Select opposite position.

    (2) LAND AS SOON AS POSSIBLE at an area that will permit a run-on landing with power. Maintain airspeed at or above effective translational lift at touchdown.

11.1.14. Flight Control/Main Rotor System Malfunctions

a) Failure of components within the flight control system may be indicated through varying degrees of feedback, binding, resistance, or sloppiness. These malfunctions are normally in isolated controls, i.e. cyclic, cyclic/collective, or anti-torque. These conditions should not be mistaken for hydraulic power failure.

b) Imminent failure of main rotor components may be indicated by a sudden increase in main rotor vibration and/or unusual noise. Severe changes in lift characteristics and/or balance condition can occur due to blade strikes, skin separation, shift or loss of balance weights or other material. Malfunctions may result in severe main rotor flapping. In the event of a main rotor system malfunction, proceed as follows:

WARNING. Danger exists that the main rotor system could collapse or separate from the aircraft after landing. A decision must be made whether occupant egress occurs before or after the rotor has stopped.

(1) Land as soon as possible.

(2) EMER SHUTDOWN after landing.

11.1.15. Mast Bumping

If mast bumping occurs:

a) Reduce severity of maneuver.

b) Land as soon as possible.

11.1.16. Electrical System

11.1.17. Main Generator Malfunction

A malfunction of the main generator will be indicated by zero indication of the Main Generator Loadmeter and DC GENERATOR caution light illumination. An attempt may be made to put the generator back on line as follows:

a) GEN and BUS RESET circuit breaker – IN.

b) MAIN GEN switch – RESET then ON. Do not hold the switch in the RESET POSITION. If the main generator is not restored or if it goes off again:

c) MAIN GEN switch – OFF.

NOTE. Check that the standby generator loadmeter is indicating a load. Flight may be continued using the standby generator.

11.1.18. Landing and Ditching

11.1.19. Landing in Trees

A landing in trees should be made when no other landing area is available. Select a landing area containing the least number of trees of minimum height.

Decelerate to a zero ground speed at tree-top level and descend into the trees vertically, applying collective pitch as necessary for minimum rate of descent. Prior to the main rotor blades entering the trees, ensure throttle is OFF and apply all of the remaining collective pitch.

11.1.20. Ditching – Power On

If it becomes necessary to ditch the helicopter, accomplish an approach to an approximate 3-foot hover above the water and proceed as follows:

1. Cockpit doors – Jettison at a hover.
2. Cabin doors – Open.
3. Crew (except pilot) and passengers – Exit.
4. Hover a safe distance away from personnel.
5. Throttle – Off and autorotate. Apply full collective pitch prior to the main rotor blades entering the water. Maintain a level attitude as the helicopter sinks and until it begins to roll, then apply cyclic in direction of the roll.
6. Pilot – Exit when the main rotor is stopped.

11.1.21. Ditching – Power Off

If ditching is imminent, accomplish engine malfunction emergency procedures. Decelerate to zero forward speed as the helicopter nears the water. Apply all of the collective pitch as the helicopter enters the water. Maintain a level attitude as the helicopter sinks and until it begins to roll, then apply cyclic in the direction of the roll. Exit when the main rotor has stopped.

1. Cockpit doors – Jettison prior to entering water.
2. Cabin Doors – Open prior to entering water.
3. Exit when main rotor has stopped.

12 KEY COMMAND LIST

12. KEY COMMAND LIST

ADF Set Control panel	
ADF BFO Switch	"Q - LCtrl - LAlt"
ADF Band 190-400 kHz	"6 - LCtrl - LAlt"
ADF Band 400-850 kHz	"7 - LCtrl - LAlt"
ADF Band 850-1750 kHz	"8 - LCtrl - LAlt"
ADF Band Select (rotary)	"5 - LCtrl - LAlt"
ADF Frequency Decrease	"[- LCtrl - LAlt"
ADF Frequency Increase	"] - LCtrl - LAlt"
ADF Gain Decrease	"- - LCtrl - LAlt"
ADF Gain Increase	"= - LCtrl - LAlt"
ADF Loop Left High	"Z - LCtrl - LAlt"
ADF Loop Left Low	"X - LCtrl - LAlt"
ADF Loop Right High	"V - LCtrl - LAlt"
ADF Loop Right Low	"C - LCtrl - LAlt"
ADF Mode ADF	"2 - LCtrl - LAlt"
ADF Mode ANT	"3 - LCtrl - LAlt"
ADF Mode LOOP	"4 - LCtrl - LAlt"
ADF Mode OFF	"1 - LCtrl - LAlt"
ADF Mode Select (rotary)	"` - LCtrl - LAlt"
Armament System	
Armament Off/Safe/Armed Down	"[- RShift"
Armament Off/Safe/Armed Up	"] - RShift"
Armament Selector Down	"] - RAlt"
Armament Selector Up	"[- RAlt"
Jettison	"J"
Jettison Cover	"J - LAlt"
Pair Less	"[- RCtrl"
Pair More	"] - RCtrl"
Right/All/Left Down	"[- RAlt - RCtrl"
Right/All/Left Up	"] - RAlt - RCtrl"
Rocket reset	"R - LCtrl"
Open/close Left Gunner Door	"4 - LAlt"
Open/close Right Gunner Door	"3 - LAlt"
Central Pedestal	
Bright/Dim switch Down	"F - LCtrl"
Bright/Dim switch Up	"F - LAlt"
De-Ice On/Off	"I"
Governor Auto/Manual	"G"
Main Fuel Switch	"F"
Reset/Test switch RESET	"R"
Reset/Test switch TEST	"R - LAlt"
Cheat	
Auto execute full start procedure	"Home - LWin"
Auto execute full stop procedure	"End - LWin"
AutoPilot	"A - LWin"
AutoPilot ATTITUDE HOLD	"A - LShift - LAlt"
AutoPilot LEVEL FLIGHT	"A - LCtrl"
AutoPilot ORBIT	"A - LAlt"
Weapon Hints On/Off	"H - LCtrl - LShift"
Flexible Sight	
Flexible Sight Backup Lamp	"O - RCtrl - RAlt"
Flexible Sight Down	"."
Flexible Sight Intensity Decrease	"O - RAlt"
Flexible Sight Intensity Increase	"O - RCtrl"
Flexible Sight Lamp Off	"O - RCtrl - RShift"
Flexible Sight Left	","
Flexible Sight Main Lamp	"O"
Flexible Sight On/Off	"M"
Flexible Sight Right	"/"
Flexible Sight Up	";"
Flight Controls - anti-torque pedals	
Left pedal	"Z"

Right pedal	"X"
Flight Controls - Collective	
Collective down	"Num-"
Collective up	"Num+"
Decrease Turbine RPM	"PageDown - RCtrl"
Increase Turbine RPM	"PageUp - RCtrl"
Landing light Extend	"/ - RCtrl"
Landing light On/Off	", - RCtrl"
Landing light Retract	"/ - RWin"
Landing light Stop	"/ - RAlt"
Search light Extend	"8"
Search light Left	"9"
Search light Off	"; - RAlt"
Search light On	"; - RCtrl"
Search light Retract	"7"
Search light Right	"0"
Search light Stow	"; - RWin"
Start-up engine	"Home"
Throttle Down	"PageDown"
Throttle Up	"PageUp"
Flight Controls - Cyclic	
Co-pilot's radio trigger ICS	"Space - LShift"
Co-pilot's radio trigger RADIO	"Space - LCtrl"
Copilot Trimmer	"T - RShift"
Copilot weapon release	"Space - RAlt"
Cyclic bank left	"Left"
Cyclic bank right	"Right"
Cyclic nose down	"Up"
Cyclic nose up	"Down"
Pilot Trimmer	"T"
Pilot weapon release/Machine gun fire	"Space"
Pilot's radio trigger ICS	"Space - RShift"
Pilot's radio trigger RADIO	"Space - RCtrl"
Trimmer reset	"T - LCtrl"
Front Dash	
Altimeter Copilot, Pressure Decrease	"B - LCtrl"
Altimeter Copilot, Pressure Increase	"B - LShift"
Altimeter Pilot, Pressure Decrease	"B - RCtrl"
Altimeter Pilot, Pressure Increase	"B - RShift"
Attitude Indicator pilot, Pitch Decrease	"N - LCtrl"
Attitude Indicator pilot, Pitch Increase	"N - LShift"
Attitude Indicator pilot, Roll Decrease	"M - LCtrl"
Attitude Indicator pilot, Roll Increase	"M - LShift"
Clock Winding/Adjust	"Q - RShift"
Clock Winding/Adjust Decrease	"Q - RCtrl"
Clock Winding/Adjust Increase	"Q - RAlt"
Copilot Gyro Cage	"G - RShift"
Copilot Gyro, Pitch Decrease	"F - RCtrl"
Copilot Gyro, Pitch Increase	"F - RShift"
General	
Active Pause	"Pause - RShift"
Clickable mouse cockpit mode On/Off	"C - LAlt"
Debriefing window	"' - RShift"
End mission	"Esc"
Frame rate counter - Service info	"Pause - RCtrl"
Get New Plane - respawn	"Tab - RCtrl - RShift"
Info bar coordinate units toggle	"Y - LAlt"
Info bar toggle	"Y - LCtrl"
Jump into other aircraft	"J - RAlt"
Multiplayer chat - mode All	"Tab"
Multiplayer chat - mode Allies	"Tab - RCtrl"
Pause	"Pause"
Rearming and Refueling Window	"' - LAlt"
Score window	"'"
Screenshot	"SysRQ"
Show Pilot Body	"P - RShift" (not implemented in DCS:

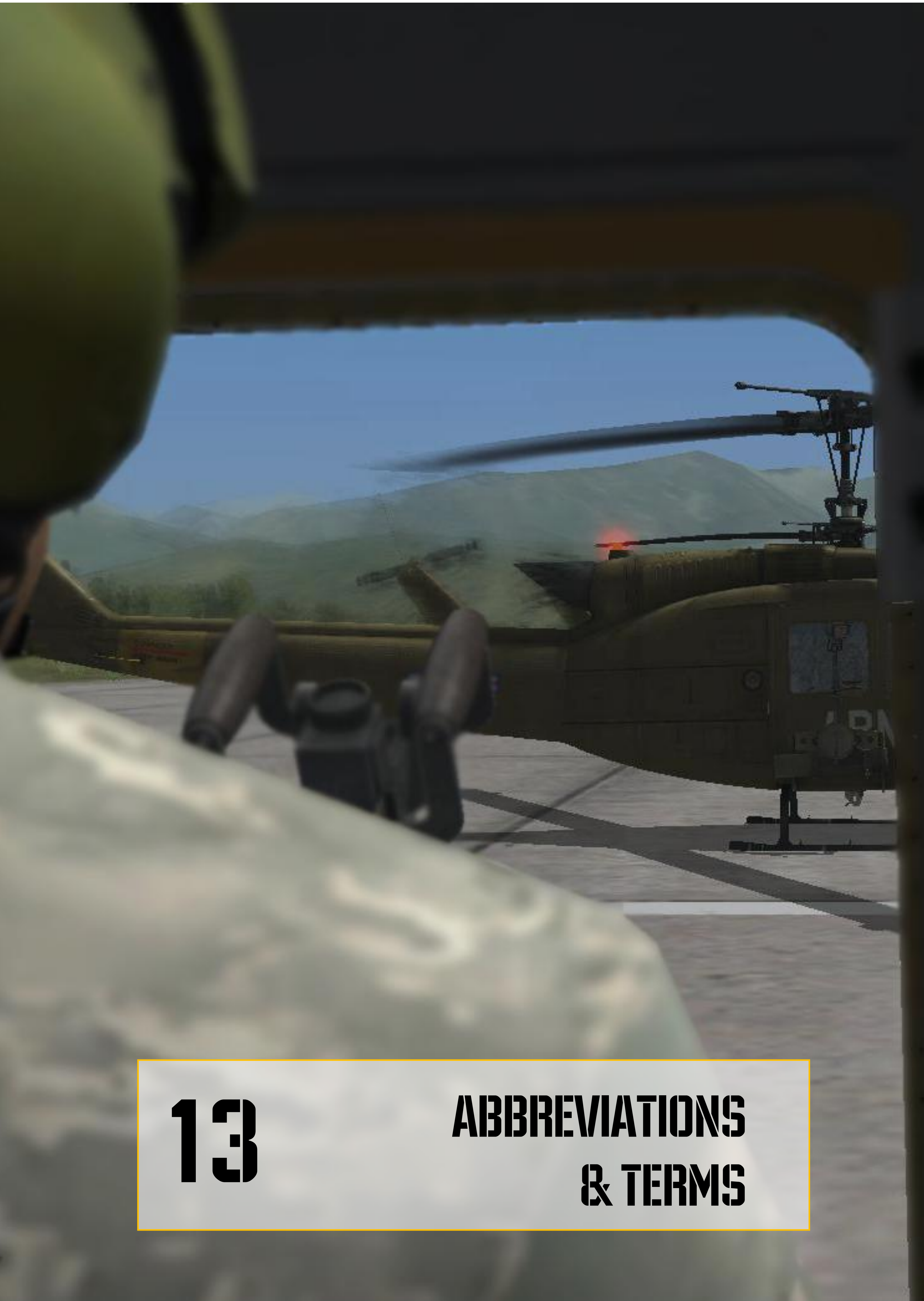
Show controls indicator	"Enter - RCtrl"
Time accelerate	"Z - LCtrl"
Time decelerate	"Z - LAlt"
Time normal	"Z - LShift"
Toggle Console	"`"
Intercom Control Panel	
Intercom Mode 1	"R - RCtrl - RShift"
Intercom Mode 2	"T - RCtrl - RShift"
Intercom Mode 3	"Y - RCtrl - RShift"
Intercom Mode 4	"U - RCtrl - RShift"
Intercom Mode INT	"W - RCtrl - RShift"
Intercom Mode PVT	"E - RCtrl - RShift"
Intercom Mode Selector(rotary)	"Q - RCtrl - RShift"
Intercom Receiver #1	"1 - RCtrl - RShift"
Intercom Receiver #2	"2 - RCtrl - RShift"
Intercom Receiver #3	"3 - RCtrl - RShift"
Intercom Receiver #4	"4 - RCtrl - RShift"
Intercom Receiver INT	"5 - RCtrl - RShift"
Intercom Receiver NAV	"6 - RCtrl - RShift"
Intercom Volume Decrease	"- - RCtrl - RShift"
Intercom Volume Increase	"= - RCtrl - RShift"
Kneeboard	
Kneeboard Next Page	"]"
Kneeboard ON/OFF	"K - RShift"
Kneeboard Previous Page	"["
Kneeboard current position mark point	"K - RCtrl"
Kneeboard glance view	"K"
Labels	
Aircraft Labels	"F2 - LShift"
All Labels	"F10 - LShift"
Missile Labels	"F6 - LShift"
Vehicle & Ship Labels	"F9 - LShift"
Main Panel	
Fire Detector Test	"T - RCtrl"
Fuel Indicator Test	"P - LShift - LCtrl - LAlt"
Night Vision Goggles	
Night Vision Goggles	"H - RShift"
Night Vision Goggles Gain Down	"H - RShift - RAlt"
Night Vision Goggles Gain Up	"H - RShift - RCtrl"
Overhead Panel	
Anti Collision Light On/Off	"L - RShift"
Battery ON/OFF	"P - LShift"
Inverter MAIN ON	"U - LShift"
Inverter OFF	"I - LShift"
Inverter SPARE ON	"O - LShift"
Inverter switch	"Y - LShift"
Main generator ON/OFF	"Q - LShift"
Main generator RESET	"A - LShift"
Main generator cover	"L - LShift"
Nav Lights Dim/Bright	"L - RAlt"
Nav Lights Flash	"L - RCtrl - RWin"
Nav Lights Off	"L - RCtrl"
Nav Lights Steady	"L - RAlt - RWin"
Non-Ess Bus NORMAL ON/MANUAL ON	"C - LShift"
Pilot/Both/Operator Down	"S"
Pilot/Both/Operator Up	"W"
Pitot Heater	"P - RAlt"
Starter-Generator STARTER/STBY GEN	"X - LShift"
Voltmeter AC switch	"W - LShift"
Voltmeter AC, AB phase	"E - LShift"
Voltmeter AC, AC phase	"R - LShift"
Voltmeter AC, BC phase	"T - LShift"
Voltmeter DC switch	"S - LShift"
Voltmeter DC, BAT	"D - LShift"
Voltmeter DC, ESS BUS	"H - LShift"
Voltmeter DC, MAIN GEN	"F - LShift"

Voltmeter DC, NON-ESS BUS	"J - LShift"
Voltmeter DC, STBY GEN	"G - LShift"
Windshield Mode Decrease	", - RAlt"
Windshield Mode Increase	". - RAlt"
Radio (UHF Control Panel)	
UHF Preset Channel Decrease	"A - LCtrl - LShift"
UHF Preset Channel Increase	"S - LCtrl - LShift"
UHF Radio 10Mhz Decrease	"W - LCtrl - LShift"
UHF Radio 10Mhz Increase	"E - LCtrl - LShift"
UHF Radio 1Mhz Decrease	"R - LCtrl - LShift"
UHF Radio 1Mhz Increase	"T - LCtrl - LShift"
UHF Radio 50Khz Decrease	"Y - LCtrl - LShift"
UHF Radio 50Khz Increase	"U - LCtrl - LShift"
UHF Radio Freq. Mode GD XMIT	"8 - LCtrl - LShift"
UHF Radio Freq. Mode MAN	"7 - LCtrl - LShift"
UHF Radio Freq. Mode PRESET	"6 - LCtrl - LShift"
UHF Radio Freq. Mode Select(rotary)	"5 - LCtrl - LShift"
UHF Radio Mode ADF	"4 - LCtrl - LShift"
UHF Radio Mode OFF	"1 - LCtrl - LShift"
UHF Radio Mode Select(rotary)	"` - LCtrl - LShift"
UHF Radio Mode T/R	"2 - LCtrl - LShift"
UHF Radio Mode T/R+G	"3 - LCtrl - LShift"
UHF Radio Squelch On/Off	"Q - LCtrl - LShift"
UHF Radio Volume Decrease	"; - LCtrl - LShift"
UHF Radio Volume Increase	"' - LCtrl - LShift"
Radio (VHF AM Control Panel)	
VHF AM Radio Freq. MHz Decrease	"O - LCtrl - LShift"
VHF AM Radio Freq. MHz Increase	"P - LCtrl - LShift"
VHF AM Radio Freq. kHz Decrease	"[- LCtrl - LShift"
VHF AM Radio Freq. kHz Increase	"] - LCtrl - LShift"
VHF AM Radio Power ON/OFF	"9 - LCtrl - LShift"
VHF AM Radio Test	"I - LCtrl - LShift"
VHF AM Radio Volume Decrease	"- - LCtrl - LShift"
VHF AM Radio Volume Increase	"= - LCtrl - LShift"
Radio (VHF FM Control Panel)	
VHF FM Radio 100kHz Decrease	"T - RCtrl - RAlt"
VHF FM Radio 100kHz Increase	"Y - RCtrl - RAlt"
VHF FM Radio 10MHz Decrease	"Q - RCtrl - RAlt"
VHF FM Radio 10MHz Increase	"W - RCtrl - RAlt"
VHF FM Radio 1MHz Decrease	"E - RCtrl - RAlt"
VHF FM Radio 1MHz Increase	"R - RCtrl - RAlt"
VHF FM Radio 50kHz Decrease	"U - RCtrl - RAlt"
VHF FM Radio 50kHz Increase	"I - RCtrl - RAlt"
VHF FM Radio Mode HOME	"4 - RCtrl - RAlt"
VHF FM Radio Mode OFF	"1 - RCtrl - RAlt"
VHF FM Radio Mode RETRAIN	"3 - RCtrl - RAlt"
VHF FM Radio Mode Select (rotary)	"` - RCtrl - RAlt"
VHF FM Radio Mode TR	"2 - RCtrl - RAlt"
VHF FM Radio Squelch CARR	"7 - RCtrl - RAlt"
VHF FM Radio Squelch DIS	"6 - RCtrl - RAlt"
VHF FM Radio Squelch Select (rotary)	"5 - RCtrl - RAlt"
VHF FM Radio Squelch TONE	"8 - RCtrl - RAlt"
VHF FM Radio Volume Decrease	"- - RCtrl - RAlt"
VHF FM Radio Volume Increase	"= - RCtrl - RAlt"
Radio (special commands)	
Attack my target	"Q - LWin"
Communication menu	"\"
Cover me	"W - LWin"
Flight - Attack air defenses	"D - LWin"
Flight - Attack ground targets	"G - LWin"
Flight - Complete mission and RTB	"E - LWin"
Join up formation	"Y - LWin"
Switch dialog	"\ - LShift"
Toggle formation	"T - LWin"
Systems	
Chip detector (rotary)	"V - LAlt"

Chip detector BOTH	"G - LAlt"
Chip detector TAIL ROTOR	"B - LAlt"
Chip detector XMSN	"T - LAlt"
Cockpit door open/close	"C - RCtrl"
Course Indicator OBS Decrease	". - LCtrl"
Course Indicator OBS Increase	", - LCtrl"
Force Trim System On/Off	"U - LAlt"
GMC Manual Heading Decrease	". - LCtrl - LShift"
GMC Manual Heading Increase	", - LCtrl - LShift"
GMC Operating Mode Slave/Gyro	"G - LCtrl - LAlt"
GMC Pointer #1 ADF/VOR	"G - LCtrl"
GMC Synchronizing +	", - LCtrl - LAlt"
GMC Synchronizing o	". - LCtrl - LAlt"
Hydraulic control On/Off	"I - LAlt"
Leave Helicopter (3 times)	"E - LCtrl"
Marker Beacon Sensitivity High/Low	"V - LShift"
Marker Beacon Volume Decrease	". - LShift"
Marker Beacon Volume Increase	". - LShift"
Views (general)	
Center View	"Num5"
F1 Cockpit view	"F1"
F1 HUD only view switch	"F1 - LAlt"
F1 Natural head movement view	"F1 - LCtrl"
F10 Jump to theater map view over current	"F10 - LCtrl"
F10 Theater map view	"F10"
F11 Airport free camera	"F11"
F11 Jump to free camera	"F11 - LCtrl"
F11 camera moving backward	"Num/ - LAlt"
F11 camera moving forward	"Num* - LAlt"
F12 Civil traffic view	"F12 - LCtrl"
F12 Static object view	"F12"
F12 Trains/cars toggle	"F12 - LShift"
F2 Aircraft view	"F2"
F2 Toggle camera position	"F2 - RAlt"
F2 Toggle local camera control	"F2 - LAlt"
F2 View own aircraft	"F2 - LCtrl"
F3 Fly-By jump view	"F3 - LCtrl"
F3 Fly-By view	"F3"
F4 Arcade Chase view	"F4 - LShift"
F4 Chase view	"F4 - LCtrl"
F4 Look back view	"F4"
F5 Ground hostile view	"F5 - LCtrl"
F5 nearest AC view	"F5"
F6 Released weapon view	"F6"
F6 Weapon to target view	"F6 - LCtrl"
F7 Ground unit view	"F7"
F8 Player targets/All targets filter	"F8 - RAlt"
F8 Target view	"F8"
F9 Landing signal officer view	"F9 - LAlt"
F9 Ship view	"F9"
Object exclude	"Delete - LAlt"
Objects all excluded - include	"Insert - LAlt"
Objects switching direction forward	"PageDown - LCtrl"
Objects switching direction reverse	"PageUp - LCtrl"
View Down Left slow	"Num1"
View Down Right slow	"Num3"
View Down slow	"Num2"
View Left slow	"Num4"
View Right slow	"Num6"
View Up Left slow	"Num7"
View Up Right slow	"Num9"
View Up slow	"Num8"
Zoom external in	"Num* - RCtrl"
Zoom external normal	"NumEnter - RCtrl"
Zoom external out	"Num/ - RCtrl"
Zoom in slow	"Num*"

Zoom normal	"NumEnter"
Zoom out slow	"Num/"
Views (cockpit)	
Camera transpose mode on/off	
Camera view down	"Num2 - RCtrl"
Camera view down slow	"Num2 - RAlt"
Camera view down-left	"Num1 - RCtrl"
Camera view down-left slow	"Num1 - RAlt"
Camera view down-right	"Num3 - RCtrl"
Camera view down-right slow	"Num3 - RAlt"
Camera view left	"Num4 - RCtrl"
Camera view left slow	"Num4 - RAlt"
Camera view right	"Num6 - RCtrl"
Camera view right slow	"Num6 - RAlt"
Camera view up	"Num8 - RCtrl"
Camera view up slow	"Num8 - RAlt"
Camera view up-left	"Num7 - RCtrl"
Camera view up-left slow	"Num7 - RAlt"
Camera view up-right	"Num9 - RCtrl"
Camera view up-right slow	"Num9 - RAlt"
Center camera view	"Num5 - RShift"
Cockpit Camera Move Back	"Num/ - RCtrl - RShift"
Cockpit Camera Move Center	"Num5 - RCtrl - RShift"
Cockpit Camera Move Down	"Num2 - RCtrl - RShift"
Cockpit Camera Move Forward	"Num* - RCtrl - RShift"
Cockpit Camera Move Left	"Num4 - RCtrl - RShift"
Cockpit Camera Move Right	"Num6 - RCtrl - RShift"
Cockpit Camera Move Up	"Num8 - RCtrl - RShift"
Cockpit panel view in	"Num0"
Cockpit panel view toggle	"Num0 - RCtrl"
Fast cockpit keyboard	"] - LShift"
Fast cockpit mouse	"[- LShift"
Head shift movement on / off	"F1 - LWin"
Normal cockpit keyboard speed	"] - LAlt"
Normal cockpit mouse speed	"[- LAlt"
Return camera	"Num5 - RCtrl"
Return camera base	"Num5 - RAlt"
Save Cockpit Angles	"Num0 - RAlt"
Set Left Gunner Seat	"4"
Set Operator Seat	"2"
Set Pilot Seat	"1"
Set Right Gunner Seat	"3"
Slow cockpit keyboard	"] - LCtrl"
Slow cockpit mouse	"[- LCtrl"
Snap View 0	"Num0 - LWin"
Snap View 1	"Num1 - LWin"
Snap View 2	"Num2 - LWin"
Snap View 3	"Num3 - LWin"
Snap View 4	"Num4 - LWin"
Snap View 5	"Num5 - LWin"
Snap View 6	"Num6 - LWin"
Snap View 7	"Num7 - LWin"
Snap View 8	"Num8 - LWin"
Snap View 9	"Num9 - LWin"
View down	"Num2 - RShift"
View down left	"Num1 - RShift"
View down right	"Num3 - RShift"
View left	"Num4 - RShift"
View right	"Num6 - RShift"
View up	"Num8 - RShift"
View up left	"Num7 - RShift"
View up right	"Num9 - RShift"
Zoom in	"Num* - RShift"
Zoom out	"Num/ - RShift"
Views (special)	
Camera jiggle toggle	"K - LShift"

Keep terrain camera altitude	"K - LAlt"
Toggle tracking fire weapon	"Num+ - RCtrl"
View all mode	"A - RCtrl - RShift - RAlt"
View enemies mode	"D - RCtrl - RShift - RAlt"
View friends mode	"F - RCtrl - RShift - RAlt"
Views (padlock)	
All missiles padlock	"Num. - RShift"
Lock terrain view	"Num. - RCtrl"
Lock view (cycle padlock)	"Num."
Threat missile padlock	"Num. - RAlt"
Unlock view (stop padlock)	"NumLock"
VOR/ILS Control Panel	
VOR/ILS Freq. MHz Decrease	"O - LShift - LAlt"
VOR/ILS Freq. MHz Increase	"P - LShift - LAlt"
VOR/ILS Freq. kHz Decrease	"[- LShift - LAlt"
VOR/ILS Freq. kHz Increase	"] - LShift - LAlt"
VOR/ILS Mode Select (totary)	"` - LShift - LAlt"
VOR/ILS Power OFF	"1 - LShift - LAlt"
VOR/ILS Power PWR	"2 - LShift - LAlt"
VOR/ILS Power TEST	"3 - LShift - LAlt"
VOR/ILS Volume Decrease	"- - LShift - LAlt"
VOR/ILS Volume Increase	"= - LShift - LAlt"



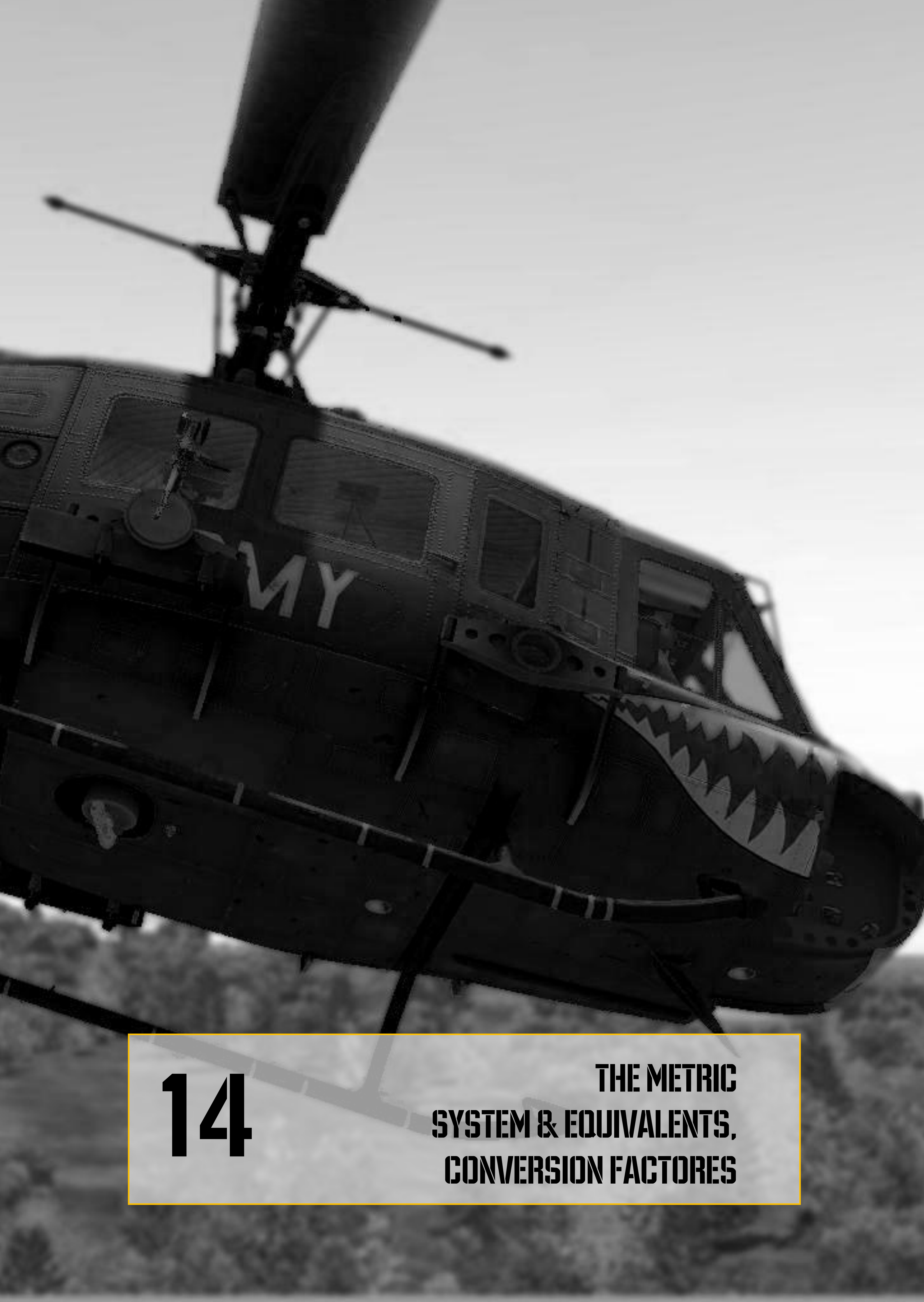
13 ABBREVIATIONS & TERMS

13. ABBREVIATIONS AND TERMS

AC	Alternating Current	COMPT	Compartment
ADF	Automatic Direction Finder	CONT	Control
AGL	Above Ground Level	CONT	Continuous
AI	Attack Imminent	CONV	Converter
ALT	Alternator	CW	Clockwise
ALT	Altitude/Altimeter	DC	Direct Current
ALTM	Altimeter	DCP	Dispenser Control Panel
AM	Amplitude Modulation	DF	Direction Finding
AMP	Ampere	DECR	Decrease
ANT	Antenna	DELTA A	Incremental Change
ATTD	Attitude	DET	Detector
AUTO	Automatic	DG	Directional Gyro
AUX	Auxiliary	DIS	Disable
AVGAS	Aviation Gasoline	DISP	Dispense
BAT	Battery	DSCRM	Discriminator
BDHI	Bearing Distance Heading Indicator	ECM	Electronic Countermeasures
BFO	Beat Frequency Oscillator (to 7.2.2)	EGT	Exhaust Gas Temperature
BL	Butt Line	ELEC	Electrical
BRIL	Brilliance	EMER	Emergency
BRT	Bright	END	Endurance
C	Celsius	ENG	Engine
CARR	Carrier	ESS	Essential
CAS	Calibrated Airspeed	EXH	Exhaust
CCW	Counter Clockwise	EXT	Extend
CDI	Course Deviation Indicator	EXT	Exterior
CG	Center of Gravity	F	Fahrenheit
CL	Centerline	FAT	Free Air Temperature
CMPS	Compass	FITG	Fitting
CNVTR	Converter	FCU	Fuel Control Unit
COLL	Collision	FM	Frequency Modulation
COMM	Communication	FOD	Foreign Object Damage
		FPS	Feet Per Second
		FREQ	Frequency

FS Fuselage Station	INVTR Inverter
FT Foot	IR Infrared
FT/MIN Feet Per Minute	IRT Indicator Receiver Transmitter
FUS Fuselage	ISA International Standard Atmosphere
FWD Forward	KCAS Knots Calibrated Airspeed
ΔF Increment of Equivalent Flat Plate Drag Area	kHz Kilohertz
G Gravity	KIAS Knots Indicated Airspeed
G Guard	km Kilometer
GAL Gallon	KTAS Knots True Airspeed
GD Guard	KN Knots
GEN Generator	kVA Kilovolt-Ampere
GND Ground	kW Kilowatt
GOV Governor	L Left
GPU Ground Power Unit	LB Pounds
GRWT Gross Weight	LDG Landing
GW Gross Weight	LH Left Hand
HDG Heading	LSB Lower Sideband
HF High Frequency	LT Lights
HIT Health Indicator Test	LTG Lighting
HTR Heater	LTS Lights
HYD Hydraulic	MAG Magnetic
IAS Indicated Airspeed	MAN Manual
ICS Interphone Control Station	MAX Maximum
IDENT Identification	MED Medium
IFF Identification Friend or Foe	MHF Medium-High Frequency
IGE In Ground Effect	MHz Megahertz
IN Inch	MIC Microphone
INCR Increase	MIN Minimum
IND Indication/Indicator	MIN Minute
INHG Inches of Mercury	MISC Miscellaneous
INOP Inoperative	mm Millimeter
INST Instrument	MON Monitor
INT Internal	MWO Modification Work Order
INT Interphone	NAV Navigation
INV Inverter	NET Network

NO Number	SEC Secure
NM Nautical Mile	SEL Select
NON-ESS Non-Essential	SENS Sensitivity
NON-SEC Non-Secure	SL Searchlight
NORM Normal	SOL Solenoid
NVG Night Vision Goggles	SQ Squelch
NR Gas Turbine Speed	SSB Single Sideband
N1 Gas Turbine Speed	STA Station
N2 Power Turbine Speed	STBY Standby
OGE Out of Ground Effect	SQ FT Square Feet
PED Pedestal	TAS True Airspeed
PLT Pilot	TEMP Temperature
PRESS Pressure	TGT Turbine Gas Temperature
PRGM Program	T/R Transmit-Receive
PSI Pounds Per Square Inch	TRANSTransfer
PVT Private	TRANSTransformer
PWR Power	TRANSTransmitter
QTY Quantity	TRQ Torque
%Q Percent Torque	UHF Ultra-High Frequency
R Right	USB Upper Sideband
RCVR Receiver	VAC Volts, Alternating Current
R/C Rate of Climb	VDC Volts, Direct Current
R/D Rate of Descent	VHF Very high Frequency
RDR Radar	VM Volt Meter
RDS Rounds	VOL Volume
REL Release	VOR VHF Omni Directional Range
REM Remote	VNE Velocity, Never Exceed (Airspeed Limitation)
RETR Retract	WL Water line
RETRAN Retransmission	WPN Weapon
RF Radio Frequency	XCVR Transceiver
RH Right Hand	XMIT Transmit
RI Remote Height Indicator	XMTR Transmitter
RPM Revolutions Per Minute	XMSN Transmission
SAM Surface to Air Missile	
SEC Secondary	



14

THE METRIC SYSTEM & EQUIVALENTS, CONVERSION FACTORES

14. THE METRIC SYSTEM AND EQUIVALENTS, CONVERSION FACTORS

14.1.1. The Metric System and Equivalents

Linear Measure

centimeter = 10 millimeters = .39 inch
decimeter = 10 centimeters = 3.94 inches
meter = 10 decimeters = 39.37 inches
dekameter = 10 meters = 32.8 feet
hectometer = 10 dekameters = 328.08 feet
kilometer = 10 hectometers = 3,280.8 feet

Weights

centigram = 10 milligrams = .15 grain
decigram = 10 centigrams = 1.54 grains
gram = 10 decigram = .035 ounce
decagram = 10 grams = .35 ounce
hectogram = 10 decagrams = 3.52 ounces
kilogram = 10 hectograms = 2.2 pounds
quintal = 100 kilograms = 220.46 pounds
metric ton = 10 quintals = 1.1 short tons

Liquid Measure

centiliter = 10 milliters = .34 fl. ounce
deciliter = 10 centiliters = 3.38 fl. ounces
liter = 10 deciliters = 33.81 fl. ounces
dekaliter = 10 liters = 2.64 gallons
hectoliter = 10 dekaliters = 26.42 gallons
kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

sq. centimeter = 100 sq. millimeters = .155 q. inch
sq. decimeter = 100 sq. centimeters = 15.5 q. inches
sq. meter (centare) = 100 sq. decimeters = 0.76 sq. feet
sq. dekameter (are) = 100 sq. meters = ,076.4 sq. feet
sq. hectometer (hectare) = 100 sq. ekameters = 2.47 acres
sq. kilometer = 100 sq. hectometers = .386 q. mile

Cubic Measure

cu. centimeter = 1000 cu. millimeters = .06 u. inch
cu. decimeter = 1000 cu. centimeters = 1.02 cu. inches
cu. meter = 1000 cu. decimeters = 35.31 u. feet

14.1.2. Approximate Conversion Factors

To change	To	Multiply by
(imperial)	(metric)	
inches	centimeters	2.540
feet	meters	.305
yards	meters	.914
miles	kilometers	1.609
knots	km/h	1.852
square inches	square centimeters	6.451
square feet	square meters	.093
square yards	square meters	.836
square miles	square kilometers	2.590
acres	square hectometers	.405
cubic feet	cubic meters	.028
cubic yards	cubic meters	.765
fluid ounces	milliliters	29,573
pints	liters	.473
quarts	liters	.946
gallons	liters	3.785
ounces	grams	28.349
pounds	kilograms	.454
short tons	metric tons	.907
pound-feet	Newton-meters	1.356
pound-inches	Newton-meters	.11296
ounce-inches	Newton-meters	.007062
(metric)	(imperial)	
centimeters	inches	.394
meters	feet	3.280
meters	yards	1.094
kilometers	miles	.621
km/h	knots	0.54
square centimeters	square inches	.155
square meters	square feet	10.764
square meters	square yards	1.196
square kilometers	square miles	.386
square hectometers	acres	2.471
cubic meters	cubic feet	35.315
cubic meters	cubic yards	1.308
milliliters	fluid ounces	.034
liters	pints	2.113
liters	quarts	1.057
liters	gallons	.264
grams	ounces	.035
kilograms	pounds	2.205
metric tons	short tons	1.102

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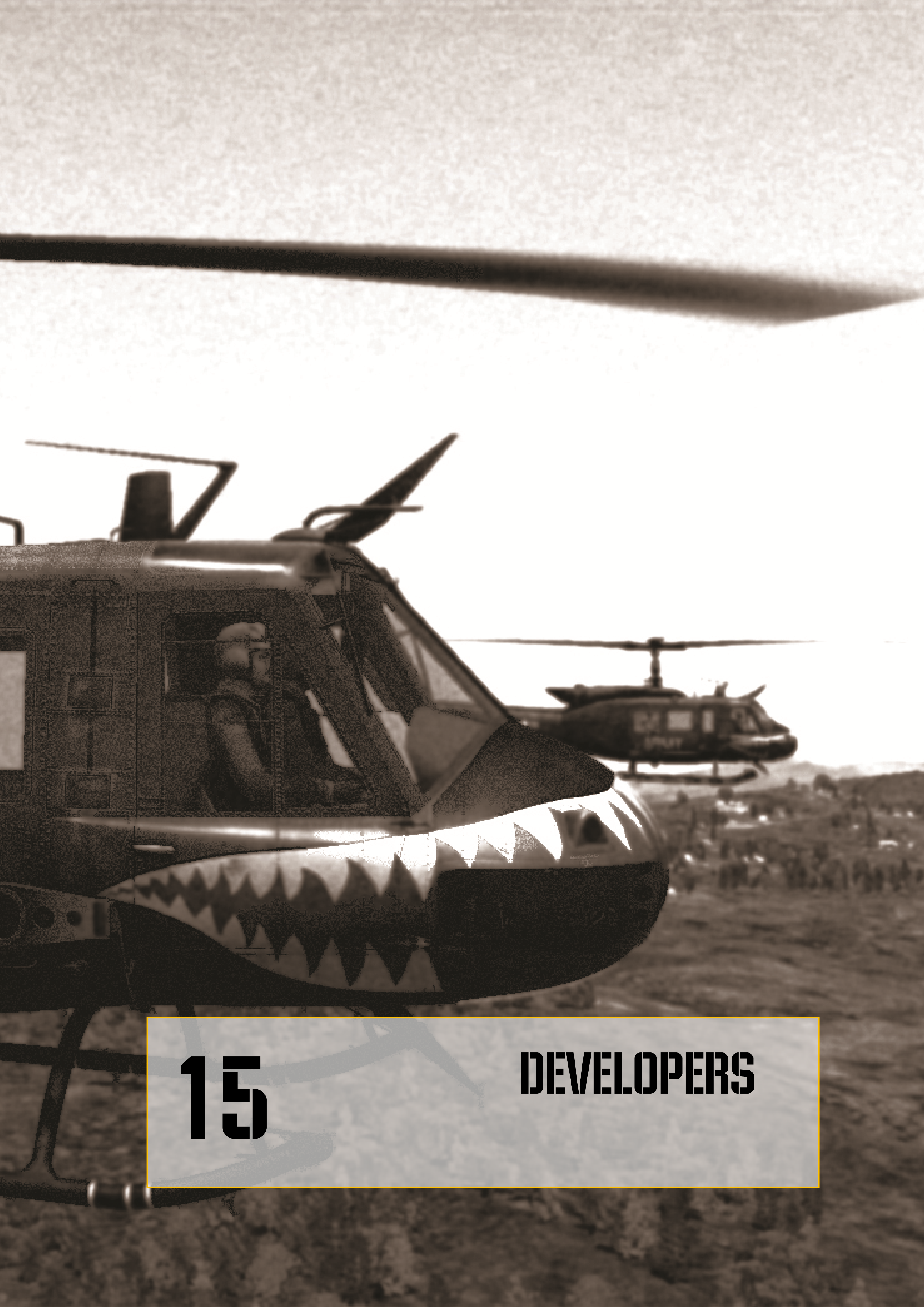

15 DEVELOPERS

15. DEVELOPERS

BELSIMTEK

MANAGEMENT

Alexander Podvoyskiy	Project and QA Manager, technical documentation

PROGRAMMERS

Andrey Kovalenko	Administration, avionics, weapons, damage model
Nikolay Volodin	Flight dynamics, damage model
Vladimir Mikhailov	Engine and related system, game autopilot
Boris Silakov	Systems of helicopter, game autopilot
Alexander Mishkovich	Systems of helicopter
Evgeny Gribovich	Systems of helicopter, avionics, effects
Konstantin Kuznetsov "btd"	Sound Developer, Music Composer

DESIGNERS

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Andrey Reshetko	Pilots and gunners
Stanislav Kolesnikov	Cockpit

SCIENCE SUPPORT

Sergey "Vladimirovich"	Mathematic model of dynamics

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Gavin "159th_Viper" Torr

Gene "EvilBivol-1" Bivol

"graywo1fg"

"Frogfoot"

"joyride"

“HuggyBear”

"luckybob"

Matt "Wags" Wagner

"paulkriii"

Peter "Weta43" McAllister

Roberto "Vibora" Seoane Penas

Norm "SiThSpAwN" Loewen

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Werner "derelor" Siedenburg

"weta43"

“Furia”

IT AND CUSTOMER SUPPORT

MISSION AND CAMPAIGNS

Oleg “Dzen” Fedorenko, Dmitry “Laivynas” Koshelev

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TRAINING

Gene "EvilBivol-1" Bivol	Training missions, technical documentation, support Forum

THIRD PARTIES

Dillon Aero (www.dillonaero.com): UH-1 support (live - video / audio). Dillon designs, develops, manufactures, and supports the M134D Gatling Gun and related products for air, land and sea applications. The company's growing product line includes high-capacity feed systems for the M134D and M240, weapon mounts, and safety and support equipment for the Gatling Gun.

American Huey 369 (www.americanhuey369.com): UH-1 support (live - video / audio / Rocket and Minigun systems). American Huey 369 was formed for the purpose of preserving the legendary UH-1 Huey in honor and tribute to all U.S. Military Veterans & Patriots and for educating future generations on the Vietnam War's most iconic aircraft.

Anthony Thigpen – UH-1 live audio recording (student - Collins College).

Richard Newsome – UH-1 live audio recording (student - Collins College).

Valerie Rubio – UH-1 live audio recording (student - Collins College).

Rick Fowler – UH-1 live audio recording supervisor (instructor - Collins College).

Jon Lemond – coordination (instructor - Collins College).

Roger Arias (www.worldatplay.com): Subject Matter Expert (former Army Aviator), Business / Product Development - Game Industry (Licensing – Textron / Bell Helicopter, UH-1 on-site permissions / live access).

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16. BIBLIOGRAPHY AND SOURCES

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