TECHNICAL MANUAL

OPERATOR'S MANUAL

ARMY MODEL

CH-47A HELICOPTER

This copy is a reprint which includes current pages from Change 1.

This manual supersedes TM 55-1520-209-10, 30 March 1973, including all changes.

HEADQUARTERS, DEPARTMENT OF THE ARMY
9 JANUARY 1979

This manual is published for the use of all concerned.

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31 Operator Requirements for CH-47A aircraft.

WARNING

Personnel performing instructions involving operations, procedures, materials, and practices which are included or implied in this technical manual shall observe the following instructions. Disregard of these warnings and precautionary information can cause serious injury or death.

Warnings, cautions, and notes emphasize important and critical instructions. They are defined as follows:

WARNING

An operating procedure or practice which, if not correctly followed, will result in personnel injury or loss of life.

CAUTION

An operating procedure or practice which, if not strictly observed, will result in damage or destruction of equipment.

NOTE

An operating procedure or condition which it is essential to highlight.

Dangerous Static Charges. Ground the helicopter during parking, fueling, or defueling.

Dangerous Voltages Exist in the Electronic Equipment. Be careful when working on the 150- and 300-volt dc circuits and on the ac generator 115- and 200-volt ac outputs.

Dangerous Voltages May Exist at Antenna Terminals. Be careful when working near the antenna or the antenna terminals. Radio-frequency (rf) high voltages exist at these points when transmitters are operating. Contact with radiating antennas can cause serious rf burns.

Poisonous Carbon Monoxide Fumes. Toxic carbon monoxide fumes may be present inside the helicopter whenever the apu or engines are operating with the cargo ramp open. Ventilate the cockpit.

Dangerous Fuel Handling. Incorrect fuel handling causes fire hazards. Ground the helicopter when fueling or defueling.

Corrosive Battery Electrolyte (Potassium Hydroxide). Wear rubber gloves, apron, and face shield when handling leaking batteries. If potassium hydroxide is spilled on clothing, hands, or other material, immediately flood the affected area with cold water or boric acid solution.

Acids and Alkalines. Do not add water to acids. A violent action will result. Acids should be added to water in small quantities. Ruststripper is an alkaline solution. Avoid contact with the skin. Wear protective clothing. Wash thoroughly after using.

Solvent and Cleaning Solutions. These materials are generally toxic and many (toluene, benzene, xylene, methyl-ethyl-ketone, perchlorethylene, naphtha, trichloroethylene) are highly flammable. Work in a well ventilated area away from open flames. Avoid inhaling fumes and prolonged contact with the skin. Wear protective clothing and goggles. Wash thoroughly after using.

Windshield Repellant. Do not let windshield rain repellant contact open flame. Deadly hydrogen fluoride gas could be generated. Wash hands with soap and water after handling repellant.

Antiseize Compounds. Some antiseize compounds are irritants. Avoid inhaling fumes and contact with the skin. Wear protective clothing. Wash thoroughly after using.

Paints, Varnishes, Dopes, Thinners, Lubricants, and Fuels. These materials are generally highly flammable and may be irritants. Work in a well ventilated area away from open flames. Avoid inhaling fumes and prolonged contact with the skin. Wash thoroughly after using.

Epoxy Resins, Cements, and Adhesives. These materials may contain toxic or irritating substances. They may also be flammable. Work in a well ventilated area away from open flames. Wear protective clothing. Avoid contact with the skin. Wash thoroughly after using.

Radiation Hazard. Some instruments contain radioactive material. (See TB 55-1500-314-25.) Do not try to disassemble these instruments. They present no radiation hazard unless seal is broken. If you think seal is broken, do not remove instrument from aircraft until you consult Base Radioactive Protective Officer (AR 40-14). Use a beta-gamma radiac meter AN/PDR-27 or equivalent to determine if instrument contains radioactive material (radium).

Fire Extinguishing Agents. Avoid repeated or prolonged exposure to high concentration of bromochloromethane (CB) or decomposition products. CB is a narcotic agent of moderate intensity but prolonged duration. It is less toxic than carbon tetrachloride, methylbromide, or products of combustion. Take normal precautions while using bromochloromethane. Use oxygen masks when available.

Monobromotrifluoromethane (CF_3Br) is highly volatile but is not easily detected by its odor. Although nontoxic, it is about the same as other freons and carbon dioxide, causing danger to personnel primarily by reduction of oxygen available for proper breathing. Do not allow the liquid to come into contact with your skin. It may cause frostbite or low temperature burns.

Noise. Sound pressure levels in this aircraft during some operating conditions exceed the Surgeon General's hearing conservation criteria, as defined in TB MED 251. Hearing protection devices, such as the aviator helmet or ear plugs, are required to be worn by all personnel in and around the aircraft during its operation.

FOD. Make sure area is clear of foreign objects before closing access doors, panels, and fairings. If the area is not cleared, damage to components and systems could result in personal injury or death.

TECHNICAL MANUAL

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 9 January 1979

Operator's Manual

ARMY MODEL
CH-47A HELICOPTER

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U. S. Army Troop Support & Aviation Materiel Readiness Command, ATTN: DRSTS-MTPS, 4300 Goodfellow Boulevard, St. Louis, MO 63120. A reply will be furnished directly to you.

CHAPTER 1

INTRODUCTION

1-1. General.

These instructions are for use by the operator. They apply to CH-47A helicopters.

1-2. Warnings, Cautions, and Notes.

Warnings, cautions, and notes are used to emphasize important and critical instructions and are used for the following conditions:

WARNING

An operating procedure, practice, etc. which, if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc., which if not strictly observed, could result in damage or destruction of equipment.

NOTE

An operating procedure, condition, etc., which it is essential to highlight.

1-3. Helicopter Description.

This manual contains the complete operating instructions and procedures for the CH-47A helicopter. The CH-47A is a tandem rotor, twin-engine helicopter. It is powered by two T55-L-7 series engines. The primary mission of the helicopter is troop and cargo transport. The observance of procedures is mandatory except when modification is required because of multiple emergencies, adverse weather, terrain, etc. Your flying experience is recognized, therefore, basic flight principles are not included. It is required that THIS MANUAL BE CARRIED IN THE HELICOPTER AT ALL TIMES.

1-4. Introductory Material.

The following paragraphs describe certain sections of this manual, referenced forms, manuals, and Army Regulations. Also included is the procedure to follow to report errors or to recommend changes.

1-5. Appendix A, References.

Appendix A is a listing of official publications cited within the manual applicable to and available to flight crews.

1-6. Index.

The index lists, in alphabetical order, every titled paragraph, figure, and table contained in this manual. Chapter 7, Performance Data, has its own index within the chapter.

1-7. Army Aviation Safety Program.

Reports necessary to comply with the Army Aviation Safety Program are prescribed in AR385-40.

1-8. Destruction of Army Material to Prevent Enemy Use.

For information concerning destruction of Army material to prevent enemy use, refer to TM 750-244-1-5.

1-9. Equipment Serviceability Criteria.

Equipment serviceability criteria for the CH-47A helicopter are prescribed in TM 55-1500-210-ESC.

1-10. Forms and Records.

Army aviators flight record and aircraft maintenance records which are to be used by crewmembers are prescribed in TM 38-750 and TM 55-405-9.

1-11. Reporting of Errors.

Every effort is made to keep this publication current and error free. Review conferences with using personnel, and a constant review of accident and flight test reports assure inclusion of the latest data in this publication. However, we cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Reports of errors and omissions or recommendations for improving this publication by you is encouraged. Your letter or DA Form 2028, Recommended Changes to Publications and Blank Forms should be mailed to Commander, U.S. Army Troop Support and Aviation Materiel Readiness Command, ATTN: DRSTS-MTPS, 4300 Goodfellow Blvd., St. Louis, Missouri 63120.

1-12. Change Symbol Explanation.

Changes, except as noted below, to the text and tables, including new material on added pages, are indicated by a vertical line. The vertical line is in the outer margin and extends close to the entire area of the material affected with the following exception: pages with emergency markings, which consist of black diagonal lines around three edges, may have the vertical line or change symbol placed along the inner margins. Symbols show current changes only. A miniature pointing hand symbol is used to denote a change to an illustration. However, a vertical line in the outer margin, rather than miniature pointing hands, is used when there have been extensive changes made to an illustration. Change symbols are not used to indicate changes in the following:

a. Introductory material.

b. Indexes and tabular data where the change cannot be identified.

c. Blank space resulting from the deletion of text, an illustration, or a table.

d. Correction of minor inaccuracies, such as spelling, punctuation, relocation of material, etc. Unless such correction changes the meaning of instructive information and procedures.

1-13. Aircraft Designation System.

The designation system prescribed by AR70-50 is used in aircraft designations as follows:

Example CH-47A

C - Mission symbol (cargo)
H - Basic mission and type symbol (Helicopter)
47 - Design number
A - Series symbol

1-14. Use of Shall, Should, and May.

Within this technical manual, the word *shall* is used to indicate a mandatory requirement. The word *should* is used to indicate a nonmandatory but preferred method of accomplishment. The word *may* is used to indicate an acceptable method of accomplishment.

CHAPTER 2

AIRCRAFT AND SYSTEMS DESCRIPTION AND OPERATION

SECTION I HELICOPTER

2-1. General.

The CH-47A (figure 2-1 thru 2-3) is a twin-turbine-engine, tandem rotor helicopter designed for transportation of cargo, troops, and weapons during day, night, visual, and instrument conditions. (Unless otherwise noted, numbers refer to figure 2-1.) The helicopter is powered by two T55-L-7 series shaft-turbine engines (27) mounted on the aft fuselage. The engines simultaneously drive two tandem three-bladed counterrotating rotors (10 and 19) thru a combining transmission (13), drive shafting (11 and 20), and reduction transmissions (9, 25, and 29). The forward transmission is mounted on the forward pylon above the cockpit (1). The aft transmission, the combining transmission, and drive shafting are in the cabin section and aft pylon section (3 and 4). Drive shafting from the combining transmission to the forward transmission is housed within a tunnel along the top of the fuselage. When the rotors are stationary, a gas-turbine auxiliary power unit (24) hydraulically drives the aft transmission accessory gearbox which furnishes hydraulic and electrical power for ground operations. Fuel is carried in a tank (32) on each side of the fuselage. The helicopter is equipped with four non-retractable landing gear. An entrance door (12) is at the forward right side of the cargo compartment (2). At the rear of the cargo compartment is a hydraulically powered loading ramp (28). The pilot's seat (6) and controls are at the right side of the cockpit; the copilot's seat (37) and controls are on the left side. See figure 2-4 for typical cockpit and controls.

2-2. Gross Weight.

The maximum gross weight of the CH-47A is 33,000 pounds. Refer to chapters 5 and 6 for additional weight information.

2-3. Landing Gear System (Without High Flotation Landing Gear).

(Non-high flotation landing gear is identified by dual small wheels on each aft gear.) The landing gear system consists of four non-retractable dual-wheel landing gear type which can be locked in trailed position. Each gear has an air-oil shock strut. Forward gear are equipped with tubeless tires. Aft gear are equipped with tube-type tires. See table 2-3 for tire pressures.
mounted in the fuselage pods. The forward wheels are fixed fore and aft. The aft wheels are full-swivel (360°)

2-4. Aft Wheel Swivel-Lock Switch.

A two-position aft wheel swivel-lock switch forward of the engine condition levers on the console (figure 2-6), is used to lock the aft wheels in a trailed position. The switch positions are SWIVEL LOCK BRAKES PRIMED and AFT WHEELS SWIVEL RELEASE. When the switch is set to SWIVEL LOCK BRAKES PRIMED, dc from the 28-volt primary bus opens a swivel-lock solenoid valve which allows hydraulic pressure to be applied to a swivel-lock cylinder on each aft gear. The cylinder and pin mechanically lock the gear spindle in the trailing position. When the switch is at AFT WHEELS SWIVEL RELEASE, the solenoid valve closes and the swivel-lock cylinders are released. Power from the 28-volt dc primary bus is supplied thru the AFT WHEEL circuit breaker on the dc circuit breaker box. (Refer to chapter 8, for aft wheel swivel-lock operation.)

2-5. Landing Gear System (High Flotation Gear).

(High flotation landing gear is identified by a single large wheel on each aft gear.) The landing gear system consists of four nonretractable, high flotation type landing gear mounted in the fuselage pods. The left and right forward landing gear are a fixed-cantilever type and have twin wheels. The aft landing gear are of the single-wheel, full-swivel (360°) type which can be power centered and locked in the trailed position. In addition, the aft right landing gear can be steered from the cockpit by a control knob on the console. (Refer to paragraph 2-7, Steering System, for additional information.) Each landing gear has an individual air-oil shock strut and is equipped with tube-type tires. See table 2-3 for tire pressures.

2-6. *Aft Wheel Swivel-Lock (High Flotation Gear).*

CAUTION

The swivel lock switch must be positioned at SWIVEL LOCK for all takeoffs and landings. A landing with aft wheels unlocked and out-of-center could result in a blown tire or damage to the landing gear.

A two-position switch, on the console (figure 2-6) forward of the engine condition levers, is used to lock and unlock the aft wheel swivels. At SWIVEL RELEASE, the switch also supplies electrical power to the power steering control box. (Refer to paragraph 2-7 for additional information.) The switch has no effect on brake system selection. A safety interlock between the swivel lock and power steering systems prevents operation of the power steering system when the swivel locks are energized. The switch positions are marked SWIVEL LOCK and SWIVEL RELEASE. When the switch is at SWIVEL LOCK, power from the 28-volt dc primary bus thru the AFT WHEEL circuit breaker on the dc circuit breaker box, simultaneously opens the swivel lock solenoid. When the swivel lock solenoid is opened, hydraulic pressure from the utility system centers and locks both aft landing gear in the trailed position when no load is on the gear. When the switch is at SWIVEL RELEASE, the swivel lock solenoid valve is closed and the swivel unlock solenoid valve is opened. This action causes the swivel locks to unlock.

2-7. *Steering System.*

The aft right landing gear is hydraulically steerable and is electrically controlled by a control knob (figure 2-5) mounted on the console. A safety interlock between the swivel lock and power steering systems prevents the use of power steering when the aft wheel swivels are locked. Power to operate the power steering actuator is supplied by the utility hydraulic system thru the power steering solenoid valve. Power to operate the electrical components of the system is provided by the 28-volt dc primary bus thru the AFT WHEEL circuit breaker on the dc circuit breaker box.

2-8. *Power Switch.* A two-position power switch on the upper left corner of the power STEERING CONTROL panel energizes and deenergizes the power steering system. The switch is marked PWR ON-OFF. When the switch is set to ON, and the swivel lock switch is at SWIVEL RELEASE, power from the 28-volt dc primary bus is applied to the power steering control box which is part of the power STEERING CONTROL panel. The swivel lock switch must be at SWIVEL RELEASE before power steering can be used. At the same time, the power steering solenoid valve opens, supplying hydraulic pressure to the power steering actuator. When the switch is moved to OFF, the power steering control box is deenergized and the power steering solenoid valve is closed.

2-9. *Control Knob.* The power steering control knob is on the right side of the power STEERING CONTROL panel (figure 2-5). Index marks around the knob indicate degrees of knob rotation to the LEFT and RIGHT in increments of 30°. The control knob is spring-loaded to a zero turn angle. Power steering is accomplished by rotating the control knob a given amount in the desired direction. When the control knob is rotated, a servo valve mounted on the power steering actuator regulates hydraulic pressure to extend or retract the actuator. A feedback potentiometer, also mounted on the power steering actuator, stops the actuator travel when the selected turn radius is reached. The index marks at 30° increments around the control knob do not represent wheel turn angle, but are only used as reference marks.

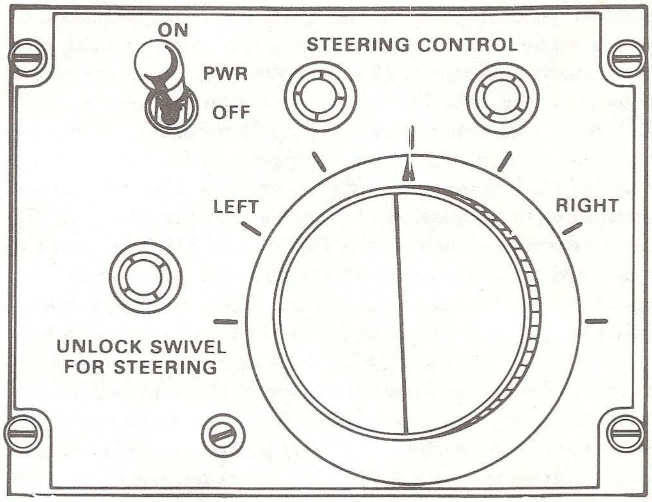


Figure 2-5. Power Steering Control Panel

2-10. Wheel De-phased Caution Light. A wheel de-phased caution light is on the master caution panel (figure 2-52) of the console. The caution light is marked WHEEL DE-PHASED and indicates that the aft right wheel has exceeded the turning limits. These limits are set at 58° for a left turn and 82° for a right turn. Because of the landing gear geometry, it is necessary to deflect the aft, right wheel an unequal number of degrees in one direction to produce an equal turn radius. If the turning limits are exceeded, an out-of-phase switch, mounted on the landing gear, automatically closes the power steering solenoid valve, lights the caution light and removes electrical power from the control knob. To reenergize the power-steering system, the landing gear must be returned within operating limits and the power switch or the aft wheel swivel lock switch must be recycled.

2-11. *Brake System (Without High Flotation Landing Gear).*

The four wheels of the forward landing gear are equipped with single-disk hydraulic brakes. The four wheels of the aft landing gear are equipped with single-disk hydraulic spot landing brakes. Only the forward brakes are applied

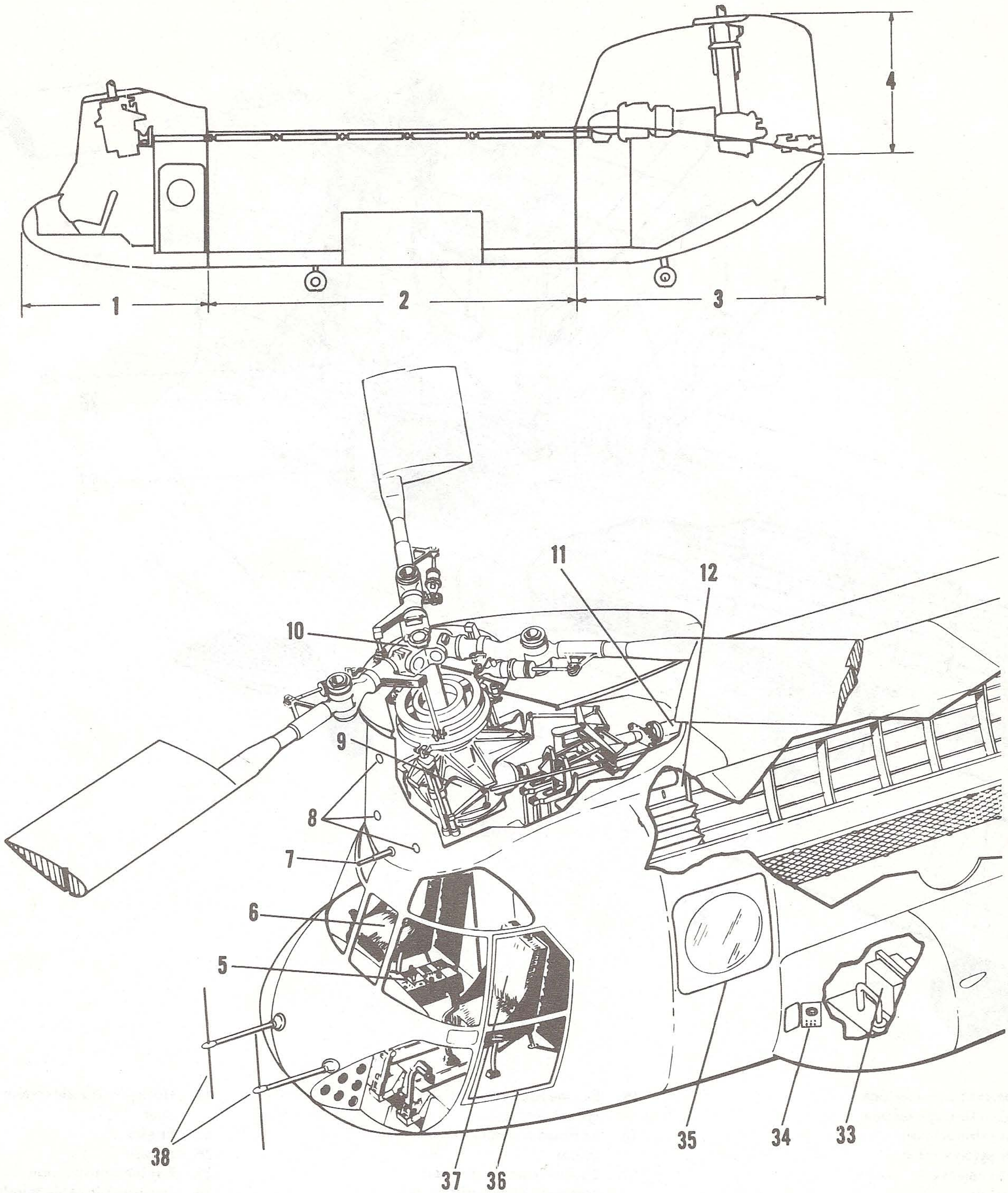
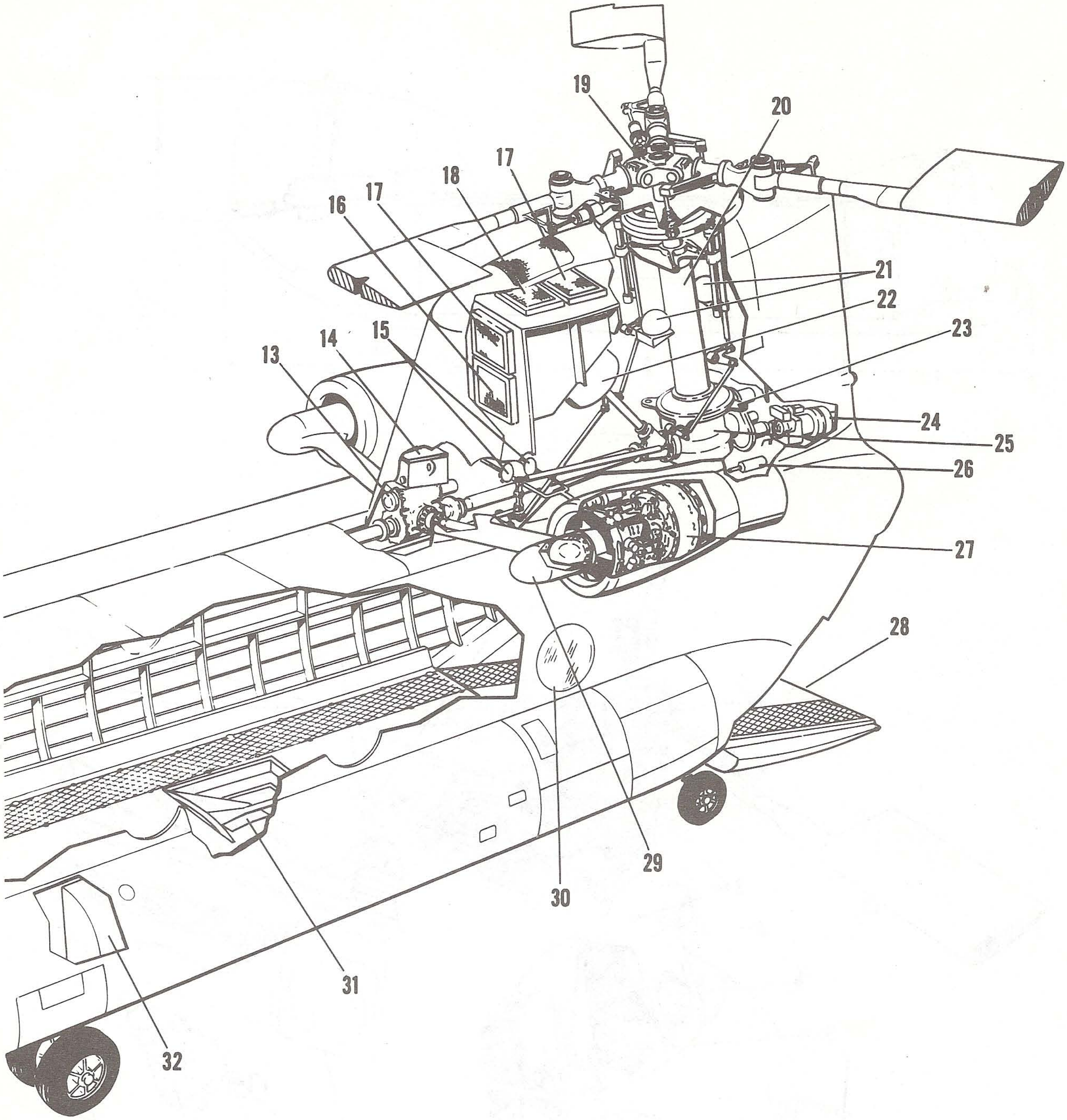
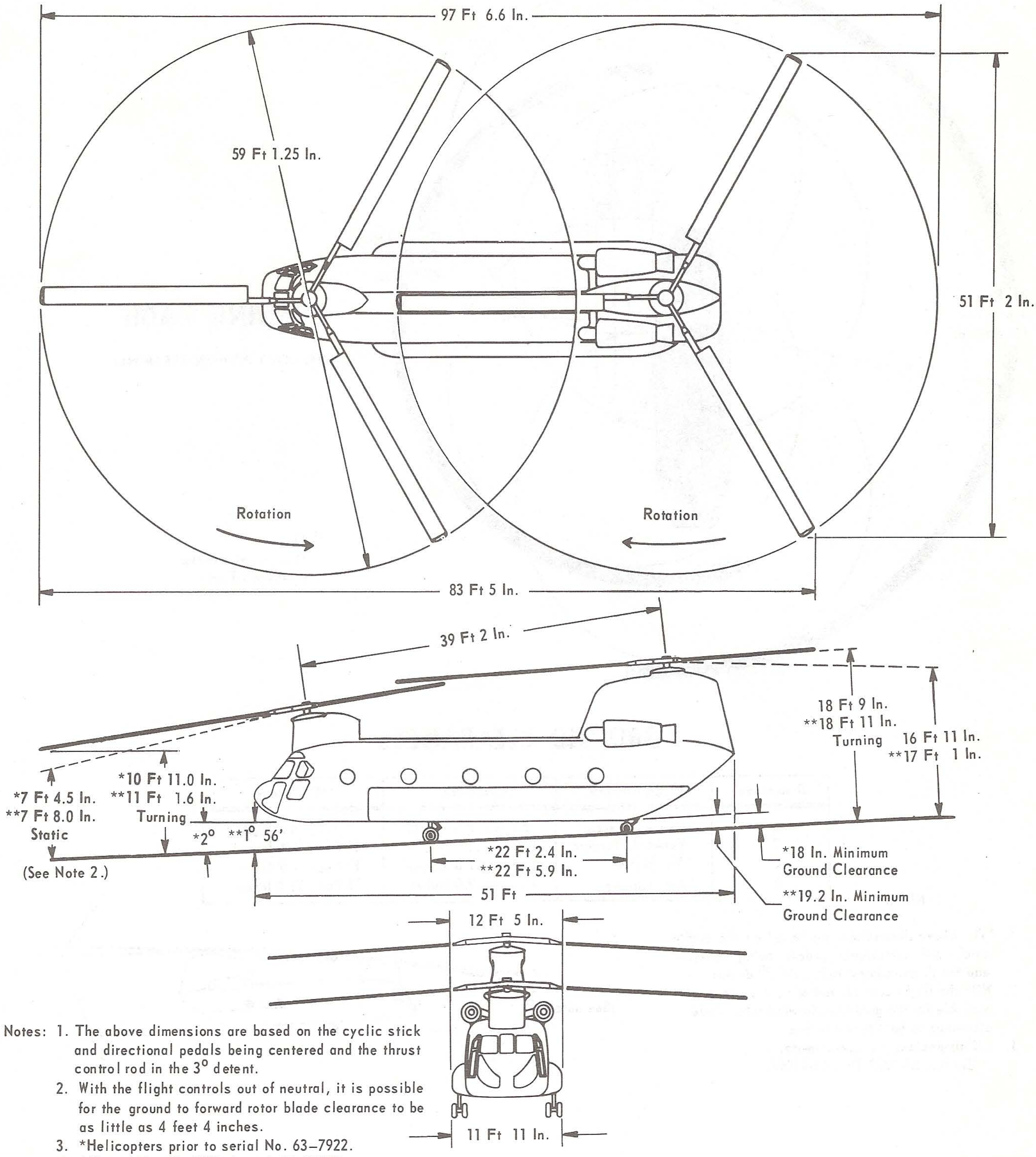


Figure 2-1. General Arrangement (Sheet 1 of 2)



1. Forward cabin section
2. Cabin fuselage section
3. Aft cabin section
4. Aft pylon section
5. Instrument panel and console
6. Pilot's seat
7. Pitot tube
8. SAS ports (4)
9. Forward transmission
10. Forward rotor head
11. Drive shaft
12. Cabin door
13. Combining transmission
14. Engine transmission and combining transmission oil tank
15. Engine fire extinguisher system containers
16. Forward transmission oil cooler
17. Engine transmission and combining transmission oil cooler
18. Aft transmission oil cooler
19. Aft rotor head
20. Aft rotor drive shaft
21. Flight control hydraulic system tanks
22. Oil cooler fan
23. Accessory gearbox (agb)
24. Auxiliary power unit (apu)
25. Aft transmission
26. Utility hydraulic system tank
27. Engine
28. Ramp
29. Engine transmission
30. Jettisonable cabin window (typical 8 places)
31. Rescue hatch door
32. Left fuel tank
33. Battery
34. External power receptacles
35. Cabin escape hatch
36. Jettisonable door
37. Copilot's seat
38. Fm homing antennas

Figure 2-1. General Arrangement (Sheet 2 of 2)



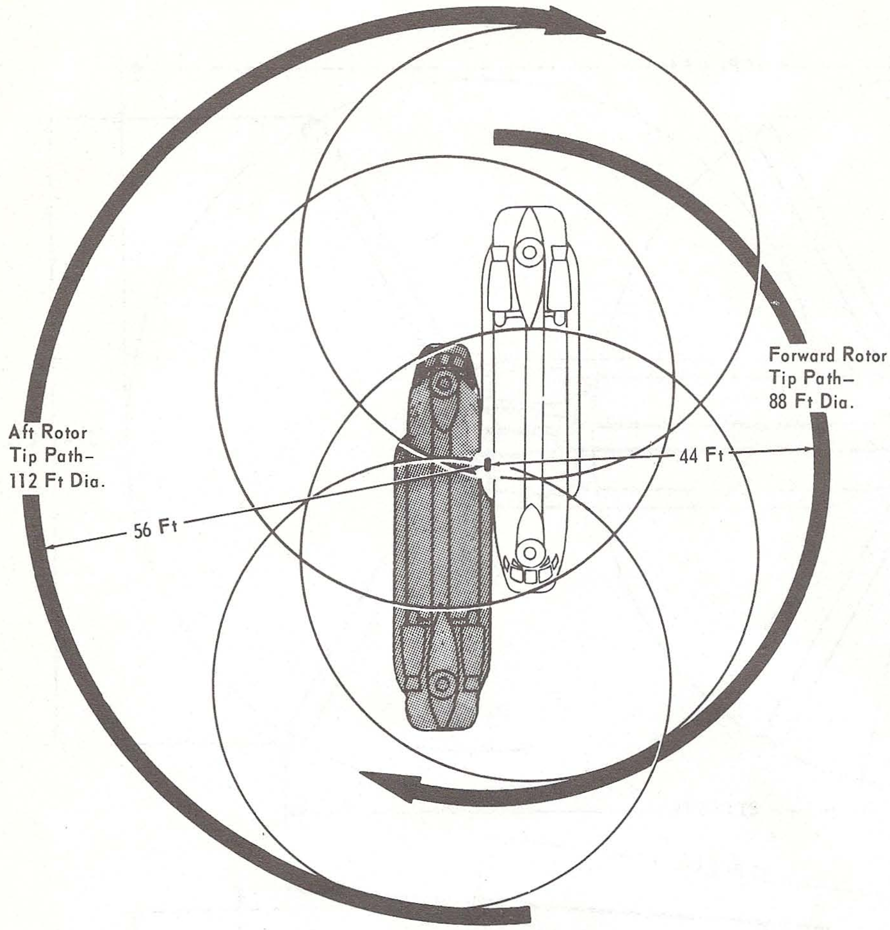
Notes: 1. The above dimensions are based on the cyclic stick and directional pedals being centered and the thrust control rod in the 3° detent.

2. With the flight controls out of neutral, it is possible for the ground to forward rotor blade clearance to be as little as 4 feet 4 inches.

3. *Helicopters prior to serial No. 63-7922.

4. **Serial No. 63-7922 through 66-19097.

Figure 2-2. Overall Dimensions



TURNING RADII

WITHOUT POWER STEERING

Note:
This is not a cockpit controlled Turn

GROUND CLEARANCES

Dimension	Blade Attitude	Clearance	**Clearance
A	*Forward, Static	7 Feet 4.5 Inches	7 Feet 8.0 Inches
B	Forward, Turning	10 Feet 11.0 Inches	11 Feet 1.6 Inches
C	*Aft, Static	16 Feet 11.0 Inches	17 Feet 1.0 Inch
D	Aft, Turning	18 Feet 9.0 Inches	18 Feet 11.0 Inches

NOTES

1. *The above dimensions are based on the cyclic stick and directional pedals being centered and the thrust control rod in the 3° detent.
2. With the flight controls out of neutral, it is possible for the ground to forward rotor blade clearance to be 4 feet 4 inches.
3. All dimensions are approximate.
4. **Ser No. 63-7922 Thru 66-19097.

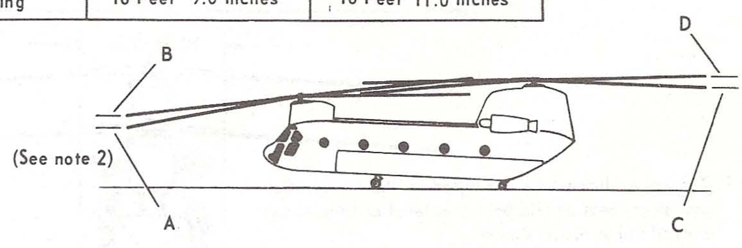


Figure 2-3. Turning Radii and Ground Clearances (Sheet 1 of 2)

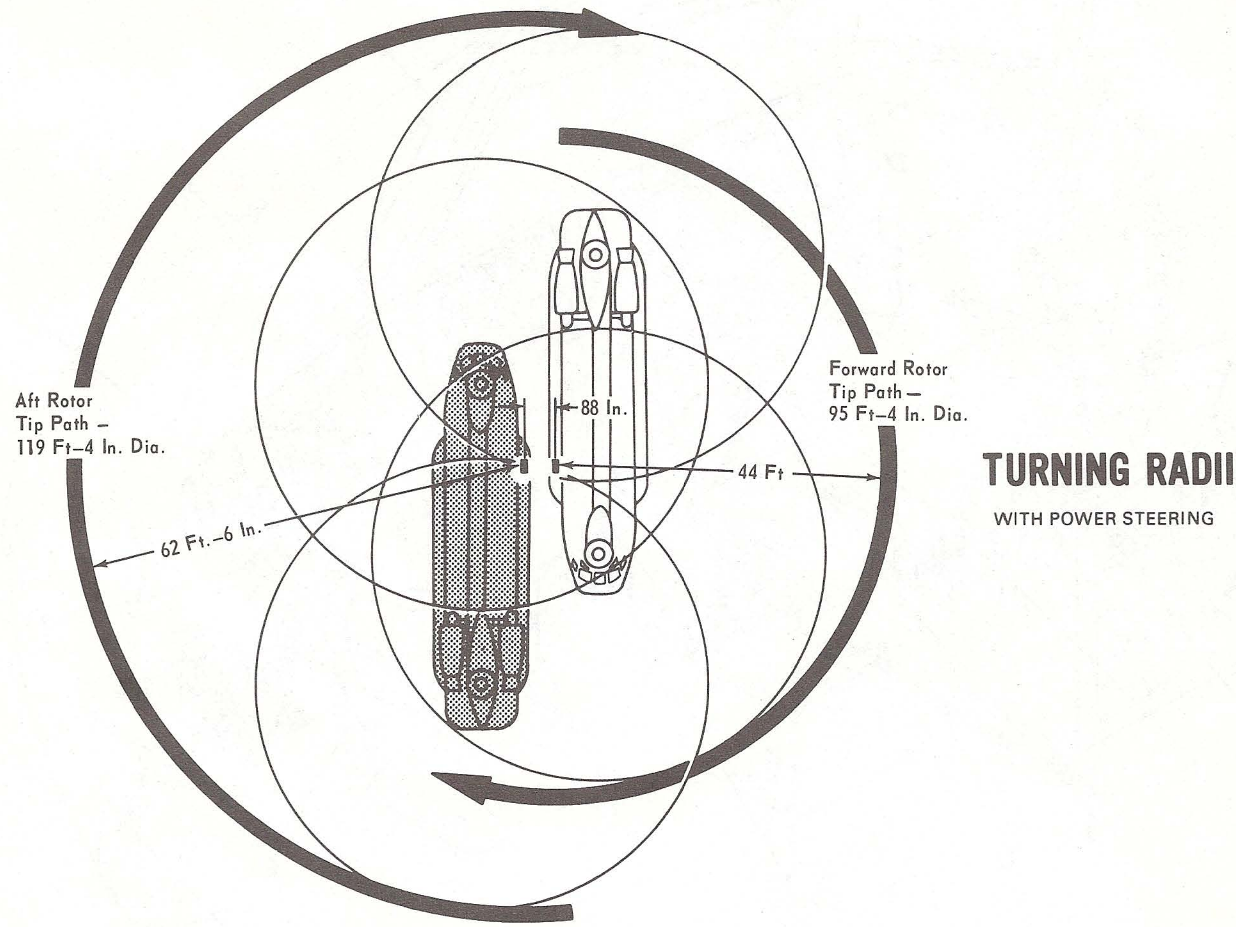
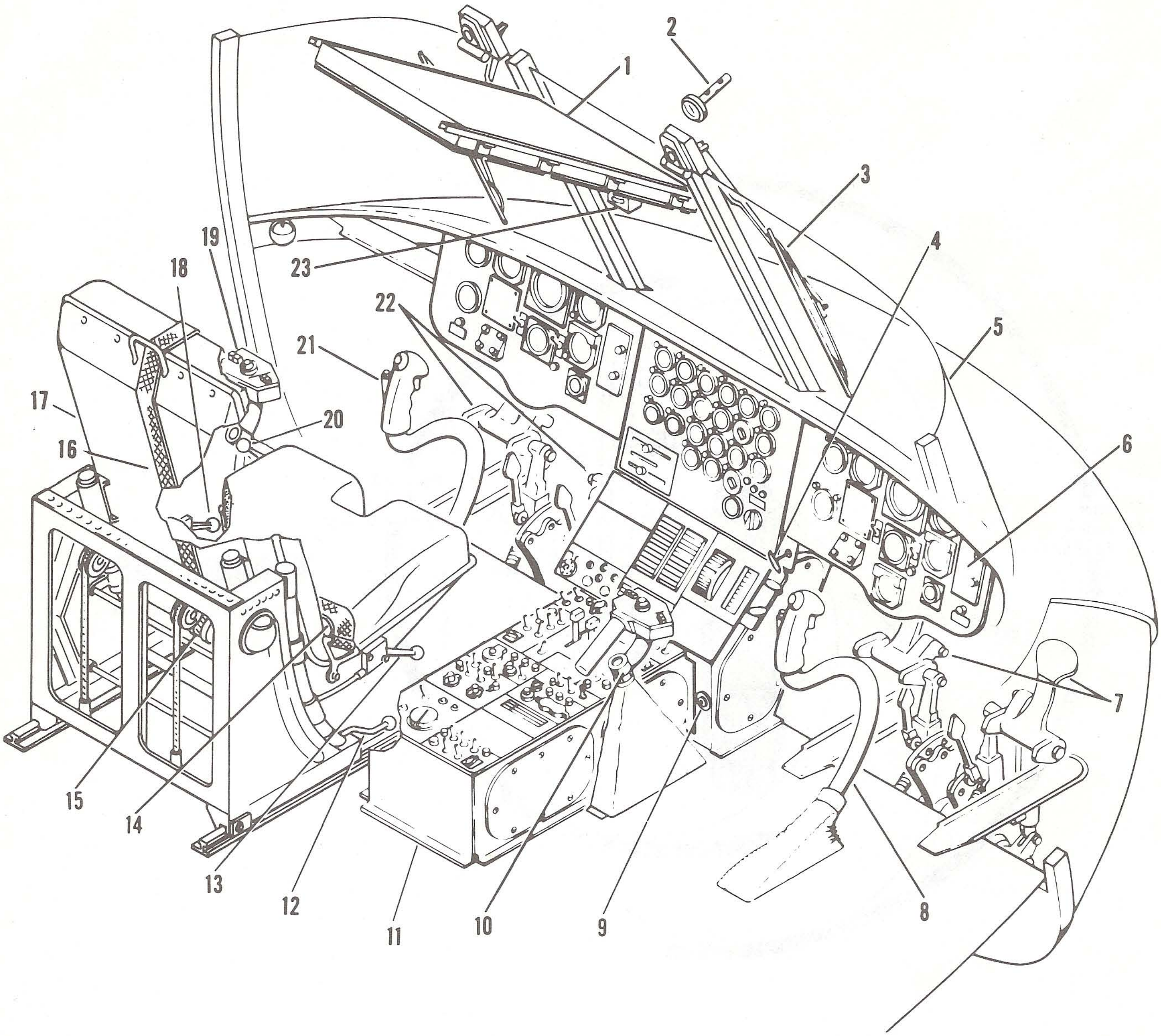


Figure 2-3. Turning Radii and Ground Clearances (Sheet 2 of 2)



1. Overhead switch and circuit breaker panel
2. Free air temperature gage
3. Windshield wiper
4. Parking brake handle
5. Windshield
6. Instrument panel
7. Pilot's wheel brakes and directional pedals
8. Pilot's pitch-roll control (cyclic stick)
9. Ignition lock switch
10. Pilot's thrust control rod
11. Console
12. Horizontal seat adjustment lever
13. Vertical seat adjustment lever
14. Safety belt
15. Inertia reel
16. Shoulder harness
17. Seat
18. Rotational adjustment lever
19. Copilot's thrust control rod
20. Inertia reel lock
21. Copilot's pitch-roll control (cyclic stick)
22. Copilot's wheel brakes and directional pedals
23. Magnetic compass

Figure 2-4. Typical Cockpit and Controls

by pressing either the pilot's or copilot's brake pedals. Both the forward brakes and the aft brakes can be applied and brake pressure is maintained by pulling parking brake handle out while the brake pedals are pressed. Hydraulic pressure for the brakes is supplied by the utility hydraulic system. After engine shutdown hydraulic pressure is not available to the wheel brakes and the brakes may not hold. The aft wheel brakes are not designed as parking brakes, but can be used to hold the helicopter on a spot following a vertical descent, provided the parking brake handle is pulled out after the brake pedals are depressed.

2-12. Brake Pedals. When either pilot's brake pedals are depressed, pressure from the master brake cylinders goes to a transfer valve in each brake line. This allows independent braking by either pilot. From these transfer valves, pressure is directed thru a parking brake valve to the forward wheel brakes.

2-13. Parking Brake Handle. A parking brake handle, figure 2-4, is at the bottom left corner of the pilot's section of the instrument panel. The brake handle is mechanically connected to the parking brake valve. The parking brake handle is also electrically connected to the aft wheel brake solenoid valve. When the brake pedals are pressed and the parking brake handle is pulled OUT, pressure is trapped and maintained on the forward brakes. At the same time, power from the 28-volt dc primary bus opens the aft wheel brake solenoid valve, allowing hydraulic pressure to apply the aft brakes. If the brake pedals are not pressed before the parking brake handle is pulled OUT, the forward brakes will not be applied. The forward and aft brakes are released by applying pressure to the brake pedals. This action automatically opens the parking brake valve and closes the aft wheel brake solenoid valve.

2-14. Parking Brake Caution Light. A parking brake caution light is on the master caution panel (figure 2-52) of the console. This light is electrically energized when the parking brake is set. When the handle is pulled, the light marked PARK BRAKE ON comes on. When the brakes are released, the light goes off. Dc to operate this light is supplied thru the CAUTION LTS circuit breaker from the 28-volt primary bus.

2-15. Brake System (High Flotation Gear).

All wheels are equipped with self-adjusting, disk-type brakes. Braking is accomplished on all wheels when the brakes are applied. Brake pressures can be applied and maintained on all wheels at all times by pulling out the parking brake handle while the brake pedals are pressed. Pressure to operate the brakes is supplied by the utility hydraulic system (figure 2-33).

NOTE

The aft wheel brakes are not designed as parking brakes but can be used to help decelerate the helicopter, for use during slope landings, and to hold the helicopter on a spot following a vertical descent.

2-16. Brake Pedals (High Flotation Gear). Braking is accomplished on all wheels when the brakes are applied. When either pedal is pressed, pressure from a master brake cylinder attached to each pedal operates a transfer valve in each brake line which allows independent braking by either crewmember. From these transfer valves, pressure is directed thru a parking brake valve directly to all brakes.

2-17. Parking Brake Handle. A parking brake handle, figure 2-4 is at the bottom left corner of the pilot's instrument panel. The parking brake handle is mechanically-linked to the parking brake valve and electrically connected to the PARK BRAKE ON caution light on the master caution panel. Pressure is trapped and maintained on all wheel brakes regardless of the position of the swivel lock switch. Dc from the 28-volt primary bus, thru the CAUTION LTS circuit breaker, illuminates the PARK BRAKE ON caution light. Parking brakes are released when pedal pressure is applied.

2-18. Parking Brake Caution Light. A parking brake caution light is on the master caution panel (figure 2-52) on the console. This light is energized when brakes are set. When the handle is pulled OUT, the light marked PARK BRAKE ON comes on. When the brakes are released the light goes off. Power to operate this light is supplied by the 28-volt primary bus thru the CAUTION LTS circuit breaker on the overhead panel.

2-19. Instrument and Control Panels.

Figures 2-6, 2-7, and 2-8 show typical arrangements for the instrument panel, console, and the overhead switch panel.

2-20. Personnel Cargo Doors.

Entry can be made through either the main cabin door or the cargo door and ramp.

2-21. Main Cabin Door.

The main cabin entrance (12, figure 2-1) door is on the right side of the cargo compartment. The door is divided into two sections: the upper section containing a jettisonable panel and the lower section forming the entrance step. When opened, the upper section slides upward on overhead rails and the lower section swings downward. When closed, the two sections mate to form the complete door. Handles are provided on both the outside and inside of the door for accessibility. Refer to chapter 5 for the allowable airspeed imposed on the helicopter while operating with the cabin entrance door sections in various positions.

2-22. Cargo Door and Ramp.

Refer to paragraph 6-50 for detail description and operation of cargo door and ramp.

2-23. Pilot and Copilot Sliding Windows.

The upper section of each jettisonable door (36, figure 2-1) in the cockpit contains a sliding window. The window slides fore and aft and is locked and unlocked by means of a handle located at the forward end of the jettisonable

316-520 O - 80 - 2

door. The handle is moved aft to lock the window and forward to unlock the window.

2-24. Seats.

The pilot's and copilot's seats (6 and 37, figure 2-1) are installed on tracks to permit forward-and-aft, vertical, and reclining position adjustments. Bungee cords or balance springs in each seat exert an upward force on the seat when it is down or tilted.

2-25. Seat Fore-And-Aft Lever.

A fore-and-aft control lever (12, figure 2-4) for horizontal seat adjustment is on the right side of each seat support carriage. When the lever is pulled UP, the seat is unlocked and can be moved along the tracks on the cockpit floor. When the lever is released, the seat is locked horizontally in position. The total range of horizontal movement is 4 inches, divided into 1-inch intervals.

2-26. Seat Vertical Lever.

Vertical seat adjustment (13, figure 2-4) is controlled by a lever on the right side of each seat. When this lever is pulled UP, the seat is unlocked and can be moved along a track thru a range of 5 inches. The range is divided into ½-inch intervals. When the lever is released, the seat is locked vertically in position.

2-27. Seat Rotation Lever.

A control lever (18, figure 2-4) for adjusting the seat reclining position is on the left side of each seat. When this lever is moved forward to LOCKED and then returned to thru a 15° tilt range divided into four equal intervals. The seat, in effect, is pivoted up and down around a horizontal axis. When the lever is released, the seat is locked in the tilt position.

2-28. Shoulder Harness Inertia Reel Lock Lever.

CAUTION

When a crash landing or ditching is anticipated and time permits, manual locking of the shoulder harness inertia reel provides added safety precautions over the automatic feature of the inertia reel. Depending on the pilot's seat adjustment, it may not be possible to reach all switches with the inertia reel locked. Each pilot should check and adjust the shoulder harness in the locked position to determine if all switches can be reached.

A two-position shoulder harness inertia reel lock lever is on the left side of each seat (20, figure 2-4). The lever positions are LOCKED (forward) and UNLOCKED (aft). The lock may be moved freely from one position to the other. When the lock lever is in the UNLOCKED position, the reel harness cable is released to allow freedom of movement. However, the reel will automatically lock if a horizontal impact force of 2 to 3 g's is encountered. When the reel is locked in this manner, it stays locked until the lock lever is moved forward to LOCKED and them returned to UNLOCKED. When the lever is at LOCKED, the reel is manually locked so the pilot is restrained from bending forward.

2-29. Armored Seats.

Both the pilot's and copilot's seats are equipped with a combination of fixed and adjustable ceramic armor panels. Fixed panels are installed under the back and bottom seat

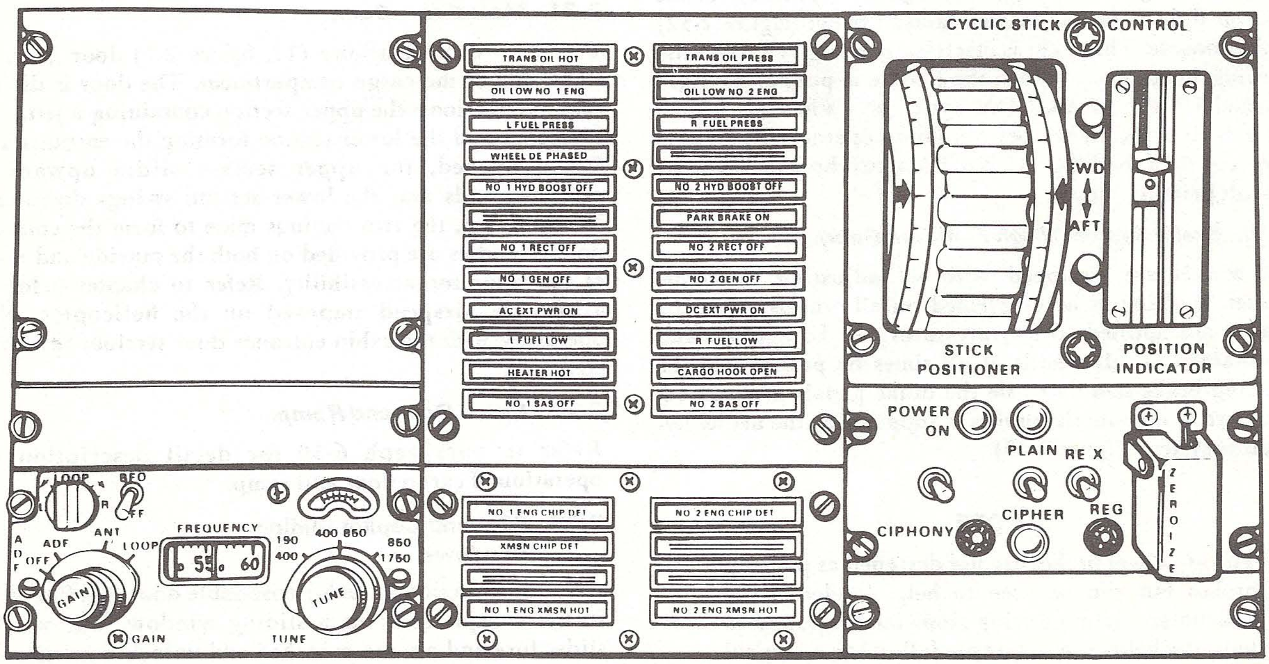


Figure 2-6. Console (Sheet 1 of 2)

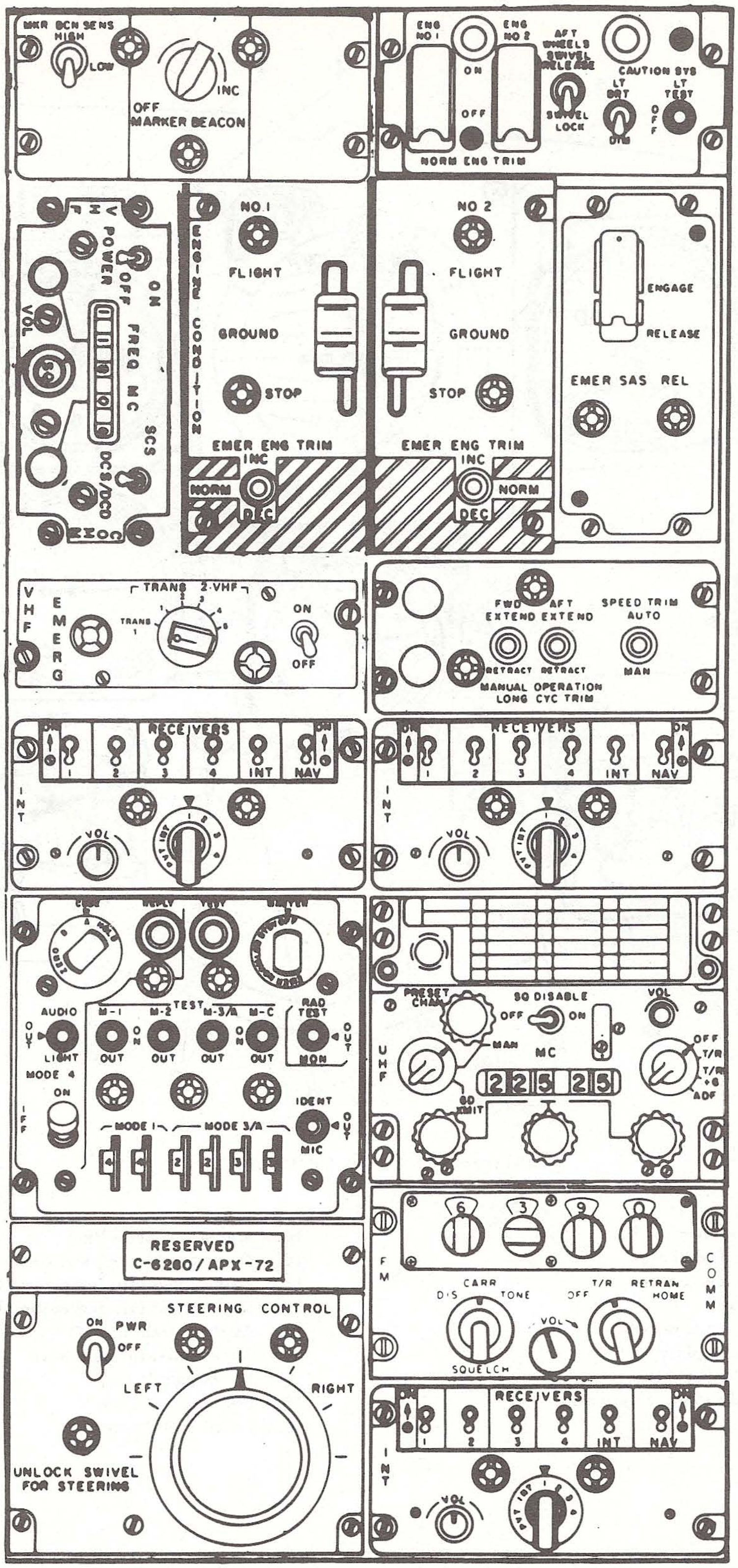
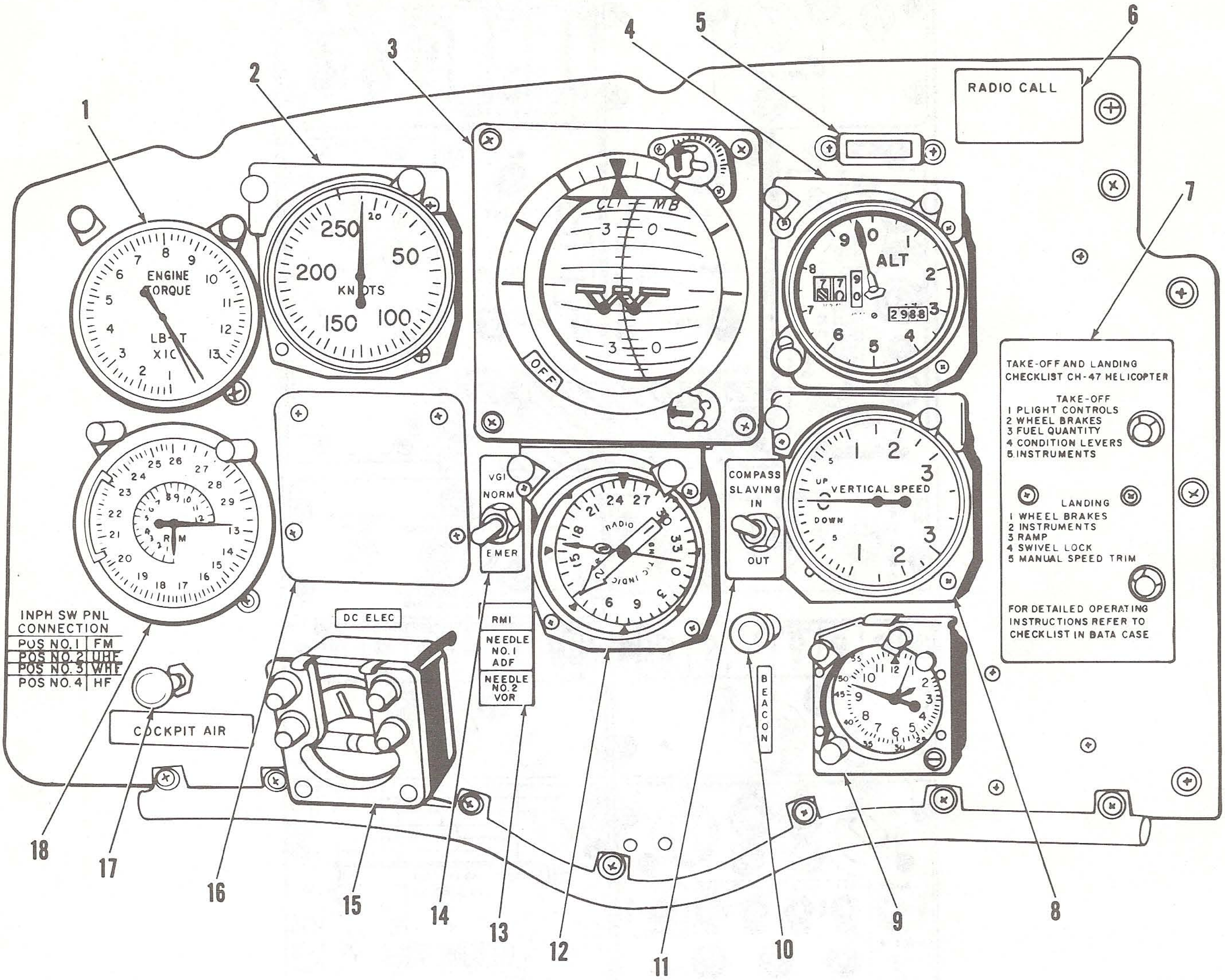


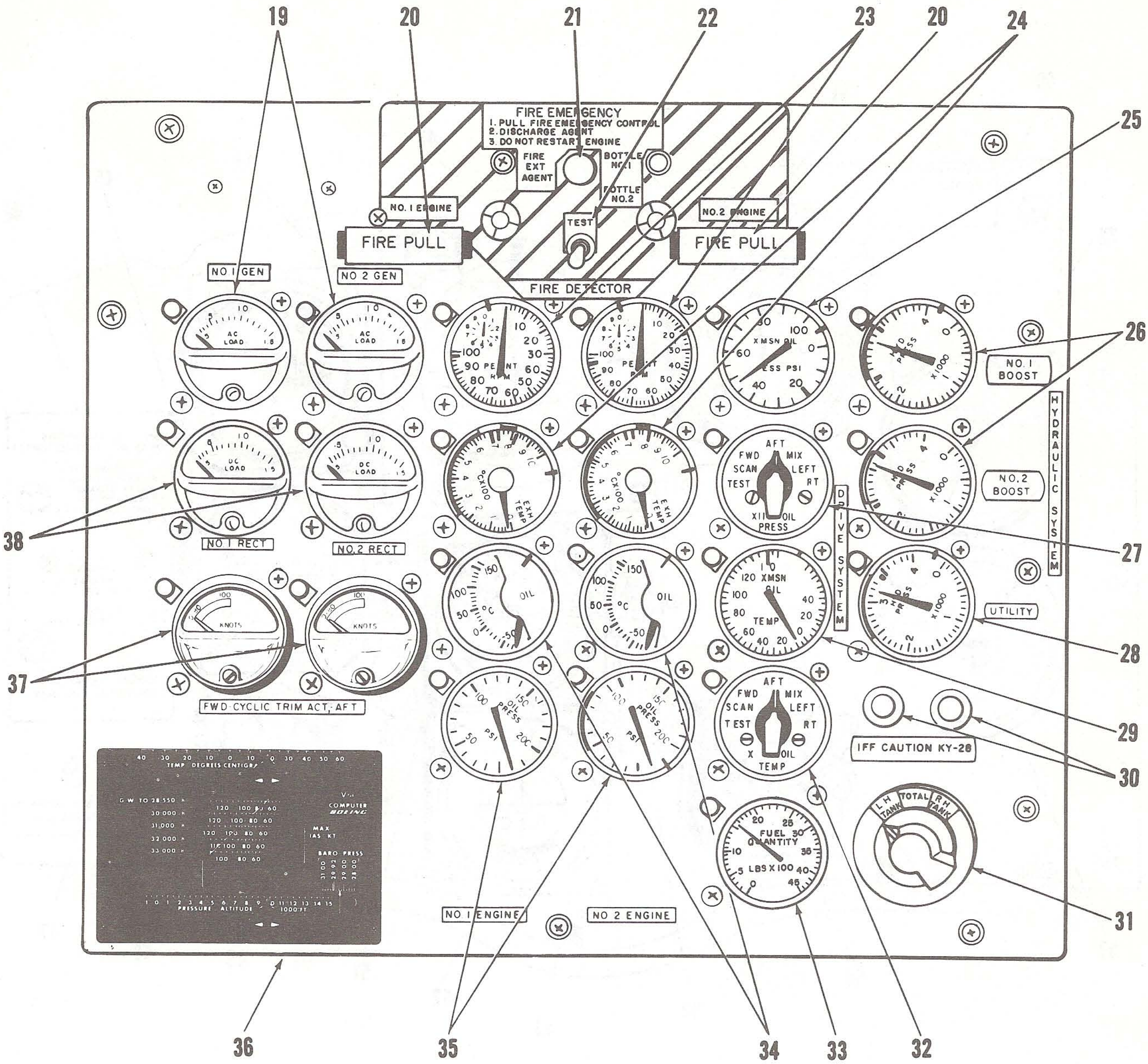
Figure 2-6. Console (Sheet 2 of 2)



COPILOT'S INSTRUMENT PANEL

1. Torquemeter
2. Airspeed indicator
3. Attitude indicator
4. Altimeter
5. Master caution light
6. Radio call plate
7. Copilot's checklist
8. Vertical velocity indicator
9. Clock
10. Marker beacon light
11. Compass slaving switch
12. Radio magnetic indicator (ID-250A/ARN)
13. Radio magnetic indicator plate
14. Attitude indicator (VGI) switch
15. Turn-and-slip indicator
16. Blank panel
17. Cockpit air knob
18. Rotor tachometer

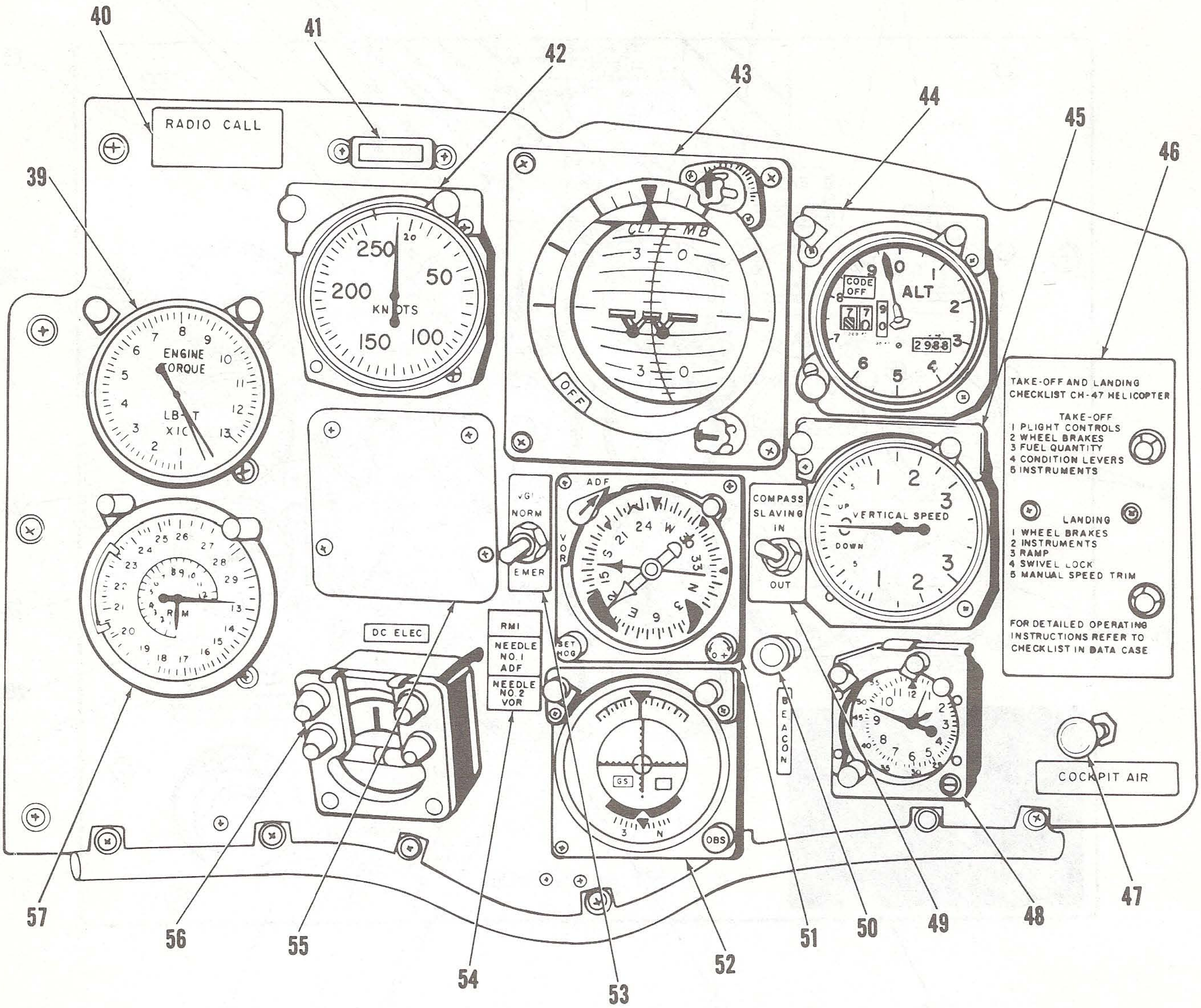
Figure 2-7. Instrument Panel (Sheet 1 of 3)



CENTER CONSOLE

19 Ac Loadmeters
20 Fire Control Handles
21 Fire Extinguisher Agent Switch
22 Fire Detector Test Switch
23 Gas Producer Tachometers
24 Exhaust Gas Temperature Indicators
25 Transmission Oil Pressure Indicator
26 Flight Control Hydraulic Pressure Indicators
27 Transmission Oil Pressure Selector Switch
28 Utility Hydraulic Pressure Indicator
29 Transmission Oil Temperature Indicator
30 KY-28 and IFF Indicator Lights
31 Fuel Quantity Selector Switch
32 Transmission Oil Temperature Selector Switch
33 Fuel Quantity Indicator
34 Engine Oil Temperature Indicators
35 Engine Oil Pressure Indicators
36 Vne Computer
37 Longitudinal Cyclic Trim Indicators
38 Dc Loadmeters

Figure 2-7. Instrument Panel (Sheet 2 of 3)



PILOT'S INSTRUMENT PANEL

39 Torquemeter
40 Radio Call Plate
41 Master Caution Light
42 Airspeed Indicator
43 Attitude Indicator
44 Altimeter
45 Vertical Velocity Indicator
46 Pilot's Checklist
47 Cockpit Air Knob
48 Clock
49 Compass Slaving Switch
50 Marker Beacon Light
51 Gyrosyn Compass Indicator (ID-998/ASN)
52 Course Indicator (ID-1347)
53 Attitude Indicator (VGI) Switch
54 Radio Magnetic Indicator Plate
55 Blank Panel
56 Turn-And-Slip Indicator
57 Rotor Tachometer

Figure 2-7. Instrument Panel (Sheet 3 of 3)

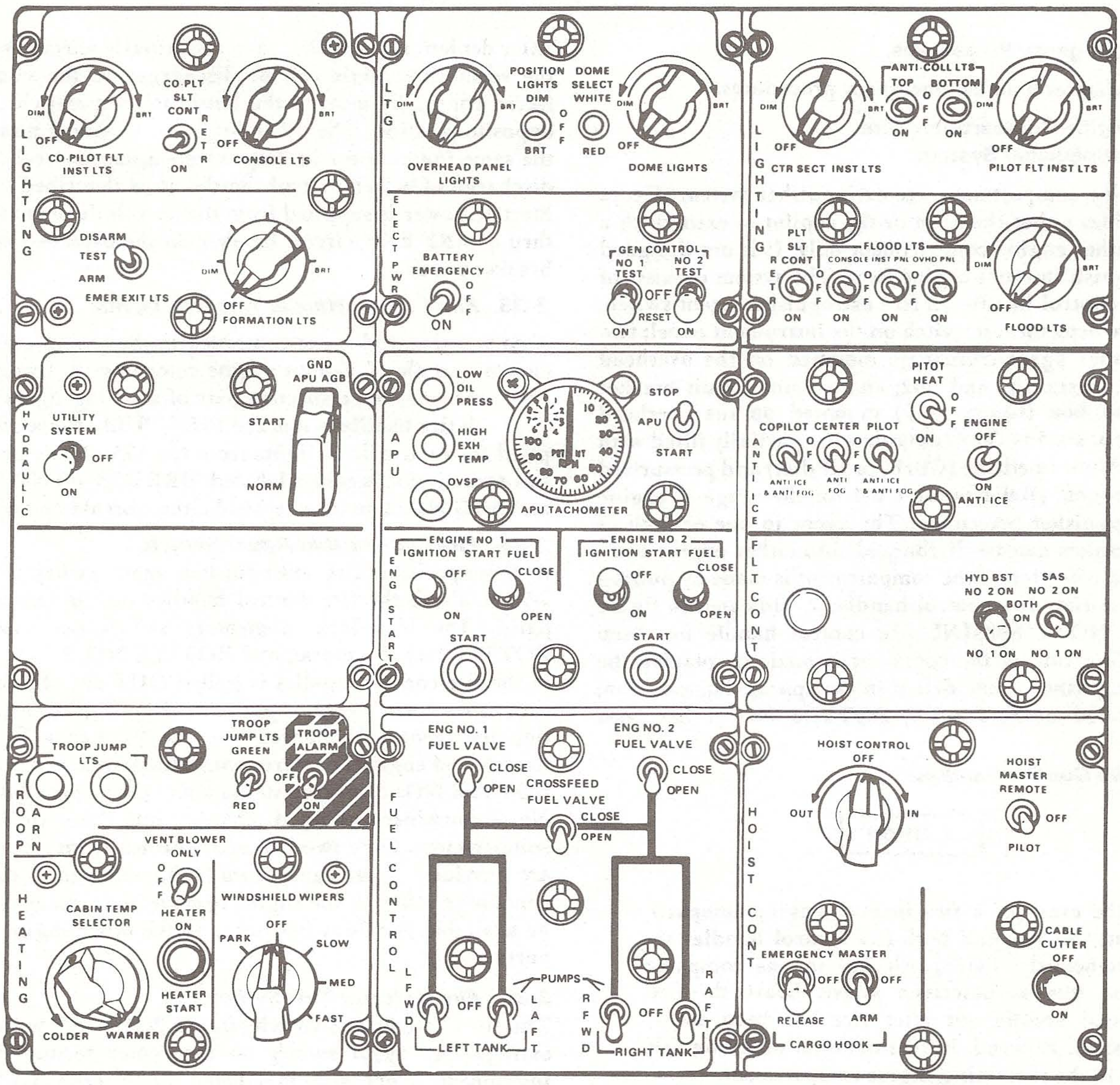


Figure 2-8. Overhead Switch Panel

cushions and on the outboard side of each seat. A shoulder panel and provisions for an adjustable torso protector are also on each seat. The torso protector is hinged and includes a quick-release type fastener at the front so the occupant can get into and out of the seat rapidly. The torso protector is track-mounted to permit reasonable movement of the body during normal flight operations. The rubber padded armor is held snug against the body at all times by an exerciser cord on each side of the seat. Manual adjustment provisions permit adjustment of the torso protector to the individual. The shoulder panel is hinged from the seat back so it can be moved aside for ease of exit from the helicopter. The panel is secured in its normal position by a latch and the exerciser cord. Seat adjustments are the same as stated in paragraph 2-24. The seat rotation lever is not operational on the armored seat.

SECTION II EMERGENCY EQUIPMENT

2-30. Emergency Procedures.

Refer to chapter 9 for all emergency procedures.

2-31. Engine Compartment Fire Extinguisher System.

The engine compartment fire extinguisher system (figure 2-9) enables either the pilot or the copilot to extinguish a fire in either engine compartment only. It is not designed to extinguish internal engine fires. The system consists of two fire control handles, a fire extinguisher agent switch, and a fire detector test switch on the instrument panel; two extinguisher agent containers mounted on the overhead structure at sta 482 and 502; and a main circuit breaker protection box (figure 2-10) mounted on the overhead structure at sta 534. The containers are partially filled with bromotrifluoromethane ($CBrF_3$ or CF_3BR) and pressurized with nitrogen. (Refer to table 2-1 for the range of engine fire extinguisher pressures.) The agent in one or both of the containers can be discharged into either engine compartment. Selection of the compartment is made by pulling the appropriate fire control handle; as indicated in figure 2-9, the NO. 1 ENGINE fire control handle has been pulled. Selection of the container is made by placing the fire extinguisher agent switch in the appropriate position; as indicated on figure 2-9, BOTTLE NO. 1 has been selected.

2-32. Fire Control Handles.

CAUTION

In the event of a fire in both engine compartments, do not pull both fire control handles simultaneously. Extinguish fire in one compartment only as described above. Leave the fire control handle out after fire has been extinguished. Proceed, in like manner, to extinguish fire in the remaining engine compartment.

Two control handles for the engine fire extinguisher system (figure 2-9) are on the center section of the instrument panel. Each handle contains two red warning lights and switches that close the engine fuel shutoff valve and arm the fire extinguishing system circuits. When one of the handles is pulled out, the respective engine fuel shutoff valve is closed and the fire extinguisher agent switch is armed for selection and discharge of either fire bottle. After depletion of the charge in the initially selected bottle, the remaining bottle can be discharged to the same affected engine by moving the bottle selector switch to the opposite position. The other fire control handle performs the same function for its respective engine. Control of the discharge of either or both bottles is as described above. Electric power is supplied from the 28-volt dc primary bus thru a FIRE EXT circuit breaker on the overhead circuit breaker panel.

2-33. Fire Control Handle Warning Lights.

Two warning lights are contained in the end of each fire control handle. When an engine compartment fire occurs on either side, the respective pair of warning lights come on. Each fire handle is marked FIRE-PULL. Power is supplied for each pair of lights from the 115-volt ac primary bus thru circuit breakers labeled FIRE DET—ENG NO. 1 and ENG NO. 2 on the overhead circuit breaker panel.

2-34. Fire Extinguisher Agent Switch.

A three-position fire extinguisher agent switch (figure 2-9) is above the fire control handles on the instrument panel. The lever-lock momentary switch positions are BOTTLE NO. 1, neutral, and BOTTLE NO. 2. When one of the fire control handles is pulled OUT and the fire extinguisher agent switch is put in the BOTTLE NO. 1 position, the agent is discharged from the No. 1 container into the selected engine compartment. If the switch is put in the BOTTLE NO. 2 position in the above case, agent from the No. 2 container will be discharged into the same engine compartment. Only two fire extinguisher agent containers are provided. If the agent from both containers is used in combating a fire in one engine compartment, no agent will be available should a fire occur in the other engine compartment.

2-35. Fire Detector Test Switch.

The fire detector test switch (figure 2-9) is below the fire extinguisher agent switch on the center section of the instrument panel and is labeled FIRE DETECTOR—TEST. A two-position toggle switch is used. The switch is spring-loaded to FIRE DETECTOR. The fire extinguisher panel is labeled FIRE DETECTOR—TEST. The switch is used to check the operation of the fire detection system. When the switch is actuated, relays in both controls units close and the lights in both fire control handles illuminate. Power to operate the test circuit is supplied by the 28-volt dc primary bus thru the CAUTION LTS circuit breaker on the overhead circuit breaker panel.

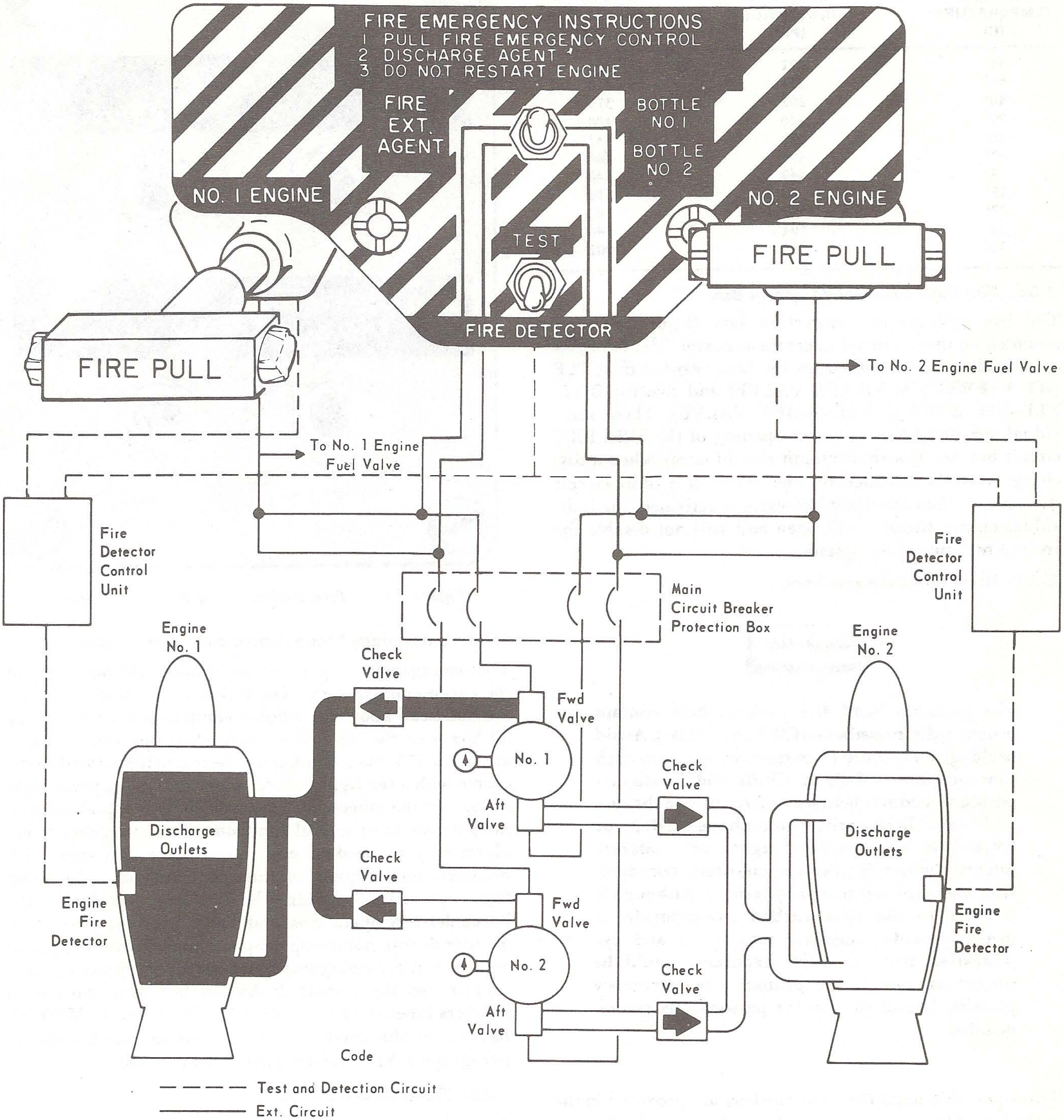


Figure 2-9. Engine Fire Detection and Extinguishing System

Table 2-1. Engine Fire Extinguisher Pressures

AMBIENT TEMPERATURE (C)	MINIMUM INDICATION (PSI)	MAXIMUM INDICATION (PSI)
-54°	271	344
-51°	275	350
-40°	292	370
-29°	320	400
-18°	355	437
-7°	396	486
4°	449	540
15°	518	618
27°	593	702
38°	691	784
52°	785	902

2-36. Fire Extinguisher Protection Box.

The fire extinguisher protection box (figure 2-10) is mounted on the overhead structure at station 534. Four circuit breakers are mounted on the box, two for BOTTLE NO. 1 (FWD VALVE-AFT VALVE) and two for BOTTLE NO. 2 (FWD VALVE-AFT VALVE). These individual circuit breakers prevent opening of the FIRE EXT circuit breaker if a short circuit should occur when a discharge valve is activated on one bottle. If a short circuit does occur when the discharge valve is activated, the individual circuit breaker will open and will not disable the entire fire extinguisher system.

2-37. Hand Fire Extinguishers.

WARNING

The portable hand fire extinguishers contain bromotrifluoromethane ($CBrF_3$ or CF_3Br). Avoid prolonged exposure (5 minutes or more) to high concentrations $CBrF_3$ or CF_3Br and its decomposition products because of irritation to the eyes and nose. Bromotrifluoromethane ($CBrF_3$ or CF_3Br) is an anesthetic agent of moderate intensity which is odorless, colorless, noncorrosive, and does not leave any residue. Although it is safer to use than carbon tetrachloride or methylbromide, adequate respiratory and eye protection from excessive exposure should be sought as soon as the primary fire emergency permits. Use of oxygen for personnel is recommended.

Three portable hand fire extinguishers are provided in the helicopter. One is mounted in the cockpit, on the floor to the right of the pilot's seat. Two hand fire extinguishers are provided in the cabin fuselage section: one mounted on the forward bulkhead and one in the rear just forward of the ramp on the left side. Each extinguisher is filled with bromotrifluoromethane ($CBrF_3$ or CF_3Br).

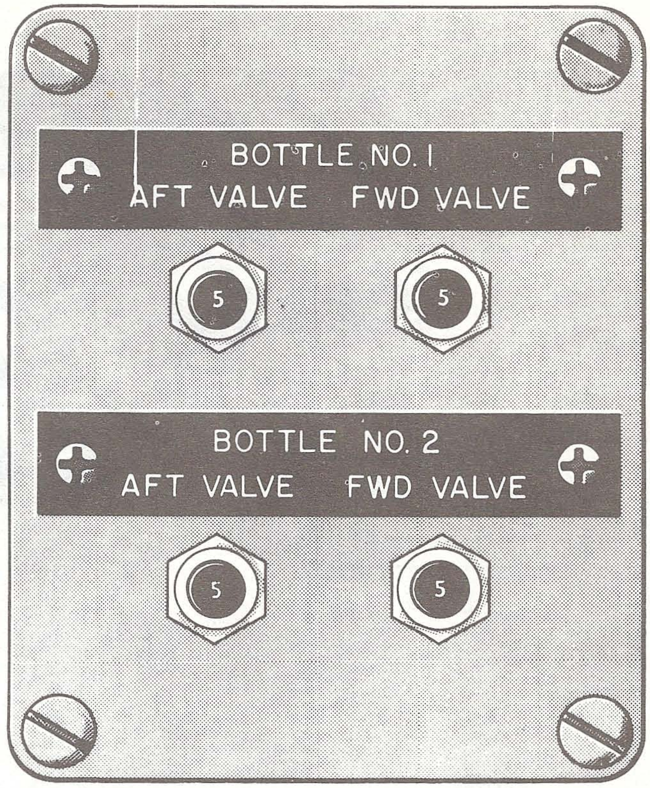


Figure 2-10. Fire Extinguisher Protection Box

2-38. Emergency Troop Alarm and Jump Lights.

Two emergency troop alarm and jump light boxes are in the cargo compartment. The forward box is mounted on the bulkhead above the avionic equipment shelves and the aft box is on the left side of the fuselage opposite the ramp at station 575. Each box has an electric bell mounted in the center with a red light fixture on one side and a green light fixture on the other side. The emergency troop alarm and jump lights have several functions. The emergency troop alarm may be used to notify passengers and crew with predetermined signals in time of emergency. The jump lights can be used to notify the flight engineer during airborne delivery operations, and also to alert the troop commander during paratroop drop missions. Power to operate and control the emergency troop alarm and jump lights is supplied by the 28-volt dc battery bus thru two circuit breakers labeled TROOP ALARM BELL and JUMP LTS, located on the overhead circuit breaker panel. Refer to paragraph 9-3 for standard use of the troop alarm.

2-39. Troop Alarm Switch.

A three-position toggle switch located on the TROOP WARN panel (figure 2-11) of the overhead switch panel is labeled TROOP ALARM with positions marked OFF and ON. Moving the troop alarm switch to ON rings the bell continuously at both stations until the switch is moved to OFF.

2-40. Troop Jump Lights Switch.

A three-position toggle switch on the TROOP WARN panel (figure 2-11) of the overhead switch panel is labeled TROOP JUMP LTS with positions marked GREEN, OFF, and RED. When the switch is moved to GREEN, the green lights on the emergency troop and jump light box, at both stations, and the troop jump lights on the overhead switch panel come on. By moving the switch to RED, the red lights come on. The OFF position turns off both sets of lights. The red and green troop jump lights can be dimmed while operating at night, by moving the CABIN AND RAMP LIGHTS control switch to RED ON.

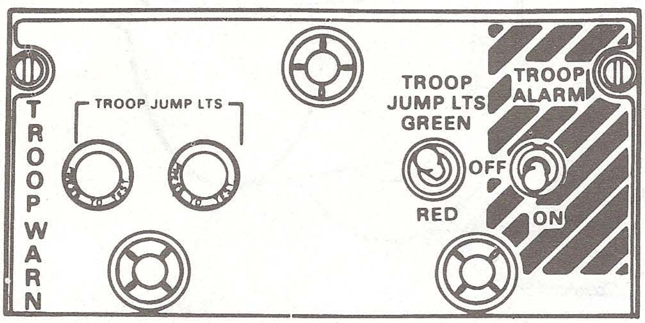


Figure 2-11. Troop Warning Panel

2-41. Troop Jump Lights.

Two troop jump lights attached to the TROOP WARN panel (figure 2-11) on the overhead switch panel are provided to allow both pilot and copilot to have a visual indication of the troop jump light being selected. One light is provided for each color selection and comes on when the respective light is selected. The troop jump lights on the overhead panel dim when the CAUTION LIGHTS switch on the console is moved to DIM.

2-42. First Aid Kits.

Seven aeronautic first aid kits are installed in the helicopter. One kit is in the passageway between the cockpit and cabin and six are in the cabin fuselage section, three on each side.

2-43. Emergency Entrances and Exits.

See figure 9-2 for information on emergency entrances and exits.

2-44. Emergency Escape Axe.

An emergency escape axe is provided and is slightly forward of station 200, on the right side of the cargo compartment.

SECTION III ENGINES AND RELATED SYSTEMS

2-45. Engines.

The CH-47A is powered by either T55-L-7/7B or T55-L-7C engines. (See figure 2-12.) The two engines are housed in separate nacelles mounted externally on each side of the aft pylon section. Basically, the T55-L-7 series engines are of the same configuration and differ only in internal details and shaft horsepower presented in table 2-2.

Table 2-2. Engine Power Levels

POWER LEVEL	SHAFT HORSEPOWER (SHP)
T55-L-7/7B	
Normal Power	2250 SHP
Military Power	2650 SHP
T55-L-7C	
Normal Power	2500 SHP
*Military Power	2850 SHP
*Maximum Power	2850 SHP

*Even though the T55-L-7C engines reflect the same sea level standard day shaft horsepower limitation at both military and maximum power, an increase in performance is gained at maximum power. Operation at military power is limited to 30 minutes and the exhaust gas temperature can remain at 650°C maximum; whereas, operation at maximum power is limited to 10 minutes, but the exhaust gas temperature can remain at 665°C maximum.

2-46. (See figure 2-12.) Each engine has two main sections: a gas producer section and a power turbine section. The gas producer supplies hot gases to drive the power turbine; it also mechanically drives the engine accessory gearbox. The power turbine shaft extends coaxially thru the gas producer rotor and rotates independently of it. The gas producer section and the power turbine section are connected by only the hot gases which pass from one section to the other. During engine starting, air enters the engine inlet and is compressed as it passes thru seven axial stages and one centrifugal stage of the compressor rotor. The compressed air passes thru a diffuser. Some of the air enters the combustion chamber where it is mixed with start fuel. The mixture is ignited by two igniter plugs on T55-L-7/7B engines and four igniter plugs on T55-L-7C engines. Some of the air is directed to the fuel nozzles. After the engine is started, it continues to operate on metered fuel supplied to the fuel nozzles. Hot expanding gases leave the combustion chamber and drive a single-stage compressor turbine. Remaining energy from the combustion gases drives the two-stage power turbine which drives the power output shaft to the engine transmission. The engine lubrication system has an integral oil tank which is inside the air inlet housing and is serviced with 14 quarts. (Refer to table 2-3.)

CAUTION

Helicopters with standard engine inlet screens must have the screens removed before flight when inflight temperatures will be below 4.4°C.

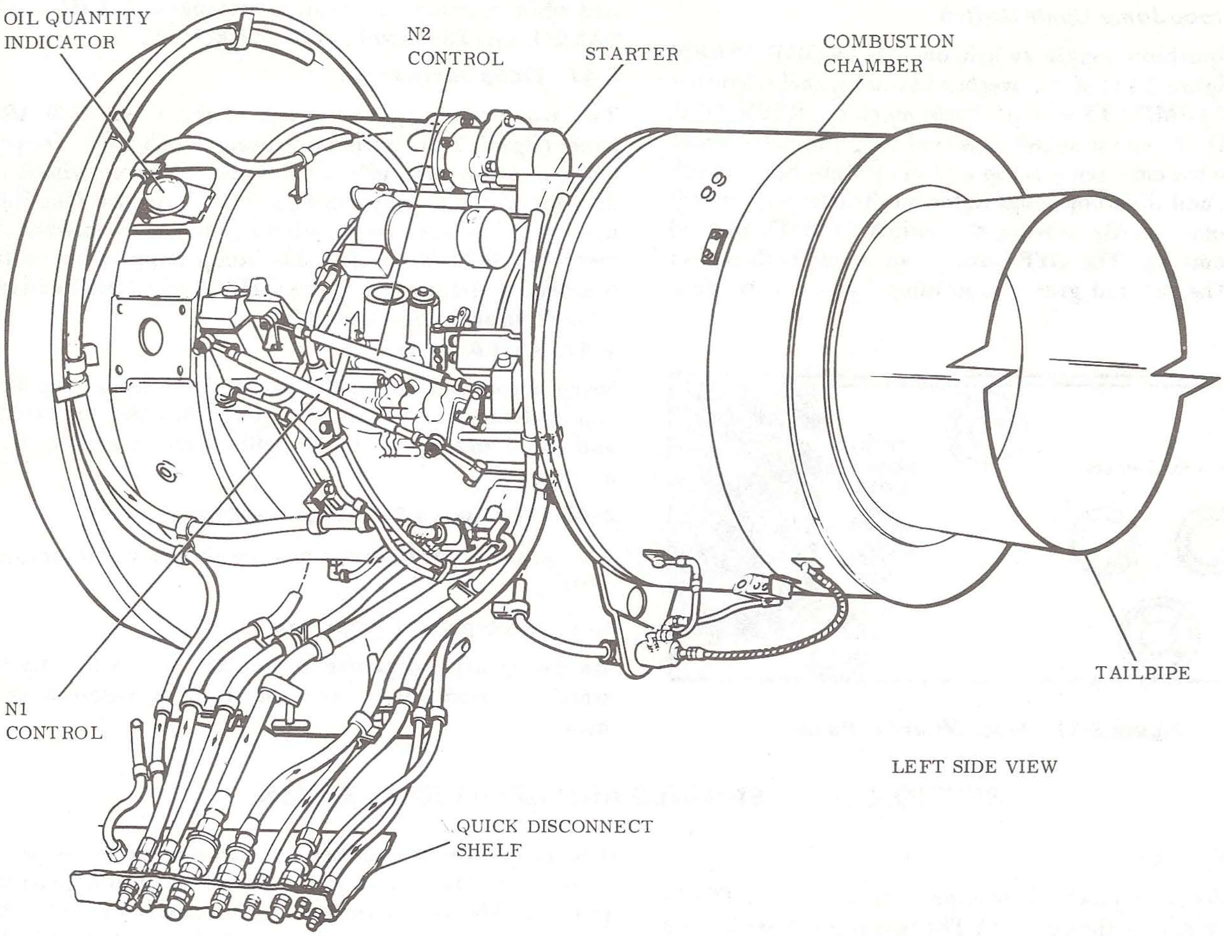


Figure 2-12. Engine, T55-L-7 Series (Sheet 1 of 2)

2-47. Engine Inlet Screens.

Engine inlet screens minimize foreign object damage (FOD). The reduction in engine power available with screens installed is negligible. Use of engine anti-icing is prohibited with engine inlet standard screens installed.

2-48. Engine Anti-Icing.

The engine receives anti-icing protection from two sources: hot air ducted to the inlet guide vanes and thermal radiation produced by the oil tank in the inlet housing. An electrically operated engine hot air valve is positioned on the top left side of the engine compressor housing directly behind, and to the left of the starter drive housing. The valve is secured on one end to the engine air bleed gallery and at the other end by a tube assembly secured to the inlet housing. When open, the valve allows hot air to flow from the compressor diffuser section to the internal passages of the inlet housing. This inhibits ice formation on the hollow inlet guide vanes. Additional anti-ice protection is provided by thermal radiation from the inlet housing. The hot oil in the oil cavity of the inlet housing warms the air as it passes into the engine inlet. When the engine anti-ice switch is moved to ON, anti-icing operation is usually indicated by the following: a rise in engine temperature (EGT), a drop in N1 speed and then a return to original speed, and an increase in engine oil temperature. In addition, a reduction in power may occur.

2-49. Engine Anti-Ice Switch. A two-position toggle switch on the anti-ice control panel (figure 2-8) of the overhead switch panel, controls the hot air valves on both engines. The ENGINE ANTI-ICE ON-OFF switch electrically positions the engine hot air valves. When the switch is at ON, the engine hot air valves are deenergized open. When the switch is at OFF, the engine hot air valves are energized closed. If electrical failure occurs, the valves remain open in anti-icing mode. The switch receives power from the 28-volt dc primary bus thru two circuit breakers on the overhead circuit breaker panel marked ENG ANTI-ICE NO. 1 and NO. 2.

2-50. Normal Operation—Engine Anti-Icing. The engine anti-icing system must be placed in operation when ambient air temperature is between +4.4° and −37.2°C, and rain or free water exists in the air in droplets of any size. Refer to table 8-1 for additional information on the use of engine anti-icing.

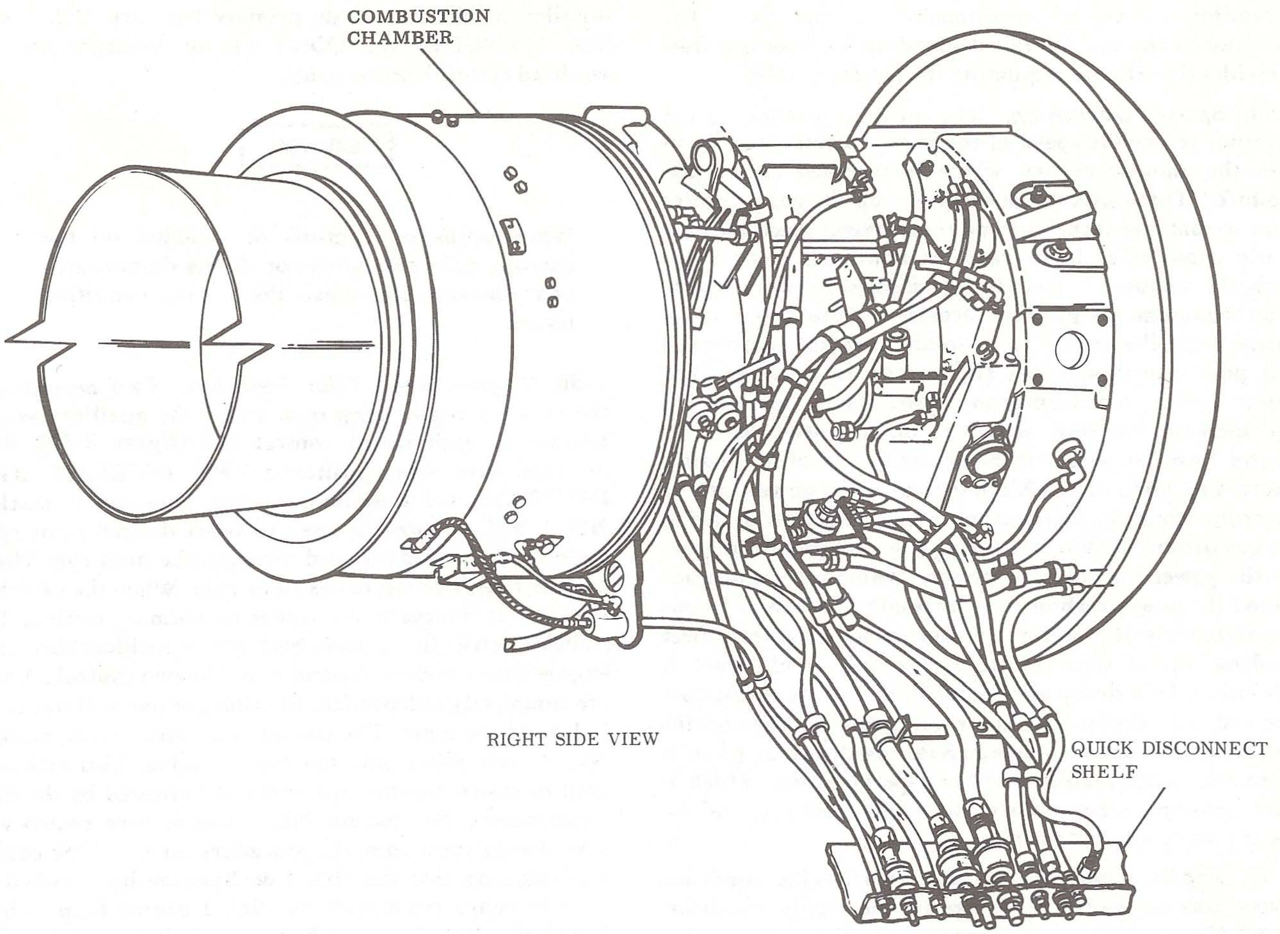


Figure 2-12. Engine, T55-L-7 Series (Sheet 2 of 2)

CAUTION

The ENG ANTI-ICE NO. 1 and NO. 2 circuit breakers must be in during operation at all ambient air temperatures. If the circuit breakers are out, anti-icing becomes continuous and a reduction in engine power occurs.

2-51. Engine Power Control System.

Each engine is controlled by a separate power control system which includes cockpit controls and an engine fuel control unit. Each system provides automatic control of engine gas producer rotor speed and power turbine speed in response to any setting of the engine controls selected by the pilot. Engine gas producer rotor speed (N1) and power turbine speed (N2) are controlled by the fuel control unit, which varies the amount of fuel delivered to the engine fuel nozzles. During normal operation, the fuel control unit automatically prevents power changes from damaging the engine. Fuel flow is automatically monitored to compensate for changes in outside air temperature and compressor discharge pressure.

2-52. Engine Fuel Control Units. Each engine fuel control unit contains a dual element fuel pump, a gas producer speed governor, a power turbine speed governor, an acceleration-deceleration control, a fuel flow limiter, a fuel control fuel shutoff valve, and a main metering valve. Mounted on the fuel control unit are two levers: a gas producer lever and a power turbine lever. The output power of the power turbine (a function of speed and torque) is restricted by limiting the maximum fuel flow to the gas producer. The maximum gas producer rotor speed is set by the engine condition lever in the cockpit. The engine condition lever electromechanically positions the gas producer lever, which controls the fuel control fuel shutoff valve and the operating mode of the gas producer. During flight the engine condition lever is left at the FLIGHT position and the output shaft speed is regulated by the power turbine speed governor. The power turbine lever is electromechanically positioned by the engine beep trim switches. Output shaft torque is limited by the fuel flow limiter, which reduces the maximum fuel flow when the power turbine speed is reduced. The position of the main metering valve is determined by the gas producer speed governor, power turbine speed governor, the acceleration-deceleration control, or the fuel flow limiter, depending on engine requirements at that time. The governor or the control unit demanding the least fuel flow overrides the other in regulating the metering valve.

2-53. Speed Governing. The power turbine speed governor senses the speed of the power turbine and regulates the amount of fuel which is supplied to the gas producer. This slows down or speeds up the gas producer rotor so that power turbine and rotor system speed remains nearly constant as loads vary. At minimum rotor blade pitch, the amount of power being supplied by either engine is at minimum. As pitch is increased, more power is required from the engine to maintain constant rotor speed and power turbine speed (N2) starts to decrease. The power turbine speed governor senses the decrease of N2 and increases the flow of fuel to the gas producer. This creates more hot gases for the power section of the engine. Decreasing pitch causes N2 to increase. The power turbine governor senses the increase and reduces the flow of fuel to the gas producer, thus decreasing the amount of hot gases for the power turbine. The power turbine speed governor allows the power turbine output speed to decrease (droop) approximately 10 percent (25 rotor rpm) when the power loading varies from minimum to full load. This is minimized by a droop eliminator linked to the thrust control rod. The droop eliminator automatically changes the power turbine lever to compensate for droop as pitch is increased or decreased. Another type of droop, which is only transient, occurs as a result of the time required for the engine to respond to changing loads.

2-54. Engine Condition Levers. Two engine condition levers, one for each engine, are on the engine condition panel (figure 2-13) on the console. Each lever is used to select the condition at which the respective engine will operate. Limit switches, which are part of the condition panel, control dc power supplied to the three-position gas producer actuator on each engine. The actuator mechanically operates a lever, which controls the fuel control fuel shutoff valve and the operating speed of the gas producer. The engine condition lever positions are STOP, GROUND, and FLIGHT. Each lever is spring-loaded outboard and moves in a slot in the panel. The engine condition levers must be at GROUND when the engine is started. When a condition lever is advanced from STOP to GROUND, it springs over the GROUND detent. Power is then supplied to the electromechanical actuator which moves the gas producer lever. The speed of the gas producer with the lever at GROUND should be 37.5 to 42.7 percent N1. When a condition lever is moved to FLIGHT, the automatic section of the fuel control then takes control to maintain selected rotor rpm in response to the engine beep trim switches. When a condition lever is moved to STOP, the gas producer lever closes the fuel control fuel shutoff valve which stops the fuel flow to the gas producer. Each electrical system is completely separate and a failure in one system will not affect the other. A built-in mechanical brake holds the actuator at its last selected position if an electrical failure occurs. Electrical power is supplied by the 28-volt dc primary bus thru NO. 1 and NO. 2 ENGINE N1 CONT circuit breakers on the overhead circuit breaker panel.

CAUTION

When adjusting controls or switches on the console, make sure gloves or sleeves do not catch and inadvertently move the engine condition levers.

2-55. Engine Beep Trim Switches. Two momentary switches for engine beep trim are on the auxiliary switch bracket of each thrust control rod (figure 2-23). Both switches have three positions: RPM INCREASE, RPM DECREASE, and a normal position. One switch, marked NO. 1 & 2, is normally used to select desired rotor rpm. Holding the switch forward increases the rotor rpm. Holding the switch aft decreases rotor rpm. When the switch is released, it returns to the center or normal position. The switch electrically controls both power turbines thru each engine power turbine control box. The two control circuits are completely independent so failure of one will not cause failure of the other. The second beep trim switch, marked NO. 1, will affect only the No. 1 engine. This switch is used to match engine load which is indicated by the dual torquemeters. Because the NO. 1 engine beep switch will also change rotor rpm, the procedure for matching engine load requires that the NO. 1 & 2 engine beep switch be used in conjunction with the NO. 1 engine beep switch. When the NO. 1 engine beep switch is moved forward (RPM INCREASE), the torque of No. 1 engine increases. At the same time rotor rpm increases, even though No. 2 engine torque decreases slightly. Moving the NO. 1 & 2 engine beep trim switch aft (RPM DECREASE) causes both engine torques to decrease and reduce rotor rpm. If torques are still not matched, this procedure is continued until torques are matched and desired rotor rpm is attained. The opposite action occurs when the NO. 1 engine beep switch is moved aft. The engine beep trim switches should not be used during power changes initiated by thrust rod movement because rotor rpm droop should only be momentary. (Refer to paragraph 2-53.) The engine beep trim system adjusts engine rpm only if the respective engine condition lever is at FLIGHT. If the engine condition levers are at STOP or GROUND, it is possible to move the power turbine lever by moving the engine beep trim switches to DECREASE or INCREASE: but in either case, engine rpm will not be affected. Power to operate the beep trim system is supplied by the 28-volt dc and the 115-volt ac primary buses. Power to operate the power turbine actuators is dc voltage. This dc voltage is derived from the 115-volt ac primary bus after the ac is transformed and rectified by the engine power turbine control box. Circuit breakers for both ac and dc power are marked ENG TRIM AC, DC, NO. 1 and NO. 2 and are on the overhead panel.

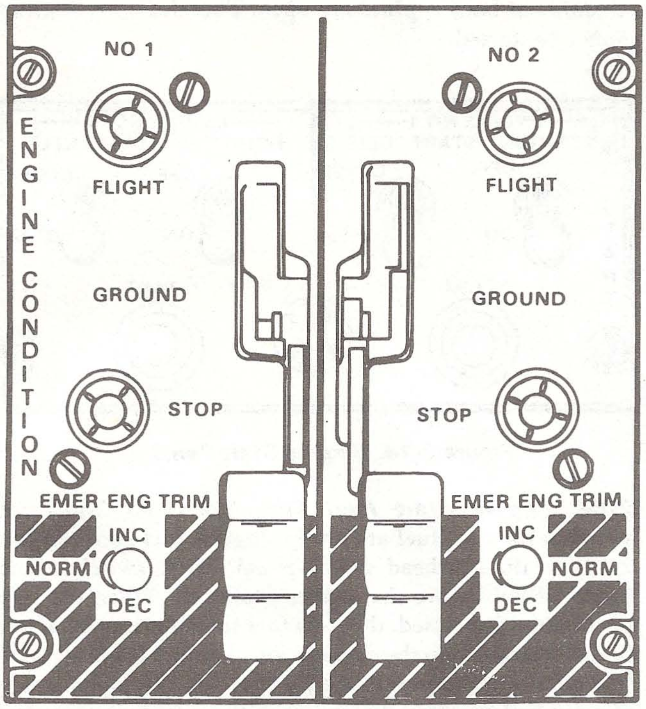


Figure 2-13. Engine Condition Panel

2-56. Normal Beep Trim System Disable Switches. Two guarded switches are installed on the pilot's console (figure 2-6). The switches permit the pilot to disable either or both normal beep trim system(s). This prevents unwanted signals from the normal beep trim system from interfering with the operation of the emergency engine trim system (refer to paragraph 2-57.) The switches are marked NORM ENG. TRIM, ENG NO. 1-ON, OFF and ENG NO. 2-ON, OFF. When either switch is at OFF the respective normal beep trim system is disabled (115-volt ac from the primary ac bus to the engine power turbine control box is interrupted). When the switch is at ON (cover down), the normal beep trim system is functional (115-volt ac from the primary bus is reconnected to the associated engine power turbine control box). (Refer to paragraph 9-21 for emergency engine trim operation.)

2-57. Emergency Engine Trim Switches.

CAUTION

Engine response is much faster when controlling rotor rpm with the emergency engine beep trim system. It is possible to beep the rotor speed below safe operating speed and low enough to disconnect the generators from the buses. The generators are disconnected at 196 to 184 rotor rpm.

Two momentary switches for emergency engine trim are aft of the engine condition levers (figure 2-13) on the console. Each switch is used to change the power turbine speed of its respective engine if the power turbine control box (normal beep trim system) malfunctions. When the normal trim system fails, the droop eliminator also fails to function. Each switch has three positions: INC, DEC, and a springloaded center position marked NORM. When one of the switches is held at INC, power from the 28-volt dc emergency bus goes directly to the respective power turbine actuator and increases the lever setting and the power turbine speed. When the switch is held at DEC, the lever setting is decreased and, the power turbine speed is decreased. The emergency engine trim switches are to be used when the normal beep trim system is disabled. If one of the switches is used while the respective power turbine control box is functioning normally, the power turbine actuator setting will temporarily change but will return to its original setting when the switch is released. Power to operate the emergency beep trim switches and actuators is supplied by the 28-volt dc emergency bus thru the EMER ENG TRIM circuit breaker on the overhead circuit breaker panel.

2-58. Oil Supply System.

The oil supply system is an integral part of the engine. The oil tank is part of the air inlet housing. The tank filler neck is on top of the housing. An oil level indicator is on the left side of the engine inlet housing. The tank capacity is 14 quarts. If the oil level decreases to about 2 quarts usable, the corresponding ENG OIL LOW caution light will come on.

2-59. Engine Oil Consumption. Operational usage of the engine should not be restricted because of oil consumption, unless the rate will curtail the mission. Furthermore, oil consumption in conjunction with possible hot starts, torching, residual fires after shutdown, or an abrupt change in consumption will necessitate an investigation to determine the cause. Normally an oil consumption of 2 quarts or less per hour will not cause hot starts, torching, or residual fires after shutdown. If oil consumption exceeds 2 quarts per hour, an entry on DA Form 2408-13 is required.

2-60. Engine Starting System.

The main components of the engine starting system are the hydraulic starters, the engine start and utility hydraulic system solenoid valves, the engine condition levers, the start fuel and ignition switches, and the start pushbuttons. The rotor dephasing arm also forms a part of the starting system in that the arm must be up and locked in PHASED position to provide continuity in the starting electrical circuit. The engine starting circuit is manually controlled. Engine starting is accomplished with the engine condition lever at GROUND, the start fuel switch at OPEN, and the ignition switch at ON. To start, press and hold the pushbutton. Power from the 28-volt dc primary bus thru the NO. 1 or NO. 2 ENG START and IGNITION-ENG. NO. 1 or NO. 2 circuit breakers energizes relays. The relays open the engine start solenoid, close the utility system solenoid valve, open the start fuel solenoid valve, and energize the ignition exciter. When the engine start solenoid valve is opened, hydraulic pressure is applied to the appropriate engine starter. Simultaneously, the utility system solenoid valve closes to prevent a loss of hydraulic pressure to the rest of the utility system. Concurrently, the ignition system is energized and start fuel goes into the combustion chamber.

NOTE

When either engine start pushbutton is pressed, the No. 2 generator, the No. 2 dc power supply (transformer-rectifier), the ac and dc secondary buses, the auxiliary bus, and the radio bus are disconnected from the electrical system. This reduces the starting load and reconnects the electrical system at the completion of the engine starting cycle. During any engine start with the apu stopped, all buses will remain connected.

When N1 speed reaches 35 percent, the start pushbutton is released. This removes power from the relays. The engine start solenoid valve closes, the start fuel solenoid valve closes, the utility system valve opens, and the ignition exciter deenergizes. The engine then sustains combustion on metered main fuel.

2-61. Engine Start Pushbuttons. Two engine start pushbuttons are on the engine start panel (figure 2-14) of the overhead switch panel. These red, spring-loaded switches, marked ENGINE NO. 1—START and ENGINE NO. 2—START are used to initiate engine starting. By pressing one of these pushbuttons continuously, hydraulic power, start fuel, and ignition are supplied to the engine. The start pushbuttons can also be used to motor the engine, provided the start fuel switch is at CLOSE, the ignition switch is at OFF, and the condition lever is at STOP, when the pushbutton is pressed and held.

2-62. Engine Ignition Switches. Two 2-position engine ignition switches are on the engine start panel (figure 2-14) on the overhead switch panel. These switches must be at ON before the engine is started. When the start pushbutton is pressed, the ignition exciter on the engine is energized; voltage is applied by the exciter to the spark splitter which distributes the voltage to the igniter plugs on the engines. Ignition is provided continuously until the start pushbutton is released at 35 percent N1.

2-63. Ignition Lock Switch. To prevent damage to the switch, be sure both IGNITION switches are OFF and the START FUEL switches are at CLOSE before turning the ignition lock switch ON or OFF. An ignition system lock switch (9, figure 2-4) has been installed on modified helicopters. The key-operated switch prevents unauthorized use of the helicopter. The switch is on the right side of the console forward of the thrust control rod. When the switch is off, the circuits to the ignition exciters and the start fuel solenoids of both engines are open. Therefore, the engines cannot be started.

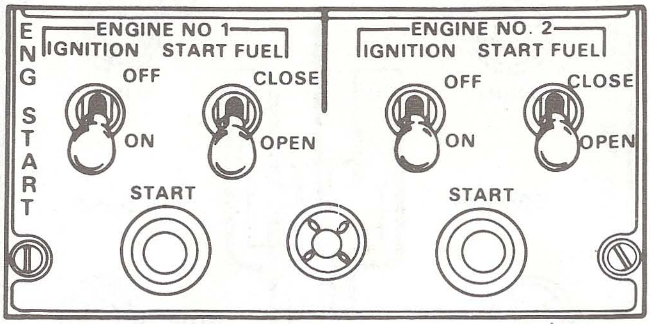


Figure 2-14. Engine Start Panel

2-64. Engine Start Fuel Switches. Two 2-position switches for start fuel are on the engine start panel (figure 2-14) on the overhead switch panel. These switches must be at OPEN before the engine is started. When the start pushbutton is pressed, the start fuel solenoid is opened and fuel is injected into the combustion chamber from two start fuel nozzles. At approximately 12 percent N1, a percentage of main fuel is metered along with the start fuel. Start fuel is provided continuously until the start pushbutton is released at 35 percent N1 or until the start fuel switch is moved to OFF. Combustion is then sustained on main metered fuel. A security lock switch has been installed on modified helicopters. The switch disables the start fuel solenoid circuit. Refer to paragraph 2-60 for a description of this switch.

2-65. Engine Instruments and Indicators.

The engine instruments are the gas producer tachometer, the torquemeter, exhaust gas temperature, and the oil pressure and temperature instruments. The indicators are the oil level and chip detector caution lights.

2-66. Gas Producer Tachometer.

Two gas producer tachometers (figure 2-7), one for each engine, are mounted on the center section of the instrument panel, above the egt indicators. Each tachometer displays gas producer turbine speed in percent of N1. The outer scale of the tachometer is calibrated from 0 to 100 in increments of two. The smaller, vernier scale calibrated 0 to 10, in increments of one. Each tachometer operates from power supplied by a gas producer tachometer generator mounted on the accessory gear box section of each engine.

2-67. Torquemeter.

Two dual torquemeters (figure 2-7) are provided. One torquemeter is mounted on the pilot's instrument panel and the other on the copilot's instrument panel. Each torquemeter has two pointers, one for each engine, labeled 1 and 2. Each torquemeter has a range from 1 to 13 (lb-ft x 100). An internal sleeve arrangement on the power output shaft of the engine produces a mechanical signal representing the amount of torque being developed and transmits this signal to an electromechanical transmitter unit mounted on the air inlet housing of the engine. The transmitter unit translates the mechanical signal into an electrical-selsyn signal which is transmitted to the dual torquemeter pointer for the respective engine. Power to operate the torque measuring system is provided by the 26-volt ac instrument bus through a circuit breaker labeled ENG TORQUE on the overhead circuit breaker panel.

2-68. Exhaust Gas Temperature Indicator.

Two exhaust gas temperature indicators (24, fig. 2-7), one for each engine, are mounted on the center section of the instrument panel. Each indicator registers from 0 to 1,000 in degrees celsius. The temperature indicated on the exhaust gas temperature indicator is produced by an exhaust thermocouple harness consisting of an electrical connector, shielded manifold, and three chromel-alumel thermocouple probes which are secured to the exhaust fairing support assembly of the engine.

2-69. Engine Oil Temperature Indicator.

Two engine oil temperature indicators (figure 2-7) are mounted on the center section of the instrument panel. Each engine oil temperature indicator is calibrated −70° to +150°C. A bimetallic temperature probe installed within the lubrication lines of the engine, before the fuel-oil cooler, is the contact point at which the temperature is sensed. Power to operate the resistance-type oil temperature circuit is supplied by the 28-volt dc primary bus thru the ENG OIL TEMP circuit breaker on the overhead circuit breaker panel.

2-70. Engine Oil Pressure Indicator.

An engine oil pressure indicator (figure 2-7) is provided for each engine. The indicators are mounted on the center section of the instrument panel. Each indicator relates pressure sensed, at the No. 2 bearing, by an oil pressure transmitter mounted on the engine. Each engine oil pressure indicator displays a pressure range from 0 to 200 psi. Power to operate the engine oil pressure circuit is supplied by the 26-volt ac instrument bus thru the PRESS IND ENG OIL circuit breaker on the overhead panel.

2-71. Engine Oil Level Caution Light.

Two engine oil level caution lights, marked OIL LOW NO. 1 ENG and OIL LOW NO. 2 ENG, are on the master caution panel (figure 2-52). When a caution light comes on, there are about 2 quarts of usable oil remaining in the respective engine oil tank. Each low oil level caution light is activated by a microswitch inside the oil quantity indicator. Power to operate the oil level caution lights is supplied by the 28-volt dc primary bus thru the CAUTION LTS circuit breaker on the overhead panel.

2-72. Engine Chip Detectors.

One engine chip detector is in the oil sump in the accessory section of each engine. Each plug is connected to a respective engine chip detector caution light on the auxiliary caution panel (figure 2-52). A chip detector plug in the oil return line of each engine transmission is also connected to the respective engine chip detector caution light.

2-73. Engine Chip Detector Caution Lights.

On helicopters without the temperature and debris detection systems, two caution lights are on the auxiliary caution panel. Each light is connected to two magnetic chip detector plugs; one plug is in the oil return line in the engine transmission housing and the other plug is in the oil sump in the accessory section of the engine. The respective caution light will come on whenever ferrous particles bridge the contacts of either plug and provide continuity in the circuit. Power to operate these lights is supplied by the 28-volt dc primary bus thru the CAUTION LTS circuit breaker on the overhead panel.

2-74. Engine Transmission Temperature and Debris Detection System.

A temperature and debris detection system has been installed on modified helicopters. The system consists of a detection screen in each engine transmission oil return line, a combination thermoswitch and chip detector in the transmission sump, and two ENG XMSN HOT caution lights. If the detection screen or the chip detector clog with metal particles, the corresponding ENG CHIP DET caution light will come on, indicating possible engine transmission failure. Also, clogging of the detection screen by metallic or nonmetallic particles will restrict oil flow to the cooler. The reduction in oil flow will cause an increase in engine transmission temperature. When oil temperature reaches about 190°C the thermoswitch on the chip detector will close and cause the corresponding ENG XMSN HOT caution light on the master caution panel to come on. Power to operate the light is from the 28-volt dc primary bus thru the CAUTION LTS circuit breaker on the overhead panel.

2-75. Engine Interstage Air Bleed.

To facilitate compressor rotor acceleration and avoid compressor stall, an interstage air bleed system is provided on each engine. A series of vent holes through the compressor housing at the sixth stage vane area allows pressurized air to bleed from the compressor area. This enables the compressor rotor to quickly attain a preselected rpm. The pneumatic interstage air bleed actuator controls operation of the air bleed by tightening or loosening a metal band over the vent holes. The interstage air bleed system will operate automatically when either the engine condition levers or the engine beep trim switches are used to govern rpm. Should the bleed band malfunction and remain open, there would be a noticeable loss in power.

2-76. Engine Drain Valves.

Pressure-operated engine drain valves are installed in the bottom of each engine combustion chamber housing. The valves automatically drain unburned fuel from the combustion chamber following a false start or whenever the engine is shut down. One valve is at the forward end of the combustion chamber and the other is at the aft end to ensure complete drainage.

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SECTION IV FUEL SYSTEM

2-77. Fuel Supply.

The fuel supply system (figures 2-15 and 2-16) furnishes fuel to the two engines, the heater, and the auxiliary power unit (apu). This system consists of a fuel control panel (figure 2-17), and two separate self-sealing fuel systems connected by a crossfeed line and valve(s). Provisions are available within the cabin fuselage section for connecting internal ferry fuel tanks to the left and right fuel cells. The attachment points are on the left and right side of the cargo compartment at station 384, beneath the heater duct. Each system consists of a fuel tank contained in a pod on the side of the fuselage, two ac-operated fuel booster pumps, two float-controlled solenoid valves, and a fuel valve (firewall fuel shutoff). Each booster pump delivers fuel under pressure to a solenoid valve. Fuel flows from the normally open float control solenoid valve thru the fuel valve and then thru the engine fuel control unit. Float switches next to the booster pumps inside the fuel tank and a pressure switch downstream of the solenoid valves are electrically connected to the solenoid valves through relays. If a float switch becomes exposed from the fuel and the differential pressure across the respective solenoid valve is less than 10 psi, as sensed by the pressure switch, the solenoid valve will close and prevent air from being drawn into the system. If one of the booster pumps fails or becomes exposed, a check valve prevents flow back into the tank. Two vent lines extend from the top of each fuel tank; fuel cannot escape thru these lines in normal helicopter attitudes. Fuel is normally delivered from the left tank to the apu fuel control unit by a separate dc operated booster pump. Fuel system switches (figure 2-17) are on the overhead panel in the cockpit. Caution lights are on the console. See the Servicing table 2-3 for fuel grade and specifications. Total fuel capacity with the crash-resistant fuel system is 567 gallons. Total fuel capacity without the crash resistant fuel system is 620 gallons. Refer to paragraph 2-90 for fuel management procedures. Refer to paragraph 5-28 for fuel limitations.

2-78. Crash Resistant Fuel System.

(See figure 2-16.) On helicopters with the crash resistant fuel system, the fuel tanks are self-sealing tanks with breakaway fittings. The main fuel lines are constructed of an elastic, memory type material which returns to its original configuration after penetration by a projectile; thereby sealing the wound and stopping fuel leakage. Both lines and tanks are capable of taking a 50-caliber hit and sealing the hole to prevent fuel leakage. The walls of the fuel tanks are constructed with an elastic sealant between two metal skins. Penetration of the wall by a projectile exposes the sealant to the fuel, activates the sealant, and closes the hole. Breakaway self-sealing fittings are installed where the main fuel lines connect to the fuel tank and the adjacent structure. Under high impact loads, the fittings shear or break at a predetermined location, seal themselves and retain the fuel; keeping fuel loss and post crash fire hazard to a minimum. Electrical cables having lanyard release type connectors, are installed where the cables are attached to adjacent structure. The connectors automatically release and are electrically deenergized if the fuel tank breaks away from the pod. Fuel is delivered to the heater from the forward end of the right main fuel tank instead of the left system which is the configuration for helicopters without crash resistant fuel systems.

2-79. Fuel Pump Switches. Four, two-position fuel booster pump switches (figure 2-17) are on the fuel control panel of the overhead switch panel. A schematic diagram of the fuel system is imprinted on this control panel. Each switch operates a single-speed electrically driven fuel booster pump. Marked next to each switch is the name of the pump it operates. Each switch has two positions: ON and OFF. When one of these switches is at ON, power supplied from the 28-volt dc primary bus closes the respective pump relay which supplies 208-volt 3-phase alternating current to the fuel pump. Each booster pump individually provides sufficient pressure to supply fuel to both engines. Four circuit breakers for these switches are on the overhead panel and are labeled FUEL PUMP CONTROL-L FWD, L AFT, R FWD, and R AFT. For the fuel pumps, there are four 3-phase circuit breakers, labeled FWD RH FUEL PUMP, FWD LH FUEL PUMP, AFT RH FUEL PUMP, and AFT LH FUEL PUMP, located on the ac circuit breaker box.

2-80. Engine Fuel Valve Switches. Two, two-position engine fuel valve switches on the fuel control panel (fig. 2-17) of the overhead switch panel electrically operate the two valves (figure 2-18) which control fuel flow to each

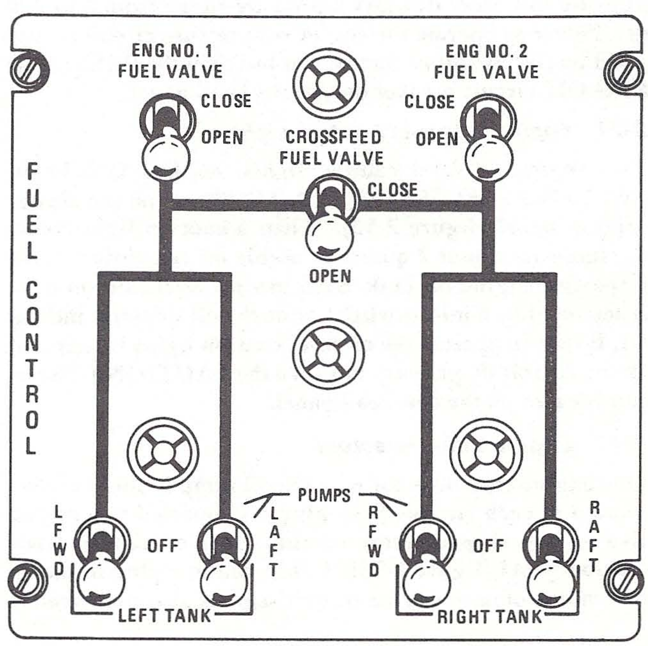


Figure 2-17. Fuel Control Panel

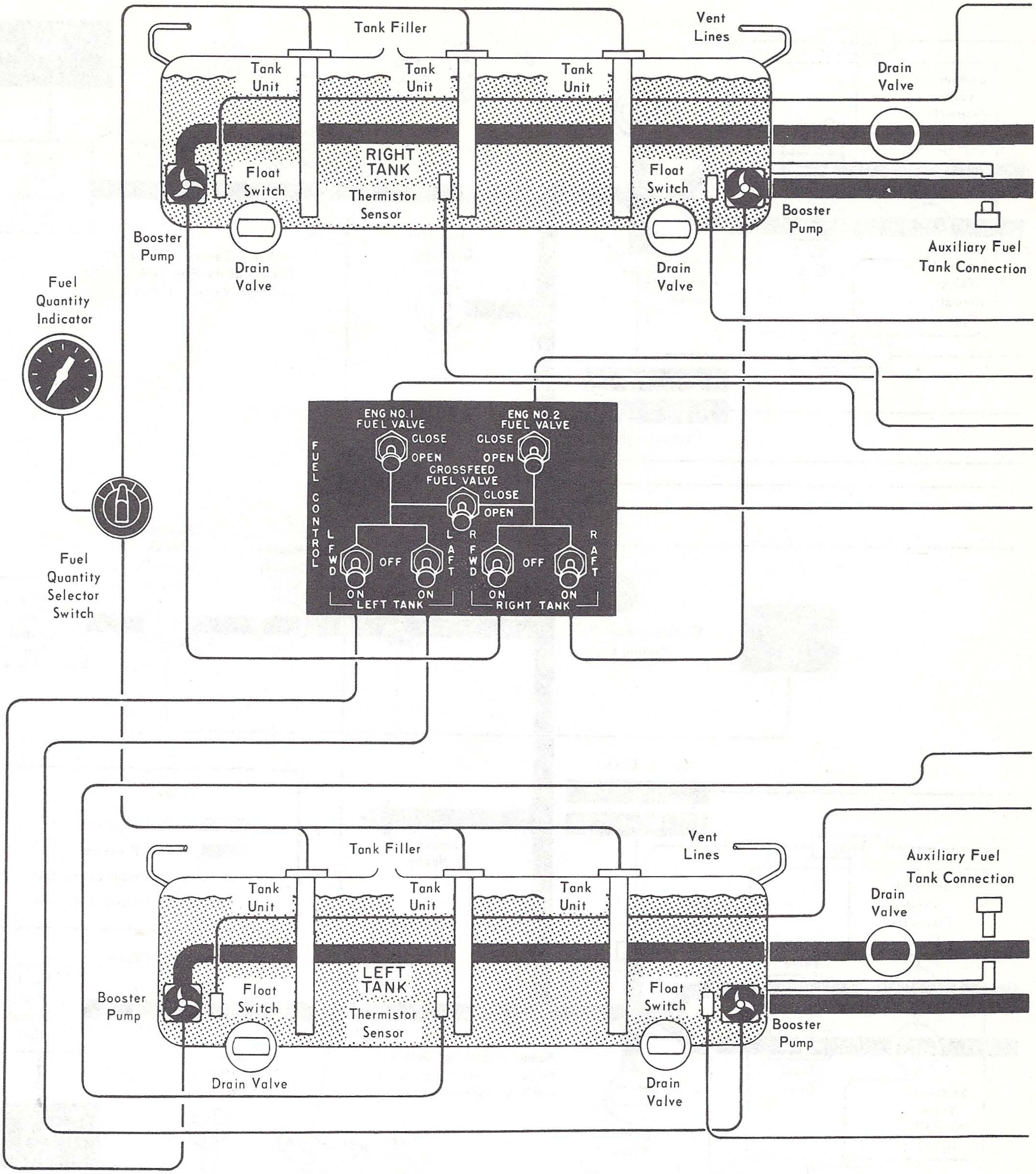


Figure 2-15. Fuel Supply System, Without Crash Resistant Fuel System (Sheet 1 of 2)

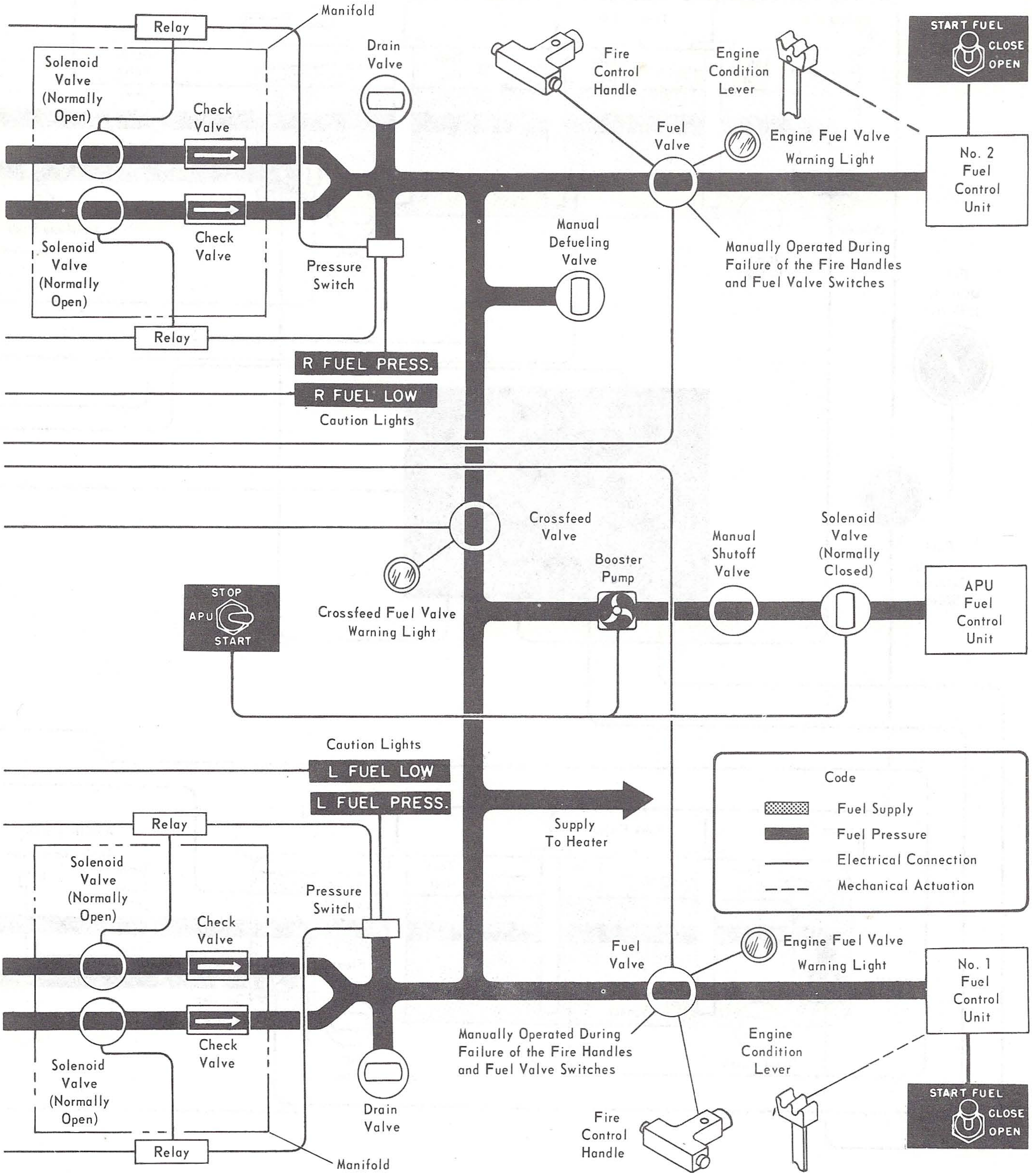


Figure 2-15. Fuel Supply System, Without Crash Resistant Fuel System (Sheet 2 of 2)

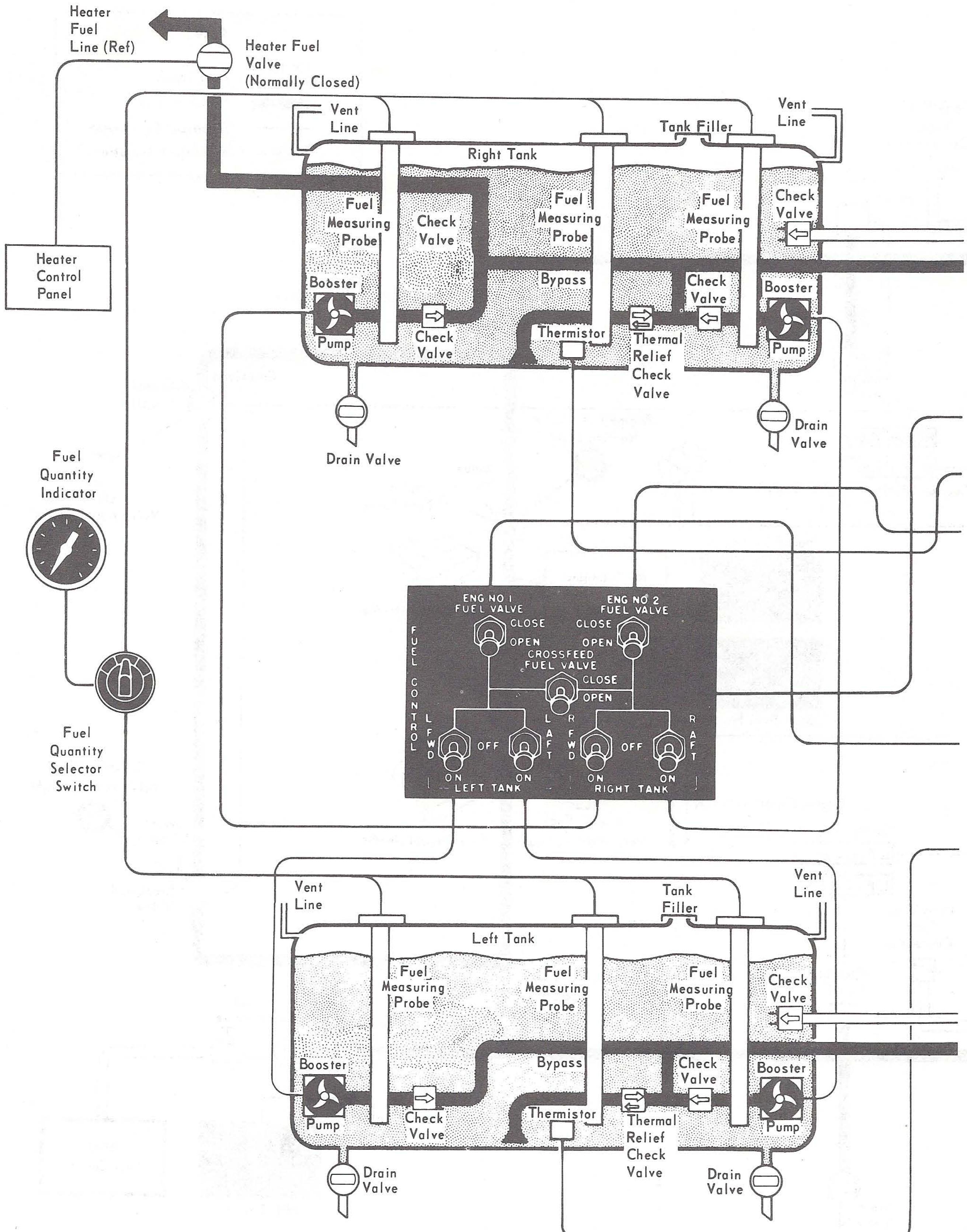


Figure 2-16. Fuel Supply System, With Crash Resistant Fuel System (Sheet 1 of 2)

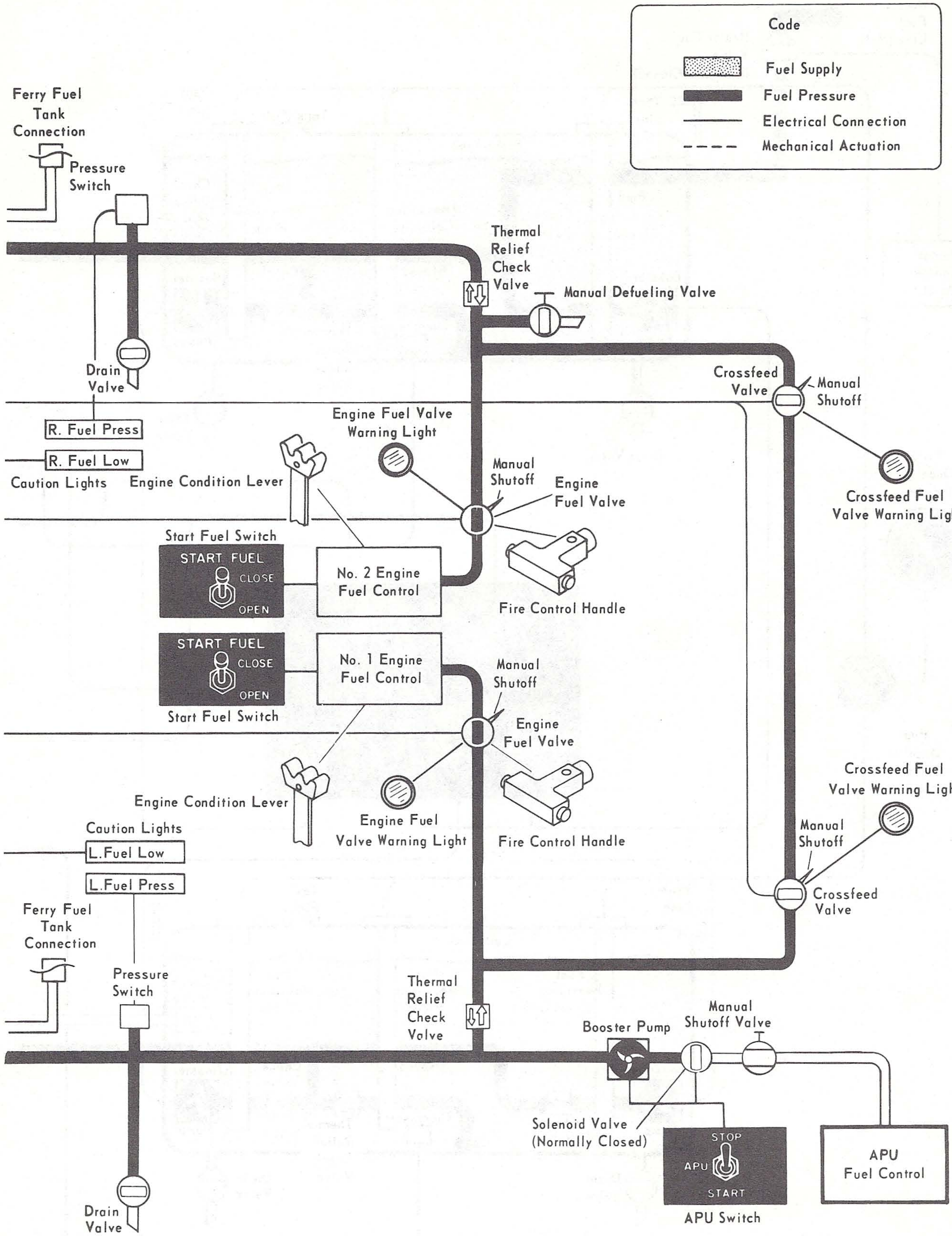


Figure 2-16. Fuel Supply System, With Crash Resistant Fuel System (Sheet 2 of 2)

engine fuel control unit. Marked ENG NO. 1 and ENG NO. 2 respectively, these switches have two positions, OPEN and CLOSE. When one of the switches is at OPEN, power from the 28-volt dc primary bus opens the proper fuel valve. When the switch is at CLOSE° power closes the fuel valve. A lever is incorporated on each fuel valve to aid manual operation during electrical failures. The fuel valves are also protected against short circuit closings and are equipped with an indicating warning light. The fuel valve can be manually operated to shut off fuel flow to the engine. Two circuit breakers for these switches, marked FUEL SHUTOFF, are on the overhead circuit breaker panel.

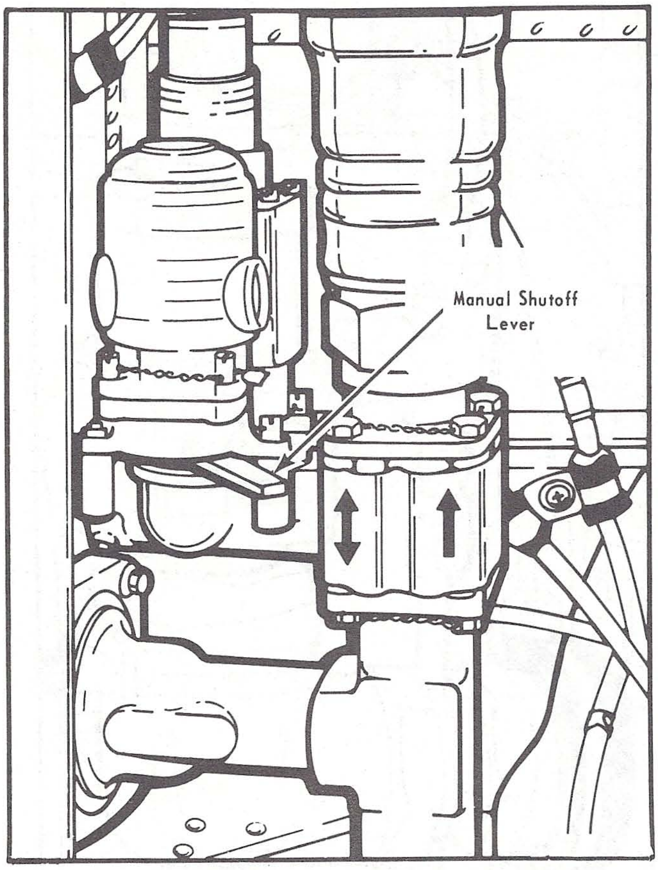


Figure 2-18. Engine Fuel Valves

2-81. Engine Fuel Valve Warning Lights. Two PRESS-TO-TEST engine fuel valve warning lights (figure 2-19), each adjacent to an engine fuel valve, are installed to indicate the operating condition of the individual fuel valve and associated circuitry. The warning light will come on under the following conditions:

a. Momentarily each time a fuel valve switch is moved from CLOSE to OPEN or OPEN to CLOSE. During this operation, the warning light should go out immediately, indicating that the fuel valve is synchronized with the switch position. If 114PS401-1 valves are installed, the warning light will not come on during valve operation. The 114PS401-1 valve has an external relay mounted next to it.

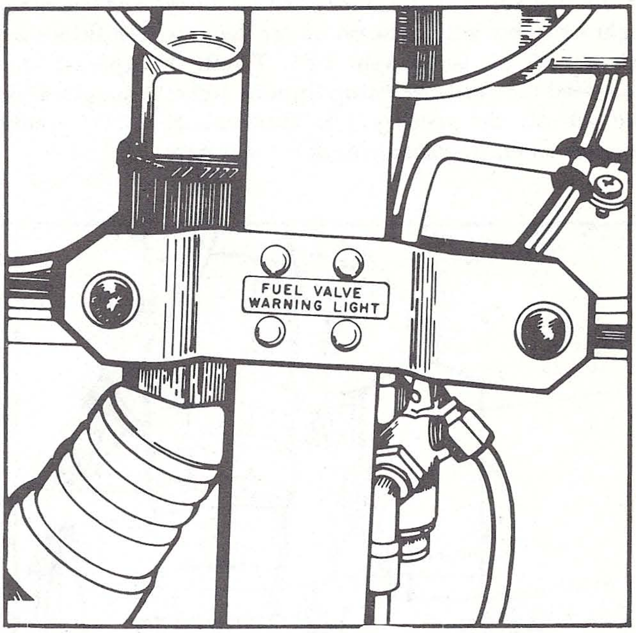


Figure 2-19. Fuel Valve Warning Light (Typical)

b. Continuously if a short circuit occurs causing a signal to be applied opposite to the valve position. However, the valve will remain at the position last selected by the fuel valve switch.

c. Continuously should the fuel valve protection relay fail. Should the warning light come on, the fuel valve will remain at the last selected position and the valve may be operated either electrically or manually, as required. Power to operate the engine fuel valve warning lights is supplied by the 28-volt dc primary bus thru the FUEL SHUT-OFF circuit breakers on the overhead circuit breaker panel.

2-82. Crossfeed Fuel Valve Switch. A two-position crossfeed fuel valve switch is on the fuel control panel (figure 2-17) of the overhead switch panel. This switch allows the pilot to select fuel from either tank for either engine or both engines. However, there are no provisions for tank-to-tank crossfeeding. The switch, on helicopters prior to 67-18464, electrically operates the crossfeed fuel valve (figure 2-20) in the crossfeed fuel line. The switch has two positions, OPEN and CLOSE. When the switch is at OPEN, power supplied from the 28-volt dc primary bus thru the X-FEED circuit breaker on the overhead circuit breaker panel, opens the fuel valve(s). When the switch is at CLOSE, electrical power closes the fuel valve(s). A lever is used to manually close the valve(s) during electrical failures. The crossfeed fuel valve(s) are protected against short circuit closings and are equipped with a warning light.

2-83. Crossfeed Fuel Valve Warning Light. On 66-19059 and subsequent and helicopters with the crash resistant fuel system, a PRESS-TO-TEST crossfeed fuel valve warning light or lights is adjacent to the crossfeed fuel valves and is installed to indicate the operating condition of the fuel valve(s) and associated circuitry. The warning light or lights will come on under the same conditions as mentioned in paragraph 2-81. Power to operate the crossfeed fuel valve warning light or lights is supplied by the 28-volt dc primary bus thru the X-FEED circuit breaker on the overhead circuit breaker panel.

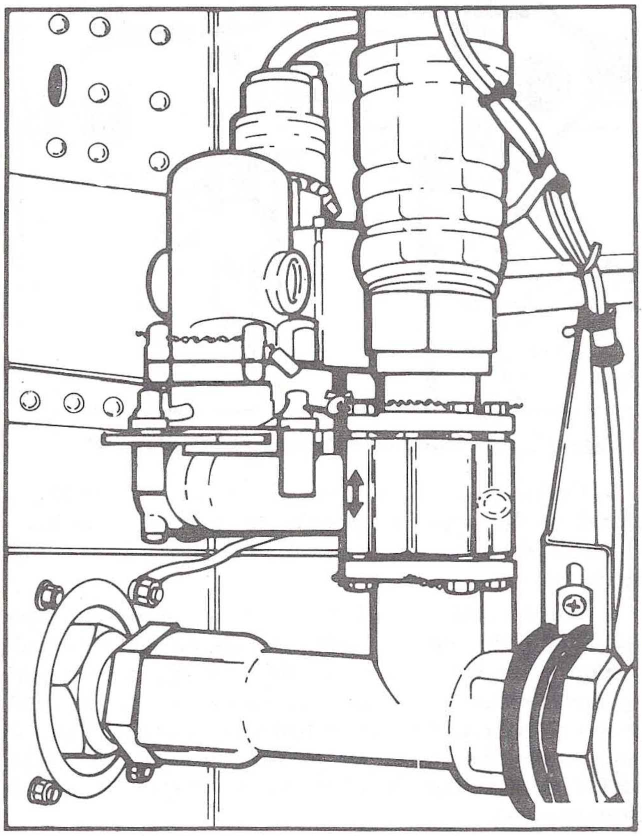


Figure 2-20. Crossfeed Fuel Valve

2-84. Manual Defueling Valve. A manual defueling valve (figure 2-21) is in the aft cargo compartment adjacent to the No. 2 engine fuel valve. The defueling valve has a selector which is rotated in the appropriate direction to either open or close the valve. Instructions on how to open or close the valve are stenciled immediately behind the valve.

2-85. Fuel Quantity Indicator. An indicator (figure 2-22) calibrated to measure fuel quantity in pounds is mounted on the center section of the instrument panel. This fuel quantity indicator is electrically connected to three capacitance-type measuring units in each tank. The 115-volt ac primary bus supplies electric power for the indicator thru a circuit breaker labeled FUEL QTY IND on the overhead circuit breaker panel.

2-86. Fuel Quantity Selector Switch. A fuel quantity selector switch (figure 2-22) is on the center section of the instrument panel to the right of the fuel quantity indicator. The switch positions are LH TANK, TOTAL, and RH TANK. When the switch knob is turned to LH TANK, power is supplied to the measuring units in the left tank only and the fuel quantity indicator indicates the quantity of fuel in that tank. When the switch knob is turned to RH TANK, fuel quantity in the right tank only is indicated. Total fuel in both tanks is indicated on the fuel quantity when the selector knob is at TOTAL.

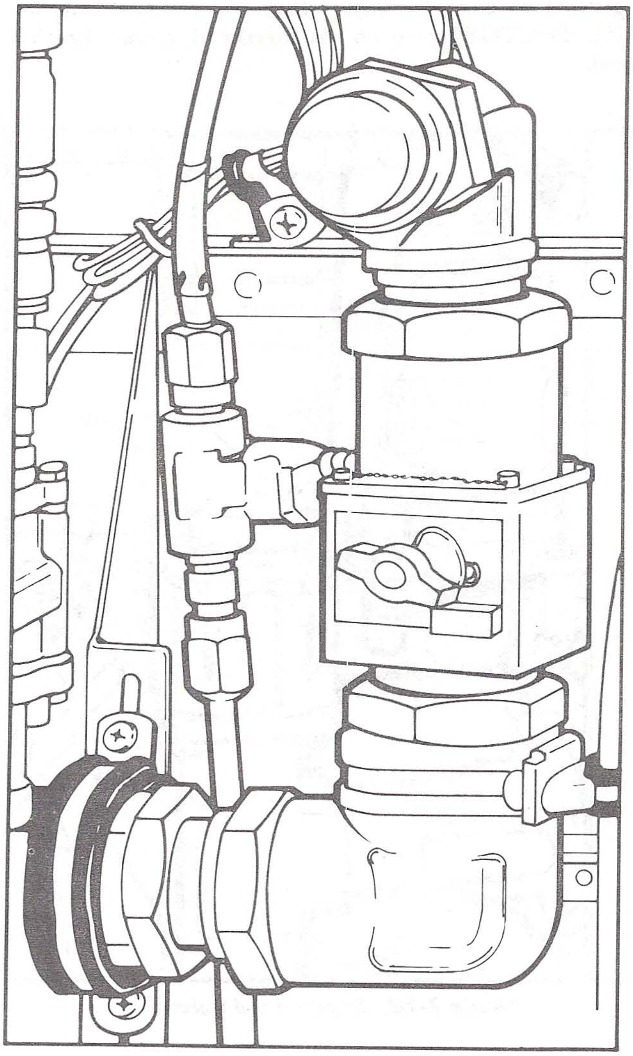


Figure 2-21. Manual Defueling Valve (Typical)

2-87. Fuel Quantity Caution Lights. Two fuel quantity caution lights, one for each tank, are on the master caution panel (figure 2-6) of the console. Each light is electrically connected to a thermistor sensor on the center fuel quantity probe in the respective tank. These lights are marked L FUEL LOW and R FUEL LOW. When there is 20 percent of fuel remaining in a tank, the caution light for that tank comes on. (Twenty percent of fuel on helicopters without the crash resistant fuel system is equal to 350 to 450 pounds, and 320 to 420 pounds on helicopters with the crash resistant fuel system.) Electric power for these lights is supplied by the 28-volt dc primary bus thru the CAUTION LTS circuit breaker on the overhead panel.

2-88. Fuel Pressure Caution Lights. Two caution lights marked L FUEL PRESS and R FUEL PRESS are on the master caution panel (figure 2-52). Each caution light is electrically connected to a fuel pressure switch between the tank and engine fuel valves. When one of these lights comes on, it indicates that the fuel pressure in the respective fuel line is below 10 psi. Power to operate the caution lights is provided by the 28-volt dc primary bus thru the CAUTION LTS circuit breaker on the overhead panel.

CAUTION

Fuel pressure is measured after the fuel booster pumps and not at the engine driven pump. When a fuel pressure caution light comes on, it does not represent impending engine flameout, unless flight is being conducted above 6,000 feet pressure altitude.

2-89. Controls and Indicators.

The fuel controls are the booster pump and crossfeed fuel valve switches and the engine fuel and manual defueling valves. Indicators include the crossfeed fuel and engine fuel valve warning lights and the fuel quantity indicator and caution lights.

2-90. Fuel System Management. Use fuel booster pumps during all operations.

2-91. Crossfeeding. A crossfeed tube which intersects each engine fuel line is located between the engine fuel valve and each fuel tank. This interconnecting crossfeed tube allows the pilot to regulate the fuel flow for balancing or for feeding one engine with both fuel tanks during single-engine operation. Crossfeeding of fuel can be broken down into two categories: balancing the quantity of fuel in both fuel tanks, and regulating the fuel flow from both fuel tanks to one engine. The following procedural steps should be used in accomplishing the above mentioned operations.

a. Fuel balancing. Complete the following:

(1) Crossfeed switch—OPEN.

CAUTION

Monitor the FUEL PRESS caution lights when the fuel booster pump switches are set to OFF. If a FUEL PRESS caution light comes on, immediately set the fuel booster pump switches back to ON.

(2) Fuel booster pump switches—OFF on the tank with the lowest fuel quantity.

(3) Fuel quantity indicator—Monitor. (Periodically check RH TANK and LH TANK positions until the fuel quantity in each tank is approximately equal.)

(4) After balancing the quantity of fuel in each tank, set the fuel booster pump switches to ON and set the crossfeed switch to CLOSE.

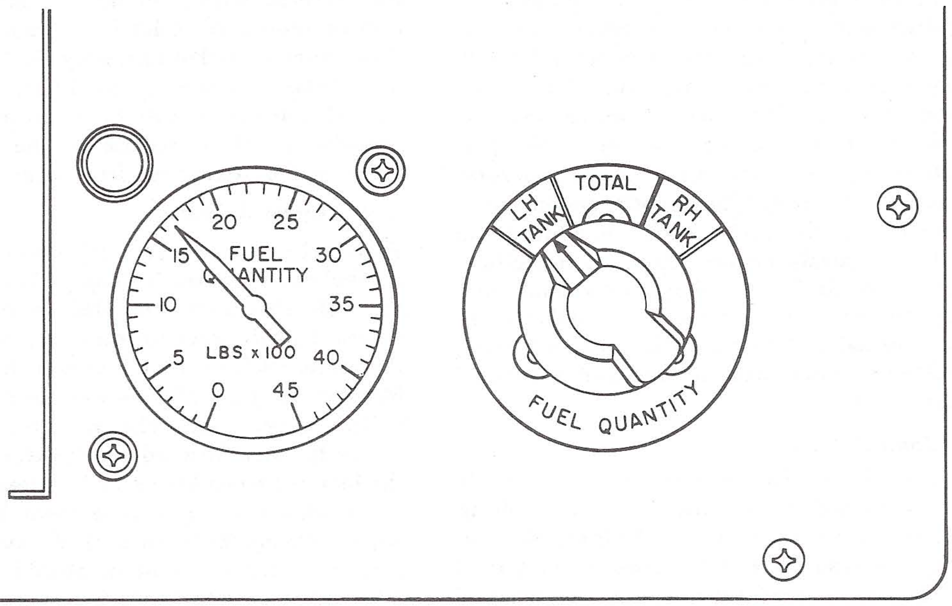


Figure 2-22. Fuel Quantity Indicator and Selector Switch

b. Feeding one engine with both fuel tanks. Complete the following:

(1) Crossfeed switch—OPEN.

(2) Fuel booster pump switches—OFF on the tank with the lowest fuel quantity.

(3) Fuel quantity indicator—Monitor. (Periodically check RH TANK and LH TANK positions. Alternate selection of the right and left tank fuel booster pump switches to the ON position will be necessary to maintain a balanced fuel condition.)

SECTION V FLIGHT CONTROLS

2-92. Flight Control System.

The helicopter is controlled by changing the pitch of the blades either collectively or cyclically. Pitch changes are made by the pilot's movement of the flight controls which include a thrust control rod, a cyclic stick, and directional pedals. The pilot's controls are interconnected with the copilot's controls.

CAUTION

The pilot or copilot must man the flight controls at all times when the rotors are turning.

Flight control movements are transmitted thru a system of bellcranks and push-pull tubes to a mixing unit located just aft of the cockpit next to the forward transmission. The control movements are mixed to give the correct lateral cyclic and collective pitch motions to the rotors thru dual hydraulic actuators. These boost actuators are under each swashplate. Each set of the dual actuators is normally powered by both hydraulic flight control systems. The helicopter is vertically controlled with the thrust control rod thru application of equal pitch to all blades. Directional control is obtained with the directional pedals by imparting equal but opposite lateral cyclic pitch to the blades. Lateral control is obtained by application of equal lateral cyclic pitch to the blades with the cyclic stick. The helicopter is controlled longitudinally with the cyclic stick thru application of differential collective pitch (dcp) change of the rotor blades. With forward movement of the cyclic stick, the pitch of the forward rotor blades is decreased collectively while the pitch of the aft rotor blades is increased collectively. The opposite action occurs with aft movement of the cyclic stick. In addition to conventional flight controls, the helicopter has the following subsystems in the flight control system: a dual automatic stability augmentation system, a manual and an automatic longitudinal cyclic trim system, and automatic differential collective pitch trim system, and a manual cyclic stick trim system.

2-93. Thrust Control Rods.

Either thrust control rod (figure 2-23) is used to apply equal pitch simultaneously to both rotors, thus controlling ascent and descent of the helicopter. Raising the rod increases pitch. Lowering the rod decreases pitch. A dual hydraulic stick boost actuator for thrust control is installed between the thrust control rod and the mixing unit. This actuator assists the pilot in moving the thrust control rod. In addition, a balance and detent capsule is installed that counteracts the downward imbalance of the thrust control rod and establishes a ground operation detent (3° of pitch) to reduce droop stop pounding. A viscous damper in the thrust control system eliminates pilot-induced oscillations. The thrust control rod is also electrically linked to the power turbine actuator through the droop eliminator. An upward movement of the control rod electrically increases the power turbine governor speed setting to compensate for inherent engine droop and maintain engine speed as rotor loads are increased. A downward movement of the control rod electrically decreases the power turbine governor speed setting. Mounted on each thrust control rod is an auxiliary switch bracket containing a searchlight control switch, a searchlight filament switch, and the two engine beep trim switches.

2-94. Thrust Control Rod Brake Switches. A trigger switch under each thrust control rod grip (figure 2-23) controls a magnetic brake in the flight control closet. Pressing and holding the switch interrupts direct current and deenergizes the thrust control rod magnetic brake. The thrust control rod can then be moved. When the switch is released, the magnetic brake is applied, holding the thrust control rod in position. Current is supplied to the thrust control rod magnetic brake from the 28-volt dc primary bus thru the THRUST BRAKE circuit breaker on the overhead panel. Should the magnetic brake malfunction or should the pilot inadvertently raise or lower the thrust control without pressing the brake switch, the magnetic brake will slip at a predetermined force between 20 and 45 pounds. If this force exceeds approximately 45 pounds, the shear section of the magnetic brake will separate, thus permitting free movement.

2-95. Cyclic Sticks.

Each cyclic stick (figure 2-24) is used for lateral and longitudinal control of the helicopter. Moving the cyclic stick to the right tilts both rotor disks equally to the right and causes the helicopter to roll to the right in flight. Moving the cyclic stick to the left causes the opposite movement. Moving the cyclic stick forward or aft causes a differential collective pitch (dcp) change of the rotor blades. Moving the cyclic stick forward simultaneously decreases pitch of the forward rotor blades and increases pitch of the aft rotor blades, causing a nose-down helicopter attitude in flight. Moving the cyclic stick aft causes the opposite movement resulting in a nose-up attitude. Two dual hydraulic stick boost actuators, one for lateral control and one for longitudinal control, are installed to assist the pilot in moving the cyclic stick. In addition to these actuators, viscous dampers are installed. One damper is for longitudinal control and one for lateral control to reduce control sensitivity. Located on the pilot's and the copilot's cyclic stick grips are a centering device release switch, a cargo hook release switch, and a transmitter trigger switch.

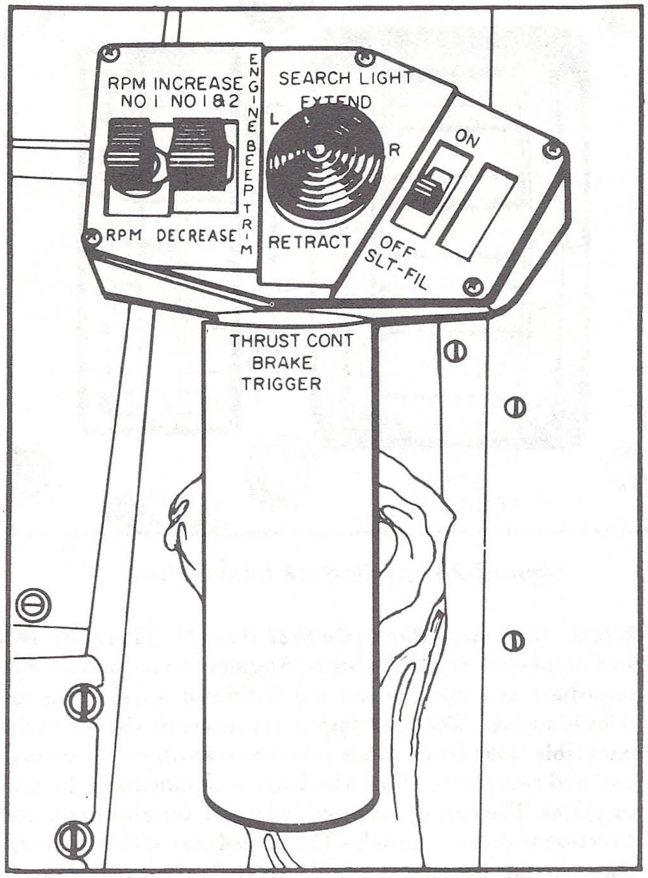


Figure 2-23. Thrust Control Rod

2-96. Stick Position Indicator. A position indicator, next to the stick positioner trim wheel and indicator on the cyclic stick control panel (figure 2-25) of the console, indicates the location of the cyclic stick within the range of longitudinal stick movement. The indicator, which is calibrated in inches of fore-and-aft stick movement is mechanically operated by the cyclic stick. When the cyclic stick is moved forward, the stick position indicator arrow moves forward along the indicator scale. When the cyclic stick is moved aft, the arrow moves aft.

2-97. Stick Positioner Trim Wheel and Indicator. A stick positioner trim wheel and indicator are located on the cyclic stick control panel (figure 2-25) of the console. This wheel and indicator allows the pilot to position the cyclic stick longitudinally. Mechanically connected to the trim wheel are two indicator arrows which move in the same direction in which the wheel is moved. Each arrow indicates on an adjacent scale the position of the wheel in relation to a neutral (zero) position. The wheel is also electrically connected to an electromechanical stick trim actuator. When the wheel is rolled forward, the cyclic stick is moved forward. When the wheel is rolled aft, the cyclic stick is moved aft. No motions are imparted by the trim wheel to the flight control system beyond the stick trim actuator if the stick is allowed to move. Motion will be imparted to the flight controls if the stick is held in a fixed position. The stick positioner trim wheel is used to reposition the cyclic stick only. It cannot aerodynamically trim the helicopter. The stick positioner is set to zero for all normal ground operations, takeoffs, and landings.

2-98. Centering Device Release Switches. The centering device release switches (figure 2-24), marked CENTERING DEVICE RELEASE, are located on top of each cyclic stick. The button switch is used to release the magnetic brakes for the lateral, the longitudinal, and the directional flight controls. A centering spring and a magnetic brake for each control provide a sense of feel and prevent the control from moving when released. However, the pilot can override the force manually while maneuvering the helicopter. When the switch is pressed, electrical power is applied to release the magnetic brakes and each centering spring assumes a new position where there is no load. Releasing the switch, removes electrical power and applies the magnetic brakes, and the centering spring units are retained in their new positions. Power to operate the magnetic brakes is supplied by the 28-volt dc battery bus through a circuit breaker labeled CONT CTR, located on the overhead circuit breaker panel.

2-99. Directional Pedals.

The directional pedals (7 and 22, figure 2-4) are used for directional control of the helicopter during flight and while taxiing with the forward gear off the ground. When the right pedal is pushed forward, the forward rotor disk tilts to the right and the aft rotor disk tilts to the left, causing the helicopter to yaw to the right. The opposite action occurs when the left pedal is pushed forward. A dual hydraulic stick-boost actuator for directional control is installed to assist the pilot in moving the pedals. The pedals are adjusted individually fore-and-aft by depressing a lever mounted on the pedal support and moving the pedal to a new position before repositioning the lever. A viscous damper is installed to reduce control sensitivity.

2-100. Dual Stability Augmentation System (SAS).

The dual Stability Augmentation System (SAS) automatically maintains stability about the pitch, roll, and yaw axes of the helicopter. With SAS, it is possible to make coordinated turns, using only the cyclic stick, thru a wide range of forward speeds.

CAUTION

The pilot or copilot must man the flight controls at all times whenever the rotors are turning.

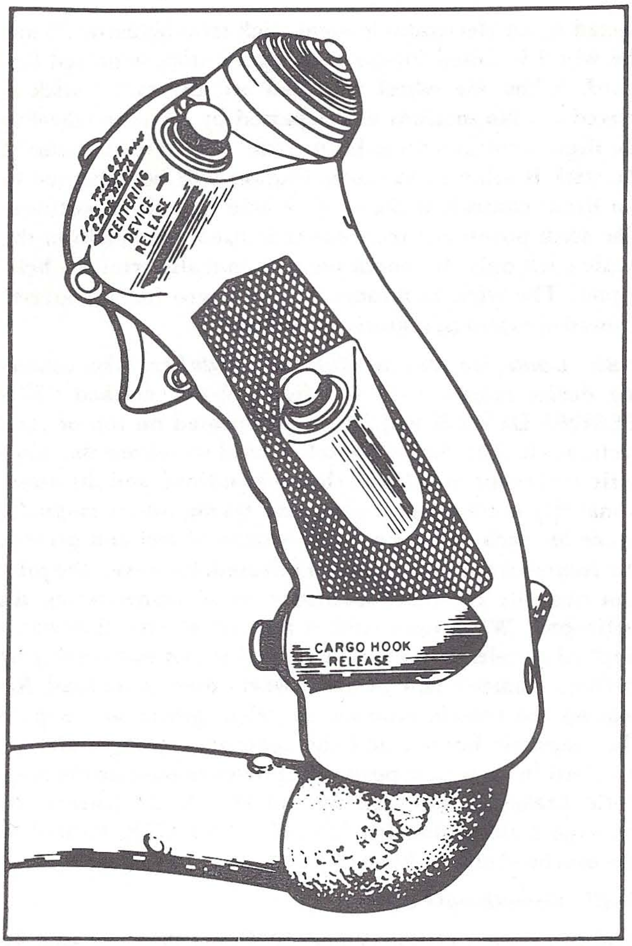


Figure 2-24. Cyclic Stick Grip

SAS provides only limited authority; sufficient overtravel has been built into the flight control system so that the pilot retains complete control in case of failure of the system. The basic components of the SAS are three dual extensible links; two SAS amplifiers (control boxes); pressure transducers for sensing sideslip, a control switch on the overhead flight control panel (figure 2-26), an emergency SAS release switch mounted next to the condition levers on the pilot's side of the console (figure 2-27) and two SAS OFF caution lights on the master caution panel (figure 2-52). Power to operate the SAS hydraulic solenoid valves and the relays within the SAS amplifiers is provided by the 28-volt dc primary bus through two circuit breakers marked NO. 1 and NO. 2 SAS DC on the overhead circuit breaker panel. Power to operate the rate gyros and other components of the SAS amplifiers is provided by the 115-volt ac primary bus thru two circuit breakers marked NO. 1 and NO. 2 SAS AC, on the overhead circuit breaker panel.

2-101. Dual SAS Extensible Links. There are three dual extensible links connected into the three control axes of the helicopter flight control system between the dual hydraulic stick boost actuators and the mixing unit. Each half of a dual SAS extensible link is electrically controlled by signals from a SAS amplifier (control box) and hydraulically actuated by the flight control hydraulic system through the SAS solenoid valve.

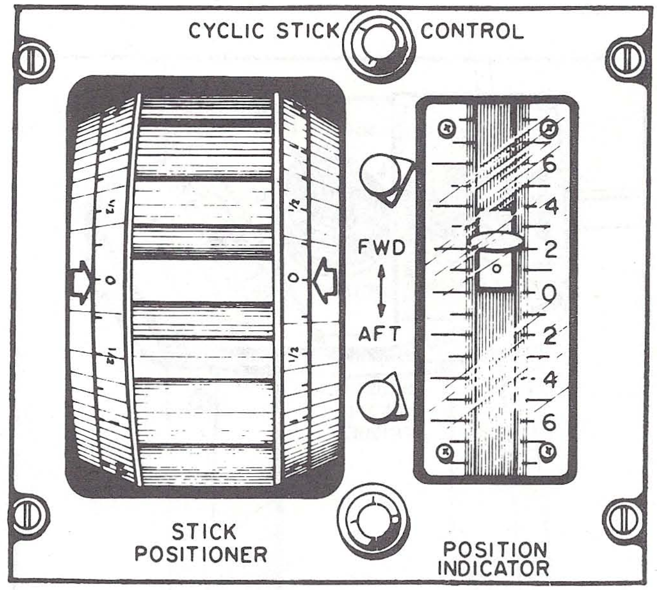


Figure 2-25. Cyclic Stick Control Panel

2-102. SAS Amplifiers (Control Boxes). There are two SAS amplifiers in the Stability Augmentation System. The amplifiers are mounted on the bulkhead adjacent to the avionic shelves. The SAS amplifiers transmit signals to the extensible links from an air pressure transducer (transmitter), and rate gyros, all of which are components of the SAS amplifier. The rate gyros provide lateral, longitudinal, and directional control signals. The transducer senses sideslip. These signals are also mixed or individually *washed out* to provide stability during all maneuvers. The inputs to the SAS amplifiers are from four yaw ports mounted in sets of two on either side of the forward pylon; from two static ports, one mounted on each side of the helicopter; and from the pitot tube which is mounted above the cockpit on the forward pylon.

2-103. Rate Gyros.

There are three rate gyros (one for each axis) in each SAS amplifier. Each rate gyro senses a rate of change in helicopter attitude and produces a signal which is amplified and then sent to its respective extensible link. The extensible link will then extend or retract hydraulically in response to the signal from the amplifier. The movement of the extensible link results in an input signal to the upper boost actuators which position the rotor controls to counteract the initial change in helicopter attitude. The control motions induced to the upper actuators do not feed back to cockpit controls.

2-104. Roll Rate System. The roll rate system senses attitude rate changes about the longitudinal axis of the helicopter. A signal from the roll rate gyro is amplified and sent to the extensible link. The extensible link then extends or retracts to correct for the change in helicopter attitude which induced the signal. In addition, the roll system sends a signal into the yaw system whenever the helicopter develops roll-rate to the left or to the right. This signal initiates helicopter yaw motion in such a manner as to effect a coordinated turn entry. As soon as the roll attitude is stabilized in a turn, the roll rate gyro signal ceases, eliminating the signal to the yaw axis.

2-105. Pitch Rate System. The pitch rate system senses attitude changes about the lateral axis of the helicopter.

2-106. Yaw Rate System. The yaw rate system senses attitude changes about the vertical axis of the helicopter. In a turn induced by cyclic stick movement, a roll signal is fed into the yaw system in the direction of the turn. To keep the helicopter is in coordinated turn, a washout signal is used in the yaw axis. The washout signal acts to essentially recenter the yaw extensible link in about 4 seconds. The yaw extensible link will remain centered as long as the rate of turn remains stabilized. However, since the yaw rate gyro senses rate of change, the corrective signal will be reactivated if the rate of turn is increased or decreased. If the turn again stabilizes after a change is made, the corrective signal from the yaw channel will again be washed out.

2-107. Sideslip Sensing System. Each SAS includes a separate pressure transducer connected pneumatically to the SAS yaw ports located on the lower nose enclosure to sense helicopter sideslip. The sideslip signal is amplified and sent to the yaw extensible link, resulting in static directional pedal gradient. To provide an optimum pedal gradient, it is necessary to modify the SAS sideslip electronics sensitivity as a function of airspeed. Accordingly, each SAS amplifier contains an airspeed sensing pressure transducer which is connected to the pitot-static system and electronic amplifying circuitry. The result is that sideslip sensitivity is reduced as airspeed is increased between 70 knots and Vne.

2-108. Stability Augmentation System (SAS) Switch. A 3-position switch on the overhead flight control switch panel (figure 2-26) controls both stability augmentation systems. The switch positions are NO. 1 ON, BOTH ON, and NO. 2 ON. The SAS switch on the overhead switch panel can be used only to turn off one Stability Augmentation System at a time. Both systems can be turned off only by using the emergency SAS release switch or by opening circuit breakers. When set at BOTH ON, the switch opens both solenoid valves and both Stability Augmentation Systems function. When the switch is placed at NO. 1 ON, power from the 28-volt dc primary bus opens the No. 1 SAS solenoid valve. This allows hydraulic pressure to be applied to the No. 1 side of the dual extensible links. At the same time the No. 2 SAS solenoid valve closes. When the switch is placed at NO. 2 ON, the No. 2 solenoid valve opens and the No. 1 solenoid valve closes. A SAS OFF caution light will come on whenever one SAS is individually selected.

2-109. Emergency SAS Release Switch. A 2-position, guarded, emergency SAS release switch (figure 2-27) on the console is used to simultaneously isolate both Stability Augmentation Systems from the flight control system in the event of a dual malfunction. The switch positions are RELEASE and ENGAGE. When the switch is set to RELEASE both SAS hydraulic solenoid valves are deenergized closed, which removes hydraulic pressure from the extensible links, thus preventing the SAS from making inputs into the flight control system. When the emergency SAS release switch is set to RELEASE, both solenoid valves will remain closed regardless of the position of the SAS selector switch. When the switch is at ENGAGE, the SAS solenoid valves are controlled by the SAS selector switch. Power to operate the emergency SAS release switch is supplied by the 28-volt dc primary bus thru the No. 1 and No. 2 SAS DC circuit breakers on the overhead breaker panel.

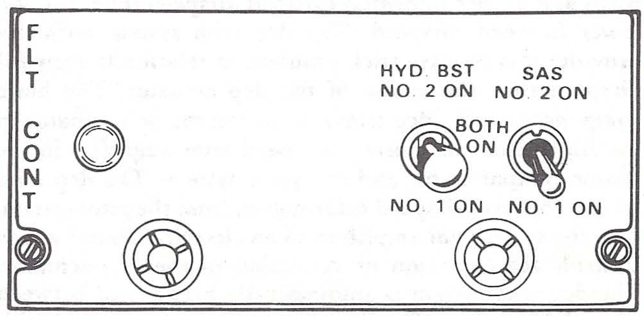


Figure 2-26. Flight Control Panel

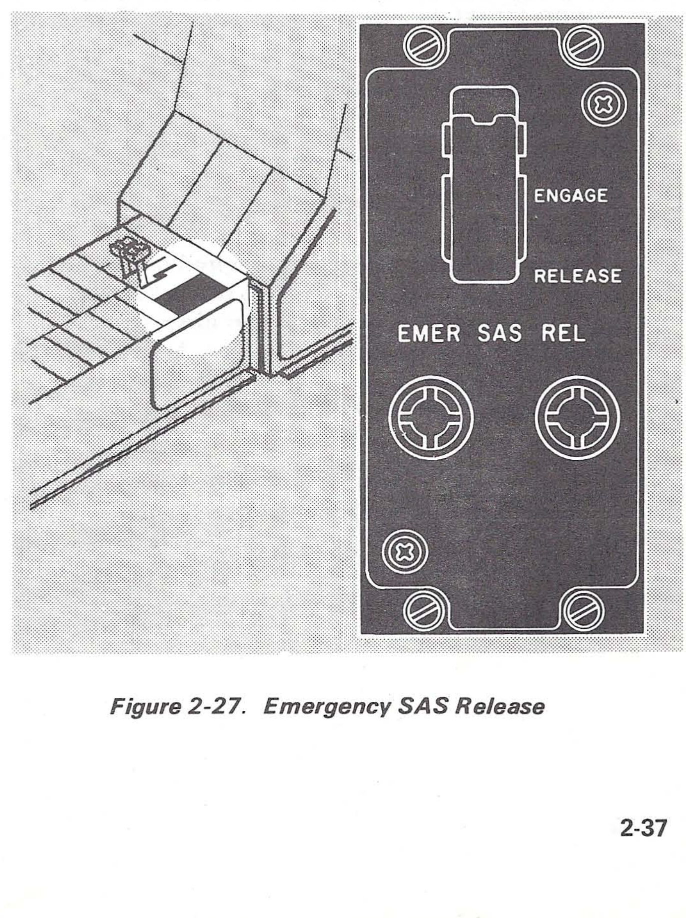


Figure 2-27. Emergency SAS Release

2-110. SAS OFF Caution Lights. Two amber SAS OFF caution lights (figure 2-52) are on the master caution panel. Marked NO. 1 SAS OFF and NO. 2 SAS OFF, these lights will come on simultaneously whenever the SAS is disabled using the EMER SAS REL switch on the console. The SAS caution lights will also come on during hydraulic or electrical failures and when the SAS switch or hydraulic boost switch on the overhead switch panel is used to select an individual SAS or flight control hydraulic system.

2-111. Differential Collective Pitch Trim.

A fully automatic differential collective pitch (dcp) trim system is incorporated in the flight control system. Normal control stability criteria requires a positive (cyclic) stick gradient. This means that the helicopter will move in the direction the cyclic stick is displaced and accelerate and maintain airspeed in proportion to the amount of displacement. With dcp trim, the cyclic stick position is farther forward at a higher stabilized forward airspeed than it is at a lower forward airspeed. The dcp trim system normally provides this positive stick gradient in relation to forward airspeed thru the action of the dcp actuator. The basic components of the dcp trim system are: the dcp actuator in the flight controls closet, the speed trim amplifier in the heater compartment, and the pitot system. The dcp trim system converts airspeed information from the pitot system, thru the speed trim amplifier, to an electrical signal which controls the extension or retraction of the dcp actuator. The dcp trim system is automatically programed between 40 and 130 knots. The dcp speed trim is integrated with longitudinal cyclic speed trim when the switch is at auto between 80 and 100 knots. Power to operate the dcp trim system is supplied by the 115-volt ac secondary bus thru the SPEED TRIM AC circuit breaker on the overhead circuit breaker panel.

2-112. Longitudinal Cyclic Trim.

CAUTION

Do not manually extend the longitudinal cyclic speed trim at indicated airspeeds below 80 knots. Use of extended cyclic trim at low airspeeds will result in high aft rotor blade stresses. An entry on DA Form 2408-13 is required any time speed trim is extended below 80 knots.

A longitudinal cyclic trim system which can be operated either manually or automatically is incorporated in the flight control system. The longitudinal cyclic speed trim system reduces the angle of attack of the fuselage relative to the airstream as forward airspeed is increased, thus reducing fuselage drag. The system also reduces rotor blade flapping which results in lower stresses in the rotor shafts. A longitudinal cyclic speed trim actuator is installed under each of the swashplates. Signals are automatically transmitted to these actuators by either the speed trim amplifier (control box) or by pilot-commanded signals from the manual longitudinal cyclic speed trim switches on the console. The cyclic trim indicators are mounted on the center instrument panel and the control switches are on the console.

2-113. Cyclic Trim Function Switch. The cyclic trim function switch is on the MANUAL OPERATION LONG CYC TRIM control panel (figure 2-28) mounted on the console. The switch is labeled SPEED TRIM and has two marked positions: AUTO and MAN. At AUTO, the manual control switches are electrically disconnected from the speed trim system and allow the speed trim amplifier (control box) to operate, providing automatic programing of the trim schedule. The automatic programing is accomplished by an air pressure transducer within the speed trim amplifier. The transducer reacts to changes in airspeed as sensed at the pitot tube. At MAN, electrical power from the 28-volt dc secondary bus thru the CYCLIC TRIM ACTUATOR FWD, AFT circuit breakers is supplied to the manual control switches to provide positioning of the forward and aft longitudinal cyclic speed trim actuators. At AUTO 28 volt dc and 115 volt ac is supplied to the trim amplifier by the ac and dc secondary buses thru the SPEED TRIM AC and DC circuit breakers on the overhead circuit breakers panel.

2-114. Manual Control Switches. Two manual control switches (figure 2-28) are provided to operate the forward and aft longitudinal cyclic speed trim actuators. Both switches are mounted on the MANUAL OPERATION LONG CYC TRIM control panel. One switch, marked FWD EXTEND-RETRACT, positions the forward actuator. The second switch, marked AFT EXTEND-RETRACT, positions the aft actuator. By using the manual control switches in conjunction with the cyclic trim indicators and airspeed indicator, the pilot can manually program the speed trim system and control fuselage attitude.

CAUTION

If the longitudinal cyclic speed trim actuators are inadvertently or intentionally left at full retract position during flight, do not exceed the airspeed limitations obtained from figure 5-8. Airspeeds in excess of these will reduce the service life of the aft rotor shaft. An entry on DA Form 2408-13 is required anytime speed trim is extended below 80 knots.

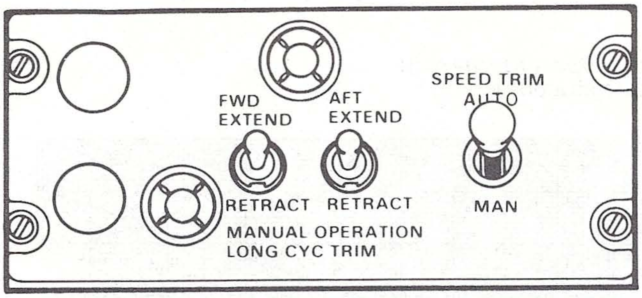


Figure 2-28. Longitudinal Cyclic Speed Trim Control Panel

2-115. Cyclic Trim Indicators. Two cyclic trim indicators (figure 2-29) are the center instrument panel. Each indicator is marked in 0-80, and 100 knots and represents airspeeds at which manual or automatic trim changes are initiated. In automatic trim, the actuators start to extend at 70 to 90 knots and are fully extended at 90 to 110 knots.

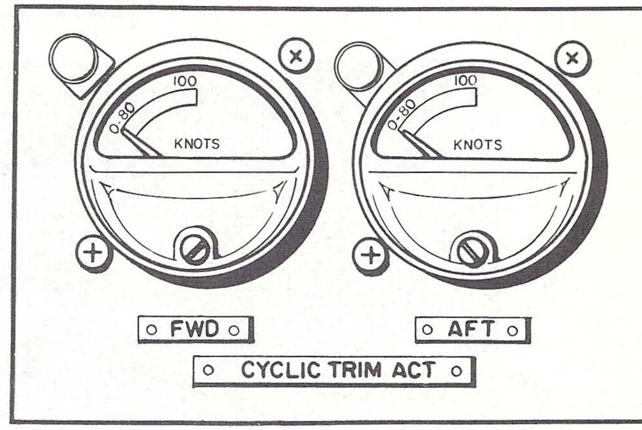


Figure 2-29. Cyclic Trim Indicators

SECTION VI HYDRAULIC SYSTEMS

2-116. Hydraulic Power Supply System.

The hydraulic power supply system is made up of three completely separate systems: a No. 1 flight control system, a No. 2 flight control system and a utility hydraulic system. Each system contains a separate variable-delivery pump and a separate tank.

2-117. Flight Control Systems.

The flight control systems consist of two identical systems: No. 1 flight control system and No. 2 flight control system. The flight control systems are parallel in operation, hydraulically separated and electrically integrated (refer to paragraph 2-119). They operate at approximately 3,000 psi, indicated in the cockpit, and are reduced to 1,500 psi for all lower actuators. The flight control systems power four dual upper boost actuators (3,000 psi), four dual stick boost actuators (1,500 psi), and three dual stability augmentation system extensible links (1,500 psi). Each flight control system powers one piston of each actuator. Each flight control system also contains an accumulator which dampens low frequency pressure surges in the system and provides stored hydraulic power for peak system loads. The accumulators are precharged to about 1,400 psi at 21°C. See figure 2-30.

2-118. Pressurized Flight Control Systems.

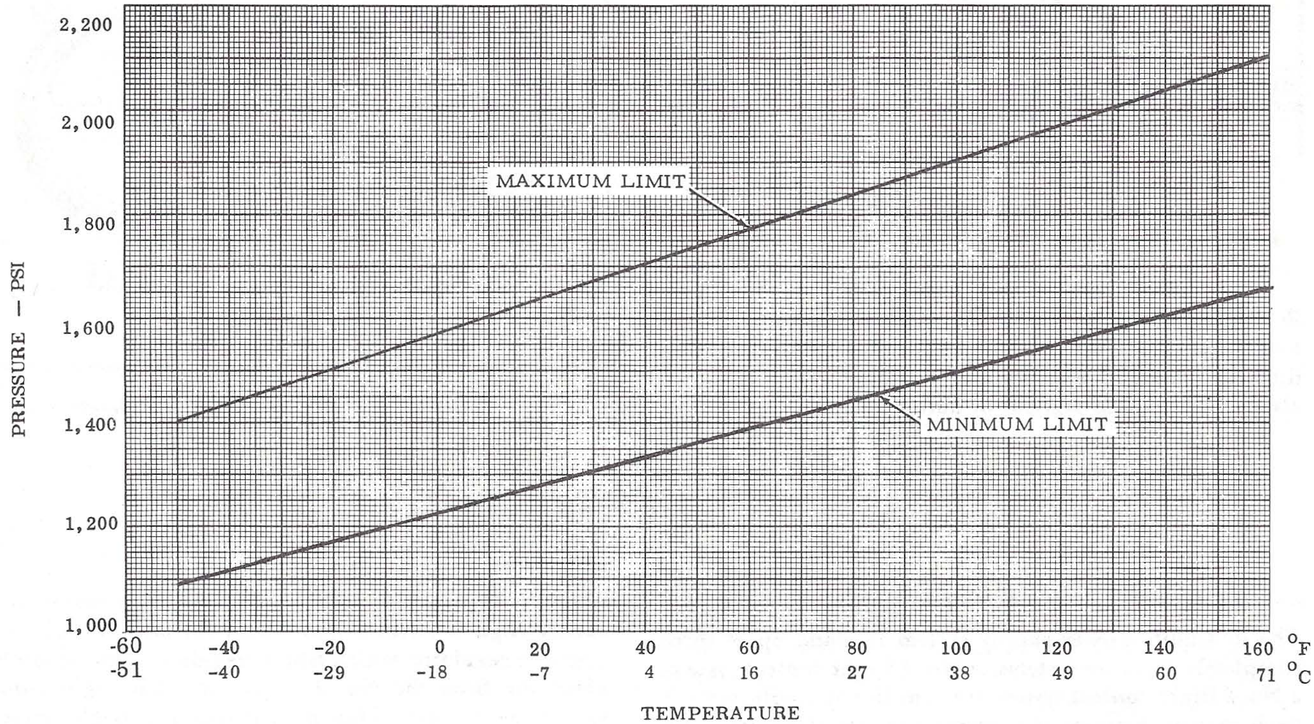
WARNING

To prevent injury to personnel, do not open the filler caps when systems are pressurized.

To prevent hydraulic pump cavitation, the flight control power systems have been pressurized. The pressurized flight control systems contain the same components as the earlier flight control systems with the addition of an air pressure regulator which filters, regulates, and distributes bleed air from the No. 2 engine to both flight control system reservoirs. This pressurizes the flight control systems reservoirs to approximately 22 psi.

2-119. Hydraulic Boost Switch. A three-position hydraulic boost switch is on the overhead flight control panel (figure 2-26). The switch positions are NO. 1 ON, BOTH ON, and NO. 2 ON. This switch can be used to turn off one of the flight control systems, only if the other one is operating. Both systems cannot be turned off simultaneously. Turning off one of the hydraulic flight control systems disables the corresponding SAS and causes the remaining SAS to make full SAS corrections. When one of the flight control hydraulic systems is turned off, the respective SAS caution light will come on. Under normal flight conditions, with both the NO. 1 and NO. 2 hydraulic boost systems functioning properly, the hydraulic boost switch shall be set to BOTH ON. Setting the switch to NO. 1 ON or NO. 2 ON position shall only be used to render the remaining hydraulic boost system inoperative following a malfunction in that system. When the hydraulic boost switch is set to NO. 1 ON, a three-way solenoid valve in the No. 1 hydraulic manifold is deenergized open, allowing the No. 1 hydraulic pump to pressurize the No. 1 flight control system. At the same time, the three-way solenoid valve in the No. 2 manifold is energized closed and the No. 2 flight control system is turned off. If the switch then is moved to NO. 2 ON, the three-way solenoid valve in the No. 2 hydraulic manifold is deenergized open, and the No. 2 flight control system is pressurized. Simultaneously, the No. 1 solenoid valve closes and the No. 1 flight system is turned off. When moved to BOTH ON, both solenoid valves are deenergized open and both flight

UTILITY SYSTEM ACCUMULATOR PRECHARGE
PRESSURE VS. TEMPERATURE



FLIGHT CONTROL SYSTEM ACCUMULATOR PRECHARGE
PRESSURE VS. TEMPERATURE

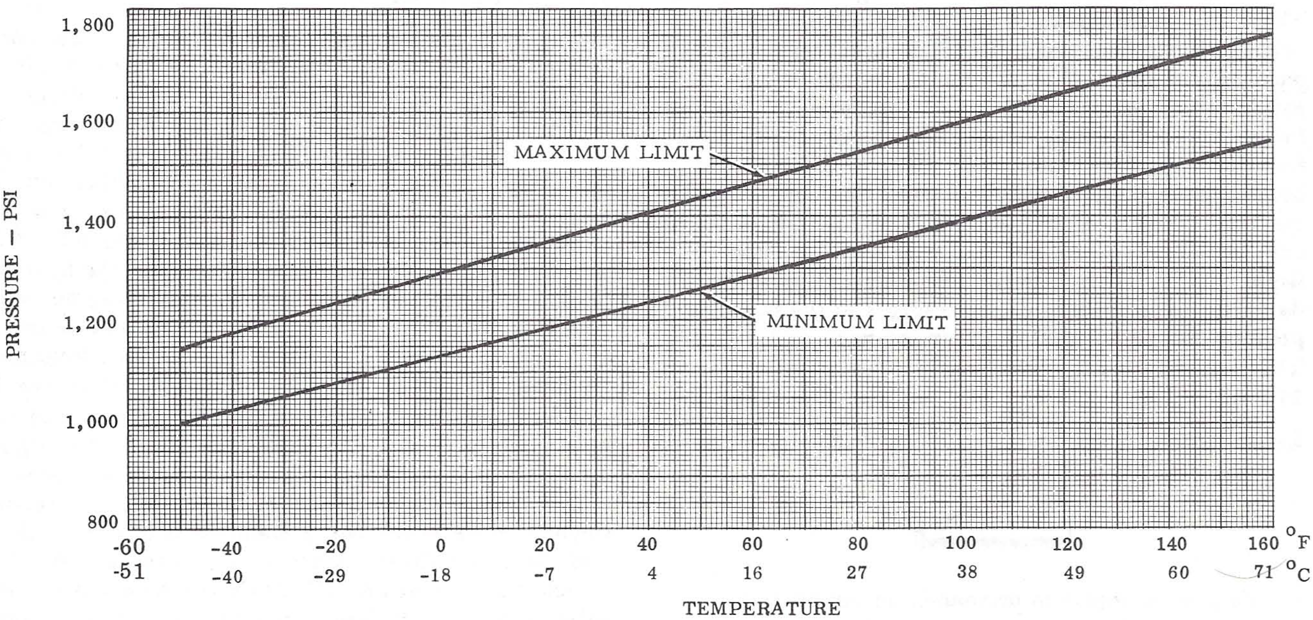


Figure 2-30. Accumulator Precharge Pressure Limits

control systems are turned on. The 28-volt dc secondary bus supplies electric power to operate the solenoid valves thru the HYD BOOST CONT circuit breaker on the overhead panel.

2-120. APU-AGB Switch.

A two-position, guarded, auxiliary power unit and accessory gearbox switch, is located on the hydraulic control panel (figure 2-31) of the overhead switch panel. The switch is used to depressurize the No. 1 flight control hydraulic pump during apu starting to allow the agb to achieve operating speed in an unloaded condition. The switch positions are NORM and START. When the switch is held at the spring-loaded START position, power from the 28-volt dc battery bus thru the APU circuit breaker actuates a solenoid valve within the No. 1 flight control pump which reduces the pump output pressure. When the APU-AGB switch is held at START while apu speed is increasing, the No. 1 flight control hydraulic pressure will be less than 600 psi pressure. When the agb has reached operating rpm, the switch is released to NORM and hydraulic pressure will increase to the range for normal operation. In addition to the function performed by the APU-AGB switch, when the apu control switch is held at START, the No. 2 flight control hydraulic pump is depressurized until the generator frequency reaches 350 Hz.

2-121. Hydraulic Pressure Caution Lights.

Two hydraulic pressure caution lights, one for each flight control system, are on the master caution panel (fig. 2-52) of the console. The lights are marked NO. 1 HYD BOOST OFF and NO. 2 HYD BOOST OFF. Each light is electrically connected to a pressure switch in the corresponding flight control manifold. Whenever hydraulic boost pressure drops below 2,000 psi in one of the flight control systems, that system caution light comes on. The caution light goes off when pressure rises above 2,100 psi. Power to operate these lights is supplied from the primary dc bus thru the CAUTION LTS circuit breaker panel.

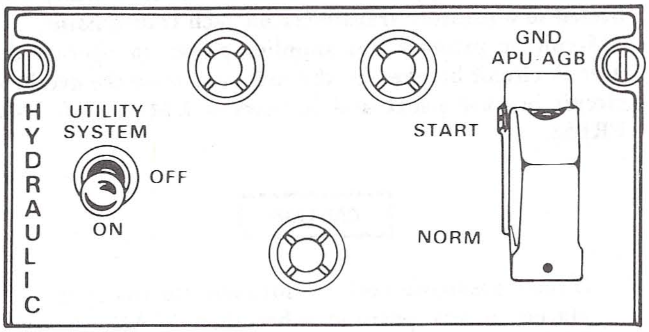


Figure 2-31. Hydraulic Control Panel

2-122. Utility Hydraulic System.

The utility hydraulic system supplies hydraulic power to the auxiliary power unit motor-pump, the accessory gearbox motor, the two engine starters, the ramp actuating cylinders, the cargo door actuator hydraulic motor, the wheel brakes, the swivel locks, the centering cams, the power steering actuator, the cargo hook, and the cargo/rescue winch hydraulic motor. The starting section of the utility hudraulic system contains an accumulator and a hand pump. When fully charged and serviced, the accumulator contains enough pressurized fluid to operate the apu motor-pump for apu starting. An additional accumulator in the system maintains 50 psi hydraulic fluid tank and return line pressure. Each accumulator is precharged (figure 2-30) with dry air or nitrogen. Normal operating pressure for the utility hydraulic system is approximately 3,000 psi. The utility hydraulic pump is equipped with a dual compensator which provides 4,000 psi for engine starting. Pressure reducers are contained in the subsystems for reducing main system pressure to the pressure required for operating the various units of equipment. See table 2-3 for flight control and utility hydraulic system capacities.

2-123. Utility Hydraulic System Switch.

A two-position utility hydraulic system control switch is on the hydraulic control panel (figure 2-31) on the overhead panel. The switch is marked UTILITY SYSTEM and has two positions: ON and OFF. The switch controls the utility system dual-solenoid valve. When the switch is ON, the 28-volt dc battery bus supplies current to open the normally closed solenoid valve. This directs main accumulator pressure to the utility subsystems, and permits operation of hydraulic equipment on the ground without the apu operating. When the switch is at OFF, the solenoid valve closes. Pressure is supplied to the subsystems thru the normally open solenoid valve in the utility system valve with the apu or main engines operating. When the apu is operating or the agb is turning, the utility system solenoid valve is automatically open. Consequently, it is not necessary to place the utility system switch at ON to operate the hydraulic equipment. Current for this switch is supplied thru the UTILITY HYD SYS circuit breaker on the overhead panel.

2-124. Hydraulic Hand Pump.

A hand pump, in the aft cargo compartment above and to the right of the ramp, is used to pump hydraulic fluid into the utility system. The pump can also be used to pressurize the main accumulator. A manual control valve located forward of the accumulator must be positioned correctly before the hand pump is used.

2-125. Manual Control Valve.

A manual control valve is installed in the utility system forward of the main accumulator in the aft cargo compartment above and to the right of the ramp. Placing the valve in the filling position connects the utility system filler line to the inlet line of the hand pump. Fluid can then be added to the system through the pump. The pump can then be used to pressurize the main accumulator when the manual control valve is returned to normal position. The valve must be in the normal position for all helicopter operation.

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2-126. Hydraulic Pressure Indicators.

Three hydraulic pressure indicators (figure 2-7) one for each hydraulic system, are mounted on the right side of the center section of the instrument panel. Each indicator is electrically connected to a respective pressure transmitter. Power to operate these indicators is supplied by the 26-volt ac instrument bus thru the PRESS IND—HYD circuit breaker on the overhead panel.

SECTION VII POWER TRAIN SYSTEM

2-127. General.

Engine power is supplied to the rotors through a mechanical transmission system. (See figure 2-1.) This system consists of a forward (9), an aft (25), a combining (13), and two engine transmissions (29) and drive shafting. An overrunning sprag clutch is installed in each engine transmission. The clutch provides a positive drive connection to transmit power, and permits freewheeling of both rotors, in autorotation during actual or simulated power failure. Should an engine (or engines) or engine transmission fail, no drag will be placed on the rotors because of the freewheeling feature. Power from the engine transmissions is transmitted through separate drive shafts to the combining transmission. The combining transmission combines the power of the engines and transmit it at reduced shaft speed thru drive shafts to the forward and aft transmissions. Further speed reduction occurs within these transmissions. Engine speed is reduced to rotor speed by an overall ratio of about 66:1.

2-128. Transmission Lubrication System.

Each transmission has a separate lubrication system. Oil pumps supply oil to lubricating jets in each of the transmissions. A single six-element (three-pressure, three-scavenge) oil pump supplies the engine transmissions and the combining transmission. The pump is in the combining transmission below the three-compartment tank (14, figure 2-1). Even though the oil systems are complete and separate, it is possible for the oil in the combining transmission system to mix with the oil in the engine transmission oil system. The oil pump for the forward transmission is on the forward transmission. The oil pump for the aft transmission is on the accessory gearbox (agb). Four oil coolers are in the aft pylon. Two coolers, composed of three separate sections, are for each engine transmission and the combining transmission. The other two coolers are for the forward and aft transmissions. Air for these coolers is drawn into the pylon section by a fan driven by the aft transmission. See table 2-3 for transmission oil specifications.

2-129. Accessory Gearbox (AGB).

The accessory gearbox agb is mounted on the rear of the aft transmission. It receives power thru a sprag (overrunning) clutch to drive two generators, three hydraulic pumps, and one oil pump. The sprag clutch allows operation of these accessories by the auxiliary power unit (apu) without the aft transmission operating. The apu motor pump provides hydraulic pressure to operate the agb hydraulic motor to drive the agb when the aft transmission is not operating.

2-130. Transmission Chip Detectors.

Chip detector plugs are installed in the forward, combining, and aft transmissions, and the aft thrust bearing. These plugs are connected to a caution light on the caution panel. A chip detector is in the oil return line of each engine transmission housing. The engine transmission chip detector and engine chip detectors are connected to the NO. 1 and NO. 2 ENG CHIP DET on the caution panel. (Refer to paragraph 2-72.)

2-131. Rotor Dephasing Mechanism.

A dephasing arm, on the right side of the combining transmission, is used to manually phase and dephase the rotors. The arm is conndcted to a yoke, that in turn is connected to a splined sleeve. When the arm is pulled down, the splined sleeve slides away from the aft shaft in the transmission, dephasing the rotors. The dephasing arm can be moved to DEPHASED for maintenance functions, but must be locked in PHASED for flight. A bolt secures the dephasing arm in PHASED. An electrical interlock prevents engine starting if the dephasing arm is in DEPHASED.

2-132. Transmission Oil Pressure Indicator.

A transmission oil pressure indicator (figure 2-32), mounted on the center section of thd instrument panel indicates either the lowest oil pressure in any one of the transmissions or only the oil pressure in the transmission selected by the pilot. The indicator is electrically connected to a pressure transducer on each transmission. The 115-volt ac primary bus supplies power to operate this unit. A circuit breaker for the indicator is on the overhead circuit breaker panel and is marked XMSN OIL IND-PRESS.

CAUTION

If the transmission oil pressure selector switch is placed in any position other than SCAN, the TRANS OIL PRESS caution light will come on only for the transmission selected.

2-133. Transmission Oil Pressure Selector Switch. A transmission oil pressure selector switch (figure 2-32), is mounted on the center section of the instrument panel. The

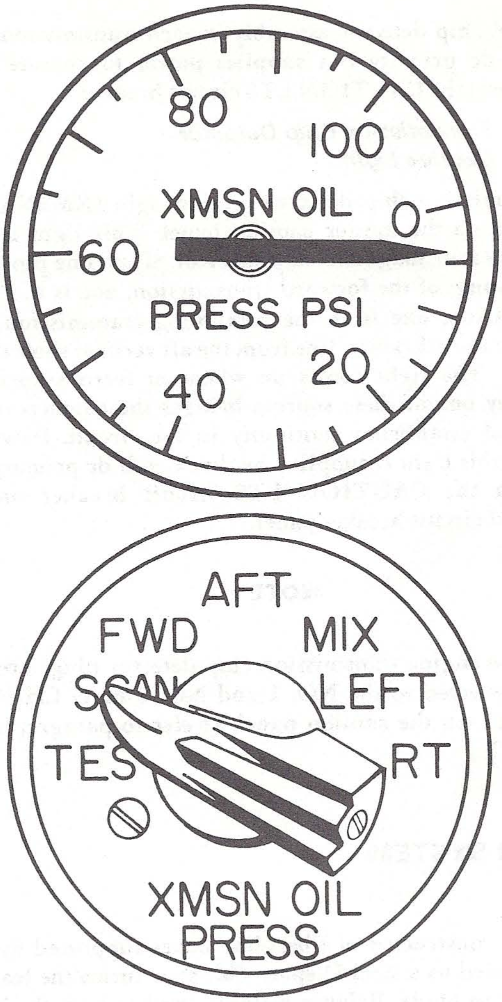


Figure 2-32. Transmission Oil Pressure Switch and Indicator

switch positions are TEST, SCAN, FWD, AFT, MIX, LEFT, and RT. When the switch is moved to TEST, the pointer on the transmission pressure indicator will drop to zero or below. In addition, the nomenclature lights on the switch for the TEST position will come on. When the switch is moved to SCAN, the SCAN nomenclature on the switch will come on and the lowest oil pressure among all the transmissions will be indicated and the nomenclature for that transmission will also come on. The remaining positions are used to select a particular transmission oil pressure indication. The nomenclature lights will also come on when a transmission is individually selected. If any one transmission oil pressure decreases below 20 psi, the nomenclature light for the affected transmission will come on and the TRANS OIL PRESS caution light will come on.

2-134. Transmission Oil Temperature Indicator.

A transmission oil temperature indicator (figure 2-33), mounted on the center section of the instrument panel, reads from −70° to +150°C and indicates the highest oil temperature among all the transmissions or only the oil temperature of the transmission selected. Wires connect the indicator and amplifier to a temperature probe in the forward and aft transmission sumps and in each compartment of a three-compartment oil tank for the combining transmission and each engine transmission. The temperature probes, located in the three tank compartments, measure oil temperature in the tank and may not immediately indicate a transmission problem. Loss of oil or low oil pressure may not be accompanied with a high oil temperature indication. Power to operate this unit is supplied by the 115-volt ac primary bus. A circuit breaker for the indicator is on the overhead circuit breaker panel and is marked XMSN OIL IND-TEMP.

2-135. Transmission Oil Temperature Selector Switch. A transmission oil temperature selector switch (figure 2-33) is mounted on the center section of the instrument panel, below the transmission oil temperature indicator. The switch positions are TEST, SCAN, FWD, AFT, MIX, LEFT, and RT. When the switch is moved to TEST, the pointer on the transmission oil temperature indicator assumes full scale deflection toward the low temperature.

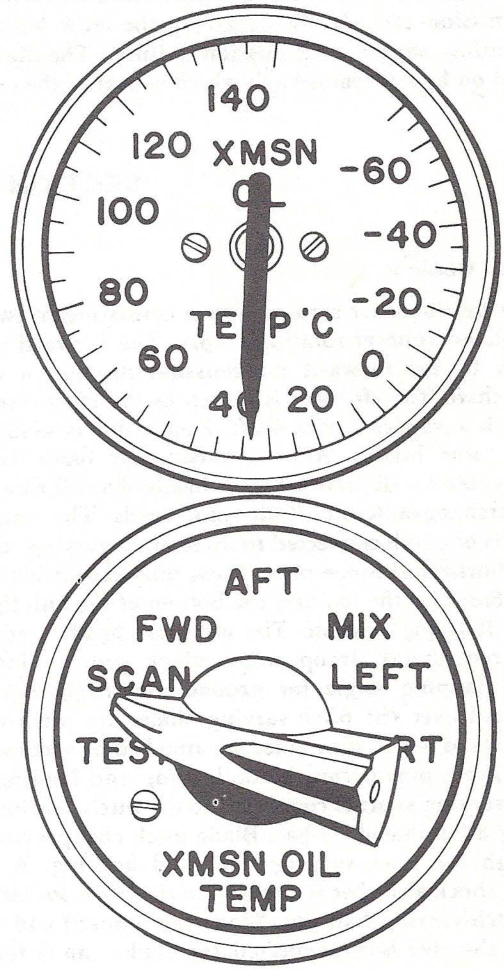


Figure 2-33. Transmission Oil Temperature Switch and Indicator

In addition, the nomenclature lights on the switch for the TEST position will come on. When the switch is moved to SCAN, the SCAN nomenclature on the switch will come on and the highest oil temperature among all transmissions will be indicated and the nomenclature for that transmission will also come on. The remaining positions are used for selecting a particular transmission oil temperature indication. The nomenclature lights will also come on when a transmission is individually selected. If any one transmission oil temperature goes above approximately 130°C, the nomenclature light for the affected transmission will come on and the TRANS OIL HOT caution light will come on.

2-136. Transmission Oil Caution Lights.

Two amber caution lights, one for pressure (TRANS OIL PRESS) and one for temperature (TRANS OIL HOT), are on the master caution panel on the console. (See figure 2-52.) The TRANS OIL PRESS light comes on if the indicated transmission oil pressure is 20 psi or less. On modified helicopters, two ENG XMSN HOT caution lights have been added to the master caution panel. These lights come on when the oil temperature in each engine transmission exceeds 190°C, giving the crew warning of impending engine transmission failure. The lights are turned on by a thermoswitch which is part of the temperature and chip detector assembly in each transmission. The 28-volt dc primary bus supplies power to operate these lights thru the CAUTION LTS circuit breaker.

2-137. Transmission Chip Detector Caution Light.

A transmission chip detector caution light (XMSN CHIP DET) is on the master caution panel. This light is connected to four magnetic chip detector plugs; one plug is in the oil sump of the forward transmission, one is in the aft transmission, one is in the combining transmission, and one is in the oil return line from the aft vertical shaft thrust bearing. The light comes on whenever ferrous particles, from any one of these sources bridges the contacts of the plug and establishes continuity in the circuit. Power to operate this light is supplied by the 28-volt dc primary bus through the CAUTION LTS circuit breaker on the overhead circuit breaker panel.

NOTE

The engine transmission chip detector plugs are connected to the NO. 1 and NO. 2 ENG CHIP DET on the caution panel. (Refer to paragraph 2-72.)

SECTION VIII ROTOR SYSTEM

2-138. General.

Lift is produced by a rotor system consisting of two fully articulated counter-rotating rotors. The forward rotor is driven by the forward transmission through a vertical drive shaft. The aft rotor is driven by the aft transmission through a vertical drive shaft. Each rotor is made up of three rotor blades. Any forward rotor blade is interchangeable on all forward rotor heads. Any aft rotor blade is interchangeable on all aft rotor heads. The rotor head consists of a hub connected to three pitch-varying shafts by three horizontal hinge pins. These pins permit blade flapping. Stops on the top and the bottom of the hub limit the blade flapping motion. The aft rotor head is equipped with centrifugal droop stops which provide increased blade flapping angle for ground and flight operation. Mounted over the pitch-varying shafts are pitch-varying housings to which the blades are attached by vertical hinge pins. These pins permit blade leading and lagging. Each pitch-varying shaft is connected to the pitch-varying housing by a laminated tie bar. Blade pitch changes are made through the pitch-varying shaft and housing. A direct-action shock absorber is attached to the blade socket and to the pitch-varying housing. When the inboard end of each shock absorber is disconnected, the blades can be folded in either direction about the vertical hinge pins. Each rotor blade is constructed of fiberglass boxes supported by ribs and bonded to a steel D-spar. This spar forms the leading edge of the blade. Balance weights, used to keep the blade in track, are contained in the blade tip. Seven lubricating oil tanks are contained in each rotor head: a tank on the top of the hub provides oil for the horizontal hinge pin bearings, and a separate tank for each vertical hinge pin bearing set and for each pitch-varying bearing set. Swashplates are grease lubricated. See table 2-3 for oil or grease specifications.

2-139. Integral Spar Inspection System (ISIS).

An Integral Spar Inspection System (ISIS) is on all CH-47A rotor blades. The ISIS rotor blade is identified by the differential pressure sensor and indicator (figure 2-34) at the root end of each rotor blade. When the rotors are stationary, the system provides a visual indication of the structural integrity of the spar and blade socket. A vacuum is pulled thru an evacuation valve installed in the blade socket. The vacuum is maintained in the spar and socket cavity. A safe condition exists when the indicator displays an all white color. If a thru crack develops in the wall of the spar or socket, the pressure differential between the spar cavity and the atmosphere will be lost. The indicator will show alternate black and white rings—an unsafe condition (figure 2-34).

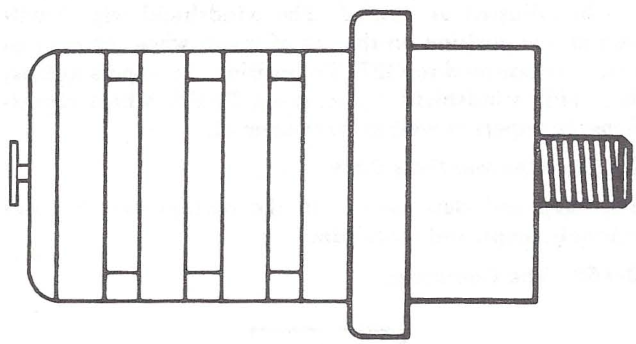
WARNING

The ISIS indicator must be checked every 2½ flight hours. If the indicator displays an unsafe condition, make an entry on DA Form 2408-13. The blade must be replaced prior to rotor operation; either ground run or flight.

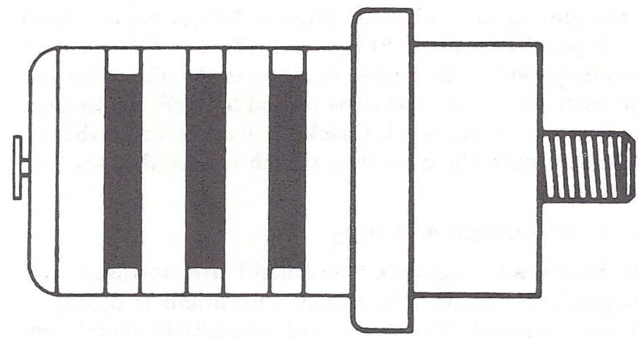
2-140. Press-To-Test Button. There is a press-to-test button on the indicator. Pressing the button produces the unsafe condition (alternate black and white rings). Releasing the spring loaded button returns the indicator to the safe condition—all white (figure 2-34).

2-141. Rotor Tachometers.

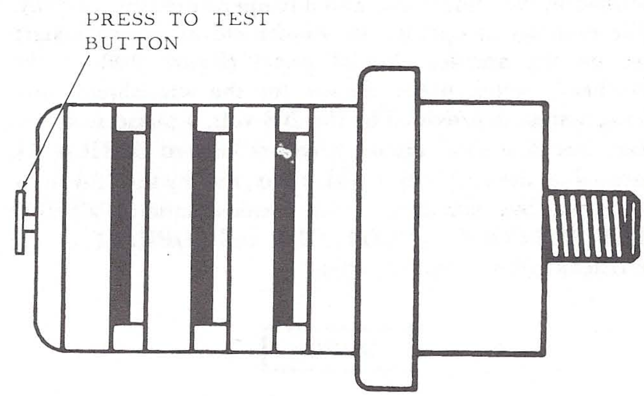
Two rotor tachometers (18 and 57, figure 2-7), one mounted on the pilot's section of the instrument panel and the other mounted on the copilot's section, indicate rotor rpm. A small needle on the tachometer indicates rpm from 0 to 130; a larger needle indicates rpm above 130. Electric power to operate these instuments is supplied by a tachometer generator mounted on the forward transmission.



SAFE CONDITION



LOSS OF VACUUM
UNSAFE CONDITION



PARTIAL LOSS OF VACUUM
UNSAFE CONDITION

Figure 2-34. Differential Pressure Sensor Indicator Integral Spar Inspection System

SECTION IX UTILITY SYSTEMS

2-142. Anti-Icing Systems.

Anti-icing is provided for the engine air inlet, engine transmission, and engine drive shaft fairings (structural anti-icing). Also, the pitot tube, SAS yaw ports, and windshields are anti-iced.

2-143. Structural Anti-Icing.

Hot air anti-ices the engine air inlet fairing, engine transmission fairing, and the drive shaft fairing. Hot air is tapped from the engine air bleed gallery thru a fairing hot air valve and ducted to the fairings. When the fairing hot air valve is open, the air travels to the leading edge of the fairings, circulates and escapes through small holes in the trailing edges. Anti-icing is also controlled by the engine anti-ice switch and a fairing hot air valve.

CAUTION

To increase the service life of the pitot tube and SAS yaw port heaters, do not operate pitot heat and yaw port heaters for more than 5 minutes on the ground.

2-144. Pitot Tube and SAS Yaw Port Anti-Icing.

Heating elements prevent ice accumulation in the pitot tube and the SAS yaw ports. Power to operate the heaters is supplied by the 115-volt secondary bus thru two circuit breakers marked PITOT HEAT and STATIC PORT HTR. The breakers are on the overhead circuit breaker panel.

2-145. Pitot Heat Switch. A two-position toggle switch on the anti-ice control panel (figure 2-8) of the overhead switch panel is marked PITOT HEAT. The ON position provides power to the heater elements in the pitot tube and yaw ports. When the switch is moved to OFF, the heating elements are deenergized. Check for indication on the AC loadmeter when the pitot heat switch is moved to the ON position.

2-146. Windshield Anti-Icing.

The pilot's and copilot's windshield are anti-iced and defogged electrically. The center windshield is defogged but not anti-iced. The laminated windshield panels are heated electrically by current which passes thru a transparent conductiwd coating imbedded between the layers. The temperature of each individual windshield is automatically maintained by a temperature controller which operates in conjunction with a sensor element imbedded in the windshield and a temperature control relay. The switches to operate the windshield anti-icing system are on the anti-ice control panel (figure 2-8) of the overhead switch panel. Power for the windshield anti-icing system is provided by the 208-volt, 3-phase ac secondary bus thru three circuit breakers labeled WSHLD AI, located on the ac circuit breaker box, and by the 28-volt dc secondary bus thru three circuit breakers labeled WSHLD ANTI-ICE CONT—PILOT, CTR, and COPILOT, on the overhead circuit breaker panel.

CAUTION

Should bubbling or delamination of the windshield occur around the sensor element, immediately move the switch to OFF for what windshield.

2-147. Windshield Anti-Ice Anti-Fog Switches. Three two-position toggle switches control the application of heat to the pilot's, copilot's, or center windshield. The switches (figure 2-8) are marked COPILOT ANTI-ICE ANTI-FOG, CENTER ANTI-FOG, and PILOT ANTI-ICE ANTI-FOG. When either switch is moved to ON, current flows to the associated temperature controller and then to the windshield. When the temperature of the windshield rises to a preset value (about 44°C), as sensed by the sensor element, the electrical current to the windshield is interrupted by the temperature control relay. Once the windshield has sufficiently cooled, the electrical current is reapplied. This causes a cycling effect which maintains the windshield temperature within operating limits. Operating temperature is reached in less than 1 minute after the switch is moved to ON. When the switch is moved to OFF, the anti-icing system is deenergized.

2-148. Miscellaneous Equipment.

Paragraphs 2-149 thru 2-165 describe other equipments available to the crewmembers.

2-149. Windshield Wipers.

CAUTION

To prevent windshield damage, do not operate the windshield wipers when the windshields are dry. The windshield wipers should be shut off at speeds above 130 knots.

Two electrically driven windshield wipers (3, figure 2-4) are installed, one on the pilot's windshield and the other on the copilot's windshield. One motor operates both wipers thru two flexible shafts and two windshield wiper converters. The windshield wiper motor is controlled by the windshield wiper switch and operated by current from the 28-volt dc secondary bus thru a circuit breaker marked WSHLD WIPER on the overhead circuit breaker panel.

2-150. Windshield Wiper Control Switch. The WINDSHIELD WIPERS control switch is on the lower left control panel of the overhead switch panel. The switch positions are marked OFF, SLOW, MED., FAST, and PARK. By rotating the switch from OFF, the speed of the wipers can be adjusted as desired. The windshield wipers will stop at any position on the arc of travel when the control switch is returned to OFF. To position the wipers against the inside windshield frame, select PARK which repositions the wipers as well as turns them off.

2-151. Map and Data Case.

The map and data case is in the passageway. It holds manuals, maps, and other data.

2-152. Vne Computer.

CAUTION

Do not use the Vne computer with longitudinal cyclic trim inoperative in the retracted position. (See figure 5-8 for airspeed limits.)

The Vne (Velocity never exceed) computer 114E5150-1 (figure 2-35) is mounted on the instrument panel. It aids the pilots in determining airspeed limitations. The computer is mechanical and provides an airspeed limit according to the gross weight and density altitude. Density altitude is not read directly. It is the product after setting the barometric pressure, the altitude, and the temperature scales. The Vne computer reflects the same airspeed limitations as those shown on figure 5-7.

2-153. Sample Problem. A mission is to be flown at 30,000 pounds gross weight from point A to point B at 3,000 feet indicated altitude. At point A, the altimeter setting is 30.25, the temperature is 30°C; at 3,000 feet, the predicted temperature is 25°C. If the flight level temperature is not available, subtract 2°C from the takeoff site temperature for each 1,000 feet of altitude up to the desired flight altitude. Determine the airspeed limit during climb and cruise, using the Vne computer as follows:

a. Move the PRESSURE ALTITUDE scale until the arrow points to a BARO. PRESS. of 30.25.

b. Set the pressure altitude adjustment knob to indicate 3,000 feet.

c. Set the temperature adjustment knob to indicate 30°C.

d. Under the hairline opposite 30,000 LB, read the airspeed limit during the climb to 3,000 feet—98 knots.

e. After leveling off at 3,000 feet indicated altitude, reset the temperature knob to the temperature and recheck the altitude.

f. Under the hairline opposite 30,000 LB, read the airspeed limit during cruise at 3,000 feet—100 knots.

2-154. Checklists.

Two checklists, one for the pilot and one for the copilot, are mounted on the instrument panel, in the cockpit. These checklists contain takeoff and landing procedures.

2-155. Cockpit Rearview Mirror.

A rearview mirror is installed on the right center windshield support to enable the pilot to observe the cargo compartment.

2-156. Spare Lamp Stowage Box.

The spare lamp stowage box is in the cockpit on top of the dc circuit breaker box. Spare lamps are provided for the instrument post lights, instrument light shields, dome lights, cabin and ramp lights, and nacelle work lights.

2-157. Cockpit Utility Receptacles.

Two 28-volt dc utility receptacles are in the cockpit, one on the dc circuit breaker box and one on the ac circuit breaker box. The cockpit utility receptacles are powered by the 28-volt dc secondary bus through two circuit breakers marked UTILITY REC-PILOT, COPILOT and are on the dc circuit breaker box.

2-158. Cabin Utility Receptacles.

Four 28-volt dc utility receptacles with three outlets each are located on the sidewalls of the cargo compartment. Each group of receptacles is capable of handling a 15-ampere, 7.5-ampere, and 5-ampere load. The total current flow with all receptacles in use is not to exceed 60 amperes. The cabin utility receptacles are powered by the 28-volt dc secondary bus thru four circuit breakers labeled UT RECP-RH AFT, UTILITY RECEPTACLE-LH FWD, RH FWD, LH AFT, on the dc circuit breaker box.

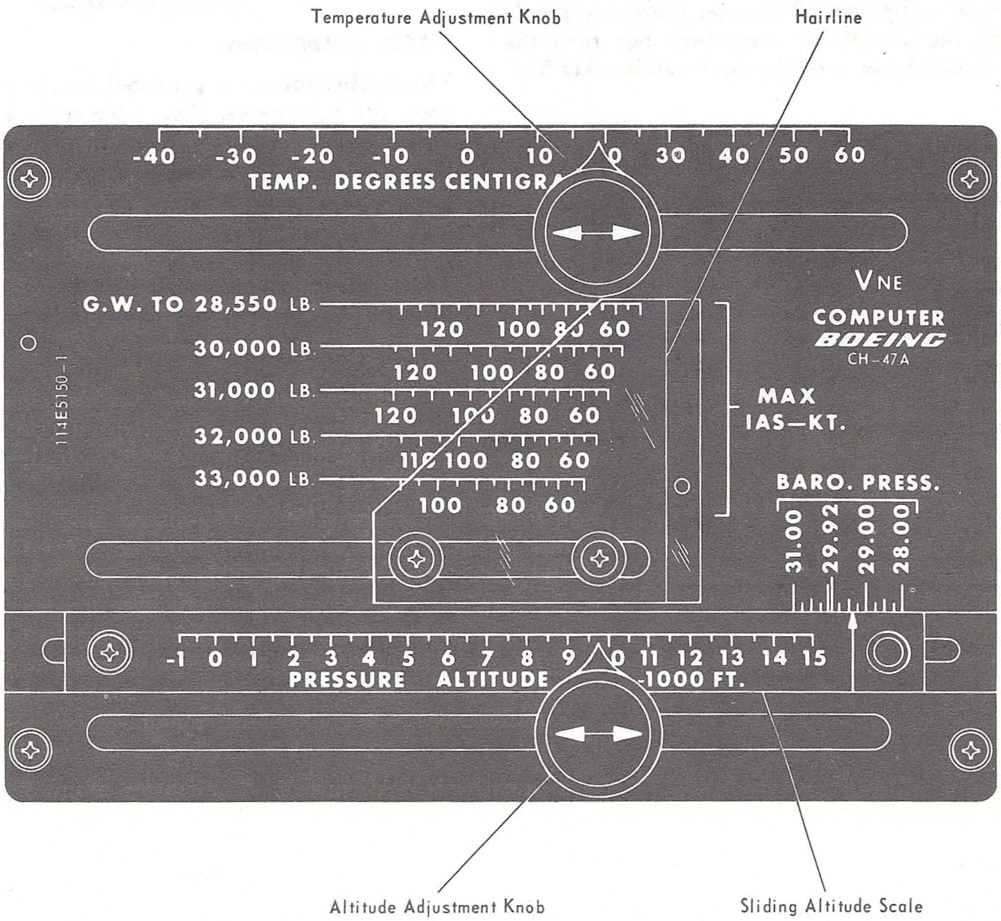


Figure 2-35. Vne Computer

2-159. Missile Warmup Receptacles.

Two 115/208-volt, 3-phase ac missile warmup receptacles are located on the left side of the cargo compartment at station 320. Each receptacle is accessible after removing the acoustical access cover and the receptacle's dust cap. Missile warmup receptacle number 1 is powered by the 208-volt, ac auxiliary bus, and missile warmup receptacle number 2 is powered by the 115/208-volt, 3-phase, ac secondary bus. Both circuits are protected by individual circuit breakers (MISSILE WARMUP #1 and #2) located on the ac circuit breaker box.

2-160. Electronic Blade Tracking Equipment Receptacles.

The two electronic blade tracking receptacles (figure 2-36) inside the access panel at station 110 on the right side of the helicopter are not used.

2-161. Strobex Blade Track Receptacles.

The Strobex blade tracking system receptacles (figure 2-37) are in the cargo compartment at station 256 right side. One receptacle, identified as 28 VDC POWER, is used as the power sourcd for the equipment. The other receptacle, identified as SIGNAL OUTPUT, is used to provide an input signal to the equipment. The power source receptacle is powered by the 28-volt dc secondary bus thru the BLADE TCK circuit breaker on the dc circuit breaker box.

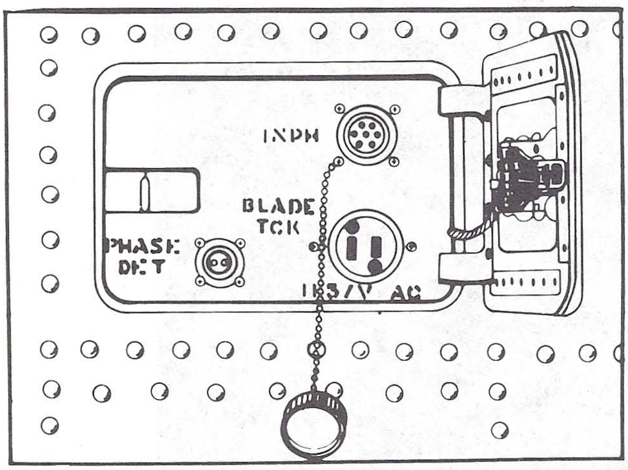


Figure 2-36. Blade Track and Interphone Receptacles

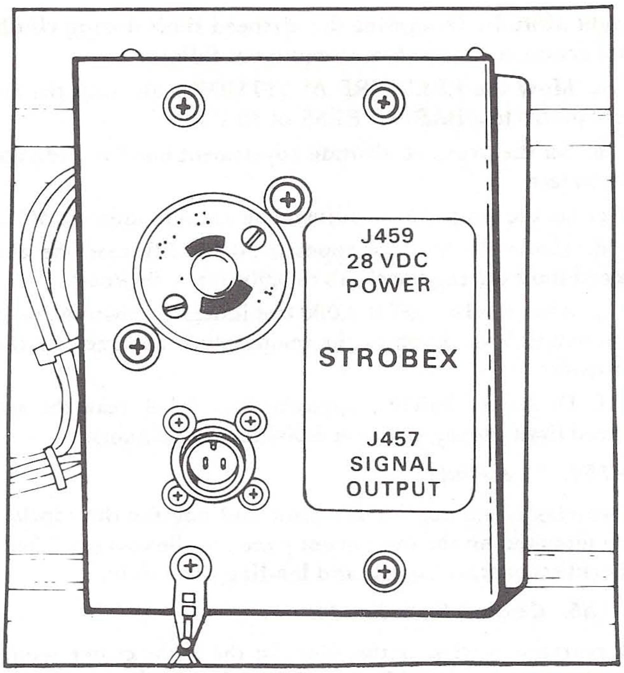


Figure 2-37. Strobex Blade Track Receptacles

2-162. Relief Tubes.

Three relief tubes are provided for the convenience of the crew and passengers. Two relief tubes are in the cockpit. One is under the pilot's seat and one is under the copilot's seat. The third relief tube is at the rear of the cargo compartment on the right side.

2-163. Ash Trays.

Three ash trays are installed in the cockpit, one for each pilot and one for the troop commander.

2-164. Compass Correction Card Holder.

The magnetic compass correction card holder is attached to the left side of the magnetic compass. The card contains the necessary deviation values which are applied to the indicated reading.

2-165. Pilots' Assist Straps.

Two assist straps are attached to the center window frame of the cockpit structure to provide the pilots with a hand hold while getting into the seats. The assist strap can be positioned flat against the structure after use.

SECTION X HEATING, VENTILATING, COOLING, AND ENVIRONMENTAL SYSTEMS

2-166. Heating and Ventilating System.

A 200,000 BTU/HR-capacity internal combustion heating system is provided. It is composed of a heater unit, a fuel control unit, an ignition assembly, a blower, control relays, and air pressure and temperature control circuits. Ducting carries heated air or ventilating air to the cockpit and the cabin. The heater receives fuel from the left fuel tank and consumes approximately 15 pounds per hour. (Helicopters with the crash resistant fuel system feed the heater from the right fuel cell.) The heater and blower are mounted vertically on the right side of the helicopter, immediately aft of the forward cabin section bulkhead. The air supply for the system is provided by the blower which draws air from an inlet located on the forward upper side of the fuselage. If sufficient air is not available for proper heater operation, an automatic differential pressure switch in the heater circuit will stop the heater. Both ventilating and combustion air enters the heater inlet. The ventilating air passes over the heated metal walls of the combustion chamber and is directed to a network of ducting. The air entering the combustion chamber is combined with atomized fuel and, after combustion, the exhaust is discharged thru an outlet on the forward upper side of the fuselage. Power for the blower is supplied by the 208-volt, 3-phase ac auxiliary bus thru a circuit breaker, marked BLOWER, on the ac circuit breaker box. The rest of the system receives its power from the 28-volt dc primary bus thru a circuit breaker marked HEATER CONT, on the overhead circuit breaker panel.

2-167. Heater Function Switch.

A three-position heater function switch (figures 2-8 and 2-38) is located on the heating control panel of the overhead switch panel. The switch selects the desired feature of the heating and ventilating system. By placing the switch to VENT BLOWER ONLY, the blower forces unheated air into both the cockpit and cabin. Further movement of the heater controls is not required. Selecting HEATER ON, energizes the various units of the heater once the heater start switch is pressed. By selecting OFF, the heating and ventilating system is shut down.

2-168. Heater Start Switch.

A spring-loaded heater start switch (figure 2-8 and 2-38) is located below the heater function switch on the heating control panel. When the HEATER ON position is selected and the HEATER START button pressed, the heater control circuits are energized. The blower starts and purges the heater combustion chamber of any unburned fuel, while the remainder of the circuit remains inactive because of a 10 to 15 second time-delay relay. After the time-delay relay is energized, the ignition assembly is powered and the master fuel solenoid valve opens, allowing fuel to flow to the heater fuel control unit to complete the start.

2-169. Temperature Selector.

The rheostat-type temperature selector is located adjacent to the HEATER START pushbutton. This switch operates in conjunction with the temperature controller relay in the heater circuit and with a cabin thermostat. One set of contacts on the temperature controller relay closes to complete a circuit to the fuel control solenoid valve. This allows fuel to be delivered to the heater. The second set of contacts on the temperature controller relay closes to complete the circuit to the heater windings in the cabin thermostat. The heater windings heat a column of mercury in the thermostat, causing it to rise. When the mercury column reaches a 34°C contact, the temperature control relay is shunted, causing its contacts to open and interrupt the circuit to the fuel control solenoid valve. This stops heater operation by shutting off the fuel supply to the heater. The circuit to the thermostat heater winding is also interrupted, allowing the winding to cool and the mercury column to contract, thus reenergizing the temperature controller relay. This creates a cycling effect, the rate of which may be varied by increasing or decreasing the resistance between the temperature selector and the thermostat heating winding. Resistance is varied by turning the temperature selector knob. This increase or decrease in resistance directly varies the time the heater is allowed to operate before being automatically cycled.

2-170. Cockpit Air Knob.

Two cockpit air knobs (17 and 47, figure 2-7 and figure 2-38) are on the lower outboard corner of both the pilot's and the copilot's instrument panels. The knobs are marked PULL FOR ON-COCKPIT AIR. Each knob controls a valve on the heater ducting which regulates the airflow to the cockpit.

2-171. Air Control Handles.

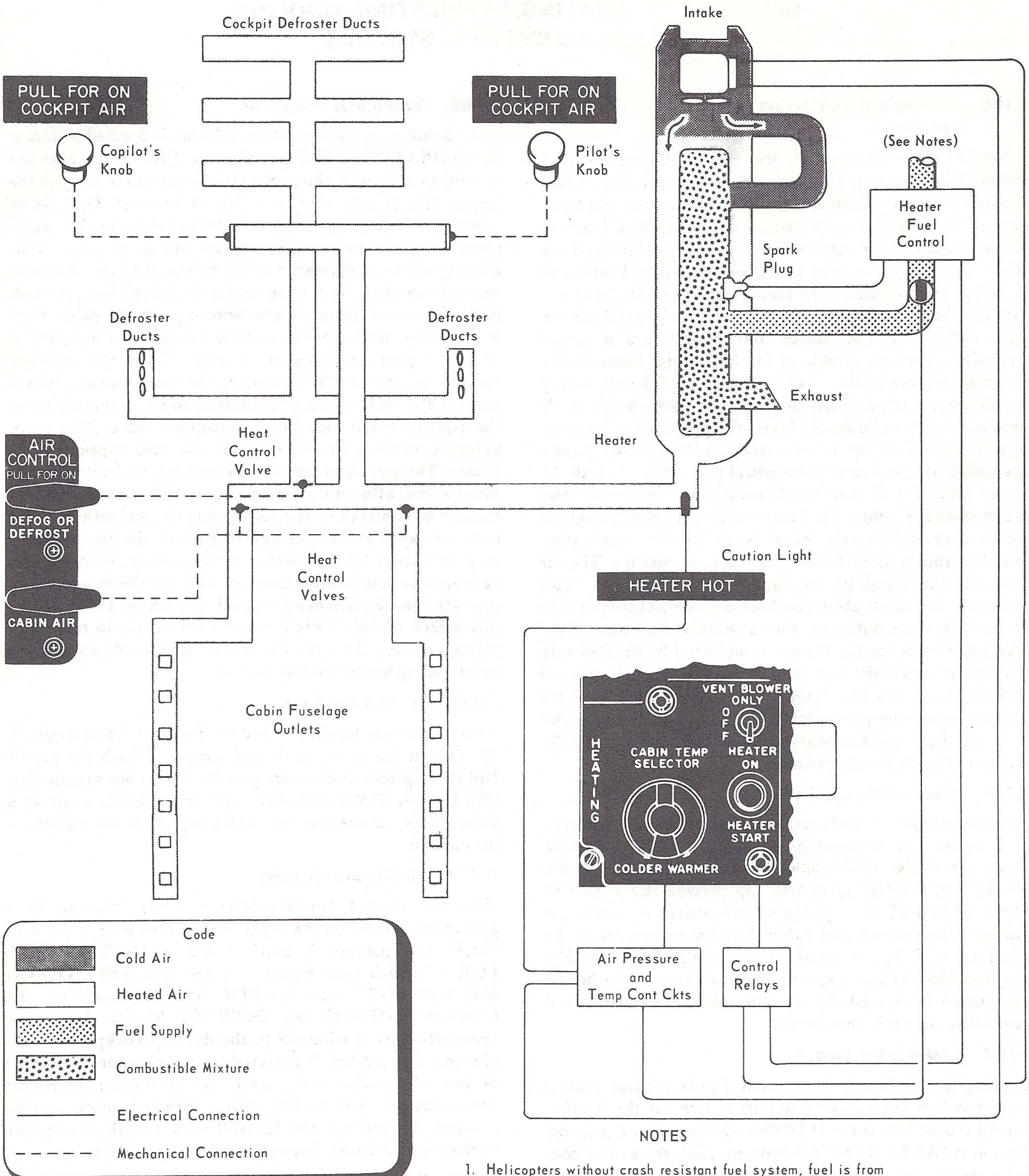
Two air control handles (figure 2-38) attached to a placard mounted on the right side of the console are provided. The placard is marked AIR CONTROL PULL FOR ON with each handle marked COCKPIT DEFOG OR DEFROST and CABIN AIR. By pulling the COCKPIT DEFOG OR DEFROST handle, heated or ventilating air is directed to the ducting cockpit nose enclosure. The airflow is directed to the transparent portion of the jettisonable doors and nose enclosure providing defrosting as well as additional forward cabin section heating. By pulling the CABIN AIR handle, heated or ventilating air flows through the ducting to the cabin.

2-172. Cabin Heat Controls.

Fourteen manually adjustable outlets are provided in the cabin for the comfort of the passengers.

2-173. Heater Caution Light.

An amber heater caution light, marked HEATER HOT, is located on the master caution panel (figure 2-52). This



NOTES

1. Helicopters without crash resistant fuel system, fuel is from the left fuel tank.
2. Helicopters with crash resistant fuel system, fuel is from the right tank.

Figure 2-38. Heating and Ventilating System light indicates failure of the automatic temperature control circuit. If the temperature of the air in the heater assembly rises to 177°C, an overheat switch deenergizes the automatic temperature controller relay, shuts off the heating system, with exception of the blower, and lights the HEATER HOT caution light. The heating system will not operate until the blower has lowered the temperature in the heater to normal and the heater start button is pressed. Even though the temperature in the combustion chamber has lowered, the HEATER HOT caution light will not go out until HEATER ON is selected and the HEATER START pushbutton is pressed.

NOTE

Since the HEATER HOT caution light will not go out until the temperature in the combustion chamber is below 177°C, it may take several attempts at restarting the heater before the HEATER HOT caution light goes out.

2-174. Normal Operation—Heating and Ventilating System.

WARNING

Push in the cockpit air control knobs to close the vents before starting the vent blower or heater. After the vent blower switch is at VENT BLOWER ONLY, or HEATER ON, open the cockpit vents by pulling out the cockpit air knobs slowly to preclude dirt and debris from being blasted into the air and the pilot's eyes.

2-175. Starting.

CAUTION

When the apu is being used for starting the engines, the 3-phase, 208-volt ac auxiliary bus is automatically disconnected from the electrical system to reduce the starting load. If the heater is operating prior to engine starting, the blower which is energized by the auxiliary bus will stop and end heater operation. Therefore, if the heater is used prior to engine starting, it must be shut down 2 to 3 minutes before engine starting to ensure proper purging of the heater.

NOTE

Make sure that the heater inlet and outlet covers are removed prior to heater starting.

a. Battery switch—ON.

b. Apu—Start.

c. Generator switches—ON.

d. Left (right with crash resistant fuel system) tank fuel booster pump switches —ON.

e. Heater function switch—As desired. (HEATER ON or VENT BLOWER ONLY.)

f. Heater start switch—PRESS.

NOTE

If the left side of the helicopter is exposed to the sun, the cabin thermostat may be heated to 34°C which is sufficient to prevent starting the heater.

g. Temperature selector—As desired.

2-176. Heat Distribution.

a. To get maximum cockpit heat proceed as follows:

(1) Pilot's and copilot's cockpit air control knobs—Pull.

(2) DEFOG OR DEFROST handle—Pull.

(3) CABIN AIR handle—Push.

(4) Temperature selector—Full clockwise.

b. To get maximum cabin heat proceed as follows:

(1) Pilot's and copilot's air control knobs—Push.

(2) DEFOG OR DEFROST handle—Push.

(3) CABIN AIR handle—Pull.

(4) Cabin adjustable outlets—Full open.

(5) Temperature selector—Full clockwise.

2-177. Stopping. Heater function switch—OFF. After the heating and ventilating system has been stopped, the blower will continue to operate until the temperature within the heater combustion chamber is below 49°C.

2-178. Emergency Operation—Heating and Ventilating System.

The following paragraphs describe heating and ventilating system failure modes.

2-179. Vibrator Contact Failure. If the heater should fail to operate, one of the causes could be faulty vibrator contacts. The vibrator is equipped with two separate sets of contacts designated NORMAL and RESERVE. Upon failure of the normal contracts, the reserve set may be brought into operation by moving the switch on the junction box to the RESERVE position. The junction box is mounted on the ignition unit adjacent to the heater.

2-180. Heater Overheat Condition. If the HEATER HOT caution light illuminates, proceed as follows:

a. HEATER START switch—Press.

b. HEATER HOT caution light—Monitor.

SECTION XI ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

2-181. Electrical Power Supply System.

Alternating current (ac) is the primary source of power used to operate the electrical and electronic equipment. (Figure 2-41.) Each of two ac generators, driven by the accessory gearbox (agb) on the aft transmission, produces 115/208-volt, 3-phase, 400-Hz current. The ac system provides 28-volt dc through two transformer-rectifiers in the forward section of the left fuselage pod. Direct current is also supplied by a 24-volt nickel-cadmium battery (33, figure 2-1). On the ground, both 208-volt 3-phase ac and 28-volt dc can be supplied by connecting an external power source to the external power receptacles (figure 2-39). If only ac external power is used, dc power is supplied by the helicopter transformer-rectifiers. If both ac and dc external power is used, the transformer-rectifiers are automatically disconnected from the buses. If only dc external power is available, the apu must be used to provide ac power. Circuits are protected by circuit breakers (figure 2-42). The electrical load is divided between the two ac generators. Should one generator fail, the other will automatically take over the entire load.

CAUTION

When external power is being used and the cabin heater is turned on, the cabin heater must be turned off 2 to 3 minutes before turning off external power to ensure proper purging of the heater.

2-182. AC System.

The ac system (figure 2-41) supplies 115/108-volt, 3-phase, 400-Hz current from the No. 1 ac generator to a primary 3-phase bus and from the No. 2 ac generator to a secondary three-phase bus. An auxiliary 3-phase bus is connected to the primary bus thru an auxiliary bus relay. The ac operated equipment is powered by these three buses. Some of the equipment is operated by 115-volt, single-phase, ac, and some equipment by 208-volt, three-phase, ac. Other equipment is operated by 26-volt ac power supplied thru a transformer. The ac system is protected from overvoltage, undervoltage, and under-frequency conditions by a generator control panel. The generators will be disconnected from the ac buses anytime the frequency drops below 350 Hz for more than 5 seconds. This frequency corresponds to 200 to 208 rotor rpm on helicopters with 114D2200 transmissions and 184 to 196 on helicopters with 114D2001 transmissions. A bus-tie relay is located between the primary and secondary 3-phase buses. If either generator fails, this bus-tie relay closes automatically and connects the disabled bus to the operating generator. This ensures continuous operation of all ac equipment. During engine starting, No. 2 generator, the No. 2 transformer-rectifier, the ac and dc secondary buses, the auxiliary bus, and the radio bus are disconnected from the electrical system to reduce the starting load on the auxiliary power unit and reconnected to the electrical system at the completion of the engine starting cycle. External ac power is supplied to the ac buses of the helicopter by connecting the external ac power source to the ac external power receptacle (figure 2-39). Application of external power closes the ac external power relay which connects the power source to the primary bus. If the primary bus is already energized by the helicopter generators, an interlock circuit between the external power relay and the main relays prevents the use of external power. If the external power phase sequence is unlike that of the helicopter bus, a phase sequence network prevents the external power relay from closing.

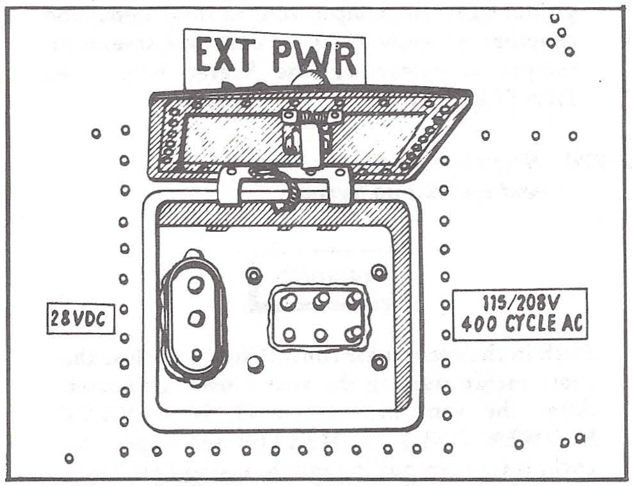


Figure 2-39. External Power Receptacles

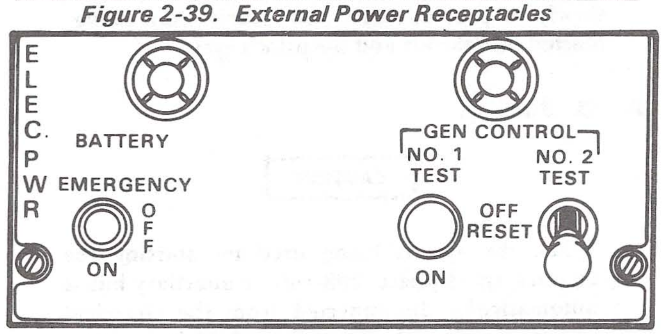


Figure 2-40. Electrical Power Panel

2-183. Generator Control Switches. Two 3-position switches to control the ac generators are on the electrical power panel (fig. 2-26) of the overhead switch panel. The switch positions are ON, OFF-RESET, and TEST.

NOTE

The generators will be disconnected from the ac buses anytime the frequency drops below 350 cps for more than 5 seconds. This frequency corresponds to 184 to 196 rotor rpm on helicopters without Part No. 114D2200 series aft transmissions, and 200 to 208 rotor rpm on helicopters with Part No. 114D2200 series aft transmissions. The generators are automatically reconnected to the ac buses when the rotor rpm is increased.

When either switch is ON, the respective main relay closes which energizes and connects the generator to the bus. At OFF RESET, the generator is deenergized and disconnected from the bus. This position is also used when attempting to reset a generator. The TEST position is provided to allow the generator to be energized but disconnected from the bus to determine whether the ac produced is of proper frequency and voltage.

2-184. AC Loadmeters. Two loadmeters for the ac system are mounted on the center section of the instrument panel (19, figure 2-7). They indicate generator output relative to the rated load. The loadmeter does not operate when external power is used.

2-185. AC Generator Caution Lights. Two amber generator caution lights are on the master caution panel (figure 2-52). The lights are marked NO. 1 GEN OFF and NO. 2 GEN OFF. These lights come on whenever the generators are inoperative. The lights are controlled by the main generator relays when the generator control switches are in either the ON or OFF RESET position. In the TEST position the lights are controlled by the generator control switch and will go out if the generator output is the proper frequency and voltage. Current to operate the lights is supplied from the primary 28-volt dc bus thru a CAUTION LTS circuit breaker on the overhead circuit breaker panel.

2-186. AC External Power Caution Light. An ac external power caution light is on the master caution panel (figure 2-52) of the console. Marked AC EXT PWR ON, this light comes on and remains on whenever external power is being used by the ac system. The light is controlled by the ac external power relay. The light goes off when the generators are supplying current to the buses. Power to operate the light is supplied from the 28-volt dc primary bus thru the CAUTION LTS circuit breaker on the overhead circuit breaker panel.

CAUTION

The caution light will go out when the ac generators are powering the system. Therefore, a visual check must be made before taxiing or takeoff to ensure external power is disconnected.

2-187. DC System.

The direct current (dc) power supply (figure 2-43) system supplies 28-volt dc from the No. 1 transformer-rectifier to a primary bus and from the No. 2 transformer-rectifier to a secondary bus. The ac system supplies input power to the transformer-rectifiers. A radio bus is connected to the primary bus thru a radio bus-tie relay which opens during engine starting to reduce starting load. An emergency bus is connected to the primary bus thru an emergency bus relay. The 24-volt nickel-cadmium battery, in the forward section of the left fuselage pod, supplies emergency dc power and power for the apu starting circuits. The battery capacity is 11 ampere-hours. A bus-tie relay is between the primary and secondary buses. If either transformer-rectifier fails, the respective transformer-rectifier failure relay energizes and the bus-tie relay closes automatically to connect the disabled bus to the operating transformer-rectifier. This ensures continuous operation of all dc equipment. External dc power is supplied to the dc buses of the helicopter by connecting the external dc power source to the dc external power receptacle (figure 2-39). Application of external power closes the dc external power relay which connects the power source to the primary bus. If the polarity of the external power is reversed, a blocking diode in the circuit of the external power relay prevents that relay from closing.

2-188. Battery Switch. A three-position battery switch is on the electrical power control panel of the overhead panel. (Figure 2-40.) The battery switch positions are ON, OFF, and EMERGENCY. When the switch is placed ON, the primary, radio, and emergency buses are energized. No battery current is supplied to these buses when the switch is OFF. Placing the battery switch at EMERGENCY closes the emergency bus relay, connecting the emergency bus only to the battery bus. Regardless of the battery switch position, the battery bus is always powered directly by the battery. To prevent excessive discharging of the battery while making extended ground checks of equipment, use an external electrical power source or place the helicopter generators into operation by operating the apu.

2-189. DC Loadmeters. Two loadmeters (38, figure 2-7) for the dc system are mounted on the center section of the instrument panel. They indicate transformer-rectifier output relative to the rated load. The loadmeters do not operate when dc external power is used.

2-190. Transformer-Rectifier Caution Lights. Two amber transformer-rectifier caution lights, on the master caution panel (figure 2-52) are marked NO. 1 RECT OFF and NO. 2 RECT OFF. These caution lights are controlled by the reverse-current cutouts. Whenever one of the transformer-rectifiers fails, either thru a fault in the transformer-rectifier or a loss of generator output, the respective caution light comes on. The reverse-current cutout prevents battery current feedback to the disabled transformer-rectifier. Current to operate the lights is supplied by the 28-volt dc primary bus through the CAUTION LTS circuit breaker on the overhead circuit breaker panel.

2-191. DC External Power Caution Light. A dc external power caution light is on the master caution panel (figure 2-52) on the console. Marked DC EXT PWR ON, this light comes on and remains on whenever external power is connected to the dc external power receptacle. The light is controlled by the dc external power relay. The light goes off when the external power is disconnected from the dc external power receptacle. The 28-volt dc primary bus supplies power to operate this light. A CAUTION LTS circuit breaker is on the overhead circuit breaker panel.

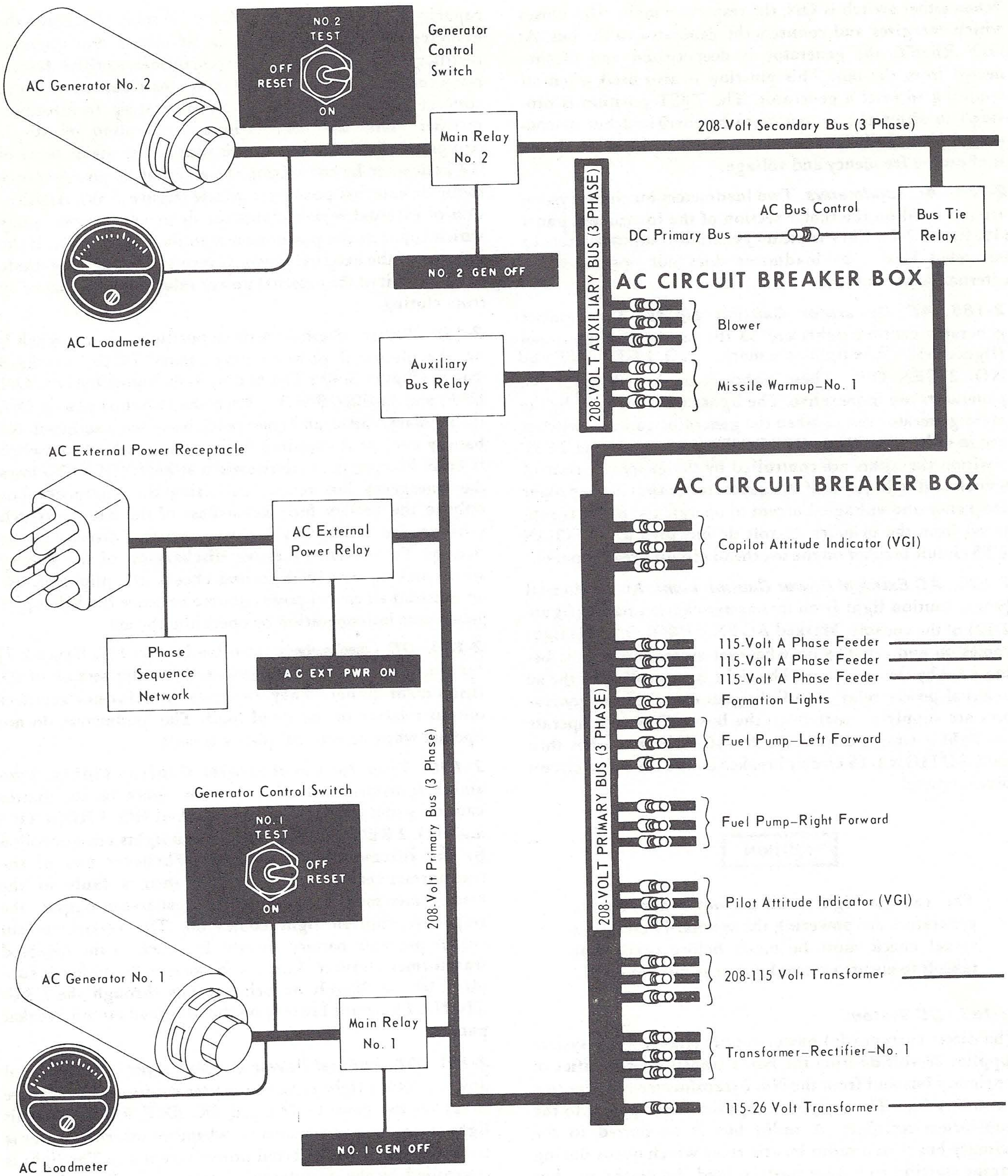


Figure 2-41. Ac Power Supply (Sheet 1 of 2)

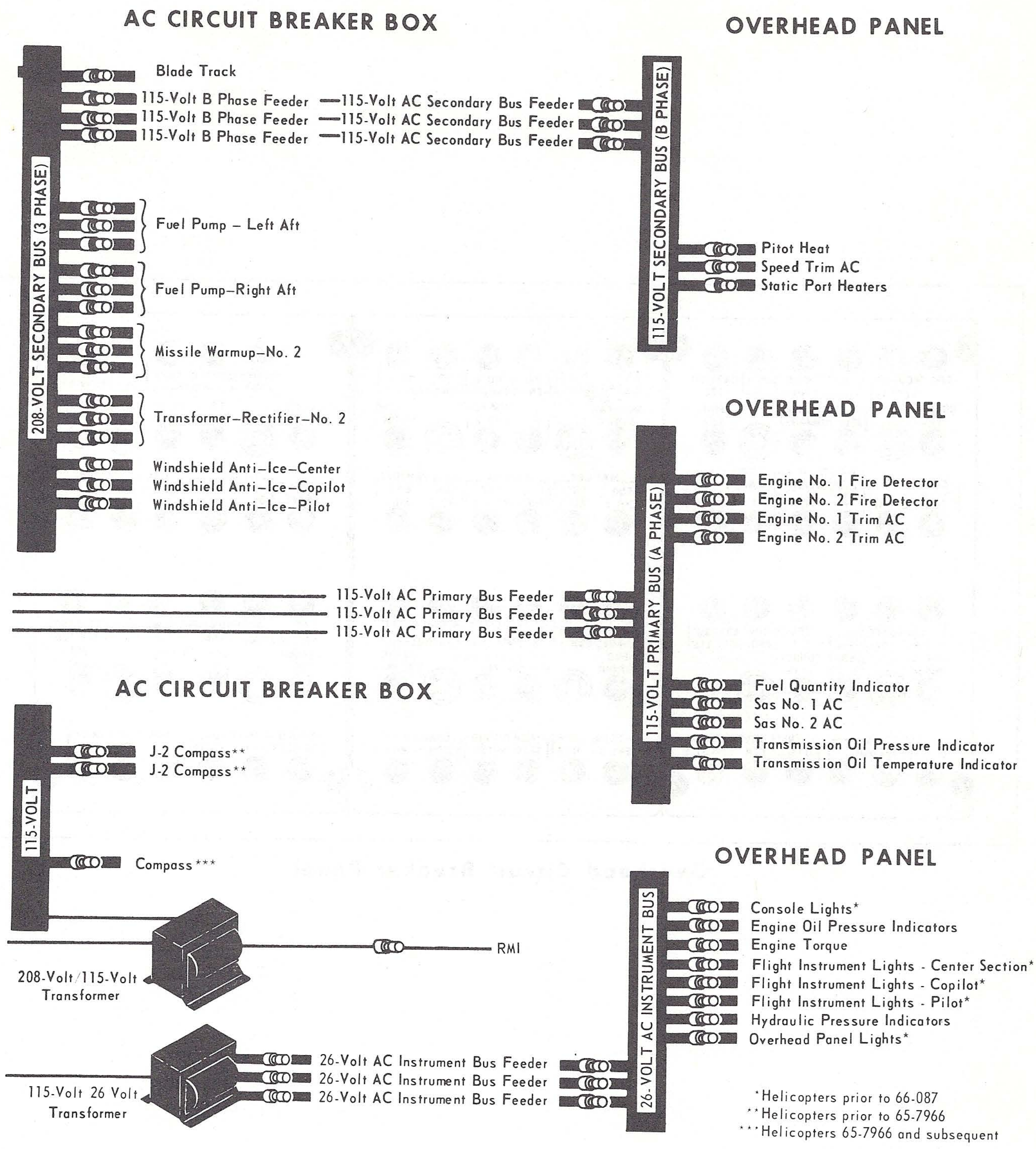
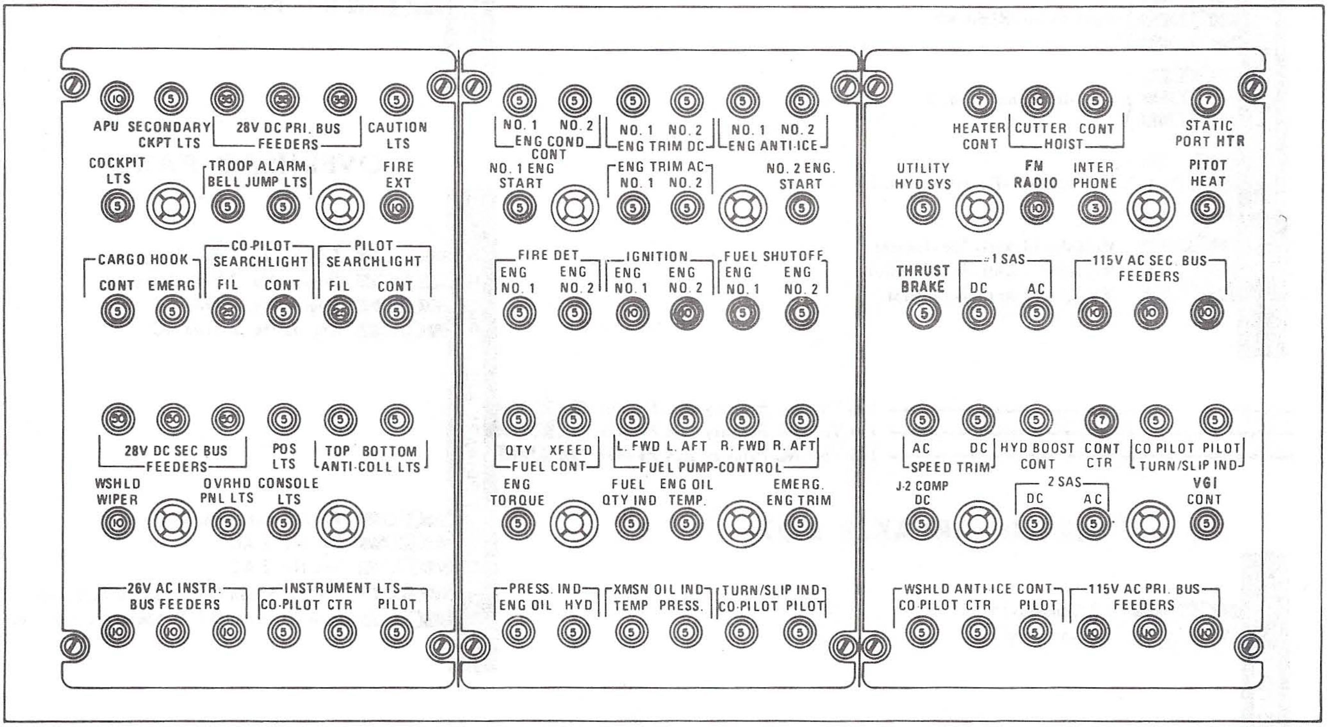
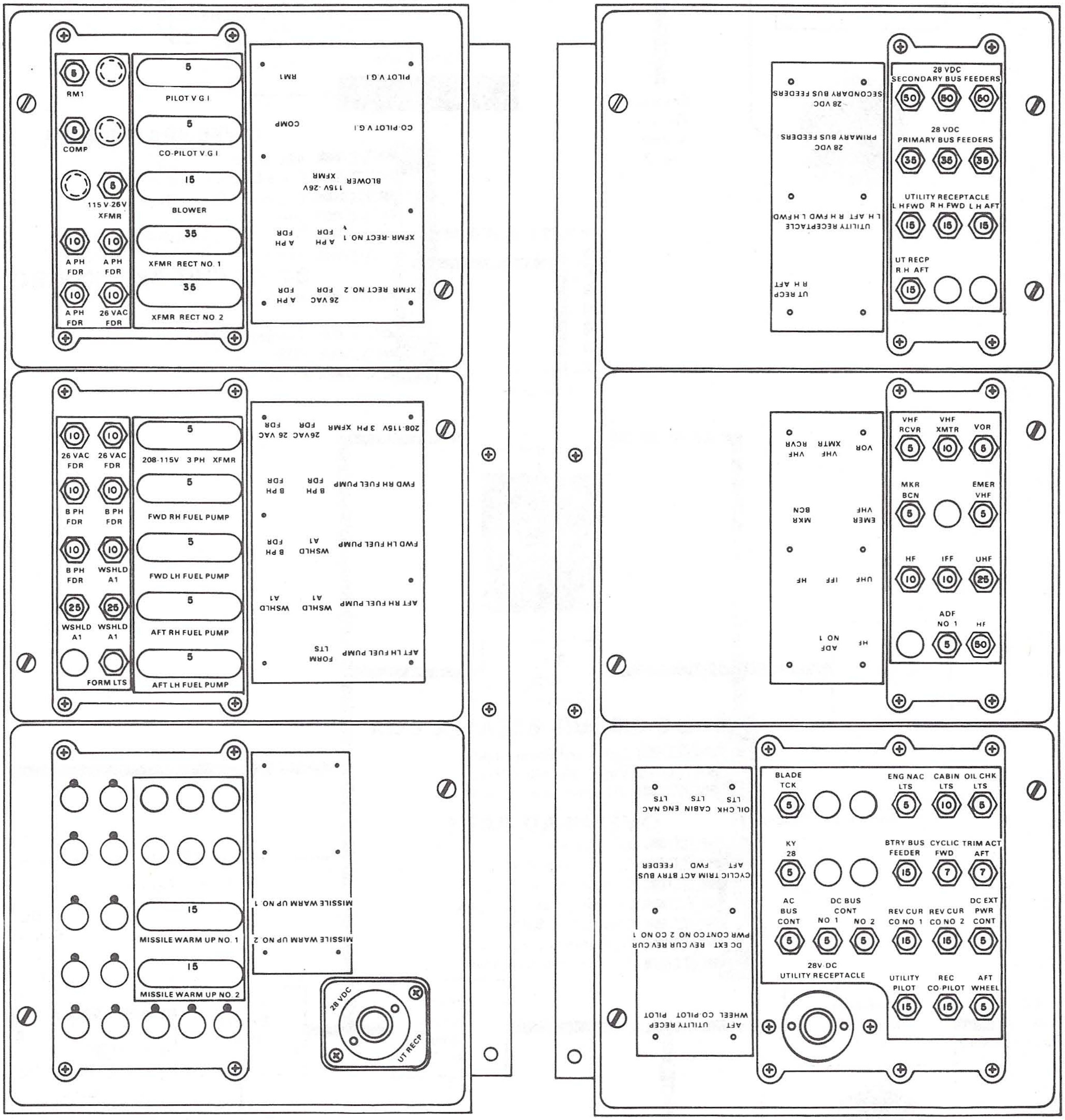


Figure 2-41. Ac Power Supply (Sheet 2 of 2)



Overhead Circuit Breaker Panel

Figure 2-42. Typical Circuit Breaker Panels (Sheet 1 of 2)



AC Circuit Breaker Box

DC Circuit Breaker Box

Figure 2-42. Typical Circuit Breaker Panels (Sheet 2 of 2)

316-520 0 - 80 - 5

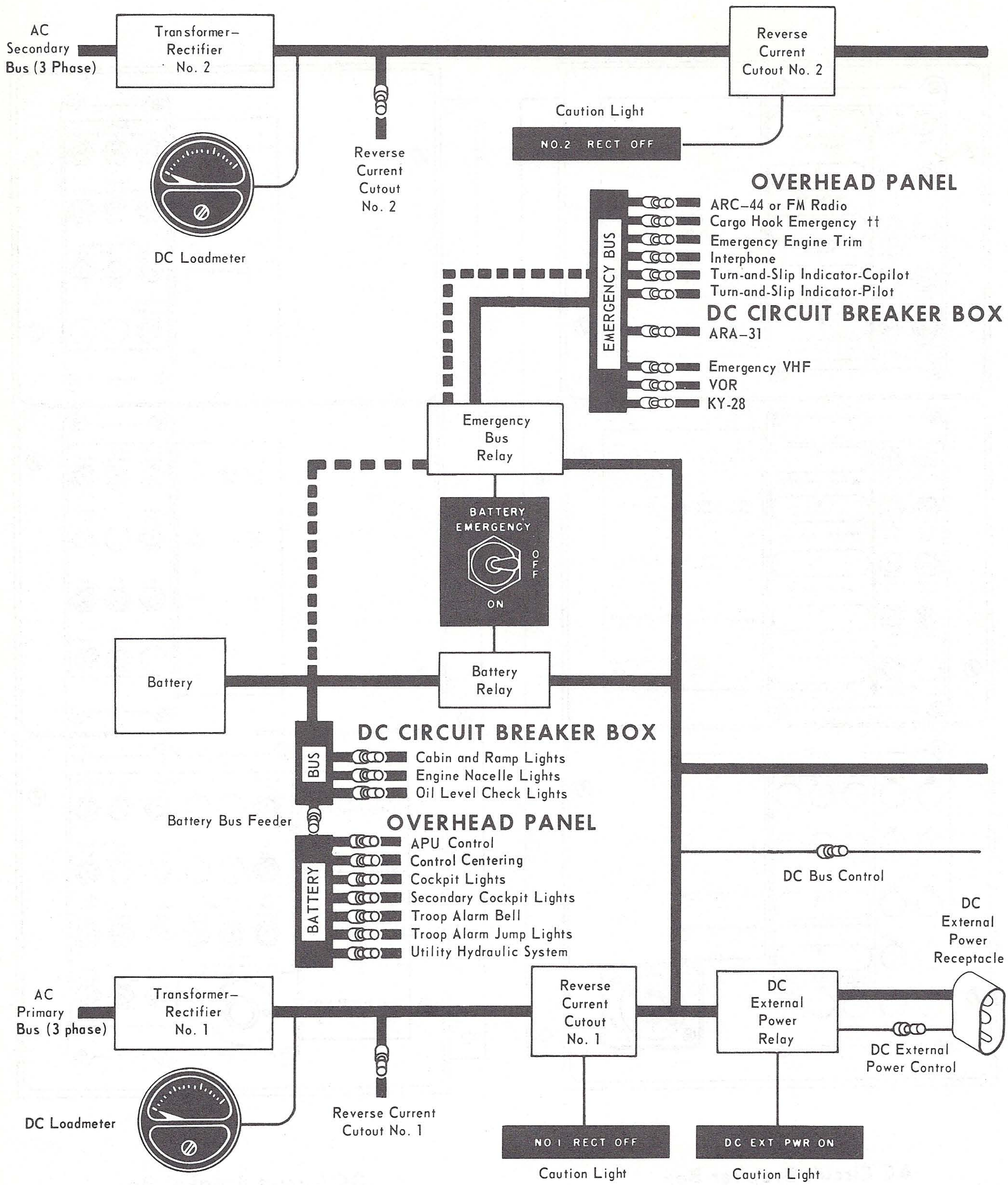


Figure 2-43. Dc Power Supply (Sheet 1 of 2)

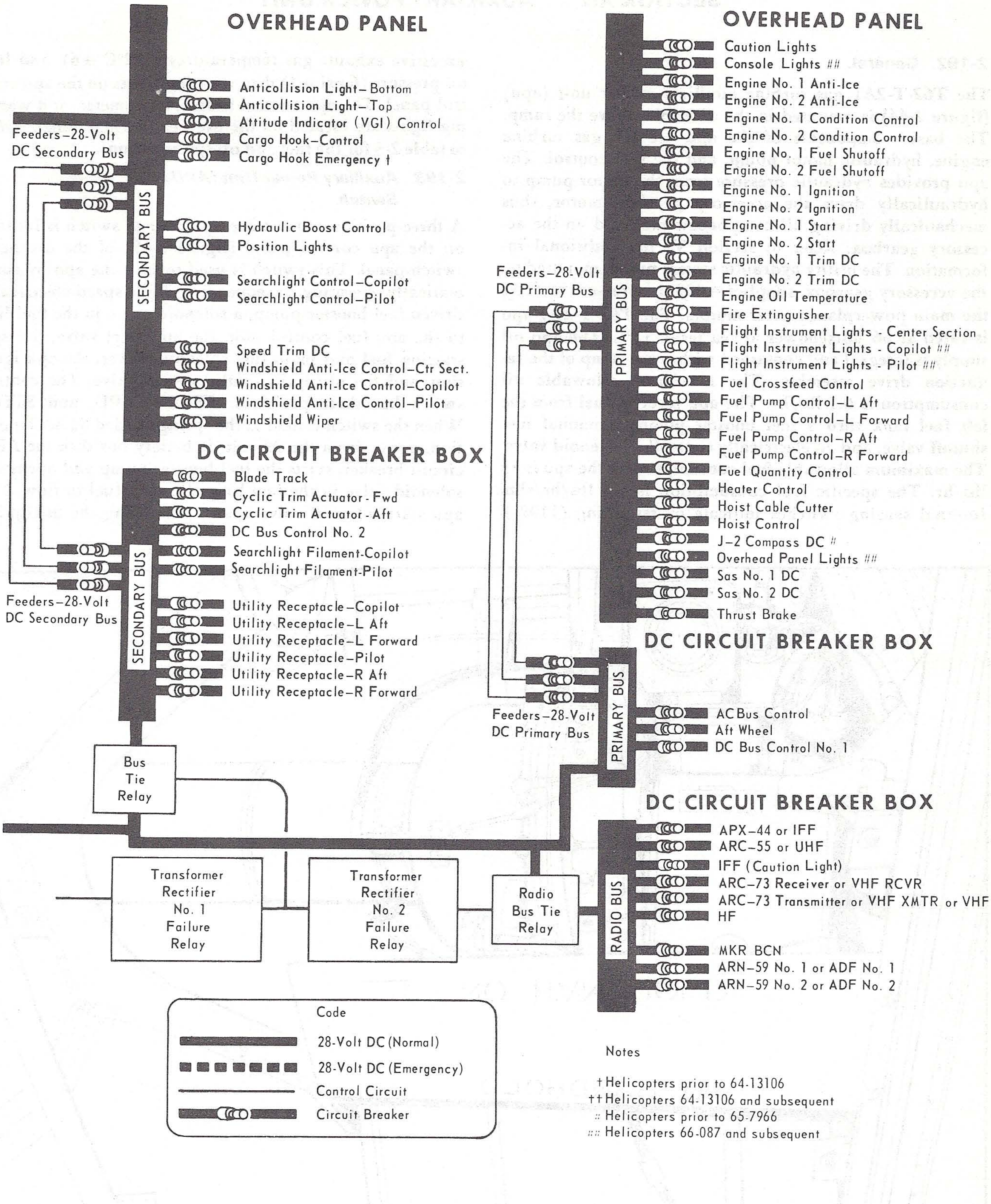


Figure 2-43. Dc Power Supply (Sheet 2 of 2)

SECTION XII AUXILIARY POWER UNIT

2-192. General.

The T62-T-2A1 gas turbine auxiliary power unit (apu) (figure 2-44) is mounted in the aft cabin above the ramp. The basic components of the apu are the gas turbine engine, hydraulic motor-pump, and the fuel control. The apu provides hydraulic pressure from the motor-pump to hydraulically drive the accessory gearbox motor, thus mechanically driving all components mounted on the accessory gearbox. Refer to section VI for additional information. The utility hydraulic system pump, mounted on the accessory gearbox, supplies 4,000 psi pressure to drive the main powerplant starter motors. The T62-T-2A1 apu is rated at 66 horsepower at sea level, 52°C. The apu oil supply is integral and contained within the sump of the reduction drive assembly. The maximum allowable oil consumption is 0.1 lbs/hr. The apu receives fuel from the left fuel tank thru a fuel booster pump, a manual fuel shutoff valve, and an electrically controlled solenoid valve. The maximum allowable fuel consumption of the apu is 83 lbs/hr. The specific fuel consumption is 1.3 lbs/hr/shp. Internal sensing switches indicate overspeeding (110%), excessive exhaust gas temperatures (582°C ±6), and low oil pressure (6 psi ±1) thru warning lights on the apu control panel. The apu control switch, tachometer, and warning lights are located on the overhead switch panel. Refer to table 2-3 for the fuel and oil specifications.

2-193. Auxiliary Power Unit (APU) Switch.

A three-position momentary apu control switch is located on the apu control panel (figure 2-45) of the overhead switch panel. This switch is used to start the apu by automatically operating in sequence a single speed electrically driven fuel booster pump, a solenoid valve in the fuel line to the apu fuel control unit, the apu start valve, the apu starting fuel and main fuel solenoid valves, the apu ignition, and the utility hydraulic system valve. The control switch has three positions: START, APU, and STOP. When the switch is held at the spring-loaded START position, power from the 28-volt dc battery bus thru the APU circuit breaker, starts the fuel booster pump and opens the solenoid valve in the fuel line, allowing fuel to flow. The apu start solenoid valve opens, permitting the utility hy-

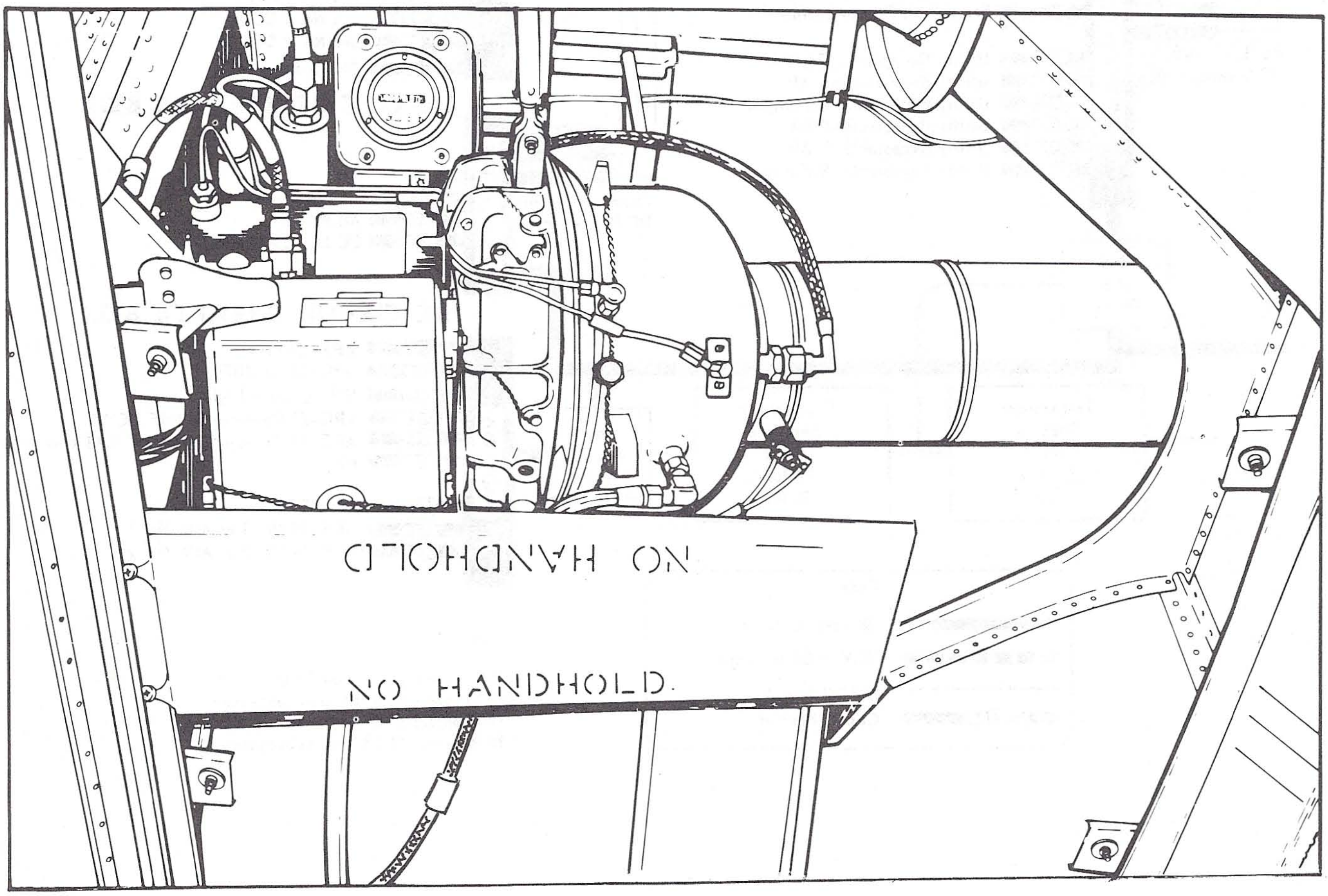


Figure 2-44. Auxiliary Power Unit

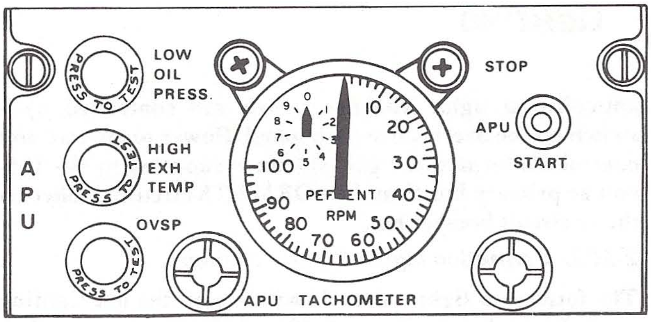


Figure 2-45. Apu Control Panel

draulic system to motor the apu. When the fuel pressure has increased to normal, the apu starting fuel solenoid and main fuel solenoid valves open and the ignition is turned on. The utility system valve closes to prevent loss of hydraulic pressure to the utility hydraulic system before 90 percent apu speed is attained. In addition to the above functions when the apu control switch is held at START, the No. 2 flight control hydraulic pump is depressurized until the generator frequency reaches 350 Hz. The No. 2 flight control hydraulic pump is depressurized to relieve some of the load on the agb during apu starting. The switch returns to the APU position when released. When the switch is moved to STOP, the apu stops.

2-194. APU Manual Fuel Shutoff Valve.

A manual fuel shutoff valve (figure 2-46) is located between the fuel booster pump and the solenoid valve in the fuel supply line to the apu. This valve is inside the aft cabin above and to the left of the ramp interphone station. The valve can also be reached from the outside of the helicopter thru an access door labeled ACCESS APU EMERG FLUID SHUTOFF. A knob on the valve is marked OPEN AND CLOSED; moving this knob to CLOSED shuts off fuel to the apu.

2-195. APU Tachometer.

The apu tachometer is located on the apu control panel (figure 2-45) of the overhead switch panel. The apu tachometer presents a visual indication of the apu performance in percent of rpm. The apu tachometer is calibrated from 0 to 110 percent. The indicator incorporates a large pointer, with a range from 0 to 100 percent, in increments of 2 percent and a smaller vernier pointer which indicates, from 0 to 10 percent, in increments of 1 percent. Power to operate the apu tachometer is produced by an apu tachometer generator mounted on the accessory drive assembly of the apu.

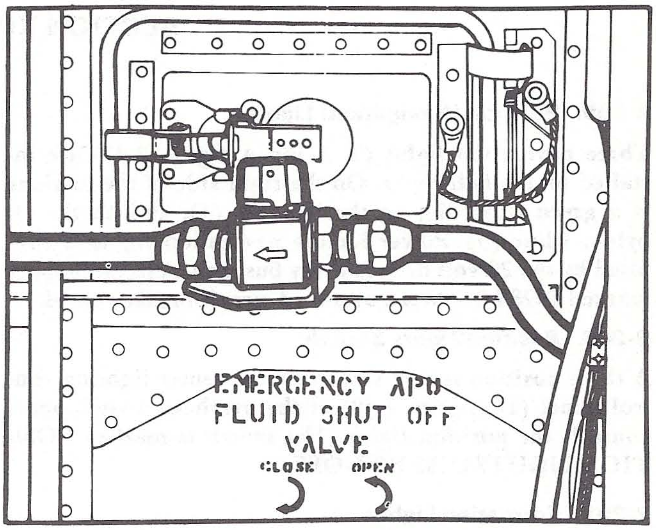


Figure 2-46. Apu Manual Fuel Shutoff Valve

2-196. APU Warning Lights.

Three warning lights are located on the apu control panel (figure 2-45) of the overhead switch panel. The three red lights are provided to warn the pilot or copilot that the apu is not functioning properly or why it is not operating. The individual light receives a signal, sensed by switches within the apu, indicating LOW OIL PRESS, HIGH EXH TEMP, and OVSP. The three warning lights are illuminated by power from the 28-volt dc battery bus when the appropriate sensing switch is activated. The apu will cease to operate if any one of the sensing switches is energized. An APU circuit breaker is located on the overhead circuit breaker panel.

2-197. APU Hour Meter.

The apu hour meter is mounted on the accessory drive assembly. The hour meter is incorporated to provide a visual indication of total apu operating time. Power to operate the hour meter is supplied by the 28-volt dc battery bus thru a circuit breaker labeled APU on the overhead circuit breaker panel.

2-198. Emergency Protection Systems—APU.

Three protective switches, low oil pressure, overspeed, and overtemperature, protect the apu from abnormal operation. If a malfunction is detected by any one of the switches, the apu automatically stops. When the main engines are shut down in the presence of tailwinds of approximately 25 knots, the apu may flame out from ram pressure in the tailpipe.

SECTION XIII LIGHTING

2-199. Position (Navigation) Lights.

Three navigation lights (1, 3 and 4, figure 2-47) are installed on the helicopter. On the right side of the fuselage is a green light (1); on the left, red (4); and on the aft pylon, white (3). Power for the navigation lights is supplied by the 28-volt dc secondary bus thru a circuit breaker marked POS LTS on the overhead circuit breaker panel.

2-200. Position Lights Switch.

A three-position toggle switch on the center lighting control panel (16, figure 2-48) of the overhead switch panel controls the position lights. The switch is marked POSITION LIGHTS DIM-BRT-OFF.

2-201. Formation Lights.

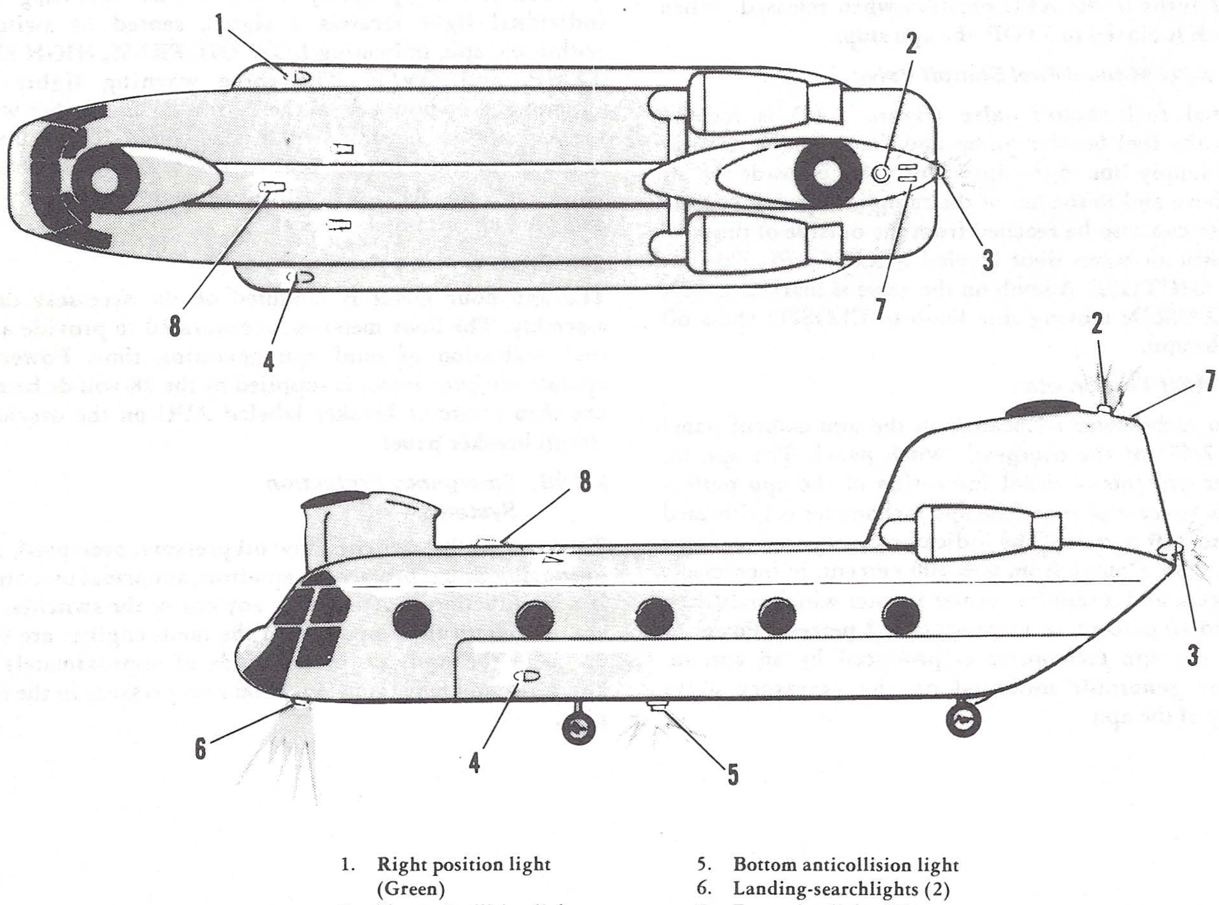
Five electroluminescent panels (7 and 8, figure 2-47) are mounted on top of the fuselage to increase the night formation capability of the helicopter. Three panels, which form an equilateral triangle, are mounted aft of the forward pylon. Two panels are mounted on the aft pylon aft of the anticollision light. The five panels are controlled by a switch on the overhead switch panel. Power to operate and control the formation lights system is supplied by the 115-volt ac primary bus thru the FORM LTS circuit breaker on the ac circuit breaker box.

2-202. Formation Lights Control Switch.

The formation lights control switch is on the left lighting control panel (16, figure 2-48) of the overhead switch panel. The rotary switch has positions: OFF, DIM, and BRT. When the switch is OFF, the formation lights system is deenergized.

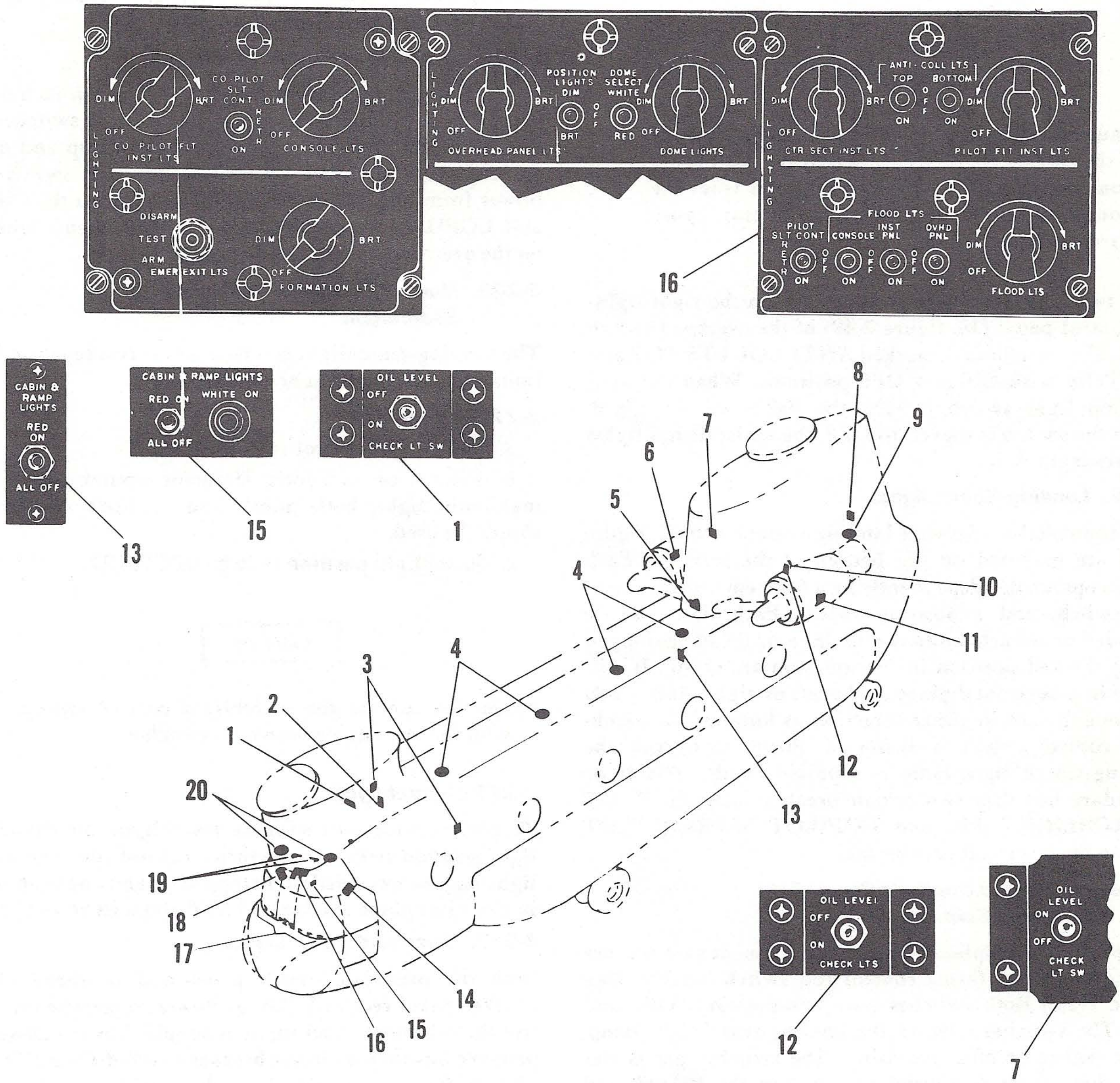
2-203. Anticollision Lights.

Two anticollision lights (2 and 5, figure 2-47) are installed on the helicopter; one on top of the aft pylon and one on the fuselage underside. The anticollision light creates a red flash which is visible for a considerable distance. Power to operate the anticollision lights is supplied by the 28-volt dc secondary bus thru two circuit breakers labeled ANTI-COL LTS TOP and BOTTOM.



1. Right position light (Green)
2. Top anticollision light
3. Position light (White)
4. Left position light (Red)
5. Bottom anticollision light
6. Landing-searchlights (2)
7. Formation lights (2)
8. Formation lights (3)

Figure 2-47. Exterior Lights



1. Forward transmission oil level check light switch
2. Forward transmission oil level check light
3. Emergency exit lights (2)
4. Cabin lights (4)
5. Combining transmission oil level check light
6. Right engine nacelle work light and switch
7. Combining transmission oil level check light switch
8. Emergency exit light
9. Ramp light
10. Aft transmission oil level check light
11. Left engine nacelle work light and switch
12. Aft transmission oil level check light switch
13. Cabin and ramp lights aft control switch
14. Copilot's utility light (C-4A)
15. Cabin and ramp lights forward control switches
16. Lighting control panels
17. Instrument panel flood lights (8)
18. Pilot's utility light (C-4A)
19. Overhead flood lights (2)
20. Dome lights (2)

Figure 2-48. Interior Lighting and Controls

2-204. Anticollision Light Switches.

WARNING

Unusual reflections on the transparent portions of the cockpit enclosure caused by the red flashes from the anticollision lights reflected from the clouds through the rotor blades may cause extreme vertigo.

Two, two-position toggle switches are on the right lighting control panel (16, figure 2-48) of the overhead switch panel. The switches are marked ANTI-COL LTS TOP and BOTTOM with ON and OFF positions. When the anticollision light switch is ON, the lights are energized. When the switch is moved to OFF, the anticollision lights are deenergized.

2-205. Landing-Searchlights.

Two controllable 450-watt landing-searchlights (6, figure 2-47) are mounted on the bottom of the fuselage. Each light is operated independently by a filament switch, a control switch, and a position switch. Each light can be extended or retracted into the fuselage, or it can be stopped at any desired position in its extension arc of 90°. It will rotate in a horizontal plane to the left or right. And it will continue to turn in either direction as long as the searchlight control switch is displaced. Power to operate the landing-search light lamp is supplied by the 28-volt dc secondary bus thru two circuit breakers marked PILOT SEARCHLIGHT FIL and COPILOT SEARCHLIGHT FIL, on the dc circuit breaker box.

2-206. Pilot's and Copilot's Searchlight Filament Switches.

The pilot's and copilot's searchlight filament switches are on the respective thrust control rod switch bracket. (See figure 2-23.) Both switches have two-positions OFF and ON. The switches turn on the landing-searchlight lamp, either before or after extension. The switches get power from the 28-volt dc secondary bus thru the PILOT and COPILOT SEARCHLIGHT FIL circuit breakers on the dc circuit breaker box.

2-207. Searchlight Control Switches.

Two searchlight control switches are on the overhead lighting control panel (16, figure 2-48). The pilot's searchlight control switch is on the right lighting control panel. The copilot's searchlight control switch is on the left lighting control panel. The control switch allows the position switch on the thrust control rod to become operational and also to retract the landing-searchlight. If the searchlight has been rotated to any angle off the centerline of the helicopter and the searchlight control switch is moved to RETR, the searchlight will automatically rotate to point forward and then will retract flush with the fuselage. The control switch is a two-position toggle switch with positions marked ON and RETR. The switches receive power from 28-volt dc secondary bus thru two circuit breakers marked PILOT and COPILOT SEARCHLIGHT CONT on the overhead circuit breaker panel.

2-208. Searchlight Position Switches.

A five-position momentary switch is located on each thrust control rod. When the filament and control switches are ON, the searchlight can be controlled both up and down or left and right. The searchlight position switch gets power from the 28-volt dc secondary bus thru the PILOT and COPILOT SEARCHLIGHT CONT circuit breakers on the overhead circuit breaker panel.

2-209. Normal Operation—Landing-Searchlight.

The landing-searchlight can be used for two separate functions: as a landing light or a searchlight.

2-210. Landing Light.

a. Searchlight control switch—ON.

b. Pilot's or copilot's filament switch—ON. For maximum light, both pilot's and copilot's searchlights should be used.

c. Searchlight position switch—EXTEND.

CAUTION

Do not confuse the searchlight control switch with the two engine beep trim switches.

2-211. Searchlight.

To cover a wide area with the searchlight, use the searchlight position switch on the thrust control rod. The searchlight may be extended and stopped at any angle up to 90° in a vertical plane and rotated 360° about its vertical axis.

2-212. Overhead Panel Lights.

Both the overhead switch panel and overhead circuit breaker panel receive lighting. Power to operate and control the overhead panel lights is supplied by the 28-volt dc primary bus thru a circuit breaker marked OVRHD PNL LTS on the overhead circuit breaker panel.

2-213. Overhead Panel Lights Dimming Rheostat.

The overhead panel lights dimming rheostat is located on the center lighting control panel of the overhead switch panel (16, figure 2-48). The rheostat adjusts the amount of light emitted. The rheostat is marked OVERHEAD PANEL LTS. It controls the light level from BRT to DIM and OFF.

2-214. Pilot's and Copilot's Flight Instrument Lights.

All flight instruments and placards on both pilot's and copilot's instrument panels receive lighting. The pilot's gyrosyn compass indicator (ID-998/ASN), magnetic compass, and the attitude indicator (VGI) for both pilot and copilot have integral lighting. Power to operate and control the pilot's and copilot's flight instrument lights is supplied by the 28-volt dc primary bus thru two circuit breakers, marked INSTRUMENT LTS PILOT and COPILOT, located on the overhead circuit breaker panel.

2-215. Pilot's and Copilot's Flight Instrument Lights Dimming Rheostat.

The pilot's flight instrument lights dimming rheostat is on the right lighting control panel of the overhead switch panel (16, figure 2-48). The copilot's flight instrument dimming rheostat is located on the left lighting control panel of the overhead switch panel. The rheostats are marked PILOT, COPILOT FLT INST LTS; both provide lighting control of the flight instruments from BRT to DIM and OFF.

2-216. Center Section Instrument Lights.

The center section instruments as well as the fire warning panel are lighted. Power to operate and control the center section lights is supplied by the 28-volt dc primary bus thru a circuit breaker marked INSTRUMENT LTS CTR, located on the overhead circuit breaker panel.

2-217. Center Section Instrument Lights Dimming Rheostat.

The center section instrument lights dimming rheostat is located on the right-hand lighting control panel of the overhead switch panel (16, figure 2-48). The rheostat is marked CTR SECT INST LTS. The center section instrument dimming rheostat provides full control of the lighting for the center section instruments from BRT to DIM and OFF.

2-218. Console Lights.

Lighting is provided for all control panels on the console. The cyclic stick positioner located on the upper right side of the console has integral lights. Power to operate and control the console lights is supplied by the 28-volt dc primary bus thru a circuit breaker, marked CONSOLE LTS, located on the overhead circuit breaker panel.

2-219. Console Lights Dimming Rheostat.

The console lights dimming rheostat is located on the left lighting control panel of the overhead switch panel (16, figure 2-48). The rheostat is marked CONSOLE LTS. The console lighting is controlled by the console dimming rheostat from BRT to DIM and OFF.

2-220. Dome Lights.

Two cockpit dome lights attached to the overhead structure and adjacent to the overhead switch panel are provided (20, figure 2-48). Each dome contains a white and red lamp which can be selected individually. Power to operate and control the dome lights is supplied by the 28-volt dc battery bus thru a COCKPIT LTS circuit breaker on the overhead circuit breaker panel. When the cockpit dome lights are on white, the master and auxiliary caution panels cannot be dimmed. If the white dome light is selected while the caution lights are operating on DIM, the caution lights will automatically switch to the BRIGHT mode of operation.

2-221. Dome Lights Select Switch.

A three-position switch on the center lighting control panel (16, figure 2-48) of the overhead switch panel selects the desired function of the dome light. The switch is marked DOME SELECT with positions WHITE, RED, and OFF.

2-222. Dome Lights Dimming Rheostat.

The dome lights dimming rheostat is on the center lighting control panel (16, figure 2-48) of the overhead switch panel. When either WHITE or RED is selected on the dome lights select switch, the dome lights dimming rheostat is operable thru a range from DIM to BRT. The dome lights dimming rheostat is marked DOME LIGHTS.

2-223. Pilot's and Copilot's Utility Lights (C-4A).

Two C-4A utility lights (14 and 18, figure 2-48) connected to individual flexible cords, are mounted in two retaining sockets on cockpit bulkhead above the pilot's and copilot's seats. The lights are detachable and can be moved about to take care of special lighting situations. Each utility light has a rheostat switch as an integral part of its assembly. This switch, located on the aft part of the light, regulates the intensity of the light from OFF to BRT. A white button on the light housing, opposite the switch, is used for flashing the light. By selecting the color desired on the barrel of the light, red or white light will be emitted. The utility light receives power from the 28-volt dc battery bus thru a COCKPIT LTS circuit breaker on the overhead circuit breaker panel.

2-224. Floodlights.

Ten floodlights (figure 2-48), of which eight are installed under the glare shield (17) and two on the cockpit bulkhead (19), provide a secondary source of light. Six of the eight floodlights light the instrument panel and the other two light the console. The two overhead floodlights light the overhead switch and circuit breaker panels. Power to operate and control the floodlights is supplied by the 28-volt dc battery bus thru a circuit breaker, marked SECONDARY CKPT LTS, located on the overhead circuit breaker panel.

2-225. Floodlights Dimming Rheostat.

The floodlights dimming rheostat is located on the lower right lighting control panel (16, figure 2-48) of the overhead switch panel. With the floodlight selection switches ON, the rheostat is used to turn the floodlights ON or OFF or control them from DIM to BRT.

2-226. Floodlight Selection Switches.

Three two-position floodlight selection switches are located on the lower right-hand lighting control panel (16, figure 2-48) of the overhead switch panel. Each switch is labeled for the area the floodlights will light FLOOD LTS CONSOLE, INST PNL, and OVHD PNL. By placing any one switch ON, the appropriate floodlights will light when the floodlight dimming rheostat is turned toward BRT. Moving the switch to OFF deenergizes the floodlight circuit.

2-227. Emergency Floodlights.

If the pilot's flight instrument lights have been turned on, loss of 28-volt dc primary bus, or loss of 115-volt ac from the ac primary bus, will cause the floodlights described in paragraph 2-224 to automatically come on. All floodlights except the two on the console will function automatically to the BRIGHT mode. The console floodlights may be turned on by selecting the console floodlights switch to ON and adjusting the floodlight dimming rheostat. Simultaneous dimming of all floodlights may be regained by placing the three floodlight selection switches ON, turning the floodlight dimming rheostat to BRT, and turning the pilot's flight instrument dimming rheostat to OFF. Floodlight intensity can be controlled by the floodlight dimming rheostat.

2-228. Cabin and Ramp Lights.

Five cabin and ramp lights, (4 and 9, figure 2-48) located in the cabin and attached to the overhead structure, are provided. Each light contains a white and red lamp which can be selected individually. Power to operate and control the cabin and ramp light is supplied by the 28-volt dc battery bus thru a CABIN LTS circuit breaker on the dc circuit breaker box.

2-229. Cabin and Ramp Red Light Control Switches.

The red light control switches (13 and 15, figure 2-48) are three-position momentary toggle switches. One switch (13) is on the CABIN AND RMP LIGHTS placard located on the bulkhead below the ramp control lever. The second switch (15) is on the CABIN AND RAMP LIGHTS placard located on the right side of the passageway between the cockpit and cabin. When the switch is moved to RED ON, current is passed thru the red cabin light relay which electrically locks the red lights on. Moving the switch to ALL OFF deenergizes both red and white light relays.

2-230. Cabin and Ramp White Light Control Switch.

The white light control switch is a two-position momentary button switch mounted on CABIN AND RAMP LIGHTS placard located on the right side of the passageway between the cockpit and cargo compartment (15, figure 2-48). When the switch is pushed to WHITE ON, current passes thru the white cabin light-relay. This electrically locks the white lights ON. The white lights cannot be turned off until the ALL OFF position is selected on either of the red light control switches.

2-231. Emergency Exit Lighting.

Three emergency exit lights are located in the cargo compartment close to each of the three primary emergency exits (figure 2-48): the main cabin door (3), the emergency exit opposite the main cabin door, and the ramp emergency exit (8). The lights (figure 2-49) come on whenever a loss of power on the battery bus occurs or during a crash landing when 3.5g ±0.5 are exceeded as sensed by an inertia switch. The lights may also be used as portable lamps by removing them from their housing and by rotating the handle, marked PULL EMERGENCY LIGHT. 45° from its normal position. Power to operate the emergency exit main lights is supplied by two, internal, 1.25 volt, nickel-cadmium batteries. Power to operate and control the charging, monitoring, and test circuit is supplied by the 28-volt dc battery bus thru the CABIN LTS circuit breaker located on the dc circuit breaker box. The emergency exit lights system is controlled by the emergency exit lights control switch on the overhead panel.

2-232. Emergency Exit Lights Control Switch.

The EMER EXIT LTS control switch on the lower left lighting control panel of the overhead switch panel arms, tests, and disarms, the system (16, figure 2-48). The switch has three marked positions: ARM, TEST, and DISARM. When the switch is moved to ARM, the main light on the emergency exit lights stay off, the batteries receive charging, the charge indicator lights come on, and the circuit monitors electrical failure or landings in excess of 3.5g ±0.5. The light from the charge indicator lamps is emitted through two pinholes at the base of the main light reflector. If the emergency exit light comes on during landing, an entry on DA Form 2408-13 is required. When the switch is moved to TEST, the main light comes on, powered by the batteries. When the switch is moved to DISARM, the main light on the emergency exit lights stays off, the batteries do not receive charging, and the charging indicator lamps stay off.

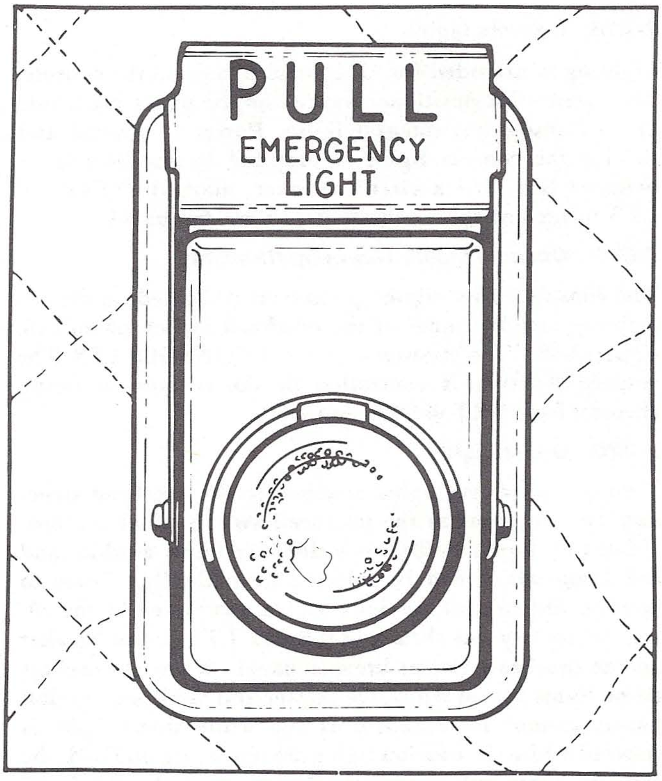


Figure 2-49. Emergency Exit Light

2-233. Oil Level Check Lights.

These floodlights provide light to check the oil level of the transmissions. (Figure 2-48.) One light each is provided for the forward (2), combining (5), and aft transmission (10). Each floodlight is near a sight gage on the respective transmission. Power to operate and control the oil level check lights is supplied by the 28-volt dc battery bus thru an OIL CHK LTS circuit breaker on the dc circuit breaker box.

2-234. Oil Level Check Light Switches.

One oil level check light switch is provided for each oil check light. (Figure 2-48.) The switches are two-position and all are marked OIL LEVEL CHECK LT SW, ON-OFF. The switch (1) for the forward transmission is inside the forward pylon attached to a former at station 120. The switch (7) for the combining transmission is inside the aft pylon to the right of the oil coolers. The switch (12) for the aft transmission is next to the fire extinguisher circuit breaker box.

2-235. Nacelle Work Lights.

One nacelle work light (6 and 11 figure 2-48) is installed in each engine cover. The nacelle light is provided to afford light for inspection and maintenance. Power to control and operate the nacelle work lights is supplied by the 28-volt dc battery bus thru an ENG NAC LTS circuit breaker on the dc circuit breaker box.

2-236. Nacelle Work Light Switch

The nacelle work light switch is mounted on the same bracket as the nacelle work light (6 and 11, figure 2-48). The switch is two-position and controls each light individually.

2-237. Jump Lights.

Refer to paragraph 2-41 for description of the jump lights.

SECTION XIV FLIGHT INSTRUMENTS

2-238. General.

The following paragraphs contain information on the flight instruments. Information on the navigation instruments will be found in chapter 3, Avionics. All other instruments directly related to one of the helicopter systems are found under the appropriate system heading in this chapter. See figure 2-6, 2-7, and 2-8 for illustrations of the instrument panels, console, and overhead switch panel.

2-239. Airspeed Indicator.

There are two airspeed indicators (2 and 42, figure 2-7) one each for the pilot and copilot. These indicators are mounted one each in the upper left portion of the pilot's and copilot's instrument panel. The difference between the dynamic pressure and the static pressure as measured by the pitot static system is introduced into these instruments, and indicated as airspeed in knots.

2-240. Altimeter—Standard.

On helicopters that have not been modified with an AIMS altimeter, two altimeters are provided: one for the copilot and one for the pilot (4 and 44, figure 2-7). The altimeter registers height above sea level and is actuated by the static system. On this helicopter, the altimeter includes a 10,000-foot pointer incorporating a notched disk with a pointer extension and a warning indicator consisting of a striped section which appears through the notched disk at altitudes below 16,000 feet. This altimeter provides a constant reminder when helicopter altitude is below 16,000 feet. When setting the altimeter make sure that the 10,000-foot pointer is reading correctly.

2-241. Altimeter—AIMS.

On modified helicopters, one AIMS altimeter (figure 2-50) is provided for the pilot. A pneumatic counter-drum-pointer type is installed for the copilot. The pilot's altimeter is a pneumatic counter-drum-pointer type which is a self-contained unit consisting of a precision pressure altimeter combined with an altitude encoder. The display indicates and the encoder transmits, simultaneously, the pressure altitude of the aircraft based on a barometric pressure of 29.92 Hg. Altitude is displayed on the altimeter by a 10,000-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 symbol will appear on the 10,000 foot counter. A barometric pressure setting knob is provided to insert the desired altimeter setting in inches of Hg. A vib-

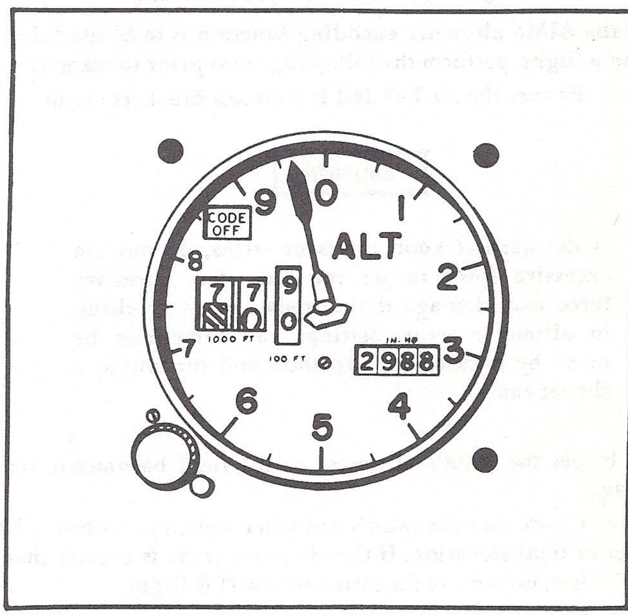


Figure 2-50. AIMS Altimeter

rator powered by the dc emergency bus is contained in the altimeter and requires a minimum of one minute warm up prior to checking or setting the altimeter. 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 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.

2-242. Preflight Operation—AIMS Altimeter.

If the AIMS altimeter encoding function is to be used during a flight, perform the following steps prior to takeoff:

a. Be sure the ALTM and IFF circuit breakers are in.

CAUTION

If the baroset knob binds or sticks, do not use excessive force to set the altimeter. Excessive force may damage the altimeter gears resulting in altimeter error. Settings can sometimes be made by backing off the knob and turning at a slower rate.

b. Set the pilot's altimeter to the field barometric setting.

c. Check that the pilot's altimeter indicates within ±70 feet of field elevation. If the altimeter error is greater than ±70 feet, do not use the altimeter for IFR flight.

2-243. In Flight Operation—AIMS Altimeter.

Operate the AIMS altimeter encoding function as follows:

a. Be sure the IFF set is on and set to the proper code.

b. Be sure the altimeter is set to the local altimeter setting.

c. Set the M-C (mode c) switch on the IFF control panel to ON.

d. Check that the red CODE OFF flag is not visible in the pilot's altimeter.

The copilot's altimeter is a pneumatic counter-drum-pointer type which displays altitude in the same manner as the pilot's altimeter. It also incorporates a barometric pressure setting knob and an internal vibrator powered by the dc emergency bus. A minimum of 1 minute of vibrator operation is required prior to setting or checking the altimeter. At ambient pressure both altimeters should agree within plus or minus 70 feet of the field elevation when the proper barometric pressure setting is set in the altimeter. If the internal vibrator of either altimeter becomes inoperative due to the internal failure of dc power, the pointer drum may momentarily hang up when passing from 9 thru 0 (climbing) or from 0 to 9 (descending). This will cause a lag of magnitude which will depend on the vertical velocity of the aircraft and the friction in the altimeter.

2-244. Vertical Velocity Indicator

The vertical velocity indicator (8 and 45, figure 2-7) on both pilot's and copilot's instrument panel is used to indicate rate of climb, based on the rate of change of atmospheric pressure. The indicator is a direct-reading-pressure instrument requiring no electrical power for operation.

2-245. Attitude Indicator (ID-1000).

Two attitude indicators (3 and 43, figure 2-7) are provided for use by the pilot and copilot. The indicators are mounted on the instrument panel. The attitude indicator installed in this helicopter has been specifically tailored for the flight characteristics of a helicopter by incorporating an electrical trim capability in the roll axis in addition to the standard pitch trim. Normal flight attitudes of helicopters, defined by fixed amounts of roll as well as pitch, are easily trimmed into this indicator, and optimum operation of the aircraft in an attitude such as hover is facilitated. Degrees of pitch and roll are indicated by movement of a universally mounted sphere painted optical black and light gray to symbolize earth and sky, with a horizon line separating the two colors. To adjust the miniature aircraft in relation to pitch, the lower knob is used (figure 2-51). To compensate attitude in the roll axis, use the upper knob. The indicator incorporates integral lighting, illuminating the attitude presentation uniformly. The attitude indicator gyros receive power from the 208-volt ac primary bus thru two circuit breakers marked PILOT VGI and COPILOT VGI, on the ac circuit breaker box. Both the pilot's and copilot's attitude indicators should erect within 30 to 90 seconds after electrical power is applied.

2-246. Pilot and Copilot Attitude Indicator (VGI) Switch.

A VGI switch is on the instrument panel adjacent to each attitude indicator (3 and 43, figure 2-7). The VGI switch has positions marked NORM and EMER. When the switch is at NORM, each attitude indicator operates from a separate gyro. If either the pilot's or the copilot's gyro fails, noticed by the OFF flag appearing on the indicator, manual switching to the remaining gyro is accomplished by moving the respective VGI switch to EMER. The switching of the gyros from NORM to EMER operation is accomplished by a gyro transfer relay. The VGI switch receives power from the 28-volt dc secondary bus thru a VGI CONT circuit breaker on the overhead circuit breaker panel.

2-247. Turn and Slip Indicator (4-Minute Type).

Each turn and slip indicator (15 and 56, figure 2-7) is controlled by an electrically actuated gyro which is powered from the 28-volt dc emergency bus. Two circuit breakers for the indicators are on the overhead circuit breaker panel and are marked PILOT TURN/SLIP IND, COPILOT TURN/SLIP IND. The instrument has a pointer (turn indicator) and a ball (slip indicator).

2-248. Magnetic Compass.

The magnetic compass, mounted on top of the instrument panel glare shield or below the overhead switch panel. It is a direct reading instrument (23, figure 2-4). It is composed of a compass card mounted on a magnetic element in a liquid-filled bowl.

2-249. Free Air Temperature Gage.

The free air temperature gage (2, figure 2-5) is on the exterior of the forward cabin section enclosure. The unit is calibrated in degrees from -70° to +50°C.

2-250. Clock.

Two manually wound 8-day clocks (9 and 48, figure 2-7) with a sweep second hand, one for the pilot and one for the copilot, are provided.

2-251. Master Caution System.

The master caution system provides the pilots with a visual indication of helicopter conditions or faults. The components of the system are: the master caution panel, the auxiliary caution panel, two master caution lights, a master caution test switch, and a master caution dimming switch. Power to operate and control the master caution system is supplied by the 28-volt dc primary bus thru a circuit breaker on the overhead circuit breaker panel labeled CAUTION LTS.

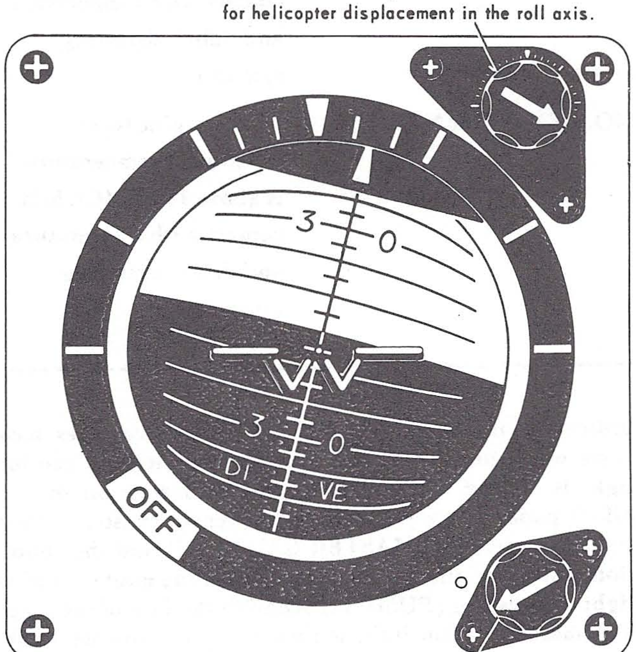


Figure 2-51. Attitude Indicator (ID-1000)

2-252. Master Caution Panel.

The master caution panel is on the inclined portion of the console (figure 2-52). Caution-capsule lights display the specific faults or conditions under which the helicopter is being operated. Each capsule is marked with word segments which are related to the fault or condition. When a caution capsule illuminates, the word segments lettered into the panel will be an orange color; when they are not illuminated, the lettering will not be readable. The following is a list of the word segments displayed on the capsules and their actual meaning and cause.

MASTER CAUTION PANEL CAPSULES

Word Segment	Explanation
TRANS OIL HOT	The indicated transmission oil temperature is more than 130°C.
TRANS OIL PRESS	The indicated transmission oil pressure is less than 20 psi.
OIL LOW NO. 1 ENG	Two (2) quarts of usable oil are remaining in the No. 1 engine oil tank.
OIL LOW NO. 2 ENG	Two (2) quarts of usable oil are remaining in the No. 2 engine oil tank.
L FUEL PRESS	The left fuel pressure is below 10 psi.
R FUEL PRESS	The right fuel pressure is below 10 psi.
WHEEL DE-PHASED	The aft, right landing gear has exceeded either 58° during a left turn or 82° during a right turn.
NO. 1 HYD BOOST OFF	The No. 1 flight control hydraulic system pressure is below 2,000 psi.
NO. 2 HYD BOOST OFF	The No. 2 flight control hydraulic system pressure is below 2,000 psi.
PARK BRAKE ON	The parking brake is on.
NO. 1 RECT OFF	The transformer-rectifier has failed or the generator output is interrupted.

Word Segment	Explanation
NO. 2 RECT OFF	The transformer-rectifier has failed or the generator output is interrupted.
NO. 1 GEN OFF	The No. 1 generator is inoperative or the generator switch is at OFF.
NO. 2 GEN OFF	The No. 2 generator is inoperative or the generator switch is at OFF.
A-C EXT PWR ON	This light will illuminate whenever external power is being used in the ac system.
D-C EXT PWR ON	A dc external power source is connected to the dc external power receptacle.
L FUEL LOW	The left fuel tank has approximately 20 percent of fuel remaining.
R FUEL LOW	The right fuel tank has approximately 20 percent of fuel remaining.
HEATER HOT	The temperature within the heater is greater than 177°C
CARGO HOOK OPEN	The cargo hook has been opened hydraulically, pneumatically, or manually.
NO. 1 SAS OFF	The No. 1 SAS is off.
NO. 2 SAS OFF	The No. 2 SAS is off.

2-253. Auxiliary Caution Panel.

The auxiliary caution panel is on the inclined portion of the console below the master caution panel. (Figure 2-52.) Eight caution-capsule lights display the specific faults or conditions under which the helicopter is being operated. The following is a list of the word segments displayed on the capsules and their actual meaning and cause. Some of the capsules on the panel are used as spares.

2-254. Master Caution Lights.

Two master caution lights located on the instrument panel indicate that one or more of the caution capsules have come on (figure 2-52). On the pilot's panel, the caution light is located above the airspeed indicator; on the copilot's panel, above the altimeter. After the master caution light has come on (MASTER CAUTION) and the condition noted, the pilots should extinguish the master caution light by pressing (PUSH TO RESET) the face of the light. The master caution light is then ready to indicate a subsequent malfunction of a different system. Once the malfunction is corrected, the affected caution capsule will go out. The HEATER HOT capsule is an exception. (Refer to section X.)

AUXILIARY CAUTION PANEL CAPSULES

Word Segment	Explanation
NO. 1 ENG. CHIP DET	Ferrous particles are present in the oil of the No. 1 engine or the No. 1 engine transmission.
NO. 2 ENG. CHIP DET	Ferrous particles are present in the oil of the No. 2 engine or the No 2. engine transmission.
XMSN CHIP DET	Ferrous particles are present in the oil of the forward, aft, combining transmission or the aft vertical shaft thrust bearing.
NO. 1 ENG XMSN HOT	NO. 1 engine transmission oil temperature is above 190°C. (On helicopters with temperature and debris detecting system.)
NO. 2 ENG XMSN HOT	NO. 2 engine transmission oil temperature is above 190°C. (On helicopters with temperature and debris detecting system.

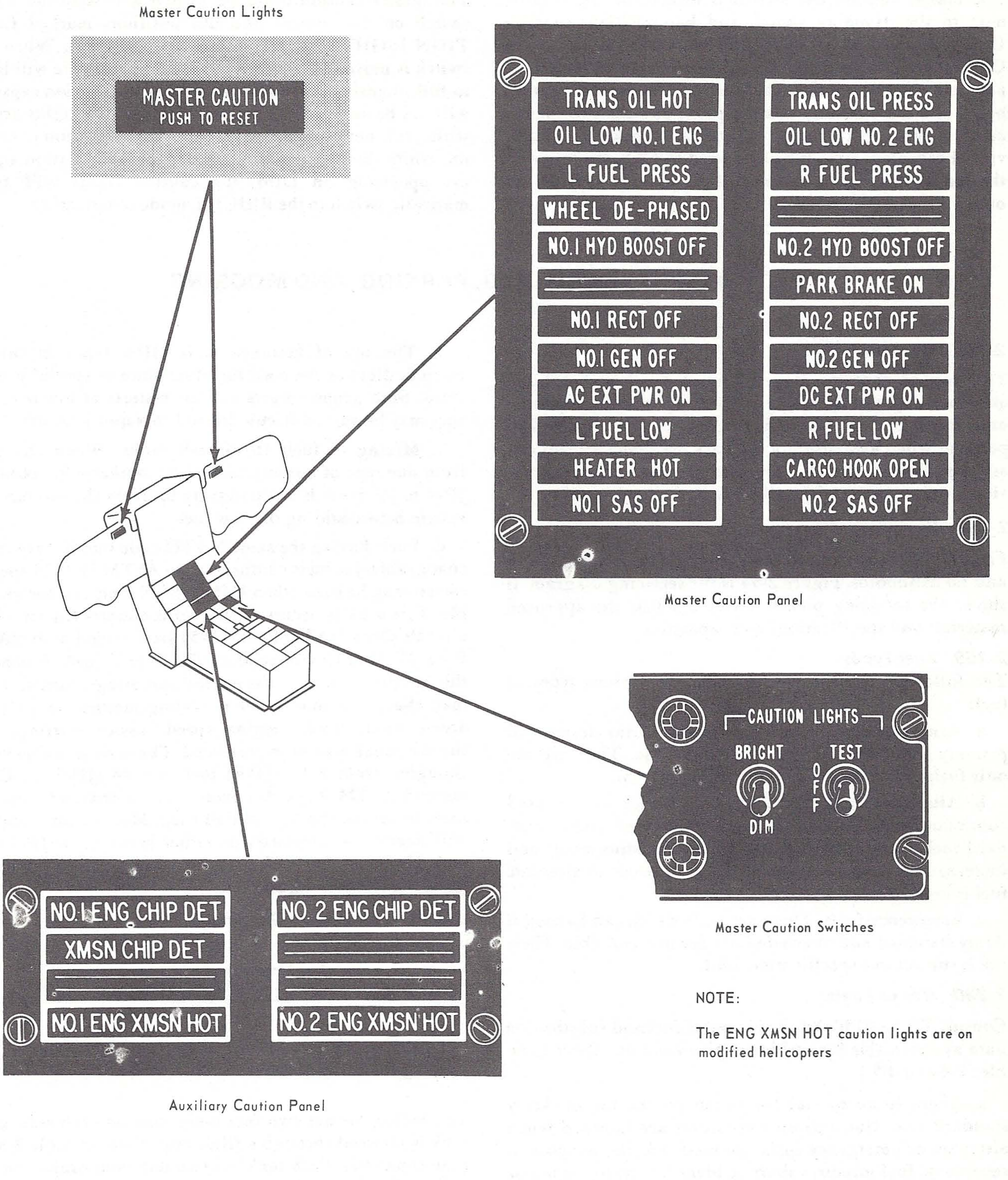


Figure 2-52. Master Caution System

2-255. Master Caution Test Switch.

The master caution test switch is located on the console next to the dimming switch and has positions marked CAUTION LIGHTS TEST-OFF. (Figure 2-52.) When the CAUTION LIGHTS TEST switch is moved to the TEST position, all the caution capsules on the master caution panel and the auxiliary caution panel and the two master caution lights will come on to facilitate checking the individual capsule lamps. When released to OFF, the lamps in the master caution lights and all the caution capsules go out.

2-256. Master Caution Dimming Switch.

The master caution dimming switch is next to the TEST switch on the console and has positions marked CAUTION LIGHTS BRIGHT-DIM (figure 2-52). When the switch is moved to BRIGHT, the caution capsule will light to full intensity; when moved to DIM the caution capsules will not be as bright. When the cockpit dome lights are on white, it is not possible to DIM the master caution panel. If the white dome light is selected while the caution lights are operating on DIM, the caution lights will automatically switch to the BRIGHT mode of operation.

SECTION XV SERVICING, PARKING, AND MOORING

2-257. General.

This section contains instructions on servicing, parking, and mooring the helicopter. These instructions include only those tasks which a flight crew may be expected to perform when away from a military maintenance support activity. Diagrams and tables are provided depicting servicing points, materials, walkways, and mooring points.

2-258. Servicing.

Figure 2-53 shows the safe walkway areas, no step areas, and no handholds. Figure 2-54 is the servicing diagram. It shows the servicing points. Table 2-3 lists the approved materials and specifications and capacities.

2-259. Fuel Types.

The following paragraphs describe the various types of fuel:

a. Army standard fuels. These are the Army-designated primary fuels adopted for worldwide use. They are the only fuels available in the Army supply system.

b. Alternate fuels. These are fuels which can be used continuously without power reduction when Army standard fuel is not available. Power setting adjustments and increased maintenance may be required when an alternate fuel is used.

c. Emergency fuels. These are fuels which can be used if Army standard and alternate fuels are not available. Their use is subject to a specific time limit.

2-260. Use of Fuels.

Consult TB 55-9150-200-24 for use of fuel and substitution data as applicable for turbine engine aircraft. (Refer to tables 2-4 and 2-5.)

a. There is no special limitation on the use of Army standard fuel. But, certain limitations are imposed when alternate or emergency fuels are used. For the purpose of recording, fuel mixtures shall be identified as to the major component of the mixture. The use of any fuels other than standard will be recorded in the FAULTS/REMARKS column of DA Form 2408-13, Aircraft Maintenance and Inspection Record, noting the type of fuel, additives, and duration of operation.

b. The use of kerosene fuels (JP-5 type) in turbine engines dictates the need for observance of special precautions. Both ground starts and air restarts at low temperature may be more difficult due to low vapor pressure.

c. Mixing of fuels in aircraft tanks. When changing from one type of authorized fuel to another—for example, JP-4 to JP-5—it is not necessary to drain the aircraft fuel system before adding the new fuel.

d. Fuels having the same NATO code number are interchangeable. Jet fuels conforming to ASTM D-1655 specification may be used when MIL-T-5624 fuels are not available. This usually occurs during cross country flights where aircraft using NATO F-44 (JP-5) are refueled with NATO F-40 (JP-4) or Commercial ASTM Type B fuels. Whenever this condition occurs, the engine operating characteristics may change in that lower operating temperature, slower acceleration, lower engine speed, easier starting, and shorter range may be experienced. The reverse is true when changing from F-40 (JP-4) fuel to F-44 (JP-5) or Commercial ASTM Type A-1 fuels. Fuel control adjustments shall be set for the type of fuel used. Most turbine engines will operate satisfactorily on either kerosene or JP-4 type fuel. However, the difference in specific gravity will require fuel control adjustments.

2-261. Fuel System Servicing.

CAUTION

Observe all regulations and precautions regarding handling of fuels.

The helicopter has two fuel tanks, one on each side. Each tank is serviced through a filler port. Refer to table 2-3 for tank capacities. Each tank has two sediment drains, one on each end of the tank and two drains in the fuel lines.

a. Be sure the helicopter is at least 50 feet from any hangar or structure.

b. Be sure the fueling vehicle is at least 20 feet from the helicopter.

c. Electrically ground the helicopter as follows:

(1) Connect one end of an approved ground cable to the aft landing gear eyebolt. Connect the other end to a grounding rod or ramp ground point. Be sure the cable has no broken strands and the clips are securely attached to the cable and ground points.

(2) Be sure the fueling unit is grounded to the same ground rod or ground point as the helicopter.

Table 2-3. Servicing

SERVICEABLE ITEM	MATERIAL		CAPACITY
Each Main Tank	JP-4 (Note 4)	MIL-T-5624	283 Gallons (1840 pounds) With crash resistant fuel system 310 Gallons (2010 pounds) Without crash resistant fuel system
Each Engine Oil Tank	Lubrication Oil (Notes 1 and 2)	MIL-L-23699 or MIL-L-7808	14.0 Quarts
APU Engine Oil	Lubrication Oil (Notes 1 and 2)	MIL-L-7808 or MIL-L-23699	3.0 Quarts
Forward Transmission	Lubrication Oil	MIL-L-7808	29.0 Quarts
Aft Transmission	Lubrication Oil	MIL-L-7808	36.0 Quarts
Engine and Combining Transmission	Lubrication Oil	MIL-L-7808	39.0 Quarts
Each Flight Control System Tank	Hydraulic Fluid (See Note 5)	MIL-H-83282 MIL-H-5606	5.25 Quarts
Utility Hydraulic System Tank	Hydraulic Fluid (See Note 5)	MIL-H-83282 MIL-H-5606	6.35 Quarts
Rotor Head Oil Tanks	Lubrication Oil	MIL-L-7808	As Required
Shock Absorbers and Landing Gear Shock Struts	Hydraulic Fluid	MIL-H-5606	As Required
Swashplates	Grease	MIL-G-23827	As Required
Tires-8.50 x 10 Type III Forward and Aft (64-13141 and subsequent)	Air		67 PSI
Tires-22 x 5.5 Type VII Forward (Low Flotation Gear)	Air		165 PSI
Tires-16 x 4.4 Type VII Aft (Low Flotation Gear)	Air		165 PSI
Tires-8.50 x 10 Type III Forward (63-7922 thru 64-13140)	Air		140 PSI
Tires-8.50 x 10 Type III Aft (63-7922 thru 64-13140)	Air		67 PSI

NOTES

1. At temperatures above -32°C, MIL-L-23699 is the primary engine oil and at temperatures below −32°C, MIL-L-7808 is used.

2. Use MIL-L-23699 in all new or newly overhauled main propulsion engines with less than 100 hours operating time. Use MIL-L-23699 in all new or newly overhauled apu engines or if a main propulsion engine is using MIL-L-23699.

3. Continue to use MIL-L-7808 in all main propulsion engines with more than 100 hours operating time that have not been changed to MIL-L-23699.

4. JP-5 is at emergency fuel for use with T55-L-7C engines. Unleaded gasoline VV-G-109 is the emergency fuel for T55-L-7/7B engines. The use of emergency fuel is limited to 50 hours. Refer to TB 55-9150-200-24.

5. MIL-H-83282 is the preferred hydraulic fluid in both flight control hydraulic systems and in the utility hydraulic system. However, when the prevailing outside air temperature is below −46°C. hydraulic fluid MIL-H-83282 must be drained from the systems and the systems reserviced with hydraulic fluid MIL-H-5606. Refer to TB 55-1500-334-24.

CAUTION

Engine lubricating oils may be mixed, during an emergency only, for up to 6 hours operating time.

CAUTION

Synthetic oils, such as MIL-L-23699 and MIL-L-7808, may soften paint or stain clothing upon contact. If synthetic oil is spilled on painted surfaces, those surfaces should be cleaned immediately. Skin should be thoroughly washed after contact and saturated clothing should be removed immediately. Prolonged skin contact with synthetic oils may cause a skin rash. Areas where synthetic oils are used should have adequate ventilation to keep mist anf fumes to a minimum.

CAUTION

Lubrication oil made to MIL-L-7808 by the Shell Oil Company under their part number 307, qualification number 7D-1, contains additives that are harmful to seals made of silicone. Therefore, Shell Oil 307 shall not be used.

316-520 O - 80 - 6

Table 2-4. JP-4 Equivalent Fuel

JP-4 EQUIVALENT FUELS	
MILITARY FUEL	
U.S.	JP-4 (MIL-T-5624)
NATO	F-40 (Wide cut type)
COMMERCIAL FUEL (ASTM-D-1655) JET B (Refer to Note 3.)	
American Oil Co.	American JP-4
Atlantic Richfield Richfield Div.	Arcojet B
B.P. Trading	B.P.A.T.G.
Caltex Petroleum Corp.	Caltex Jet B
Chevron	Chevron B
Continental Oil Co.	Conoco JP-4
EXXON Co., USA	EXXON Turbo Fuel B
Gulf Oil	Gulf Jet B
Mobil Oil	Mobil Jet B
Phillips Petroleum	Philjet JP-4
Shell Oil	Aeroshell JP-4
Texaco	Texaco Avjet B
Union Oil	Union JP-4
FOREIGN FUEL	
Belgium	BA-PF-2B
Canada	3GP-22F
Denmark	JP-4 MIL-T-5624
France	Air 3407A
Germany (West)	VTL-9130-006
Greece	JP-4 MIL-T-5624
Italy	AA-M-C-1421
Netherlands	JP-4 MIL-T-5624
Norway	JP-4 MIL-T-5624
Portugal	JP-4 MIL-T-5624
Turkey	JP-4 MIL-T-5624
United Kingdom (Britain)	D. Eng RD 2454

NOTES:
1. Any of the above fuels may be used as Army standard fuel when JP-4 is not available.
2. When changing from one type of authorized fuel to another, for example, JP-4 to JP-5, it is not necessary to drain the fuel system before adding new fuel.
3. Commercial fuel, such as ASTM D1655, not containing an icing inhibitor requires the addition of ice inhibitor per MIL-I-27686 (commercial name is "PRIST") when the temperature is below 5°C. Use of icing inhibitor in commercial fuel is limited to .08% to .20% by volume which is approximately 1 fluid ounce to every 5 gallons of fuel added to the tank. It should be added proportionately and simultaneously while fueling to ensure adequate mixing.

CAUTION

Exceeding the limit of 0.20% by volume may soften elastomers in fuel system. Softened rubber like material may flake away causing clogging within the fuel system or fuel filters.

(3) Prior to opening the filler cap, ground the nozzle to the ground jack directly above the fuel tank filler. When finished fueling the tank, close and secure the filler cap before disconnecting the nozzle ground.

WARNING

Fuel quantity markings, in pounds, are on the wall of the tank. Use an approved explosion proof flashlight when checking fuel quantity in this manner.

d. Fill the tank to the required level.

e. When the fuel is at the desired level, remove the nozzle. Secure the filler cap. Then, disconnect the nozzle ground wire.

f. Remove the ground connection. If the helicopter is to remain parked, do not disconnect the helicopter ground.

2-262. Engine Oil System.

The engine oil tank and oil quantity indicator are an integral part of the engine. Service either engine oil system as follows.

a. If the engine has not been operated in preceding 24 hours, run it before oil level is checked. Otherwise, an inaccurate oil level may be indicated.

b. Open the access panel on the forward left side of the engine cover. Check oil level on indicator.

c. If the indicator shows less than full, open the oil filler access panel on the forward top side of the engine cover.

CAUTION

There is no easily recognized difference in appearance between the two types of oil used in this helicopter. The only way of determining which type of oil is in an engine is by careful examination of servicing records.

d. Refer to DA Form 2408-13 and table 2-3 for the type of oil to use. Under normal conditions, engines shall be serviced with one type of oil only. If one type of oil is in an engine and that oil is not available, the other type may be used in an emergency. If two types of oil are mixed, the engine oil shall be changed and the system flushed within 6 hours of engine operation.

e. Remove the filler cap. Fill the tank with oil until the indicator shows full. Do not overfill tank.

f. Install the filler cap. Close both access panels.

2-263. Auxiliary Power Unit (APU) Oil System.

Service the apu as follows:

CAUTION

Do not use the apu drip pan as a handhold. Damage to equipment will result.

a. Remove the filler cap from left side of apu.

CAUTION

There is no easily recognized difference in appearance between the two types of oil. The only way of determining which type of oil is in an apu is by careful examination of servicing records. Do not overfill. Damage to the apu can result from overfilling.

Table 2-5. JP-5 Equivalent Fuel

		JP-5 EQUIVALENT FUELS	
		MILITARY FUEL	
U.S.		JP-5 (MIL-T-5624)	
NATO		F-44 (High Flash Type)	
		F-34 (Low Freeze Point)	
		COMMERCIAL FUELS (ASTM-D-1655) JET A/JET A-1 (Refer to Note 3.)	
American Oil Co.	American Type A		Arcojet A-1
Atlantic Richfield	Arcojet A		Richfield A-1
Richfield Div.	Richfield A		B.P.A.T.K.
B.P. Trading			Caltex Jet A-1
Caltex Petroleum Corp.			Chevron A-1
Chevron	Chevron A-50		
Cities Service Co.	CITGO A		
Continental Oil Co.	Conoco Jet-50		Conoco Jet-60
EXXON Co., USA	EXXON A		EXXON A-1
Gulf Oil	Gulf Jet A		Gulf Jet A-1
Mobil Oil	Mobil Jet A		Mobil Jet A-1
Phillips Petroleum	Philijet A-50		
Shell Oil	Aeroshell 640		Aeroshell 650
Sinclair	Superjet A		Superjet A-1
Standard Oil Co.	Jet A Kerosene		Jet A-1 Kerosene
Texaco	Avjet A		Avjet A-1
Union Oil	76 Turbine Fuel		
		FOREIGN FUELS	
Canada		3-GP-24e	
West Germany		UTL-9130-007/UTL-9130-000	
Italy	AMC-143		
Netherlands		D. Eng RD 2493	
United Kingdom (Britain)		D. Eng. RD 2498	

NOTES:
1. Any of the above fuels may be used in lieu of JP-5 (MIL-T-5624) when not available.
2. When changing from one type of authorized fuel to another, for example JP-4 to JP-5, it is not necessary to drain the fuel system before adding new fuel.
3. Commercial fuel, such as ASTM D1655, not containing an icing inhibitor requires the addition of ice inhibitor per MIL-I-27686 (commercial name is "PRIST") when the temperature is below 5°C. Use of icing inhibitor in commercial fuel is limited to .08% to .20% by volume which is approximately 1 fluid ounce to every 5 gallons of fuel added to the tank. It should be added proportionately and simultaneously while fueling to ensure adequate mixing.

CAUTION

Exceeding the limit of 0.20% by volume may soften elastomers in fuel system. Softened rubber like material may flake away causing clogging within the fuel system or fuel filters.

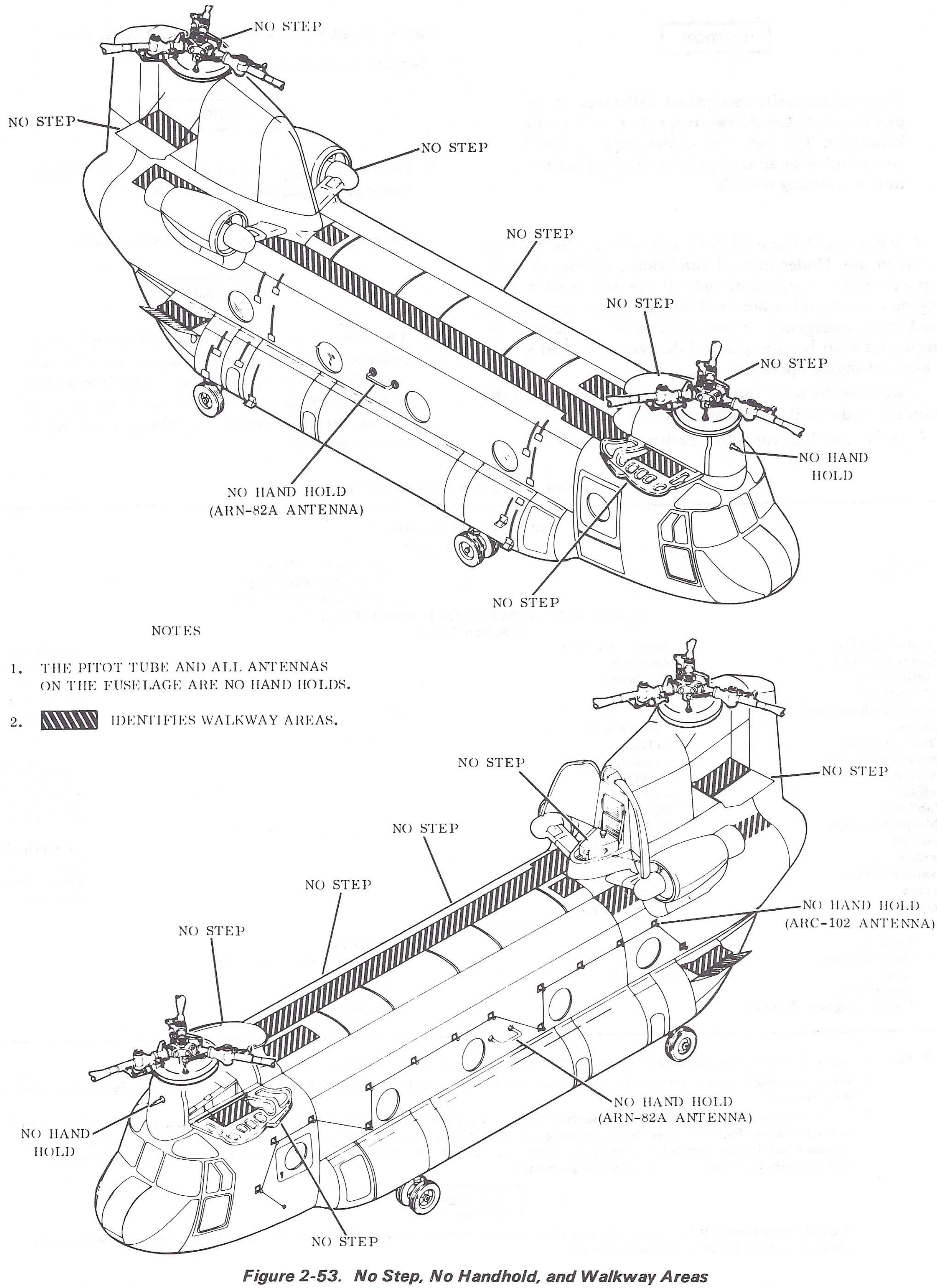


Figure 2-53. No Step, No Handhold, and Walkway Areas

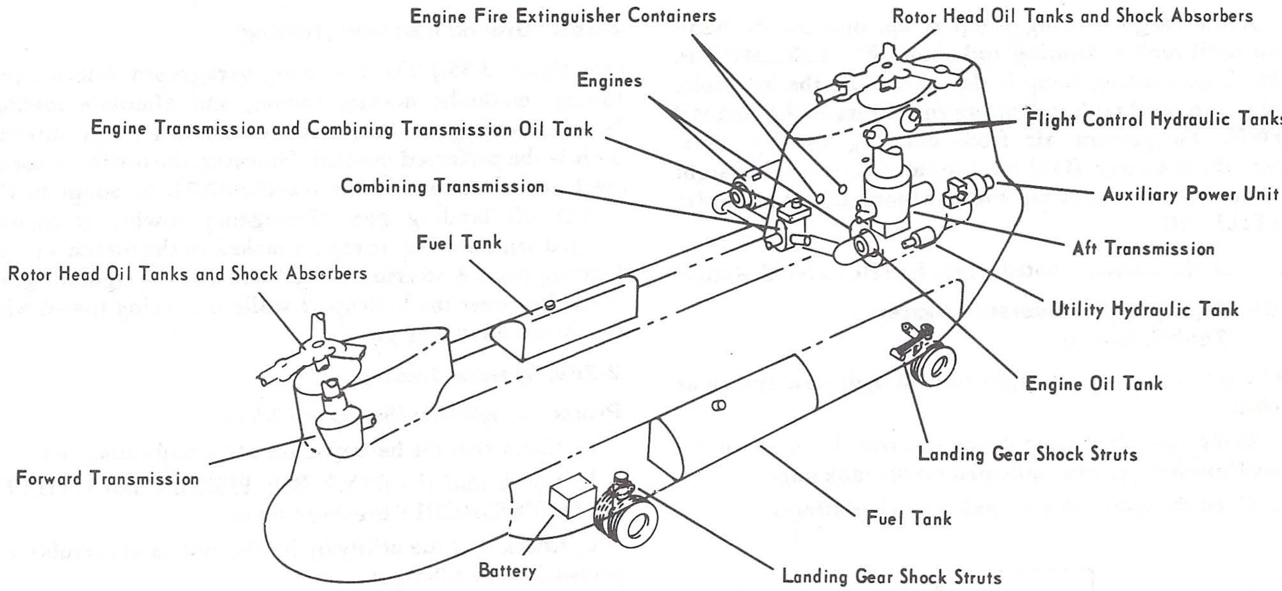


Figure 2-54. Servicing Diagram

b. Add oil to the apu oil tank until the oil level reaches the FULL mark on the dipstick. Refer to DA Form 2408-13 and table 2-3 for the proper oil to use depending on prevailing air temperature. Under normal conditions, the apu shall be serviced with one type of oil only. If one type of oil is in an apu and that oil is not available, the other type may be used in an emergency. If the two types of oil are mixed, the oil shall be changed and the system flushed within 6 hours of apu operation.

c. Reinstall and check security of the filler cap.

2-264. Transmission Oil System.

Service the forward transmission, engine combining transmission, and aft transmission as follows:

a. Access to oil filler and location of sight gage of each transmission are as follows:

(1) The oil filler and sight gage for forward transmission are accessible within hinged fairing on the right side of the forward pylon. The filler neck is located in the top forward area of the transmission and the sight gage is located in the bottom aft area.

(2) The oil filler for aft transmission is located in left side of aft pylon section. It is accessible thru an access panel at sta 555. The sight gage is located on forward right side of transmission sump. It is accessible from cargo ramp area.

(3) The oil filler and sight gages for the combining transmission and both engine transmissions are located on the combining transmission oil tank. They are accessible within the fairing of aft pylon leading edge.

b. Fill the forward transmission, engine transmission, and aft transmission to the FULL mark on each sight gage.

NOTE

To prevent overfilling the transmissions, do not check the oil levels immediately after rotor shutdown. Wait about 10 minutes to allow oil to drain into the transmission sumps.

CAUTION

Do not select the manual control valve FILLING position when the engine or the apu is running. Damage to components could result.

2-265. Utility Hydraulic System Tank Servicing.

Service the system tank as follows:

a. Be sure the cargo loading ramp is full up or full down.

b. Turn manual control valve handle to FILLING. This relieves utility system pressure.

c. Read the indicating rod on the hydraulic tank. Check accumulator for proper precharge.

d. Fill the filler assembly with hydraulic fluid.

CAUTION

The hand pump can be damaged by careless operation. Do not slam handle against the upper and lower stops. When two men operate the handle, do not overstress pump by seeing how fast you can pump up pressure. Careless operation can result in broken mounting lugs, broken fulcrum support lugs, and cracked handle supports.

e. If the cargo loading ramp is up, operate the hand pump until tank indicating rod shows FULL/RAMP UP. If the cargo loading ramp is down, operate the hydraulic hand pump until tank indicating rod shows FULL/RAMP DOWN. To prevent air from entering the hydraulic system, do not allow fluid level to fall below level of sight glass on the filler assembly while the manual control valve is at FILLING.

f. Turn the manual control valve handle to NORMAL.

2-266. Flight Control Hydraulic System Tank Servicing.

Service either tank of the flight control hydraulic system as follows:

a. Make sure the thrust control is full down so an accurate fluid level can be indicated on the tank gage.

b. Open the applicable aft pylon work platform.

WARNING

If the WATER DRAIN button is not pressed, personnel injury could occur when cap is removed.

c. On helicopters modified with the pressurized flight control hydraulic system reservoirs, press the WATER DRAIN button on the air pressure regulator valve. This relieves air pressure on the flight control hydraulic return system. The valve is in the right side of aft pylon.

WARNING

The cap is not properly installed until the cap release pins are extended.

d. Remove the filler cap from the tank. Fill the tank with hydraulic fluid to the FULL level. Install filler cap.

e. Close the work platform.

2-267. Tire Servicing.

If a tire requires an excessive amount of air compared to the other tires on the helicopter, have the tire checked for leaks prior to flight.

WARNING

Remote Inflation Safety Chuck Gage AS1675 (30003) or equivalent shall be used when inflating tires to 50 psi and above.

a. Remove the cap from the air valve.

b. Attach the air chuck to the valve.

c. Inflate the tire. Refer to table 2-3.

d. Remove the air chuck. Install the valve cap.

2-268. Ground Handling (Towing).

(See figure 2-55.) The following paragraphs describe two towing methods: normal towing and alternate towing. Normal towing is done with a standard Army towbar. This is the preferred method. However, the towbar must be modified with towbar kit, 114E5002-21, to adapt to the CH-47 aft landing gear. Emergency towing is accomplished with a cable or rope attached to the forward or aft landing gear. A steering bar, attached to the right aft gear, is used to steer the helicopter while it is being towed with the forward landing gear.

2-269. Normal Towing.

Proceed as follows: (See figure 2-55.)

a. Check that the battery is installed and connected.

b. Check that the BTRY BUS FEEDER and UTILITY HYD SYS CIRCUIT breakers are in.

c. Check that the utility hydraulic system accumulator is pressurized to 3,000 psi.

CAUTION

Do not proceed further until a visual inspection is made to ensure that swivel locking mechanism is disengaged (unlocked). Damage to equipment will result if helicopter is towed with the swivel locking mechanism engaged (locked).

d. Make sure the aft swivel locking mechanism is disengaged.

e. Attach the tow bar to right aft landing gear axle. Secure spreader bar to the tow bar.

f. Connect the tow bar to towing vehicle.

CAUTION

Wheel brakes can be operated with or without utility hydraulic pressure. However, for emergency stopping, turn the UTILITY SYSTEM switch ON. To conserve battery power, the UTILITY SYSTEM switch should be placed to OFF until hydraulic boost pressure is needed.

g. Station one crewmember in cockpit to place UTILITY SYSTEM switch to ON and to operate brakes when required.

CAUTION

The free wheel shall be swiveled about 120° to one side before towing aft. Otherwise, damage to the tire and landing gear can result. To avoid damaging the rotary-wing blades, station a crewmember on each side of the helicopter to observe clearances. If it becomes necessary to rotate either rotary-wing head independently of the other, dephase the rotary-wing system.

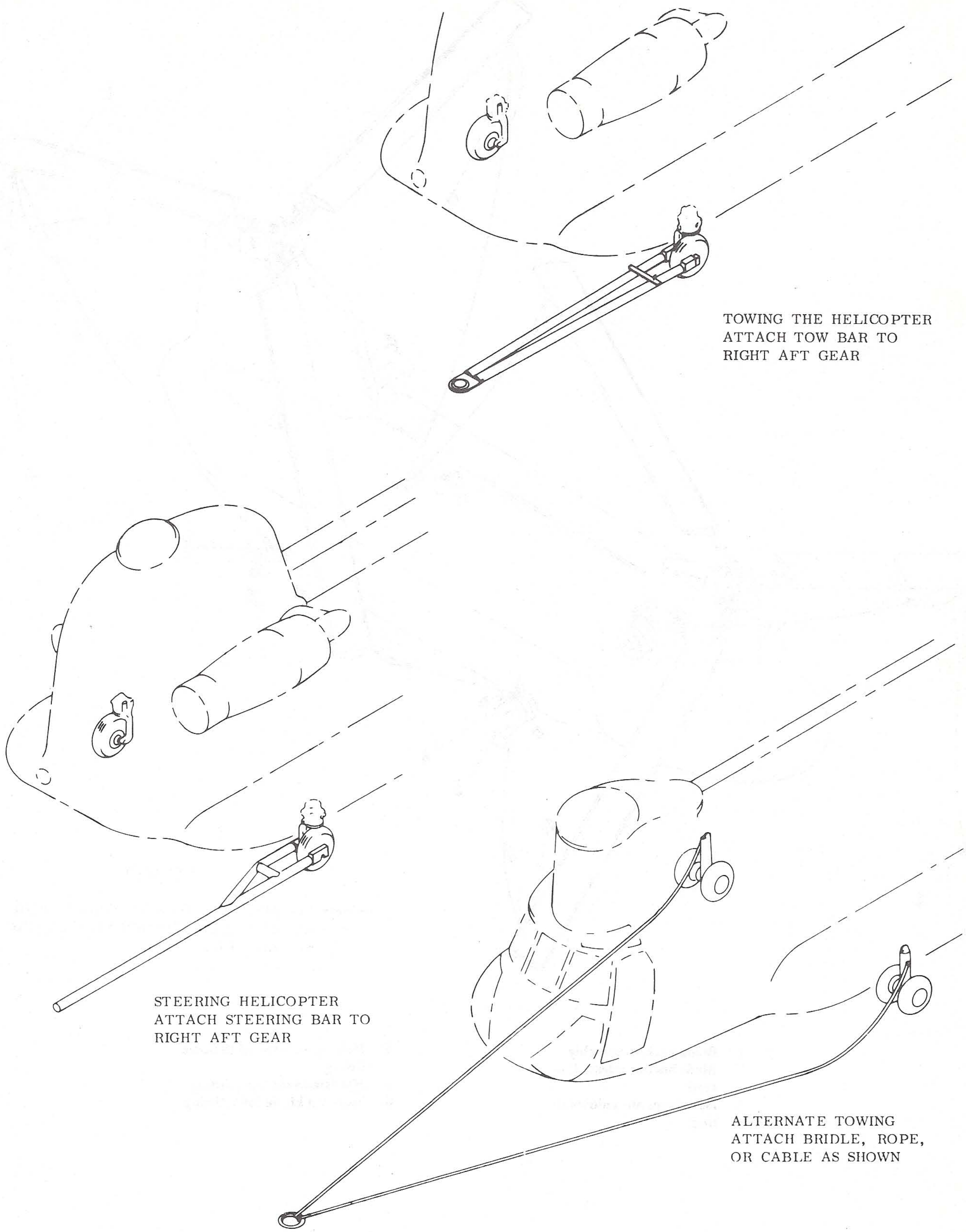
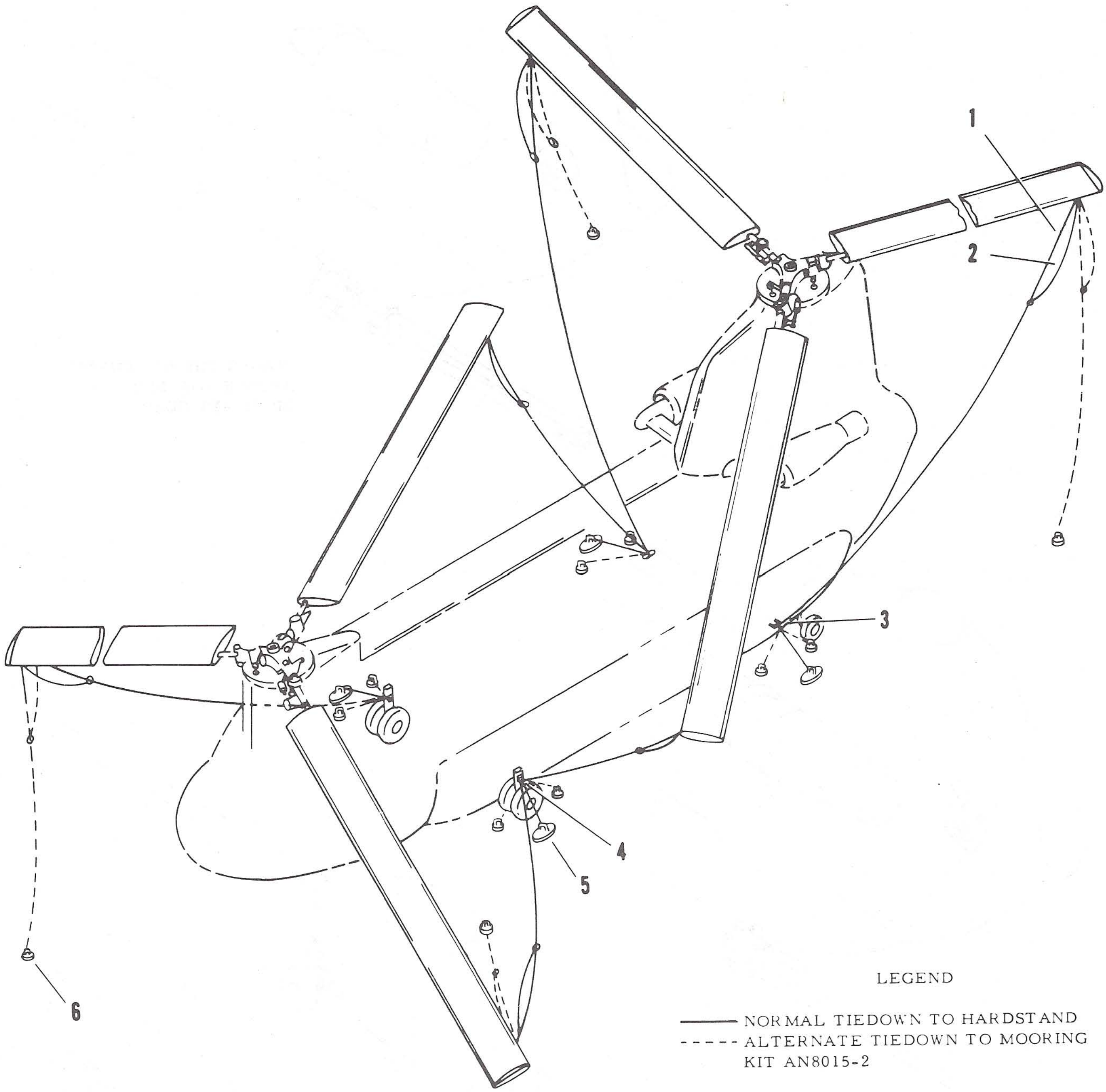


Figure 2-55. Towing the Helicopter



1. Blade anchor assembly
2. Blade anchor release lanyard
3. Helicopter aft tiedown fitting
4. Helicopter forward tiedown fitting
5. Hardstand mooring fitting
6. Mooring kit tiedown fitting

Figure 2-56. Mooring the Helicopter

h. Remove chocks from wheels. Release parking brakes. If helicopter is to be towed aft, swivel the free wheel about 120° to one side.

i. Tow the helicopter slowly. Avoid sudden starts and stops.

j. When towing is completed, park the helicopter. (Refer to paragraph 2-271.) Disconnect towing equipment from helicopter.

2-270. Alternate Towing.

This method of towing is used only when normal method of towing cannot be used.

a. Repeat steps a. thru d. of paragraph 2-269.

CAUTION

Be sure towing rope or cable is long enough to allow turning and stopping clearance between towing vehicle and helicopter. Two 29-foot lines will provide clearance of about 10 feet.

b. Attach a towing bridle, if available, or a rope or cable of sufficient length and strength, to tiedown rings on forward or aft landing gear, whichever is applicable.

CAUTION

Be careful when towing with rope or cable. Helicopter brakes are the only means of stopping the helicopter. Station a crewmember on each side of the helicopter to stand by with wheel chocks in event of brake malfunction and to watch for blade clearance.

c. If helicopter is being towed forward, attach a steering bar to an aft landing gear axle. If the apu can be operated, start the apu, and use brakes and power steering, if installed.

d. Connect towing bridle, towing rope, or cable to towing vehicle. Position towing vehicle so the slack is just removed from towing bridle, rope or cable. If the apu is not operating, station a crewmember by the utility accumulator gage to monitor pressure and to pressurize the system when utility pressure drops below 2,800 psi.

e. Perform steps g. and h. of paragraph 2-269.

f. Tow helicopter slowly. Avoid sudden starts and stops.

g. When towing is completed, park the helicopter. (Refer to paragraph 2-271.) Disconnect towing equipment from helicopter.

2-271. Parking.

Park the helicopter as directed in the following steps:

a. Apply wheel brakes. Then, set parking brakes.

b. Place chocks against front and back of forward and aft tires.

WARNING

With only safety blocks installed, blade forces imposed on swashplate can change direction as the blades turn and swing within their lead-lag range. Injury to personnel or damage to equipment can occur if the blades move unexpectedly.

CAUTION

Failure to position blades properly or install safety blocks may allow a blade to hit fuselage. This may damage the fuselage and blade.

c. Position rotary-wing blades 30 degrees off centerline of helicopter.

2-272. Mooring.

(See figure 2-56.) The helicopter can be secured with tiedown lines 114E5060-1 or equivalent to permanent fittings at hardstands or to fittings of mooring kit AN8015-2 in unpaved areas. The methods of mooring vary with intensity of winds. Table 2-6 provides necessary precautions to be taken pertaining to these conditions.

Table 2-6. Mooring Data

WIND VELOCITY	TIEDOWN REQUIREMENT
0 to 39 kts	No tiedown requirement
40 to 65 kts	Fuselage and blades tied down or fuselage tied down and blades folded
Over 65 kts	Evacuate helicopter from the area or store helicopter in hangar

CAUTION

Tie down blades on parked helicopters if they will be in rotor wash of other helicopters.

a. Park the helicopter. (Refer to paragraph 2-271.) If mooring the helicopter to hardstand, position the helicopter so tiedown fittings (3 and 4) are close to a mooring fitting (5).

b. Working from the walkway on top of the fuselage, insert blade interlock of blade anchor assembly (1) into anchor fitting at tip of the nearest blade.

c. Use tiedown line of the installed blade anchor assembly to pull the next blade into position so that its blade anchor assembly can be installed.

d. Repeat steps b. and c. until all blade anchors are installed.

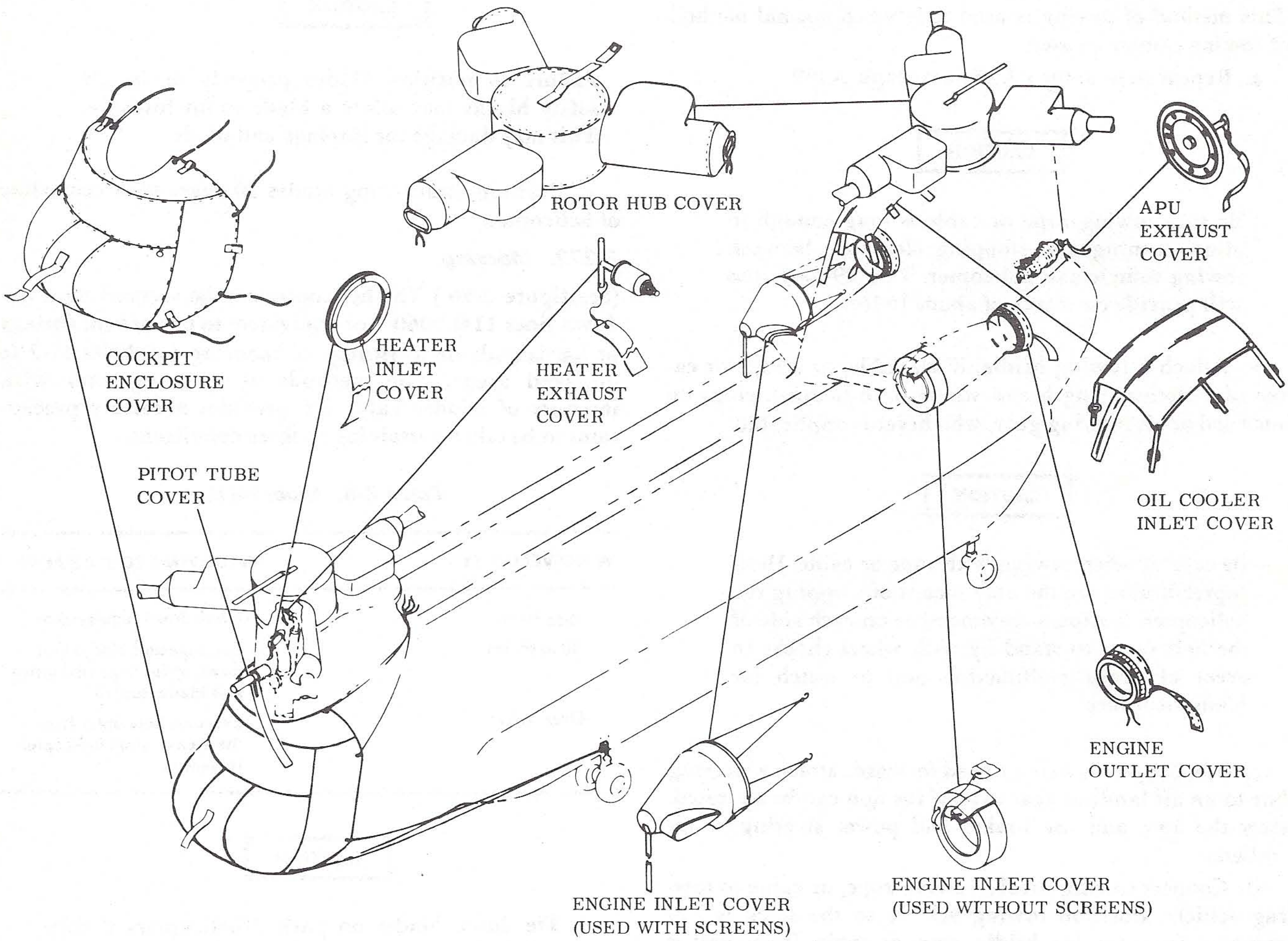


Figure 2-57. Protective Covers

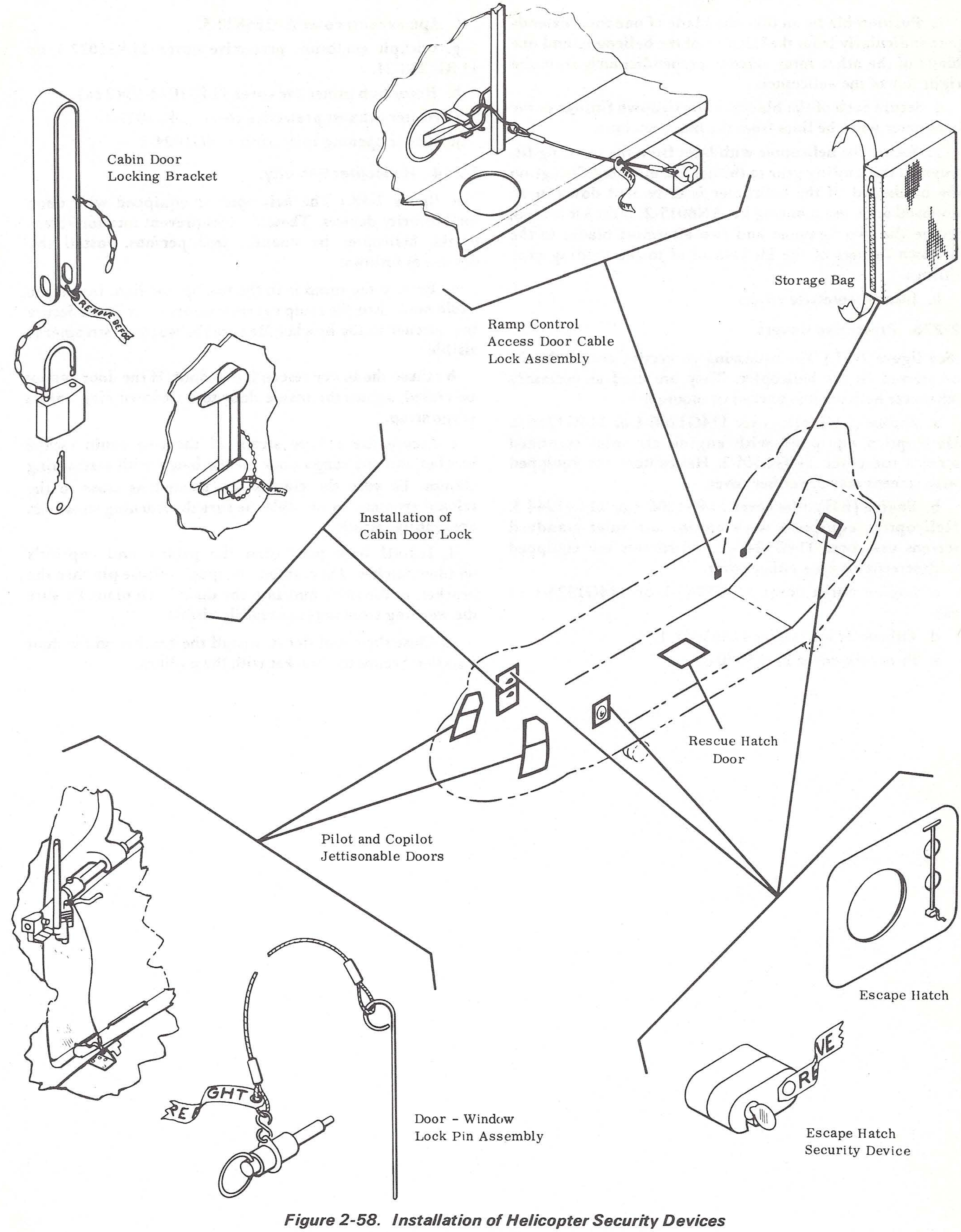


Figure 2-58. Installation of Helicopter Security Devices

e. Position blades so that one blade of one rotor extends perpendicularly from the left side of the helicopter and one blade of the other rotor extends perpendicularly from the right side of the helicopter.

f. Secure each of the blades to the tiedown fittings of the helicopter with the lines from the blade anchors.

g. Secure the helicopter with lines from the mooring fittings on the landing gear to the nearest mooring fittings on the hardstand. If the helicopter is to be tied down in an unpaved area, use mooring kit AN8015-2. If the kit is used, secure the two foremost and two aftermost blades to the tiedown fittings of the kit instead of to the landing gear fittings.

h. Install protective covers.

2-273. Protective Covers.

(See figure 2-57.) The following protective covers should be stowed in the helicopter. They are used as necessary whenever helicopter is parked or moored.

a. Engine (LH) inlet cover 114G1206-1 or 114G1244-2. Helicopters equipped with engine air inlet standard screens use cover 114G1244-2. Helicopters not equipped with screens may use either cover.

b. Engine (RH) inlet cover 114G1206-1 or 114G1244-3. Helicopters equipped with engine air inlet standard screens use cover 114G1244-3. Helicopters not equipped with screens may use either cover.

c. Engine outlet cover 114E5042-1 or 114G1323-1 (2 ea).

d. Oil cooler inlet cover 114E5061-1.

e. Pitot tube cover 114E5040-33.

f. Apu exhaust cover A02E5828-5.

g. Cockpit enclosure protective cover 114G1022-1 or 114G1238-21.

h. Rotor hub protective cover 114G1023-16 (2 ea).

i. Heater exhaust protective cover 114G1025-1.

j. Heater opening inlet cover 114G1024-1.

2-274. Helicopter Security.

(See figure 2-58.) The helicopter is equipped with door lock security devices. These devices prevent interior access to the helicopter by unauthorized persons. Install the devices as follows:

a. Be sure the ramp is in the full up position. Install the cable hook thru the ramp controls access door latch. Secure the fastener to the bracket. Be sure the warning streamer is visible.

b. Close the lower rescue hatch door. If the door cannot be closed, secure the inside door to a tiedown ring with a cargo strap.

c. Secure the release straps of the two cabin escape hatches and the cargo door escape hatch with restraining clamps. Be sure the clamps are located as close to the release grommet as possible. Be sure the warning streamers are readily visible.

d. Install lock pins thru the pilot's and copilot's window latches. Then, insert the quick-release pin thru the bracket on the floor and into the door latch plate. Be sure the warning streamers are readily visible.

e. Close the cabin doors. Install the bracket on the door handles. Secure the bracket with the padlock.

CHAPTER 3
AVIONICS

SECTION 1 COMMUNICATIONS

3-1. This chapter covers the avionic equipment installed in Army CH-47A helicopters. It includes a brief description of the avionic equipment, its technical characteristics, capabilities, and location. The chapter also contains complete operating instructions for all avionic equipment installed in the aircraft.

3-2. Basic helicopter missions, operational commitments, and geographical factors vary the combinations of avionic equipment installed in the helicopter. When applicable, the first paragraph of each equipment description contains the effectivity of the avionic equipment installed. This effectivity provides the crewmember with a guide to the avionic equipment which is installed on his particular helicopter.

3-3. Communication and Associated Electronic Equipment List.

Table 3-1 is a ready reference to all the communication and navigation equipment available for installation in the helicopter.

3-4. Interphone System (C-1611A/AIC).

The interphone system is a multi-station intercommunication and radio control system for control of voice radio communication (air-to-air or air-to-ground). It also monitors the output of a maximum of three navigation radio receivers and routes the output of the emergency radio receiver (vhf navigation set) directly to the headsets. The basic components of the interphone system are six control panels. There is one panel each for the pilot, copilot, flight engineer/troop commander, the two gunners stations, and the ramp area. In addition, there is an interphone station for the hoist operator and two external interphone receptacles. There are cords with a press-to-talk switch for all stations. The press-to-talk switches for the pilot and copilot are on the cyclic sticks and on the floor. A control panel, a cord with a press-to-talk switch, and a press-to-talk foot switch in a rubber mat on the floor are provided for the left and right cabin gunner positions. (See figure 3-1.) A discrete signal discriminator is also installed. The discrete signal discriminator (MD-736/A) is used in conjunction with the interphone control C-1611A/AIC to provide filtering of audio signals. Power to operate and control the system is supplied by the 28-volt dc emergency bus thru the INTERPHONE circuit breaker on the overhead circuit breaker panel or the dc circuit breaker box.

3-5. Interphone Control Panel (C-1611A/AIC).

Controls, function, and operating procedures for the interphone control (C-1611A/AIC) are given in paragraph 3-6. (See figure 3-2.)

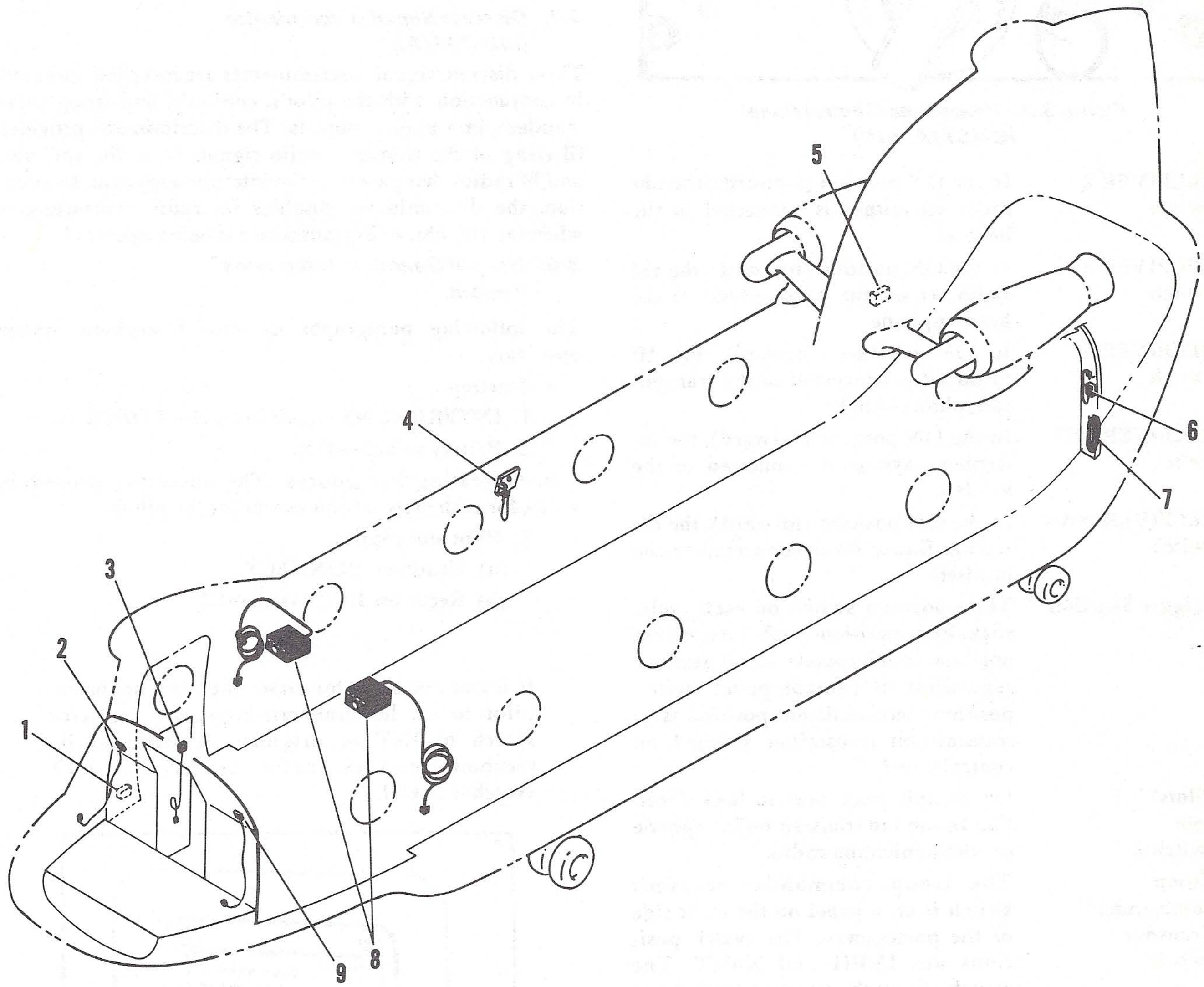
3-6. Controls and Function, Interphone Control Panel (C-1611A/AIC).

CONTROL/ INDICATOR	FUNCTION
RECEIVER 1 Switch	In the ON position (forward), the fm radio set output is connected to the headset.
Transmit-Interphone Rotary Selector-Switch	The PVT position provides private (hot mike) communication between the troop commander, ramp interphone, and ramp interphone extension. In the INT position, the headset microphone is connected to the interphone system for voice communications. In position No. 1, the head-set-microphone is connected to the fm radio set for voice communications and interphone. In position No. 2, the headset microphone is connected to the uhf radio set for voice communication and interphone. In position No. 3, the headset-microphone is connected to the vhf radio set for voice communications and interphone. The No. 4 position is connected to the hf radio set.
VOL Control	Controls the audio level of the interphone and radio receivers, except the direction finder set, vhf navigation set and the marker beacon.

Table 3-1. Communications and Associated Electronic Equipment

FACILITY	DESIGNATION	USE	LOCATION
Interphone	C-1611A/AIC	Intercommunication between crewmembers	Three INT panels on console, three INT panels in cabin, hoist operator's station, two exterior stations
Fm liaison set	AN/ARC-44 AN/ARC-54, or AN/ARC-131	Fm communication and homing	Control panel on console
Voice security equipment	TSEC/KY-28	Fm communication security	Control panel on console
UHF radio set	AN/ARC-55 or -51BX	Two-way UHF communication	Control panel on console
VHF radio set	AN/ARC-73 or AN/ARC-73A or AN/ARC-134	Short range 2-way VHF communication	Control panel on console
Direction finder set	AN/ARN-59 (V) or AN/ARN-83	Automatic direction finding and homing	Control panel on console
VHF navigation set	AN/ARN-30D, E or AN/ARN-82 or AN/ARN-82A	Receives omni-directional radio range bearing information and VHF voice	Control panel on console
Marker beacon set	R-1041/ARN	Visual and aural marker beacon reception	Controls on console
IFF set	AN/APX-44 or AN/APX-72	Identification and tracking	Control panel on console
Emergency VHF command transmitter	T-366A/ARC	Emergency transmission	Control panel on console
High frequency radio set	AN/ARC-102	Long range 2-way communications	Control panel on console

*Range of transmission and reception is dependent upon many variables including weather conditions, time of day, operating frequency, power of transmitter, and altitude of helicopter.



1. External interphone receptacle
2. Pilot's headset-microphone jack
3. Troop commander's headset-microphone jack
4. Hoist operator's headset-microphone jack
5. External interphone receptacle
6. Flight engineer's headset-microphone jack
7. External interphone walking cord
8. Gunner's interphone panels and headset-microphone jacks
9. Copilot's headset-microphone jack

Figure 3-1. Interphone Stations

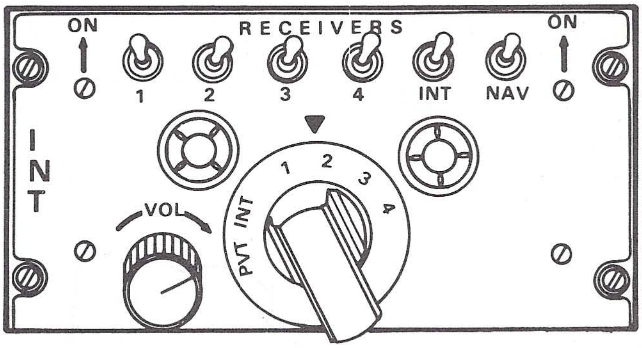


Figure 3-2. Interphone Control Panel (C-1611A/AIC)

RECEIVER 2 Switch	In the ON position (forward), the uhf radio set output is connected to the headset.
RECEIVER 3 Switch	In the ON position (forward), the vhf radio set output is connected to the headset phone.
RECEIVER 4 Switch	In ON position (forward), the Hf radio set is connected to the transmit interphone switch.
RECEIVER INT Switch	In the ON position (forward), the interphone system is connected to the headset.
RECEIVER NAV Switch	In the ON position (forward), the direction finder set is connected to the headset.
Trigger Switches	Three-position switch on each cyclic stick. First position is off. First detent position is interphone to all stations regardless of control panel switch position. Second detent position is to transmit on transmitter selected on control panel.
Pilots' Foot Switches	On cockpit floor next to heel slides. Can be used to transmit on interphone or communication radio.
Troop Commanders' Transmit Switch	The troop commander transmit switch is on a panel on the right side of the passageway. The switch positions are INPH and XMIT. The switch allows the troop commander to transmit on hf or fm radios. (See figure 3-3.)
Gunners' Foot Switches	Located in pressure sensitive mat at each gunners' position. The switch is used to transmit on interphone.
Hoist Control Microphone Switch	On hoist control grip. When ramp position transmit selector is at INT and microphone switch is pressed, communications are enabled between hoist operator and other crew sections.
Hoist Operator's Function Switch	On hoist control panel. At HOT-MIKE, operation of the hoist control microphone switch is not required. MOM ON position also bypasses the hoist control microphone switch. At OFF, operation of the hoist control microphone switch is required.

3-7. Discrete Signal Discriminator (MD-736/A).

Three discrete signal discriminators are installed and used in conjunction with the pilot's, copilot's, and troop commander's interphone controls. The discriminator provides filtering of the transmit audio signals from the vhf, uhf, and hf radios that pass thru the interphone system. In addition, the discriminator disables fm radio transmissions when the vhf, uhf, or hf transmitter is being operated.

3-8. Normal Operation Interphone System.

The following paragraphs describe interphone system operation.

a. Starting.

1. INTERPHONE circuit breaker—CHECK in.
2. Battery switch—ON.

b. Operating Procedures. The operating procedure varies for each crew station except for the pilots.

1. Pilot and copilot.
   (a) Headset—CONNECT.
   (b) Receivers INT switch—UP.

NOTE

It is not necessary for either the pilot or the copilot to set his transmit-interphone selector switch to INT or originate or listen to interphone messages when the receivers INT switch is at ON.

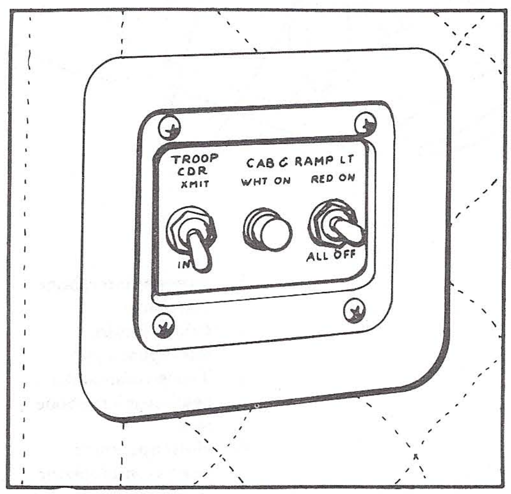


Figure 3-3. Troop Commander's Transmit Switch

(c) Volume control—ADJUST to a comfortable level.

(d) To transmit, complete either of the following:

(1) Trigger switch—PRESS to first detent.

(2) Foot switch—PRESS. (Transmit-interphone selector switch must be at INT.)

2. Flight engineer/troop commander.

(a) Headset—CONNECT.

(b) Receivers INT switch—UP.

(c) Transmit-interphone selector switch—INT.

(d) Volume control—ADJUST for a comfortable level.

(e) Press-to-talk switch—PRESS.

(f) To transmit and receive on hf or fm radios, perform the following:

(1) Transmit-interphone selector switch—Select position 1 for fm or position 4 for hf.

(2) Receivers switches—Set switch number 1 to ON for fm or set switch number 4 to ON for hf.

(3) Press the button on the headset cord and simultaneously hold the INPH-XMIT switch to XMIT.

3. Gunners' station.

(a) Headset—CONNECT.

(b) Receivers INT switch—UP.

(c) Transmit-interphone selector switch—INT.

(d) Volume control—ADJUST for a comfortable level.

(e) Press-to-talk switch or foot switch—PRESS.

4. Hoist operator's station. This station is an extension of the ramp interphone station and requires that the ramp interphone panel transmit-interphone selector switch be at INT for two-way intercommunications.

(a) Ramp transmit-interphone selector switch—INT.

(b) Headset—CONNECT.

(c) Press-to-talk switch—PRESS the switch on the hoist control grip.

(d) Alternate method, function switch—HOT MIKE. (Talk into microphone.)

(e) Alternate method, function switch—MOM ON. (Talk into microphone.)

(f) Press-to-talk switch—PRESS and talk.

5. Private interphone. The troop commander, the ramp interphone station, and the extensions of the ramp station can communicate privately by selecting PVT on the transmit-interphone selector switch. When operating at PVT, the individual's microphone is *hot*. It is not necessary to press the press-to-talk switch to communicate.

6. External interphone stations. The exterior interphone stations can be used when coordination between cockpit (forward cabin section) and other interphone stations is required.

(a) Flexible cord (15-foot)—CHECK plugged in. See figure 3-1 for locations of the exterior interphone receptacles.

(b) Headset—CHECK connected.

(c) Press-to-talk switch—PRESS and talk; RELEASE and listen.

c. Stopping Procedure. The interphone system has no on-off switch. The system is shut down by pulling the INTERPHONE circuit breaker out or by setting the battery switch to OFF.

d. Emergency Operation—Interphone System. If both ac systems fail, it is possible to operate the interphone system by moving the battery switch to EMERGENCY.

3-9. UHF Radio Set (AN/ARC-55).

(On 61-2408 thru 61-2425.) The uhf radio set (AN/ARC-55) provides two-way radio telephone communication air-to-air and air-to-ground. The set is capable of providing transmission and reception by manually selecting 1 of 1,750 frequency channels in the band of 225.0 to 399.9 mHz. It is also possible to monitor and transmit on one predetermined frequency guard-channel (243.0 mHz). Audio output and input are amplified thru the INT panels. The uhf radio set comprises the following components: the uhf receiver-transmitter, the uhf control panel (figure 3-4) and the uhf antenna (7, figure 3-5) on the underside of the helicopter. Power to operate and control the uhf radio set is supplied by the 28-volt dc radio bus thru a UHF circuit breaker on the dc circuit breaker box.

3-10. Controls and Function UHF Radio Set (AN/ARC-55). (See figure 3-4.)

CONTROL/ INDICATOR	FUNCTION
Function select switch	Applies power to the uhf radio set and selects type of operation. In the OFF position, power is removed from the uhf radio set. In the T/R position, power is applied to the uhf radio set, which permits transmission and reception with guard receiver inoperative. In the T/R+G position, power is applied to the uhf radio set, which permits transmission and reception with guard receiver operative. The ADF function (switch position) is not used in this installation.
VOL control	Controls the level of audio applied to the headset.
SENS control	Concentric with volume control. Controls receiver sensitivity above a preset minimum level.
Frequency selectors	Three selectors grouped around the frequency indicator. Left selector is for 10-megahertz settings. The selector on the right is for 1-megahertz settings. The top selector is for 0.1 megahertz settings.

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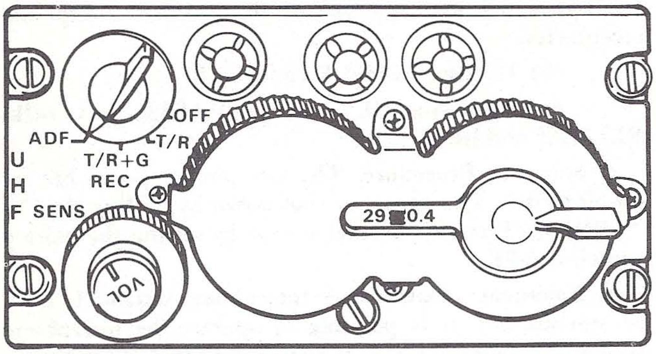


Figure 3-4. UHF Radio Control Panel (AN/ARC-55)

3-11. *Normal Operation—UHF Radio.*

The following starting procedures are recommended for the uhf radio set:

a. Starting.

1. ARC-55 or UHF circuit breakers—CHECK in.
2. Battery switch—ON.
3. Interphone control power (INT)—Position switches as follows:
   (a) Receiver 2 switch—UP.
   (b) Transmitter selector switch—2.
4. Function switch—T/R or T/R+G REC.
5. Frequency selectors—Desired frequency.
6. Sensitivity control—As desired.
7. Volume control—As desired.

3-12. UHF Radio Set (AN/ARC-51BX)

The uhf radio set (AN/ARC-51BX) provides two-way radio communications between helicopters in flight, and between helicopters and ground stations. The AN/ARC-51BX is capable of providing transmission and reception by manual selection of 3,500 frequencies in the band from 225.00 to 399.95 mHz in 50 kHz increments, plus 20 preset frequencies. It is also possible to monitor and transmit on one predetermined frequency, guard channel (243.00 mHz). The audio output and input are amplified thru the interphone control panel (INT). The uhf radio set includes the following components: the uhf radio set includes the following components: the uhf receiver-transmitter, the control panel (figure 3-6), and the uhf antenna which is mounted on the underside of the helicopter (7, figure 3-6). Power to operate and control the uhf radio set is supplied by the 28-volt dc radio bus thru the UHF circuit breaker on the dc circuit breaker box.

1. Hf antenna
2. Vhf navigation antenna (typical both sides) (66-087 and subsequent)
3. Marker beacon antenna
4. Adf sense antenna
5. Adf loop antenna
6. Vhf navigation antenna (61-2408 thru 66-086)
7. Uhf or vhf antenna
8. Fm Homing antenna (AN/ARC-54 or AN/ARC-131)
9. IFF antenna
10. Fm communications antenna
11. Fm Homing Antenna (AN/ARC-44)

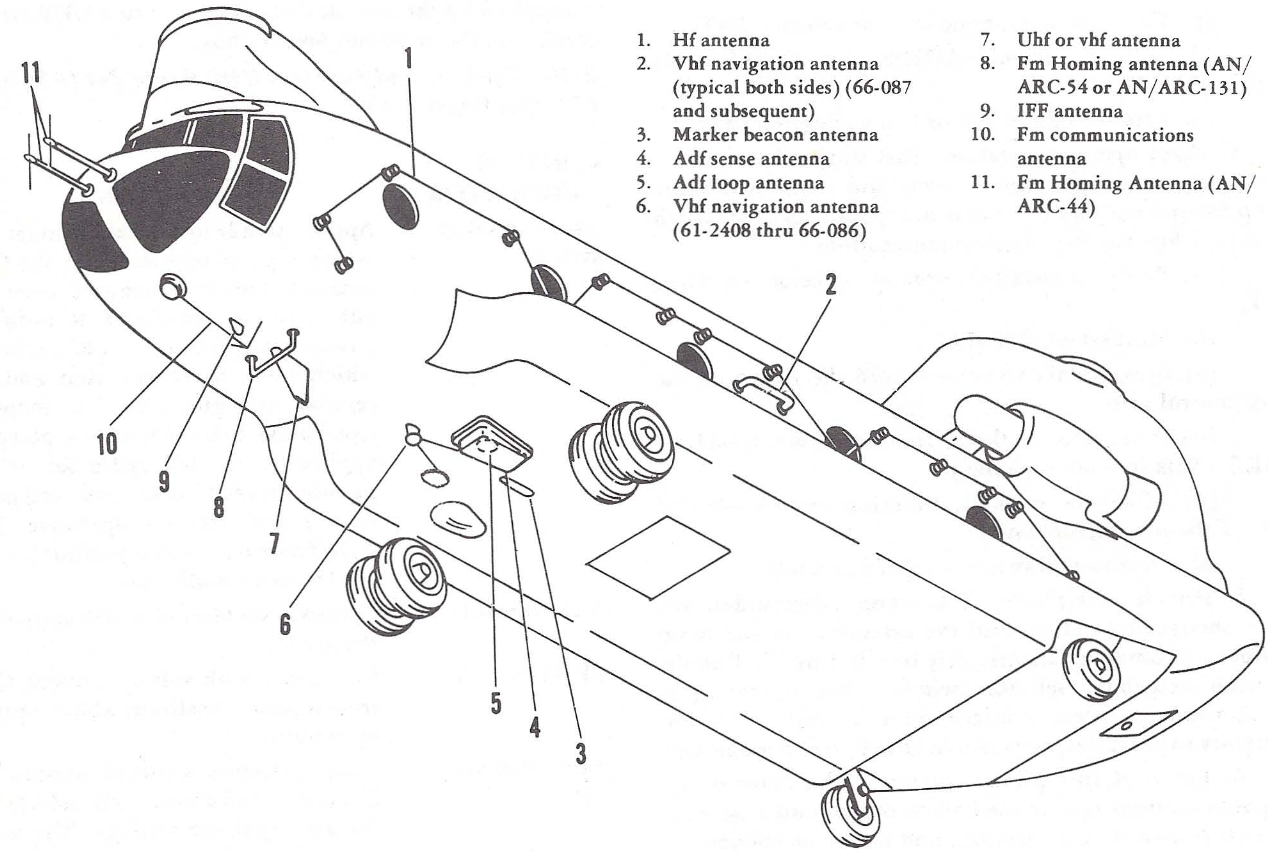


Figure 3-5. Antenna Locations

3-13. Controls and Function UHF Radio Set (AN/ARC-51BX.) (See figure 3-6.)

CONTROL/ INDICATOR	FUNCTION
Function select switch	Applies power to the uhf radio set and selects type of operation. In the OFF position, power is removed from the uhf radio set. In the T/R position, power is applied to the uhf radio set, which permits transmission and reception with guard receiver inoperative. In the T/R+G position, power is applied to the uhf radio set, which permits transmission and reception with guard receiver operative. The ADF function (switch position) is not used in this installation.
VOL control	Controls the level of audio applied to the headset.
SQ DISABLE switch	In the ON position, the squelch is disabled. In the OFF position, the squelch is operative.
Mode selector	Determines the manner in which frequencies are selected. In the PRESET CHAN position, it permits the selection of one of 20 preset channel controls. In the MAN position, it permits frequency selection by means of the megahertz controls (MC). In the GD XMIT position, the receiver/transmitter automatically tunes to the guard channel frequency.
PRESET CHAN control	Controls the selection of any one of the 20 preset channels.
10-megahertz control (MC)	Selects the 10-megahertz digits (first two numbers) of the desired frequency.
1-megahertz control (MC)	Selects the 1-megahertz digit (third number) of the desired frequency.
0.05-megahertz control (MC)	Selects the 0.05-megahertz digits (fourth and fifth numbers) of the desired frequency.

3-14. Normal Operation—UHF Radio Set.

The following paragraphs provide radio set operating procedures.

a. Starting.

1. UHF circuit breaker—CHECK in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Set switches as follows:
   (a) Receivers 2 switch—UP.
   (b) Transmit-interphone selector switch—2.
4. Function select switch—T/R or T/R+G.
5. Mode selector—As required.
6. Squelch disable switch—As required.
7. Volume control—As required.

b. Presetting Channels. Perform the following steps to preset channels to a desired frequency.

1. Loosen the two holddown screws on the memory drum access door and open the door.
2. Turn the preset channel control to the channel to be preset as indicated on the right-hand side of the memory drum. Disregard the channel number shown in the preset channel indicator. This is not the channel being preset.
3. Using the preset tool mounted in the memory drum access area, move the eight adjustable pins according to designation and letter code on the access door cover to preset the channels to a desired frequency. For example: if the frequency 225.25 mHz is desired, the three center digits (252) are selected with two pins for each number according to the letter code on the access door cover. The hundreds digit (2 or 3) and the hundredths digit (0 or 5) are selected by a single pin for either digit as designated on the control.

NOTE

Be sure the adjustable pins are firmly seated before rotating the memory drum to the next channel.

4. Record the channel frequencies on the chart provided on the front of the memory drum access door in accordance with the channel indicated on the right side of the memory drum.
5. Replace the preset tool in its holder.
6. Close the memory drum access door and tighten the two holdown screws.

c. Stopping. Function select switch—OFF.

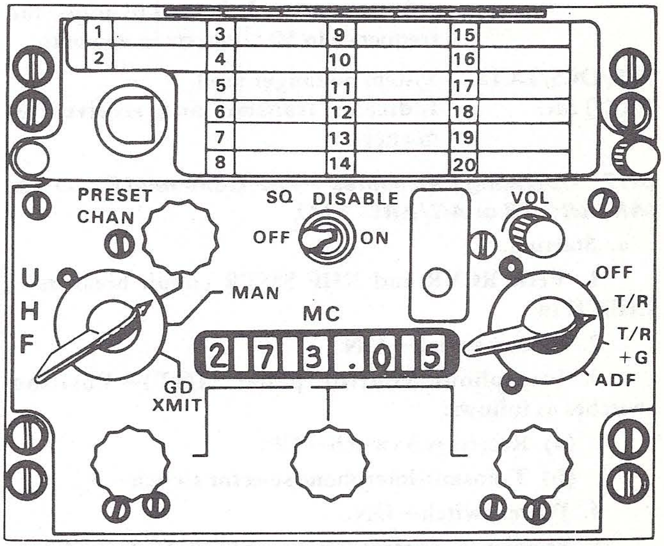


Figure 3-6. UHF Radio Control Panel (AN/ARC-51BX)

3-15. VHF Command Radio Set (AN/ARC-73 or AN/ARC-73A).

(Effectivity: All helicopters without uhf radio sets.) The vhf command radio set (AN/ARC-73 or AN/ARC-73A) is an airborne radio communications set. The set provides air-to-ground and air-to-air transmission and reception of amplitude-modulated, very-high frequency radio signals within the frequency range of 116.00 to 151.95 megahertz. The audio output and input of the AN/ARC-73 or AN/ARC-73A are amplified through the interphone control panel. The vhf command radio set includes the following components: The vhf receiver, the vhf transmitter, the vhf control panel (figure 3-7), and the vhf antenna which is located on the underside of the helicopter (7, figure 3-5). The vhf command radio set is powered by the 28-volt dc radio bus thru the VHF RCVR and VHF XMTR circuit breakers on the dc circuit breaker box.

3-16. Controls and Function, VHF Command Radio Set (AN/ARC-73 or AN/ARC-73A). (See figure 3-7.)

CONTROL/ INDICATOR	FUNCTION
Pwr switch	At PWR, switch provides power to the set. At OFF, set is inoperative.
Volume control	This control is the outer knob concentric with the squelch control. When turned clockwise, volume increases.
Squelch control	This is the inner knob concentric with the volume control. It is used to adjust the squelch threshold level.
Megahertz control	Located to the left of the squelch/ volume control. It is used to adjust the frequency in 1 megahertz increments.
Kilohertz control	Located to the right of the squelch/ volume control. It is used to adjust the frequency in 50 kilohertz increments.
SCS/DCS/DCD	System no longer used.
FREQ MC	Indicates transmit and receive frequency.

3-17. Operating Procedures—VHF Command Radio Set (AN/ARC-73 or AN/ARC-73A).

a. Starting.

1. VHR RCVR and VHF SMTR circuit breakers—CHECK in.

2. Battery switch—ON.

3. Interphone control panel (INT)—Position switches as follows:

(a) Receivers 3 switch—UP.

(b) Transmit-interphone selector switch—3.

4. Power switch—ON.

5. Frequency control knobs—SELECT desired frequency.

6. Squelch control knob—ADJUST for minimum noise.

7. Volume control—As desired.

b. Stopping. Power switch—OFF.

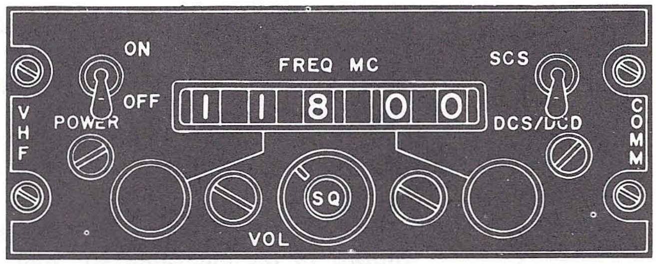


Figure 3-7. VHF Radio Control Panel (AN/ARC-73 or 73A)

3-18. VHF Radio Set (AN/ARC-134).

On designated helicopters, the vhf radio set (AN/ARC-134) provides voice communication between helicopters, and between the helicopter and fixed or mobile ground radio stations in the very-high frequency (vhf) range from 116.000 thru 149.975 mHz. The audio output and input of the AN/ARC-134 systems are amplified through the interphone control panels (INT). The vhf radio set includes the following components: the transceiver on the avionics shelf, the control panel (figure 3-8) on the console, and the vhf antenna on the underside of the helicopter (7, figure 3-5). The vhf radio set is powered by the 28-volt dc radio bus thru the VHF circuit breaker on the dc circuit breaker box.

3-19. Controls and Function, VHF Radio Set (AN/ARC-134). (See figure 3-8.)

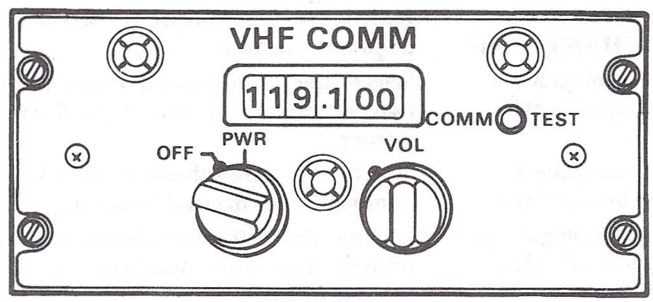


Figure 3-8. VHF Radio Control Panel (AN/ARC-134)

CONTROL/ INDICATOR	FUNCTION
Power Swtich	Outer ring of left concentric control. At PWR, power is applied to set. At OFF, set is inoperative.
Megahertz select knob	Left concentric knob selects frequency is megahertz. (Second and third digits in megahertz display).
Kilohertz, select knob	Right concentric knob selects frequency in kilohertz. (25 kHz spacing.)

Frequency indicator	Displays transmitter and receiver frequencies.
VOL control	Outer ring of right concentric control. Turning control clockwise increases receiver audio volume.
COMM/TEST	Disables squelch circuit. When pressed, noise should be heard in headset.

3-20. Operating Procedures—VHF Radio Set (AN/ARC-134).

a. Starting. Proceed as follows:

1. VHF circuit breaker—CHECK in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Set switches as follows:
   (a) Receivers 3 switch—UP.
   (b) Transmit-interphone selector switch—3.
4. Power switch—PWR.
5. Frequency select knobs—SELECT desired frequency.
6. VOL control—As desired.

b. Stopping. Power switch—OFF.

3-21. FM Radio Set (AN/ARC-131).

(On helicopters without AN/ARC-54.) The AN/ARC-131 fm radio set provides two-way fm communication and fm homing capability within the tactical frequency band of 30.00 and 75.95 mHz. Power to operate and control the fm set is provided by the 28-volt dc emergency bus thru the FM RADIO circuit breaker on the overhead circuit breaker panel. The course indicator (ID-1347/ARN) is also used in conjunction with this facility. Refer to paragraph 3-72 for a description of the course indicator.

3-22. Controls and Function, FM Radio Set (AN/ARC-131). (See figure 3-9.)

CONTROL/ INDICATOR	FUNCTION
Mode control	At OFF, power is removed from set. At T/R (transmit/receive), power is applied to the set and the set operates in the normal communications mode. RETRANS (retransmission) position is not used. HOME position provides fm homing capability.
VOL control	Adjusts the audio level of the set.
SQUELCH control	The three switch position are DIS, CARR, and TONE. At DIS, the squelch circuit is disabled. At CARR, the squelch circuit operates normally. The TONE position is not used in this installation.
Frequency control	The four frequency control knobs are used to select the digits of the operating frequency. The associated indication displays the frequency.

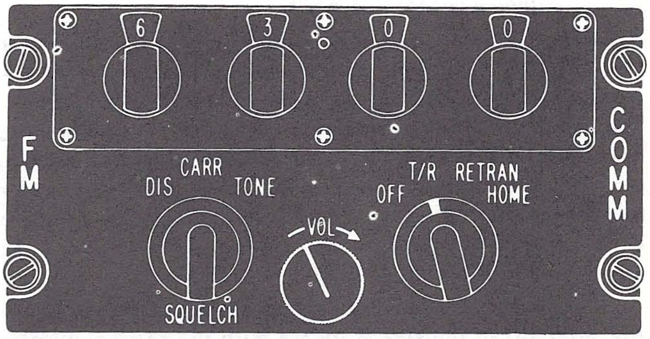


Figure 3-9. FM Radio Control Panel (AN/ARC-131)

3-23. Normal Operation—FM Radio Set.

The following paragraphs provide fm set operating procedures.

a. Starting.

1. FM RADIO circuit breaker—CHECK in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Set switches as follows:
   (a) Receivers 1 switch—ON.
   (b) Transmit-interphone selector switch—1.
4. Mode control—As required.
5. Warmup—20 seconds.

b. Two-Way Voice Communications.

1. Mode control—T/R.
2. Operating frequency—SET.

NOTE

A channel changing tone should be heard in the headset while the set is tuning. When the tone stops, the set is tuned.

3. Squelch control—CARR.

NOTE

The squelch control is normally placed at the CARR position. However, if communication is being conducted with a weak station, positioning the squelch control to DIS may improve reception.

c. Homing Operation

1. Mode control—HOME.
2. Operating frequency—SET.

NOTE

Any strong signal within the frequency range of the radio set can be used for homing. Sufficient signal strength is indicated when the OFF flag for the vertical pointer on the course indicator (ID-1347/ARN) retracts.

3. Squelch control—CARR.

d. In-Flight Homing Procedures. The course indicator (ID-1347/ARN) is used as the primary navigation instrument when the AN/ARC-131 is operated in HOME mode. The indicator only provides information on whether the helicopter is left, right, on a heading to the signal source, or over the signal source. The TO-FRom ambiguity window of the indicator will not function and the selective course feature is not available. Ambiguity is solved using either of the following methods:

1. Directional method. When the helicopter is heading inbound to the signal source with the vertical pointer centered, the indications are directional in that a change in heading to the right will cause the vertical pointer to drift to the left. Conversely, a change in heading to the left will cause the vertical pointer to drift to the right. When the helicopter is heading outbound from the signal source with the vertical pointer centered, the indications are nondirectional. A change in heading to the right will cause the vertical pointer to drift to the right or a change in heading to the left will cause the vertical pointer to drift left.

2. Build and fade method. If the signal source is transmitting a 150-Hz tone-modulated signal and the helicopter is inbound to the signal source, the tone will increase in intensity and decrease in intensity on an outbound heading.

3. The following additional characteristics may be observed during homing flights: the horizontal pointer, like the indicator OFF flags, may indicate signal strength and the pointer may be observed to rise and recede from the horizontal mark as the helicopter approaches and leaves the signal source. A dip in the horizontal pointer may or may not occur when passing over the station depending on the signal source, the helicopter speed, and altitude.

e. Stopping. Mode control—OFF.

f. Emergency Operation. If both ac systems fail, the set can be operated by setting the battery switch to EMERGENCY.

3-24. FM Radio Set (AN/ARC-54).

(On helicopters without AN/ARC-131.) The fm radio set is a lightweight airborne radio which provides 2-way communications and a homing capability within the tactical frequency modulation band of 30.00 to 69.95 megahertz on 800 preset channels. The range is limited under average conditions to approximately 80 miles. The audio input and output of the fm radio are amplified the interphone control panels (INT). The basic components of the fm radio set are a receiver-transmitter mounted on the avionics shelves, the fm radio control panel (figure 3-10) located on the console, the fm whip antenna (10, figure 3-5) mounted on the underside of the helicopter, the fm homing antenna mounted on the underside of the helicopter (8 figure 3-5), and the course indicator (ID-1347/ARN) located on the pilot's side of the instrument panel. Power to operate and control the fm radio set is provided by the 28-volt dc emergency bus thru the FM RADIO circuit breaker on the overhead circuit breaker panel. The course indicator (ID-1347/ARN) is also used with this facility. Refer to paragraph 3-72 for a description of it.

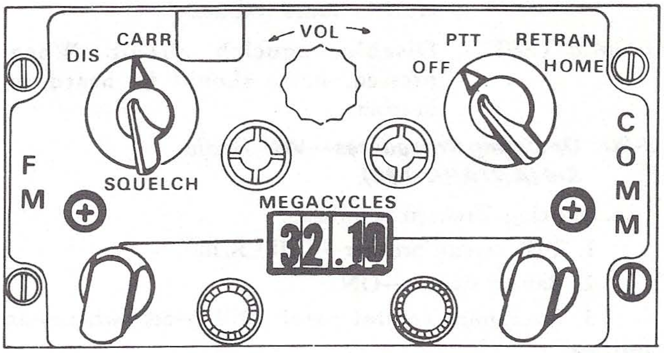


Figure 3-10. FM Radio Control Panel (AN/ARC-54)

3-25. Controls and Function, FM Radio Set (AN/ARC-54). (See figure 3-10.)

CONTROL/ INDICATOR	FUNCTION
Mode control	At OFF, power is removed from set. At PTT (push to test), power is applied to the set and the set operates in the normal communications mode. RETRANS (retransmission) position is not used. HOME position provides fm homing capability and normal communication.
VOL control	Adjusts the audio level of the set.
SQUELCH control	The three switch position are DIS, CARR, and TONE. At DIS, the squelch circuit is disabled. At CARR, the squelch circuit operates normally. The TONE position cannot be selected in this installation.
Frequency control	The two frequency control knobs are used to select the digits of the operating frequency. The associated indication displays the frequency. The control on the left selects the whole megahertz digits of the operating frequency. The right control selects the decimal-megahertz digits.

3-26. Normal Operation—FM Radio Set.

a. Starting.

1. FM RADIO circuit breaker—CHECK in.

2. Battery switch—ON.

3. Interphone control panels—Set switches as follows:

(a) Receiver 1 switch—ON.

(b) Transmit-interphone selector switch—1.

4. Mode control—As required.

5. Warmup—3 minutes.

b. Two-way voice communications.

1. Mode control—PTT.

2. Operating frequency—SET. A channel changing tone should be heard in the headset while the set is tuning. When the tone stops, the radio set is tuned.

3. Squelch control—CARR. If communication is being carried on with a weak station, positioning the squelch control at DIS may improve reception.

c. Homing Operation.

1. Mode control—HOME.

2. Operating frequency—SET. Any strong signal within the frequency range of the radio set can be used for homing. Sufficient signal strength is indicated when the OFF flag for the vertical pointer on the course indicator (ID-1347/ARN) retracts.

3. Squelch control—CARR.

d. In-Flight Homing Procedures. The course indicator (ID-1347/ARN) is used as the primary navigation instrument when operating the AN/ARC-54 in HOME mode. The indicator only provides information as to whether the helicopter is left, right, or on a heading to the signal source or over the signal source. The TO-FROM ambiguity window of the indicator will not function and the selective course feature is not available. Ambiguity is solved using either of the following methods:

1. Directional method. When the helicopter is heading inbound to the signal source with the vertical pointer centered, the indications are directional in that a change in heading to the right will cause the vertical pointer to drift to the left. Conversely, a change in heading to the left will cause the vertical pointer to drift to the right. When the helicopter is heading outbound from the signal source with the vertical pointer centered, the indications are nondirectional. A change in heading to the right will cause the vertical pointer to drift to the right or a change in heading to the left will cause the vertical pointer to drift left.

2. Build and fade method. If the signal source is transmitting a 150-hertz, tone-modulated signal and the helicopter is inbound to the signal source, the tone will increase in intensity and decrease in intensity on an outbound heading.

3. The following additional characteristics may be observed during homing flights: the horizontal pointer, like the indicator OFF flags, may indicate signal strength and the pointer may be observed to rise and recede from the horizontal mark as the helicopter approaches and leaves the signal source. A dip in the horizontal pointer may or may not occur when passing over the station depending on the signal source, the helicopter speed, and altitude.

e. Stopping. Mode control—OFF.

f. Emergency Operation—Fm Radio Set. If both ac systems fail, the fm radio set can be operated by setting the battery switch to EMERGENCY.

3-27. FM Liaison Set (AN/ARC-44) (61-2408 thru 61-2425).

The fm liaison set (AN/ARC-44) provides two-way air-to-air and air-to-ground communication within the tactical military frequency-modulation (fm) channels. The fm liaison set provides communication within the 24.0 to 51.9 megacycle frequency range on 280 preset channels. The range is limited to line sight up to distances of approximately 50 miles. The audio input and output of the fm liaison set (AN/ARC-44) are amplified through the interphone control panels (INT). The basic components of the fm liaison set are a receiver-transmitter, an fm control panel (figure 3-11), and an fm whip antenna on the underside of the helicopter (10, figure 3-5). Power to operate fm liaison set is supplied by the 28-volt dc emergency bus through a circuit breaker labeled ARC-44, on the overhead panel.

NOTE

The fm liaison set (AN/ARC-44) is disabled when the emergency interphone switch is moved to INPH EMER.

3-28. Controls and Function; FM Liaison Set (AN/ARC-44) (See figure 3-11.)

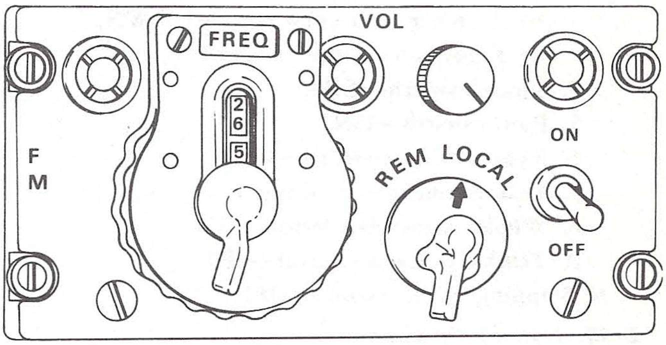


Figure 3-11. FM Radio Control Panel (AN/ARC-44)

CONTROL/ INDICATOR	FUNCTION
Power switch	On right side of panel, marked ON and OFF. At On, power is applied to set. At OFF, power is removed from the set.
Remote-local switch	Marked REM-LOCAL next to ON-OFF switch. Only the LOCAL position is used in this installation.
Volume control	The VOL control provides volume control for the fm receiver audio.

Megahertz selector	Knurled knob selects the first two numbers of the receiver transmitter operating frequency.
Tenth-megahertz selector	Inside knob selects the third number of the operating frequency.
Frequency indicator	Inside frequency selector displays the transmitter-receiver operating frequency.
Squelch control	On miscellaneous switch panel (figure 3-12). At ON, the squelch circuit is to the AN/ARC-44 radio. At OFF, the squelch circuit is disconnected to permit reception of weak signals.
ANTENNA position switch	On the miscellaneous radio switch panel (figure 3-12). At extend, the FM antenna is extended. At retract, the antenna is retracted. DC to operate the antenna is from the 28-volt radio bus.

3-29. Normal Operation—FM Liaison Set.

a. Starting. Use the following procedures when operating the AN/ARC-44 fm liaison set:

1. ARC-44 circuit breaker—CHECK in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Position switches as follows:
   (a) Receiver 1 switch—UP.
   (b) All other receiver switches—DOWN.
   (c) Transmitter selector switch—1.
4. Squelch switch—OFF.
5. Power switch—ON.
6. REM-LOCAL switch—LOCAL.
7. Volume control—As desired.
8. Whole megacycle selector—SET.
9. Tenth megacycle selector—SET.

b. Stopping. Power switch—OFF.

3-30. Homing Operation.

The fm liaison set (AN/ARC-44) provides a homing capability within the frequency range of the fm liaison set. The components of the system are: the antenna on the front of the helicopter (11, figure 3-5), a keyer unit which translates the incoming signals to coded D (-..) or U(..-) signals, and a switch panel (SA-474/AR) on the console (figure 3-13). DC to operate the system is provided by the 28-volt emergency bus through the ARA-31 circuit breaker on the dc circuit breaker box.

3-31. Controls and Function, FM Homing Switch Panel AN/ARA-31. The controls for the antenna group are on the fm homing switch panel on the console (see figure 3-13.)

CONTROL/ INDICATOR	FUNCTION
Switch 1	Two position switch marked HOME and COMM. At COMM, the fm liaison set operates in the normal communication mode. At HOME, the homing circuits in the fm liaison set are energized. The transmitter is deenergized, and the homing antennas are connected.
Switch 2, 3, 4, and 5	Not used in this installation.

3-32. Homing Procedures.

a. Use the fm liaison set for in-flight homing, as follows:

1. ARA-31 circuit breaker—CHECK in.
2. AN/ARC-44—ON. (Refer to paragraph 3-29 for the normal operating procedures.)
3. Switch panel (SA-474/AR)—Position switches as follows:
   a. Switch number 1—FM HOME.
   b. All other switches—OFF (down).
4. Operating frequency—Adjust.

b. Types of Signals Received While Homing. When the fm liaison set is operated in the FM HOME mode, three types of signals will be received in the headset:

1. A coded letter D (–..) will be received when the transmitting station is to the left of the helicopter within an arc of 180°.
2. A coded letter U (..–) will be received when the transmitting station is to the right of the helicopter within an arc of 180°.
3. A steady tone will be received anytime the helicopter is headed directly toward or directly away from the transmitting station.

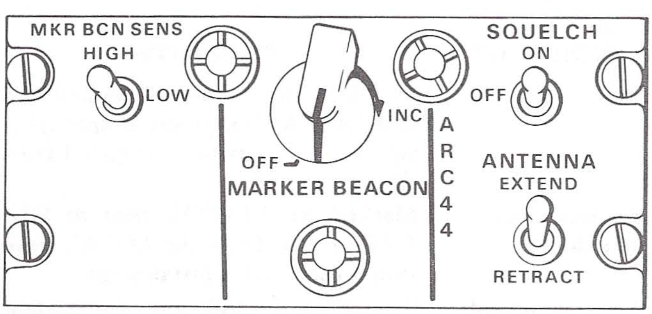


Figure 3-12. Miscellaneous Radio Switch Panel (61-2408 thru 61-2425)

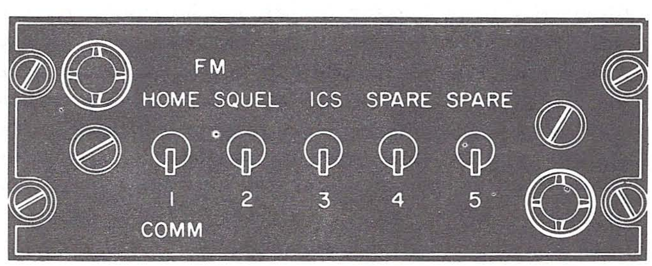


Figure 3-13. Homing Switch Panel (SA-474/AR)

NOTE

To solve ambiguity, perform a turn to the right or left until a coded signal is received. Determine from the coded signal whether the station is right or left of the helicopter then turn in this direction until the steady tone is again intercepted.

3-33. VHF Emergency Command Transmitter (T-366A/ARC).

The emergency vhf command transmitter (T-366A/ARC) is a five-channel, crystal-controlled, amplitude-modulated transmitter. It transmits voice signals for air-to-air or air-to-ground communication. The basic components of the vhf emergency command transmitter system are a transmitter on the avionic shelves, a VHF EMERG control panel on the console (see figure 3-14), the vhf antenna on the underside of the helicopter (7, figure 3-5), the vhf navigation set (AN/ARN-82) which is used as the receiver section of the system, and a vhf antenna relay which disconnects the vhf transmitter-receiver (AN/ARC-73, or AN/ARC-73A) from the antenna when the T-366A/ARC is being used. (Refer to paragraph 3-47 for a description of the AN/ARN-82.) The output of the T-366A/ARC is thru the interphone control panels (INT). Power to control and operate the emergency vhf command transmitter is supplied by the 28-volt dc emergency bus thru a circuit breaker labeled EMER VHF, located on the dc circuit breaker box.

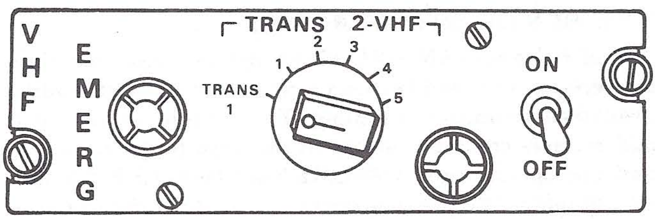


Figure 3-14. VHF Emergency Transmitter Control Panel (T-366A/ARC)

3-34. Controls and Function, VHF Emergency Command Transmitter (T-366A/ARC). (See figure 3-14.)

CONTROL/ INDICATOR	FUNCTION
Power switch	ON-OFF power switch on right side of panel. At ON, power is supplied to set.
Transmitter channel selector	This rotary selector switch has six positions: TRANS 1; TRANS 2-VHF; 1 (121.5), 2 (121.9), 3 (122.1), 4 (122.5) and 5 (122.7). (See figure 3-14.) At TRANS 1, transmissions are made over the vhf transmitter-receiver (AN/ARC-73 or AN/ARC-73A). When the selector is moved to any of the other five positions, the emergency vhf command transmitter is in use on one of the above frequencies.

3-35. Operating Procedures—Emergency VHF Command Transmitter.

a. Starting. Use the following procedures when operating the emergency vhf command transmitter and vhf navigation set (AN/ARN-82).

1. EMER VHF and VOR circuit breakers—CHECK in.
2. Battery switch—ON.
3. Vhf navigation set (AN/ARN-82)—ON.
4. Channel selector switches—As required.
5. Emergency vhf command transmitter—ON.
6. Transmitter channel selector—As desired.

NOTE

When the transmitter channel selector is moved to one of the five numbered or frequency positions, the vhf antenna is connected to the emergency vhf command transmitter by the antenna relay when the transmitter is keyed. Also, regardless of the position of the vhf emergency transmitter power switch, it will not be possible to receive VOR audio unless the RECEIVERS 3 switch on the INT panel is UP.

7. Interphone control panel (INT)—Position switches as follows:

(a) Receiver 3 switch—UP.

NOTE

The RECEIVERS NAV switch need not be positioned up while operating the emergency vhf transmitter and vhf navigation set because the automatic coupling is accomplished at the VHF EMER control panel.

(b) Transmit-interphone selector switch—3.

b. Stopping.

1. Vhf navigation set (AN/ARN-82)—OFF.
2. Emergency vhf command transmitter—OFF or TRANS 1.

c. Emergency Operation. If both ac systems fail, operate the emergency vhf command transmitter and vhf navigation set (AN/ARN-82) by moving the battery switch to EMERGENCY.

3-36. Voice Security System (TSEC/KY-28).

The voice security system (TSEC/KY-28) is used as auxiliary equipment. The system provides voice security (X mode) operation. The C-8157/ARC voice security system control panel (figure 3-15) on the console, is used with the TSEC/KY-28 and the fm radio set. Transmission of reception in plain or ciphony mode can be done without retransmission units. Only one aircraft at a time can use a voice security system and constant listening surveillance must be maintained before trying to use the system. Upon receipt of a message, the set will switch automatically to the receiver mode. This will be indicated by a short beep heard in the headset. Upon loss of signal, the set will automatically return to standby. Power to operate the voice security system is supplied by the 28-volt dc emergency bus thru the KY-28 circuit breaker on the dc circuit breaker box.

3-37. Controls and Function, Voice Security System Control Panel (C-8157/ARC). (See figure 3-15.)

CONTROL/ INDICATOR	FUNCTION
Power switch	In up position, power is applied to the set. And the amber POWER ON indicator lamp will come on.
PLAIN—CIPHER switch	Two position lever-lock switch. At PLAIN, normal communications can be conducted and the red indicator lamp will be on. At CIPHER, ciphered communications can be conducted and the green indicator lamp will be on.
RE-X-REG switch	Two position lever-lock switch. At REG, ciphered or clear speech can be conducted. At RE-X-, ciphered communications thru a retransmission unit can be accomplished.
ZEROIZE switch	Two position switch held OFF by a spring-loaded cover. Switch used in an emergency to disable the KY-28 cipher equipment.
KY-28 indicator light	On the lower right corner of center instrument panel. The green light comes on during ciphered communications.

3-38. Normal Operation.

The following paragraphs provide voice security system operating procedures.

a. Starting.

1. KY-28 circuit breaker—CHECK in.
2. FM RADIO circuit breaker—CHECK in.

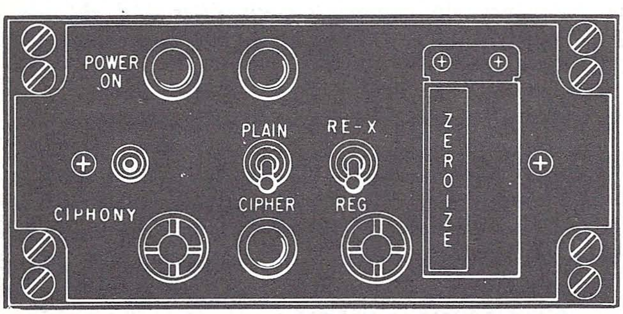


Figure 3-15. C-8157/ARC Voice Security System Control Panel (TSEC/KY-28)

3. Battery switch—ON.
4. Control panel power switch—ON (up). Amber indicator light on.
5. Trigger switch—Press to second detent momentarily to clear the intermittent tone. Set automatically goes to standby mode when the tone is cleared.
6. PLAIN-CIPHER switch—As required. At PLAIN, a red indicator light comes on. At CIPHER, a green indicator light comes on.
7. RE-X-REG switch—As required.
8. Trigger switch—PRESS and hold at second detent. If the switch is at CIPHER, wait approximately ½ second. At that time, a beep will be heard. The set is now ready for use as a transmitter. If the switch is at PLAIN, transmit the message immediately after pressing the trigger switch.

NOTE

The trigger switch must be released to receive messages.

b. Stopping. Power switch—OFF (down).

c. Emergency Operation (Neutralization). Emergency operation is used only when the cipher data is subject to compromise by an unfriendly agent.

1. ZEROIZE switch cover—LIFT and hold up.
2. ZEROIZE switch—UP.

3-39. HF Radio Set (AN/ARC-102).

The hf radio set (AN/ARC-102) provides communication between aircraft, and between aircraft and fixed or mobile ground communication stations. The hf radio set transmits and receives communications in the high frequency band and can operate over a 28-mHz band between 2.000 and 29.000 mHz. The primary operating mode of the hf radio set is the single sideband (ssb) mode. However, the set can transmit a compatible amplitude-modulation (am) signal so that communication with stations without the ssb capability is possible. The audio input and output from the hf radio set are amplified thru the interphone control panel (INT). The hf radio set includes the following components: a receiver-transmitter, an hf control panel (figure 3-16), an antenna (1, figure 3-5), and an antenna coupler. Power to operate and control the hf radio set is supplied by the 28-volt dc radio bus thru one or two HF circuit breakers on the dc circuit breaker box.

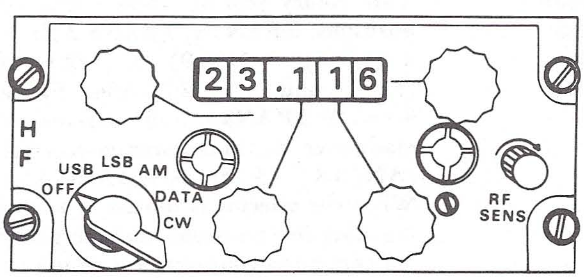


Figure 3-16. HF Radio Control Panel (AN/ARC-102)

CAUTION

If acoustical insulation is installed around the avionic shelves, it must be removed when ambient temperature exceeds 27°C. When the AN/ARC-102 radio is operating, the insulation must be removed when ambient temperature exceeds 21°C.

3-40. Controls and Function, HF Radio Set (AN/ARC-102). (See figure 3-16.)

CONTROL/ INDICATOR	FUNCTION
Mode selector switch	Six position switch used to turn the set on and select operating mode as follows: USB (upper sideband), LSB (lower sideband), AM (amplitude modulation), DATA and CW (not used in this installation).
Megahertz select switch	This 28 position knob selects a frequency from 2 to 29 megahertz in 1-megahertz steps.
One-hundred kilohertz select knob	This 10-position rotary switch selects a frequency from 0.0 to 0.9 megahertz in 0.1 megahertz steps.
Ten kilohertz select knob	This 10-position rotary switch selects a frequency from 0.00 to 0.09 megahertz in 0.01 megahertz steps.
One-kiloherts select knob	This 10-position rotary switch selects a frequency from 0.00 to 0.09 megahertz in 0.01 megahertz steps.
RF SENS (sensitivity control	This control is used to adjust the rf gain of the receiver.

3-41. Normal Operation—HF Radio Set.

The following paragraphs provide hf set operating instructions.

a. Starting.

1. HF circuit breaker(s)—CHECK in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Set switches as follows:
   (a) Receivers 4 switch—UP.
   (b) All other receiver switches—DOWN.
   (c) Transmit-interphone selector switch—4.
4. Mode selector switch—AM, USB, or LSB.
5. Operating frequency—As desired.

NOTE

If the mode selector switch was moved from OFF to an operating mode and the required operating frequency was already set, rotate the 1-kilohertz select knob one digit off frequency and then back to the operating frequency. This will allow the receiver-transmitter to return to the operating frequency.

6. Trigger switch—Press momentarily.

NOTE

Wait for the receiver-transmitter and antenna coupler units to tune. A 1,000-Hz tone will be heard in the headset until tuning is complete.

7. RF SENS control—Adjust so that the noise in the headset is barely audible.

b. Stopping. Mode selector switch—OFF.

SECTION II NAVIGATION EQUIPMENT

3-42. VHF Navigation Set (AN/ARN-30D, -30E).

The AN/ARN-30D or -30E is on 61-2408 thru 66-086. The vhf navigation set is an airborne, 190-channel, navigation-communication radio receiving set, with a frequency range of 108.00 thru 126.90 megahertz. The principal function of the AN/ARN-30D is to receive and interpret vhf omnidirectional range (VOR) and localizer signals. The principal function of the AN/ARN-30E is to receive and interpret vhf omnidirectional range (VOR) and localizer signals and, in addition, tune an associated glide slope receiver. In addition to the preceding function, the equipment is used as the receiver section of the vhf emergency communication system. (Refer to paragraph 3-33.) The audio output from the AN/ARN-30D, -30E is amplified thru the signal distribution panel (INT). Power to operate the vhf navigation equipment is supplied by the 28-volt dc emergency bus thru a circuit breaker labeled VOR, on the dc circuit breaker box.

3-43. Controls and Function, VHF Navigation Set (AN/ARN-30D, -30E). (See figure 3-17.)

CONTROLS/ INDICATOR	FUNCTION
Volume control	Marked OFF-VOL. Clockwise rotation from OFF, applies power to the set and increases audio.
Megahertz select switch	This switch sets the frequency in 1 megahertz increments between 108 and 126 only. The frequency is displayed in the left side of the indicator.
Fractional megahertz select switch	This switch sets the frequency in 0.1 increments from 0.0 to 0.9 mHz. The frequency selected is displayed in the right side of the indicator.
Squelch control	Used to control squelch circuits. Clockwise rotation increases squelch and subdues weak signals.

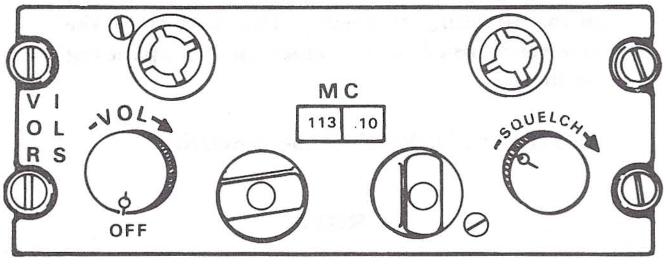


Figure 3-17. VHF Navigation Control Panel (AN/ARN-30D, -30E)

3-44. Course Indicator (IN-14 or ID-453). Refer to paragraph 3-70.

3-45. Radio Magnetic Indicator (ID-250/ARN). Refer to paragraph 3-74.

3-46. Gyrosyn Compass Indicator (ID-998/ASN). Refer to paragraph 3-76.

3-47. Normal Operation — Vhf Navigation Set.

a. Starting procedures are as follows:

1. ARN-30 or VOR circuit breaker—CHECK in.
2. Battery switch—ON.
3. Signal distribution panel (INT)—Position switches as follows:
   a. Receiver NAV switch—UP.
   b. All other receiver switches—DOWN.
4. Volume control switch—ON. (Turn cw for desired volume).
5. Squelch switch—FULL ccw.
6. Warmup—1 minute.
7. Megahertz channel selector switch—SET frequency.
8. Fractional megahertz channel selector switch—SET frequency.
9. Tune and identify a known station; check for the corner bearing indication.

b. Stopping. Volume control switch—OFF.

c. Emergency operation. On 61-2408 and subsequent an fm dynamotor failure will have no effect on the INT panels. If both ac systems fail, the vhf navigation set AN/ARN-30D or -30E can be operated by moving the battery switch to EMERGENCY.

3-48. VHF Navigation Set (AN/ARN-82 or AN/ARN-82A).

The vhf navigation set (AN/ARN-82 or AN/ARN-82A) receives very-high frequency omnirange (vor) signals and localizer signals in the frequency range of 108.00 to 117.95 mHz and presents this information on the ID-250A/ARN, ID-998/ASN, and ID-1347/ARN or ID-1347A/ARN indicators. Vhf navigation set AN/ARN-82A has been designed to suppress the effects of rotor modulation on the ID-1347A/ARN course deviation indicator. The set can also be used as a communications receiver in the frequency range of 111.80 and 126.95 mHz. The audio output of the vhf navigation set is amplified by the interphone control panel (INT). Components of the vhf navigation system include a receiver on the avionic shelves, the control panel (figure 3-18) on the console, and two vhf navigation antennas (split loops) on each side of the helicopter (2, figure 3-5). Power to operate and control the vhf navigation set is supplied by the 28-volt dc emergency bus thru the VOR circuit breaker on the dc circuit breaker box:

WARNING

When operating the AN/ARN-82 navigation set in the ILS frequency range, the vertical pointer on the ID-1347/ARN course indicator will intermittently fluctuate up to one-half scale when tracking on the localizer course. It is recommended that the AN/ARN-82 navigation set not be used to perform localizer only ILS approaches during instrument conditions.

3-49. Controls and Function, VHF Navigation Set (AN/ARN-82 or AN/ARN-82A). (See figure 3-18.)

CONTROL/ INDICATOR	FUNCTION
Power switch	This three-position switch forms the outer ring of the left concentric control. At OFF, power is removed from the set. At PWR, the set is operative. The TEST position is used for maintenance purposes.
VOL control	This control forms the outer ring of the right concentric control. It is used to adjust the audio level.

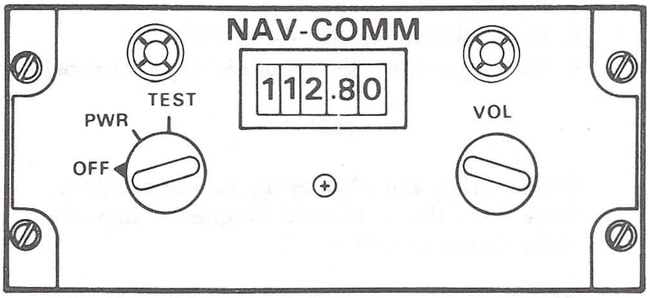


Figure 3-18. VHF Navigation Control Panel (AN/ARN-82 or AN/ARN-82A)

Megahertz selector	This control forms the inner part of the left concentric control. It is used to select the megahertz digits of the operating frequency.
Kilohertz selector	This control forms the inner part of the right concentric control. It is used to select the kilohertz digits of the operating frequency.
Frequency indicator	This indicator displays the navigation or communication frequency selected.

3-50. Course Indicator (ID-1347 or 1347A/ARN).

The course indicator (ID-1347 or 1347A/ARN) (figure 3-24) is on the pilot's section of the instrument panel. Refer to paragraph 3-72 for a description of the course indicator.

3-51. Radio Magnetic Indicator (ID-250A/ARN).

The radio magnetic indicator (ID-250A/ARN) (figure 3-25) is on the copilot's section of the instrument panel. Refer to paragraph 3-73 for a description of the radio magnetic indicator.

3-52. Gyrosyn Compass Indicator (ID-998/ASN).

The gyrosyn compass indicator (ID-998/ASN) is on the pilot's section of the instrument panel. Refer to paragraph 3-76 for a description of the gyrosyn compass indicator.

3-53. Normal Operation—VHF Navigation Set.

The following paragraphs provide vhf set operating procedures.

a. Starting.

1. VOR circuit breaker—CHECK in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Set switches as follows:
   (a) Receivers NAV switch—UP.
   (b) All other receiver switches—DOWN.
4. Power switch—PWR.
5. Megahertz and kilohertz selectors—SET frequency.
6. Volume control—ADJUST.
7. Tune control—SET frequency of a known radio station; check for the correct bearing indication.

b. Stopping. Power switch—OFF.

c. Emergency Operation—Vhf Navigation Set. If both ac systems fail, the vhf navigation set can be operated by setting the battery switch to EMERGENCY.

3-54. Direction Finder Set (AN/ARN-59V).

(On 61-2408 thru 66-086.) The direction finder set (AN/ARN-59V) is an airborne radio compass system that automatically provides a visual indication of the direction from which radio signal is received. It provides for aural reception of signals in the 190 to 1,750 kilohertz (khz) frequency range in three selectable bands. Audio output from the AN/ARN-59(V) is amplified thru the interphone control panels (INT). The AN/ARN-59(V) system consists of a receiver on the avionic shelves, a control panel (figure 3-19) on the console and a sense antenna and loop antenna (4 and 5, figure 3-5) on the underside of the helicopter.

NOTE

On 64-13143 and subq, the adf sense antenna is on the underside of the helicopter, covering the left loop antenna. In this configuration, the second direction finder set (on 61-2408 thru 61-2425) can only be operated in the LOOP mode.

Provisions are available on 61-2408 thru 61-2425 to incorporate an additional direction finder set (AN/ARN-59(V)). Power to operate the AN/ARN-59(V) is supplied by the 28-volt dc radio bus thru a circuit breaker labeled ADF NO. 1 and ADF NO. 2.

3-55. Controls and Function, Direction Finder Set (AN/ARN-59V) (See figure 3-19.)

CONTROL/ INDICATOR	FUNCTION
Beat frequency Oscillator switch	Two position switch marked BFO and ON. At ON, continuous wave signals can be heard. At BFO off, continuous wave signals cannot be heard.
Band select switch	This switch is marked MC BAND. It is used to select the operating frequency band.
Volume control	The volume control is to the right of the band select switch. It is marked OFF and VOL. When rotated from OFF, power is applied to the set. Further rotation increases audio level when the function switch is in COMP, ANT, or LOOP.
Function switch	This is the upper right switch. It is marked COMP, ANT, and LOOP. At COMP, the set operates as a radio compass using the loop and sense antennas. At ANT the set operates from the sense antenna, and at LOOP the set operates from the loop antenna.

Tuning meter — The meter is below the function switch. It is marked TUNE TO MAX and is used to facilitate accurate tuning of the receiver.

LOOP switch — This switch is below the tuning meter. The switch positions the loop antenna when the function switch is at COMP or LOOP. Moving the switch left causes the loop antenna to turn left. The opposite results by moving the switch right.

Tuning crank — The tuning crank is used to turn the receiver. Turning the crank clockwise causes the tuning dial to move to the lower end of the band. Each band is covered by 29 turns of the crank.

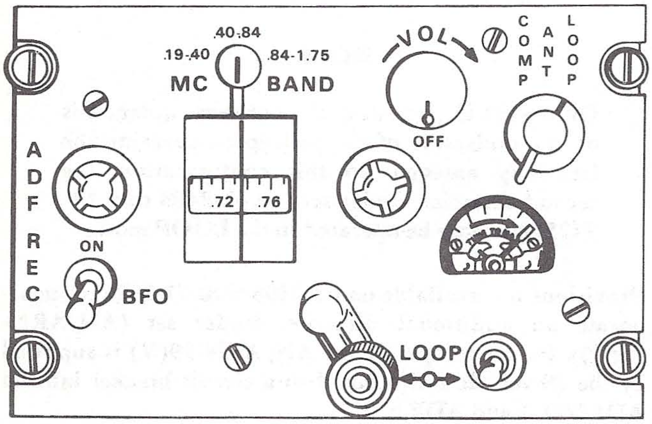


Figure 3-19. Direction Finder Control Panel (AN/ARN-59V)

3-56. Radio Magnetic Indicator (ID-250A/ARN). Refer to paragraph 3-74.

3-57. Gyrosyn Compass Indicator (ID-998/ASN). Refer to paragraph 3-76.

3-58. Normal Operation — Direction Finder Set.

a. Starting:

1. ARN-59 No. 1 and ARN-59 No. 2 or ADF No. 1 and ADF No. 2 circuit breakers—Check in.

2. Battery switch—ON.

3. Interphone control panel (INT)—Position switches as follows:

a. Receiver NAV switch—UP.

b. All other receiver switches—DOWN.

4. Volume control—Rotate fully cw.

5. Tuning dial alignment—Check. (Select the .19 to .40 megahertz band and turn the tuning crank cw to the stop. Check that the alignment line is under the reference line. If not, note the difference and apply to future settings.)

6. Bfo switch—BFO (off).

7. Function switch—ANT.

8. Band selector switch—As desired.

9. Turning crank—Tune and identify a local radio.

NOTE

While tuning and identifying the radio facility, check that the published frequency appears under the reference line.

10. Tuning meter—TUNE TO MAX deflection.

11. Volume control—ADJUST to a comfortable level.

12. Function switch—LOOP.

13. BFO switch—ON.

14. Loop switch—CHECK. (Locate the aural null and check for correct bearing indication.)

15. Function switch—COMP. (Check for CORRECT bearing indication.)

16. Bfo switch—BFO (off).

b. Automatic Direction Finding (Adf). When the AN/ARN-59(V) is used for homing, tracking, or position fixing, use the following procedures:

1. Volume control—ON.

2. Bfo switch—BFO (off).

3. Function switch—ANT.

4. Band selector switch—As desired.

5. Turning crank—Select desired frequency and identify radio facility.

6. Function switch—COMP. (Check bearing to the radio facility.)

7. Volume control—ADJUST to a comfortable level.

8. Tuning meter—TUNE TO MAX and recheck indicated bearing.

c. Radio Range. The following procedures are to be used when employing the AN/ARN-59(V) for radio range orientation or navigation:

1. Volume switch—On.

2. Bfo switch—BFO (off).

3. Function switch—ANT.

4. Band selector switch—As desired.

5. Tuning crank—Select desired frequency and identify radio facility.

6. Volume control—ADJUST to a comfortable level.

d. Aural Null. Navigation using the radio direction finding procedures should be considered an alternate method. Aural null is generally used as a synonym for rdf. Aural null is the absence of audible sound or, at times, the area of minimum reception. The following procedures should be used when conditions dictate a need for aural null navigation:

1. While operating with the function switch in ANT and BFO (off), tune and identify the desired radio station.

2. Function switch—LOOP.

3. Bfo switch—ON.

4. Loop switch—ROTATE for maximum reception.

5. Tuning crank—RETUNE for high pitch (solid tone).

6. Loop switch—ROTATE and locate the null.

NOTE

It will be necessary to determine the signal source direction (ambiguity) before establishing a track to the radio facility.

7. Volume—ADJUST. (Maintain a null width of 5° to 8°.)

NOTE

When inbound to the radio station, it will be necessary to decrease the volume to maintain a null width of 5° to 8°. The procedure is opposite when heading outbound from the station.

e. Stopping. Volume Control—OFF.

3-59. Direction Finder Set (AN/ARN-83).

The direction finder set (AN/ARN-83) is an airborne automatic direction finder (adf) operating within the frequency range of 190 to 1,750 kHz. The equipment provides visual and aural facilities for adf homing, radio range navigation, and position fixing. It is used as a navigational radio aid to continuously and visually indicate a magnetic bearing of a radio station while providing aural reception. The bearing of a radio station is displayed on the ID-250A/ARN and ID-998/ASN indicators. The audio output of the direction finder set is amplified by the interphone control panel (INT). Components of the direction finder system consist of a receiver on the avionic shelves, a control panel on the console (figure 3-20), and a sense and loop antenna mounted on the underside of the helicopter (4 and 5, figure 3-5). Power to operate and control the direction-finder set is provided by the 28-volt dc radio bus thru ADF circuit breaker on the dc circuit breaker box.

3-60. Controls and Function, Direction Finder Set (AN/ARN-83). (See figure 3-20.)

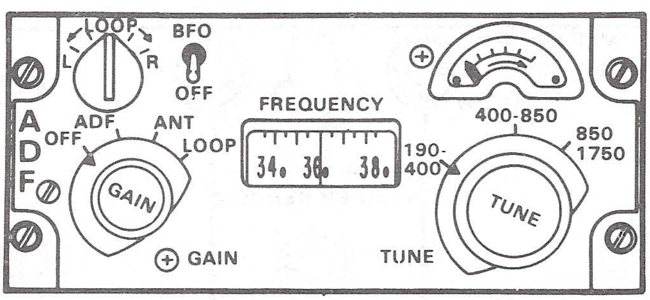


Figure 3-20. Direction Finder Control Panel (AN/ARN-83)

CONTROL/ INDICATOR	FUNCTION
Function switch (OFF, ADF, ANT, LOOP)	Energizes, deenergizes, and selects the operating mode. In the OFF position, deenergizes the direction finder set. In the ADF, ANT, and LOOP positions, energizes the direction finder set in addition to selecting type of operation. The ADF position selects automatic operation with loop and sense antennas to permit operation for homing or automatic direction finding. In the ANT position, permits radio station reception for radio range navigation, or for use as a broadcast receiver. The LOOP position, used in conjunction with LOOP switch, permits aural null homing and manual direction finding.
GAIN control	Adjusts audio level.
LOOP switch	When function switch is set to LOOP position, LOOP switch enables manual rotation of adf fixed loop antenna electromagnetic field and bearing indicator pointer 360 degrees left or right for manual direction finding, or when using aural null for homing to a radio station.

Switch Position	Action
Center position	Removes manual direction finding mode.
First position L (left) or R (right) of center	Permits slow rotation of bearing indicator pointer 360 degrees left or right.
Second position L (left) or R (right) of center	Permits fast rotation of bearing indicator pointer 90 degrees left or right.

NOTE

Returning LOOP switch to center position stops rotation of bearing indicator pointer at any desired position.

CONTROL/ INDICATOR	FUNCTION
Range switch	Selects one of three frequency ranges: 190-400 kilohertz, 400-850 kilohertz, or 850-1,750 kilohertz.
TUNE control	Permits tuning receiver frequency within range selected by range switch.

BFO-OFF switch	Turns beat frequency oscillator on in BFO position for reception of continuous wave (cw) signals.
Tuning meter	Indicates relative signal strength of the station to which the set is tuned.
Frequency indicator	Displays the frequency to which the set is tuned.

3-61. Radio Magnetic Indicator (ID-250A/ARN).

The radio magnetic indicator (ID-250A/ARN) (figure 3-25) is on the copilot's side of the instrument panel. Refer to paragraph 3-73 for a description of the radio magnetic indicator.

3-62. Gyrosyn Compass Indicator (ID-998/ASN).

The gyrosyn compass indicator (ID-998/ASN) (figure 3-19) is on the pilot's side of the instrument panel. Refer to paragraph 3-76 for a description of the gyrosyn compass indicator.

3-63. Normal Operation—Direction Finder Set.

The following paragraphs discuss df set operation.

a. Starting.

1. ADF circuit breaker—Check in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Set switches as follows:
   (a) Receivers NAV switch—UP.
   (b) All other switches—Down.
   (c) Function switch—ADF. (Allow 5 minutes for warmup.)
4. BFO switch—OFF.
5. Range switch—As required.
6. Tune control—Set frequency.
7. Gain control—Adjust.

b. Adf Operation.

1. Function switch—ADF.
2. Tune control—Set frequency of a known station; then tune for maximum signal strength on the tuning meter. Check for the correct bearing indication.

c. Radio Range.

1. Function switch—ANT.
2. Tune control—Set frequency; then tune for maximum signal strength on the tuning meter.

d. Aural Null.

1. Function switch—ANT.
2. Tune control—Set frequency; then tune for maximum signal strength on the tuning meter.
3. BFO switch—BFO (on). Adjust the GAIN control for minimum audio output. Tune for a zero beat on the radio station. Then turn the BFO switch OFF.
4. Function switch—LOOP.
5. Loop switch—Rotate for maximum reception.

3-64. Marker Beacon Receiver (R-1041/ARN).

The marker beacon receiver (R-1041/ARN) is a fixed frequency (75 mHz) receiver which receives signals from a ground marker beacon transmitter to determine helicopter position. The audio output of the marker beacon receiver is amplified thru the interphone control panel (INT). The marker beacon system includes of an OFF-INC control switch, a marker beacon indicator light on the instrument panel, a HI-LOW SENS switch above the OFF-INC switch, a receiver on the avionic shelves, and an antenna attached to the underside of the helicopter (3, figure 3-5). Power to operate and control the marker beacon receiver is supplied by the 28-volt dc radio bus thru the MKR BCN circuit breaker on the dc circuit breaker box.

3-65. Controls and Function, Marker Beacon Receiver (R1041/ARN). (See figure 3-21.)

CONTROL/ INDICATOR	FUNCTION
Control switch	When this switch is turned clockwise from OFF, power is applied to the set. When switch is rotated toward INC, marker beacon audio signal volume is increased.
MKR BCN SENS	At LOW, the marker beacon beam width is standard. At HIGH, the marker beacon beam width is wider.
Marker beacon indicator	Blue light comes on when passing thru marker beacon beam.

3-66. Normal Operation—Marker Beacon Receiver.

a. Starting.

1. MKR BCN circuit breaker—CHECK in.
2. Battery switch—ON.
3. Interphone control panel (INT)—Set switches as follows:
   (a) Receivers NAV switch—UP.
   (b) All other switches—DOWN.
4. Control switch—INC (adjust volume).
5. MKR BCN SENS switch—As required.

b. Stopping. Control switch—OFF.

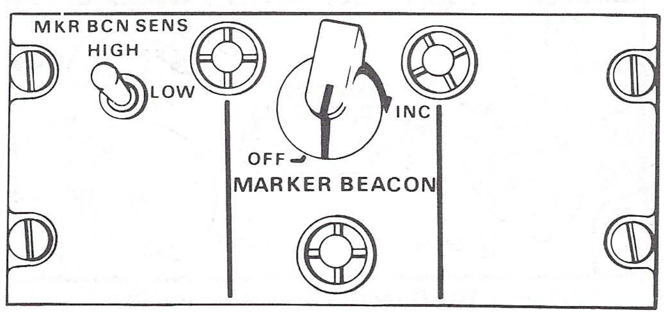


Figure 3-21. Marker Beacon Control Panel (64-13106 and subsequent)

3-67. Helicopter Magnetic Compass System (J-2K or Universal Heading Reference System (AN/ASN-43).)

(The J-2 compass system is on 61-2408 thru 64-13165. The AN/ASN-43 compass system is on 65-7966 and subsequent.) The helicopter compass system, either J-2 or AN/ASN-43, is a direction-sensing system which provides a visual indication of the magnetic heading of the helicopter with respect to the magnetic meridian. The heading information is displayed on the radio magnetic indicator (ID-250/ARN) and the gyrosyn compass indicator (ID-998/ASN). The display is used in navigation to maintain flight path direction. Power to operate and control the J-2 compass system is supplied by the 115-volt, 3-phase ac transformer and the 28-volt dc primary bus through two circuit breakers labeled J-2 COMP on the ac circuit breaker box and one circuit breaker on the overhead circuit breaker panel, labeled J-2 COMP DC. Power to operate and control the AN/ASN-43 compass system is supplied by the 115-volt, 3-phase, ac transformer thru the RMI and COMP circuit breakers on the ac circuit breaker box.

NOTE

Compass alignment is much slower with the AN/ASN-43 compass system.

3-68. Controls and Function, Universal Heading Reference System (AN/ASN-43). (See figure 3-22.)

CONTROL/ INDICATOR	FUNCTION
LATITUDE switch	Two position switch on directional gyro on avionics shelf. This switch is used to correct for proper gyro precession for the hemisphere of operation. N for northern hemisphere. S for southern hemisphere.
LATITUDE control switch	Rotary control on directional gyro labeled 0 to 90. It is used to set the local latitude into the directional gyro for free gyro operation.
COMPASS SLAVING switch	On both pilots instrument panels. (See figure 2-7.) When either switch is at IN, the gyro indicators are slaved to the directional gyro and indicate the magnetic heading of the helicopter. When both switches are at OUT, the compass card on the gyrosyn compass indicator (ID-998/ASN) acts as a turn indicator. The OUT position is used primarily in polar regions where magnetic indications may be unreliable.

3-69. Navigation Instruments.

In the following paragraphs, the navigation instruments and associated controls and indicators will be discussed.

3-70. Course Indicator (IN-14 or ID-453).

(On 61-2408 thru 66-086.) The course indicator (IN-14 or ID-453) (figure 3-23) is on the pilot's instrument panel below the ID-998/ASN indicator. The IN-14 or ID-453 is a combination instrument with three functions: a course deviation indicator, a glide slope deviation indicator, a course selector, and a TO-FROM indicator. Two flag alarms, are installed, one flag indicates localizer or radial signal reliability or signal strength if the indicator is used during fm homing operations. The other flag indicates glide path signal reliability (not operable in this installation) and an over-station indication if the indicator is used during fm homing operation. (Refer to paragraph 3-26.) The flag alarm for the glide path pointer will always be visible unless the fm radio set (AN/ARC-54 or AN/ARC-131) is operated in the homing mode. Glide path information is not available in this helicopter. The localizer pointer (vertical pointer) moves left or right to furnish steering information. The TO-FROM meter (ambiguity meter) indicates whether the helicopter is on the inbound or outbound radial selected for the received signal. The course indicator dial is graduated in a compass scale, 360° in 2° increments. A knurled knob is on the left corner of the course indicator. Rotating the knob causes the course pointer (triangular pointer) and the reciprocal pointer (ball pointer) to move through an arc of 360°. The course selector knob is used to determine the line of position from the station and also to select a course to or from the station.

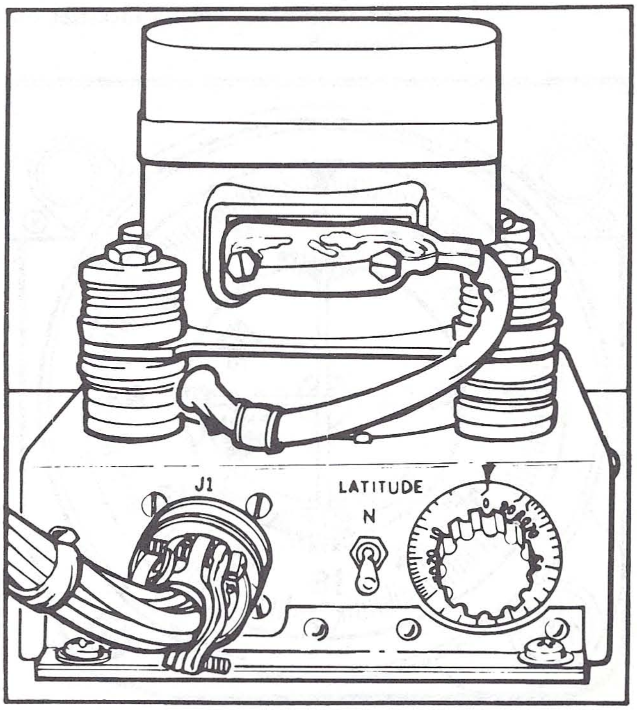


Figure 3-22. Directional Gyro (CN-998/ASN-43)

316-520 O - 80 - 8

3-71. Controls and Function, Course Indicator (1N-14 or 1D-453). Refer to paragraph 3-69.

3-72. Course Indicator (ID-1347/ARN or ID-1347A/ARN).

(On 66-087 and subsequent.) The course indicator is on the pilot's instrument panel below the ID-998/ASN indicator (see figures 2-7 and 3-24). The indicator displays vor navigation information from the vhf navigation set (AN/ARN-82) or from the fm radio set (AN/ARC-54) (AN/ARC-131).

3-73. Controls and Function, Radio Magnetic Indicator, (ID-1347/ARN or ID-1347A/ARN). (See figure 3-17.)

CONTROL/ INDICATOR	FUNCTION
OBS (omni bearing selector)	Rotates course card to select desired course for vor navigation.
Course index	Indicates selected radial for vor navigation.
Reciprocal course index	Indicates radial 180 degrees from selected radial.
Course card	Course card is driven by OBS until desired vor radial is directly below course index.
TO/FRom indicator	Indicates whether selected radial would take helicopter to (TO) or away from (FR) vor station. Does not operate on fm homing.
Course deviation indicator	Indicates direction of deviation from selected vor radial or fm signal source during fm homing. Indicates deviation from beam during localizer only approach.

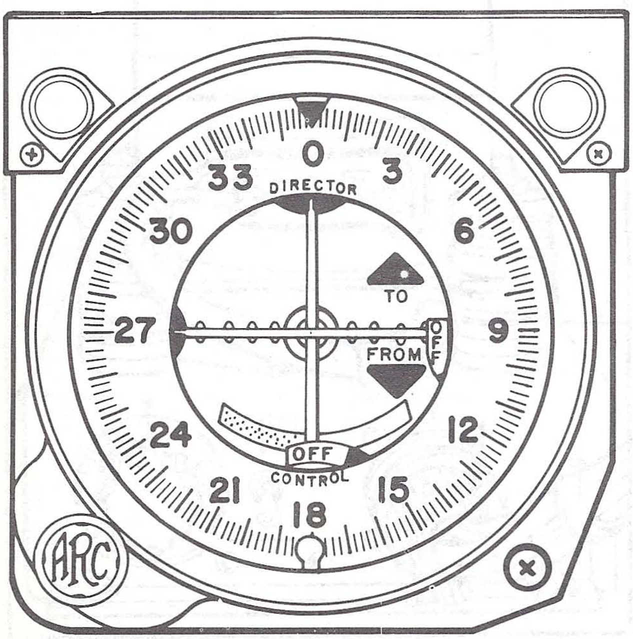


Figure 3-23. Course Indicator (IN-14- or ID-453)

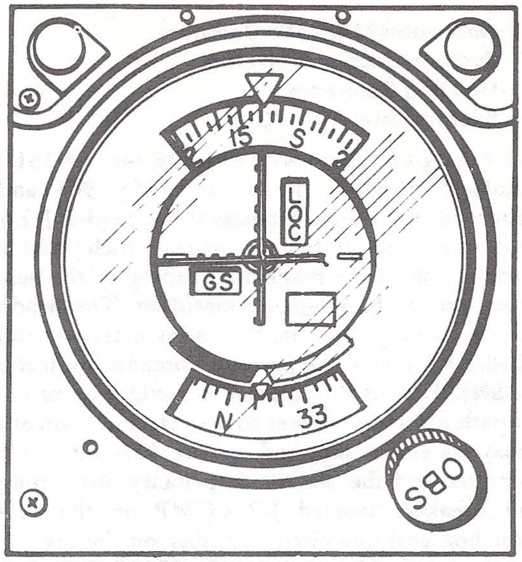


Figure 3-24. Course Indicator (ID-1347/ARN)

WARNING

When the AN/ARN-82 navigation set is operated in the ils frequency range, the course deviation indicator on the ID-1347/ARN course indicator will intermittently fluctuate up to one-half scale when tracking on the localizer course. It is recommended that the AN/ARN-82 navigation set not be used to perform localizer only ils approaches during instrument conditions. The AN/ARN-82A navigation set has been designed to suppress the effects of rotor modulation on the course deviation indicator.

Vor/localizer warning	A red LOC flag appears when vor or localizer signal is unreliably weak or the receiver has malfunctioned.
Glide slope deviation	(Glide slope function not operative in this installation.) This indicator indicates overstation passage during fm homing.
GS warning flag	Not operative in this installation.

3-74. Radio Magnetic Indicator (ID-250A/ARN).

The radio magnetic indicator (rmi) is on the copilot's instrument panel. (See figures 2-7 and 3-25.) The rmi displays the magnetic heading of the helicopter and the relative bearing of two radio stations. The instrument receives synchronous signals from the AN/ASN-43 compass system, the direction finder set AN/ARN-43, and the vhf set AN/ARN-82. The indicator relates the magnetic heading of the helicopter on a rotating compass card, and the relative bearing of the radio stations under two pointers marked 1 and 2.

3-75. Controls and Function, Radio Magnetic Indicator (ID-250/ARN). (See figure 3-25.)

CONTROL/ INDICATOR	FUNCTION
Heading index	Indicates heading of helicopter on compass card.
Pointer No. 1	Indicates bearing of radio station selected on adf.
Pointer No. 2	Indicates bearing of vor radio facility selected on vhf navigation set.
Compass card	Rotates in synchronous with gyro magnetic compass to indicate heading of helicopter.

3-76. Gyrosyn Compass Indicator (ID-998/ASN).

The gyrosyn compass indicator (ID-998/ASN) (figure 3-26) is on the pilot's section of the instrument panel below the attitude indicator (figure 2-7). The indicator combines primary magnetic compass information with dual radio-magnetic indicators. The radio magnetic pointers indicate the magnetic bearing of the signal source. The compass card is calibrated in increments of 5 degrees through a range of 360 degrees. A sail-shaped red flag with the letters OFF appearing at the bottom of the instrument, indicates a power supply failure to heading servo. If a compass system fails (indicated by failure of the compass card to rotate and the OFF flag appearing), useful information is still available from the direction finder and vhf navigation radios. Direction finder information will provide relative bearing and pointer 1 will always point to the station. Vor information will be presented as magnetic bearing and pointer 2 will point to the magnetic bearing that will lead to the station.

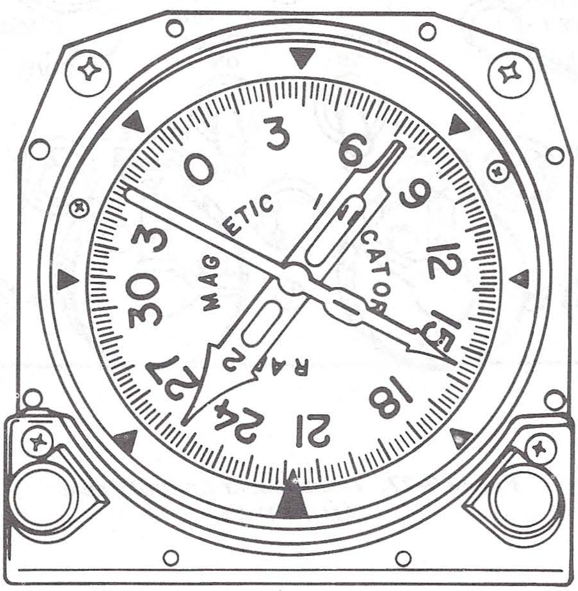


Figure 3-25. Radio Magnetic Indicator (ID-250/ARN)

3-77. Controls and Function, Gyrosyn Compass Indicator (ID-998/ASN). (See figure 3-26.)

CONTROL/ INDICATOR	FUNCTION
VOR/ADF select switch	At ADF, pointer No. 1 will indicate the bearing of a radio station selected on the adf set. At VOR, pointer No. 1 is disconnected. Pointer No. 2 will indicate the bearing of a vor radio facility.
Heading select cursor	Indicates the desired heading selected by the pilot with the SET HDG knob.
Course index	Indicates helicopter heading on compass card.
Annunciator	Indicates misalignment of (nonsynchronization) of compass card and AN/ASN-43 gyro-compass when a dot (.) or cross (+) appears in window.
Pointer No. 1	Indicates bearing of radio station selected on adf when VOR/ADF select switch is at ADF. Inoperative when VOR/ADF select switch is at VOR.
Pointer No. 2	Indicates bearing of vor radio facility regardless of VOR/ADF select switch position.
Synchronizing knob	Rotated in direction indicated in annunciator window to rapidly align the gyrosyn compass indicator with the gyro-magnetic compass.
Power OFF flag	Red OFF flag indicates power supply failure.
SET HDG knob	Moves heading select cursor to desired heading.

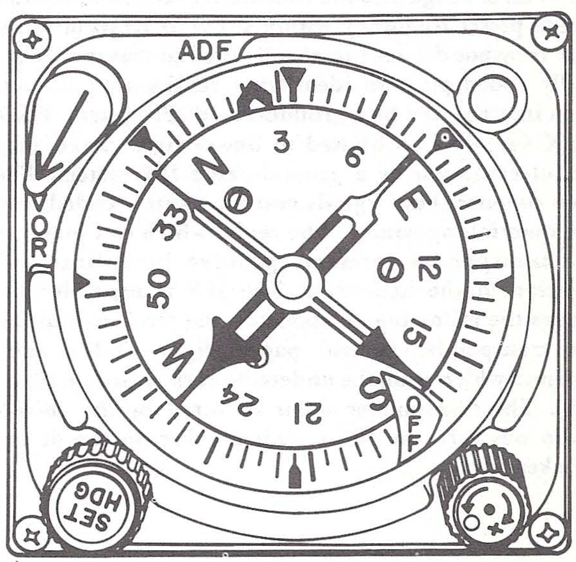


Figure 3-26. Gyrosyn Compass Indicator (ID-998/ASN)

3-78. Operating Procedures—Gyrosyn Compass Indicator (ID-998/ASN). (See figure 3-26.)

a. Slaved Gyro Operation. If either the pilot's or copilot's compass slaving switches are IN, the ID-998/ASN system operates in the slaved mode and the directional gyro precesses to align the indicator card with the magnetic heading of the helicopter. During the first 2 minutes after power is applied, the ID-998/ASN system operates in a fast slave mode while the gyro attains its speed. This rate is about 60 degrees per minute. After this initial alignment period is complete, any small corrections required to eliminate the effects of gyro drift due to unbalance, friction, or the rotation of the earth are made at a rate of 2 to 6 degrees per minute. During this mode of operation, the compass card will remain aligned with the magnetic heading of the helicopter. The annunciator window will occasionally show a dot or a cross indicating that corrections are automatically being made.

b. Free Directional Gyro Operation. If the pilot's and copilot's compass slaving switches are OUT, the ID-998/ASN system operates in the free directional gyro mode. In this mode, the ID-998/ASN indicator card can be set to any heading by pressing the synchronization knob and turning it until the card reaches the selected setting. Normally, the free directional gyro mode is employed only in polar regions of the earth where magnetic references are unreliable. However, it can be useful if the slaving system malfunctions.

c. Manual Synchronization. If power has been applied to the ID-998/ASN system while both the pilot's and copilot's compass slaving switches are OUT or if the ID-998/ASN system has been operated in the free directional gyro mode for a period of time, it is to be expected that the ID-998/ASN indicator card will not be aligned with the magnetic heading of the helicopter. The ID-998/ASN system can be reset to the correct magnetic heading by turning the synchronization knob in the direction of the arrow on the knob pointing to the symbol until the dot or the cross in the annunciator window disappears. If the slaving switches are then pushed IN, the compass card will maintain the correct magnetic heading.

SECTION III TRANSPONDERS

3-79. Transponder System (AN/APX-44).

(May be installed in place of AN/APX-72.) The IFF transponder set (AN/APX-44) receives, decodes, and responds to the characteristic interrogations of the Mark X Identification Friend or Foe (IFF) system and is supplemented by a Selective Identification Feature (SIF). It also receives, decodes, and responds to interrogations of the civil secondary ground radar systems. The receiver section of the set operates on a preset frequency within the 1,010 to 1,030 mHz range and the transmitter section operates on a single preset frequency within 1,090 to 1,110 mHz range. The transponder set can also be used to transmit (64) specially coded position identifying replies after the set has been interrogated by a ground-based IFF system. The AN/APX-44, which is limited to line-of-sight range, receives an interrogation by a ground-based IFF system. The set then decodes these signals and transmits a coded reply to the questioning source. The reply, which can be preset in the transponder, presents positive identification and position of the helicopter. The IFF transponder set includes the following components: the receiver-transmitter, the transponder control panel (figure 3-27), and the antenna which is on the underside of the fuselage (9, figure 3-5). The transponder set is powered by the 28-volt dc radio bus thru the IFF circuit breaker on the dc circuit breaker box.

3-80. Controls and Function, Transponder Control Panel, (AN/APX-44) (See figure 3-27.)

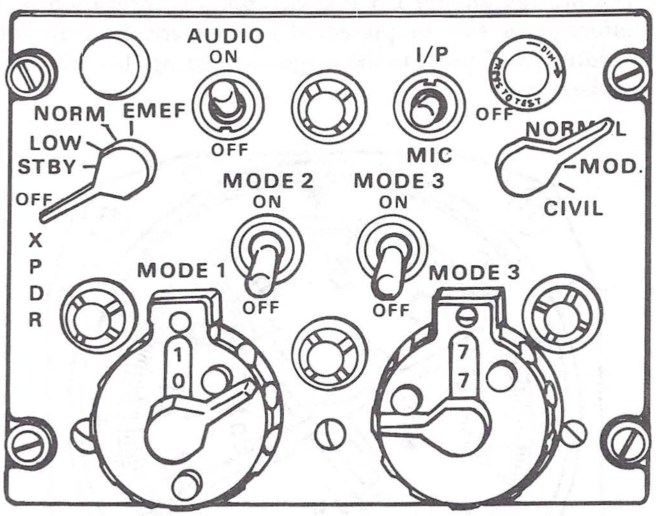


Figure 3-27. Transponder Control Panel (AN/APX-44)

CONTROL/ INDICATOR	FUNCTION
MASTER CONTROL switch positions:	
OFF	Removes power from transponder set and computer.
STBY	Power is applied to transponder receiver and computer; transmitter inoperative. Set ready for operation after several minutes warmup in STBY Position.
LOW	Transponder in operation at reduced receiver sensitivity.
NORM	Transponder in operation at normal receiver sensitivity.
EMER	Transmits emergency reply signals to mode 1, 2, or 3 interrogations, regardless of mode control settings. Mode 3, code 77 must be selected to reply to civil interrogations in emergency code.
Function control switch	Three position switch marked NORM, MOD, and CIVIL. At NORM, the basic MARK X IFF replies with a standard pulse code in mode 1, mode 2, or mode 3 to valid interrogations from military stations. At MOD or CIVIL, the Selective Identification Feature (SIF) enables the set to reply with a preset code to 1 of 32 codes on mode 1, 1 of 4096 codes on mode 2, or 1 of 64 codes on mode 3 received from military or civil interrogators.
1/P switch	This is a 3-position switch marked 1/P, OFF, and MIC. When the switch is at 1/P momentarily, the set will send an identification of position signal for 30 seconds. At MIC, the set will send a position signal each time the AN/ARC-55, or AN/ARC-51BX is operating and the trigger switch is pushed. During 1/P operation, the pulse code is modified. Therefore, the function control switch must be at NORM or MOD for military interrogations and at CIVIL for civil interrogations.
AUDIO switch	Not connected in the installation.
MODE 2 switch	A 2-position switch marked OFF and ON. At ON, mode 2 signals are transmitted. At OFF, mode-2 operation is disabled. Refer to paragraph 3-82 for information on setting up mode 2 codes.
MODE 3 switch	A 2-position switch marked OFF and ON. At ON, the set replies to mode 3.
MODE 1 code control switch	This is a rotary-type switch which selects and indicates the required 2-digit, mode 1, code number.
MODE 3 code control switch	Rotary switch which selects the required 2-digit, mode 3, code number.
Pilot light	Light comes on when power is applied to set. On upper right corner of central panel.

3-81. Normal Operation—IFF Transponder Set.

a. Starting.

1. APX-44 or IFF circuit breakers—Check in.
2. Battery switch—ON.
3. Master control switch—STBY.
4. Warmup—Several minutes.
5. Audio switch—OFF.
6. I/P switch—OFF.
7. Function control switch—As required.
8. Mode 2 and 3 switches—As required.
9. Mode 1 and 3 control switches—As required.

b. Stopping.

1. Master control switch—OFF.
2. All modes and codes—Removed.

3-82. Mode 2 Code Control Switches. Switches for setting up the mode 2 reply code are on the receiver-transmitter front panel. They are enclosed by a small door on the left side. The 12 mode 2 code switches are arranged in four horizontal rows with three switches in each row. They are numbered left to right and top to bottom, with numerals 1 through 12. The four rows of switches correspond to the four pulse groups (A, B, C, and D), and the three switches in each row correspond to the pulse position numbers (1, 2, and 4) within the pulse group. This explanation is simplified in the following table.

SWITCH NO.	PULSE GROUP	PULSE POSITION NO.
1	A	1
2	A	2
3	A	4
4	B	1
5	B	2
6	B	4
7	C	1
8	C	2
9	C	4
10	D	1
11	D	2
12	D	4

The mode 2 code assignments are given as a 4-digit number. The digits represent pulsed group letters and the digit numeral represents the sum of the pulse group position numbers from zero to seven. For example: Code number 5610 would require switches No. 1, 3, 5, 6, and 7 to be at ON, with all other switches at OFF. The left digit of the code number being 5 calls for the A group pulses in positions No. 1 and 4, because only these two position numbers have a sum total of 5. Switch No. 1 controls pulse A1; switch NO. 3, controls pulse A4; switch No. 5, pulse B2; switch No. 6, pulse B4; and switch No. 7, pulse C1. No D group pulses are required in code 5610. The following table clarifies the above example.

Presetting Code Number 5610

CODE LETTER	CODE NO.	PULSES IN REPLY CODE
A	5	Pulses A1 and A4 (1+4=5)
B	6	Pulses B2 and B4 (2+4= 6)
C	1	Pulses C1= 1
D	0	No pulses = 0

3-83. Transponder System (AN/APX-72)

The transponder system (AN/APX-72) provides automatic radar identification of the helicopter. The system receives, decodes, and replies to interrogations on modes 1, 2, 3/A, 4, and C from all suitably equipped challenging aircraft or ground facilities. The receiver section operates on a frequency of 1030 mHz and the transmitter section operates on a frequency of 1,090 mHz. Because these frequencies are in the uhf band, the operational range is limited to line-of-sight. The system includes the following components: the receiver-transmitter (figure 3-28), the computer, the transponder test set, the transponder control panel (figure 3-29), and the antenna (9 figure 3-5). The system is powered by the 28-volt dc radio bus thru IFF two circuit breakers on the dc circuit breaker box and a fuse in the receiver-transmitter. On modified helicopters the system is powered by the 28-volt dc emergency bus.

3-84. Receiver-Transmitter.

The receiver-transmitter (figure 3-28) is on the avionics shelf. It receives coded interrogating pulses on modes 1, 2, and 3/A and tests them for validity. If the signals conform to the preset mode and code, a coded reply is transmitted. Additional preset codes for emergency use are available when selected at the transponder control panel. The mode 2 code select switches, three fuse holders, and an elapsed time meter are on the face of the set. The 28V and SPARE fuse holders contain 5-ampere fuses. The 115V fuse holder is not used in this installation.

3-85. MODE 2 Code Select Switches. The MODE 2 code select switches (See figure 3-29) on the front panel of the receiver-transmitter selects and indicates the mode 2 four-digit reply code number.

3-86. Computer.

The computer is on the avionics shelf. It decodes mode 4 coded interrogating pulses and generates coded reply pulses for transmission to the interrogating source.

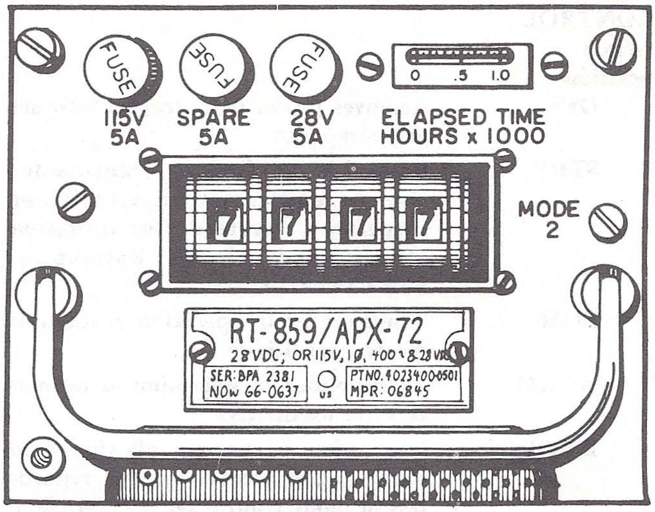


Figure 3-28. Receiver-Transmitter (AN/APX-72)

3-87. Transponder Test Set.

The transponder test set is on the avionics shelf. It is used to indicate either satisfactory or unsatisfactory performance of the IFF system on a go, no-go basis.

3-88. Transponder Control Panel.

The transponder control panel (figure 3-29) is on the console. It provides the control switches for application of power, setting of the modes and codes (except mode 2 code settings), modes of operation, signal strength, identification of position, and emergency functions of the set.

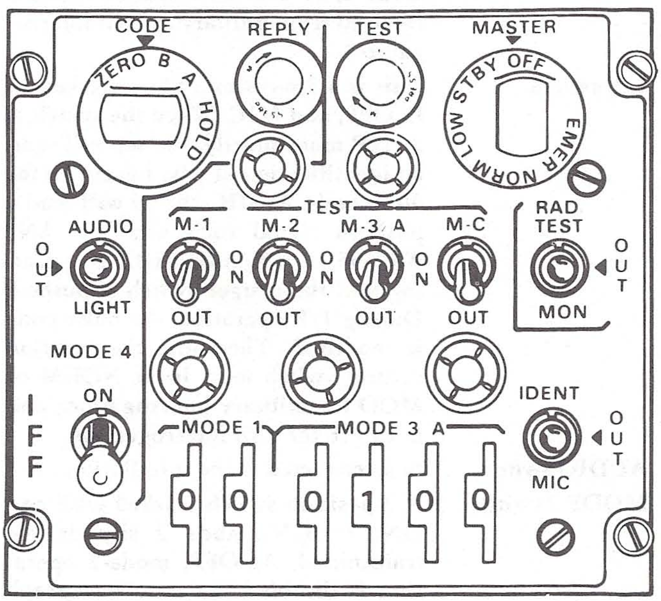


Figure 3-29. Transponder Control Panel (AN/APX-72)

3-89. Controls and Function, Transponder Control Panel (AN/APX-72). (See figure 3-29.)

CONTROL/ INDICATOR	FUNCTION
Mode 4 REPLY light	Lights to indicate valid mode 4 replies when MODE 4 AUDIO LIGHT switch is set to either AUDIO or LIGHT.
TEST light	Lights when transponder responds properly to mode 1, 2, 3/A, or C test signal.
RAD TEST MON	At RAD TEST, the transponder replies to interrogations from external transponder test equipment. At MON, the set replies to interrogations from internal transponder test set. At OUT, the RAD TEST and MON features are inoperative.
IDENT MIC switch	At IDENT, the set will transmit a coded identification pulse for about 25 seconds to all interrogating stations on modes 1, 2, and 3/A to identify the helicopters position. OUT position turns off the identification pulse. MIC feature is not used in this installation.
IFF caution light	On center instrument panel adjacent to fuel quantity selector. Light will come on it no reply or incorrect reply is made to a valid interrogation or a power failure occurs in transponder.
MASTER CONTROL switch positions:	
OFF	Removes power from transponder set and computer.
STBY	Power is applied to transponder receiver and computer; transmitter inoperative. Set ready for operation after 1 to 2 minute warmup in STBY Position.
LOW	Transponder in operation at reduced receiver sensitivity.
NORM	Transponder in operation at normal receiver sensitivity.
EMER	Transmits emergency reply signals to mode 1, 2, or 3/A interrogations, regardless of mode control settings.
M-1, M2, M3/A switches	At ON, the applicable mode is selected for operation. OUT position turns off applicable mode. At TEST, that particular mode is tested for proper operation. If test is valid, TEST lamp will come on.
M-C	In mode C, altitude information is provided to ground controllers by the AAU-32A encoding altimeter. Switch position functions are the same as for M-1, M-2, and M-3A switches.
MODE 1 select switches	Selects and indicates a two digit reply code number.
MODE 3A selector switches	Selects and indicates a 4-digit reply code number.
CODE control switch:	Selects type of MODE 4 operation.
HOLD	In HOLD, the mode 4 code zeroizing function is overridden when electrical power is removed from the helicopter. Switch is spring loaded to A position.
A	Enables transponder to reply to code A interrogations.
B	Enables transponder to reply to code B interrogations.
ZERO	Cancels (zeroizes) mode 4 code settings in transponder computer.
AUDIO LIGHT	At AUDIO, the REPLY indicator light will come on and pulse tone will be heard in the headset when the transponder replies to valid mode 4 interrogations. At LIGHT, only the light will come on when the transponder replies to mode 4 interrogations. At OUT, the audio and REPLY light monitoring is disabled.
MODE 4 switch	At ON, the transponder replies to valid mode 4 interrogations. At OUT, mode 4 is disabled.

3-90. Normal Operation— Transponder System.

The following steps provide transponder system operating procedures.

a. Starting.

1. IFF and ALTM circuit breakers—CHECK in.
2. Battery switch—ON.
3. MASTER control switch—STBY.
4. Warmup—1 to 2 minutes.
5. RAD TEST-MON switch—OUT.
6. IDENT-MIC switch—OUT.
7. AUDIO-LIGHT switch—OUT. (During mode 4 operation—as desired.)
8. M-1, M-2, M-3/A, and MODE 4 switches—As required.
9. CODE select switches—As required.
10. MASTER control switch—NORM or LOW, as required.

b. Stopping.

1. MASTER control switch—OFF.
2. CODE select switches—ZERO.

CHAPTER 4
MISSION EQUIPMENT

SECTION I MISSION AVIONICS

(Not Applicable)

SECTION II ARMAMENT

4-1. Armament Subsystem (M24).

The armament subsystem M24 (figure 4-1) is installed in the cabin door and the cabin escape hatch. The two flexible 7.62-millimeter machine guns (M60D) (figure 4-2) are free pointing but limited in traverse, elevation, and depression by cam surfaces, stops on the pintles, and pintle posts of the left and right mount assemblies (figure 4-3). Spent cartridges are collected by an ejection control bag (figure 4-4) on the right side of the machine gun. An ammunition can assembly (figure 4-4) is on the left side of the machine gun (figure 4-4).

4-2. Machine Gun.

The 7.62-millimeter machine gun (M60D) (figure 4-2) is a link belt-fed, gas-operated, air-cooled, automatic weapon. It is mounted on the left and right side pintles.

4-3. Mount Assemblies.

The mount assemblies (figure 4-5) are installed on mounting brackets fastened inside the helicopter and secured with mounting pins.

4-4. Machine Gun Controls.

These paragraphs locate, describe, and illustrate the controls provided for operating the machine gun M60D. For information on the basic 7.62-millimeter machine gun M60D, refer to TM 9-1005-224-10.

4-5. Cover Latch. The cover latch (figure 4-2) is at the right rear side of the feed cover assembly. When placed in vertical position, it secures the cover assembly in the closed position. When turned to horizontal position, it unlocks the cover assembly.

4-6. Barrel Lock Lever. The barrel lock lever (figure 4-2) at the right front side of the receiver is secured to the barrel locking shaft. It turns the shaft to lock or unlock the barrel assembly.

WARNING

To prevent injury to personnel, the cocking handle assembly must be returned to the forward or locked position before firing.

4-7. Cocking Handle Assembly. The cocking handle assembly at the right front side of the receiver is used for manually charging the machine gun.

4-8. Safety. The safety, at the lower front section of the receiver, consists of a cylindrical pin with a sear clearance cut. The pin slides across the receiver to block the sear and prevent an accidental firing. The ends of the pin are marked for pushing to safe (S) and firing (F) positions (figure 4-2).

WARNING

Pressing the trigger to release the bolt assembly accomplishes feeding and releasing of the firing mechanism. Unless firing is intended, make sure the machine gun is cleared of cartridges before pressing the trigger.

CAUTION

To prevent damage to the cartridge tray when no ammunition is in the machine gun, retard the forward force of the released bolt assembly by manually restraining forward movement of the cocking handle assembly.

4-9. Grip and Trigger Assembly. The grip and trigger assembly includes the spade grips which are at the rear section of the receiver. The U-shaped design permits firing of the weapon by thumb pressure from either hand.

4-10. Magazine Release Latch. The magazine release latch is on the left side of the receiver. The latch spring automatically locks the magazine when seated in the magazine bracket. Depressing the latch handle assembly manually releases the magazine.

4-11. Mount Assembly Stops, Cams, Quick-Release Pin, and Shock Cord.

The mount assembly stops, cams, quick-release pin, and shock cord have the following functions:

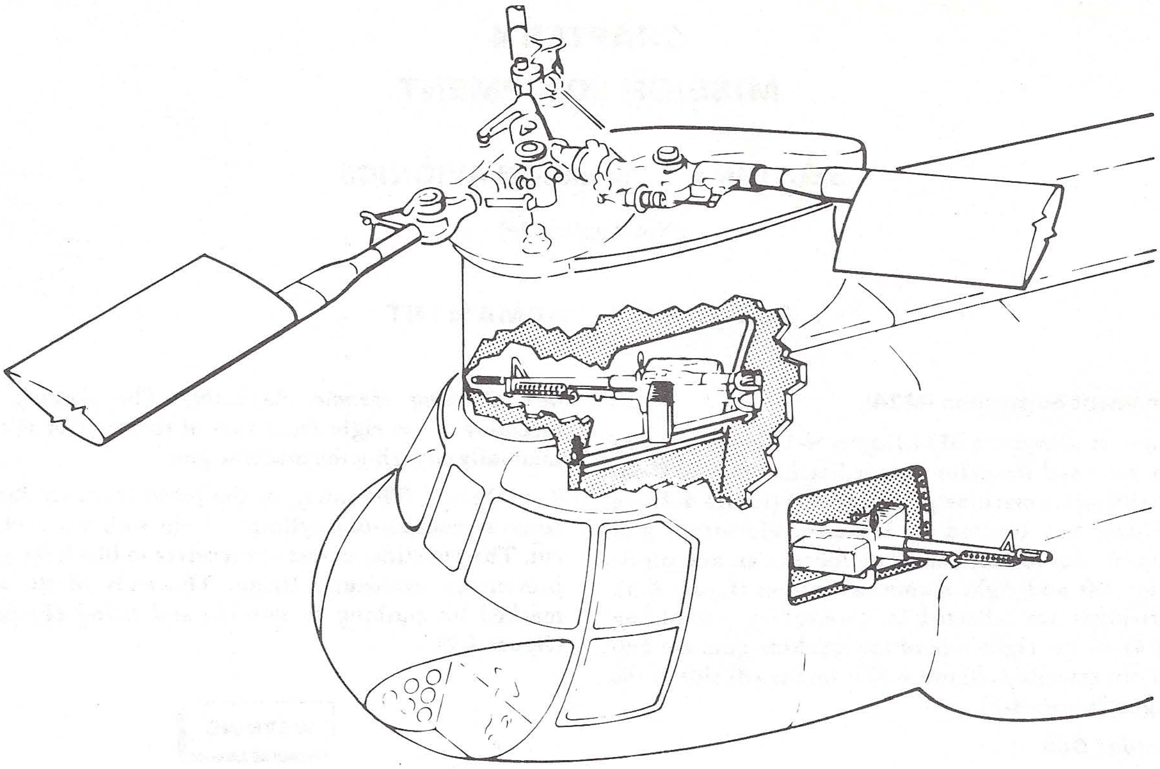


Figure 4-1. M24 Armament Subsystem

a. Maximum traverse movements (table 4-1) of the machine gun are controlled by stops on both sides of the cam on the pintle post.

b. Maximum elevation and depression are controlled by cam surfaces on the pintle.

c. The quick-release pin (figure 4-5) is attached by cable to the mount bracket of the mount assembly and fastens the mount bracket to the rear bracket at the helicopter opening.

d. The shock cord assembly (figure 4-6) is fastened to the mount bracket and to the machine gun when stowed.

4-12. Operation—Armament Subsystem M24.

Operate the ARMAMENT SUBSYSTEM M24 as described in the following paragraphs.

4-13. Preflight Checks. The preflight check consists of the following:

1. Machine Gun M60D—Check to make sure that gun is thoroughly cleaned and lubricated, operable, and secured on the pintle with the quick-release pin (figure 4-9).
2. Barrel—Dry and free of obstructions.
3. Gas cylinder—Plug is tight in cylinder.
4. Cover assembly—Check for freedom of movement and security of latch.
5. Ejection control bag (figure 4-7)—Installed and securely latched.
6. Ammunition can assembly (figure 4-8)—Installed on machine gun and loaded.
7. Safety—Push button to safe (S) position and try to fire the unloaded machine gun (figure 4-2).
8. Mount assembly—Secured and checked for free pintle movement.
9. Extra ammunition boxes—Properly stowed.

Table 4-1. Armament Subsystem M24 Data

Weight (subsystem w/o ammunition)	87 lb
Weight (subsystem w/ ammunition 400 rnd)	111 lb
Ammunition capacity	200 rnd. per gun
Effective range	1100 meters (max)
Rate of fire	550-650 spm
Length, overall	44.875 in.
Sighting	Aircraft ring and post type
Total traversing capability—left side	122°
Total traversing capability—right side	127°
Depression and elevation limits:	
Left side maximum depression	67°30′
Left side maximum elevation	7°30′
Right side maximum depression	73°
Right maximum elevation	7°

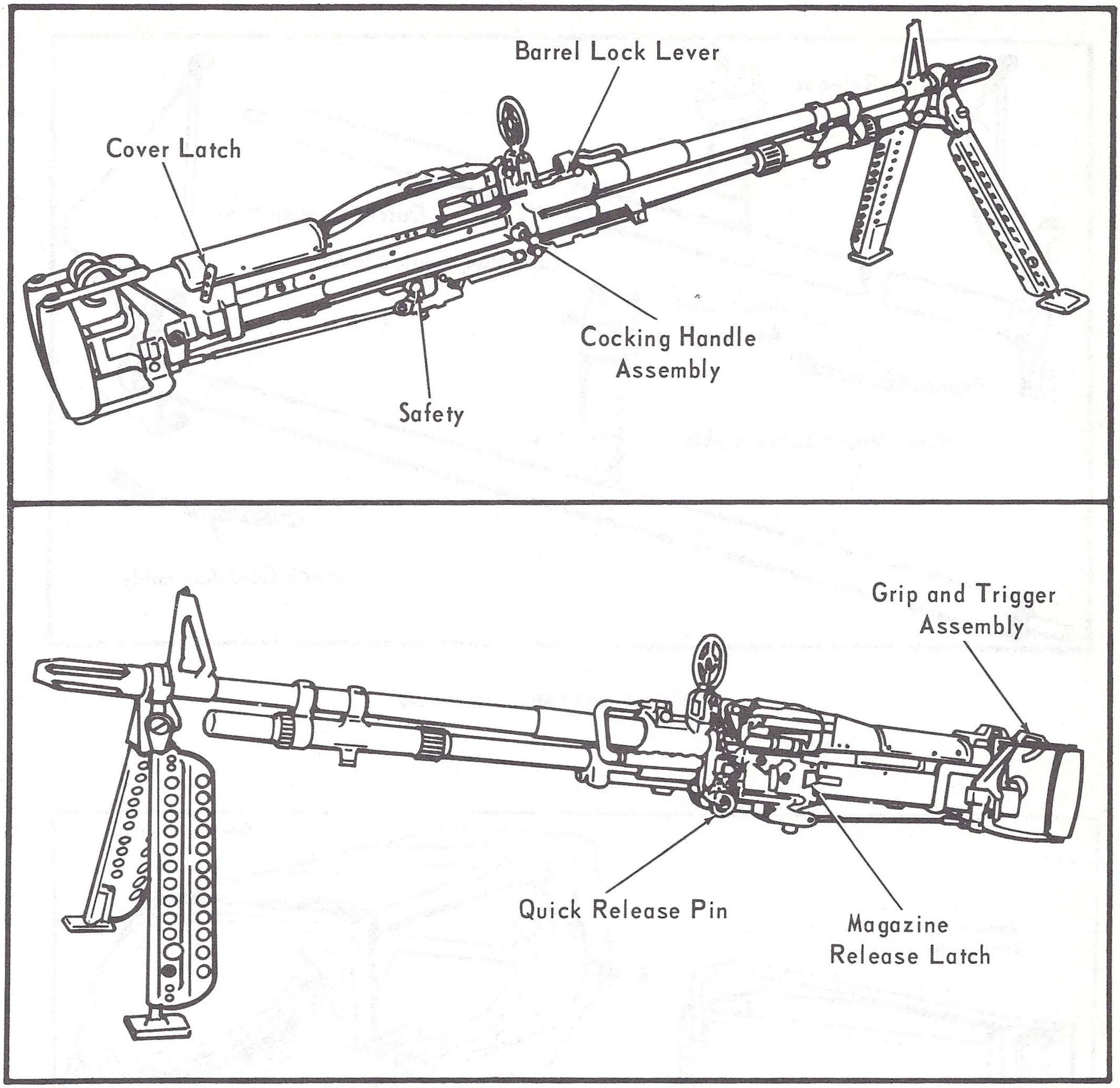


Figure 4-2. Machine Gun M60D

4-14. Before Takeoff Check.

1. Push the safety button to safe (S) position.

2. Retract the bolt assembly by pulling the handle assembly fully rearward until the sear engages and then push the handle to the forward position. Move the cover latch rearward to the horizontal position and then raise the cover assembly.

3. Inspect the chamber to be sure it is clear.

4. Close the cover and secure the machine gun in the stowed position.

4-15. Inflight Operation. Inflight operation consists of the following:

a. Preparation for firing.

1. Check the machine gun to see that it is secured with a quick-release pin on the pintle (figure 4-9).

2. Check the machine gun for freedom of movement in elevation, depression, and traverse.

3. Load the linked cartridges into the machine gun as follows: (figure 4-10.)

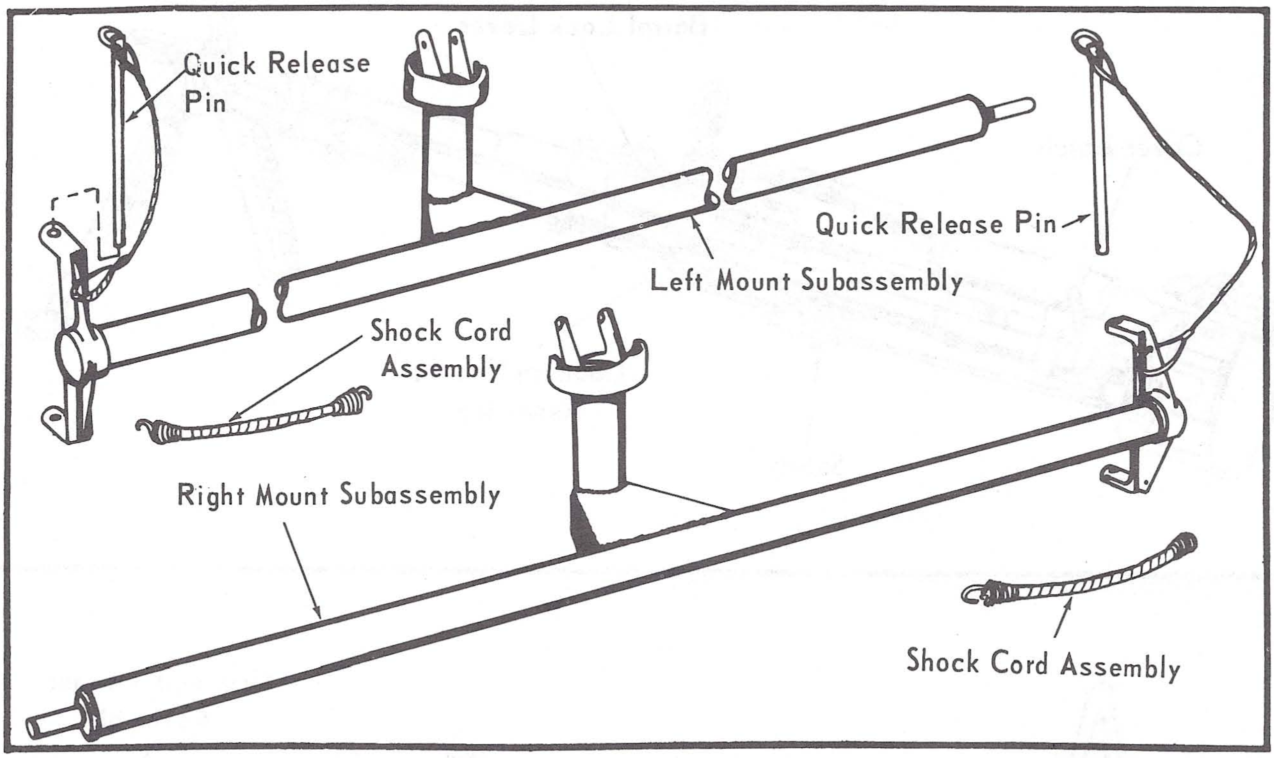


Figure 4-3. M24 Mount Assembly

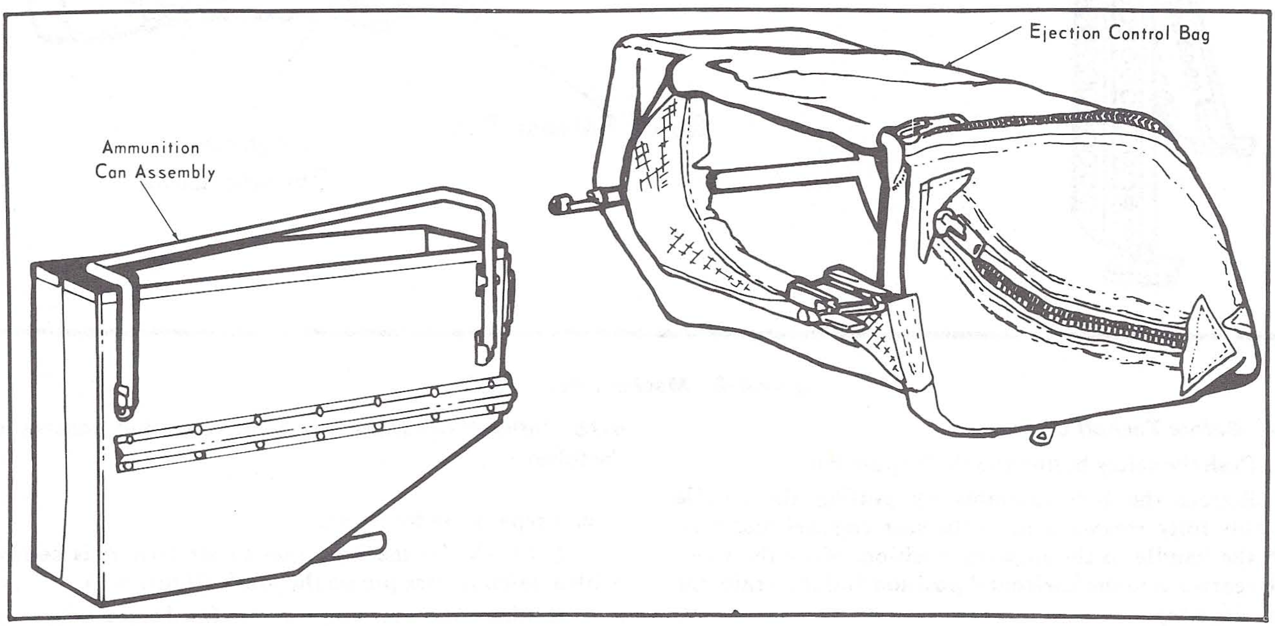


Figure 4-4. Ammunition Can Assembly and Ejection Control Bag

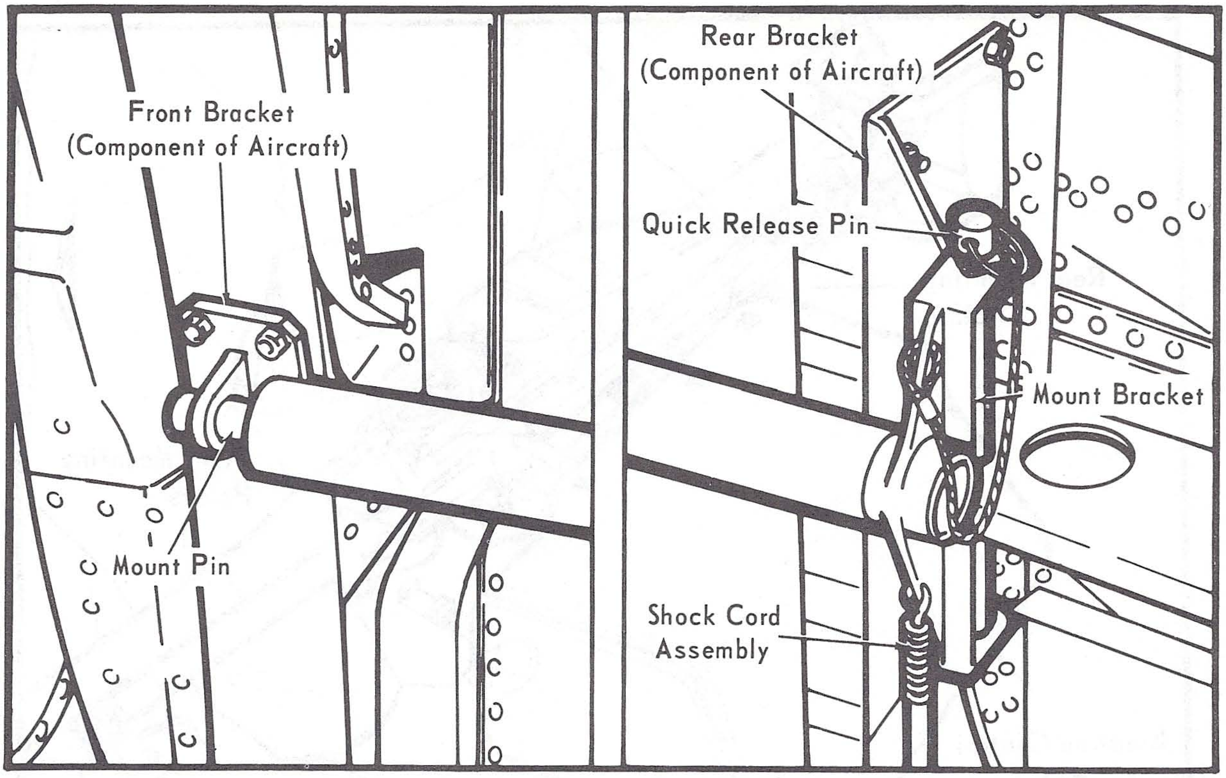


Figure 4-5. Right Machine Gun Mount—Installed

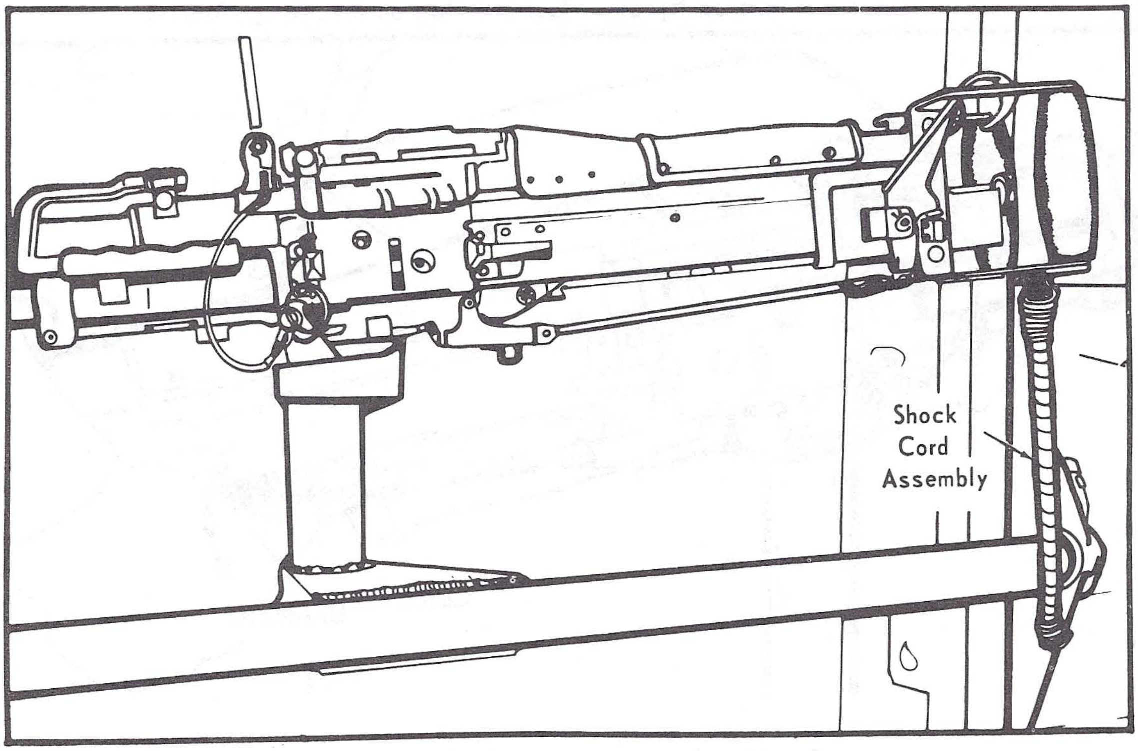
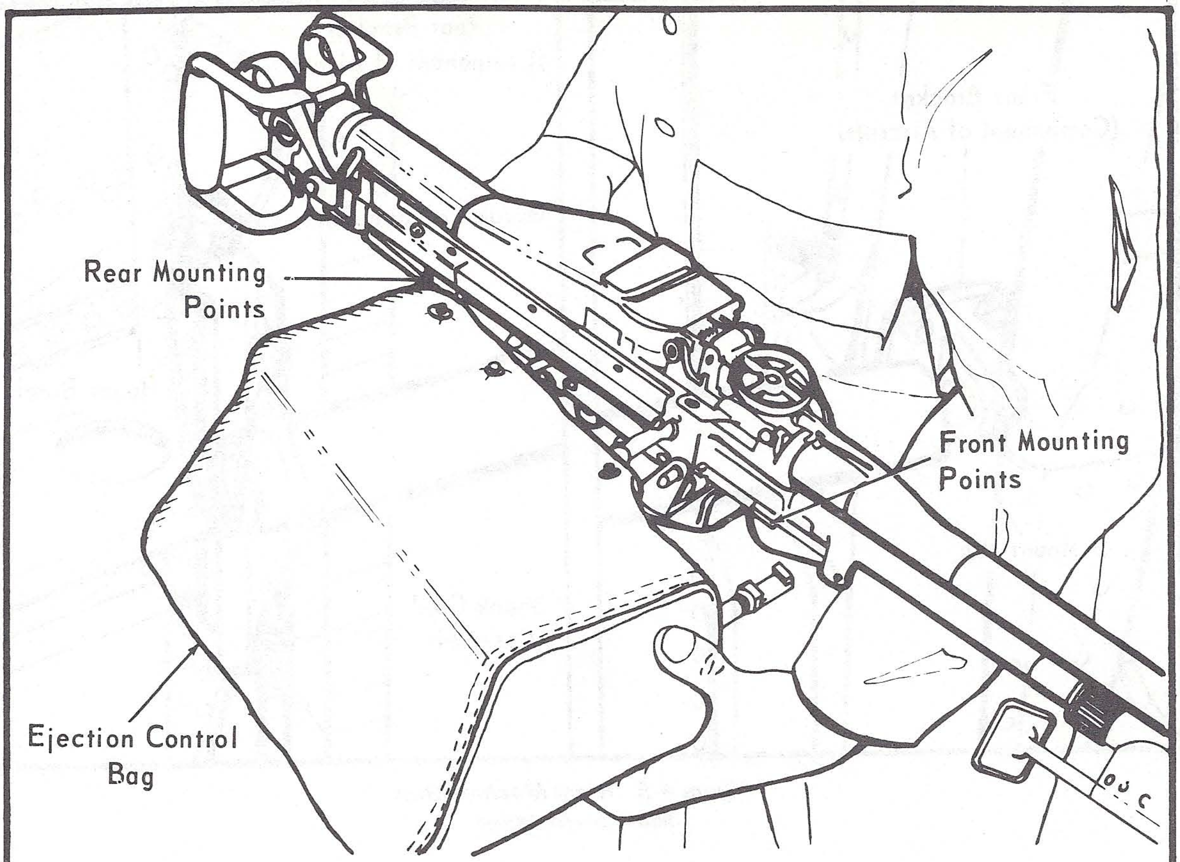
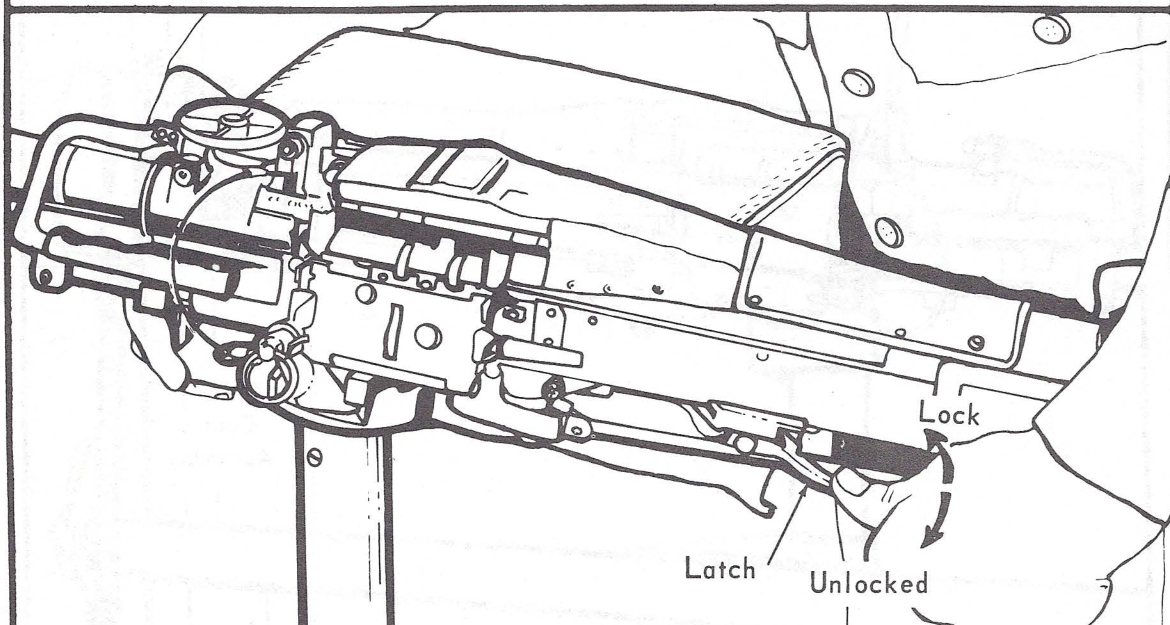


Figure 4-6. Machine Gun Stowed on Right Mount



Step 1 – Position Ejection Control Bag on Mounting Points.



Step 2 – Locked or unlocked position.

Figure 4-7. Ejection Control Bag—Installed

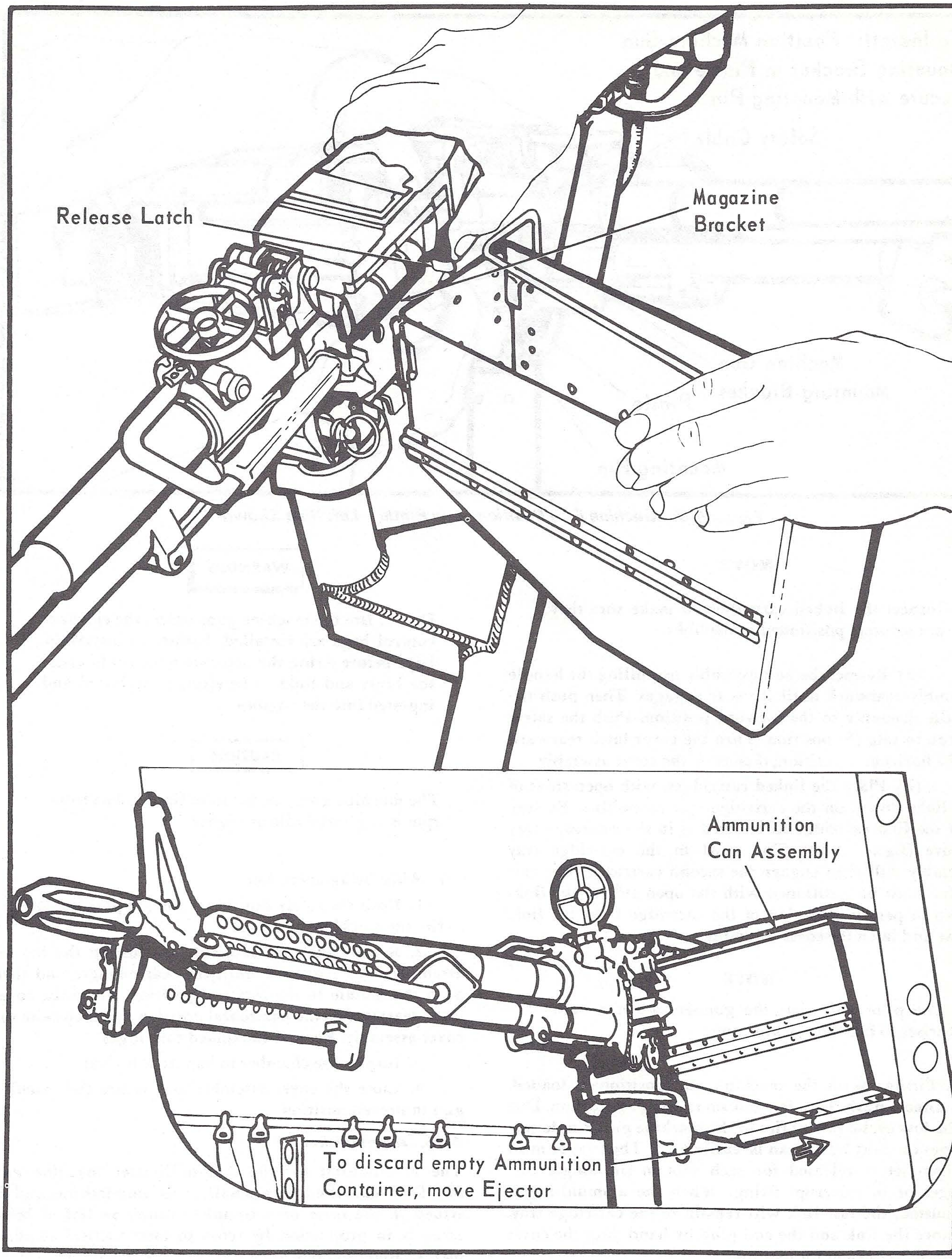


Figure 4-8. Ammunition Can Assembly—Installed

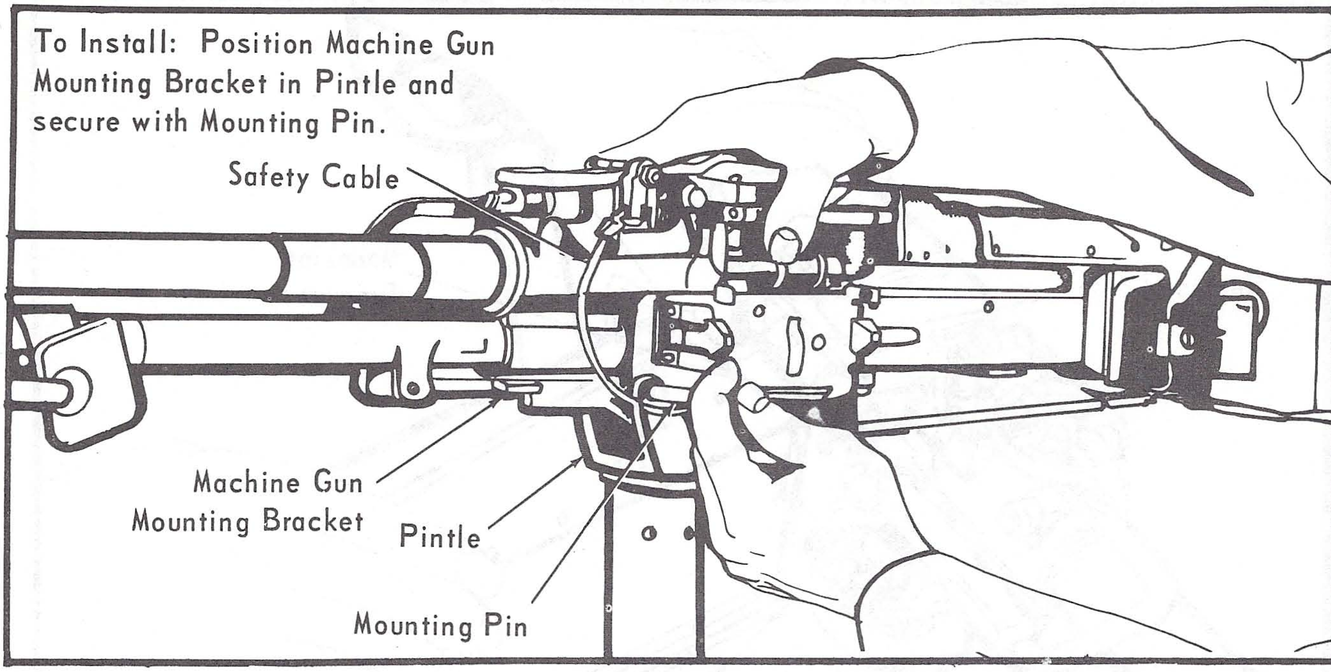


Figure 4-9. Machine Gun Positioned on Pintle—Left Side Shown

NOTE

Inspect the linked cartridges to make sure they are securely positioned in the links.

(a) Retract the bolt assembly by pulling the handle assembly rearward until the sear engages. Then push the handle assembly to the forward position. Push the safety button to safe (S) position. Turn the cover latch rearward to the horizontal position; then raise the cover assembly.

(b) Place the linked cartridges, with open sides of the links down, on the cartridge tray assemblies. Be sure that the first cartridge to be fired is in the cartridge tray groove (figure 4-10). The pawl in the cartridge tray assembly will then engage the second cartridge. The cartridge must be positioned with the open side of the links down to permit stripping of the cartridge from the link. Close and latch the cover assembly.

NOTE

The pilot will alert the gunners when a need arises to fire the machine gun.

b. Firing. With the machine gun positioned, loaded, and aimed, push the safety button to fire (F) position. Due to the low cyclic rate of fire of the machine gun, single cartridges or short bursts can be easily fired. The trigger must be completely released for each shot to fire single cartridges or to interrupt firing. When the ammunition is exhausted, the last link will remain in the cartridge tray. Remove the link and the end plug by hand after the cover assembly is opened for loading.

WARNING

Do not fire the machine guns unless the ejection-control bags are installed. Failure to install the bags before firing the machine guns could cause the brass and links to be ejected overboard and ingested into the engines.

CAUTION

The machine guns are not to be fired unless rotor rpm is at ground idle or higher.

c. After firing operation.

1. Push the safety button to safe (S) position and try to fire the machine gun.

2. Retract the bolt assembly by pulling the handle assembly fully rearward until the sear engages and then push the handle to the forward position. Move the cover latch rearward to the horizontal position and then raise the cover assembly. Remove the linked cartridges.

3. Inspect the chamber to be sure it is clear.

4. Close the cover assembly and secure the machine gun in stowed position.

4-16. Ammunition.

The ammunition for the 7.62-millimeter machine gun M60D is classified as a small arms ammunition and is issued in the form of a complete round in linked belts. Issue is in proportion by types to meet tactical requirements. (Refer to table 4-2.)

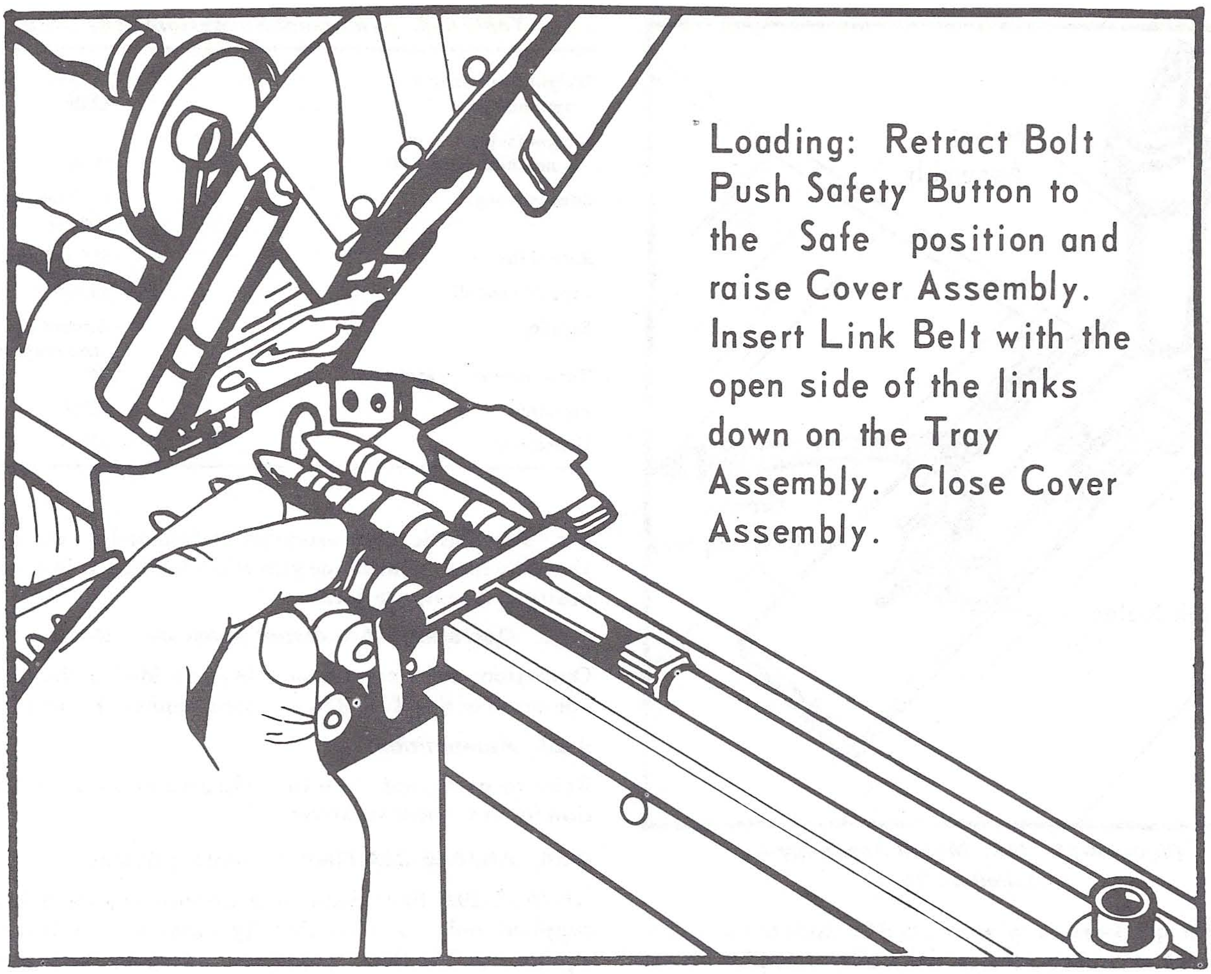


Figure 4-10. Loading

Table 4-2. Authorized Cartridges

7.62-millimeter:AP, NATO M61
7.62-millimeter: Ball, NATO M59
7.62-millimeter: Ball, NATO M80
7.62-millimeter: Tracer, NATO M62
7.62-millimeter: Dummy, NATO M63

4-17. Armament Subsystem M41.

Armament subsystem M41 is installed at the center, rear edge of the ramp. The armament subsystem mount assembly has a pintle and post with limiting cam surfaces similar to those on armament subsystem M24 mount assembly. The machine gun, ammunition can assembly, and ejection control bag are the same as those on armament subsystem M24. (Refer to paragraph 4-1.)

4-18. Machine Gun.

Refer to paragraph 4-2 for a description of the 7.62-millimeter machine gun M60D. The machine gun is mounted on the pintle and is secured with a quick-release pin. (See figure 4-9.)

4-19. Mount Assembly.

The mount assembly is positioned on the lugs of the ramp bracket and is secured with a quick-release pin. (See figure 4-11.)

NOTE

If the bracket must be installed, be sure to center it along the rear edge of the loading ramp.

4-20. Machine Gun Controls.

Refer to paragraphs 4-4 thru 4-10 for information on the machine gun controls (M60D).

4-21. Mount Assembly Stops, Cams, Quick-Release Pin, and Elastic Cord. The mount assembly stops, cams, quick-release pin, and elastic cord have the following functions:

a. Maximum traverse, elevation, and depression of the machine gun M60D are controlled by cam surfaces and stops on the pintle and the pintle post. (See table 4-3.)

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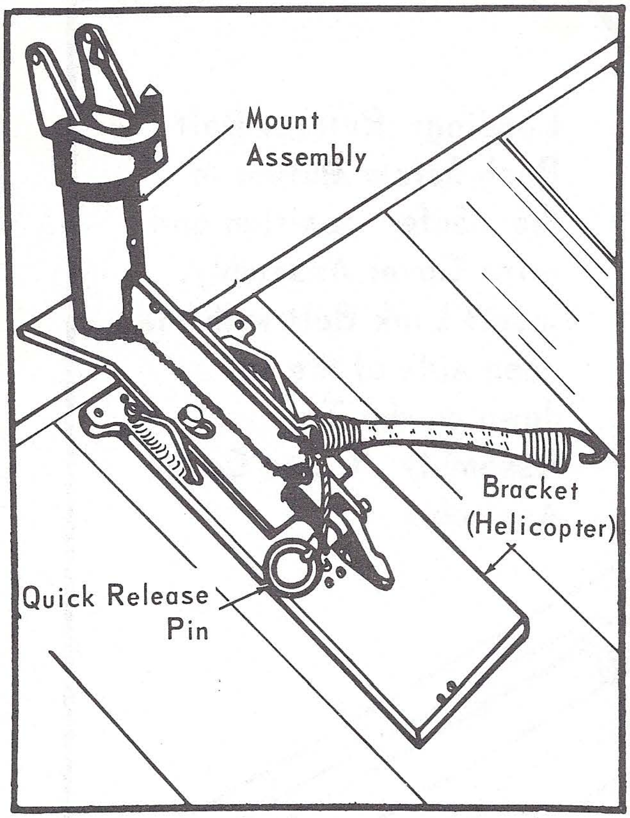


Figure 4-11. M41 Mount Assembly—Installed on Ramp

b. The quick-release pin, attached by cable to the rear of the mount assembly, secures the mount assembly to the ramp. (See figure 4-11.)

Table 4-3. Armament Subsystem M41 Data

Weight (subsystem w/o ammunition)	42 lb
Weight (subsystem w/ ammunition 200 rnd)	55 lb
Effective range	1100 meters (max)
Rate of fire	550-650 spm
Length° Overall	44.875 in.
Sighting	Aircraft ring and post type
Total traversing capability	94°
Elevation	12°30″
Depression	69°

c. The elastic cord assembly is fastened to the mount assembly and the machine gun when holding it in a stowed position. (See figure 4-12.)

4-22. Operation—Armament Subsystem M41.

Operation of the armament subsystem M41 is the same as operation of the M24. Refer to paragraphs 4-12 thru 4-15.

4-23. Ammunition.

Refer to paragraph 4-16 for information on the ammunition for armament subsystem M41.

4-24. AN/ALE-29A Flare Dispensing System.

AN/ALE-29A flare dispensing systems (figure 4-13) are supplied only to units that fly missions requiring this equipment. Use these systems according to the following criteria:

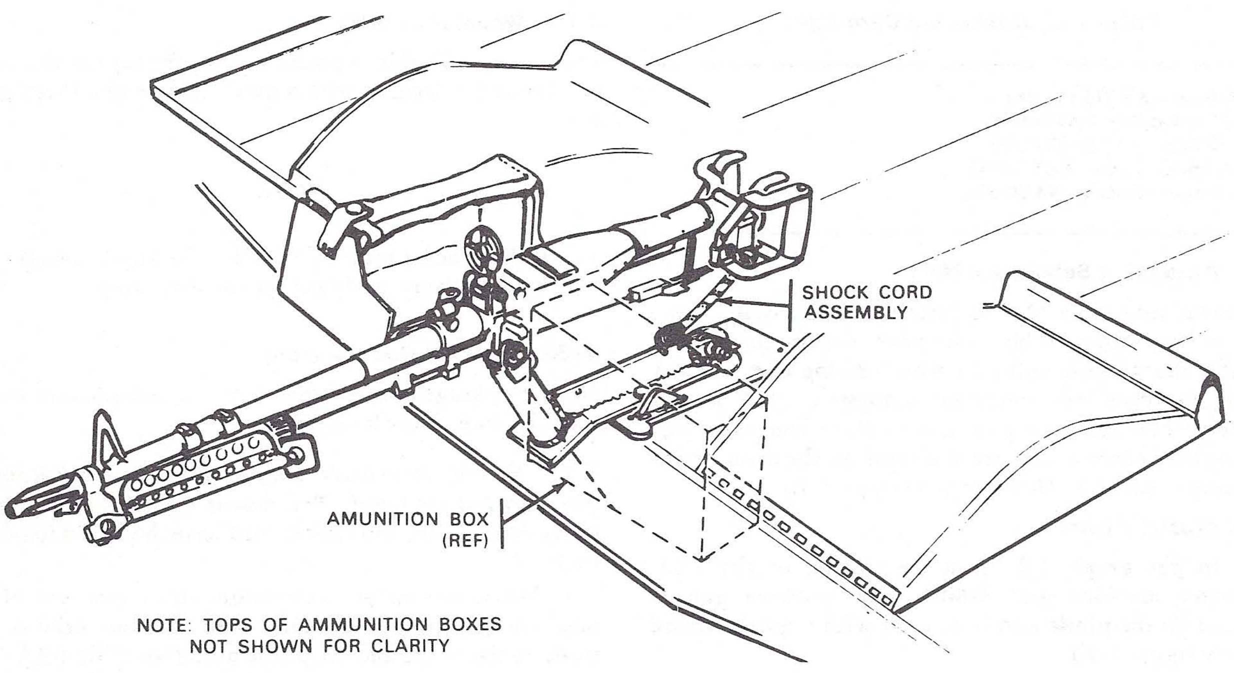


Figure 4-12. Machine Gun in Stowed Position—Right Rear View

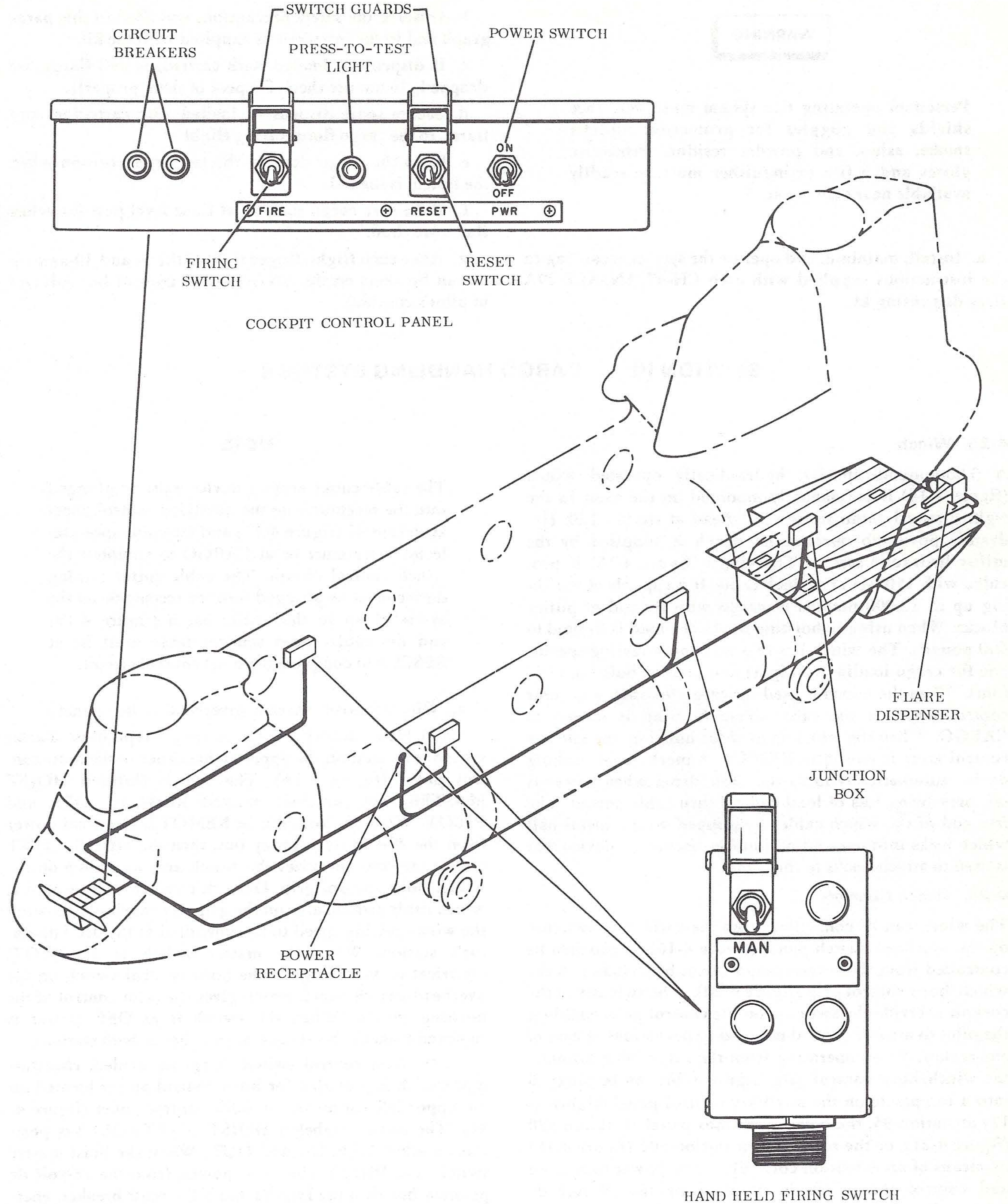


Figure 4-13. AN/ALE-29A, Flare Dispensing System

WARNING

Personnel operating this system must wear face shields and goggles for protection against smoke, ashes, and powder residue. Protective gloves and a fire extinguisher must be readily available near the system.

a. Install, maintain, and operate the system according to the instructions supplied with each CH-47 AN/ALE-29A flare dispensing kit.

b. Observe the safety precautions specified in this paragraph and in the instructions supplied with the kit.

c. If dispensers, loaded with cartridges and flares, are dropped, do not use them. Dispose of them properly.

d. Secure spare dispensers, loaded with cartridges and flares, to the cargo floor during flight.

e. Keep the cargo door in the retracted position when the system is loaded.

f. Make sure cargo ramp is at floor level position when flares are fired.

g. After each flight, finger tighten the 5- and 10-ampere circuit breakers on the AN/ALE-29A control box (aft end of pilot's console).

SECTION III CARGO HANDLING SYSTEMS

4-25. Winch.

A 3,000-pound-capacity, hydraulically operated winch (figure 4-14) is permanently mounted on the floor in the right forward cabin section bulkhead at station 120. Hydraulic power to operate the winch is supplied by the utility hydraulic system. The winch (figure 4-15) is provided with 150 feet of ¼-inch cable. It is capable of winching up to 12,000 pounds of cargo with the aid of pulley blocks. When using in hoisting mode, the load is limited to 600 pounds. The winch has two maximum reeling speeds: one for cargo loading (20 fpm) and one for hoisting (100 fpm). When the winch is used for cargo loading, a selector control lever on the cable drum housing is moved to CARGO. When the winch is used for hoisting, the selector control lever is moved to RESCUE. A mechanical braking device automatically locks the cable drum when power is off, preventing loss of load control thru cable payout. The free end of the winch cable is equipped with a metal ball which locks into one end of a quick-disconnect device that is used to attach hooks to the cable.

4-26. Winch Controls.

The winch can be controlled from the cockpit by switches on the overhead switch panel (figure 4-16). It can also be controlled from the cargo compartment by switches on the winch/hoist control grip (figure 4-20). The switches in the cockpit override the switches on the control grip, enabling the pilot to assume control of hoisting operations in case of emergency. When operating from the cargo compartment, the winch/hoist control grip (figure 4-20) can be plugged into a receptacle on the auxiliary control panel (figure 4-17) at station 95, the hoist operations panel at station 320 (figure 4-21), or the receptacle at station 502 (figure 4-18) by means of an extension cord. Electrical power to operate and control the winch is supplied by the 28-volt dc primary bus thru two circuit breakers on the overhead circuit breaker panel. These two circuit breakers are marked HOIST CUTTER and HOIST CONT.

NOTE

The cable cutter arming device must be plugged into the receptacle on the auxiliary control panel at station 95 (figure 4-17) and the cable speed selector lever must be at CARGO to complete the winch control circuit. The cable cutter arming device must be plugged into the receptacle on the overhead above the utility hatch (figure 4-19) and the cable speed selector lever must be at RESCUE to complete the hoist control circuit.

a. Winch control switches (overhead switch panel).

(1) Hoist master switch. A toggle-type hoist master switch is located on the upper right corner of the hoist control panel (figure 4-16). The switch (labeled HOIST MASTER) has positions marked REMOTE, OFF, and PILOT. When the switch is at REMOTE, electrical power from the 28-volt dc primary bus, thru the HOIST CONT circuit breaker, energizes the winch arming switch on the winch/hoist control grip. Once this switch is pressed, the winch cable switch, also on the grip, is energized, allowing the winch reeling speed to be controlled at the hoist operator's station. When the master switch is at PILOT, electrical power energizes the hoist control switch on the overhead switch panel, which gives the pilot control of the hoisting system. When the switch is at OFF, power is removed from the hoist control switches at both stations.

(2) Hoist control switch. A spring-loaded, rheostat-type switch is provided for hoist control and is located on the upper left corner of the hoist control panel (figure 4-16). The switch (labeled HOIST CONTROL) has positions marked OFF, IN, and OUT. When the hoist master switch is at PILOT, electrical power, from the 28-volt dc primary bus thru the HOIST CONT circuit breaker, energizes the hoist control switch. When the switch is moved to IN or OUT, the hoist brake release solenoid valve is energized open. The open valve applies hydraulic pressure

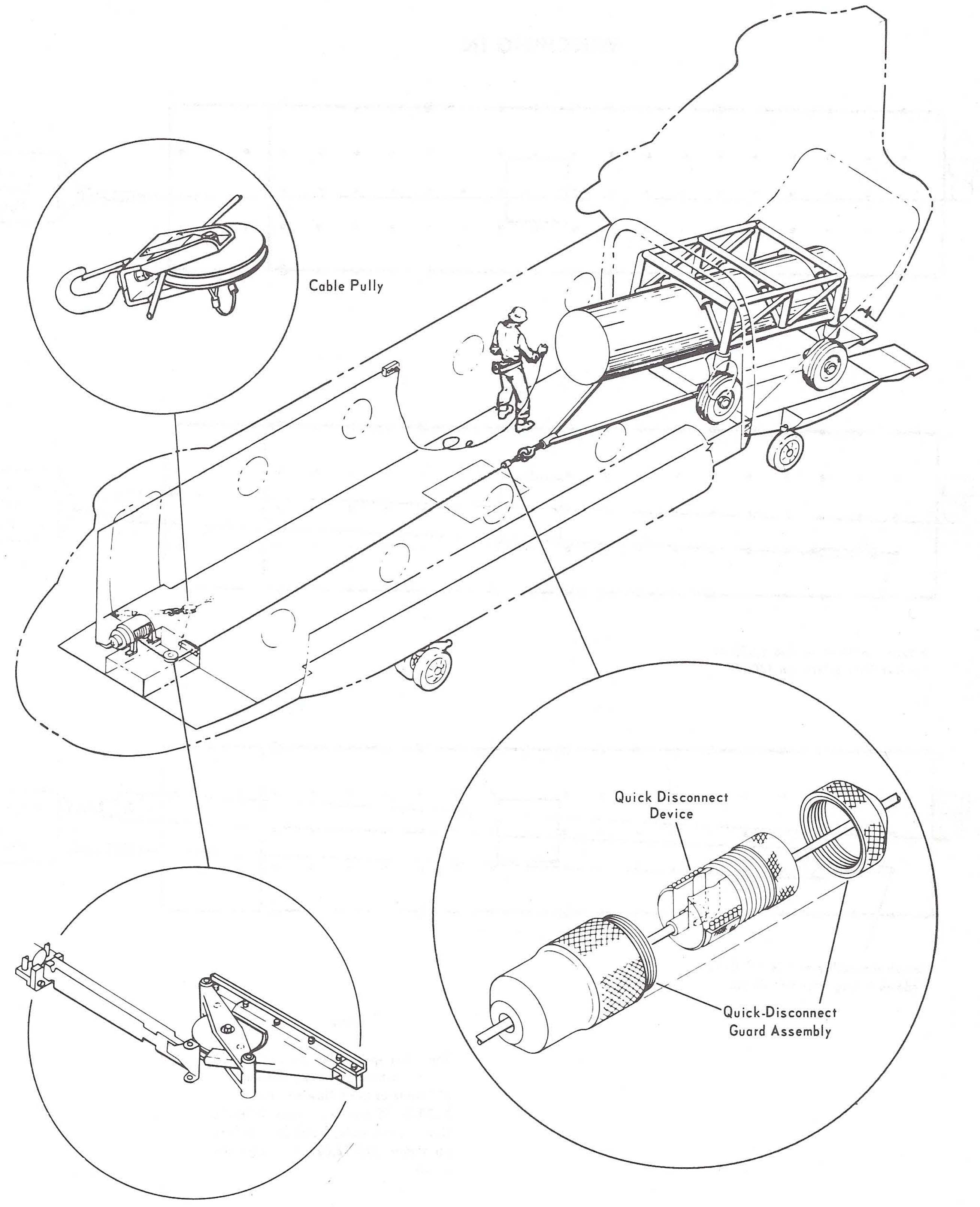
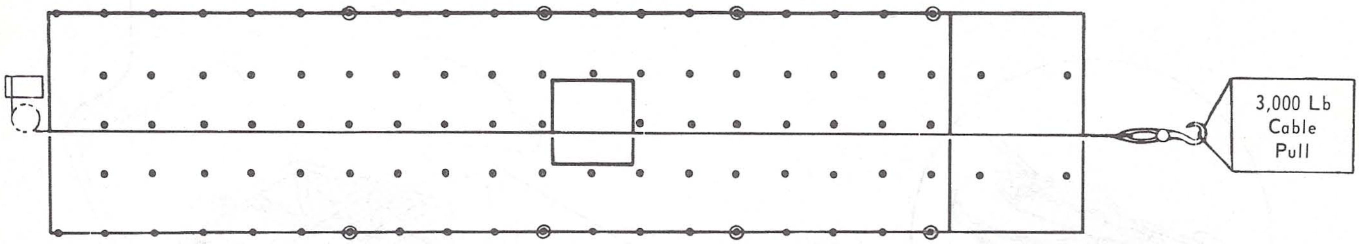
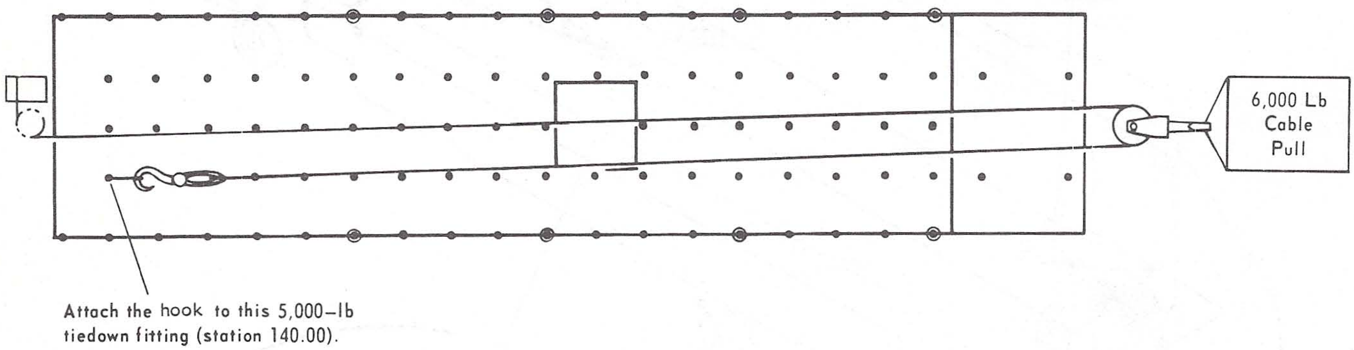
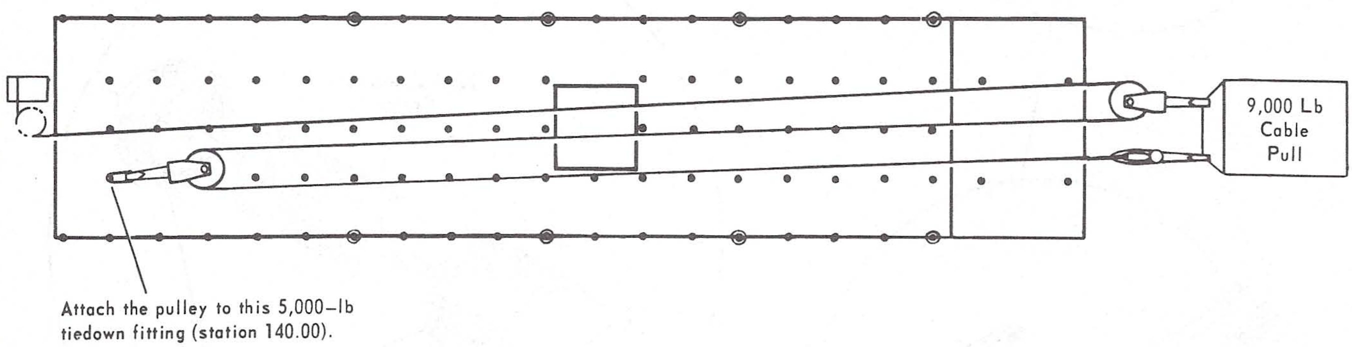


Figure 4-14. Winching System

WINCHING IN







Note

The cable speed when winching is 20 feet per minute; however, the load will move at the following rates: 3,000 lb--20 feet per minute, 6,000 lb--10 feet per minute, 9,000 lb--6.6 feet per minute, and 12,000 lb--5 feet per minute.

Figure 4-15. Winch Capabilities (Sheet 1 of 2)

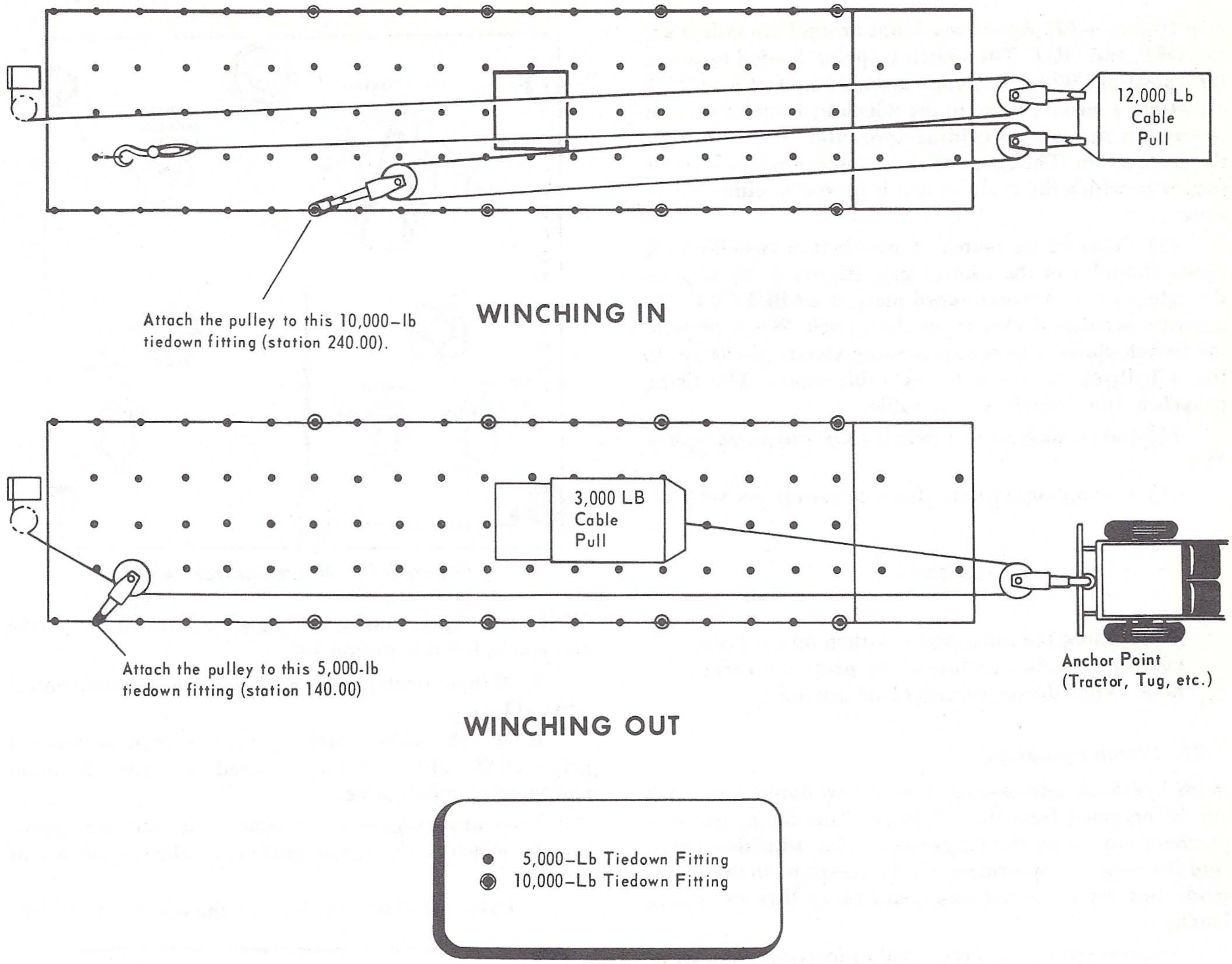


Figure 4-15. Winch Capabilities (Sheet 2 of 2)

thru the hoist control valve to the winch to turn the cable drum in the appropriate direction. The speed of the cable is governed by the degree to which the hoist control switch is moved in either direction. When the switch is released, the switch assumes the center-Off position. In addition, the brake release solenoid valve is deenergized closed, which removes hydraulic pressure to brake the cable drum.

(3) Cable cutter switch. A cable cutter switch is on the lower right side of the hoist control panel (figure 4-16). The switch (labeled CABLE CUTTER) has positions marked ON and OFF. When the switch is at ON, electrical power from the 28-volt dc primary bus thru the HOIST CUTTER circuit breaker, detonates a ballistic cartridge in the cable cutter which cuts the cable. When the switch is at OFF, the cable cutter circuit is deenergized.

b. Winch control switches (control grip, figure 4-20). A portable pistol-shaped control grip contains a built-in microphone switch and a number of other switches used in hoisting, winching, and cargo hook operations. A receptacle for plugging in the extension cord is located in the butt end of the grip. A hook extending from the side of the grip is used to hang the grip in its stowed position on the hoist control panel. The switches contained in the grip are as follows:

(1) Winch arming switch. The winch is armed for use by a trigger-type, spring-loaded switch (figure 4-20). The location of the switch on the grip is the same as that of the trigger position on a hand gun. When the switch is pressed, a circuit closes, arming the control circuits of the winch hydraulic motor. When the switch is released, the circuit opens, rendering the winch inoperable.

NOTE

The winch arming switch must be depressed in order to operate the winch.

(2) Winch cable switch. Winch cable reeling is controlled by a rotary switch on the left side of the control

grip (figure 4-20). Action markings around the switch are IN, OFF, and OUT. The switch is spring-loaded to center OFF position. When the switch is moved in the IN or OUT direction, a selector valve in the winch hydraulic system is electrically actuated, providing hydraulic pressure to turn the cable drum. The speed of the cable is governed by the degree to which the cable switch is moved in either direction.

(3) Cable cutter switch. A pushbutton switch on the upper shoulder of the control grip (figure 4-20) actuates the cable cutter. A metal guard marked CABLE CUTTER prevents accidental closing of the switch. When pressed, the switch closes a circuit, providing electrical current to fire a ballistic cartridge in the cable cutter. The firing propels a cutter which cuts the cable.

(4) Cargo hook release switch. (Refer to paragraph 4-35.)

(5) Microphone switch. (Refer to paragraph 3-4.)

CAUTION

When using the microphone switch on the hoist control grip, be careful not to press the cargo hook switch during external load missions.

4-27. Winch Operation.

With hydraulic and electrical power available, the winch can be operated from the cockpit or from the cargo compartment, in either the cargo mode (for winching cargo into the cargo compartment via the ramp) or in the rescue mode (for rescue or hoisting small cargo thru the rescue hatch).

a. Control settings and electrical connections for operating the winch in the cargo mode from the cockpit are as follows:

1. Cable speed selector lever on the winch—CARGO.
2. Cable cutter arming device—Plugged into the auxiliary control panel, in the heater compartment at station 95.
3. Hoist master switch on the cockpit overhead panel—PILOT.
4. Hoist control switch on cockpit overhead panel—OUT, OFF, or IN as required to control direction and speed of cable.

b. Control settings and electrical connections for operating the winch in the cargo mode from the cargo compartment are as follows:

1. Cable speed selector lever on the winch—CARGO.
2. Cable cutter arming device—Plugged into the auxiliary control panel, in the heater compartment at station 95.
3. Hoist master switch on the cockpit overhead panel—REMOTE.
4. Winch/hoist control grip—Plugged into either the auxiliary control panel in the heater compartment, station

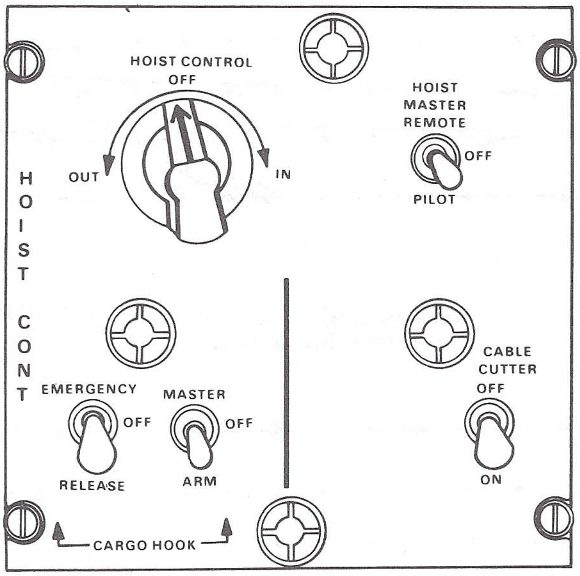


Figure 4-16. Hoist Control Panel

95, the hoist operations panel, right side station 320, or the receptacle, left side station 502.

5. Winch arming switch on the winch/hoist control grip—Depress.
6. Winch cable switch on the winch/hoist control grip—OUT, OFF, or IN as required to control direction and speed of winch cable.

c. Control settings and electrical connections for operating the winch in the rescue mode from the cockpit are as follows:

1. Cable speed selector lever on the winch—RESCUE.

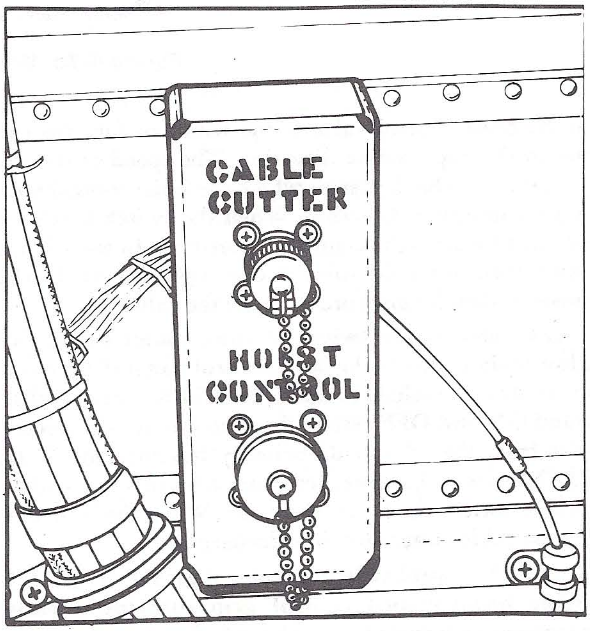


Figure 4-17. Auxiliary Control Panel (Station 95)

2. Cable cutter arming device—Plugged into the overhead receptacle above the rescue hatch.

3. Hoist master switch on the cockpit overhead panel—PILOT.

4. Hoist cable switch on the cockpit overhead panel—OUT, OFF, or IN as required to control the direction and speed of the winch cable.

d. Control settings and electrical connections for operating the winch in the rescue mode from the cargo compartment are as follows:

1. Cable speed selector lever on the winch—RESCUE.

2. Cable cutter arming device—Plugged into the overhead receptacle above the rescue hatch.

3. Hoist master switch on cockpit overhead panel—REMOTE.

4. Winch/hoist control grip—Plugged into the receptacle on the hoist control panel, right side, station 320.

5. Winch arming switch on the winch/hoist control grip—Depress.

6. Winch cable switch on the winch/hoist control grip—OUT, OFF, or IN as required to control direction and speed of the winch cable.

e. Rigging and operating procedures for use of the winch in the cargo mode are as follows:

1. Using the hoist control switch on either the cockpit overhead panel or on the winch/hoist control grip—Reel out the winch cable as required for rigging. As the cable is being reeled out, a crewman should maintain tension on the cable to avoid snarling and kinking. After extending the cable, the usable cable length will be checked to insure that the cable is free of any broken strands or definite bends that may reduce the cable capability.

CAUTION

Do not exceed 3,000 pounds single line pull. Damage to the winch can result from the overload.

2. Reeve the winch cable thru the pulley blocks to provide the required pull and angle of entry (figure 4-15) for rigging configurations for various loads.

WARNING

The quick disconnect cover guard must be installed during all cargo operations. Otherwise, the hook assembly can be inadvertently disconnected from the winch cable which can result in serious injury to personnel.

3. Attach the winch cable to the cable hook assembly by depressing the lock rings on each end of the quick disconnect device, inserting the ball ends of the winch and hook assembly cables into the quick disconnect device and releasing the lock rings. Install the quick disconnect cover guard.

4. Attach the winch cable to the load.

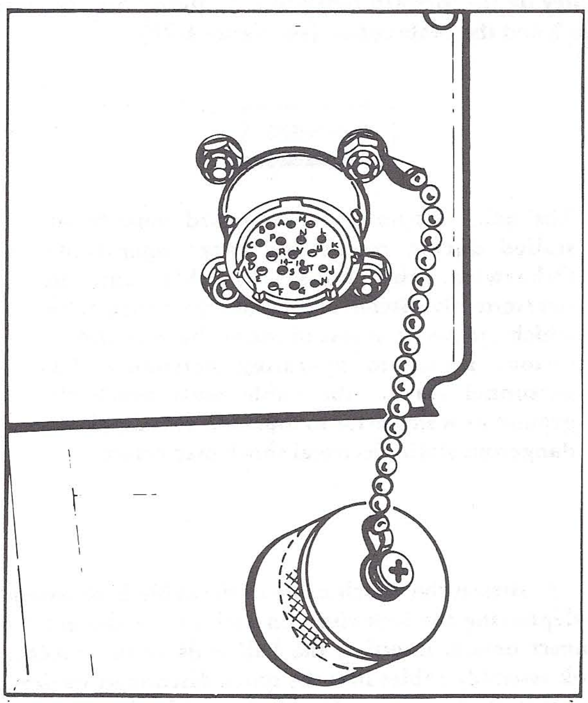


Figure 4-18. Winching Receptacle (Station 502)

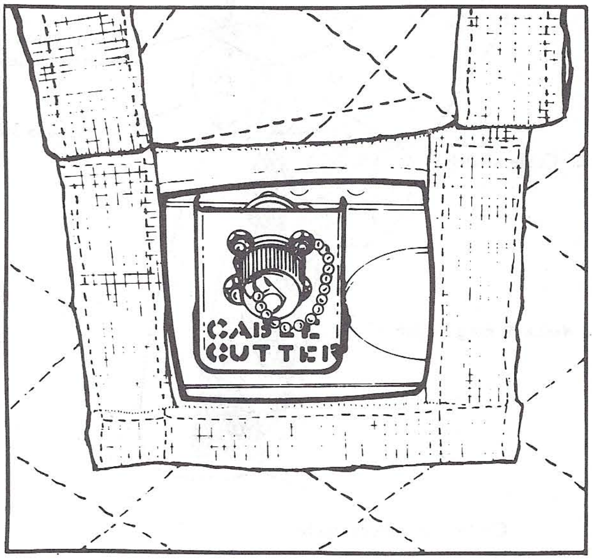


Figure 4-19. Overhead Cable Cutter Receptacle

WARNING

Personnel not required for the winching operation must remain well clear of the winch cable to prevent possible injury should the cable break.

CAUTION

Slack must be removed from the cable train before applying the full load to the winch system to prevent shock and over load of the system.

5. Reel the cable in slowly until all slack in the cable is removed. Then winch the load into the cargo compartment to the desired position.

WARNING

Chock vehicles and wheeled cargo before disengaging cable hook. Injuries to personnel can result from uncontrolled rolling of the load.

6. Reel the cable out slowly to provide slack in the cable. The hook can either be left attached to the load or disconnected. If the hook is disconnected, it should be attached to a tie-down fitting to prevent damage to the cargo floor due to in-flight vibrations.

f. Rigging and operating procedures for use of the winch in the rescue mode are as follows:

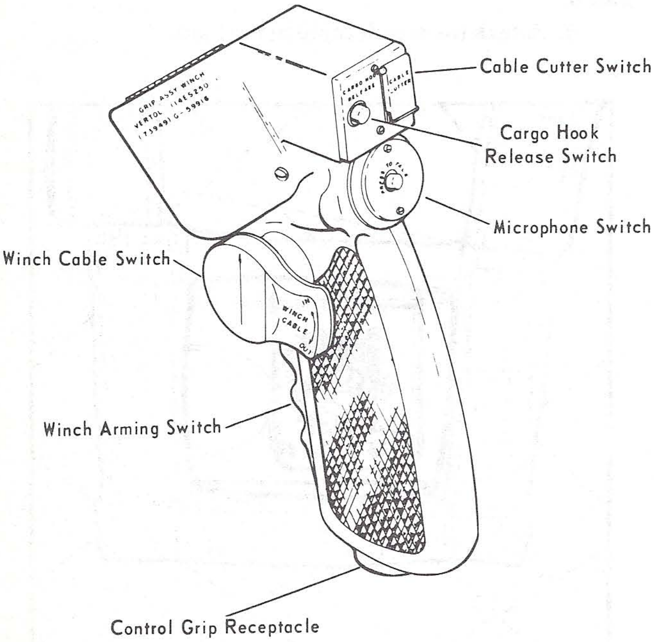


Figure 4-20. Winch/Hoist Control Grip

NOTE

The cargo hook assembly must be removed from the rescue hatch.

1. Using the hoist control switch on either the cockpit overhead panel or on the winch/hoist control grip, reel out the winch cable as required for rigging. As the cable is being reeled out, a crewman should maintain tension on the cable to avoid snarling and kinking. After extending the cable, the usable cable length will be checked to insure that the cable is free of any broken strands or definite bends that may reduce the cable capability.

CAUTION

Some pulley block assemblies have flanges with cable retainer pins as shown in figure 4-22. These pins should be installed only if the cable makes a wrap angle of 180 degrees or more around the pulley. Otherwise, the cable will bind on the pins and overload the winch and cable. When not in use, the pins and attaching hardware should be stowed in the container provided for the hoist accessories.

2. Reeve the cable thru the pulley on the floor, the pulley on the forward bulkhead, the pulley over the rescue hatch and the cable cutter, (see figure 4-22).

WARNING

The quick disconnect cover guard must be installed during rescue and cargo operations. Otherwise, the hook assembly can be inadvertently disconnected from the winch cable which can result in loss of life or the load and/or serious injury to operating personnel. For personnel rescue, the cable must touch the ground or water prior to touching personnel or a dangerous static electrical shock may result.

3. Attach the winch cable to the cable hook assembly by depressing the lock rings on each end of the quick disconnect device, inserting the ball ends of the winch and hook assembly cables into the quick disconnect device and releasing the lock rings. Install the quick disconnect cover guard.

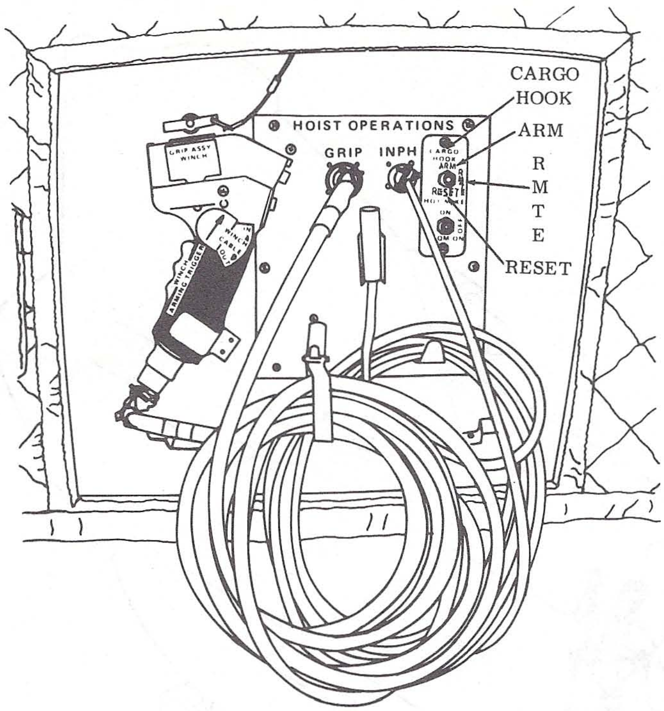


Figure 4-21. Hoist Operations Panel (Station 320)

WARNING

Slack must be removed from the cable train before applying the full load to the winch system to prevent shock and overload of the system and possible injury to the person being hoisted.

WARNING

Ensure that the load is clear of the ground and all obstacles before proceeding from hover to forward flight. Do not exceed 600 pounds. An overload can result in damage or failure of the support structure for the overhead cable pulley.

4. Reel the cable out and attach the cable hook to load—Reel in or out as required.

4-28. Winching Accessories.

A number of accesories are provided for use in winching and hoisting operation. Employment of these accessories is determined by winch usage. A compartment bag is attached to the bulkhead wall above the winch for stowage of winching accessories.

a. Cable pulleys. A sufficient number of pulleys are provided to permit routing the winch cable for winching and hoisting operations. The pulleys are equipped with snaplock fasteners for attachment to tiedown fittings or shackles as required.

b. Cable hook. A 2-ton-capacity removable hook assembly is provided for use in winching and hoisting operations. Extending from the hook assembly is a length of 1/4-inch cable, equipped with a metal ball which locks into a quick-disconnect device that is used for attaching the hook to the cable. The full-swiveling hook contains a spring snap lock to prevent opening of the hook and accidental loss of cargo.

c. Quick-disconnect device. The quick-disconnect device permits rapid connecting and disconnecting of winch cable hooks. The device consists of a short length of tooled steel with socket cavities at each end. The sockets are enclosed by spring-loaded rings that rest against flared rims on either edge of the device. The lockrings are depressed to admit the ball ends of the cables into the sockets and snap into place when released, securing the ball ends of the cables in a positive connection. A guard is supplied with the quick-disconnect device. When installed, it prevents the hoist operator from inadvertently operating the quick-disconnect device when assisting a rescued person into the helicopter.

d. Cable cutter. In hoisting during hovering operations, there is always a possibility that the cable hook might snag, resulting in critical strain on the hoisting system and restriction of helicopter mobility. The cable cutter provides a means of quickly severing the snagged hook by cutting the cable. The cable cutter consists of a housing, two follower rollers that permit free travel of cable thru the housing, a cutting shelf, a ballistic cartridge, and a threaded receptacle for an electrical connector. The cutter housing is split to allow reeving the cable and is bolted to a pulley bracket thru two holes in the housing. The cable cutter is armed by coupling an arming device to the receptacle in the cutter housing and plugging the device into the receptacle above the utility hatch marked CABLE CUTTER. The cable cutter cartridge is to be checked for total time prior to any hoisting or rescue operations. The cartridge should not be used after 5 years from the date of manufacture and should also be replaced after 1 year of installed service life. Cartridges are considered overage when either limit is exceeded.

WARNING

If personnel are in the cabin fuselage section when a load is jettisoned, make sure that they remain aft of the rescue hatch and face away from the cable cutter. The hoist cable can whip forward when it is cut and particles can be ejected from the cable cutter.

e. Cable cutter arming device. The arming device consists of an electrical wiring harness with electrical connectors at either end. This device is used to arm the cable cutter during hoisting operations. A connector at one end of the device couples with the threaded receptacle in the ca-

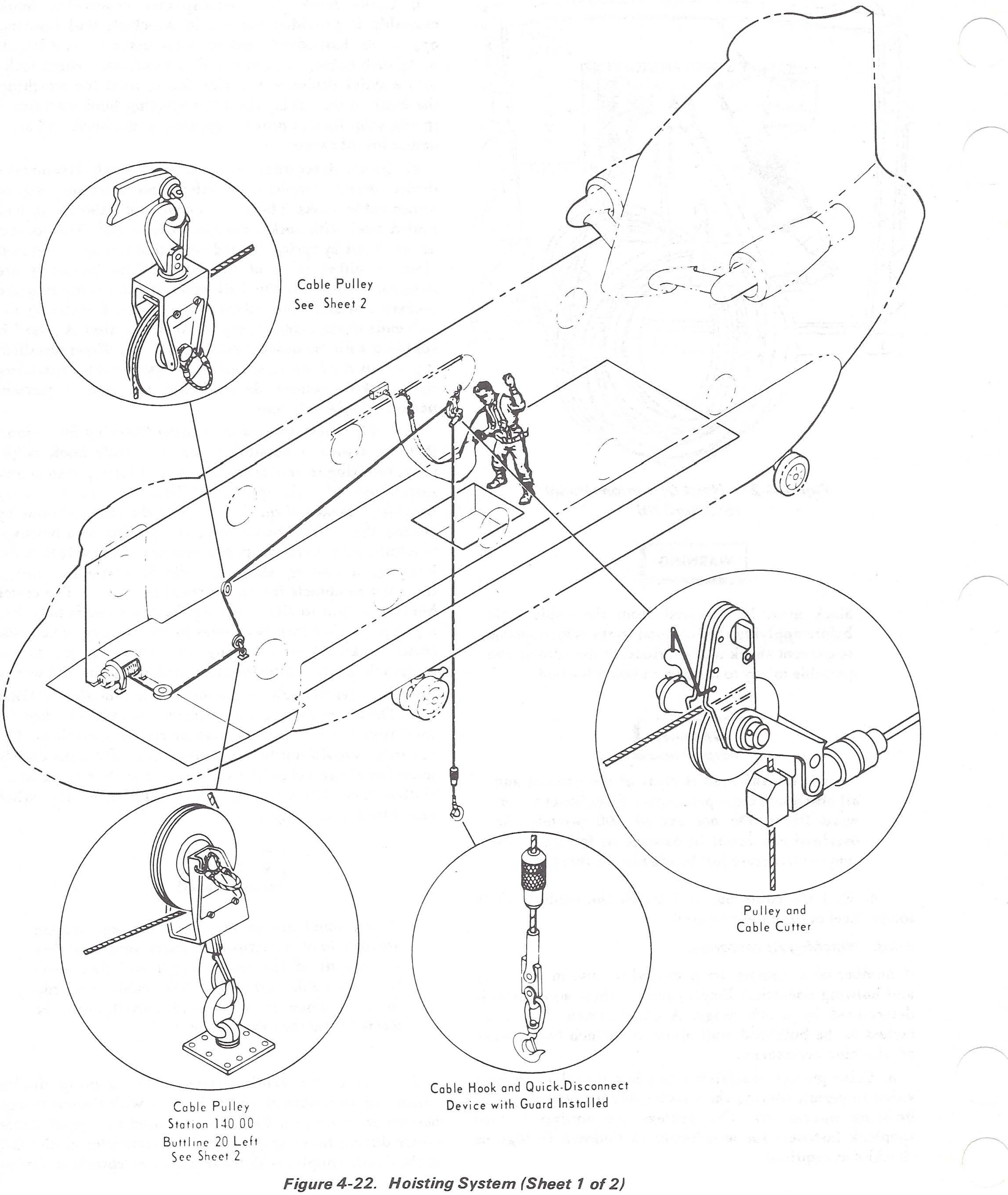


Figure 4-22. Hoisting System (Sheet 1 of 2)

ble cutter; the connector at the other end of the device plugs into a receptacle above the utility hatch and is labeled CABLE CUTTER. (See fig. 4-19.)

f. Extension cord. A 15-foot extension cord is provided to allow mobility of the winch operator and the hoist operator. Electrical connectors at each end of the cord are designed to connect with receptacles in the winch control grip and in the hoist control panel. This cord is the only means of plugging in power to the switches on the control grip.

g. Safety harness. A safety harness is provided for the hoist operator in operations involving the use of the rescue door. The harness permits complete freedom of movement while affording a measure of safety to prevent the wearer from falling out of the helicopter thru the door opening. In use, the safety harness is attached to a fitting on the wall of the cargo compartment near the hoist control panel.

4-29. Hoisting System.

The hoisting system (figure 4-22) is used for air rescue and for aerial loading of smaller general cargo thru the utility hatch. The hoisting system differs from the winching system only in the manner in which the cable is reeved. Hoisting operations require the winch cable to be reeved overhead and the hoist load capacity to be limited to a maximum of 600 pounds. The winch cable hook is used for hoisting operations together with the cable cutter which provides for quick release of the paid out cable and hook in event of emergency. On those aircraft provided with pulley block assemblies having pins as shown in figure 4-22, sheet 2, the following instructions apply: When the hoisting system is reeved as shown in figure 4-22, sheet 1, the pins and their retaining hardware are to be installed only if the cable makes a wrap angle of 180 degrees or more around the pulley. When not in use, the pins and their retaining hardware are to be stowed in the container provided for hoist accesories. The cargo hook assembly must be removed from the utility hatch before engaging in operations requiring use of the hoisting system.

4-30. Hoist.

(Refer to paragraph 4-25.)

4-31. Hoist Controls.

(Refer to paragraph 4-26.)

4-32. Hoist Control Switches.

(Refer to paragraph 4-26a. and b.)

4-33. Hoist Operation.

(Refer to paragraph 4-27.)

WARNING

To prevent dangerous electrical shock to personnel being hoisted, the cable must touch the ground or water prior to contacting personnel.

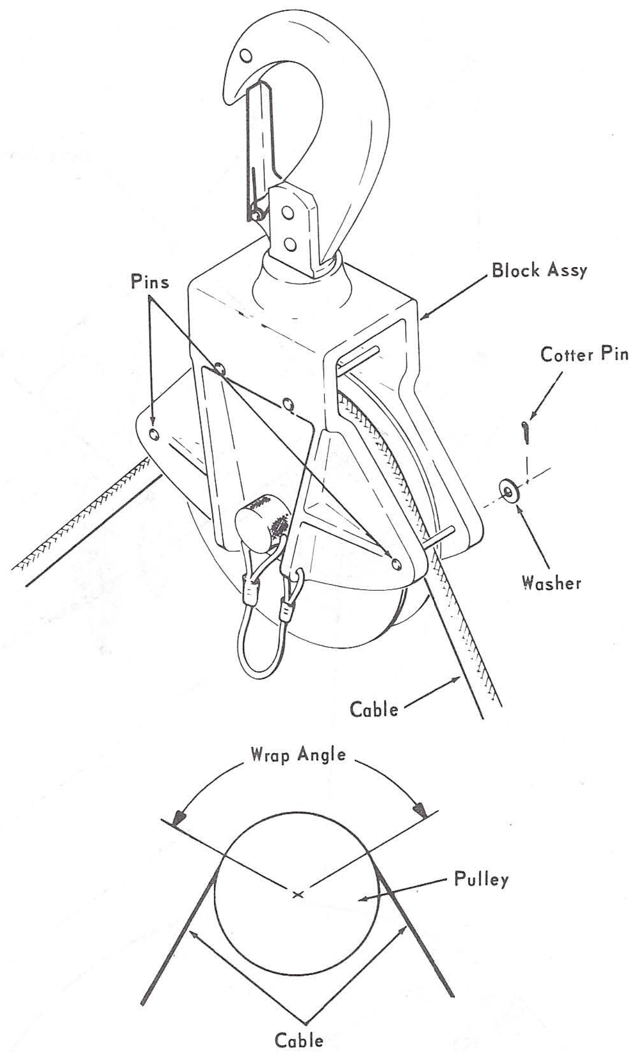


Figure 4-22. Hoisting System (Sheet 2 of 2)

4-34. Static Line Retriever.

A static line retriever is provided with the static line anchor cable. (See figure 4-23.) The retriever is used to haul static lines into the helicopter at the completion of a paradrop mission and can also be used to haul in a paratrooper "hung up" on a static line. The static line anchor cable and retriever are installed and operated as follows:

a. Install the anchor cable between stations 120 and 592.

NOTE

Do not allow the cable to sag more than 12 inches.

b. Plug the cable cutter into the auxiliary control panel at station 95 and move the speed selector on the winch to CARGO.

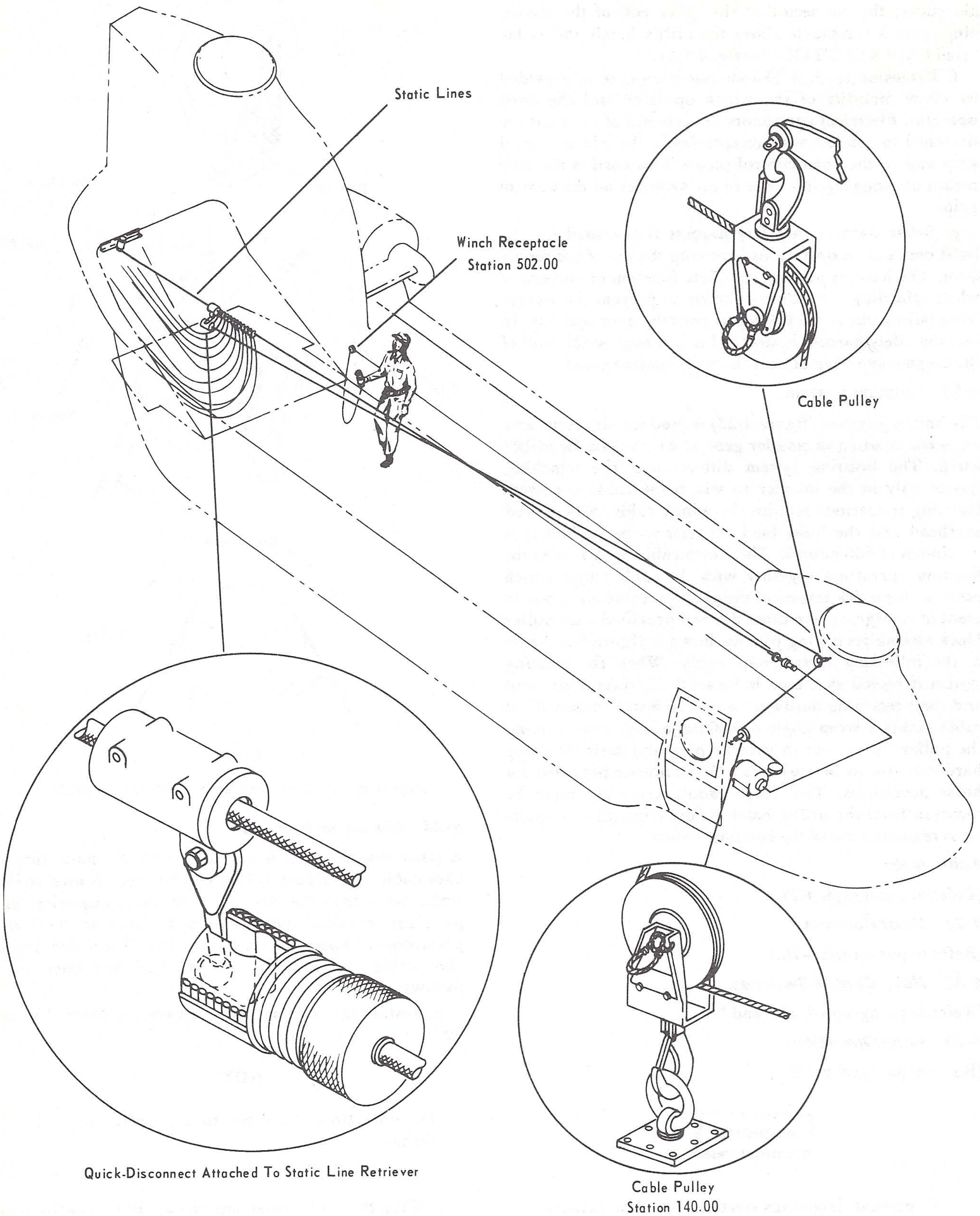


Figure 4-23. Static Line Retriever System

c. Plug the winch control grip into the power receptacle at station 502 on the left side of the helicopter.

d. Reeve the winch cable through a pulley attached to a 5,000-pound tiedown fitting at station 140, buttline 20 left and then thru another pulley attached at station 120, buttline 18 left (figure 4-23).

e. Reel enough cable out to allow the cable to rest on the floor and out of the way of personnel. Attach a quick-disconnect to the winch cable.

f. When the static lines are ready to be retrieved, reel out additional cable and attach the retriever to the winch cable. Reel sufficient cable in; then disconnect the static lines from the anchor cable.

4-35. Cargo Hook System.

A cargo hook (figure 4-24) which can be loaded to a maximum of 16,000 pounds is provided to lift and transport external loads. The position of the cargo hook is such that the load is suspended beneath the center-of-gravity of the helicopter. The hook assembly consists of a cargo hook, hydraulic actuator, and a carriage equipped with rollers. The hook is suspended by means of the carriage from a removable beam which is mounted inside the rescue hatch. This beam is curved and rotates within its mounting supports to minimize the effects of a shifting load on helicopter stability. Stops mounted near both ends of the beam prevent the moving carriage from damaging the surrounding structure. The cargo hook system is normally operated hydraulically by pressure from the utility hydraulic system. In the event of a loss in utility system pressure, the cargo hook can be opened pneumatically or manually. The cargo hook contains a spring-tensioned keeper which prevents accidental loss of cargo thru slippage of the sling rings. When not in use, the cargo hook can be removed from the hatch since both the electrical and hydraulic lines are equipped with quick-disconnects or the cargo hook can be stowed (figure 4-25). The cargo hook and beam assembly should be removed for rescue operations thru the hatch.

4-36. Cargo Hook Controls.

The cargo hook can be operated from the cockpit by a switch on each cyclic stick grip (figure 2-24) and switches on the overhead control panel (figure 4-16.) It can be operated from the cargo compartment by a switch on the winch/hoist control grip (figure 4-20) and switches on the hoist operations panel (figure 4-21). Power to control the cargo hook system is supplied by the 28-volt dc secondary bus, thru the CARGO HOOK CONT circuit breaker on the overhead circuit breaker panel. Power to operate and control the emergency release is provided by the 28-volt dc emergency bus thru the CARGO HOOK EMERG circuit breaker on the overhead circuit breaker panel.

a. Cargo hook master switch. The CARGO HOOK MASTER switch is on the HOIST CONT panel (figure 4-16) of the overhead switch panel. The switch has two marked positions, ARM and OFF. When the switch is set to ARM, power is applied to the CARGO HOOK RELEASE switches on the cyclic sticks and also to the CARGO HOOK ARM switch at the hoist operator's station. The CARGO HOOK MASTER switch is also used to close the cargo hook.

CAUTION

Do not mistake the CARGO HOOK EMERGENCY RELEASE switch for the CARGO HOOK MASTER switch. The switches are close to each other on the overhead switch panel.

b. Cargo hook arming switch. The CARGO HOOK ARMING switch is on the hoist operations panel (figure 4-21) in the cargo compartment. The CARGO HOOK ARM switch has three marked positions ARM, RMTE (remote), and RESET. When the CARGO HOOK MASTER switch is at ARM, and the switch is moved to ARM, power is applied to the CARGO HOOK RELEASE on the winch/hoist control grip. When the switch is at RMTE, power is removed from the CARGO HOOK RELEASE switch and the cargo hook can only be operated from the cockpit. The RESET position is used when the pilot requests that the cargo hook be closed from the hoist operator's station.

c. Cargo hook release switches. A CARGO HOOK RELEASE switch is on each of the following: the pilot's cyclic stick grip (figure 2-24), the copilot's cyclic stick grip (figure 2-24) and the winch/hoist control grip (figure 4-20). Any one of these switches can be used to operate the cargo hook. Each of these switches are the momentary type. When either the pilot's or copilot's CARGO HOOK RELEASE switch is pressed with the CARGO HOOK MASTER switch at ARM, the cargo hook will open and remain open. The hook can be closed by setting the CARGO HOOK MASTER switch to OFF or by setting the CARGO HOOK ARM switch to RESET. The CARGO HOOK RELEASE on the winch/hoist control grip when pressed will cause the hook to open and when released, to close.

d. Emergency cargo hook release switch. The emergency cargo hook release switch is on the overhead hoist control panel (figure 4-16) in the cockpit and is labeled CARGO HOOK EMERGENCY RELEASE. This switch provides means of opening the cargo hook should a loss of utility system pressure occur. When the switch is moved from OFF to RELEASE, a solenoid valve attached to the hydraulic actuator opens and releases the compressed air charge which is stored in the lower half of the hydraulic actuator. Releasing the air pressure allows the hook to open and it will remain open until the switch is moved to OFF. After this method of opening the hook is used, the hook actuator must be recharged to 2,100 psi.

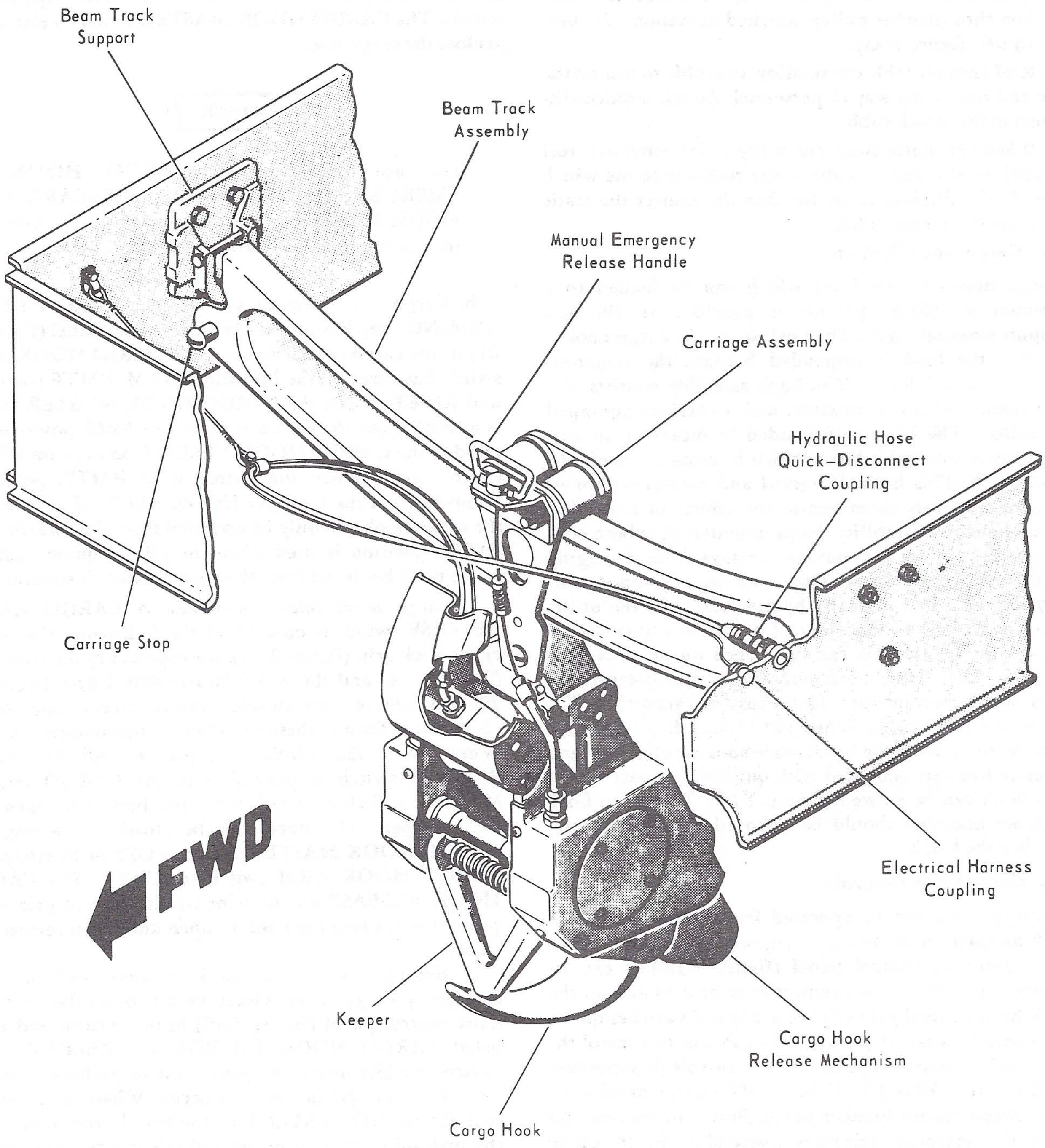


Figure 4-24. Cargo Hook

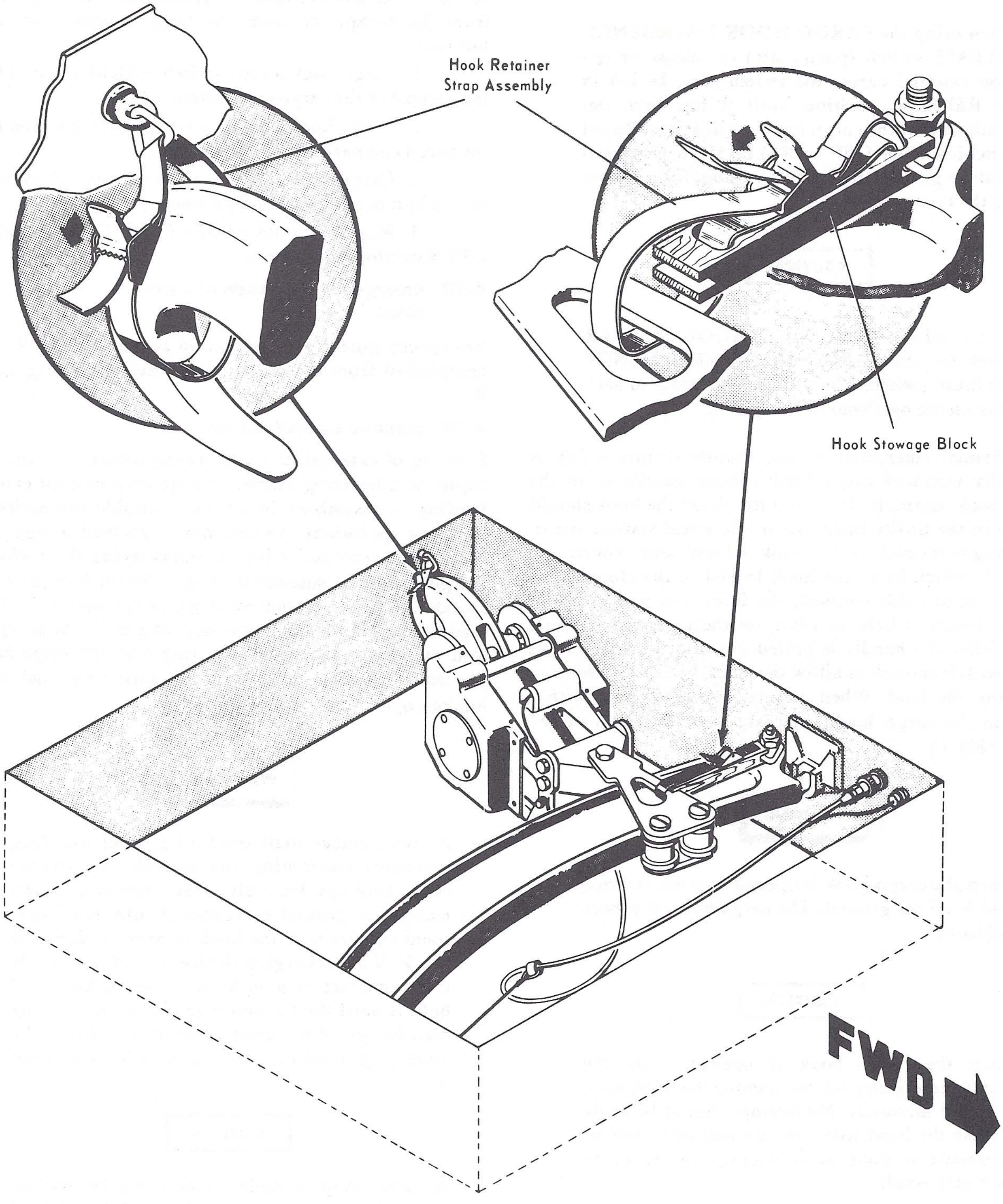


Figure 4-25. Cargo Hook Stowage

316-520 O - 80 - 10

WARNING

When using the CARGO HOOK EMERGENCY RELEASE switch (pneumatic) to release or jettison external cargo, the switch must be left in the RELEASE position until it has been determined that the cargo has been dropped. Rapid switching from OFF to RELEASE to OFF will result in partial air bleedoff without fully actuating the release mechanism.

CAUTION

Do not mistake the CARGO HOOK MASTER switch for the CARGO HOOK EMERGENCY RELEASE switch. The switches are close to each other on the overhead switch panel.

e. Manual emergency release handle (figure 4-24). A manually operated cargo hook release handle is on the cargo hook assembly. It is used to release the hook should failure in the utility hydraulic or electrical systems occur. A spring-tensioned cargo hook release lever controls a camshaft which keeps the hook locked in the closed position. A metal cable connects the lever arm to the release handle which is held in place on the carriage by metal clips. When the handle is pulled upward, the lever moves the camshaft enough to allow the cargo hook to swing free, releasing the load. When manual release is used with a load on the cargo hook, an entry must be made in DA Form 2408-13.

WARNING

When the cargo hook is opened and the external load is off the ground. The cargo will whip back and forth.

CAUTION

When the cargo hook is opened using the manual emergency release handle, the hook must be closed manually. No attempt should be made to close the hook using the normal hydraulic or pneumatic method, since damage to the cargo hook may result.

f. Cargo hook caution light. One cargo hook caution light, marked CARGO HOOK OPEN, is on the master caution panel (figure 2-52) on the console. The light will come on when the hook is opened hydraulically, pneumatically, or manually. The light is actuated by microswitches on the cargo hook assembly.

4-37. Normal Operation of Cargo Hook.

Normal (electrohydraulic) operation of the cargo hook from the cockpit or from the cargo compartment is as follows:

1. Cargo hook master switch—ARM. (If used from the cockpit or the cargo compartment.)
2. Cargo hook arming switch—ON. (If used from the cargo compartment.)
3. Cargo hook release switch—Press. (From either the cockpit or the cargo compartment.)
4. Master caution panel—Check CARGO HOOK OPEN caution light comes on.

4-38. Emergency Operation of Cargo Hook.

Emergency (pneumatic) operation of the cargo hook is accomplished from the cockpit only. Refer to paragraph 9-87.

4-39. External Cargo Loading.

Loading of external cargo is accomplished with the helicopter in a hovering attitude. Cargo prepared for external loading is assembled in an area suitable for helicopter hovering operations. An external cargo load is rigged for pickup and transport with a cargo carrying sling which is equipped with a suspension ring. (Nylon loop or metal shackle). The cargo hook loading pole (paragraph 4-43.) is used to grapple for the suspension ring and to hook up the load by placing the suspension ring over the cargo hook. The safety harness must be worn during external cargo hookup operations.

WARNING

A crewmember shall brief all ground handling personnel concerning the hazards of external cargo hookups. He shall stress safety and recommend that ground personnel should avoid personal contact with the hook to prevent electrical shock. If a discharging device is used, and while it is in contact with the hook, grasp the hook and hold it until the hookup is made. If the hook-up man lets go of the hook prior to completing the hookup, ground the hook again before touching it.

CAUTION

A nylon loop or metal shackle will be used between the cargo hook and sling. External loads must not be rigged entirely with steel cable (wire rope) slings. A nylon vertical riser of at least 6 feet in length must be placed between a steel cable sling and the nylon loop to dampen vibration tendencies. Nylon and chain leg slings and pure nylon slings must have at least 6 feet of nylon in each leg.

4-40. Checklist. The following procedures should be observed in preparing the helicopter to transport external cargo:

1. Equipment—Stow and Secure.
2. Emergency equipment—Check.
3. Emergency exits—Inspect.
4. Utility hatch door—Open.
5. Lower rescue door—Open.
6. Cargo hook stowage straps—Remove.
7. Cargo hook hydraulic line coupling—Inspect.
8. Cargo hook electrical harness coupling—Inspect.

WARNING

Prior to positioning the cargo hook, pull out the applicable circuit breakers and set the arming switch to OFF. In addition, do not use the synchronizer bar as a grip; injury to the hands can result if the cargo hook is accidentally energized.

9. Cargo hook air pressure—Check 2,100 psi.
10. Cargo hook operation—Check.
11. Cargo hook loading pole—Check.
12. Interphone—Check operation at the hoist operator's station.
13. Safety harness—Fit and Attach.

4-41. Cargo Sling Hookup Procedures. Use the following phraseology during cargo sling hookup:

1. Pilot—Load is under the nose.
2. Flight engineer—Load is in sight. (To direct the pilot over the load, use BACK___feet, FORWARD___feet, UP___feet, DOWN___feet, RIGHT___feet, or LEFT___ feet.)
3. Flight engineer—Load is hooked. UP___feet, sling is tight. Load is off the ground___feet. Load is cleared for flight.

NOTE

During flight, the sling load should be continuously observed for airworthiness.

4-42. Final Approach Procedure With an External Sling Load. Use the following phraseology during the final approach with an external sling load:

1. Pilot—Short final.
2. Flight engineer—Start verbal countdown from 100 feet. Tell the pilot when clear of any barriers. Use direction and distance in feet, talk the pilot to a 10-foot hover. Once the load is stable, direct the pilot to the drop zone. Release the load. On intercom, tell the pilot the load is released and cleared for flight.

WARNING

Before releasing the load, make sure the sling is slack (the load is on the ground) to keep the cargo hook from swinging up into the cabin. If the load is released while it is still off the ground, the cargo hook may swing upward into the cabin and injure the flight engineer.

4-43. Cargo Hook Loading Pole.

A tubular metal pole is provided for use in attaching external cargo loads to the external cargo hook. The pole is 75 inches long and is fitted at one end with a wide-angle hook. The pole is secured to the fuselage by a 10 foot length of $3/32$-inch cable, thus preventing accidental loss of the pole when in use. When not in use, the loading pole is stowed on the cargo compartment floor directly beneath the hoist control panel.

CHAPTER 5

OPERATING LIMITS AND RESTRICTIONS

SECTION I GENERAL

5-1. Purpose.

This chapter includes all important operating limits and restrictions that shall be observed during ground and flight operations.

5-2. General.

The operating limitations set forth in this chapter are the direct result of design analysis, test, and operating experience. Compliance with these limits will allow the pilot to safely perform the assigned missions and to derive maximum utility from the aircraft. Limits concerning maneuvers, weight, and center of gravity limitations are also covered in this chapter.

5-3. Exceeding Operational Limits.

Any time an operational limit is exceeded, an appropriate entry shall be made on DA Form 2408-13. Entry shall state what limit or limits were exceeded, range, time above limits, and any additional data that would aid maintenance personnel in performing inspections that may be required.

5-4. Minimum Crew Requirement.

The minimum crew required to fly this helicopter under normal conditions is a pilot, copilot, and flight engineer. Additional crewmembers, as required, will be added at the discretion of the commander, in accordance with appropriate Department of the Army Regulations.

5-5. Water Operation Limitations.

The following limitations apply to helicopters subsequent to serial number 63-7917. Helicopters prior to 63-7917 are not cleared for water operation.

5-6. Night Operation On Water. Night operation on water is prohibited.

5-7. Sea State Limits. Operation on water is restricted to a maximum of Sea State 2. Refer to table 5-1 for information on sea states.

5-8. Operation Time Limit. Operation on water is restricted to 30 minutes total flotation time without draining the helicopter. In addition, the helicopter must be drained following each water operation. This can be accomplished by opening the drain valves.

5-9. Gross Weight Limitations. Maximum gross weight for water operation is 28,550 pounds.

5-10. Taxiing Limitations. Taxiing will not be conducted in water conditions above Sea State 1 or in winds above 6 knots. Fast taxiing will be conducted in a straight line only and to a maximum speed of 10 knots when the lower nose enclosure is left in the water.

5-11. Landing Limitations. Water landings can be performed within the limitations presented on figure 5-1. Running landings will only be conducted onto calm water.

5-12. Rotor Starting And Shutdown Limitations. Rotor starting or shutdown will not be conducted when water conditions exceed Sea State 1 or wind conditions exceed 6 knots.

5-13. Autorotative Landings. Practice autorotations to the water are prohibited.

5-14. Single-Engine Takeoffs. Practice single-engine takeoffs from the water are prohibited.

5-15. Additional Restrictions.

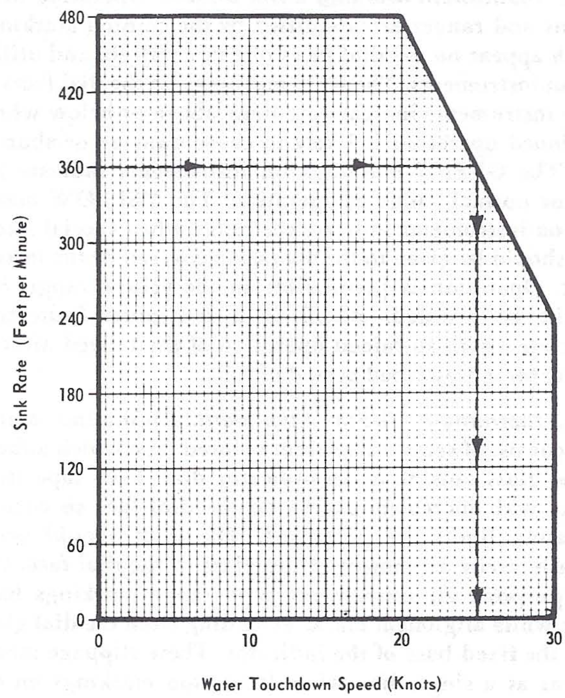
The following restrictions apply:

a. Air-to-ground towing operations are prohibited.

b. Do not operate the apu while in flight, except during emergencies. If the apu is operated during flight, do not shut the apu down until on the ground.

c. Hoist is limited to 600 pounds.

d. Cargo hook is limited to 16,000 pounds.



NOTE:

The touchdown speeds presented do not reflect indicated airspeed.

Figure 5-1. Water Landing Speed Limitations

Table 5-1. Description of Sea States

SEA STATE	SEA DESCRIPTION	WIND DESCRIPTION	WIND VELOCITY (KNOTS)	AVERAGE WAVE HEIGHT (FT)
	Sea like a mirror (calm)	Calm	Less than 1	0.0
0	Ripples with appearance of scales; no foam crests (smooth)	Light Air	1-3	0.05
1	Small wavelets; crests of glassy appearance, not breaking (slight)	Light Breeze	4-6	0.2
2	Large wavelets; crests begin to break; scattered whitecaps	Gentle Breeze	7-10	0.6 0.9
3	Small waves, becoming longer, numerous whitcaps (moderate)	Moderate Breeze	11-16	1.4 2.0 2.9

SECTION II SYSTEM LIMITS

5-16. System Limits.

5-17. Instrument Markings.

Limitations (figure 5-2) which are marked on the various instruments are not necessarily repeated in the subsequent text. When further explanation of certain markings is required, refer to the specific area of discussion.

5-18. Instrument Marking Color Codes. Operating limitations and ranges are identified by the colored markings which appear on the dial faces of engine, flight and utility system instruments. The RED markings on the dial faces of these instruments indicate the limit above or below which continued operation is likely to cause damage or shorten life. The GREEN markings on instruments indicate the safe or normal range of operation. The YELLOW markings on instruments indicate the range when special attention should be given to the operation covered by the instrument. Operation is permissible in the yellow range, but should be avoided. BLUE is a maximum indication associated with sustained operation of the related aircraft system for a prescribed period of time.

5-19. Instrument Glass Alignment. Limitation markings consist of semi-transparent colored tape which adhere to the glass outside of an indicator dial. Each tape strip aligns with increment marks on the dial face so correct operating limits are portrayed. The pilot should occasionally verify alignment of the glass to the dial face. For this purpose, all instruments with range markings have short white alignment marks extending from the dial glass onto the fixed base of the indicator. These slippage marks appear as a single line when limitation markings on the glass properly align with the proper increments on the dial face. However, the slippage marks appear as separate radial lines when a dial glass has rotated.

5-20. Rotor Limitations.

The following rotor limitations apply.

a. The operating rotor speed is 230 rpm at all gross weights. However, 225 rotor rpm may be used during partial power descent to reduce vibration.

b. The minimum rotor speed for ground operation is 204 rpm.

c. The maximum rotor speed is 233 rpm with power-on. This is an engine limitation.

d. The maximum continuous rotor speed during autorotation is 261 rpm. Should 261 rpm be inadvertently exceeded, no entry need be made in the DA Form 2408-13 unless the rotor speed attains or exceeds 288 rpm. Should the rotor system accelerate to 265 rpm or above, it must be reported on DA Form 2408-13 for maintenance action. Even though no action is required when the rotor rpm exceeds 261 but remains less than 288, willful operation should not be conducted in this range.

e. Transmission resonance may occur in the 210 to 224 rotor rpm range during operations requiring engine power with certain transmissions installed. Operations in this rotor rpm range shall be transient and avoided when one or more of the following transmissions are installed.

(1) Forward Transmissions:

114D1001-1 thru -19	114D1001-534 and -535
114D1001-501 and -502	114D1001-547 and -548
114D1001-514 and -515	114D1001-552 and -553
114D1001-519 thru -528	114D1001DK102-4 and -7

(2) Aft Transmissions:

114D2001-1 thru -18	114D2001-538
114D2001-501	114D2001-540 thru -547
114D2001-503 thru -510	114D2001-549
114D2001-512	114D2001-552
114D2001-515	114D2001-557
114D2001-522 thru -531	114DK 102-5

(3) Engine Transmissions: 114D6001-1 thru -7

ENGINE LIMITATIONS
BASED ON USE OF JP-4 FUEL

ROTOR TACHOMETER (T55-L-7/7B ENGINE)

- 204 RPM Minimum for Ground Operation
- 205 to 226 RPM Caution
- 227 to 233 RPM Normal Operation

CAUTION

Avoid the 210 to 224 rotor RPM range during all operations requiring engine power. Operation in this range shall be transient only.

- 233 RPM Maximum Power On
- 261 RPM Maximum During Autorotation

NOTE

Refer to paragraph 7-35 for additional rotor limitations.

ENGINE LIMITATIONS
BASED ON USE OF JP-4 FUEL

ROTOR TACHOMETER (T55-L-7C)

- 209 RPM Minimum for Ground Operation
- 210 to 226 RPM Caution
- 227 to 233 RPM Normal Operation

CAUTION

Avoid the 210 to 224 rotor RPM range during all operations requiring engine power. Operation in this range shall be transient only.

- 233 RPM Maximum Power On.
- 261 RPM Maximum During Autorotation

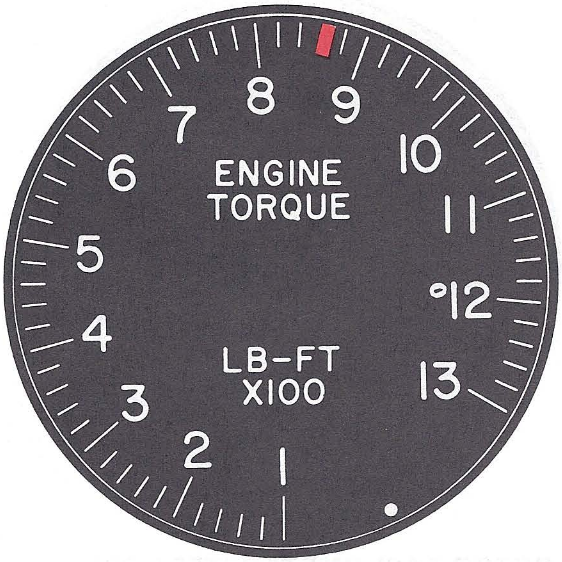
NOTE

Refer to paragraph 7-35 for additional rotor limitations.

ROTOR TACHOMETER
(114D2200 SERIES AFT TRANSMISSION)

- 214 RPM Minimum for Ground Operation
- 215 to 226 RPM Caution
- 227 to 233 RPM Normal Operation
- 233 RPM Maximum Power On
- 261 RPM Maximum During Autorotation

Figure 5-2. Instrument Markings (Sheet 1 of 5)



TORQUEMETER

860 Lb-Ft Maximum

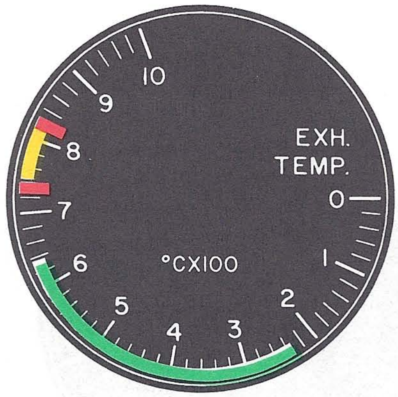
AIRSPEED

132 Knots Maximum

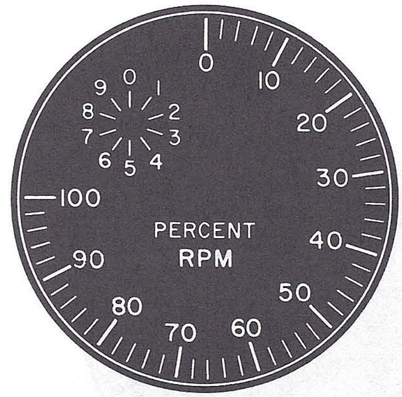
NOTE

Refer to paragraph 7-51 for additional airspeed limitations.

Figure 5-2. Instrument Markings (Sheet 2 of 5)



EXHAUST GAS TEMPERATURE



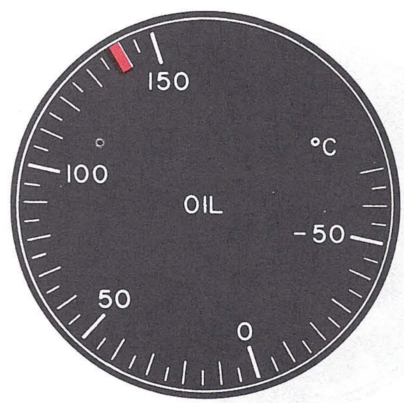
GAS PRODUCER TACHOMETER

- 230° to 635°C Continuous Operation
- 735°C Maximum For Not More Than 30 Minutes
- 735° to 816°C Transient Operation Only
- 816°C Maximum Not To Be Exceeded For More Than 5 Seconds

- Marked Per Each Engine

T55-L-7B ENGINES

ENGINE OIL PRESSURE



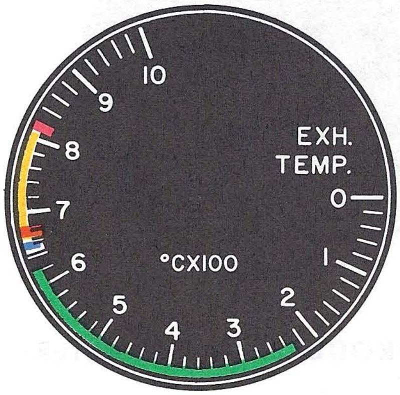
ENGINE OIL TEMPERATURE

- 10 PSI Minimum at Ground Idle
- 40 to 50 PSI at or Above 70 Percent N1 RPM
- 50 to 90 PSI at Normal Power or Above
- 110 PSI Maximum

- 138°C Maximum

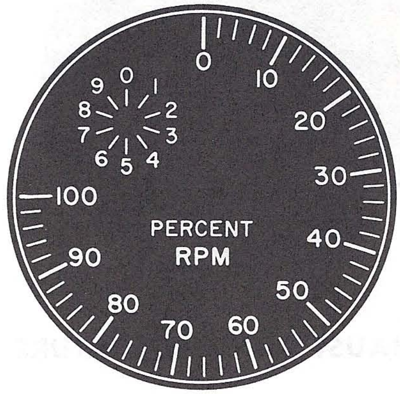
A114-162-10 (2)

Figure 5-2. Instrument Markings (Sheet 3 of 5)



EXHAUST GAS TEMPERATURE

- (Green) 230° to 620°C Continuous Operation
- (Blue) 650°C Maximum For Not More Than 30 Minutes
- (Red) 665°C Maximum For Not More Than 10 Minutes
- (Yellow) 665° to 816°C Transient Operation Only
- (Red) 816°C Maximum Not To Be Exceeded For More Than 5 Seconds



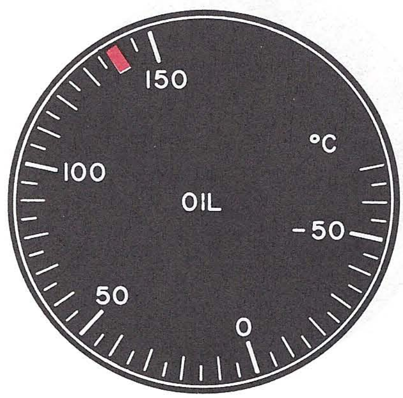
GAS PRODUCER TACHOMETER

- (Red) Marked Per Each Engine

T55-L-7C ENGINES

ENGINE OIL PRESSURE

- (Red) 10 PSI Minimum at Ground Idle
- (Yellow) 40 to 50 PSI at or Above 70 Percent N1 RPM
- (Green) 50 to 90 PSI at Normal Power or Above
- (Red) 110 PSI Maximum



ENGINE OIL TEMPERATURE

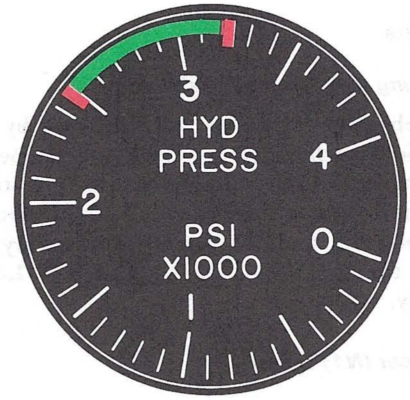
- (Red) 138°C Maximum

A 114-162-10 ③

Figure 5-2. Instrument Markings (Sheet 4 of 5)

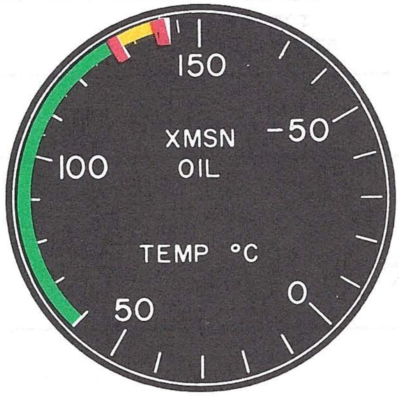
TRANSMISSION OIL PRESSURE

- 20 PSI Minimum
- 20 to 90 PSI Normal Operation



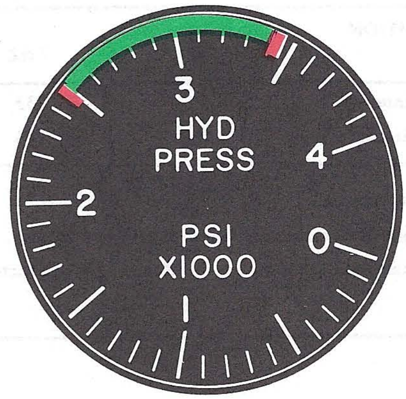
FLIGHT CONTROL HYDRAULIC PRESSURE

- 2500 PSI Minimum
- 2500 to 3200 PSI Normal Operation
- 3200 PSI Maximum



TRANSMISSION OIL TEMPERATURE

- 60° to 130°C Normal Operation
- 130°C Maximum Continuous Operation
- 130° to 140°C 1-Hour Operation Limit
- 140°C Maximum Never Exceed



UTILITY HYDRAULIC PRESSURE

- 2500 PSI Minimum
- 2500 to 3400 PSI Normal Operation
- 3400 PSI Maximum

4-162-10 (5)

Figure 5-2. Instrument Markings (Sheet 5 of 5)

SECTION III POWER LIMITS

5-21. Power Limits.

5-22. Engine Rating and Power Level Limits.

Operation of a turboshaft engine is greatly affected by atmospheric conditions such as air pressure and temperature. For variations in torque available with temperature and pressure altitude, refer to the Torque Available charts in chapter 7. Tables 5-2 and 5-3 present a summary of operating limits for the T55-L-7/-7B and T55-L-7C engines respectively.

5-23. Gas Producer (N1) Speed.

The production engine acceptance test log assigned to each engine, records the percent N1 speed at which the engine will produce maximum power (engine topping) at sea level, and standard day (15°C) conditions. This percent N1 speed will be placarded on the instrument panel for each engine. To determine the N1 at which the engine will produce rated power on other than a standard day, proceed as follows:

a. From figure 5-3, determine the N1 correction for the existing free air temperature.

b. This correction factor is algebraically summed with the N1 speed shown on the placard on the instrument panel.

c. The resulting percent of N1 is the maximum allowable speed at which the engine should operate at maximum power for this temperature.

5-24. Engine Overspeed.

An engine overspeed condition exists whenever either of the following occurs:

a. A gas producer (N1) overspeed exists when the N1 limit, as derived in paragraph 5-23, has been exceeded for more than 1 minute or by more than 2 percent. If N1 exceeds the limit derived in paragraph 5-23 by up to 2 percent limit the time spent in that range.

CAUTION

Any operation that exceeds the above N1 limit may cause excessive temperatures in the engine.

Table 5-2. Summary of T55-L-7/7B Operating Limitations

OPERATING CONDITION AND TIME	N1	*N2	SHP	TORQUE LIMIT AT 230 ROTOR RPM	EGT
Normal Power (Continuous)	—	233	2,250	780	Up to 635°C
Military Power (30-Minutes)	***	233	2,650	**860	636° to 735°C

*Stated in terms of rotor rpm.

**Transmission torque limit is reached before engine power limit.

***The N1 limit is established per each engine. Refer to the production engine acceptance test log.

Table 5-3. Summary of T55-L-7C Operating Limitations

OPERATING CONDITION AND TIME	N1	*N2	SHP	TORQUE LIMIT AT 230 ROTOR RPM	EGT
Normal Power (Continuous)	—	233	2,500	**860	Up to 620°C
Military Power (30-Minutes)	—	233	2,850	**860	621° to 650°C
Maximum Power (10-Minutes)	***	233	2,850	**860	651° to 665°C

*Stated in terms of rotor rpm.

**Transmission torque limit is reached before engine power limit.

***The N1 limit is established per each engine. Refer to the production engine acceptance test log.

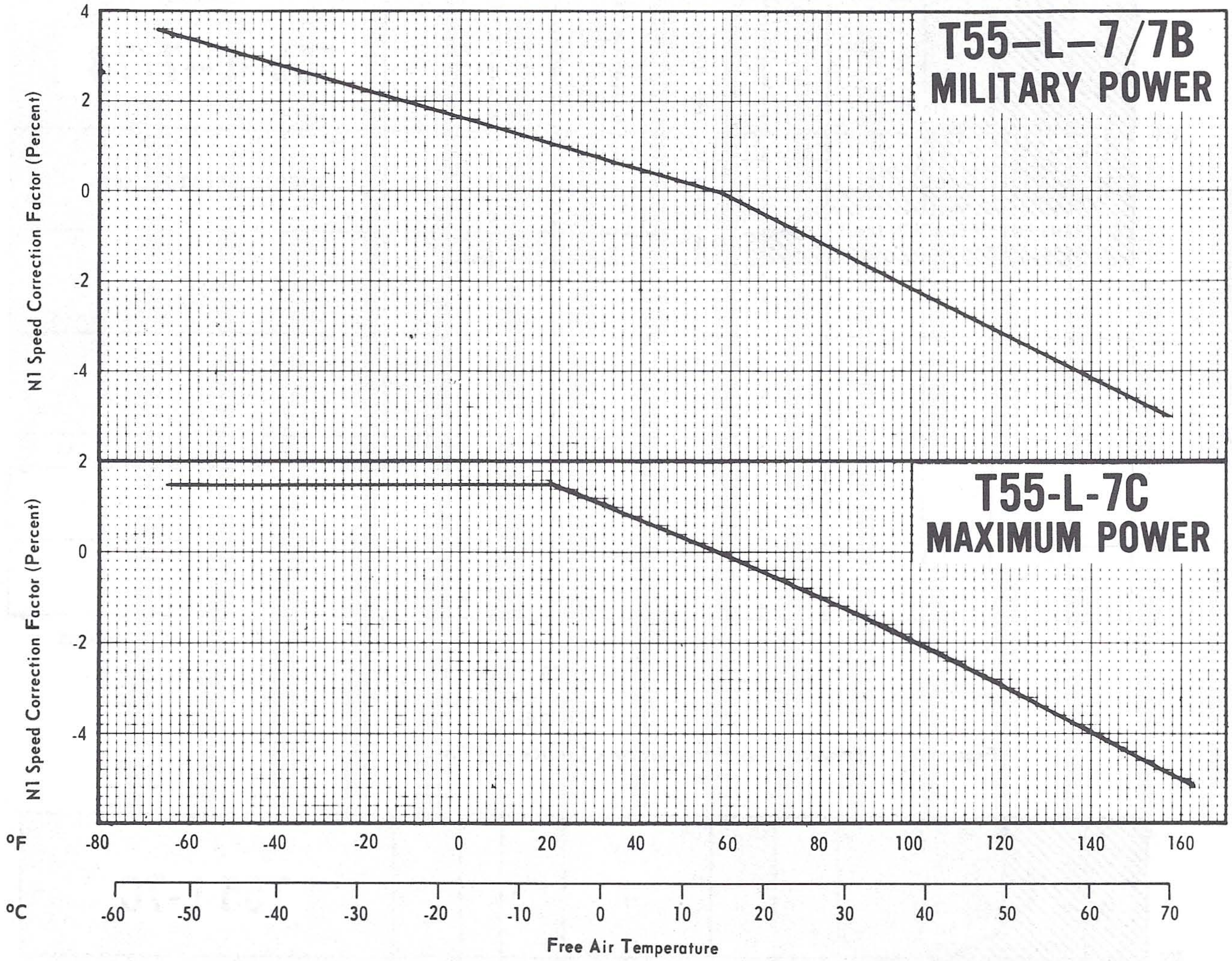


Figure 5-3. Variation in Gas Producer Speed (N1)

b. A power turbine (N2) overspeed condition may exist, depending on power being used, when 244 rotor rpm for more than 5 seconds. To aid maintenance personnel in determining if an actual N2 overspeed has occurred, the pilot must record the following in the DA Form 2408-13 when noting an N2 overspeed: pressure altitude, free air temperature, peak torque, peak rotor rpm, and duration of overspeed. Although no maintenance action may be required when rotor rpm exceeds overspeed limits, willful operation must not be conducted in excess of 233 rpm.

5-25. Causes Of Engine Overspeed. An N2 overspeed may be caused by one or more of the following:

a. Fuel control governor overshoot.

b. An abrupt load decrease.

5-26. Results Of Engine Overspeed. The results of an overspeed are as follows:

a. An N1 overspeed may result in one or more of the following:

(1) Overpower

(2) Overtemperature

(3) Overtorque

b. An N2 overspeed may result in a reduction of power turbine rotor tip clearance.

5-27. Engine Overtemperature. An overtemperature exists when the time/temperature limits shown on figure 5-4 (T55-L-7/-7B) or 5-5 (T55-L-7C) are exceeded. The figures are for the purpose of defining overtemperature. They do not necessarily indicate the normal operating temperature for any individual engine. Significant changes in egt at any power level are cause for investigation; even though the limits are not exceeded. A transient is defined as any one-time cycle (increase then a decrease) of the egt.

5-28. Fuel Limitations.

JP-4 (MIL-T-5624) fuel is the Army standard fuel for the T55-L-7 series engines. Operation of T55-L-7/7B engines on emergency fuels is limited to 50 cumulative hours. Operation of T55-L-7C engines on emergency fuels is limited to 100 cumulative hours. At the end of the specified operating period, an internal engine inspection (hot-end) must be performed. The inspection may be delayed for 10 hours operating time, provided that standard fuels are used during the delay.

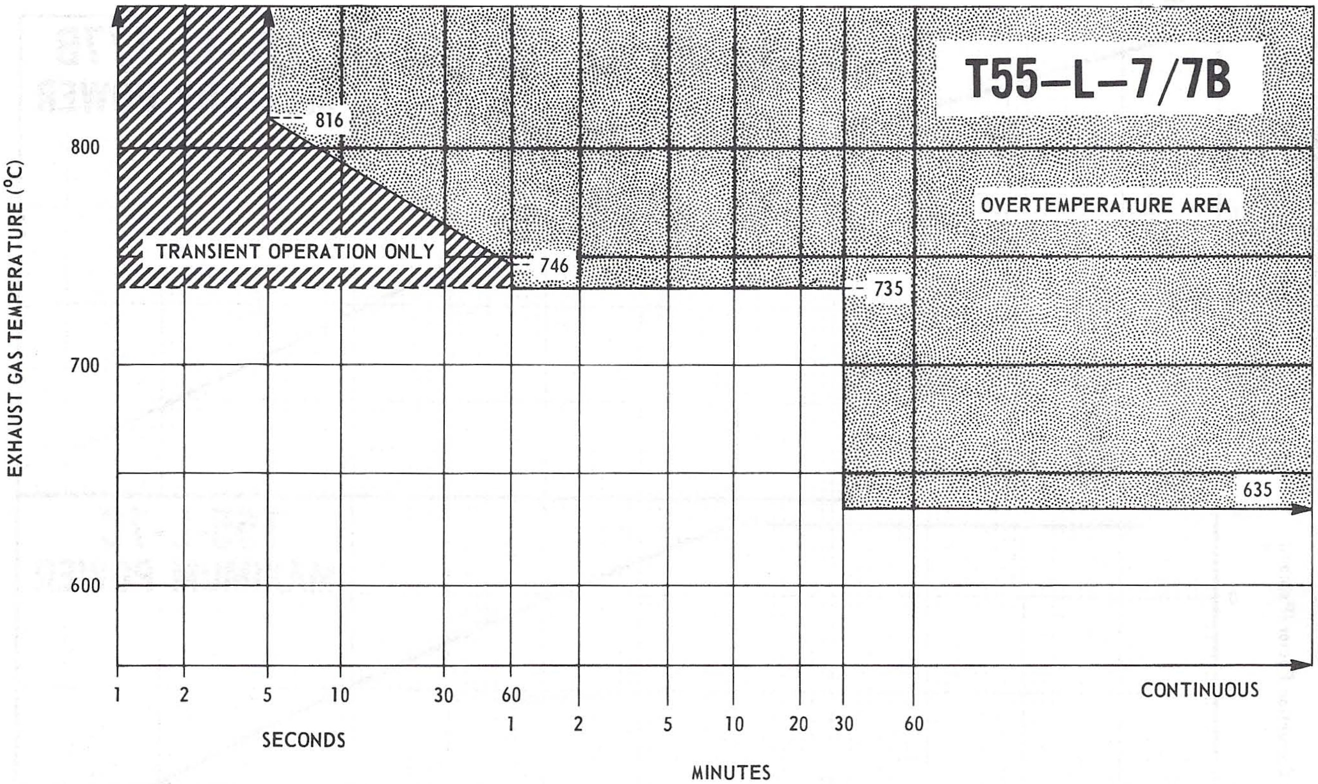


Figure 5-4. Exhaust Gas Temperature Limits — T55-L-7/-7B Engines

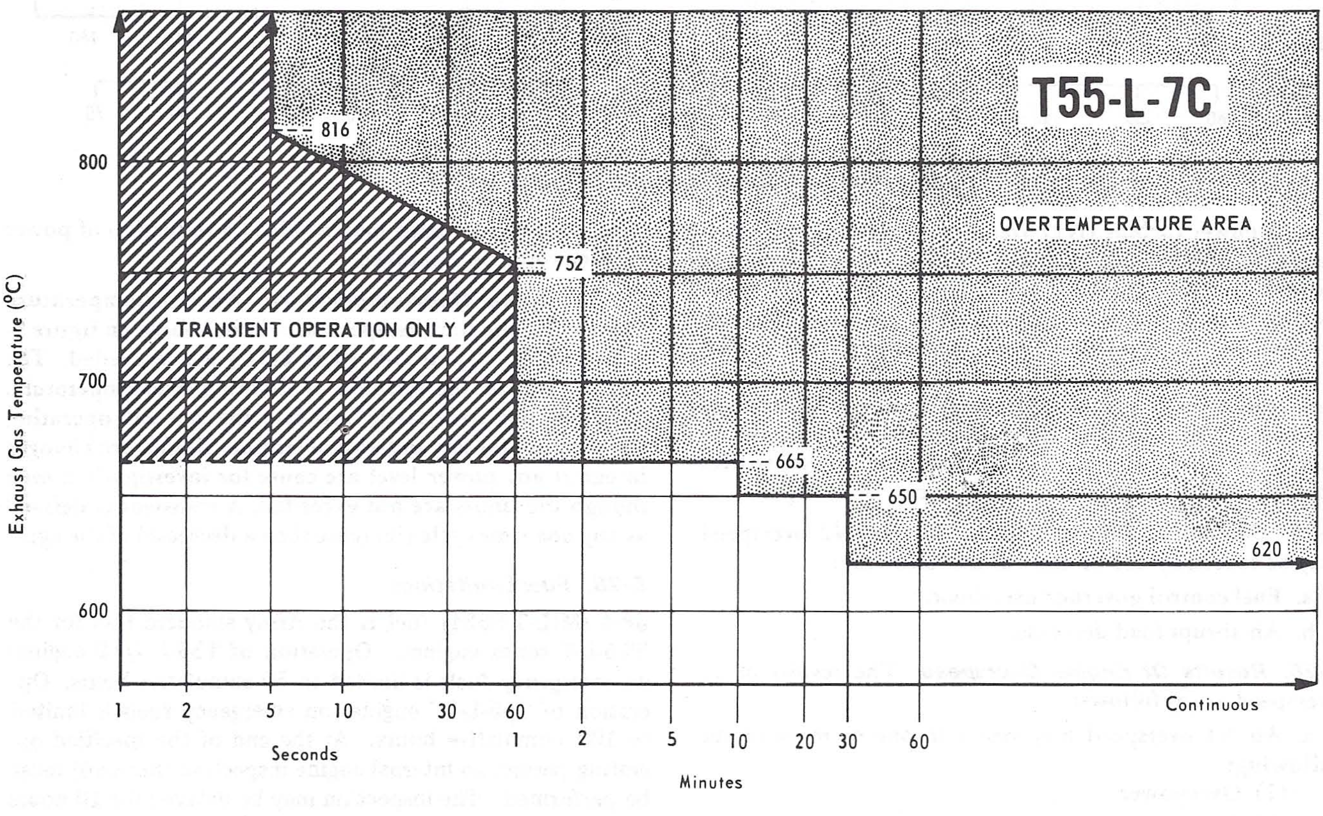


Figure 5-5. Exhaust Gas Temperature Limits, T55-L-7C Engines

5-29. Transmission Torque Limitations (Steady-State).

The output shaft torque is not to exceed 860 lb ft during single or dual engine continuous operation.

5-30. Transmission Torque Limitations (Transient).

During transient operation, the following torque and time limits apply:

(1) 860 to 1,200 lb ft for no more than 10 seconds during dual or single engine operation.

(2) 1,200 lb ft never exceed during single or dual engine operation only.

SECTION IV LOADING LIMITS

5-31. Loading Limits.

Maximum gross weight is 33,000 pounds.

5-32. Center-Of-Gravity Limitations.

See figure 5-6 for center-of-gravity limitation in terms of fuselage frame stations. An explanation of total cg travel is as follows:

a. Forward limit. The extreme forward limit is 30.0 inches forward of the datum line between the rotors up to a gross weight of 27,500 pounds. From this point, the cg limit decreases linearly to 17.0 inches forward of the datum line between the rotors at a gross weight of 33,000 pounds.

b. Aft limit. The extreme aft cg limit is 18.0 inches aft of the datum line between the rotors up to a gross weight of 28,550 pounds. From this point, the cg limit decreases linearly to 6.0 inches aft of the datum line between rotors at a gross weight of 33,000 pounds. Refer to chapter 6 for additional weight, balance, and loading information.

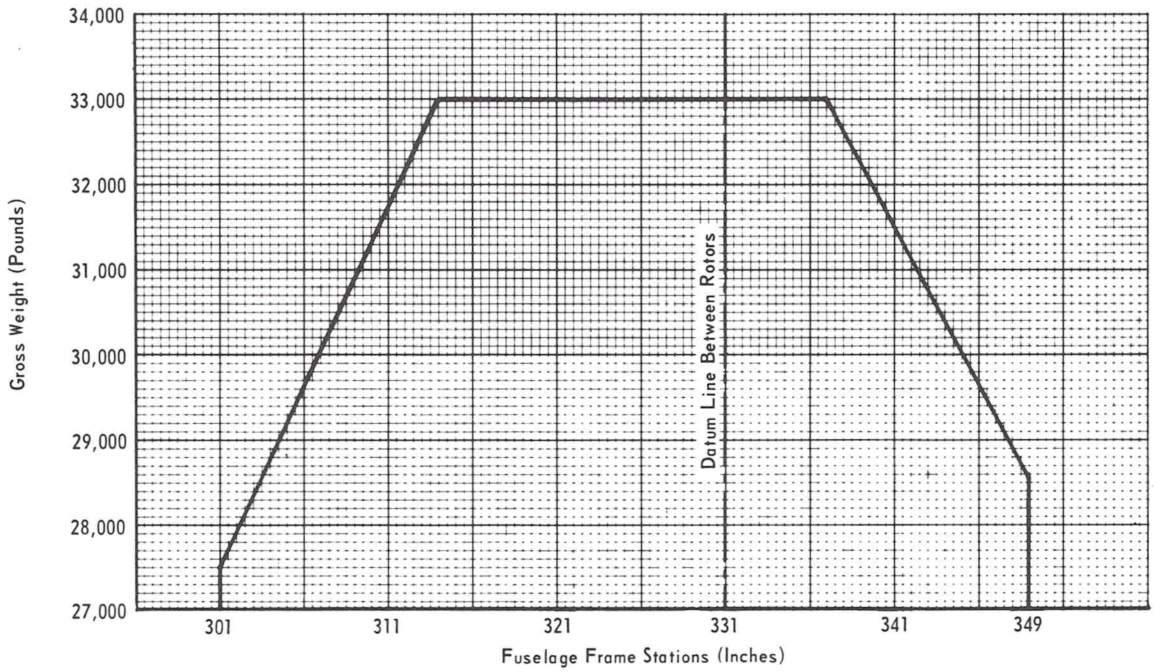


Figure 5-6. Center-of-Gravity Limits

SECTION V AIRSPEED LIMITS

5-33. Airspeed Limits with Programmed Longitudinal Cyclic Trim.

The airspeed limitations for operation at normal operating rotor rpm are shown on figure 5-7. Additional airspeed limitations are as follows:

a. Maximum airspeed in sideward flight is 35 knots.

b. Maximum airspeed in rearward flight is 30 knots.

c. Maximum airspeed with the lower section of the cabin entrance door open and locked is 60 KIAS.

d. The rescue hatch door shall not be opened above 90 KIAS; but if the door is open, airspeed is limited to the values on figure 5-7.

e. Maximum airspeed for SAS off is 100 KIAS or Vne whichever is less.

5-34. Airspeed Limits With Cyclic Trim Actuator Retracted.

The maximum airspeed with either a forward or an aft cyclic trim actuator failed at the fully retracted position is shown in figure 5-8. Use figure 5-8 to find the maximum airspeed with both cyclic trim actuators failed at the fully retracted position.

AIRSPEED OPERATING LIMITS
PROGRAMMED LONGITUDINAL CYCLIC TRIM

230 ROTOR RPM

AIRSPEED OPERATING LIMITS
CH-47A

EXAMPLE

WANTED

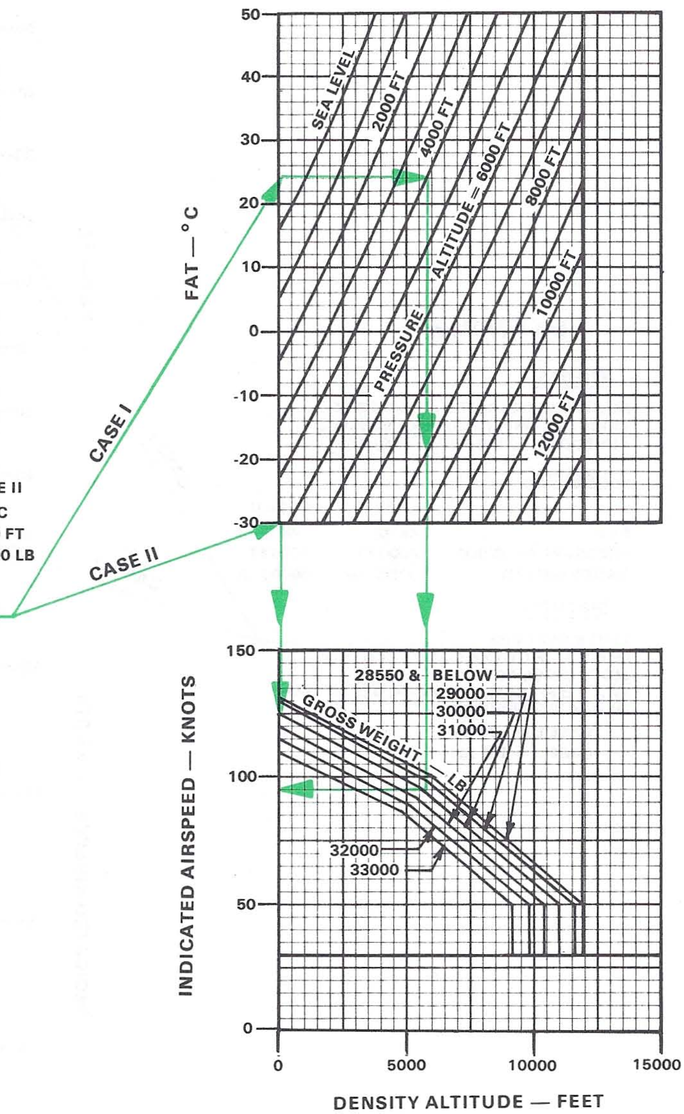
MAXIMUM INDICATED AIRSPEED FOR VARIOUS TEMPERATURES, PRESSURE ALTITUDES, AND GROSS WEIGHTS.

KNOWN

	CASE I	CASE II
FAT	24° C	-30° C
PRESSURE ALTITUDE	4000 FT	4000 FT
GROSS WEIGHT	30000 LB	30000 LB

METHOD

ENTER FAT HERE.
MOVE RIGHT TO PRESSURE ALTITUDE.
MOVE DOWN TO GROSS WEIGHT
MOVE LEFT, READ MAXIMUM ALLOWABLE INDICATED AIRSPEED:
CASE I = 94 KN
CASE II = 125 KN



CH-47A-5.1-7B

Figure 5-7. Airspeed Limitations—Programmed Longitudinal Cyclic Trim

316-520 O - 80 - 11

AIRSPEED OPERATING LIMITS
RETRACTED LONGITUDINAL CYCLIC TRIM

230 ROTOR RPM

AIRSPEED OPERATING LIMITS
CH-47A

EXAMPLE

WANTED

MAXIMUM INDICATED AIRSPEED FOR VARIOUS TEMPERATURES, PRESSURE ALTITUDES, AND GROSS WEIGHTS.

KNOWN

	CASE I	CASE II
FAT	24°C	-30°C
PRESSURE ALTITUDE	4000 FT	4000 FT
GROSS WEIGHT	30000 LB	30000 LB

METHOD

ENTER FAT HERE.
MOVE RIGHT TO PRESSURE ALTITUDE.
MOVE DOWN TO GROSS WEIGHT.
MOVE LEFT, READ MAXIMUM ALLOWABLE INDICATED AIRSPEED:

CASE I = 88 KN
CASE II = 101 KN

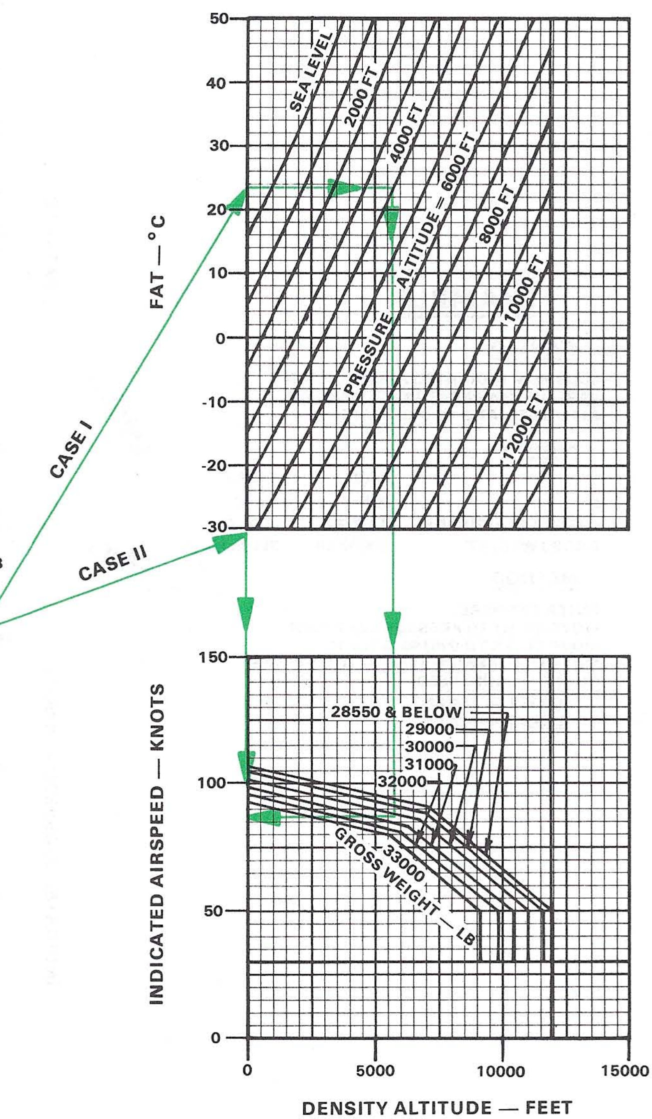


Figure 5-8. Airspeed Limitations—Longitudinal Cyclic Trim Retracted

SECTION VI MANEUVERING LIMITS

5-35. Maneuvering Limits.

5-36. Aerobatics Prohibition.

Aerobatics are prohibited with this helicopter.

5-37. Acceleration Limitations.

a. At 28,550 pounds gross weight, the maximum allowable acceleration is 2.67 positive and 0.5g negative.

b. At 33,000 pounds gross weight, the maximum allowable acceleration is 2.0g positive and 0.5g negative.

5-38. Bank Limitations.

a. When at Vne for all gross weight, the maximum bank angle is 25°C.

b. For each 1 knot reduction in airspeed from Vne, bank angle may be increased 1°, up to a maximum of 40° for internal loads and 30° for external loads up to 16,000 pounds.

5-39. Landing Limitations.

a. The maximum rate of descent at touchdown for gross weights up to 28,550 pounds is 8.0 feet per second (480 feet per minute).

b. The maximum rate of descent at touchdown for gross weights from 28,550 to 33,000 pounds is 6.0 feet per second (360 feet per minute).

c. The maximum ground speed for running landings is 60 knots.

d. The maximum nose up attitude during water landings is 25°.

5-40. Flight Control Limitations.

a. When operating at or above an airspeed of 100 knots, the thrust control rod is not to be lowered at a rate which exceeds 2.7 inches per second when lowered more than 2.3 inches at any one time. There are no limitations on lowering rate when the thrust control rod is lowered less than 2.3 inches at any one time.

b. Do not manually extend the longitudinal cyclic trim at indicated airspeeds below 80 knots. Use of extended cyclic trim at low airspeeds will result in high aft rotor blade stresses.

5-41. Ground Taxiing Limitations (Flight Controls).

To prevent droop stop pounding while taxiing, flight control movements are not to exceed 0.75 inch right or left for the directional pedals, 2.00 inches longitudinally aft and 1.00 inch laterally right or left for the cyclic stick, and not below the 3° ground operation detent for the thrust control rod.

SECTION VII ENVIRONMENTAL RESTRICTIONS

5-42. Environmental Restrictions.

5-43. Engine Anti-Icing Limitation.

The use of engine anti-icing is prohibited on helicopters with engine inlet standard screens.

CAUTION

Operation of the engine anti-icing system with air inlet standard screens installed could damage the air inlet fairing. The inlet screens cover the bleed air holes on the outer circumference of the inlet fairing and cause a pressure buildup in the inlet fairing.

5-44. Wind Limitations For Starting Engines/Rotors.

Engine/rotor starting and shutdown should not be attempted if surface winds are above 30 knots from any quadrant.

5-45. Rotor Blade Limitations.

No flight operations are to be conducted below −18°C free air temperature with Narmco processed blades. However, AF-30 processed rotor blades may be flown up to the minimum temperature limit imposed on the helicopter. The following are Narmco processed rotor blades.

a. Part number 114R1002-113

b. Part number 114R1002-130

c. Part number 114R1002-141

5-46. Altitude Limitations.

a. Maximum pressure altitude is 15,000 feet. This limit applies because the hydraulic reservoir pressurization system is not redundant.

b. Maximum altitudes, as derived from figures 5-7 and 5-8 and defined by gross weight are listed in table 5-4.

Table 5-4. Altitude Limitations

GROSS WEIGHT	MAXIMUM DENSITY ALTITUDE
28,550 pounds and below	11,900 feet
29,000 pounds	11,600 feet
30,000 pounds	11,000 feet
31,000 pounds	10,400 feet
32,000 pounds	9,800 feet
33,000 pounds	9,200 feet

5-47. Flight Under IMC (Instrument Meteorological Conditions).

This helicopter is qualified for flight under instrument meteorological conditions provided the following conditions exist.

a. Both SAS are operational.

NOTE

Should one SAS fail during IMC flight, the flight may be continued to destination. Should both SAS fail during IMC flight, a landing should be made as soon as practical.

b. Two vertical gyros and two vertical gyro indicators (VGI) are installed and operative.

SECTION VIII HEIGHT VELOCITY

5-48. Height Velocity.

5-49. Minimum Height and Velocity for Safe Landing After Single Engine Failure.

Figure 5-9 presents the height-velocity diagram for a safe landing following a single-engine failure during takeoff or during operations near the ground. The diagram provide the combinations of airspeed and height above ground which should be avoided during normal operations. The height velocity diagram is applicable to gross weights up to and including those at which a hover out-ground-effect capability (OGE) exists up to 5,000 feet pressure altitude.

5-50. Minimum Height And Velocity For Safe Landing After Dual Engine Failure.

Figure 5-10 presents the autorotational and single engine landing corridor. This corridor is based on a second engine failure from single engine level flight at maximum gross weight for single engine service ceiling capability at military/maximum power.

HEIGHT VELOCITY DIAGRAM FOR SAFE LANDING AFTER SINGLE-ENGINE FAILURE

HEIGHT VELOCITY
CH-47A

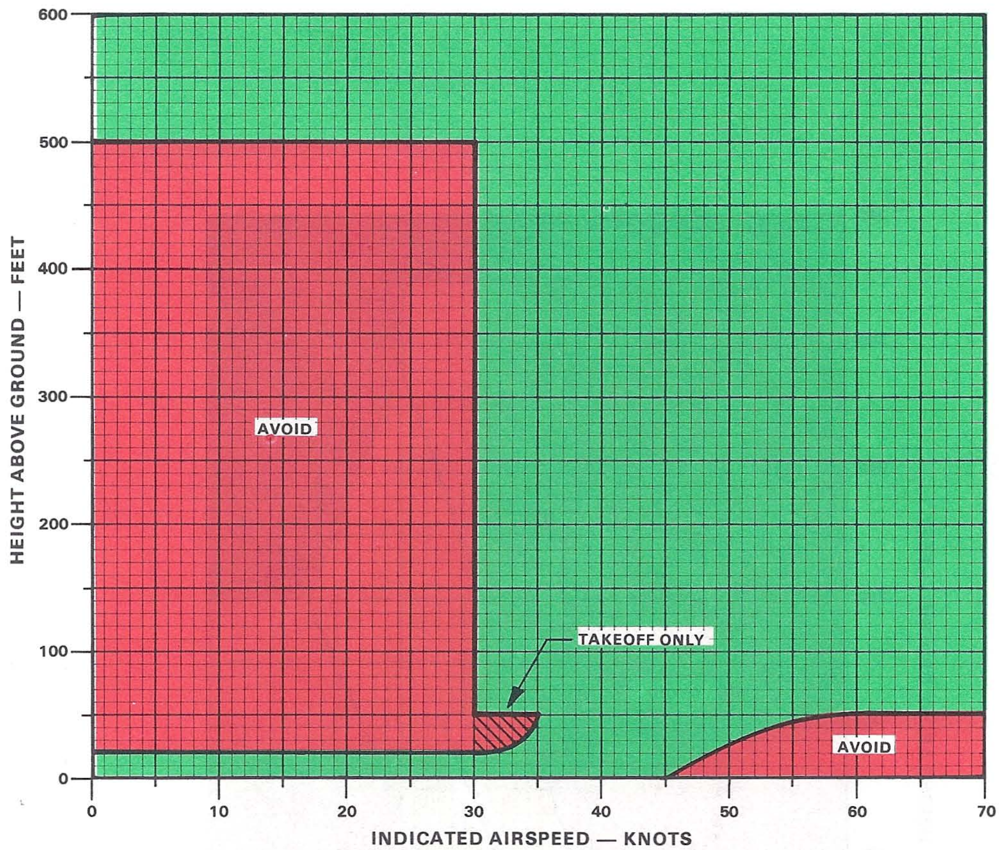


Figure 5-9. Height Velocity Diagram For Safe Landing After Single Engine Failure

HEIGHT VELOCITY DIAGRAM FOR SAFE LANDING AFTER DUAL ENGINE FAILURE

HEIGHT VELOCITY
CH-47A

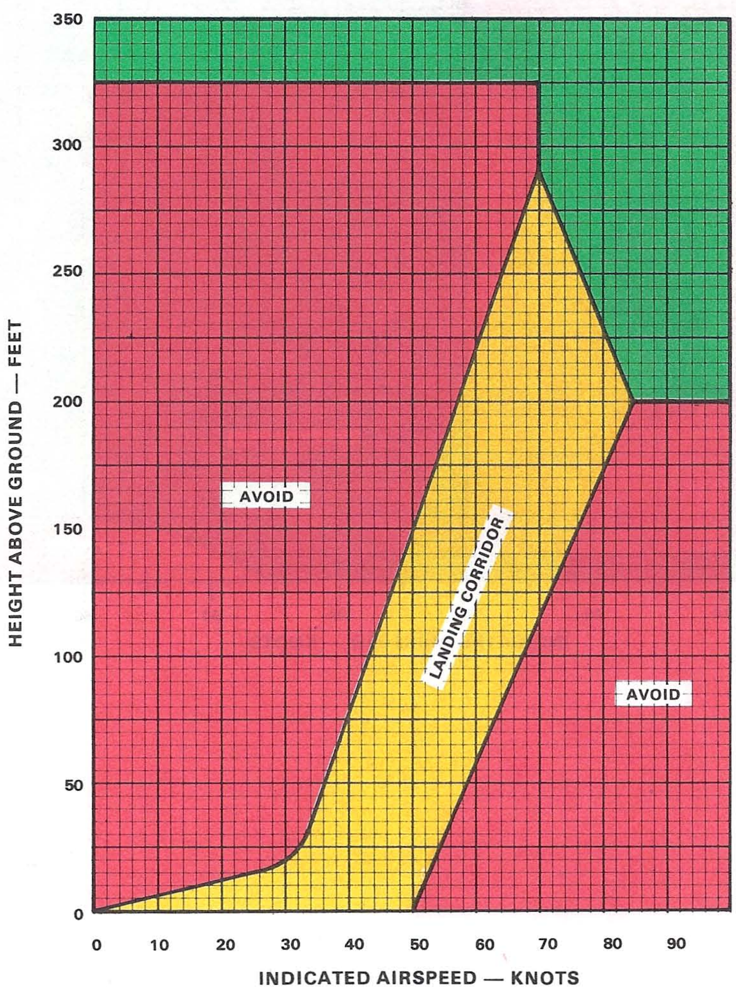


Figure 5-10. Height Velocity Diagram For Safe Landing After Dual Engine Failure.

CHAPTER 6
WEIGHT/BALANCE AND LOADING

SECTION I GENERAL

6-1. Purpose.

This chapter provides the information required to compute the weight and balance for loading individual helicopters. The data inserted on the charts and forms are applicable only to the individual helicopter—the serial number of which appears on the title page of the various forms and charts. The charts and forms may change from time to time, but the principle on which they are based will not change. The forms currently in use are the DD 365 series.

6-2. The helicopter must be weighed periodically as required by pertinent directives (AR 95-16 and TM 55-405-9), when major modifications or repairs are made, when the pilot reports an unsatisfactory flight characteristic, and when the basic weight data contained in the records are suspected of being in error.

6-3. This chapter contains sufficient instructions and data so that the aviator, knowing the basic weight and moment of the helicopter, can compute any combination of weight and balance. Figure 6-1 defines the compartments, shows the reference datum line, and depicts other information essential for helicopter weight/balance and loading.

6-4. For the purpose of clarity, Army CH-47A helicopters are in class 2. Additional directives governing weight and balance of class 2 aircraft forms and records are contained in AR 95-16 and TM 55-409-9.

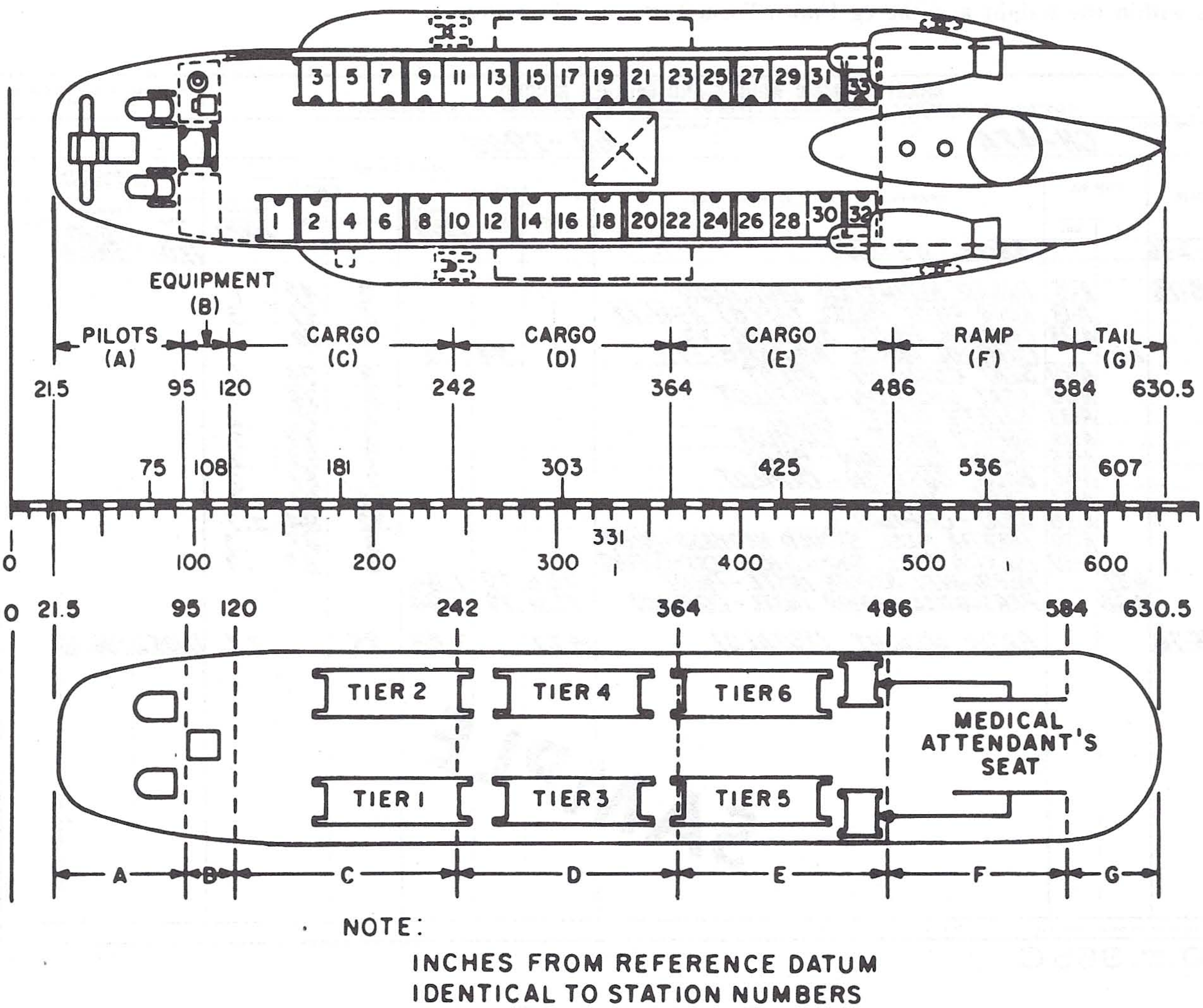


Figure 6-1. Aircraft Compartment and Loading Diagram

SECTION II WEIGHT AND BALANCE

6-5. This section contains an explanation and sample of Chart C, Basic Weight and Balance Record, DD Form 365C (the source of the basic weight and moment), and a practical example of loading problem using Charts C and clearance form F (DD Form 365F) are also included. Refer to TM 55-405-9 for instructions concerning completion of other DD Form 365 series forms.

6-6. Chart C—Basic Weight and Balance Record.

Chart C is a continuous history of the basic weight and moment resulting from structural and equipment changes in service. (See figure 6-2.) At all times, the last weight and moment/1,000 are considered the current weight and balance status of the basic helicopter.

6-7. Form F—Weight and Balance

Form F (figure 6-3) is a summary of the actual disposition of the load in the helicopter. It records the balance status of the helicopter step by step. It serves as a work sheet on which to record weight and balance calculations and any corrections that must be made, to assure that the helicopter will be within the weight and the cg limits. Form F is furnished in expendable pads, or as separate sheets, which can be replaced when exhausted. An original and a carbon copy are prepared for each loading. The original sheets, carrying the signature of responsibility, can be removed to serve as certificates of proper weight and balance as required by existing clearance directives. The duplicate copy must remain in the helicopter for the duration of the flight. On a cross-country flight this form aids the weight and balance technician at refueling bases and stopover stations. There are two versions of this form: Transport and Tactical; they are designed to provide for the respective loading arrangements of these two type aircraft. The general use and fulfillment of either version are the same. Specific instructions for filling out the version for this helicopter are as follows:

6-8. Sample Form—Transport Mission.

To complete the Form F for a transport mission, proceed as follows:

a. Information blocks—Insert the necessary identifying information.

CHART C—BASIC WEIGHT AND BALANCE RECORD
(CONTINUOUS HISTORY OF CHANGES IN STRUCTURE OR EQUIPMENT AFFECTING WEIGHT AND BALANCE)

FOR USE IN T. O. 1-1B-40 & AN 01-1B-40

AIRPLANE MODEL: CH-47A SERIAL NO.: 63-7900 PAGE NO.: 1

DATE	ITEM NO.		DESCRIPTION OF ARTICLE OR MODIFICATION	WEIGHT CHANGE						RUNNING TOTAL BASIC AIRPLANE		
				ADDED (+)			REMOVED (−)					
	IN	OUT		WEIGHT	ARM	MOMENT[1] / 1000	WEIGHT	ARM	MOMENT[1] / 1000	WEIGHT	MOMENT[1] / 1000	INDEX[2]
6-2-76			BASIC WEIGHT							17,062	5885.8	
6-15-76		A-5	RADAR ALTIMETER INDICATOR				2	49	.1			
		A-13	AUTO PILOT PANEL (AFCS) ASW-12				5	57	.3			
		A-23	CONTROL PANEL AN/ARC-73				2	70	.1			
	A-27		CONTROL PANEL AN/ARC-31X	3	74	.2						
		A-29	SEAT CUSHION - PILOT				3	74	.2			
		A-30	SEAT CUSHION - COPILOT				3	74	.2			
		A-33	SAFETY BELT - PILOT				3	79	.2			
		A-34	SAFETY BELT - COPILOT				3	79	.2			
		A-35	BACK CUSHION - PILOT				2	83	.2			
		A-36	BACK CUSHION - COPILOT				2	83	.2			
		A-37	SEAT - PILOT				32	84	2.7			
		A-38	SEAT - COPILOT				32	84	2.7			
		A-39	INERTIA REEL, SHOULD HARNESS - PILOT				3	87	.3			
		A-40	INERTIA REEL, SHOULD HARNESS - COPILOT				3	87	.3			
	A-37		PERSONNEL ARMOR INSTL - PILOT	73.6	79	1.84						
	A-38		PERSONNEL ARMOR INSTL - COPILOT	73.6	79	1.84						
6-15-76			BASIC WEIGHT (TOTALS)	147.2		3.88	95		7.7	17,105.2	5881.98	

SAMPLE

[1] Enter constant used below line [2] Balance computer index

DD FORM 1 SEP 54 365C PREVIOUS EDITIONS OF THIS FORM MAY BE USED UNTIL STOCKS ARE EXHAUSTED

Figure 6-2. Sample Form C

b. CG limits chart—Use gross weight and cg limitations obtained from figure 6-29.

c. Ref 1—Enter the basic weight and moment/1,000; obtain these figures from the last entry on the Chart C—Basic Weight and Balance Record.

d. Ref 2—Enter the amount, weight, and moment/1,000 of engine oil. All other oils are considered fully serviced and are included in the basic weight.

e. Ref 3—Enter the number, weight, and moment/1,000 of the crew. Use actual crew weights, if available. Refer to figure 6-4.

f. Ref 4—Enter the weight and moment/1,000 of the crew's baggage. Use cargo moments chart, figure 6-14.

g. Ref 5—Not applicable.

h. Ref 6—Enter the weight and moment/1,000 of emergency equipment. Not listed on chart c. Use cargo moment chart, figure 6-14.

i. Ref 7—Enter the weight and moment/1,000 of any extra equipment. Use cargo moments chart figure 6-14.

j. Ref 8—Enter the sum of the weights and moments/1,000, for Ref 1 thru Ref 7 inclusive, to obtain the Operating Weight.

k. Ref 9—Enter the total fuel weight (left and right tanks) and the total fuel moment (figure 6-28). Enter the number of gallons of fuel in the space provided. List in the remarks block the fuel tank concerned and the amount of fuel in each tank.

l. Ref 10—Not applicable.

m. Ref 11—Enter the sum of the weights and moments/1,000 for Ref 8 thru Ref 10, inclusive to obtain the Total Airplane Weight.

n. Determine the allowable load based on the takeoff and landing restrictions by use of the limitations table in the upper left corner of the form, as follows:

(1) Enter the Allowable Gross Weight for Takeoff and Landing in the respective columns. Refer to chapter 5.

NOTE

The limiting Wing Fuel column is not used for this helicopter.

(2) Enter the Total Airplane Weight (from Ref 11) under the Takeoff column.

(3) Estimate the fuel weight to be aboard at the time of landing. To this value, add the Operating Weight (from Ref 8). Enter this total under the Landing column.

(4) Subtract the above weights from the respective allowable gross weights to obtain the respective allowable loads. The smallest of these allowable loads is the Allowable Load and represents the maximum amount of weight which may be distributed throughout the helicopter in the various compartments without exceeding the limiting gross weight of the helicopter.

o. Ref 12—Enter the number and weight of passengers and the weight of cargo (baggage, mail, etc.). Refer to the applicable personnel (figure 6-4), litter patient (figure 6-5) or cargo moments chart (figure 6-14). Use actual passenger weights, if available. Enter the total for each compartment in the Weight and Moment/1,000 column. If desired for statistical purposes, the Total Freight and Total Main Weights may also be listed in the space provided under Remarks.

NOTE

The sum of the compartment totals must not exceed the Allowable Load determined.

p. Ref 13—Enter the sum of Ref 11 and the compartment totals under Ref 12 opposite Takeoff Condition (Uncorrected).

q. Check the weight figure, Ref 13, against the Gross Weight Takeoff in the Limitations table. Check the moment/1,000 opposite Ref 13 by means of figure 6-29 to ascertain that the indicated cg is within the allowable limits.

r. If changes in amount of distribution of load are required, indicate necessary adjustments by proper entries in the Corrections table in the lower, left corner of the form. Enter a brief description of the adjustment made in the column marked item. Refer to the applicable personnel (figure 6-4), litter patient (figure 6-5) or cargo moments chart (figure 6-14). Add all the weight and moment/1,000 decreases and insert the totals in the space opposite Total Weight Removed. Add all the weight and moment/1,000 increases and insert the totals in the space opposite Total Weight Added. Subtract the smaller from the larger of the two totals and enter the difference (with applicable + or − signs) opposite the Net Difference. Transfer these Net Difference figures to the spaces opposite Ref 14.

s. Ref 15—Enter the sum of, or the difference between Ref 13 and 14. Recheck to assure these figures do not exceed allowable limits.

t. Ref 16—Refer to the applicable cg chart, figure 6-29 to determine the takeoff cg position. Enter this figure in the space provided opposite Takeoff CG.

u. Ref 17—Estimate the weight of fuel which may be expended before landing. Enter this weight figure together with the moment/1,000 in the spaces provided.

NOTE

Do not consider reserve fuel as expended when determining Estimated Landing Condition.

v. Ref 19—Enter the weight of Miscellaneous items to be expended before landing with the moment/1,000 and enter shift of crew to landing positions together with the moment/1,000 due to crew movement. Explain under Remarks if necessary.

w. Ref 20—Enter the differences in weights and moment/1,000 between Ref 15 and the total of Ref 17, 18, and 19.

x. Ref 21—Again refer to the cg chart figure 6-29 and determine the estimated landing cg position. Enter this figure opposite Estimated Landing CG.

WEIGHT AND BALANCE CLEARANCE FORM F

TRANSPORT

(USE REVERSE FOR TACTICAL MISSIONS)

Cross Reference RAF Form 2670 RCAF Form F. 115 C 50M 5-51 (6797)

FOR USE IN T. O. 1-1B-40 & AN 01-1B-40

DATE	AIRPLANE TYPE	FROM	HOME STATION
3 MAY 1977	CH-47 A	FORT X	FORT Y
MISSION/TRIP/FLIGHT/NO.	**SERIAL NO.**	**TO**	**PILOT**
TRAINING	63-7900	FORT Y	CAPT CLARK

LIMITATIONS

CONDITION	TAKEOFF	LANDING	LIMITING WING FUEL
[1] ALLOWABLE GROSS WEIGHT	33,000	33,000	—
TOTAL AIRPLANE WEIGHT *(Ref. 11)*	21,733	X	X
OPERATING WEIGHT PLUS ESTIMATED LANDING FUEL WEIGHT	X	19,783	X
OPERATING WEIGHT *(Ref. 8)*	X	X	—
ALLOWABLE LOAD *(Ref. 12) (use SMALLEST figure)*	11,267	13,217	—
[2] PERMISSIBLE C. G. TAKEOFF	FROM 301	TO ([redacted] IN.) 349	
[4] PERMISSIBLE C. G. LANDING	FROM 301	TO ([redacted] IN.) 349	
[5] LANDING FUEL WEIGHT	2050		

REF	ITEM	WEIGHT	[1] [redacted] MOM/ 1,000
1	BASIC AIRPLANE *(From Chart C)*	17105	5882.0
2	OIL (3.7 Gal.)	28	13.5
3	CREW (No.) 3	600	52.0
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8	OPERATING WEIGHT	17733	6947.0
9	TAKEOFF FUEL (615 Gal.)	4000	1260.0
10	WATER INJ. FLUID (Gal.)		
11	TOTAL AIRPLANE WEIGHT	21733	7207.0

12 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

COMPT (Upper)	PASSENGERS NO.	PASSENGERS WEIGHT	CARGO	COMPT (Lower)	PASSENGERS NO.	PASSENGERS WEIGHT	CARGO	WEIGHT	MOM/1,000
A									
B									
C				C			800	800	144.8
D				D			1200	1200	363.6
E				E			1500	1500	637.5
F									
G									
H									
I									
J									
K									
L									
M									
N									
O									
P									
FWD BELLY									
AFT BELLY									

SAMPLE

REMARKS

TOTAL FREIGHT

TOTAL MAIL

COMPUTER PLATE NUMBER *(If used)*

[1] *Enter constant used.*
[2] *Enter values from current applicable T. O.*
[3] *Applicable to gross weight (Ref. 15).*
[4] *Applicable to gross weight (Ref. 18).*
[5] *Ref. 9 minus Ref. 17.*

REF	ITEM	WEIGHT	MOM/1,000
13	TAKEOFF CONDITION *(Uncorrected)*	25233	8352.9
14	CORRECTIONS *(If required)*		
15	TAKEOFF CONDITION *(Corrected)*		
16	TAKEOFF C. G. IN [redacted] IN.	331.0	
17	LESS FUEL 300 gal.	1950	620.0
18	LESS AIR SUPPLY LOAD DROPPED		
19	MISC. VARIABLES		
20	ESTIMATED LANDING CONDITION	23283	7732.9
21	ESTIMATED LANDING C. G. IN [redacted] IN.	332.1	

CORRECTIONS *(Ref. 14)*

COMPT	ITEM	CHANGES (+ or −) WEIGHT	[1] INDEX OR MOM/1000
TOTAL WEIGHT REMOVED		−	−
TOTAL WEIGHT ADDED		+	+
NET DIFFERENCE *(Ref. 14)*			

COMPUTED BY
SIGNATURE J. J. Jones, SGT, USA

WEIGHT AND BALANCE AUTHORITY
SIGNATURE S. S. Snorkel, MAJ, USA.

PILOT
SIGNATURE C. C. Clark CPT, USA

DD FORM 1 SEPT 54 365F

GPO 1955 O - 315286

NOTE.—THIS TRANSPORT CLEARANCE FORM HAS RESULTED FROM TRIPARTITE AGREEMENT AND NO FURTHER CHANGES MAY BE MADE TO IT WITHOUT PRIOR CONSIDERATION BY TRIPARTITE AUTHORITIES.

Figure 6-3. Sample Form F

SECTION III PERSONNEL

6-9. Personnel Loading and Unloading.

The loading procedures should be accomplished and observed prior to loading to ensure the safety and comfort of personnel to be airlifted:

a. Passenger compartment—Clean.

b. Equipment—Stow and secure.

c. Troop seats—Install, as required.

d. Litters—Install, as required.

e. Static line anchor cable—INSTALL, as required.

f. Safety belts—Check, attached.

g. Emergency equipment—Check.

h. Emergency exits—Inspect.

i. Special equipment—Check.

j. Comfort provisions—Check.

6-10. Personnel Weight Computation. When aircraft are operated at critical gross weights, the exact weight of each individual occupant plus equipment should be used. If weighing facilities are not available, or if the tactical situation dictates otherwise, loads shall be computed as follows:

a. Combat equipped soldiers—240 lb per individual.

b. Combat equipped paratroopers—260 lb per individual.

c. Litter patient (including litter, splints, etc.)—200 pounds per individual.

d. Medical attendants—200 pounds per individual.

e. Crew and passengers with no equipment—compute weight according to each individual's estimate.

f. Refer to figure 6-4 or 6-5 for personnel or litter patient moment data.

6-11. Seating Arrangement.

(See figure 6-6.) Seating arrangement for 33 fully equipped ground troops is provided by ten 3-man seats and three 1-man seats. A row of five 3-man seats are installed along each side of the cargo compartment. One-man seats are installed at the forward and aft ends of the left-hand row of seats and one at the aft end of the right-hand row of seats.

6-12. Troop Seats.

The seats are made of nylon on tubular aluminum frames and are joined together for greater rigidity and comfort. The seats are joined by means of slide bolt fasteners in the front seat tubes, zipper fasteners on the underside of the seat fabric, and snap fasteners along the vertical edges of the seat-back rests. A slide adjuster below the back rest hanger clips affords adjustment of back rest tension. Seat tension is adjusted by relocating holes drilled in the front seat tubes. A row of male snap fastener studs along the rear of the seat-back rest matches a row of female snap fastener sockets along the rear edge of the seat fabric. These fasteners are jointed to provide greater seat depth for troops equipped with parachutes. Two stowage straps are attached to the underside of the seat fabric; one is equipped with a hanger clip for folded stowage, the other is equipped with a buckle for rolled stowage. The seats will normally be stowed in the folded position for cargo transport.

6-13. Troop Seat Installation.

Install the troop seats from the rolled position as shown in figure 6-7. Install troop seats from the folded position by performing steps 1, 4, 6, and 7 of figure 6-7.

6-14. Troop Seat Stowage.

Stow the troop seats in the rolled position by performing steps 1 thru 9 in reverse order as set forth in figure 6-7. Stow troop seats in the folded position by reversing the procedures in steps 7, 6, 4, and 1 of figure 6-7.

6-15. Safety Belts.

A 2,000-pound-capacity nylon web safety belt is provided for each seat occupant. The belt is adjustable and is equipped with a positive-grip buckle fastener designed for quick release.

6-16. Troop Loading.

The loading and unloading of troops will normally be accomplished through the lowered aft cargo door and ramp. The most orderly and efficient troop loading procedure is for the troops to occupy seats from the front to the rear. In unloading, the troops will leave the helicopter progressively from the rear to the front. If the troops to be loaded are carrying full field equipment, it is recommended that the seat-back rests be removed to avoid entanglement with the equipment and damage to the seat-back rests.

6-17. Troop Commander's Jump Seat.

A collapsible fold-away seat is located in the cockpit entrance for the use of the troop commander. The seat is made of nylon on a tubular aluminum frame. An automatic feature is incorporated into the seat which retracts the pins from the seat support holder when the back rest is folded.

CAUTION

Care must be taken when raising or lowering the troop commander's seat during flight to avoid interfering with the flight controls in the closet.

6-18. Litter Arrangement.

(See figure 6-6.) Provisions for 24 litters are furnished by installing three tiers of litters, four high, along each cargo compartment wall normally occupied by the troop seats. The two 1-man seats in the aft section of the cargo compartment may remain in place to serve as seats for medical attendants. If needed, the 1-man seat in the forward section

PERSONNEL MOMENTS

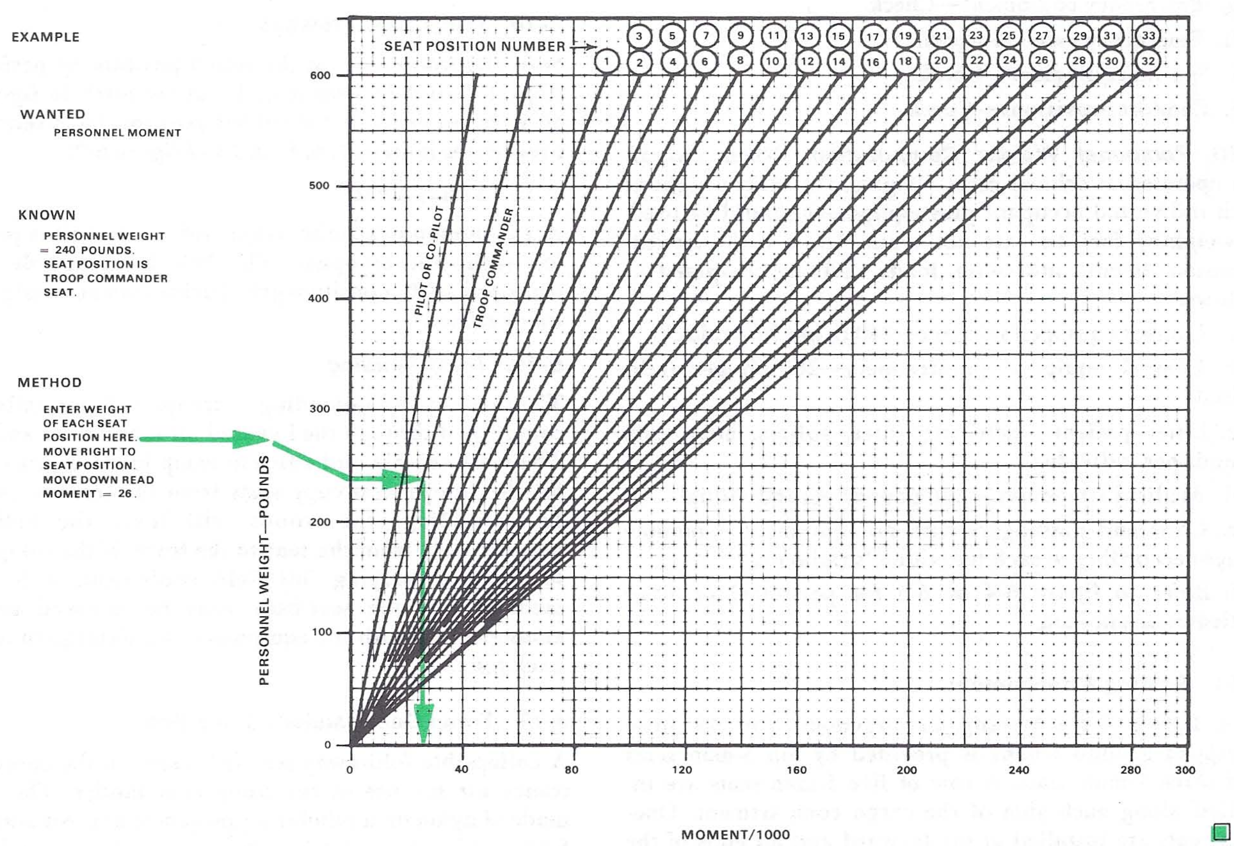


Figure 6-4. Personnel Moments

LITTER PATIENT MOMENT

EXAMPLE

WANTED

PATIENT MOMENT

KNOWN

PATIENT WEIGHT = 800 POUNDS.
TIER POSITION IS NUMBER 5.

METHOD

ENTER WEIGHT OF EACH TIER POSITION HERE. MOVE RIGHT TO TIER POSITION. MOVE DOWN READ MOMENT = 326

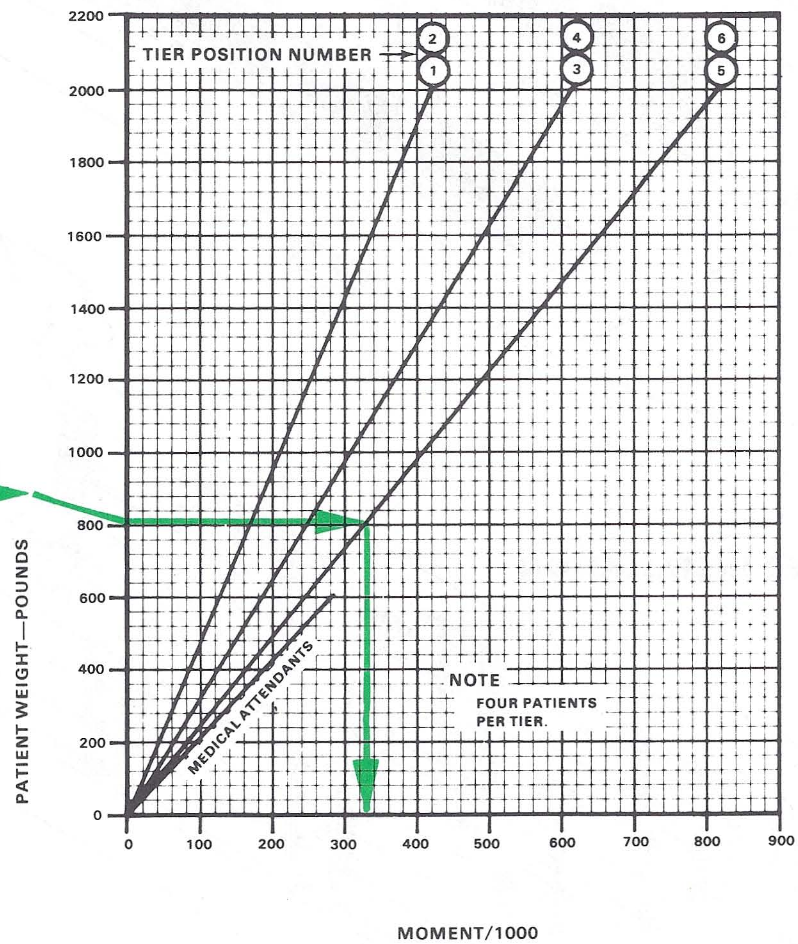
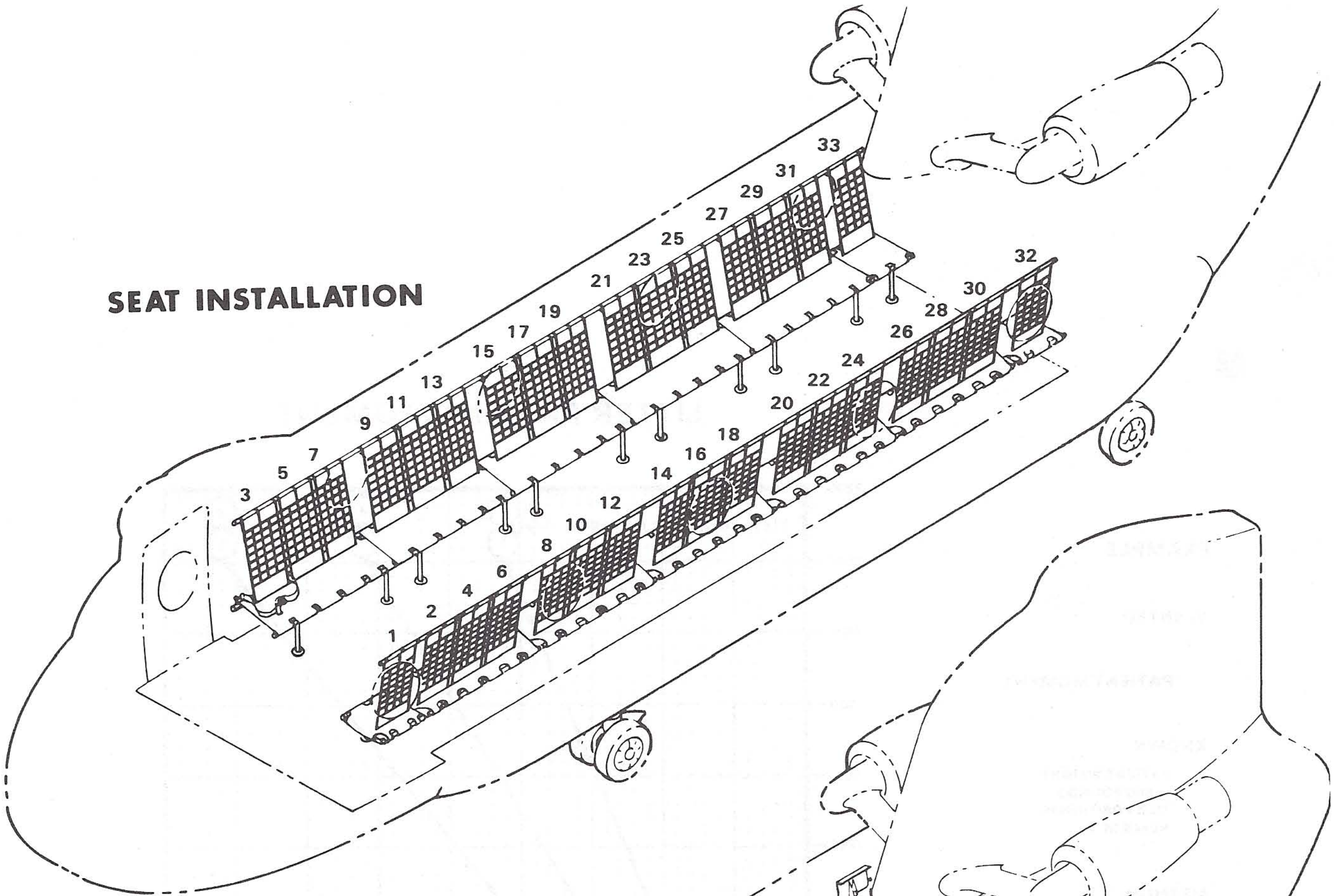


Figure 6-5. Litter Patient Moments



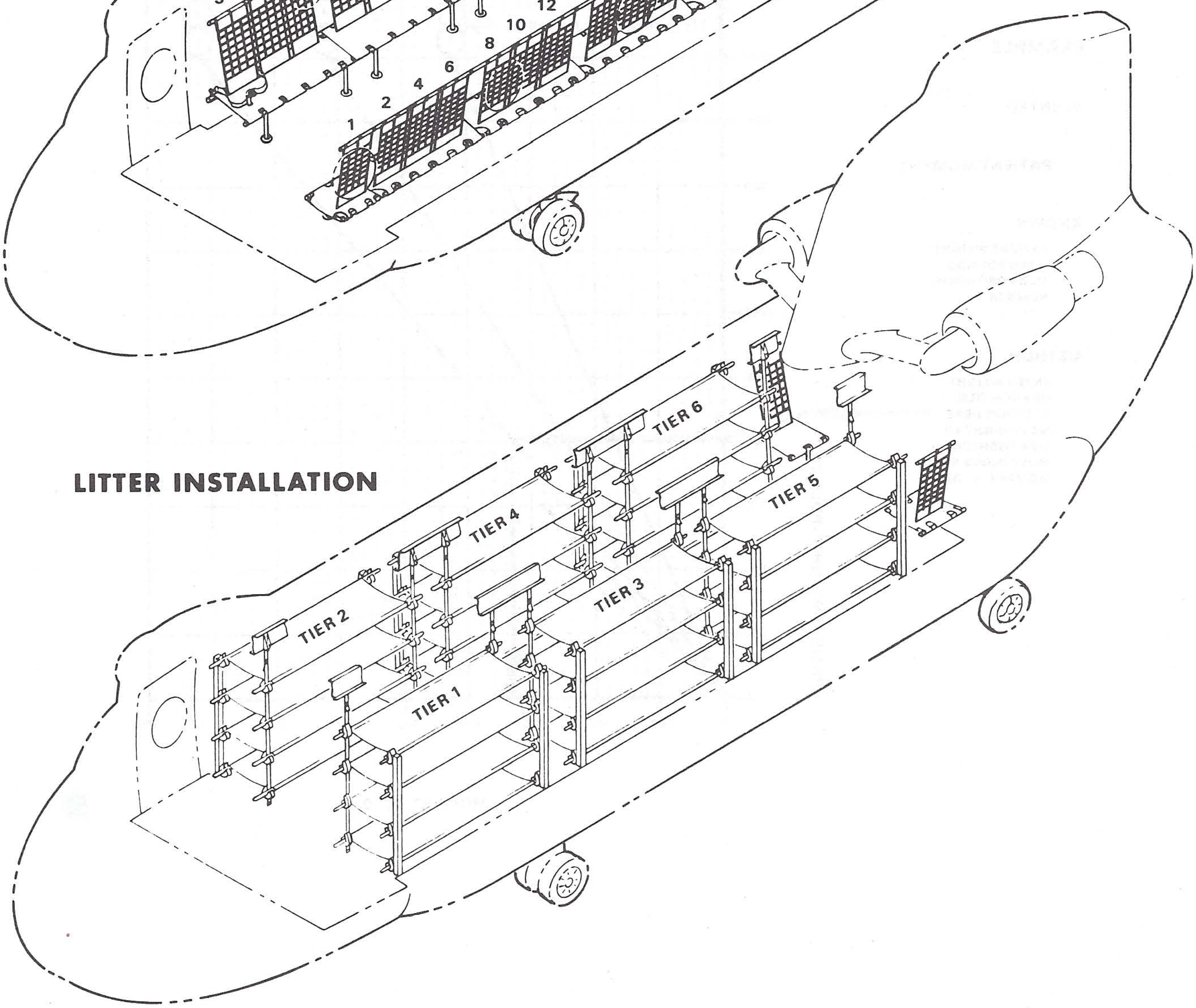
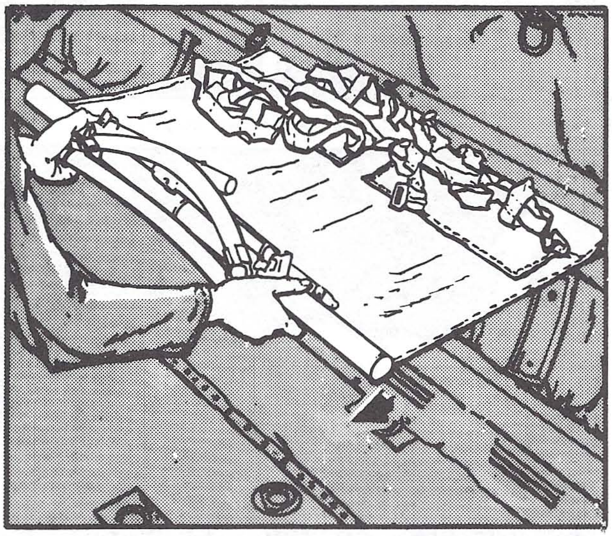
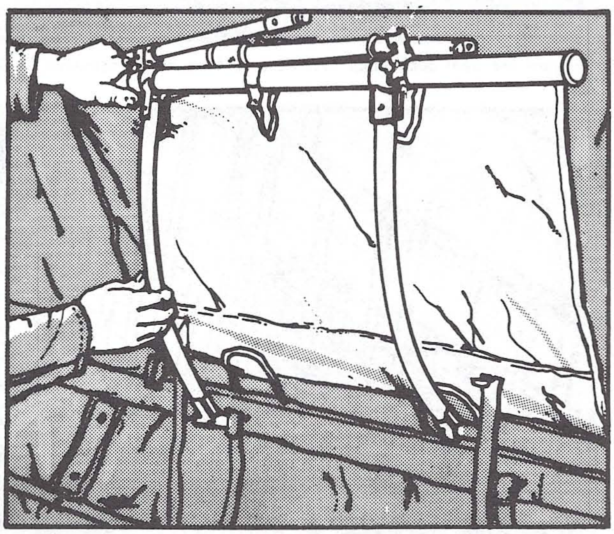


Figure 6-6. Troop Seats and Litters

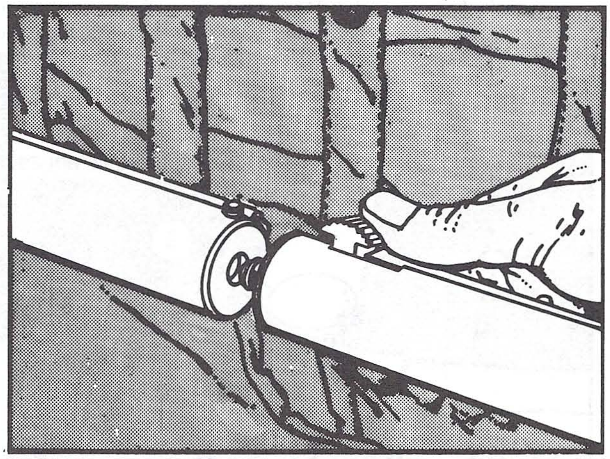
1 Unbuckle, unroll, and extend the seat.

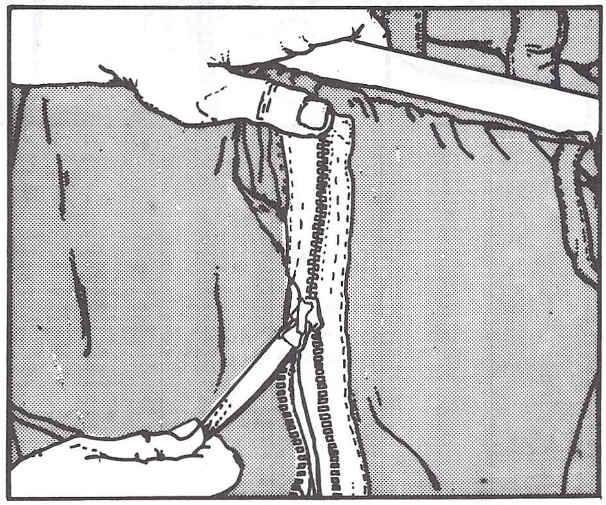


2 Swing the spreader tubes into position, and engage the end of each spreader with the clip on the rear seat tube.



3 Join the front seat tubes and zipper the seats together to form one continuous seat.





4 Swing the seat legs toward the perpendicular position until they lock in this position.

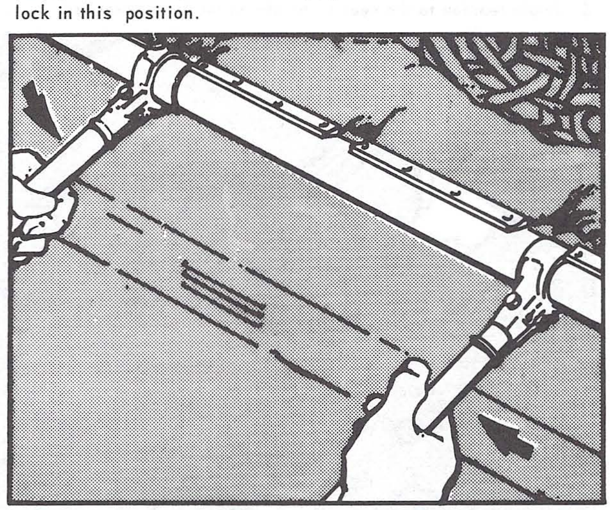
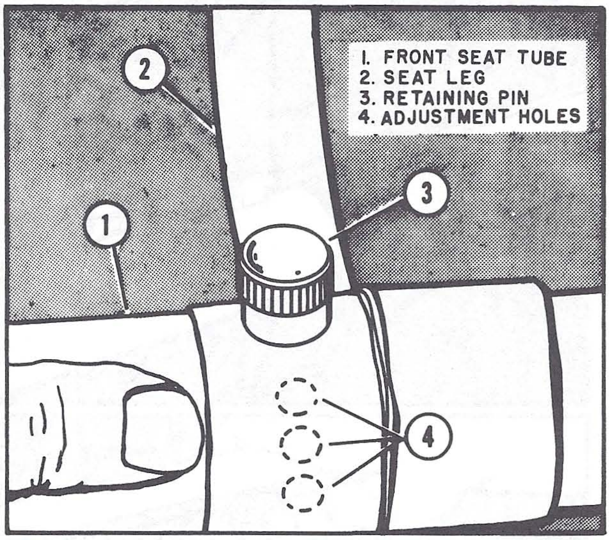


Figure 6-7. Troop Seat Installation (Sheet 1 of 2)

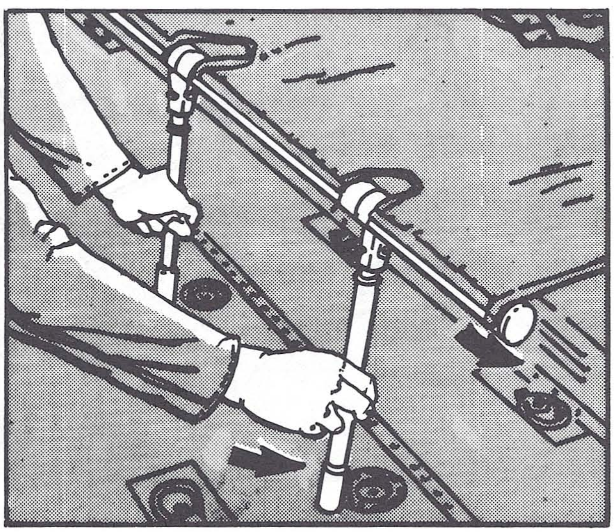
5 Adjust seat tension by engaging the spring-loaded retaining pin on the upper fitting of each seat leg in any one of four holes drilled around the front seat tube. The top hole gives the greatest tension, and the bottom hole adjusts the seat in its most relaxed position.



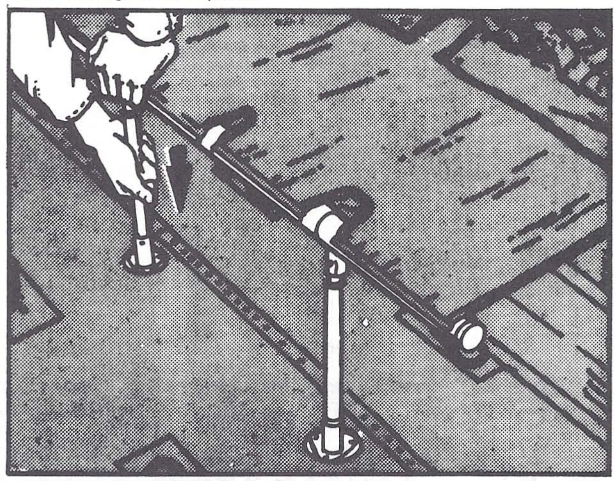
Note

Be sure the seat fabric is tightly stretched. If it is too loose, the seat will sag and the occupant will be uncomfortably seated on the spreader tube.

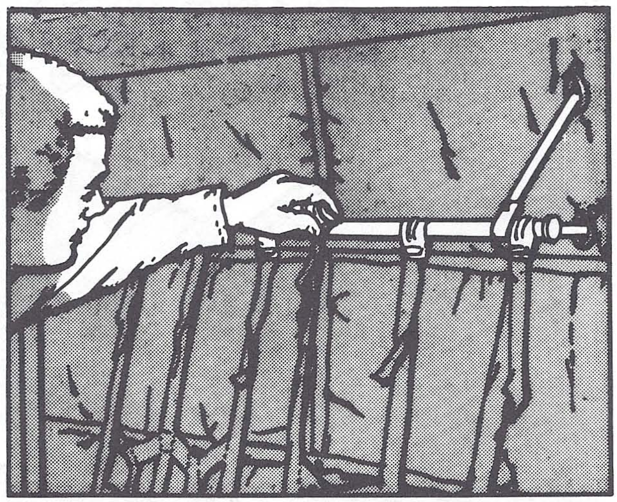
6 Apply tension to the seat by revolving the legs downward.



7 Place the legs directly over the studs on the floor and push down until the legs lock in place.



8 Attach the seat-back clips to the seat-back support tube.



9 Fasten the seat-back snap fasteners to form one continuous back rest.

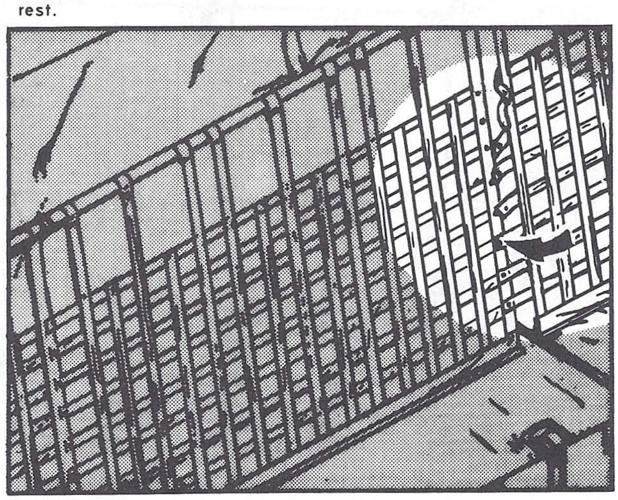


Figure 6-7. Troop Seat Installation (Sheet 2 of 2)

of the cargo compartment may also remain. It is not necessary to remove the troop seats in order to install the litters.

6-19. Litter Support Brackets.

Four litter support brackets are permanently attached to each litter pole and each litter strap. The brackets are spaced 18 inches apart. A locking device in each bracket secures the litter handles in place. The locking device consists of a handle clip, a slotted locking bar, and a locking handle. The locking handle is hinged to the lower jaw of the bracket. The slotted locking bar is hinged, cam fashion, to the locking handle. The handle clip is hinged to the upper jaw of the bracket and has a hook end which is engaged in one of the slots in the locking bar. When the locking handle is moved down, it forces the locking bar up and releases tension on the handle clip. When the locking handle is moved up, it pulls the locking bar down and forces the handle clip to a positive grip on the litter handle.

6-20. Litter Poles.

Twelve litter poles are provided for use in adapting the helicopter for medical evacuation. An attachment fitted to the bottom of each pole has two indentations, on opposing sides, which fit between two studs located in a floor channel. The upper rear side of the pole contains two keyhole slots by which the pole is anchored to studs on the seat-back support tubes. A metal spring retainer inside the pole locks under one of the studs when the pole is installed. This prevents accidental dislocation of the pole. The retainer is released for litter pole removal by pulling the grommet which protrudes from the front of the pole. When not being used, the litter poles are stowed at station 120.

6-21. Litter Straps.

Twelve litter straps are provided for use with the litter poles to support the litters. The straps can be adjusted upward or downward by means of slide adjusters near the upper and lower ends of the straps. All of the straps are fitted at the top with slip-over hooks which are fastened to brackets mounted in the strap stowage recesses. The lower end of each strap has a fitting for attaching the strap to a tiedown stud on the the floor. The straps are stowed in overhead recesses located directly over the floor studs to which the straps will be attached. The stowage recesses are covered with canvas flaps which are zipped along two sides.

6-22. Litter Installation. The litters are installed as shown in figure 6-8.

NOTE

If buffer boards are installed, remove them prior to installation of the litter poles. Upon completion of the litter mission, reinstall the buffer boards.

6-23. Litter Removal.

The litters are removed by reversing the procedure shown in figure 6-8.

6-24. Litter Loading.

The loading of litters will be accomplished through the lowered aft cargo door and ramp. The forward litter tiers should be loaded first, top to bottom, and then progressively rearward. Litter patients requiring in-flight medical care should be positioned to facilitate access to wounds requiring attention. If the helicopter is to be loaded with a combination of troops and litter patients, the litter patients should be positioned to the rear of the troops.

6-25. Combination Seat and Litter Arrangement.

Combined troop and litter patient loads can be transported by arranging seats and litters as required. Table 6-1 gives the various combinations of seats and litters which can be used.

6-26. Static Line Anchor Cable.

A static line anchor cable is provided. The cable is normally stowed in a container (3, figure 6-18) located on the right side of the cargo compartment at station 160. When the static line anchor is installed, the cable is attached to the structure between stations 120 and 592. A static line retriever is provided with the static line anchor cable. The retriever is used in conjunction with the winch and is provided to haul-in the static lines at the end of the jumping exercise or to retrieve a "hung up" paratrooper in an emergency. Refer to chapter 4 for the procedures on using the static line retriever.

316-520 O - 80 - 12

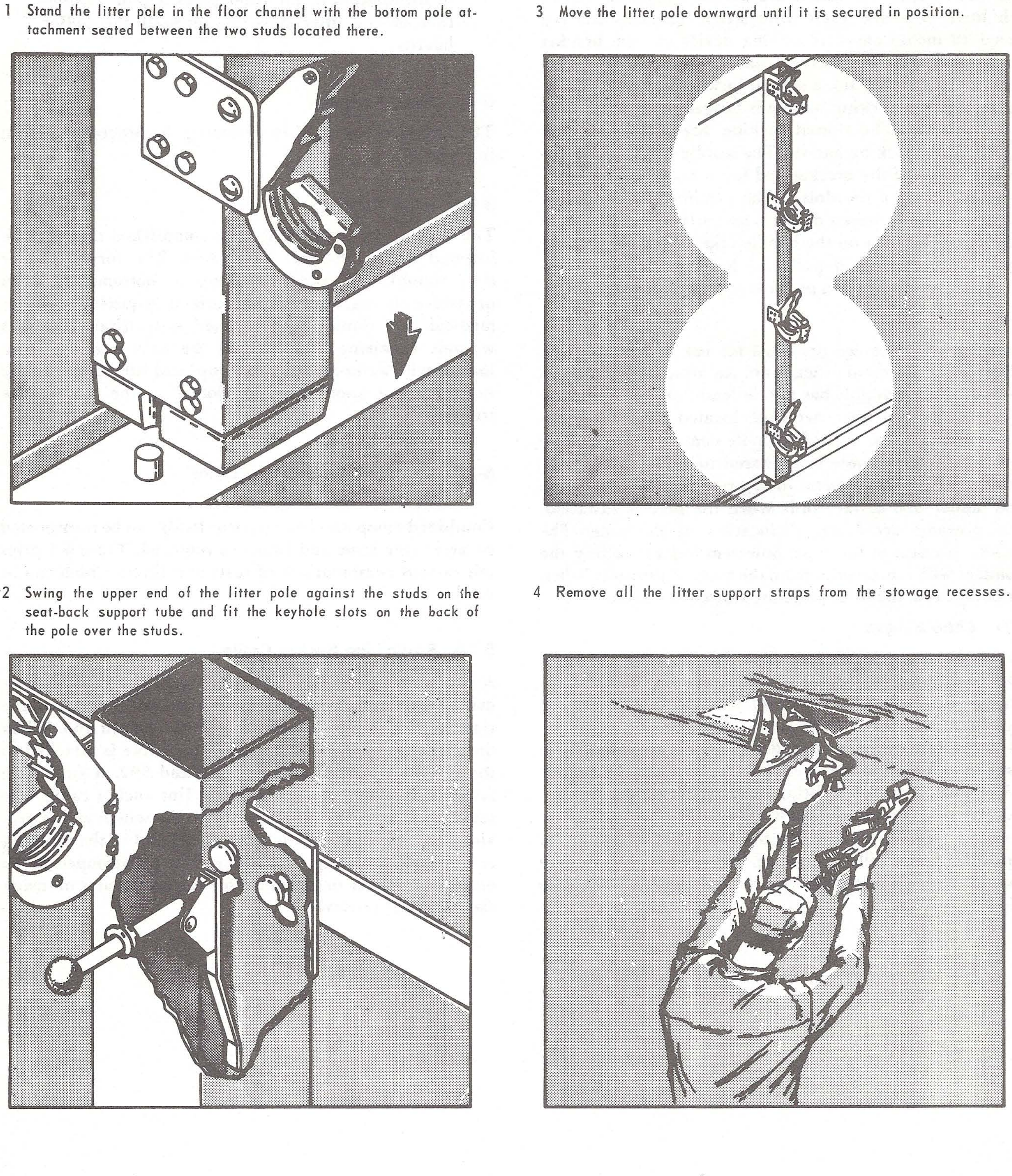
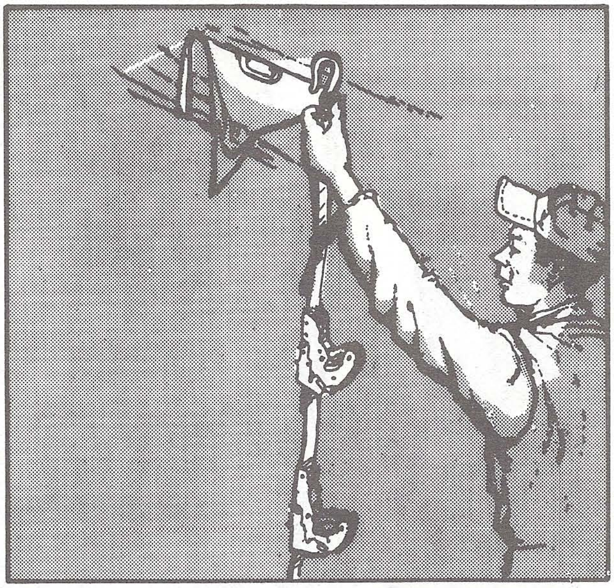
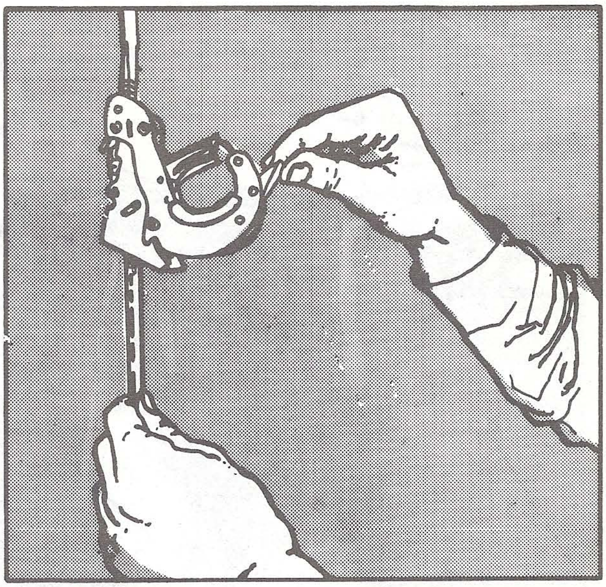


Figure 6-8. Litter Installation (Sheet 1 of 3)

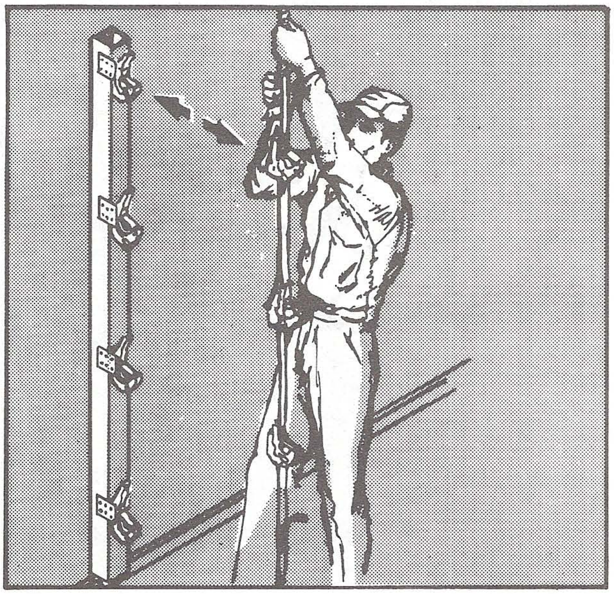
5 Attach the top ends of the straps to the brackets inside the stowage recesses.



7 Pull down on the locking handle of the litter support bracket.



6 Adjust each strap upward and downward until the strap support brackets are the same height as those on the corresponding litter poles.



8 Pull the handle clip away from the locking bar.

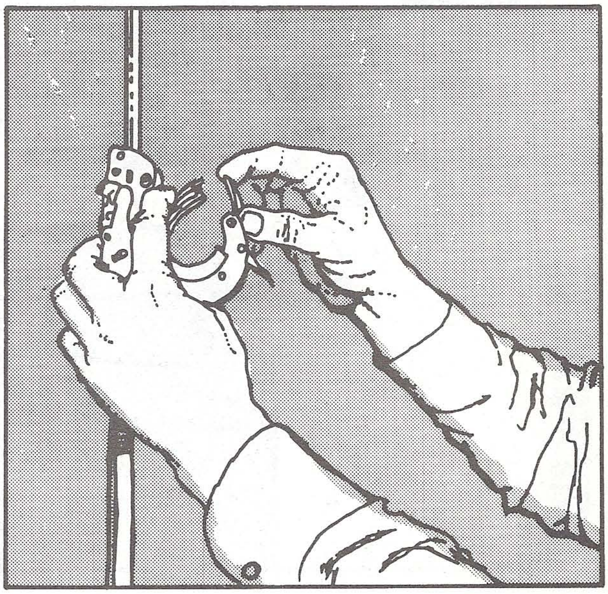
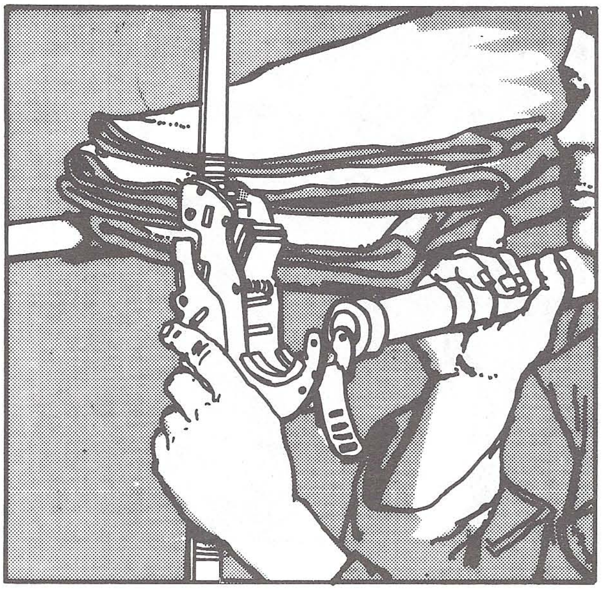
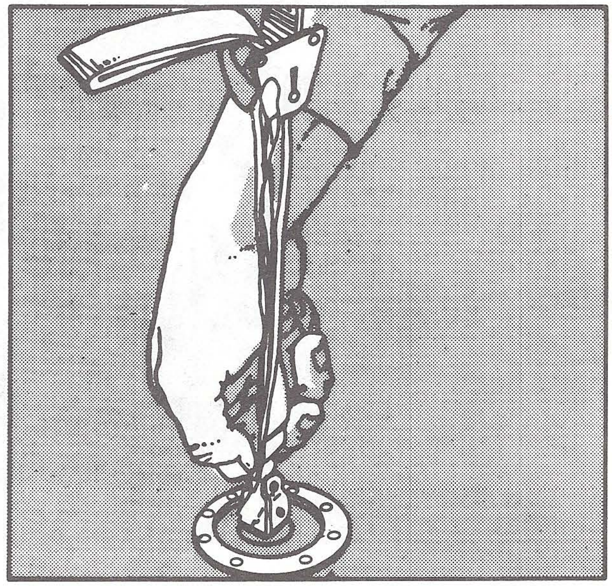


Figure 6-8. Litter Installation (Sheet 2 of 3)

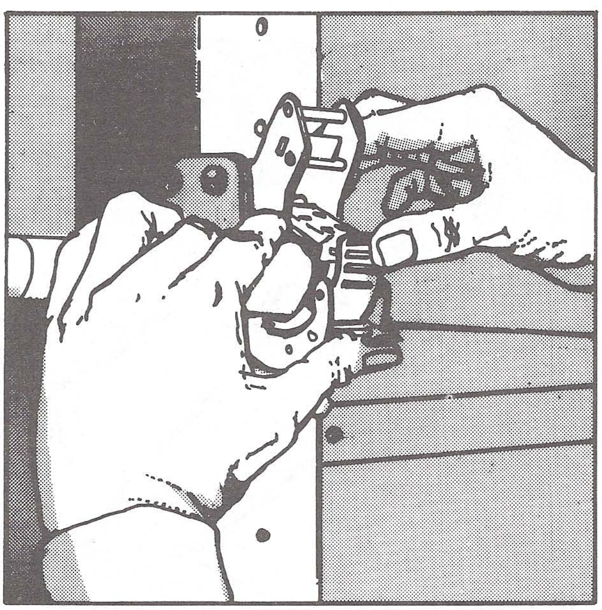
9 Place the litter handles into the litter support brackets.



11 Attach the fitting on the bottom of each litter support strap to the proper stud on the cargo floor. Do this by pressing inward on the spring lever, slipping the catch over the stud, and releasing the spring lever.



10 When all four litter handles are in place, reengage the handle clip in the locking bar and lock the bracket by moving the locking handle upward.



12 Tighten the litter support strap by pulling on the free end of the strap until the strap is sufficiently tight.

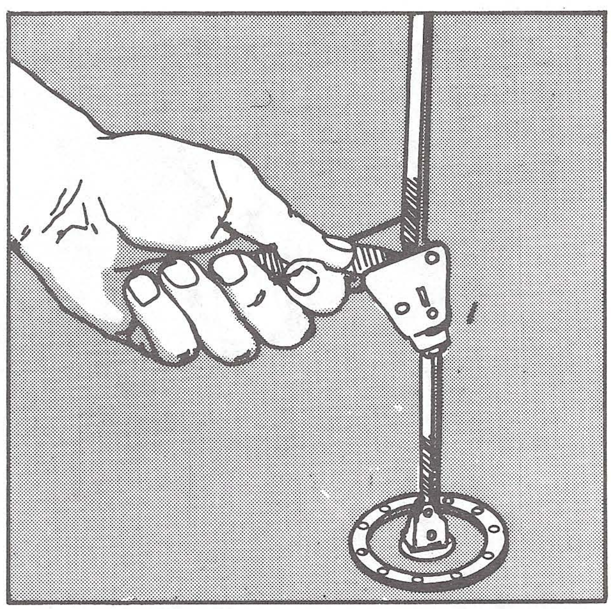


Figure 6-8. Litter Installation (Sheet 3 of 3)

Table 6-1. Seat and Litter Arrangement Data

PERSONNEL		LITTER TIERS	SEATS	
SEATS	LITTERS	(4-MAN)	(1-MAN)	(3-MAN)
33	0	0	3	10
27	4	1	3	8
21	8	2	3	6
18	12	3	3	5
12	16	4	3	3
6	20	5	3	1
3	24	6	3	0

SECTION IV MISSION EQUIPMENT

6-27. CH-47A mission equipment consists of the M-24 armament subsystem, the M-41 armament subsystem, the AN/ALE-29A flare dispensing system, the cargo handling systems, the cargo hook, and the static line retriever. The cargo handling systems, the cargo hook, and the static line retriever are included in the basic weight of the helicopter or are listed on the chart C for the particular helicopter. Figure 6-9 lists the weight and the moment/1,000 for the M-24 armament subsystem, the M-41 armament subsystem, and the AN/ALE-29A flare dispenser system. If spare ammunition or flare container are carried on a particular mission, compute the moment/1,000 for each spare container from the cargo moments chart (figure 6-14).

ARMAMENT LOADING

M24 GUN (7.62 MM) WEIGHT/GUN = 43.5 LBS ARM (STA) = 140 MOM/1000 = 6.1		
AMMUNITION LH OR RH ARM = 140		
ROUNDS	WEIGHT	MOM/1000
10	.7	.1
20	1.3	.2
40	2.6	.4
60	3.9	.5
80	5.2	.7
100	6.5	.9
120	7.8	1.1
140	9.1	1.3
160	10.4	1.5
180	11.7	1.6
200	13.0	1.8

M41 GUN (7.62 MM) WEIGHT/GUN = 42.0 LBS ARM (STA) = 584 MOM/1000 = 24.5		
AMMUNITION RAMP ARM = 584		
ROUNDS	WEIGHT	MOM/1000
10	.7	.4
20	1.3	.8
40	2.6	1.5
60	3.9	2.3
80	5.2	3.0
100	6.5	3.8
120	7.8	4.6
140	9.1	5.3
160	10.4	6.1
180	11.7	6.8
200	13.0	7.6

FLARE DISPENSER LOADING

FLARE DISPENSING SET AN/ALE-29 WEIGHT = 15 LBS ARM (STA) = 580 MOM/1000 = 8.7		
FLARES WT./FLARE = .4 LB ARM (STA) = 580		
FLARES	WEIGHT	MOM/1000
1	.4	.2
2	.8	.5
4	1.6	.9
6	2.4	1.4
8	3.2	1.9
10	4.0	2.3
12	4.8	2.8
14	5.6	3.2
16	6.4	3.7
18	7.2	4.2
20	8.0	4.6
22	8.8	5.1
24	9.6	5.6
26	10.4	6.0
28	11.2	6.5
30	12.0	7.0

Figure 6-9. Mission Equipment Weights and Moments

SECTION V CARGO LOADING

6-28. General.

This section contains information and instructions required to load and secure cargo in the helicopter. It lists and describes the items of equipment incidental to these operations, instructions for their use, and illustrations where necessary or desirable. In addition, this section deals with the factors of stress, balance, restraint, and methods and procedures essential to safe, effective delivery of cargo. The study and use of this data will help you load and unload cargo safely and efficiently. It is not the function of this section to teach the principles of cargo loading. Your experience and ability are recognized. Nevertheless, it is the function of this section to provide the detailed information on cargo loading with regard to this helicopter.

6-29. Cargo Compartment.

The cargo compartment (figure 6-10) is 366 inches long, 90 inches wide, and 78 inches high. These dimensions are uniform throughout the cargo compartment. A hatch in the center of the cargo floor opens to provide access to the cargo hook and the lower rescue door. The lower rescue door is opened for rescue operations, aerial loading, and external cargo transport operations. A hydraulically operated door and ramp provide a means for quick and efficient straight-in loading and unloading.

NOTE

Figure 6-11 shows the maximum cube size which can be taken into the helicopter thru either the main cabin entrance, utility hatch, or cargo loading ramp.

6-30. Main Cabin Entrance

The main entrance door is located on the right side of the cargo compartment at the forward end and measures 66 inches in height by 36 inches in width. The door is composed of two sections; the upper section rolls inward and upward to a rest position overhead; the lower section opens outward and downward and serves as a step in the lowered position.

6-31. Utility Hatch Door.

The utility hatch door is located in the center of the cargo compartment floor between stations 320 and 360. The door is hinged along its entire forward edge. It opens upward and forward to expose the lower rescue door and the cargo hook. The door is unlatched by pressing the knob marked PUSH, and is latched by pressing the unmarked knob.

6-32. Lower Rescue Door.

The lower rescue door forms a part of the fuselage bottom when closed and is accessible thru the utility hatch door. The lower rescue door is secured by four latches centered around the door perimeter. These latches are connected by linkage to an actuator marked OPEN and CLOSED. A handcrank, stowed in spring metal clips on the left side of the fuselage, is used to unlatch the door and turn the gears. A drive shaft, which is turned by the gears, moves the door actuator links. The door opens downward and aft underneath the fuselage where it remains during operations.

NOTE

When opening or closing the lower rescue door, be certain that the cargo hook is properly stowed and supported by the restraining straps. In addition, close the lower rescue door by using the actuator only to the point where the latch can engage; the latches will then lift the door and compress the door seal.

6-33. Cargo Compartment Floor.

The floor is made of extruded panels, riveted together in sections. Raised extruded ridges, running the entire length of the floor, provide surfaces on which cargo is moved. The flooring in the cargo compartment contains sections on either side of the centerline which are strengthened to serve as vehicle treadways. The flooring, from station 200 to 400 and from buttline 44 left to 44 right, rests on rubber vibration isolators which reduce overall internal load vibrations. Tiedown fittings (figure 6-12) for securing cargo are installed in the floor. There are also studs for attaching troop seats, litter supports, and the base plate for the maintenance crane. The flooring is covered with a walkway compound which provides a non-skid surface for personnel and for vehicles. The ramp floor is identical in construction to the cargo floor.

CAUTION

Although tightening of the tiedown straps may be necessary to reduce internal load vibrations, excessive tightening of tiedowns attached to the outboard row of tiedown fittings will limit the effectiveness of the isolated cargo floor.

NOTE

Whenever possible, place all wheeled vehicles entirely on the isolated floor.

6-34. Strength Areas.

The weight which the cargo compartment floor (figure 6-13) can support varies. These variations are largely due to differences in strength of supporting frames and fuselage construction, not because of varying floor strength. To gain the maximum benefit from the cargo compartment floor, the following definitions and weight limitations must be observed.

6-35. Uniformly Distributed Loads. Uniformly distributed loads are those loads wherein the total weight of the item is equally spread over the item's entire contact area. The contact area is large compared to the size and weight of the load.

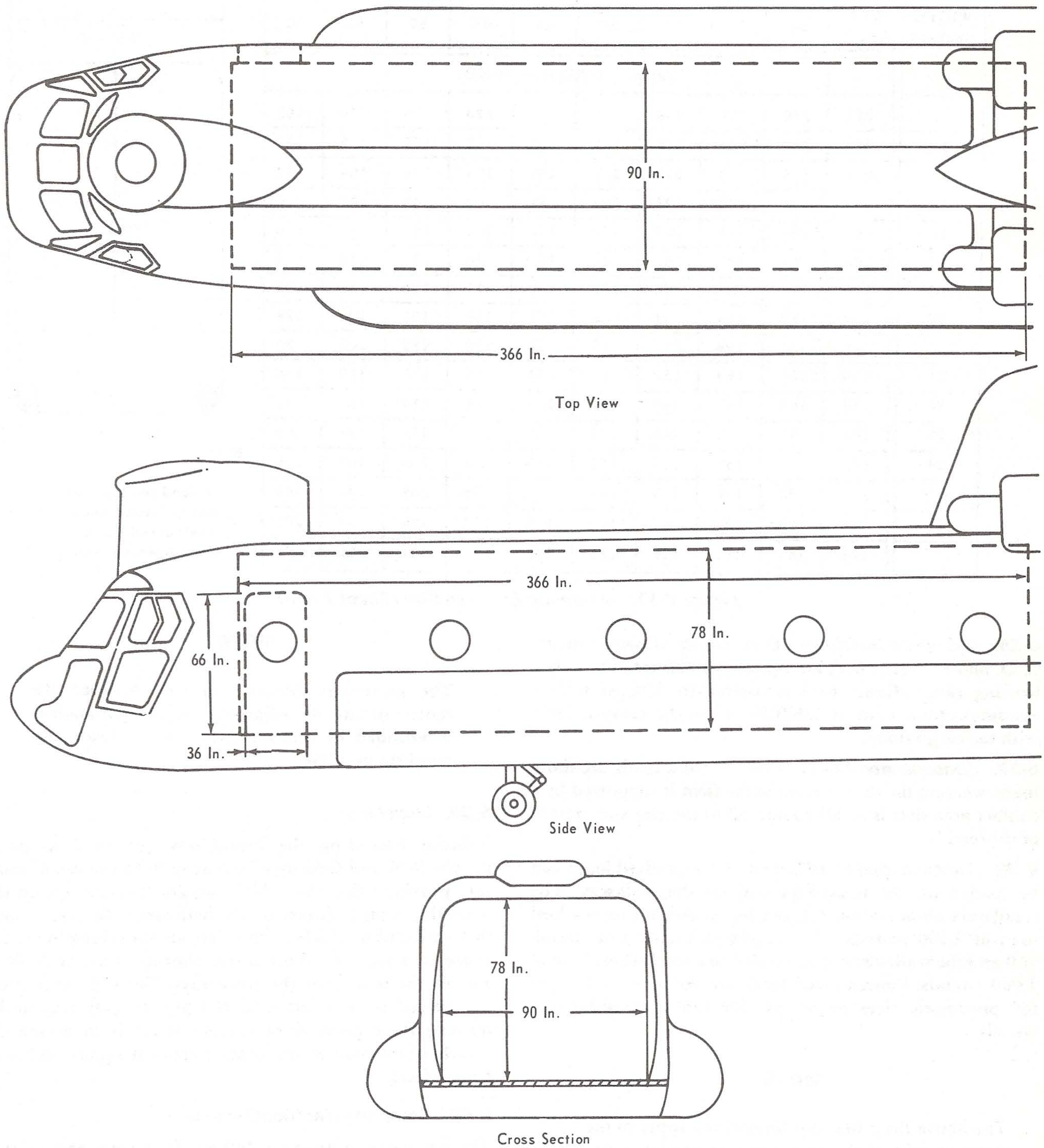
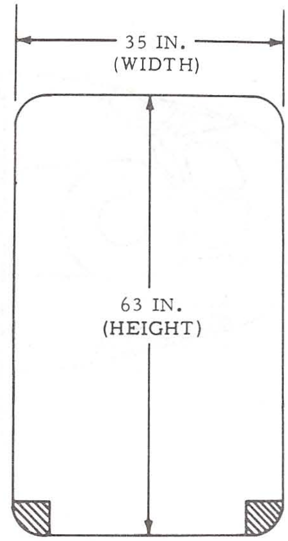


Figure 6-10. Cargo Compartment Dimensions

MAXIMUM PACKAGE SIZE TABLE
FORWARD DOOR--RIGHT SIDE

WIDTH (Inches)	HEIGHT--INCHES									
	53 & Under	54	55	56	57	58	59	60	61	62
	MAXIMUM LENGTH--INCHES									
12	249	246	242	238	234	223	170	170	170	165
13	233	230	227	224	221	211	162	162	162	157
14	217	215	213	210	208	199	154	154	154	150
15	205	204	203	199	197	187	147	147	147	144
16	195	194	193	189	187	176	141	141	141	138
17	186	185	183	180	178	166	136	136	136	133
18	177	176	174	172	170	157	131	131	131	128
19	169	168	166	164	162	149	126	126	126	124
20	161	160	159	157	155	142	122	122	122	120
21	155	154	153	151	148	135	118	118	118	116
22	149	148	147	145	141	129	114	114	114	112
23	143	143	142	140	135	124	111	111	111	109
24	138	138	137	135	129	119	108	108	108	106
25	133	133	132	130	124	114	105	105	105	103
26	128	128	127	125	119	110	103	103	103	101
27	125	124	123	121	115	106	101	101	101	99



NOTE:

Shaded part shows approximate area obstructed due to door opening linkage.

Figure 6-11. Maximum Package Size (Sheet 1 of 3)

6-36. Uniformly Distributed Load Limits. Compartments C, D, and E (figure 6-1) are limited to 300 psf. The cargo loading ramp (figure 6-1) is limited to 300 psf with a maximum total load of 3,000 lbs when the ramp is level with the cargo floor.

6-37. Concentrated Loads. Concentrated loads are those loads wherein the total weight of the item is supported by a contact area that is small compared to the size and weight of the load.

6-38. Concentrated Load Limits. Concentrated loads can be loaded on the treadways and on the walkway. The treadways aft of station 160 can be loaded to a total wheel load of 2,500 pounds. The treadways forward of station 160 and the walkway can be loaded to a total wheel load of 1,000 pounds. Concentrated loads are not to exceed 75 psi for pneumatic tires or 50 psi for block or roller-type wheels.

NOTE

The above floor loading limitations apply to the static weight of the item prior to applying any restraint devices.

NOTE

The minimum distance, in feet, between the centers of any two adjacent concentrated loads is determined by totaling the adjacent loads and dividing by 1,000.

6-39. Load Limits.

Vehicles exceeding the limitations described in paragraphs 6-36 and 6-38 may be loaded with the use of shoring, provided that the vehicle weights remain within the operating weight limits of the helicopter. In cases where the wheels of a vehicle cannot rest on both threadways because of a narrow wheel tread, shoring must be used to spread the load over the treadways. General cargo must not exceed floor pressure of 300 psf. An easy way to determine floor pressure of various loads is to divide the weight of the load by the contact area (in square inches or square feet).

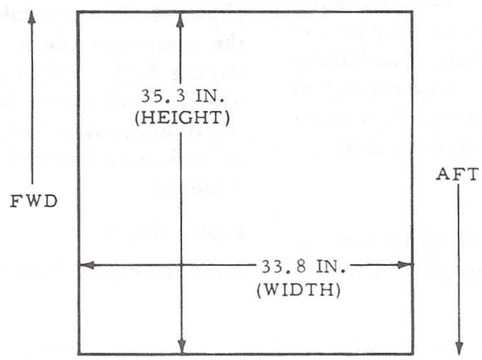
6-40. Compartment Identification.

The cargo compartment is divided, for weight and balance purposes, into three compartments designated C, D, and E,

MAXIMUM PACKAGE SIZE TABLE
BELLY UTILITY HATCH

WIDTH (Inches)	HEIGHT--INCHES																						
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	MAXIMUM LENGTH--INCHES																						
33 & Under	136	132	128	124	120	116	113	110	107	104	102	100	98	96	94	92	90	88	86	84	82	81	80

PACKAGES LOADED IN FORWARD DIRECTION



WIDTH (Inches)	HEIGHT--INCHES																						
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	MAXIMUM LENGTH--INCHES																						
33 & Under	146	140	135	130	126	122	118	114	111	108	105	102	99	96	93	91	89	87	85	83	81	80	79

PACKAGES LOADED IN AFT DIRECTION

Figure 6-11. Maximum Package Size (Sheet 2 of 3)

running fore and aft. (See figure 6-1.) When the cargo ramp is used as an extension of the cargo compartment, it is designated as F for weight and balance purposes. These compartment designations and their limiting fuselage stations are stenciled on the cargo compartment walls.

6-41. Compartment Capacities.

Based on a maximum distributed floor loading of 300 psf, the compartment capatities can be obtained by multiplying the floor loading by the floor area of the individual compartment; however, this weight may exceed present limitations. Figure 6-13 lists the maximum capacity of each compartment. In addition to the limitations in figure 6-13, compartment loads will be limited by those limitations set forth in chapter 5.

6-42. Tiedown Fittings.

Tiedown fittings (figure 6-12) for the purpose of securing cargo are installed on the cargo compartment floor and on the ramp floor. All the fittings are of the D-ring type. There are eighty-seven (83 in the fuselage floor and 4 in the ramp floor) 5,000-pound capacity tiedown rings and eight 10,000-pound capacity tiedown fittings. The fittings are normally used with tiedown devices which will not exceed the limits of the fitting.

6-43. Five Thousand-Pound Capacity Tiedown Fittings.

The eighty-three 5,000-pound capacity tiedown fittings in the cargo compartment floor are equally spaced five rows in width and are spaced every 20 inches longitudinally. The four in the ramp are spaced in a square pattern. Each 5,000-pound capacity fitting swivels freely and is capable of resisting a single maximum load of 5,000 pounds exerted along any radius of a hemisphere, the flat side of which is the surface of the floor. The fittings are hinged so that they can be seated in floor recesses when not in use.

6-44. Ten Thousand-Pound Capacity Tiedown Fittings.

There are eight 10,000-pound capacity tiedown fittings on the cargo compartment floor. Four fittings are interposed along both outboard rows of 5,000-pound capacity fittings, spaced at intervals of 80 inches from station 240 to station 480. Because these fittings are not always used and because they might be in the way when installed, they are installed only when necessary. When they are to be used, the fittings are screwed into threaded receptacles at the fitting locations. When the fittings are not being used, threaded plugs are screwed into the receptacles to prevent entrance of foreign material and to protect the threads in the receptacles.

WARNING

The 10,000-pound capacity tiedown fittings must be screwed into the threaded receptacles to full depth to achieve their rated capacity.

6-45. Cargo Loading Aids.

The helicopter has a number of features to facilitate loading of cargo. Some of these features are parts of regular systems and are permanently installed; others are pieces of equipment which are stowed in the helicopter. The following paragraphs contain descriptions of items classed as loading aids. Specific instructions for some of these items may be found in other parts of this manual and are referenced.

6-46. Cargo Loading Ramp.

The ramp provides a means of quickly loading and unloading troops and cargo. (Refer to paragraph 6-50 thru 6-67.) It can also be used to support portions of a cargo load which exceeds the longitudinal dimensions of the cargo floor. When used for additional cargo space, the ramp must be positioned so that the ramp floor is level with the cargo floor. The weight of the cargo item resting on the ramp must not exceed 3,000 pounds in this position.

6-47. Auxiliary Loading Ramps.

Three auxiliary loading ramps are hinged to the aft end of the ramp. When the ramp is lowered, these auxiliary ramps (figure 6-15) are unfolded to provide flush contact between the ramp and the ground. The auxiliary loading ramps (figure 6-15) can be positioned to accommodate various vehicle tread widths or butted together to facilitate winching of bulk cargo. When not in use, the auxiliary ramps are stowed in an inverted position on the floor of the ramp or removed.

6-48. Winch.

Refer to chapter 4, section III.

MAXIMUM PACKAGE SIZE TABLE
RAMP DOOR

WIDTH (INCHES)	HEIGHT - INCHES															
	62 & Under	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	MAXIMUM LENGTH--INCHES															
62 & Under	362	362	362	362	362	362	362	362	330	282	230	180	135	100	67	30
63	362	362	362	362	362	362	362	362	328	280	228	178	133	98	66	
64	362	362	362	362	362	362	362	362	326	278	226	176	130	96	64	
65	362	362	362	362	362	362	362	362	322	274	222	173	127	93		
66	362	362	362	362	362	362	362	362	318	270	218	169	123	90		
67	362	362	362	362	362	362	362	362	313	266	214	165	119	86		
68	362	362	362	362	362	362	362	357	307	260	208	160	114	81		
69	362	362	362	362	362	362	362	348	299	252	201	154	107	75		
70	362	362	362	362	362	362	362	339	290	243	193	146	99			
71	362	362	362	362	362	362	362	330	281	234	185	139	91			
72	362	362	362	362	362	362	362	321	272	226	177	131	83			
73	362	362	362	362	362	362	352	312	263	216	167	122	75			
74	362	362	362	362	362	362	339	298	250	203	156	112				
75	362	362	362	362	362	362	325	284	237	190	144	101				
76	362	362	362	362	362	348	311	270	223	177	132	90				
77	362	362	362	362	362	334	297	256	209	164	119					
78	362	362	362	362	346	316	278	237	191	147	104					
79	362	362	362	362	329	298	258	218	173	129	85					
80	362	362	362	362	310	276	236	195	151	108						
81	362	362	362	362	289	253	213	172	128	85						
82	362	362	362	362	267	230	188	148	105							
83	362	362	362	362	241	202	161	121								
84	362	362	362	362	213	174	133	93								
85	362	362	362	362	182	142	100									
86	362	362	362	362	146	105										
87	362	362	362	362	105											
88	362	362	362	362												
89	362	362	362	362												
90	362															

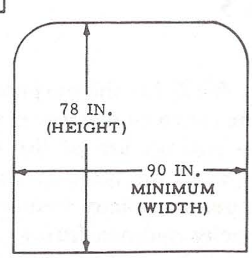


Figure 6-11. Maximum Package Size (Sheet 3 of 3)

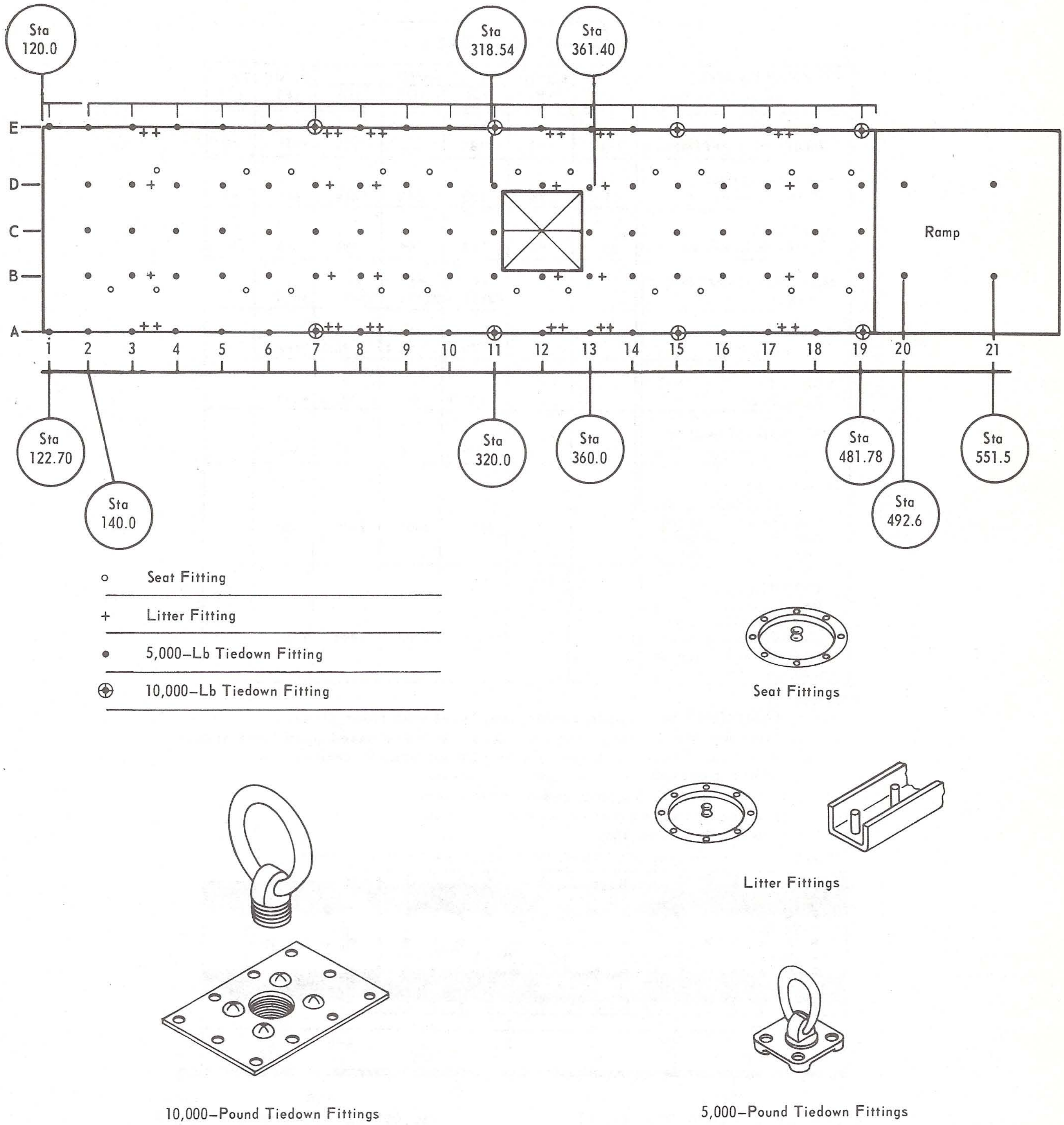


Figure 6-12. Tiedown Fittings

COMPARTMENT DATA

COMPARTMENT DESIGNATION	PILOTS' (A)	EQUIP (B)	CARGO (C)	CARGO (D)	CARGO (E)	RAMP (F)	TAIL (G)
CENTROID Inches from Ref Datum	75	108	181	303	425	*536	607
FORWARD LIMIT Inches from Ref Datum	21.5	95	120	242	364	486	584
AFT LIMIT Inches from Ref Datum	95	120	242	364	486	584	630.5
MAXIMUM CAPACITY Pounds			** 22875	** 22875	** 22875	3000	
FLOOR AREA Square Feet			76.3	76.3	76.3	*61.8	
VOLUME Cubic Feet			491.3	491.3	491.3	*373.8	
MAXIMUM CAPACITY Pounds per Square Foot			300	300	300	300	
TREADWAY Max uniformly distributed load over limited area of 1 square foot or max load per wheel.			2500	2500	2500	2500	
CENTER SECTION Between treadway-max uniformly distributed load over limited area of 1 square foot or max load per wheel.			1000	1000	1000	1000	

NOTES:

1. RAMP (F) * based upon ramp open, level with floor plane.
2. Centroids for Compartments C, D, E, & F are based upon floor area.
3. All volumes based upon projection of floor area to ceiling.
4. **Do not exceed Gross Weight Limitations
5. In order to keep the emergency exits clear, it is recommended that cargo not be loaded forward of station 160.

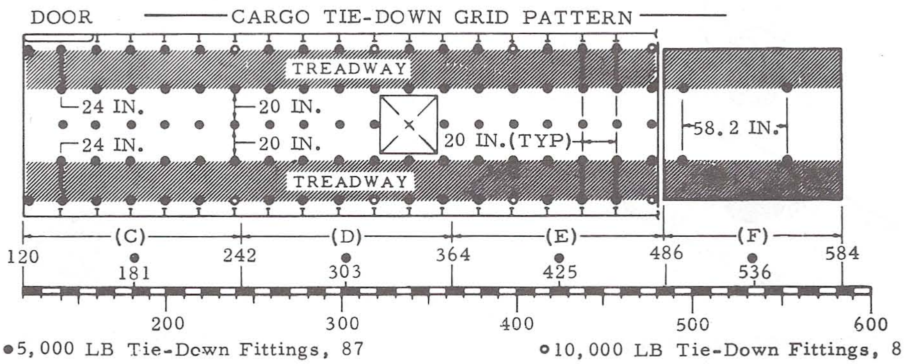


Figure 6-13. Compartment Data

CARGO MOMENT
CH-47A

CARGO MOMENT

EXAMPLE

WANTED

CARGO MOMENT

KNOWN

CARGO WEIGHT = 15500 LB.
CARGO LOCATION = STA. 210

METHOD

ENTER WEIGHT OF EACH ITEM OF CARGO HERE. MOVE RIGHT TO CARGO LOCATION MOVE DOWN. READ MOMENT = 3250

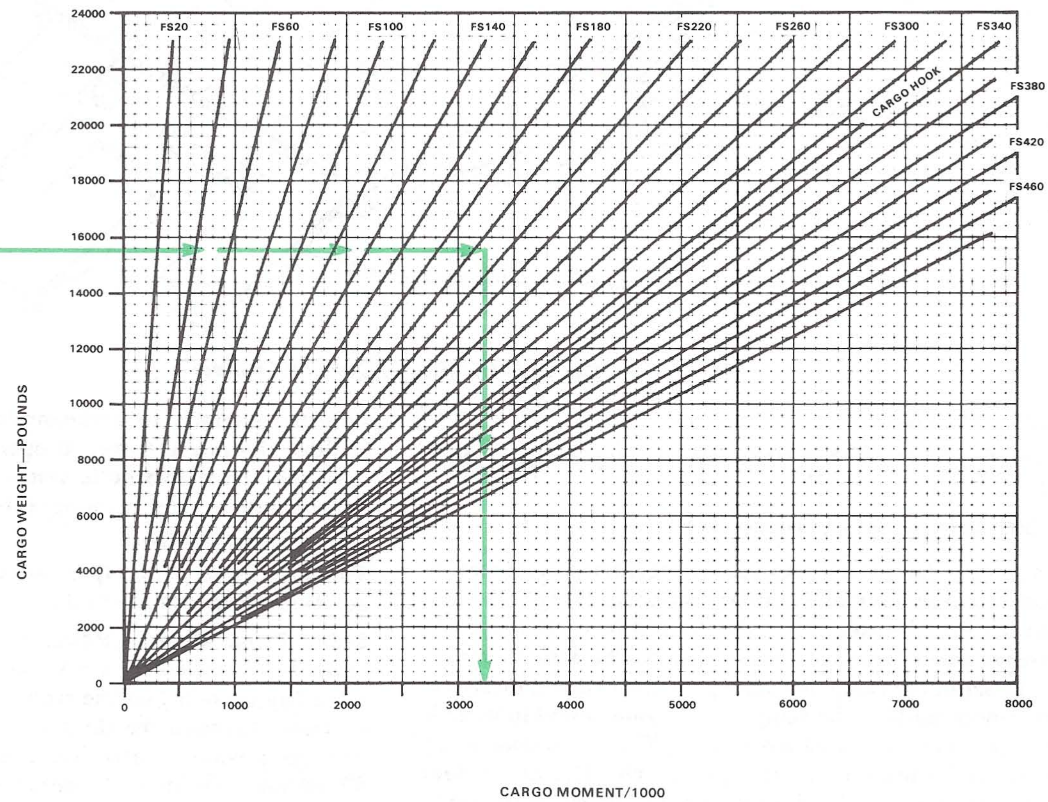


Figure 6-14. Cargo Moments Chart

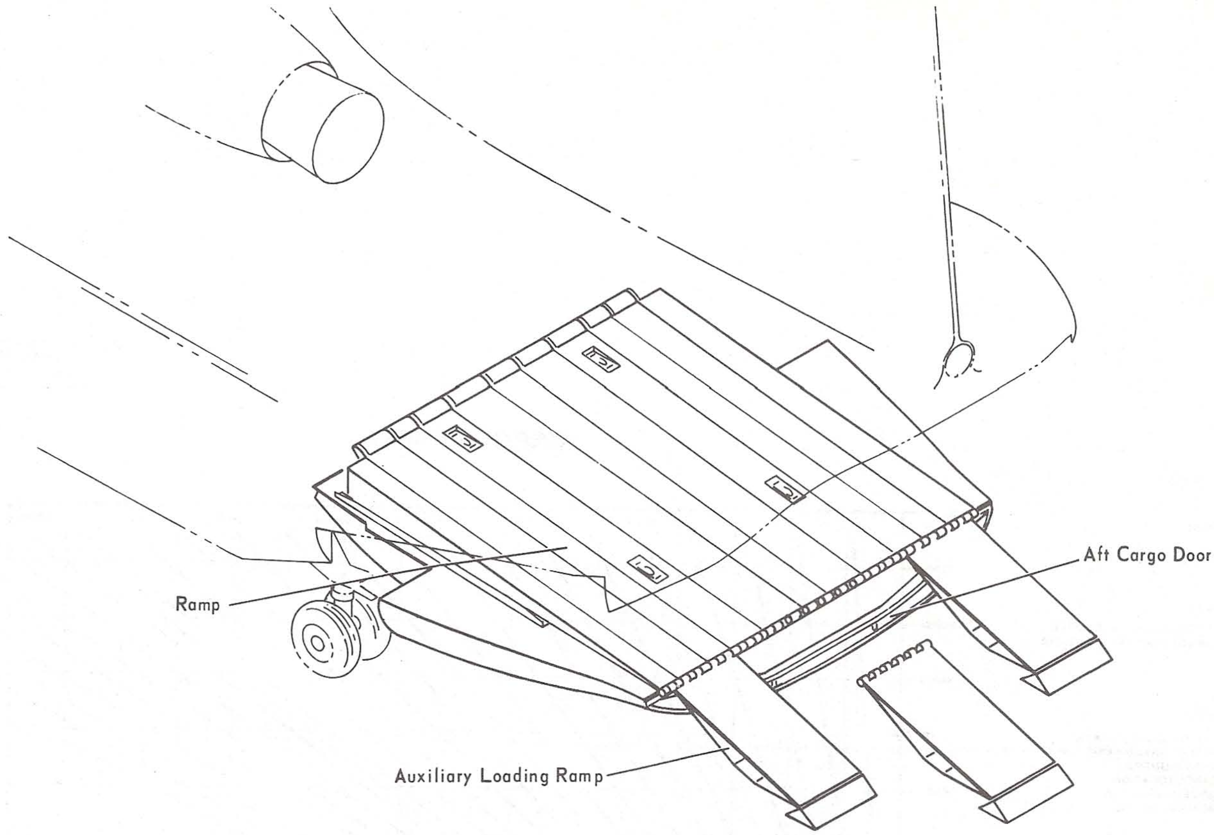


Figure 6-15. Cargo Door and Ramp

6-49. Tiedowns.

Refer to paragraphs 6-89 thru 6-92 and figures 6-24 and 6-25.

6-50. Cargo Door and Ramp.

The cargo door and ramp has two sections: an upper section, or cargo door, and a lower section, or ramp. The door retracts into the ramp when the ramp is being lowered and extends when the ramp is being raised. The door is an integral part of the ramp and only provides closure; therefore, references made to the ramp will be understood to include the door and its related movements. The cargo door is jettisonable to provide an emergency exit. The cargo door and ramp (figure 6-15) is located at the aft end of the cargo compartment and is used for troop and cargo loading and unloading. In the closed position, it conforms to the side contours of the fuselage. Internal locks in the ramp actuating cylinders prevent accidental opening and constitute the only locking mechanism for keeping the ramp closed. The ramp is hinged to the fuselage and opens rearward and downward to rest on the ground. When lowered to ground rest, the ramp inclines downward approximately 6.75 degrees and maintains a uniform 78-inch overhead clearance of the cargo compartment. A continuous hinge runs the entire width of the aft upper edge of the ramp and holds the three auxiliary loading ramps. The auxiliary ramps unfold to bridge the gap between the ramp and the ground for vehicle loading and unloading. They can be adjusted laterally to accommodate various vehicle tread widths. Hydraulic power to operate the ramp is supplied thru the utility hydraulic system. For information about the ramp floor, refer to paragraph 6-33.

6-51. Ramp Controls.

The following paragraphs discuss the various controls necessary to operate the ramp.

6-52. Ramp Control Valve. Lowering and raising the ramp is controlled by a manually operated ramp control valve (figure 6-16) on the right side of the aft cargo compartment between the floor and the overhead at sta 490. The ramp control valve has three marked positions, UP, STOP, and DN (down). The valve can be reached from the outside through a hinged panel on the aft fuselage.

6-53. Ramp Control Sequence Valve. A mechanically operated sequence valve (figure 6-16) controls the sequence of cargo door and ramp operation. The valve is below the ramp control valve at the ramp hinge line. A plunger on top of the valve is manually pressed to hold the cargo door at full open during ramp operation. The plunger is locked in the depressed position by rotating a retainer pin which extends from the side of the valve (figure 6-17).

6-54. Pressure Actuated Valve. Ramp operation is stopped during cargo door operation by a hydraulic pressure actuated valve. The valve is below and slightly aft of the ramp control valve (figure 6-16.) A plunger provides manual override of the valve if it sticks.

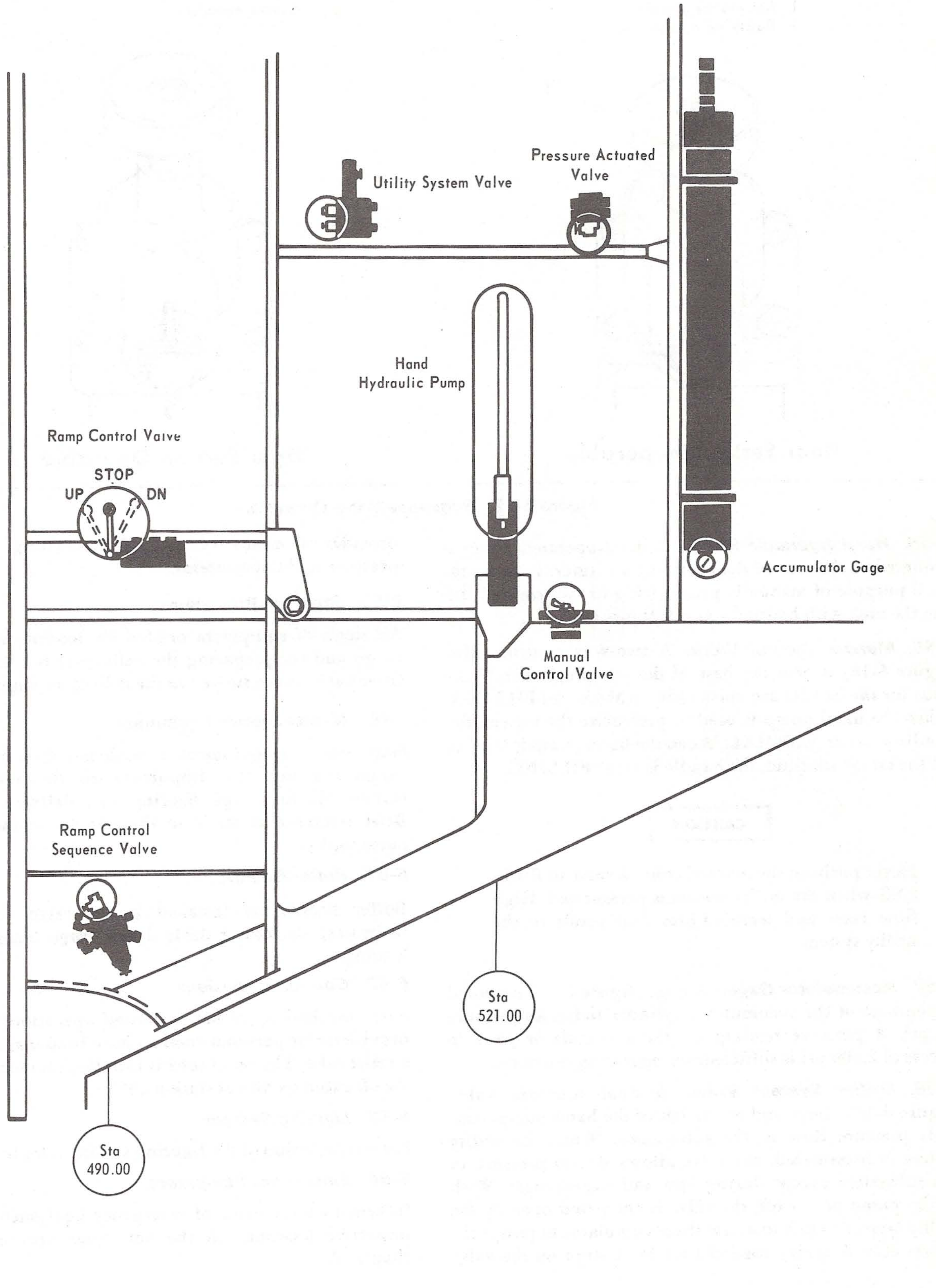


Figure 6-16. Ramp Controls

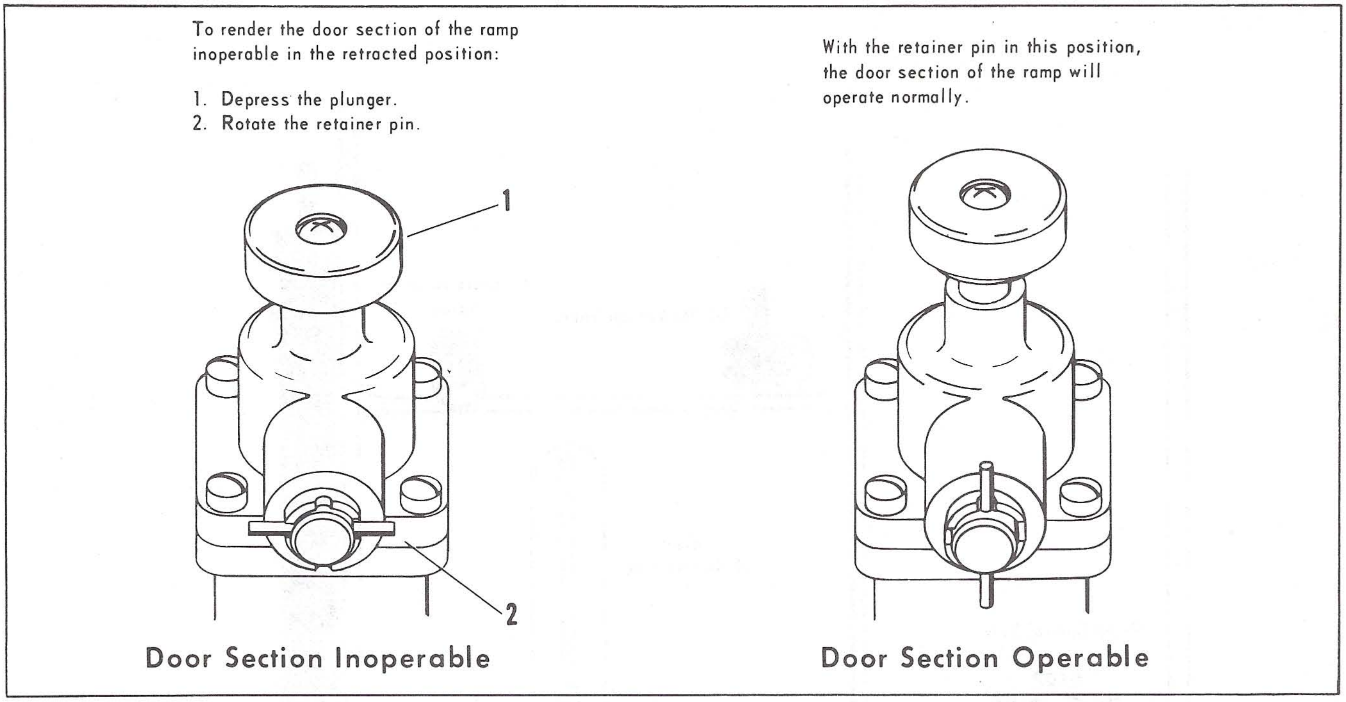


Figure 6-17. Sequence Valve Operation

6-55. Hand Hydraulic Pump. A hand-operated pump is mounted to the rear of the ramp control lever. It serves the dual purpose of manually pressurizing the system and filling the tank with hydraulic fluid (figure 6-16).

6-56. Manual Control Valve. A two-way control valve (figure 6-16) is near the base of the pump cylinder. Positions for the handle are marked NORMAL and FILLING. When the hand pump is used to pressurize the system, the handle is set at NORMAL. When the hand pump is used to fill the tank with fluid, the handle is set at FILLING.

CAUTION

Never position the manual control valve to FILLING when the utility system is pressurized. High flow rates and temperatures will result in the utility system.

6-57. Accumulator Gage. A gage (figure 6-16) mounted at the base of the accumulator cylinder indicates pressure in psi. A pressure reading on the accumulator gage in excess of 2,500 psi is sufficient for operating the ramp.

6-58. Utility System Valve. A dual solenoid valve (figure 6-16) above and to the left of the hand pump, controls pressure flow to the subsystems. When the utility system is pressurized, the valve allows system pressure to the subsystem except during apu and engine start. With utility pump power off, the valve is energized open by the utility system switch to allow the accumulator to power the subsystems. A spring-loaded override button on the valve provides a means of manually releasing accumulator pressure to the subsystems.

6-59. Stowage Provisions.

All items of equipment needed for loading and securing cargo and for preparing the helicopter to carry troops or litter patients are stowed in the helicopter (figure 6-18).

6-60. Miscellaneous Equipment.

Some items of equipment, though not directly related to cargo loading, are important to the crewmembers responsible for cargo loading and delivery operations. Brief reference is made to these items in the following paragraphs.

6-61. Buffer Boards.

Buffer boards are installed in the cargo compartment to protect the heater ducts during cargo loading and unloading.

6-62. Comfort Provisions.

Since the helicopter has a limited operational range, no provisions for personal comfort have been made other than a relief tube. The relief tube is installed on the right side of the aft cabin section at station 485.

6-63. Lighting System

For a description of the lighting system, refer to chapter 2.

6-64. Emergency Equipment.

Information on items of emergency equipment and their respective locations in the helicopter are contained in chapter 2.

1. Winching accessories
2. 10,000-pound tiedown fittings
3. Anchor line container
4. Litter strap containers
5. Winch control grip
6. Cargo hook loading pole
7. Auxiliary loading ramps
8. Rescue hatch
9. Handcrank
10. Cargo hook
11. Litter poles

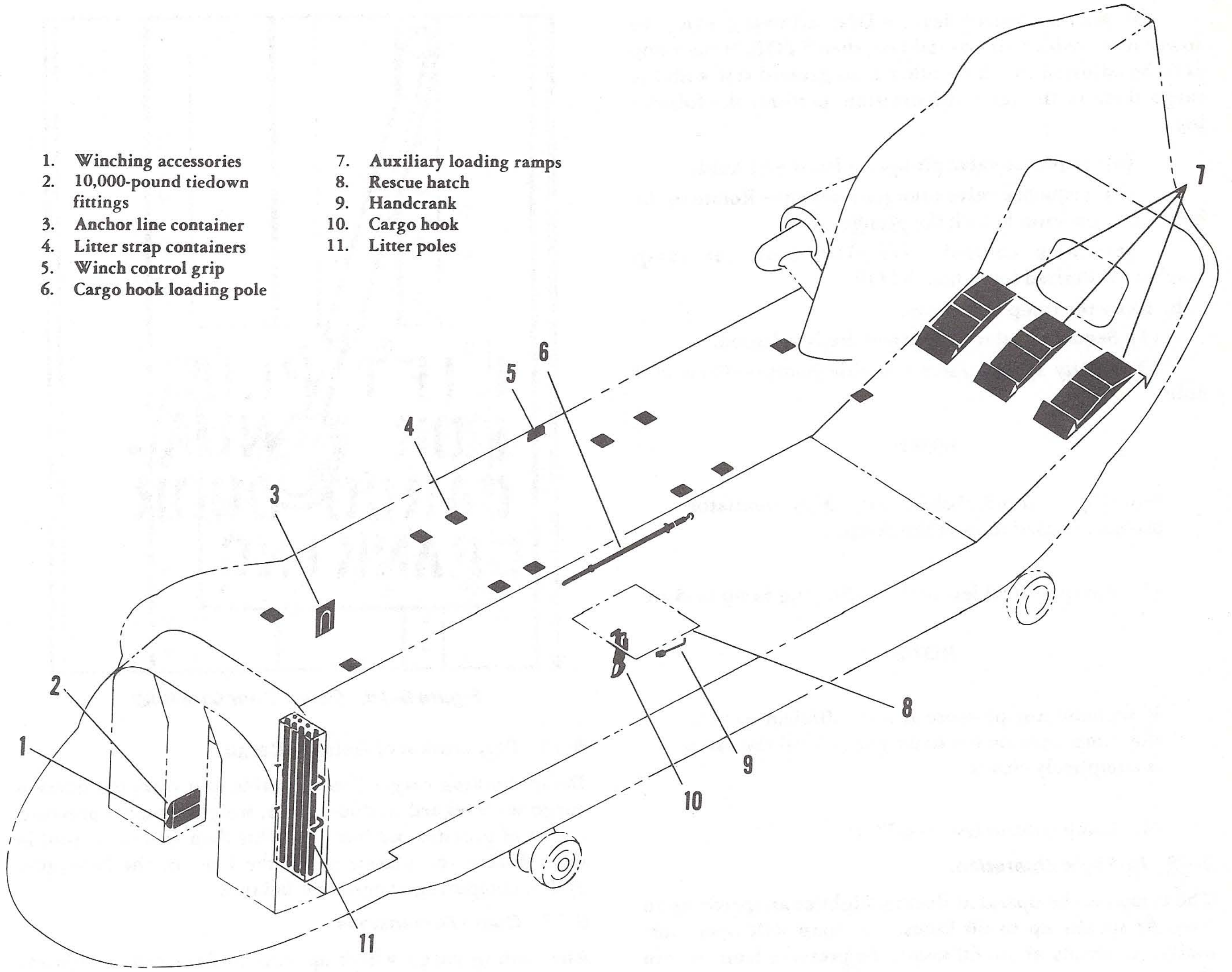


Figure 6-18. Stowage Locations

6-65. Emergency Exits.

Information on emergency exits, their locations, and instructions for their use are contained in chapter 9.

6-66. Equipment Loading and Unloading.

The following procedures should be observed in preparing the helicopter for a cargo transport mission:

a. Doors—Open.

b. Parking brake—On.

c. Troop seats—Stow.

d. Cargo compartment—Clean.

e. Tiedown devices—Check, for type and quantity.

f. Tiedown fittings—Install.

g. Loading aids—Check, for condition and operation.

h. Weight and balance data—Check.

i. Emergency equipment—Check.

j. Emergency exits—Inspect.

k. Cargo load—Inspect.

6-67. Ramp Operation.

6-68. Normal Operation

a. Lower the ramp as follows:

(1) Accumulator gage—Check 2,500 psi or more.

NOTE

If the pressure reading is below 2,500 psi, operate the hand pump to build up sufficient pressure, being certain that the control valve handle near the base of the pump cylinder is at NORMAL.

(2) Utility system valve override button—Press and hold.

NOTE

Use step (2) only if the ramp is lowered with accumulator pressure.

316-520 O - 80 - 13

(3) Ramp control lever—DN, allowing ramp to lower to a position of ground rest, then STOP. If the ramp is to be adjusted to a level other than ground rest with the cargo door in the retracted position, perform the following:

(a) Sequence valve plunger—Press and hold.

(b) Sequence valve plunger retainer—Rotate to the horizontal position to lock the plunger in.

(c) Ramp control lever—UP, until the ramp reaches the desired level, then STOP.

b. Raise the ramp as follows:

(1) Sequence valve plunger—Check, released.

(2) Utility system valve override button—Press and hold.

NOTE

Step (2) is accomplished only if accumulator pressure is used to raise the ramp.

(3) Ramp control lever—UP, allowing ramp to close.

NOTE

If accumulator pressure is not sufficient to raise the ramp, operate the hand pump until the ramp is completely closed.

(4) Ramp control lever—STOP.

6-69. In-Flight Operation.

The ramp can be operated during flight at airspeeds up to Vne. At speeds up to 60 knots, the ramp will open normally. At speeds above 60 knots, air pressure from within the cargo compartment is required. To get this pressure, the vent blower can be turned on or the upper section of the cabin door can be opened.

CAUTION

The ramp is not to be opened below floor level during takeoffs and landings.

6-70. Manual Operation—Cargo Door.

Should the need arise to retract or extend the cargo door section of the ramp manually, insert the handcrank as shown in figure 6-19. Crank clockwise to retract. Crank counterclockwise to extend.

CAUTION

Do not attempt to manually operate the cargo door when the utility hydraulic system is pressurized by the utility pump. Motor damage may result.

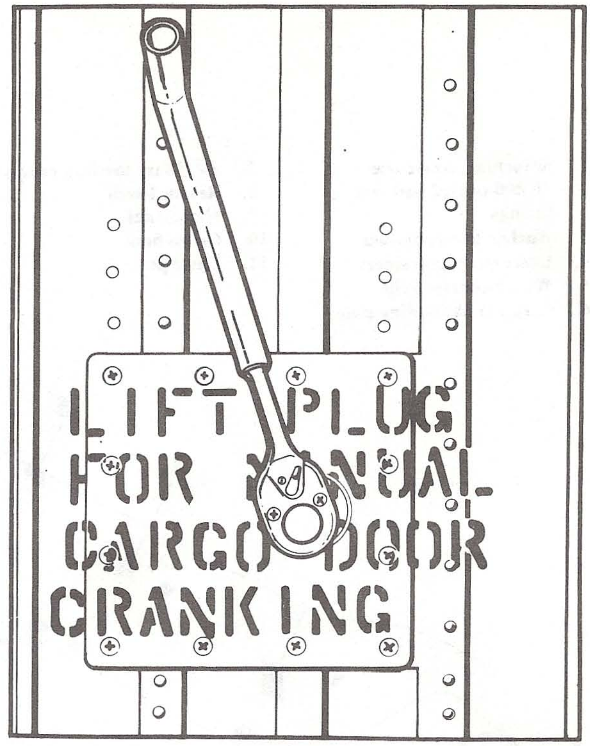


Figure 6-19. Cargo Door Cranking

6-71. Preparation of General Cargo.

Before loading cargo, it is advisable to inspect the items of cargo with regard to dimensions, weight, contact pressure, center of gravity, and hazards. This data will be helpful in determining the placement of the load in the helicopter and in computing weight and balance.

6-72. Cargo Dimensions.

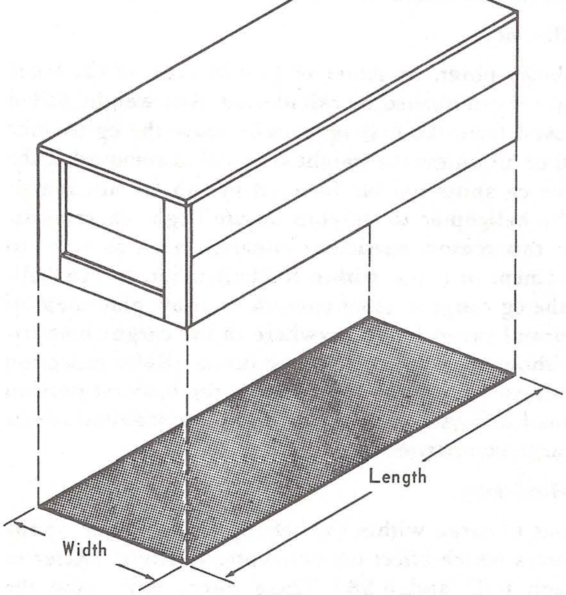
Any item of cargo which appears to have critical dimensions for loading into the helicopter should be measured and checked against door and compartment dimension limitations. These limits are shown in figure 6-10 and 6-11. Items which exceed the limiting loading dimensions must be repacked to conform to these limits or be rejected for transport.

6-73. Cargo Weight.

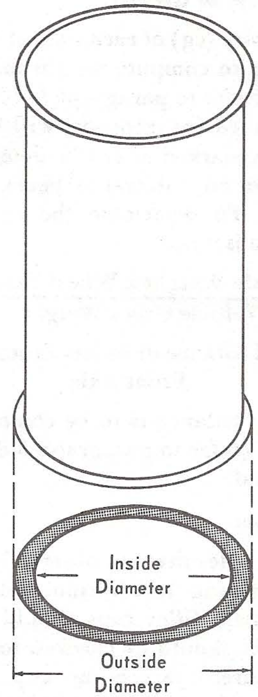
Package weight of individual items of cargo should be legibly stenciled on an exterior surface. If not provided, the weight must be determined in order to plan cargo placement, to calculate contact pressure, and to compute helicopter weight and balance. The same rule applies to palletized cargo and vehicle loads.

6-74. Contact Pressure.

Contact pressure (figure 6-20) is calculated to determine if the floor structure is strong enough to support a given item. The contact pressure of boxed and crated cargo is determined by dividing the weight of the item by the area of cargo which the item covers. The contact pressure of vehicles and other wheeled cargo is determined by dividing the weight of the item by the collective contact surface of the



Rectangular Contact Area
Area = Length X Width

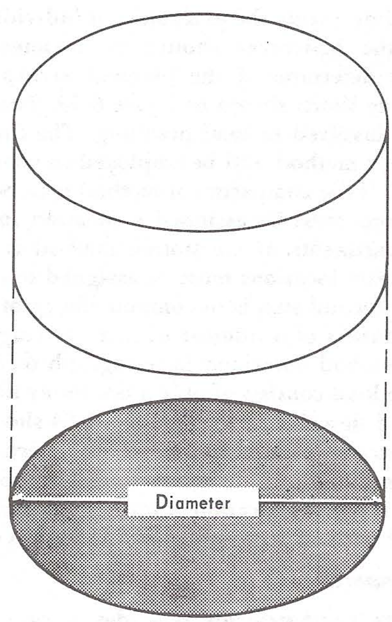


Rim Contact Area

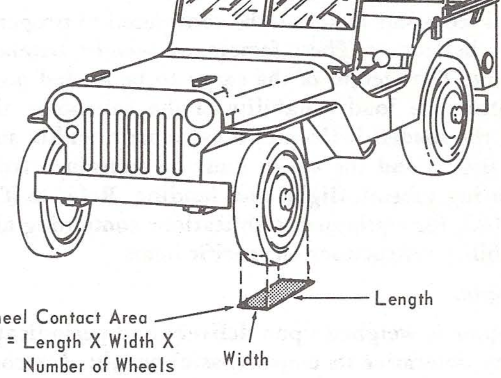
Area = .8 X Outside Diameter^2
Minus .8 X Inside Diameter^2

Note

The contact area can be quickly approximated by reducing the dimensions to the smallest whole foot. For example, if the box is 3–1/6 by 6–1/2 feet, reduce it to 3 by 6 feet for a quick approximation.



Circular Contact Area
Area = Diameter^2 X 0.8



Wheel Contact Area
Area = Length X Width X
Number of Wheels

Figure 6-20. Contact Pressure

wheels supporting the item. If the contact pressure of a cargo item exceeds floor strength limitations, it can still be loaded with the use of shoring, giving due consideration to helicopter load and center of gravity limits. (Refer to paragraph 6-86.)

6-75. Cargo Center of Gravity.

The center of gravity (cg) of each item of cargo must be determined in order to compute weight and balance by the station method. (Refer to paragraph 6-84.) As a rule, those items of cargo crated for transport will be marked with a cg. If the cg is not marked, it can be determined by simply balancing the item on a dowel or beam and marking the balancing point. To determine the cg of vehicles, the following formula is used:

$$\frac{\text{Rear Axle Weight x Wheel Base}}{\text{Vehicle Gross Weight}} = \text{Cg Distance in Inches From the Front Axle}$$

If the weight and balance is to be computed by the compartment method (refer to paragraph 6-84), the cg of each item is not required.

6-76. Vehicle Load.

The same general rules that are observed in cargo loading apply to vehicle loading. In addition, fuel tank caps, radiator caps, and battery filler caps should be checked and secured. Fuel tanks should be checked to see that they are not filled above three-quarters capacity. Air trapped in a fuel tank will expand at altitude and force fuel out through the filler neck, creating a fire hazard. If fuel tanks are filled to capacity, some fuel must be drained off before loading the vehicle. Also, check for excessive tire pressures and, if necessary, deflate tires to the prescribed limits.

6-77. Hazardous Cargo.

Items of cargo possessing dangerous physical properties, such as explosives, acids, flammables, etc., must be handled with extreme caution and in accordance with established regulations. Refer to TM 38-250.

6-78. General Instructions for Loading, Securing, and Unloading Cargo.

There are three prime factors to be considered in properly loading the helicopter. These factors are weight, balance, and restraint. The weight of the cargo to be loaded must remain within the load capability of the helicopter, the balance of the loaded helicopter must remain within safe operating limits, and the cargo must be restrained from shifting during takeoff, flight, and landing. Refer to TM 55-1500-210-L for equipment publications containing air-transportability instructions on specific items.

6-79. Weight.

The helicopter is weighed upon delivery and periodically thereafter to determine its empty (basic) weight. A record of helicopter weighing is maintained in Chart C of the Basic Weight and Balance Handbook. The last entry in Chart C reflects the current basic weight of the helicopter. To determine the allowable cargo load for a particular mission, the weights of the crew, the required fuel and oil, and other essential equipment, are added to the basic weight and the total subtracted from the helicopter alternate gross weight. (See Sample Form F, figure 6-3.) Obviously, the allowable payload weights will vary depending on the number of crewmembers assigned and the weight of fuel on board.

6-80. Balance.

The balance point, or center of gravity (cg), of the basic helicopter is established by calculation. Any weight added or removed from the helicopter will cause the cg to shift forward or aft unless the weight is added or removed at the cg. If the cg shifts too far forward or too far aft, it will cause the helicopter to develop unsafe flight characteristics. For this reason, particular attention must be given to the placement of cargo within the helicopter. In this helicopter the cg range is great enough to allow placement of most normal cargo loads anywhere in the cargo compartment without exceeding critical cg limits. (Refer to section II.) It is recommended, however, that the heaviest portion of the load always be located near the longitudinal center of the cargo compartment.

6-81. Restraint.

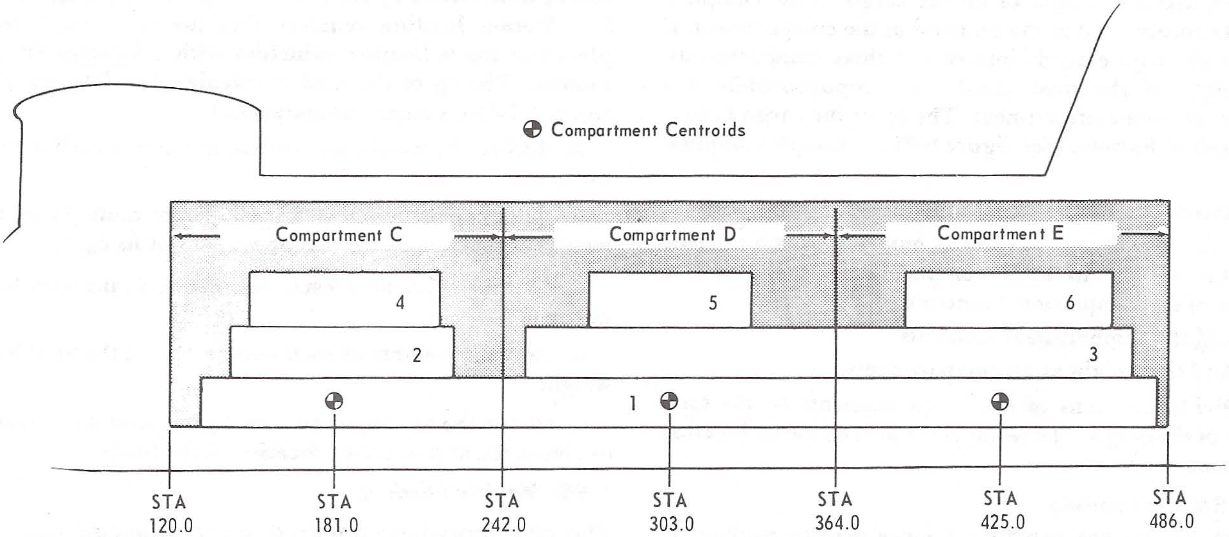
The items of cargo within the helicopter are subject to the same forces which affect the helicopter in flight. (Refer to paragraph 6-87 and 6-88.) These forces will cause the cargo to shift unless the cargo is restrained or tied down. Cargo must be restrained from shifting in order to maintain helicopter balance and prevent injury to personnel.

6-82. Load Planning.

Before loading cargo, the placement of individual items of cargo in the helicopter should be planned and then checked to determine if the planned arrangement falls within the cg limits shown in figure 6-29. There are three basic steps involved in load planning. The first step is to decide which method will be employed to compute the cg of the load. If the compartment method is to be used, each item of cargo must be assigned a location in one of the three compartments. If the station method is to be used, specific station locations must be assigned to each item of cargo. The second step is to compute the cg of the load. If the load consists of a number of items of cargo, the compartment method described in paragraph 6-83 should be used. If the load consists of only a few bulky items, the station method described in paragraph 6-84 should be used. The third step is to check figure 6-29 to determine if the cg falls within the allowable limits. If it does, the cargo can be loaded; if not, the location of individual items should be rearranged until an acceptable loading plan is obtained.

6-83. Compartment Loading.

Loading by compartments provides a rapid means of computing the cg of a load and can be used whenever the cargo load consists of a number of items. The helicopter cargo compartment is divided into three compartments. (See figure 6-21.) The centroid, or center of balance, of



Example

Problem: There are six items of cargo to be loaded. The weight of each item was found when the cargo was prepared for loading and is as follows:

Item 1	900 Pounds
Item 2	300 Pounds
Item 3	1,000 Pounds
Item 4	200 Pounds
Item 5	700 Pounds
Item 6	400 Pounds

The loading plan is to locate items 2 and 4 in compartment C, item 5 in compartment D, and item 6 in compartment E. Item 1 and 3 are long and will be loaded so 1/3 of item 1 will be in compartments C, D, and E and 1/2 of item 3 will be in compartments D and E. Compute the CG of the total load.

Solution: Since the load consists of several items, the compartment method is used to calculate the CG of the load. Refer to paragraph 6-83, for step by step instructions.

Total Moment = (Total wt in compartment C) 181 + (Total wt in compartment D) 303 + (Total wt in compartment E) 425 = (800 X 181) + (1,500 X 303) + (1,200 X 425) = 1,109,300

Weight in C
300 (1/3 wt of item 1)
300 (wt of item 2)
200 (wt of item 4)
Total Wt 800 Pounds in C

Weight in D
300 (1/3 wt of item 1)
500 (1/2 wt of item 3)
700 (wt of item 5)
Total Wt 1,500 Pounds in D

Weight in E
300 (1/3 wt of item 1)
500 (1/2 wt of item 3)
400 (wt of item 6)
Total Wt 1,200 Pound in E

Total Weight in Helicopter

800 in compartment C
1,500 in compartment D
1,200 in compartment E
3,500 Total

$$CG = \frac{\text{Total Moment}}{\text{Total Weight}} = \frac{1{,}109{,}300}{3{,}500} = 314 \text{ (Station)}$$

Now that the center of gravity of the total load has been computed, compute the helicopter center of gravity.

Figure 6-21. Compartment Loading

each compartment is located at station 181, 303, and 425, respectively. When using the compartment method, it is assumed that the weight of all the cargo in the compartment is concentrated at the centroid of the compartment. If an item of cargo extends into two or three compartments, the weight of the item should be proportionately distributed in each compartment. The cg of the cargo load is computed as follows: (See figure 6-21 for sample computation.)

a. Record the weight of cargo in each compartment.

b. Calculate the compartment moment by multiplying the total weight in each compartment by the station number of the compartment centroid.

c. Add the compartment moments.

d. Add the weight in all compartments.

e. Divide the sums of the cargo moments by the total weight of the cargo. The result is the arm or the cg location of the load.

6-84. Station Loading.

Loading by stations provides a more precise method of computing the cg of a load and should be used whenever possible. To use this method, it is necessary to know the cg of each item of cargo. If the cg of an item is not marked, it can be determined by the procedure given in paragraph 6-75.) Station loading requires that the cg of each item placed in the helicopter coincides with a fuselage station number. The cg of the load is calculated as follows: (See figure 6-22 for sample computation.)

a. Record the weight and station number of each item of cargo.

b. Calculate the moment of each item by multiplying the weight of the item by the station number of its cg.

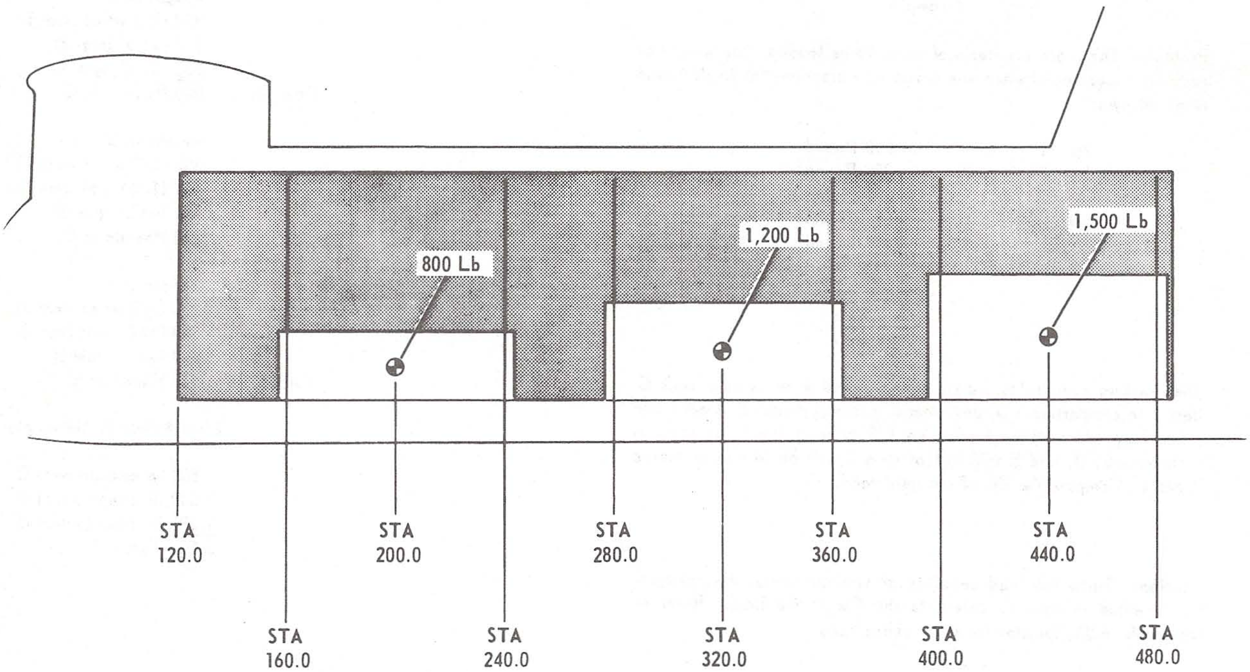
c. Add the moment of each item to obtain the total load moment.

d. Add the weights of each item to obtain the total load weight.

e. Divide the total load moment by the total load weight to obtain the arm or the cg location of the load.

6-85. Vehicle Loading.

The same procedures observed in cargo loading apply to vehicle loading. (Refer to paragraph 6-78 thru 6-84.)



Example

Problem: Three items of cargo are to be loaded into the helicopter. The weight and center of gravity of each item was found when the cargo was prepared for loading and is indicated above. The loading plan is to locate these items at stations 200, 320, and 440. Compute the CG of the total load.

Solution: Since there are only three items, the station method is used to calculate the CG of the load. Refer to paragraph 6-84, for step by step instructions.

	Weight X Station Number	Moment
Item 1	800 X 200	160,000
Item 2	1,200 X 320	384,000
Item 3	1,500 X 440	660,000

$$\text{CG of Load} = \frac{\text{Total Moment}}{\text{Total Weight}} \quad \frac{1,204,000}{3,500} = 344 \text{ (Station)}$$

Total Weight 3,500 Total Moment 1,204,000

Now that the center of gravity of the total load has been computed, compute the helicopter center of gravity.

Figure 6-22. Station Loading

6-86. Shoring.

Shoring is used to protect the cargo floor and to distribute load pressure over a greater area of the floor. Planking 1 inch or 2 inches thick is used for these purposes. The use of shoring can often make the difference between being able to carry a given load and not being able to; however, it is important not to exaggerate the effectiveness of shoring. The spreading effect of shoring is limited to an area which is developed by extending a line downward and outward from the perimeter of the load contact surface, at an angle of 45 degrees, until it intersects the surface on which the shoring rests. (See figure 6-23.) Thus the area over which the load is distributed is enlarged by the addition of a border equal in width to the thickness of the shoring. For example: shoring 2 inches thick under a box 12 inches square will add 112 inches to the original contact surface of 144 inches. Some vehicles have a tread width too narrow to allow the wheels to rest on the treadways. In this case, shoring must be used to reduce the contact pressure on the walkway to an allowable figure. In general, shoring is required for all wheeled platforms and dollies and for any item of cargo whose contact pressure exceeds the floor limitations described in paragraph 6-34 thru 6-39.

6-87. Securing Cargo.

The helicopter is subjected to forces which result from air turbulence, acceleration, rough or crash landings, and aerial maneuvers. These same forces act upon the cargo in the helicopter and tend to shift the cargo unless it is firmly secured. Forward motion of the helicopter is the most rapid movement that will be encountered and since the cargo moves at the same rate of speed as the helicopter, forward movement is the strongest force that is likely to act on the cargo if the helicopter is suddenly slowed or stopped in a crash landing. Other forces tending to shift the cargo aft, laterally, or vertically will be less severe. The amount of restraint required to keep the cargo from moving in any direction is called the restraint criterion and is expressed in units of the force of gravity, or g's. In each case, the maximum force exerted by the item of cargo to be restrained would be its normal weight times the number of g's of the restraint criteria. In order to safely carry cargo, the amount of restraint applied should equal or exceed the maximum amount of restraint required. Restraint is referred to by the direction in which it keeps the cargo from moving. Forward restraint keeps the cargo from moving forward, aft restraint keeps the cargo from moving aft, and so on.

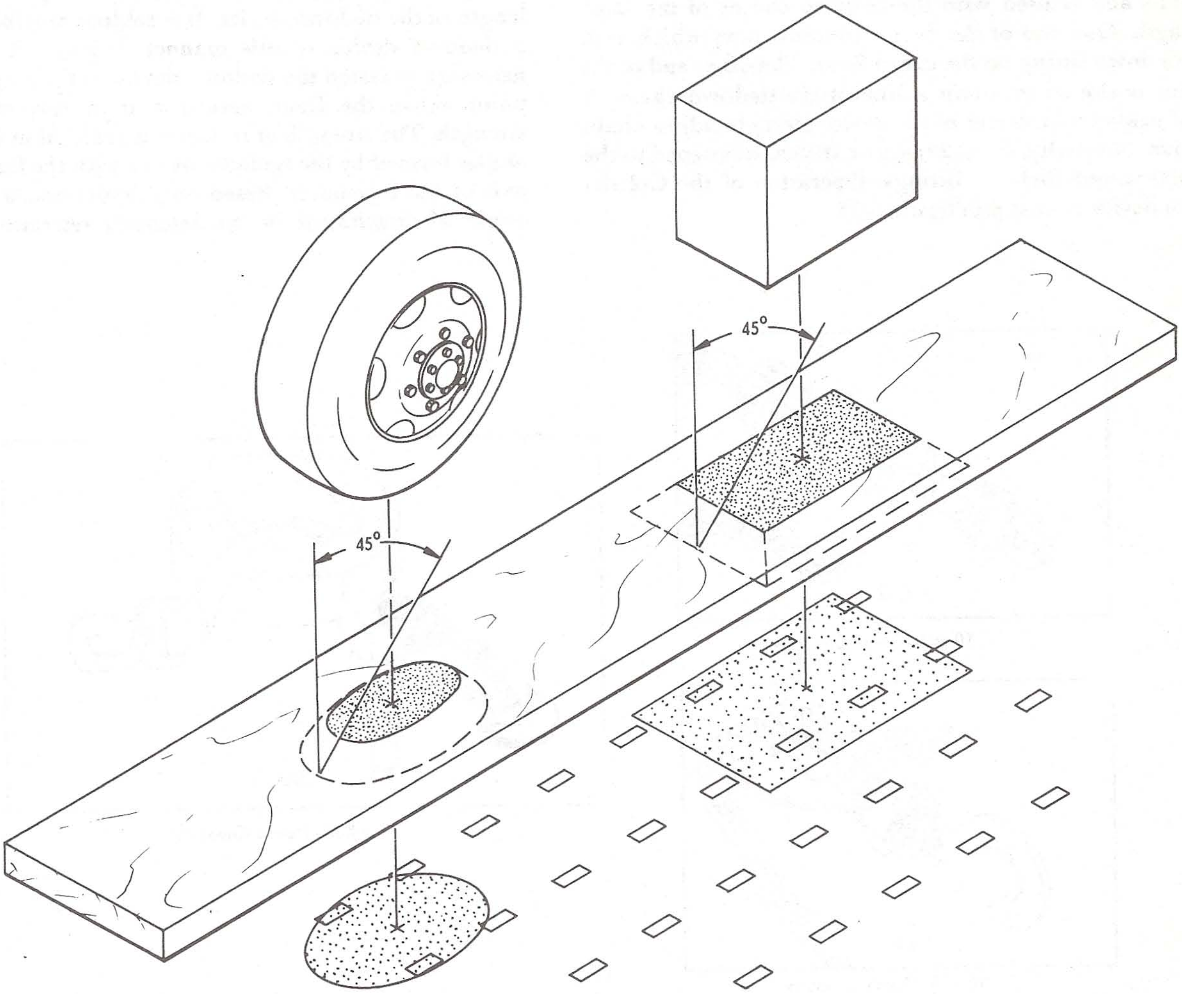


Figure 6-23. Effects of Shoring

6-88. Restraint Criteria.

The following restraint factors are ultimate values and the minimum acceptable factors for crew and passenger safety. (Refer to AR 705-35 for additional information.)

Direction	Restraint Criteria
Forward	4.0 g's
Aft	2.0 g's
Down	4.0 g's
Up	2.0 g's
Lateral	1.5 g's

6-89. Restraint Devices.

Three types of restraint devices are recommended for use in applying the required restraint to the cargo. These devices are commonly called tiedown devices and are shown in figure 6-24. Each tiedown device has a rated strength which is the load, or force, it is guaranteed to withstand. When a sufficient number of tiedown devices are correctly attached to the tiedown fittings on the cargo floor and to the cargo, the tiedown devices will restrain the cargo from moving in any direction within the helicopter.

6-90. C-2 Tiedown Device.

The C-2 tiedown device has a rated capacity of 10,000 pounds and is used with the tiedown chains of the same strength. One end of the device contains jaws which grip the tiedown fitting on the cargo floor. The other end of the device is slotted to admit a link of the tiedown chain. A turnbuckle in the center of the device serves to adjust chain tension. Normally, the C-2 tiedown device is fastened to the 10,000-pound tiedown fittings. Operation of the C-2 tiedown device is shown in figure 6-25.

6-91. MB-1 Tiedown Device.

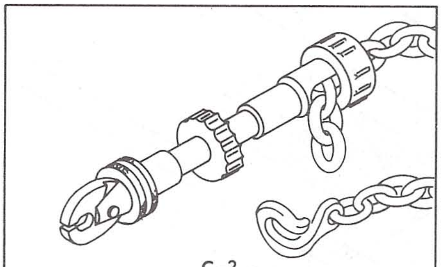
The MB-1 tiedown device is rated at 10,000 pounds and is used with tiedown chains of the same strength. At one end of the device is a hook which is attached to a tiedown fitting on the cargo floor; the other end of the device is slotted to admit a link of the tiedown chain and contains a levered quick-release fastener. Chain tension is adjusted by a turnbuckle in the center of the device. Normally, the MB-1 tiedown device is fastened to the 10,000-pound tiedown fittings. Operation of the MB-1 tiedown device is shown in figure 6-25.

6-92. CGU-1/B Tiedown Device.

The CGU-1/B tiedown device has a rated capacity of 5,000 pounds. It consists of a nylon strap with a fixed hook at one end and a hook equipped with a ratchet tightening device at the opposite end. Normally, the CGU-1/B tiedown device is fastened to the 5,000-pound tiedown fittings. Operation of the CGU-1/B tiedown device is shown in figure 6-25.

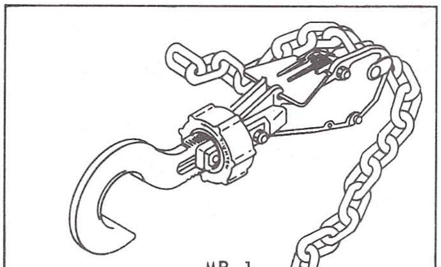
6-93. Effect of Tiedown Devices at Angles.

A tiedown device will withstand a force equal to its rated strength only when the force is exerted parallel to the length of the tiedown device. It is seldom possible to fasten a tiedown device in this manner. Instead, it is usually necessary to fasten the tiedown device to the cargo at some point above the floor, resulting in a loss of restraint strength. The strength of restraint is reduced in ratio to the angles formed by the tiedown device with the floor and the axis of the helicopter. Based on calculations, a 30 degree angle of attachment in the intended restraint direction



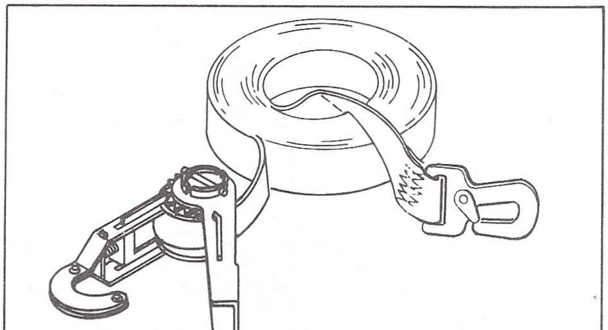
C-2

10,000–Pound Capacity



MB-1

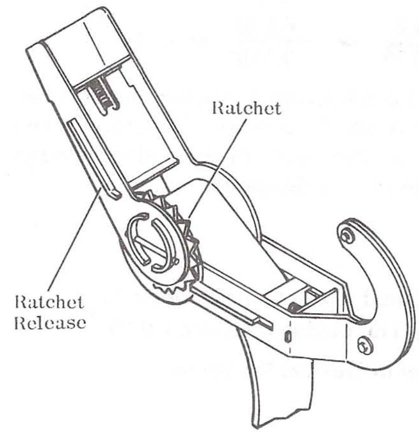
10,000–Pound Capacity



CGU-1B

5,000 –Pound Capacity

Figure 6-24. Tiedown Devices



CGU-1/B
TIEDOWN DEVICE

1. Hook tiedown device to tiedown fittings

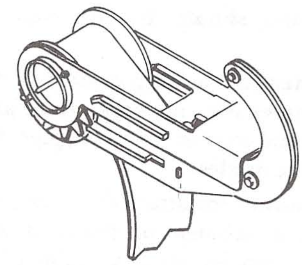
2. To secure cargo after both hooks are attached, pull strap webbing through the tightening device until approximately 4 inches of slack remains between hooks

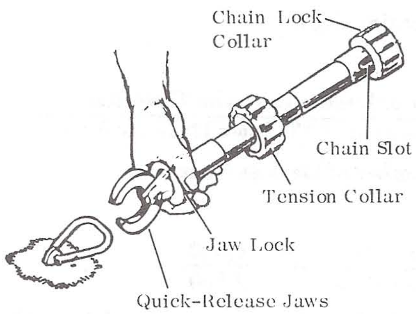
NOTE

Do not use any type of lever or mechanical means to assist hand ratcheting.

3. Hold the main web and the loose end of web with one hand and ratchet the tightening device with the other hand. This procedure will permit the webbing to wrap at least one full turn around the spindle of the tightening device. This procedure should provide sufficient friction to prevent slipping.

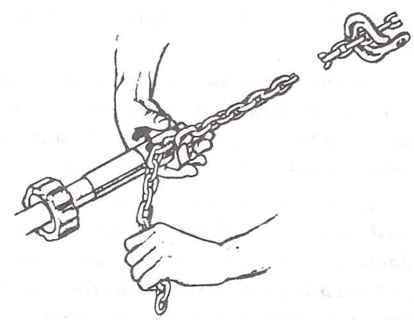
4. If slipping still occurs discontinue use of the tiedown device.

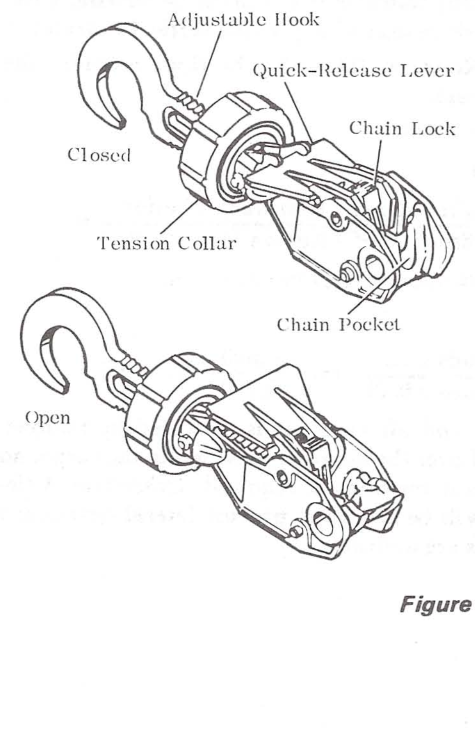




C-2
TIEDOWN DEVICE

1 Turn jaw lock to open quick-release jaws.
2 Turn jaw lock to close jaws on the tiedown fitting.
3 Turn chain locking collar to expose chain slot. Draw up chain until snug and insert in slot.
4 Turn chain locking collar to lock chain.
5 Rotate tension collar to tighten chain.





MB-1
TIEDOWN DEVICE

1 Extend adjustable hook by rotating tension grip.
2 Insert chain in chain pocket.
3 Push chain down until it bottoms and is sedured by the chain lock.
4 Rotate tension collar until chain is tight.
5 To release device under load pull up on quick release lever.

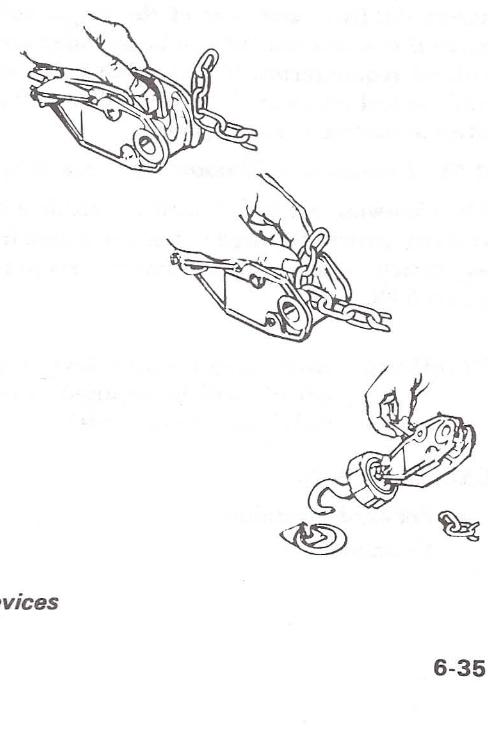


Figure 6-25. Operation of Tiedown Devices

causes a restraint loss of only 25 percent in that direction and is the most desirable angle. While causing a loss of restraint in one direction, imposing these angles on the tiedown device furnishes restraint in two other directions so that one tiedown device provides restraint in three directions simultaneously. Thus, a tiedown device applied to provide forward restraint at angles of 30 degrees also furnishes approximately 50 percent of its rated strength in lateral and vertical restraint.

6-94. Rules for Application of Tiedown Devices.

These rules should be followed when using tiedown devices.

a. Fasten the tiedown devices so that they form an angle of 30 degrees with the cargo floor and 30 degrees with the longitudinal axis of the helicopter. Come as close as possible to these angles.

b. Consider the strength of the tiedown fittings and the points of attachment on the load. A tiedown device is no stronger than its weakest point of attachment. Tiedown devices attached to the same tiedown fitting to provide restraint in one direction lose half their rated strength. A 10,000-pound tiedown device attached to a 5,000-pound tiedown fitting will only provide 5,000 pounds of restraint. Axles, towhooks, bumper supports, and vehicle frames are good points of attachment for securing most vehicles. Since general cargo items may not have points of attachment, the tiedown devices will be applied over or across the cargo items.

c. It is desirable to use an even number of tiedown devices to maintain a symmetrical pattern. However, should there be a limited supply, it may be necessary to use an uneven number of tiedown devices.

d. Calculate the number of tiedown devices required for forward and aft restraints. If the tiedown devices providing forward and aft restraint are criss-crossed over the cargo, then adequate restraint in the lateral and vertical directions will automatically be provided. If the tiedown devices providing forward and aft restraint are applied across the front and rear of the cargo, then lateral and vertical restraint will have to be provided according to calculated requirements. Vehicles will have sufficient lateral and vertical restraint if the forward and aft restraint is applied according to rules a. and c.

6-95. Calculation of Tiedown Devices Required.

The following method is used to calculate the number of tiedown devices required to restrain a load from moving in any direction, using the restraint criteria provided in paragraph 6-88.

PROBLEM: How many tiedown devices rated at 5,000 pounds will be required to restrain a load weighing 4,000 pounds?

CALCULATION:

a. Forward Restraint:

(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.75}} = \text{Number of Devices Required}$$

(Solution)

$$\frac{\text{4,000 pounds x 4.0}}{\text{5,000 pounds x 0.75}} = \frac{16{,}000}{3{,}750} = 4.2$$

Since the equation yields a fractional number, this number is increased to the next whole number. Therefore, 5 tiedown devices will be required to provide forward restraint; 6 tiedown devices are desirable.

b. Aft Restraint:

(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.75}} = \text{Number of Devices Required}$$

(Solution)

$$\frac{\text{4,000 pounds x 2.0}}{\text{5,000 pounds x 0.75}} = \frac{8{,}000}{3{,}750} = 2.1$$

Since the equation yields a fractional number, this number is increased to the next whole number. Therefore, 3 tiedown devices will be required; 4 tiedown devices are desirable.

c. Vertical Restraint (Up):

(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.50}} = \text{Number of Devices Required}$$

(Solution)

$$\frac{\text{4,000 pounds x 2.0}}{\text{5,000 pounds x 0.50}} = \frac{8{,}000}{2{,}500} = 3.2$$

If the forward and aft restraint is provided by tiedown devices applied over the cargo or attached to the cargo, no additional vertical restraint is required. Otherwise, 4 tiedown devices will be needed to provide vertical restraint.

d. Vertical Restraint (Down): The floor provides the downward restraint.

e. Lateral Restraint:

(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.45}} = \text{Number of Devices Required}$$

(Solution)

$$\frac{\text{4,000 pounds x 1.5}}{\text{5,000 pounds x 0.45}} = \frac{6{,}000}{2{,}250} = 2.6$$

If the forward and aft restraint is provided by tiedown devices applied over the cargo or attached to the cargo, no additional lateral restraint is required. Otherwise, 3 tiedown devices will be needed to provide lateral restraint; 4 tiedown devices are desirable.

6-96. Tiedown Methods.

Methods of applying restraint will vary depending on the type of cargo making up the load. Vehicles, crated objects, and assorted items of general cargo will require different methods of application.

CAUTION

Excessive tightening of the tiedown straps attached to the outboard row of tiedown fittings will limit the effectiveness of the isolated floor.

6-97. Vehicle Tiedown.

Because of the numerous points of attachment available, vehicles are the items of cargo easiest to tiedown. Chain devices such as the C-2 or MB-1 should be used to restrain vehicle loads. (See figure 6-24.) These devices should be fastened to the 10,000-pound tiedown fittings whenever possible. Vehicle tiedowns must include restraint for:

a. The sprung portion of the vehicle, which consists of everything above the springs, such as frame, body, cab, load bed, and any cargo in the vehicle.

b. The unsprung portion of the vehicle, which consists of everything below the springs, such as the wheels, axles, and the springs. Cargo in the vehicle must be considered as a separate item and must be securely fastened to the vehicle.

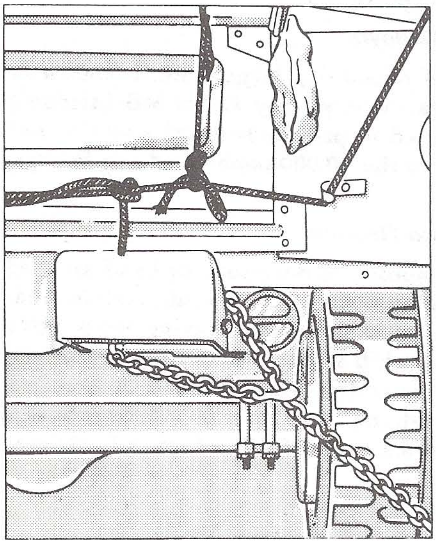
c. See figure 6-26 for typical methods of restraining the sprung and unsprung portions of a vehicle.

6-98. Bulk Cargo Tiedown.

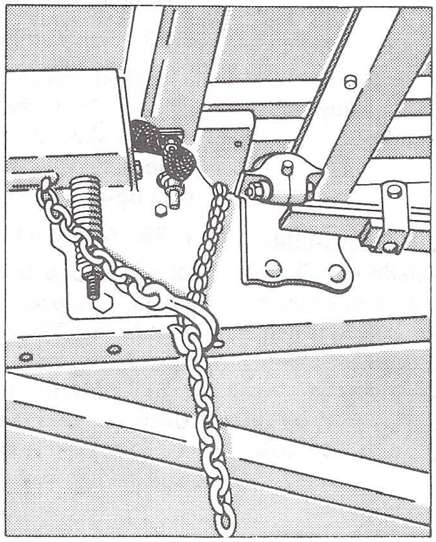
A typical method of restraining large crates is shown in figure 6-27. If the crate is very heavy, C-2 or MB-1 tiedown devices should be used to provide forward restraint and should be fastened to the 10,000-pound tiedown fittings. (See figure 6-12.)

6-99. General Cargo Tiedown.

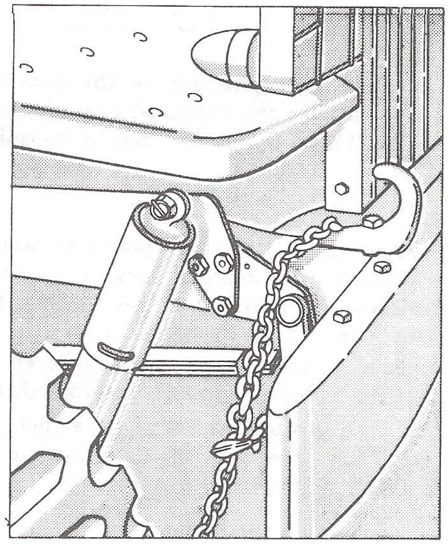
When a load is composed of numerous items of assorted cargo, it is practically impossible to restrain each item individually. The most suitable method of tying down such a load is to apply CGU-1/B straps over the assembled load longitudinally and laterally (See figure 6-27.) To effectively use this method, the cargo must be loaded in such a way that the assembled items of cargo form a fairly even outline.



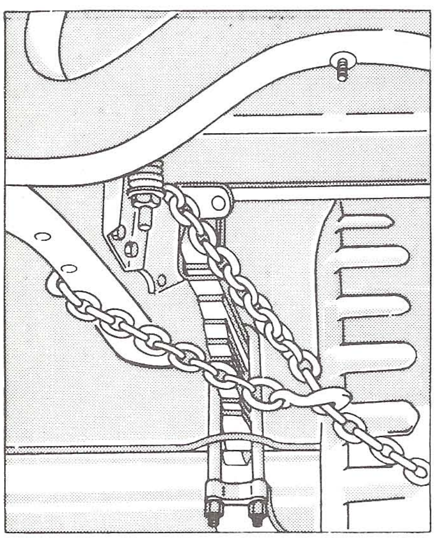
Around Rear Bumperette (Sprung)



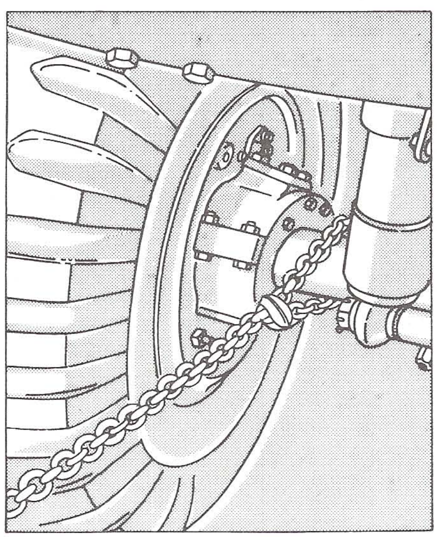
Over Frame and Under Cross Member (Sprung)



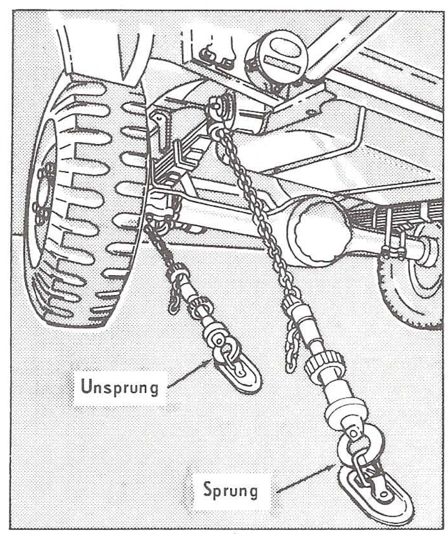
Around Frame, Aft of Bumper (Sprung)



Around Frame (Sprung)

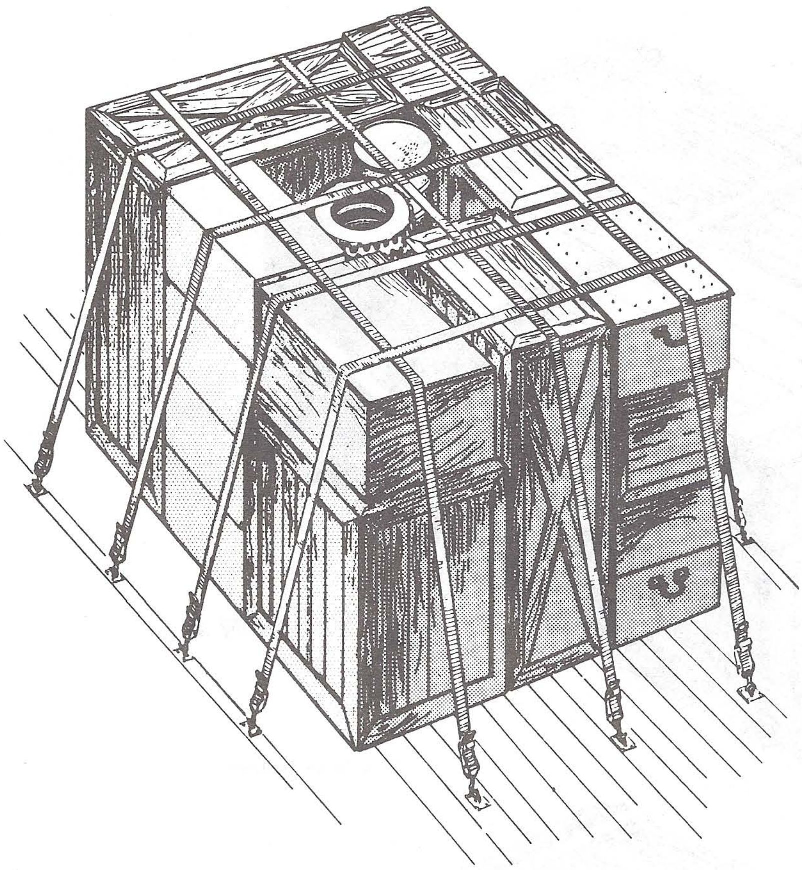


Around Axle (Unsprung)



C-2 Tiedowns Attached To Floor Fittings

Figure 6-26. Restraining Sprung and Unsprung Vehicles



VIEW 1
General Cargo Tiedown

VIEW 2
Vehicle Tiedown

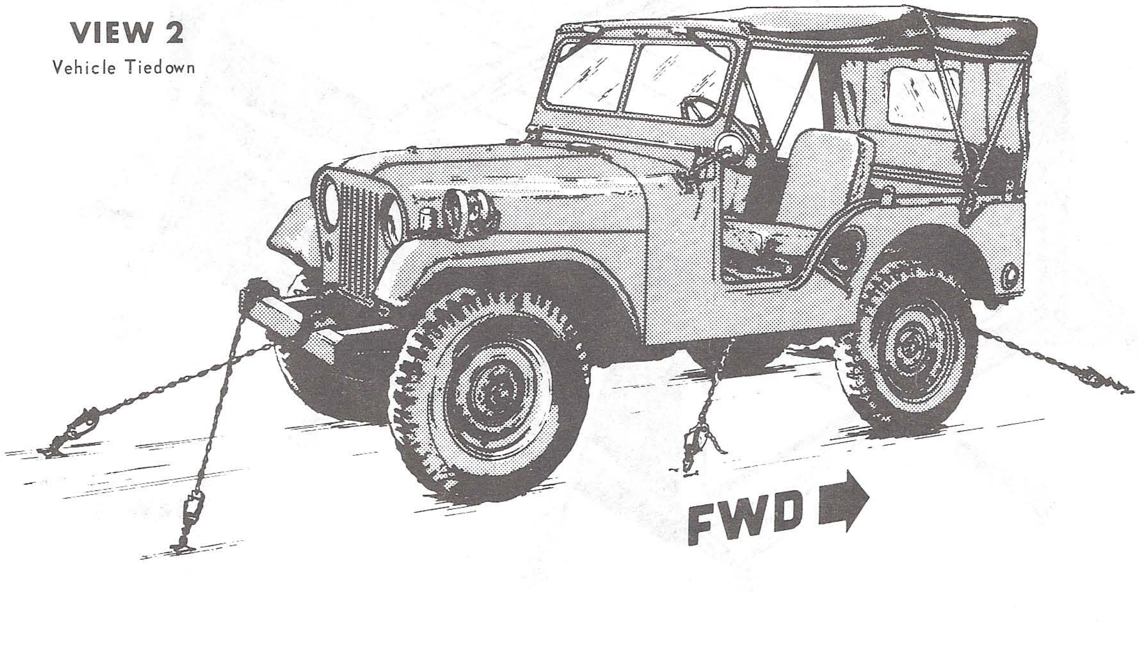
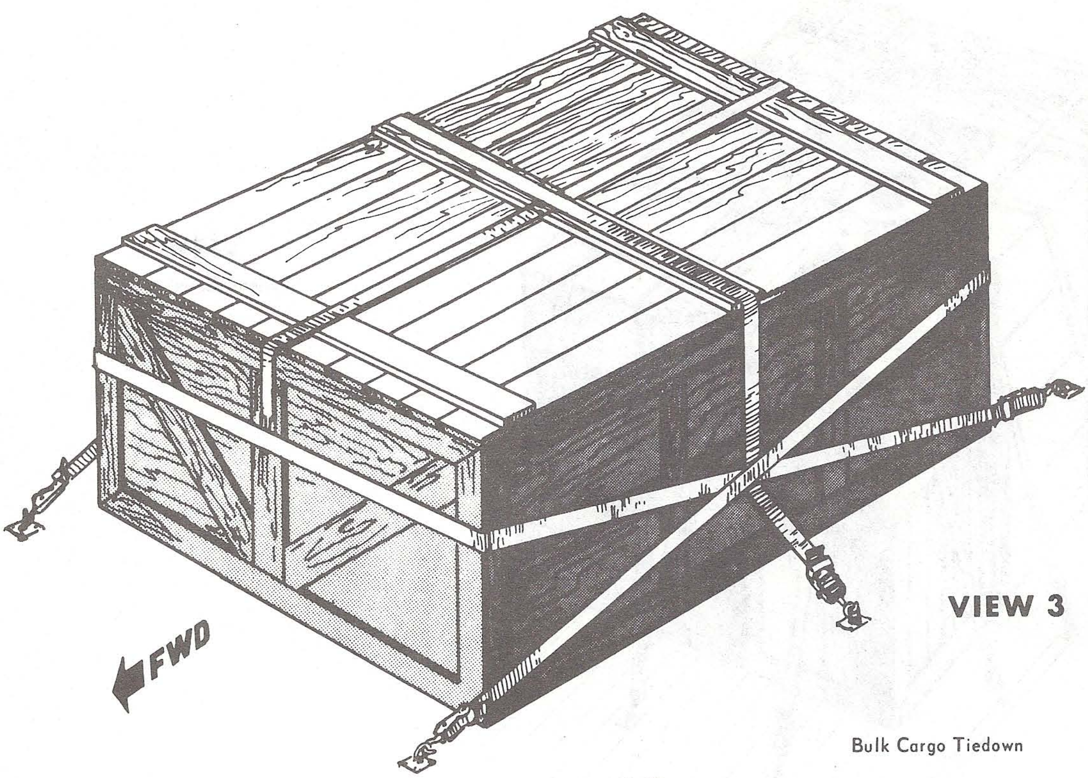


Figure 6-27. Typical Tiedown Methods (Sheet 1 of 2)



Bulk Cargo Tiedown

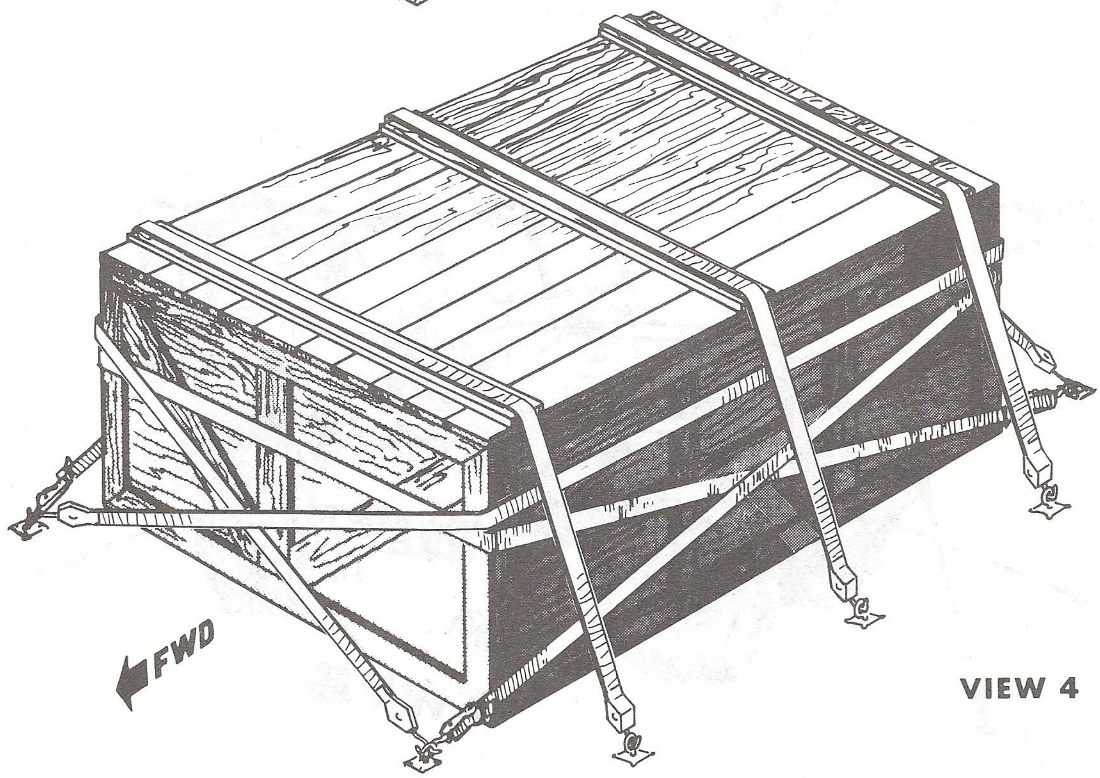


Figure 6-27. Typical Tiedown Methods (Sheet 2 of 2)

SECTION VI FUEL/OIL

6-100. Fuel and Oil Data.

The CH-47A is equipped with two fuel tanks and an integral oil tank on each engine. The capacities of each fuel tank and each engine oil tank are given in table 2-2.

6-101. Fuel Weight and Moment.

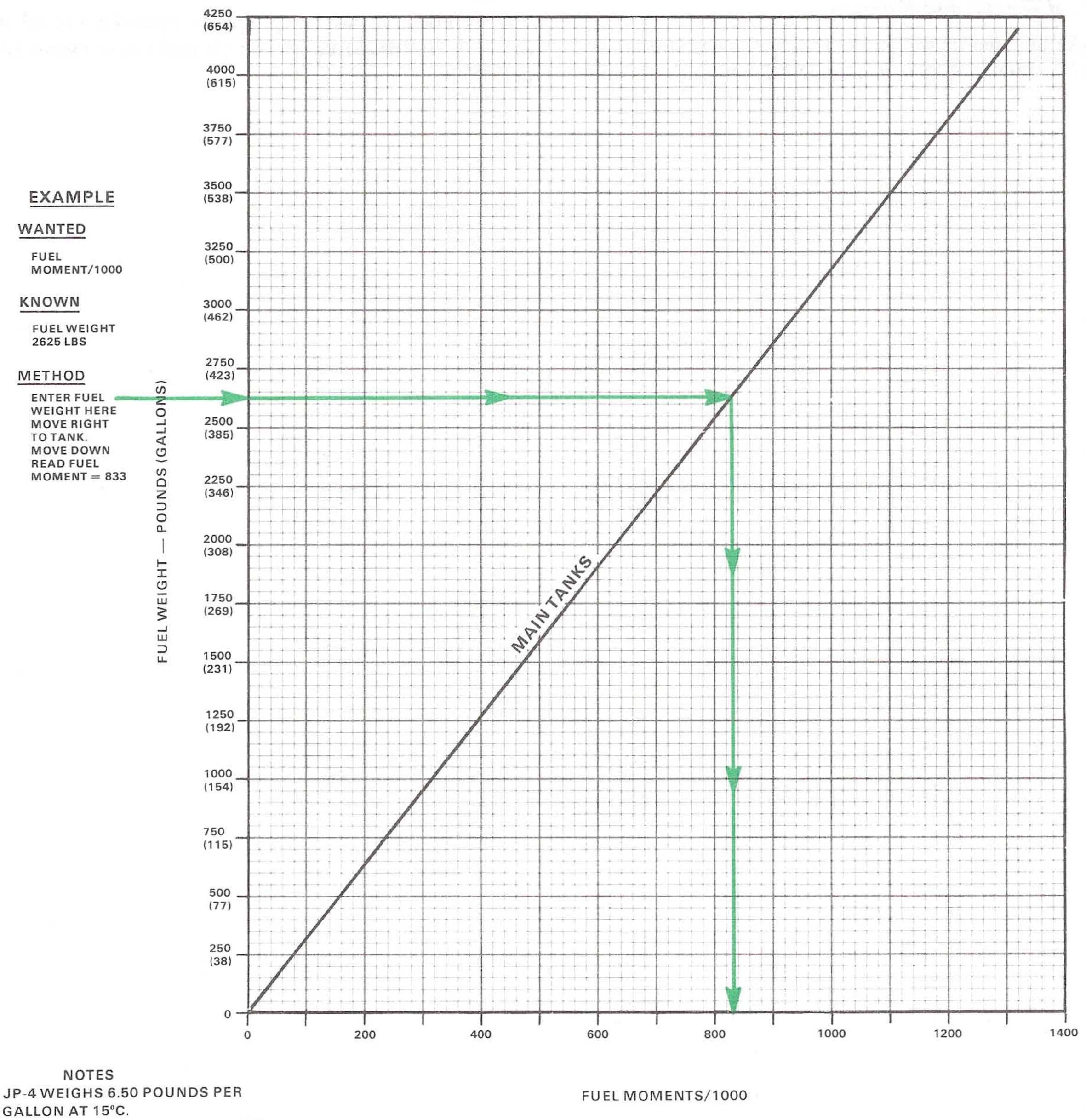
Fuel weight and moments for the fuel tanks are shown on figure 6-28. Fuel weight is presented in gallons and pounds based on JP-4 fuel at 6.5 pounds per gallon. To determine the fuel moment, enter the chart at the total fuel weight in both tanks, proceed right to the tank line, then down to read the fuel moment. See example on figure 6-28.

6-102. Oil Data.

For weight and balance purposes, consider the oil weight for both engines to be 28 pounds and the moment/1,000 to be 13.5.

FUEL MOMENT
CH-47A

FUEL MOMENT



NOTES

1. JP-4 WEIGHS 6.50 POUNDS PER GALLON AT 15°C.
2. INDEX MARKS ARE IN EACH TANK TO DENOTE VARIOUS FUEL QUANTITIES.

Figure 6-28. Fuel Moment Chart

SECTION VII LOADING LIMITS

6-103. General.

The loading limits are depicted on figure 6-29. Using loading technique specified in this chapter, it would be difficult to exceed these limits.

316-520 O - 80 - 14

CENTER OF GRAVITY LIMITS

(SHEET 1)

C.G. LIMITS
CH-47A

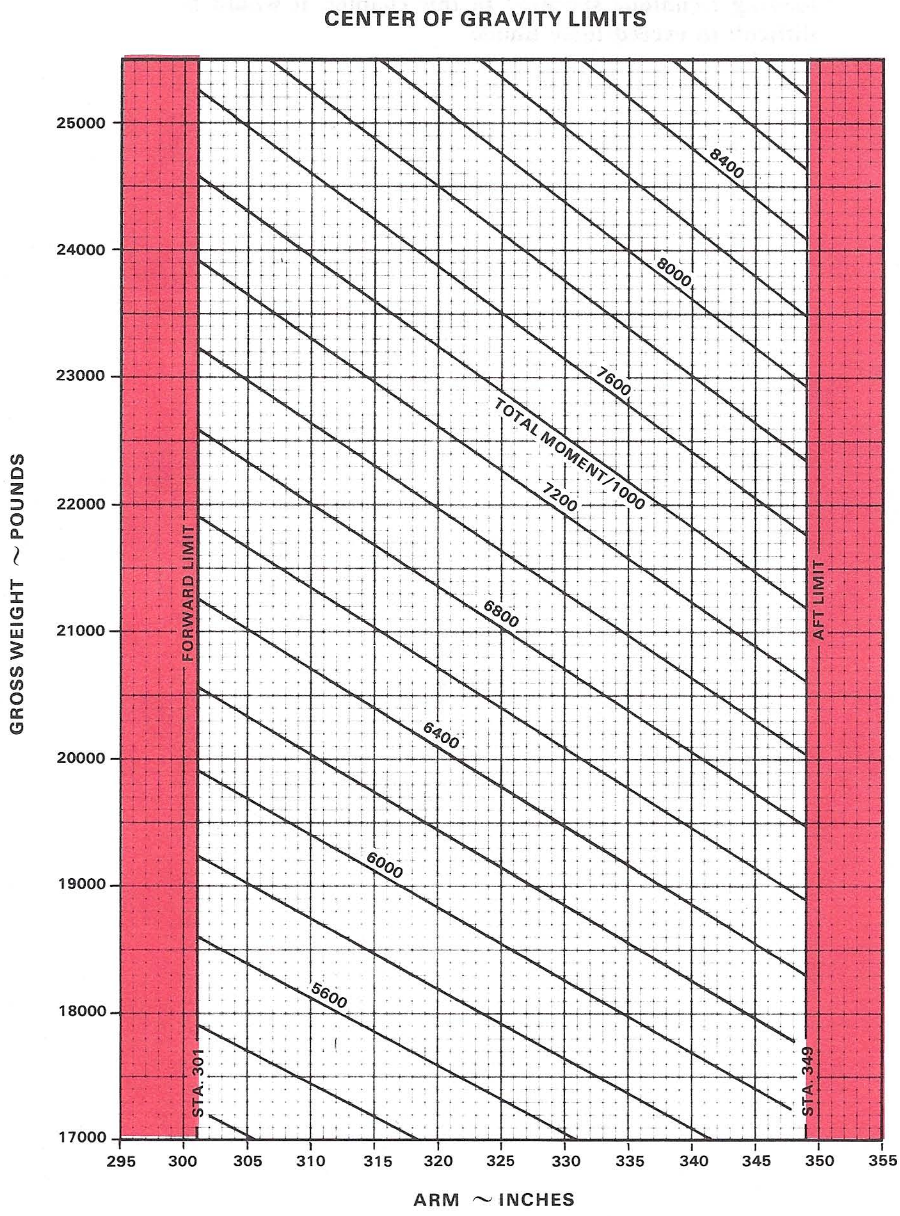


Figure 6-29. Allowable Loading Limits Chart (Sheet 1 of 2)

CENTER OF GRAVITY LIMITS

(SHEET 2)

C.G. LIMITS
CH-47A

EXAMPLE

WANTED
DETERMINE IF LOADING LIMITS ARE EXCEEDED AND DETERMINE C.G. POSITION

KNOWN
GW = 30450 LBS.
MOMENT/1000 = 9500

METHOD
ENTER GROSS WEIGHT HERE. MOVE RIGHT TO TOTAL MOMENT = 9500. READ LOAD WITHIN LIMITS. MOVE DOWN, READ ARM = 312.0

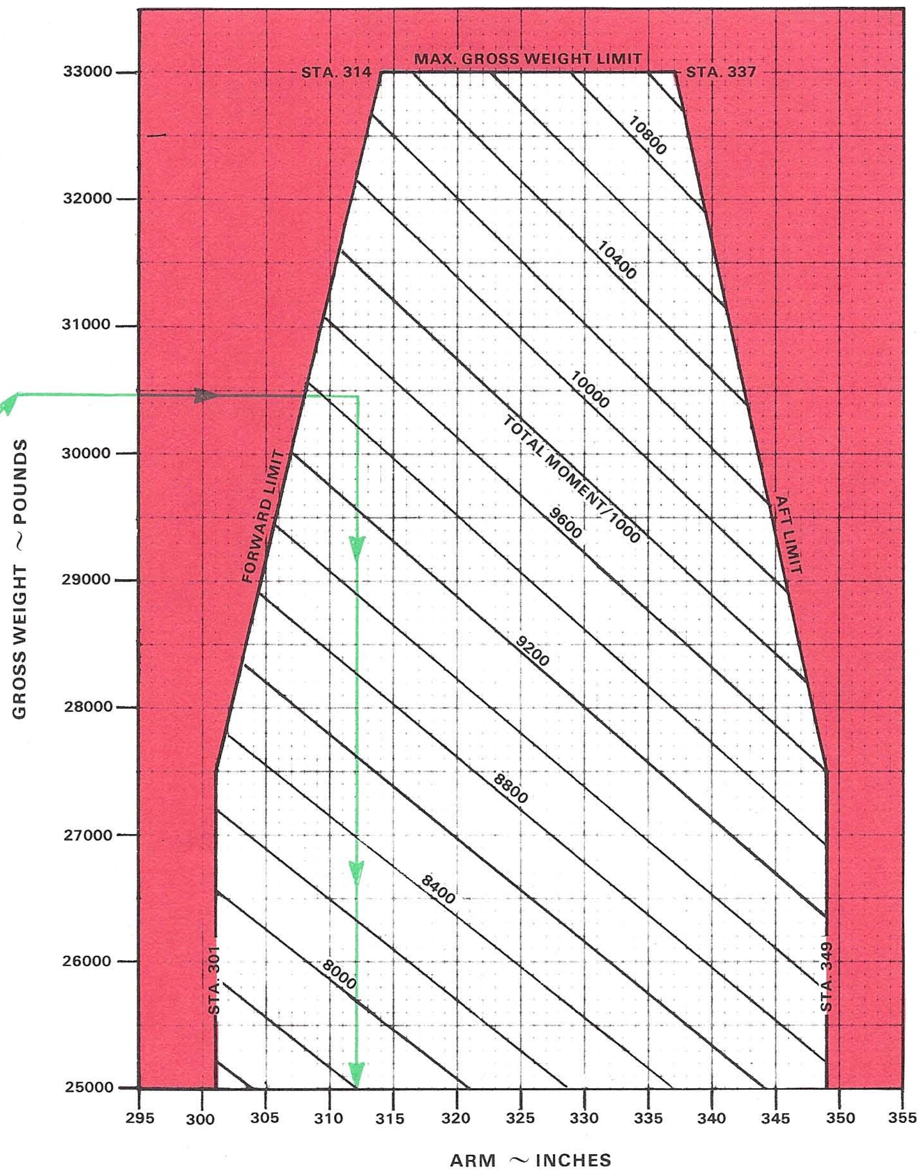


Figure 6-29. Allowable Loading Limits Chart (Sheet 2 of 2)

CHAPTER 7
PERFORMANCE DATA

SECTION I INTRODUCTION

7-1. Purpose.

The purpose of this chapter is to provide the best available performance data for the CH-47A helicopter. Regular use of this information will enable you to receive maximum safe utilization from the aircraft. Although maximum performance is not always required, regular use of this chapter is recommended for the following reasons.

a. Knowledge of your performance margin will allow you to make better decisions when unexpected conditions or alternate missions are encountered.

b. Situations requiring maximum performance will be more readily recognized.

c. Familiarity with the data will allow performance to be computed more easily and quickly.

d. Experience will be gained in accurately estimating the effects of variables for which data are not presented.

NOTE

The information provided in this chapter is primarily intended for mission planning and is most useful when planning operations in unfamiliar areas or at extreme conditions. The data may also be used inflight, to establish unit or area standard operating procedures, and to inform ground commanders of performance/risk tradeoffs.

7-2. Chapter 7 Index.

The following index contains a list of the sections and their titles, the figure numbers, subjects, and page numbers of each performance data chart contained in this chapter. The data in Sections III thru XI are presented in two parts: the first part applies to those helicopters with T55-L-7/7B engines. The second part applies to those helicopters with T55-L-7C engines.

CHAPTER 7 INDEX

CHAPTER 7 INDEX — Continued

7-3. General Data.

The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of altitude, temperature, gross weight, and other parameters relating to that phase of flight are presented. In addition to the presented data, your judgment and experience will be necessary to accurately obtain performance under a given set of circumstances. The conditions for the data are listed under the title of each chart. The effects of different conditions are discussed in the text accompanying each phase of performance. Where practical, data are presented at conservative conditions. However, NO GENERAL CONSERVATISM HAS BEEN APPLIED. All performance data presented are within the applicable limits of the aircraft.

CAUTION

Exceeding operating limits can cause permanent damage to critical components. Over limit operation can decrease performance, cause immediate failure, or failure on a subsequent flight.

7-4. Limits.

Applicable limits are shown on the charts as red lines. Performance generally deteriorates rapidly beyond limits. If limits are exceeded, minimize the amount and time. Enter the maximum value and time above limits on DA Form 2408-13 so proper maintenance action can be taken.

7-5. Use of Charts.

a. Chart Explanation. The first page of each section describes the chart(s) and explains its use.

b. Color Coding. Chart color codes are used as follows.

(1) Green is used for example guidelines.

(2) Red is used for limit lines.

(3) Yellow is used for precautionary or time-limited operation.

c. Reading the Charts. The primary use of each chart is given in an example and a green guideline is provided to help you follow the route thru the chart. The use of a straight edge (ruler or page edge) and a hard fine point pencil is recommended to avoid cumulative errors. The majority of the charts provide a standard pattern for use as follows: enter first variable on top left scale, move right to the second variable, deflect down at right angles to the third variable, deflect left at right angles to the fourth variable, deflect down, etc. until the final variable is read out at the final scale. In addition to the primary use, other uses of each chart are explained in the text accompanying each set of performance charts. Colored registration blocks located at the bottom and top of each chart are used to determine if slippage has occurred during printing. Letter codes (G, green; R, red; and Y, yellow) adjacent to the upper or lower registration blocks are used to indicate whether the colors have been printed in their intended positions. If slippage has occurred, or if colors are printed incorrectly, refer to chapter 5 for correct operating limits.

NOTE

An example of an auxiliary use of the charts referenced above is as follows: Although the hover chart is primarily arranged to find torque required to hover, by entering torque available as torque required, maximum wheel height for hover can also be found. In general, any single variable can be found if all others are known. Also, the tradeoffs between two variables can be found. For example, at a given pressure altitude, you can find the maximum gross weight capability as free air temperature changes.

d. Dashed Line Data. Data beyond conditions for which tests were conducted are shown as dashed lines.

7-6. Data Basis.

The type of data used is indicated at the bottom of each performance chart under DATA BASIS. The data provided generally is based on one of four categories:

a. Flight Test Data. Data obtained by flight test of the aircraft by experienced flight test personnel at precise conditions using sensitive calibrated instruments.

b. Derived From Flight Test. Flight test data obtained on a similar rather than the same aircraft and series. Generally small corrections will have been made.

c. Calculated Data. Data based on tests, but not on flight test of the complete aircraft.

d. Estimated Data. Data based on estimates using aerodynamic theory or other means but not verified by flight test.

7-7. Specific Conditions.

The data presented are accurate only for specific conditions listed under the title of each chart. Variables for which data are not presented, but which may affect that phase of performance, are discussed in the text. Where data are available or reasonable estimates can be made, the amount that each variable affects performance will be given.

7-8. General Conditions.

In addition to the specific conditions, the following general conditions are applicable to the performance data.

a. Rigging. All airframe and engine controls are assumed to be rigged within allowable tolerances.

b. Pilot Technique. Normal pilot technique is assumed. Control movements should be smooth and continuous.

c. Aircraft Variation. Variations in performance between individual aircraft are known to exist; however, they are considered to be small and cannot be accounted for individually.

d. Instrument Variations. The data shown in the performance charts do not account for instrument inaccuracies or malfunctions.

e. Airspeed Calibrations. The airspeed calibration chart presents the difference between indicated and calibrated airspeeds for different flight conditions.

f. Except as noted, all data is for a clean configuration (all doors installed, without armament).

7-9. Performance Discrepancies.

Regular use of this chapter will allow you to monitor instruments and other aircraft systems for malfunction, by comparing actual performance with planned performance. Knowledge will also be gained concerning the effects of variables for which data are not provided, thereby increasing the accuracy of performance predictions.

7-10. Definitions of Abbreviations.

a. Capitalization and punctuation of abbreviations varies, depending upon the context in which they are used. In general, lower case abbreviations are used in text material, whereas abbreviations used in charts and illustrations appear in full capital letters. Periods do not usually follow abbreviations; however, periods are used with abbreviations that could be mistaken for whole words if the period were omitted.

b. The following list provides definitions for abbreviations used in this chapter. Abbreviations used elsewhere in this manual are found in appendix B of this manual. The same abbreviation applies for either singular or plural applications.

List of Abbreviations

Abbreviations	*Definitions*
ALT	Altitude
AS	Airspeed
AVAIL	Available
C	Celsius
ENG	Engine
EXT	External
F	Fahrenheit
FAT	Free Air Temperature
FL	Flow
FPM	Feet Per Minute
FT	Feet
GR WT	Gross Weight
Hg	Mercury
HGT	Height
IAS	Indicated Airspeed
IGE	In Ground Effect
IN.	Inch
KN	Knots

List of Abbreviations — Continued

Abbreviations	*Definitions*
LB	Pound
LB-FT	Pound Feet
LB/HR	Pounds Per Hour
LG	Length
LVL	Level
MAX	Maximum
MIL	Military
MIN	Minute, Minimum
N1	Gas Generator Speed
N2	Power Turbine Speed
OBST	Obstacle
OGE	Out of Ground Effect
PRESS.	Pressure
R/C	Rate of Climb
R/D	Rate of Descent
RPM	Revolutions Per Minute
SL	Sea Level
SPEC	Specification
SQ FT	Square Feet
TAS	True Airspeed
TEMP	Temperature
TRQ	Torque
Vne	Velocity Never Exceed
WT	Weight

SECTION II PERFORMANCE PLANNING

7-11. General.

This section of the manual contains a performance planning card, a temperature conversion chart, and information needed for use of the performance planning card. The performance planning card (figure 7-1) is provided to assist the pilot in recording data applicable to the mission and may be reproduced at the local level.

7-12. Performance Planning Procedure.

The following sequence is provided to aid the pilot in preparing the performance card.

a. Departure.

(1) Calculate and record the departure gross weight. Refer to chapter 6 for weight and balance information and restrictions.

(2) Determine and record mission fuel.

(3) Determine and record external load characteristics, weight and drag. These characteristics can be found in figure 7-30 for T55-L-7/7B engines or figure 7-31 for engines T55-L-7C.

(4) Determine departure point pressure altitude by setting 29.92 in. Hg at the altimeter barometric pressure scale and reading pressure altitude from the altimeter. Record in space provided. Estimate pressure altitudes for climb, cruise, and arrival by adding altitude increase above departure elevation (if destination is below departure elevation, subtract the difference in elevation). Record pressure altitudes in spaces provided under climb, cruise, and arrival headings.

(5) Obtain free air temperature from free air temperature gage; record in space provided under departure heading. Estimate FAT for climb, cruise, and arrival by subtracting 2 degrees C for each 1000 feet of altitude above departure point (if destination is below departure elevation, add 2 degrees C for each 1000 feet decrease in elevation). Record temperature in spaces provided under climb, cruise, and arrival headings. If required, refer to figure 7-2 for temperature conversion from Fahrenheit to Celsius and vice versa.

(6) Determine idle fuel flow from figure 7-36 for T55-L-7/7B engines or figure 7-37 for T55-L-7C engines and enter in space provided.

(7) Determine and record field length and obstacle height at flight origin.

(8) Determine rotor rpm at departure point and record in space provided.

(9) Determine and record maximum torque available from figure 7-3 for T55-L-7/7B engines or figures 7-4 or 7-5 for T55-L-7C engines.

(10) Determine and record fuel flow from cruise

charts at the appropriate altitude and temperature (see figures 7-13 thru 7-20 for T55-L-7/7B engines or figures 7-22 thru 7-29 for T55-L-7C engines).

(11) Record desired ige hover height (10-foot minimum). With external loads, ige hover height must provide a 10-foot minimum load height.

(12) Determine and record torque required to hover at desired ige height. Refer to figure 7-8 for T55-L-7/7B engines or figure 7-9 for T55-L-7C engines.

(13) Determine and record ige hover fuel flow from cruise charts, figure 7-13 thru 7-20 for T55-L-7/7B engines or figures 7-22 thru 7-29 for T55-L-7C engines.

(14) Using maximum torque available, determine and record maximum hover height. Refer to figure 7-8 for T55-L-7/7B engines or figure 7-9 for T55-L-7C engines.

(15) If maximum hover height is oge, determine torque required to hover oge (figure 7-8 for T55-L-7/7B engines or figure 7-9 for T55-L-7C engines) and determine and record oge fuel flow from cruise charts at appropriate altitude and temperature (figures 7-13 thru 7-20 for T55-L-7/7B engines or figures 7-22 thru 7-29 for T55-L-7C engines).

(16) Using level acceleration takeoff technique, record climbout airspeed from takeoff charts (figure 7-10 for T55-L-7/7B engines or 7-11 for T55-L-7C engines) that will allow helicopter to safely clear obstacle.

b. Climb.

(1) Determine and record gross weight at start of climb.

(2) Determine and record indicated airspeed for best rate of climb from cruise charts, figures 7-12 thru 7-20 for T55-L-7/7B engines or 7-22 thru 7-29 for T55-L-7C engines.

(3) Determine torque available per engine by referring to torque available charts, figure 7-3 or 7-6 for T55-L-7/7B engines or figures 7-4, 7-5, or 7-7 for T55-L-7C engines. Observe applicable time limitations.

(4) Determine and record level flight torque required at airspeed for maximum rate of climb from cruise charts found in figures 7-13 thru 7-20 for T55-L-7/7B engines and 7-22 thru 7-29 for T55-L-7C engines (include change in torque required for external load if appropriate).

(5) Calculate change in torque required for desired rate of climb or maximum rate of climb (maximum torque available minus level flight torque) and record.

(6) Determine and record rate of climb from figure 7-32 for T55-L-7/7B engines or figure 7-33 for T55-L-7C engines.

(7) Determine and record fuel flow from cruise charts, figures 7-13 thru 7-20 for T55-L-7/7B engines or figures 7-22 thru 7-29 for T55-L-7C engines. Use total torque required for climb.

c. Cruise (Planned Performance).

(1) Determine and record cruise gross weight by subtracting fuel consumed prior to start of cruise from climb gross weight.

(2) Determine and record fuel available by subtracting fuel consumed prior to cruise from fuel at departure.

(3) Select and record rotor rpm.

(4) Determine and record from cruise charts, figures 7-13 thru 7-20 for T55-L-7/7B engines or figures 7-22 thru 7-29 for T55-L-7C engines the following: torque per engine (include change in torque for external load), indicated airspeed, true airspeed, and fuel flow.

d. Cruise (Maximum Performance).

(1) Determine and record airspeed limit at cruise gross weight and altitude with programmed cyclic trim from chapter 5.

(2) Determine and record airspeed limit at cruise gross weight and altitude with retracted cyclic trim from chapter 5.

(3) Determine and record maximum torque available from figure 7-3 for T55-L-7/7B engines or figure 7-4 for T55-L-7C engines.

(4) Determine and record ias, tas, and fuel flow at maximum torque or airspeed limit (whichever is less) from cruise charts, figures 7-13 thru 7-20 for T55-L-7/7B engines or figures 7-22 thru 7-29 for T55-L-7C engines.

e. Arrival.

(1) Compute arrival gross weight by subtracting from initial cruise gross weight, fuel consumed during the cruise leg of the mission (insure that adequate reserve fuel remains at completion of cruise leg). Enter gross weight in space provided.

(2) Determine and record field length and obstacle height at destination.

(3) Determine and record rotor rpm at destination.

(4) Determine and record maximum torque available from figure 7-3 for T55-L-7/7B engines or figure 7-4 for T55-L-7C engines.

(5) Determine and record desired ige hover height from landing charts (figure 7-34 for T55-L-7/7B or figure 7-35 for T55-L-7C engines) and torque required from hover charts (figure 7-10 for T55-L-7/7B or figure 7-11 for T55-L-7C engines). Insure that torque required is less than torque available and select and record approach speed and angle from landing chart. If oge hover capability exists, record torque required.

f. Emergency Procedure (Single Engine Cruise).

(1) Determine and record cruise gross weight from the planned performance section of the flight card or for greater accuracy, subtract fuel burn-off during cruise.

(2) Determine and record pressure altitude and free air temperature for single engine cruise.

PERFORMANCE PLANNING

DUAL ENGINE PROCEDURE

DEPARTURE

GR WT ____________ FUEL ____________

EXT LOAD: WT ________ DRAG ____________

PRESS ALT. ____________ FAT ____________

IDLE FUEL FL ____________

FIELD LG ____________ OBST HGT ____________

ROTOR RPM ____________

MAX TRQ/ENG ____________ FUEL FL ____________

HOVER: IGE HGT ________ TRQ/ENG ____________

FUEL FL ____________

MAX HOVER HGT ________ FUEL FL ________

TAKEOFF:

TECHNIQUE ____________ CLIMBOUT TAS ________

CLIMB

GRWT ________ PRESS ALT ________ FAT ________

MAX R/C IAS ________ MAX TRQ/ENG ________

LVL FLT TRQ AT R/C IAS/ENG ____________

CHANGE IN TRQ FOR CLIMB/ENG ____________

(MAX TORQUE/ENG)–(LVL FLT TRQ/ENG)

MAX R/C ____________ FUEL FL ____________

CRUISE

(PLANNED PERFORMANCE)

GR WT ____________ FUEL ____________

PRESS ALT. ____________ FAT ____________

ROTOR RPM ________ IAS ________ TAS ________

TRQ/ENG ____________

FUEL FL ____________

(MAXIMUM PERFORMANCE)

A S LIMIT (PROGRAMMED CYCLIC) ____________

A S LIMIT (RETRACTED CYCLIC) ____________

TRQ/ENG (AVAIL) ____________

IAS ________ TAS ________ FUEL FL ________

ARRIVAL

GRWT ________ PRESS ALT ________ FAT ________

FIELD LG ____________ OBST HGT ____________

ROTOR RPM ____________

MAX TRQ/ENG ____________

HOVER: IGE HGT ________ TRQ/ENG ________

OGE TRQ/ENG ____________

APPROACH SPEED: TAS ____________ IAS ________

EMERGENCY PROCEDURE

SINGLE ENGINE

CRUISE:

GRWT ____________ FUEL ____________ PRESS ALT ____________ FAT ____________

TRQ ____________ IAS ____________ TAS ____________ FUEL FL ____________

ARRIVAL:

GRWT ____________ PRESS ALT ____________ FAT ____________

FIELD LG ____________ OBST HGT ____________ MAX TRQ ____________

HOVER: IGE HGT ____________ TRQ ____________

AUTOROTATION

MIN R/D IAS ____________ MAX GLIDE IAS ____________ ROTOR RPM ____________

Figure 7-1. Performance Planning Card

TEMPERATURE CONVERSION

TEMPERATURE CONVERSION
CH-47A

EXAMPLE

WANTED

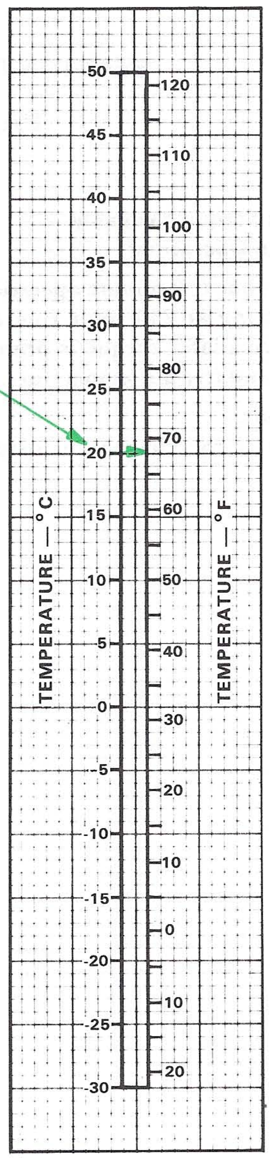
FAT IN DEGREES FAHRENHEIT — °C

KNOWN

FAT = 20° C

METHOD

ENTER FAT HERE.
MOVE RIGHT AND READ FAT = 68° F.



G

Figure 7-2. Temperature Conversion Chart

(3) Determine and record torque available, ias, tas, and fuel flow at cruise altitude from cruise charts, figures 7-13 thru 7-20 for T55-L-7/7B engines or figures 7-22 thru 7-29 for T55-L-7C engines.

g. Emergency Procedure (Single Engine Arrival).

(1) Calculate and record arrival gross weight (account for fuel burn off and cargo jettisoned).

(2) Determine and record emergency field pressure altitude and free air temperature.

(3) Determine and record emergency field length and obstacle height.

(4) Determine and record maximum torque available from figure 7-3 for T55-L-7/7B engines or figure 7-4 for T55-L-7C.

(5) Determine and record desired ige hover height from landing charts (figure 7-34 for T55-L-7/7B or figure 7-35 for T55-L-7C engines) and torque required from hover charts (figure 7-10 for T55-L-7/7B or figure 7-11 for T55-L-7C engines). Insure that torque required is less than torque available and select and record approach speed and angle from landing chart.

SECTION III MAXIMUM TORQUE AVAILABLE

PART ONE—T55-L-7/7B ENGINES

7-13. Maximum Torque Available (30-Minute Operation).

The maximum torque (30-minute operation) for T55-L-7/7B engines operating at 230 rotor rpm may be obtained from figure 7-3. Available torque is presented in terms of pressure altitude and free air temperature.

7-14. Use of Chart.

The primary use of the chart is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know pressure altitude and free air temperature. Enter the left side of the chart at the known pressure altitude, move right to the known temperature, then down to read maximum torque available.

7-15. Conditions.

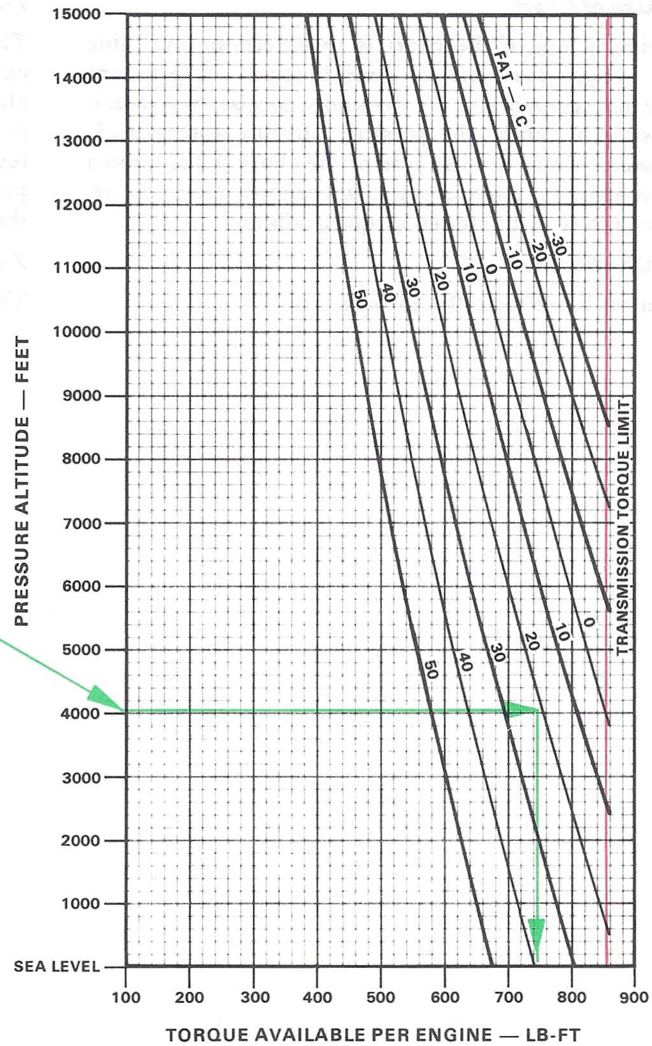
The chart is based on a rotor speed of 230 rpm.

MAXIMUM TORQUE AVAILABLE (30 Min Operation)

ENGINE ANTI-ICING OFF

230 ROTOR RPM   JP-4 FUEL   TAS = 0 KN

MAX TORQUE
CH-47A
T55-L-7/7B



EXAMPLE

WANTED

MAXIMUM TORQUE AVAILABLE

KNOWN

PRESSURE ALTITUDE = 4000 FT
FAT = 20° C

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
MOVE DOWN, READ MAXIMUM TORQUE AVAILABLE PER ENGINE = 757 LB-FT.

DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.20-A

R
G

Figure 7-3. Maximum Torque Available (30-Minute Operation)

SECTION III MAXIMUM TORQUE AVAILABLE

PART TWO—T55-L-7C ENGINES

7-16. Maximum Torque Available (10-Minute Operation).

The maximum torque (10-minute operation) for T55-L-7C engines operating at 230 rotor rpm are presented in figure 7-4. Available torque is in terms of pressure altitude and free air temperature.

7-17. Use of Chart.

The primary use of the chart is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know the pressure altitude and free air temperature. Enter the left side of the chart at the known pressure altitude, move right to the known temperature, then down to read maximum torque available.

7-18. Conditions.

The chart is based on 230 rotor rpm.

7-19. Maximum Torque Available (30-Minute Operation).

The maximum torque available (30-minute operation) for T55-L-7C engines is presented in figure 7-5. Available torque is in terms of pressure altitude and free air temperature.

7-20. Use of Chart.

The primary use of the chart is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know the pressure altitude and free air temperature. Enter the left side of the chart at the known pressure altitude, move right to the known temperature, then down to read continuous torque available.

7-21. Conditions.

The chart is based on 230 rotor rpm.

MAXIMUM TORQUE AVAILABLE (10 Min Operation)

ENGINE ANTI-ICING OFF

230 ROTOR RPM JP-4 FUEL TAS = 0 KN

MAX TORQUE
CH-47A
T55-L-7C

EXAMPLE

WANTED

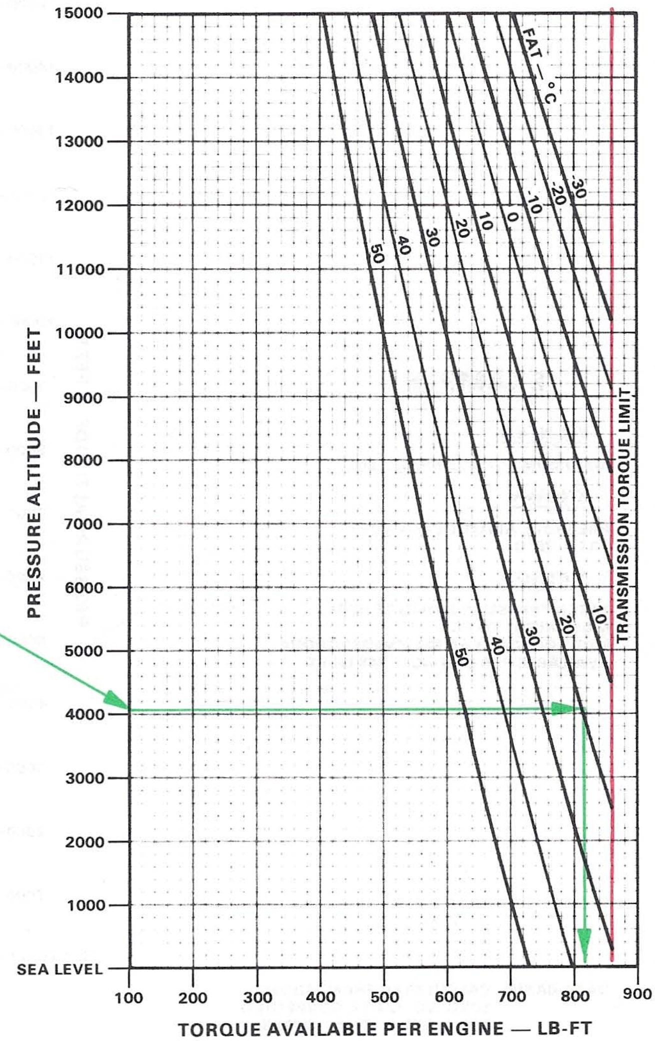
MAXIMUM TORQUE AVAILABLE

KNOWN

PRESSURE ALTITUDE = 4000 FT
FAT = 20° C

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
MOVE DOWN, READ MAXIMUM TORQUE AVAILABLE PER ENGINE = 812 LB-FT.



DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.31, CORRECTED FOR INSTALLATION LOSSES

G R

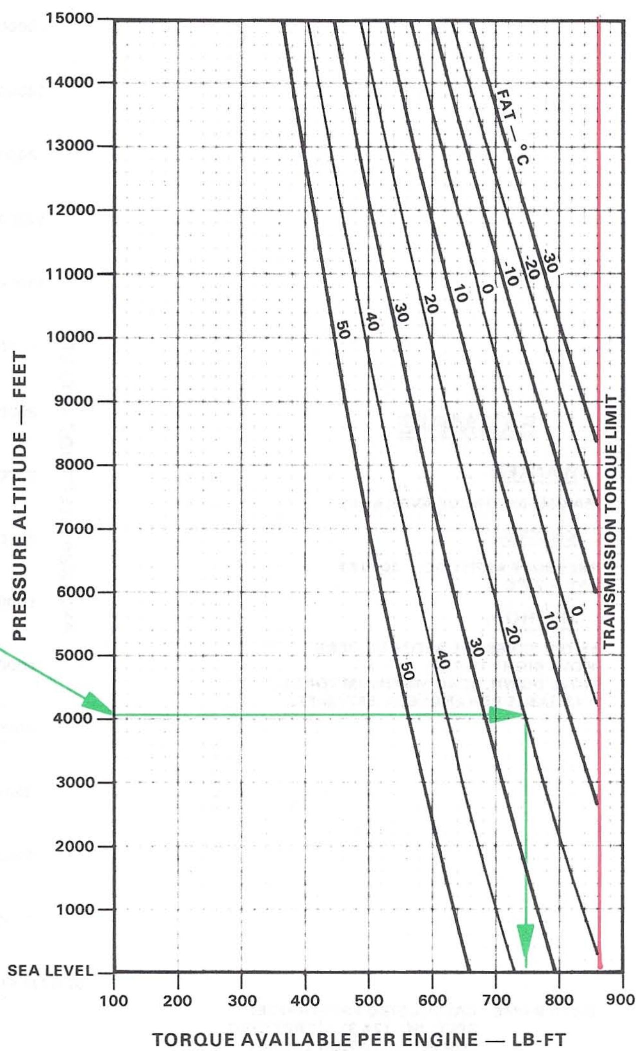
Figure 7-4. Maximum Torque Available (10-Minute Operation)

MAXIMUM TORQUE AVAILABLE (30 Min Operation)

ENGINE ANTI-ICING OFF

230 ROTOR RPM JP-4 FUEL TAS = 0 KN

MAX TORQUE
CH-47A
T55-L-7C



EXAMPLE

WANTED

MAXIMUM TORQUE AVAILABLE

KNOWN

PRESSURE ALTITUDE = 4000 FT
FAT = 20° C

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
MOVE DOWN, READ MAXIMUM TORQUE AVAILABLE PER ENGINE = 748 LB-FT.

DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.31, CORRECTED FOR INSTALLATION LOSSES

R
G

Figure 7-5. Maximum Torque Available (30-Minute Operation)

316-520 0 - 80 - 15

SECTION IV CONTINUOUS TORQUE AVAILABLE

PART ONE—T55-L-7/7B ENGINES

7-22. Description.

The continuous torque available for T55-L-7/7B engines operating at 230 rotor rpm may be obtained from figure 7-6. Available torque is presented in terms of pressure altitude and free air temperature.

7-23. Use of Chart.

The primary use of the chart is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know the rotor rpm, pressure altitude, and free air temperature. Enter the left side of the chart at the known pressure altitude, move right to the known temperature, then down to read maximum torque available.

7-24. Conditions.

The chart is based on a rotor speed of 230 rpm.

CONTINUOUS TORQUE AVAILABLE

ENGINE ANTI-ICING OFF

230 ROTOR RPM JP-4 FUEL TAS = 0 KN

CONTINUOUS TORQUE
CH-47A
T55-L-7/7B

EXAMPLE

WANTED

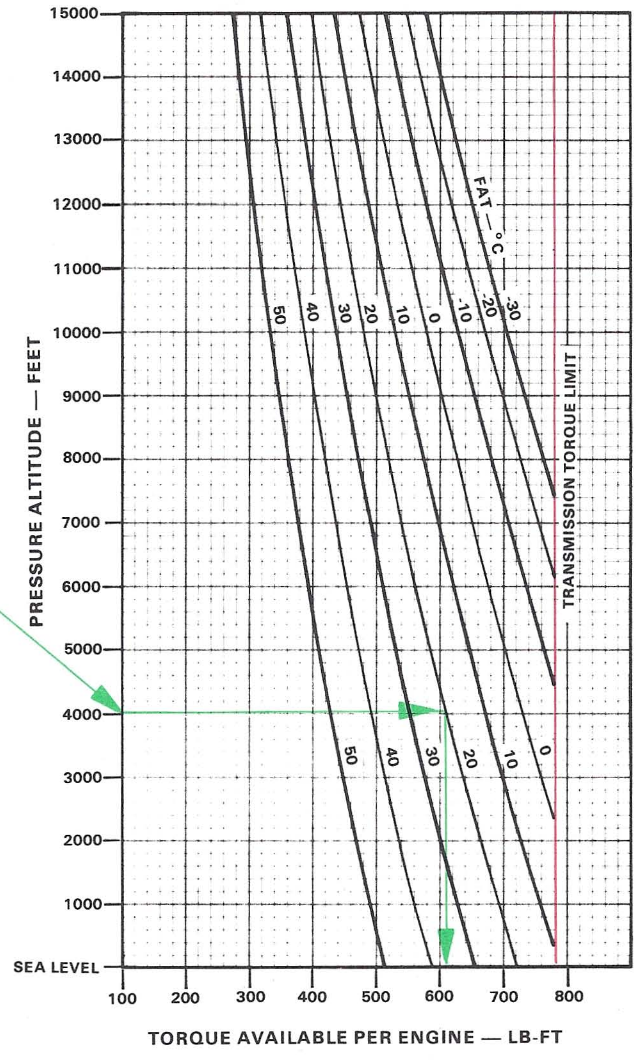
CONTINUOUS TORQUE AVAILABLE

KNOWN

PRESSURE ALTITUDE = 4000 FT
FAT = 20° C

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
MOVE DOWN, READ CONTINUOUS TORQUE AVAILABLE PER ENGINE = 610 LB-FT.



DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.20-A

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Figure 7-6. Continuous Torque Available

SECTION IV CONTINUOUS TORQUE AVAILABLE

PART TWO—T55-L-7C ENGINES

7-25. Description.

The continuous torque available for T55-L-7C engines is presented in figure 7-7. Available torque is presented in terms of pressure altitude and free air temperature.

7-26. Use of Chart.

The primary use of the chart is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know the pressure altitude and free air temperature. Enter the left side of the chart at the known pressure altitude, move right to the known temperature, then down to read maximum torque available.

7-27. Conditions.

The chart is based on 230 rotor rpm.

CONTINUOUS TORQUE AVAILABLE

ENGINE ANTI-ICING OFF

CONTINUOUS TORQUE
CH-47A
T55-L-7C

230 ROTOR RPM JP-4 FUEL TAS = 0 KN

EXAMPLE

WANTED

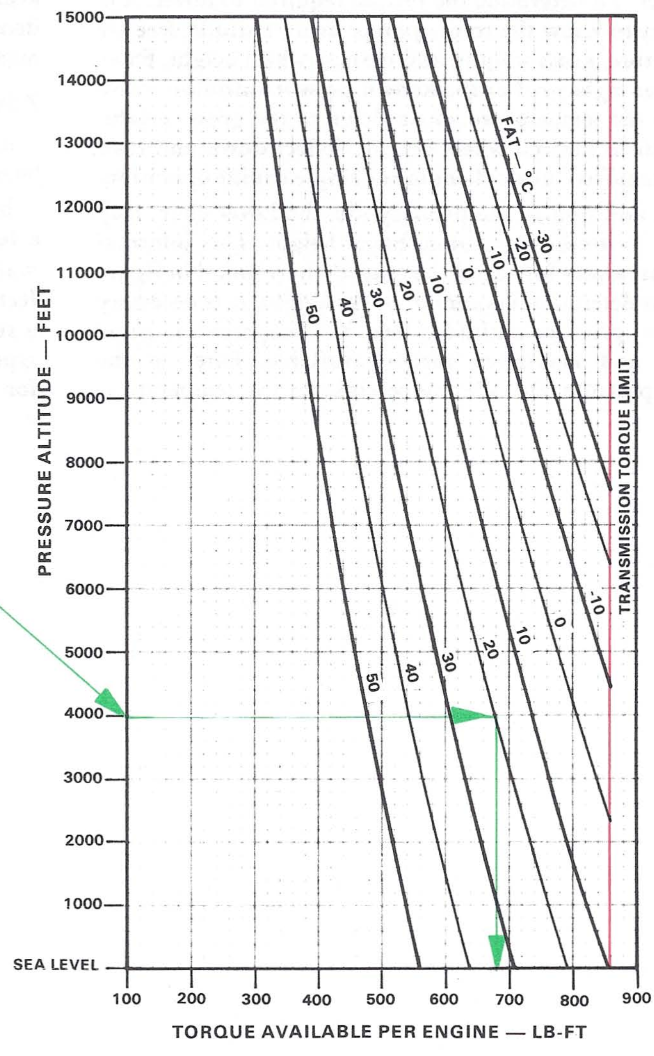
CONTINUOUS TORQUE AVAILABLE

KNOWN

PRESSURE ALTITUDE = 4000 FT
FAT = 20° C

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
MOVE DOWN, READ CONTINUOUS TORQUE AVAILABLE PER ENGINE = 679 LB-FT.



DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.31 CORRECTED FOR INSTALLATION LOSSES

G
R

Figure 7-7. Continuous Torque Available

SECTION V HOVER

PART ONE—T55-L-7/7B ENGINE

7-28. Description.

The hover chart, figure 7-8, presents torque required to hover at 230 rotor rpm at various combinations of pressure altitude, free air temperature, gross weight, and wheel height for single and dual engine operation.

7-29. Use of Chart.

a. The primary use of the chart is illustrated by the examples. To determine the torque required to hover, it is necessary to know the rotor rpm, pressure altitude, free air temperature, gross weight, and desired wheel height. Enter the upper right grid at the known pressure altitude, move right to the temperature, move down to the gross weight. Move left to desired wheel height, deflect down and read torque required for dual engine or single engine operation.

b. In addition to the primary use, the hover chart may be used to predict maximum hover height, This information is necessary for use of the takeoff chart found in figure 7-10. To determine maximum hover height, it is necessary to know pressure altitude, free air temperature, gross weight, and maximum torque available. Enter at the known pressure altitude, move right to the temperature, move down to gross weight, move left to intersection with maximum torque available and read wheel height. This wheel height is the maximum hover height.

c. The hover chart may also be used to determine maximum gross weight for hover at a given wheel height, pressure altitude, and temperature. Enter the known pressure altitude, move right to the temperature, then move down to the bottom of the lower grid, and read density altitude. Now enter lower left grid at maximum torque available, move up to wheel height, then move right to density altitude and read gross weight. This is the maximum gross weight at which the helicopter will hover.

7-30. Conditions.

a. The hover charts are based on calm wind, level surface, and 230 rotor rpm.

b. In ground effect hover data is based on hovering over a level surface. For normal transition from hover to forward flight, the minimum hover wheel height should be 10 feet to prevent ground contact. If helicopter is to hover over a surface known to be steep, covered with vegetation, or if type of terrain is unknown, the flight should be planned for out of ground effect hover capability.

HOVER

230 ROTOR RPM CALM WIND
LEVEL SURFACE

HOVER
CH-47A
T55-L-7/7B

EXAMPLE

WANTED

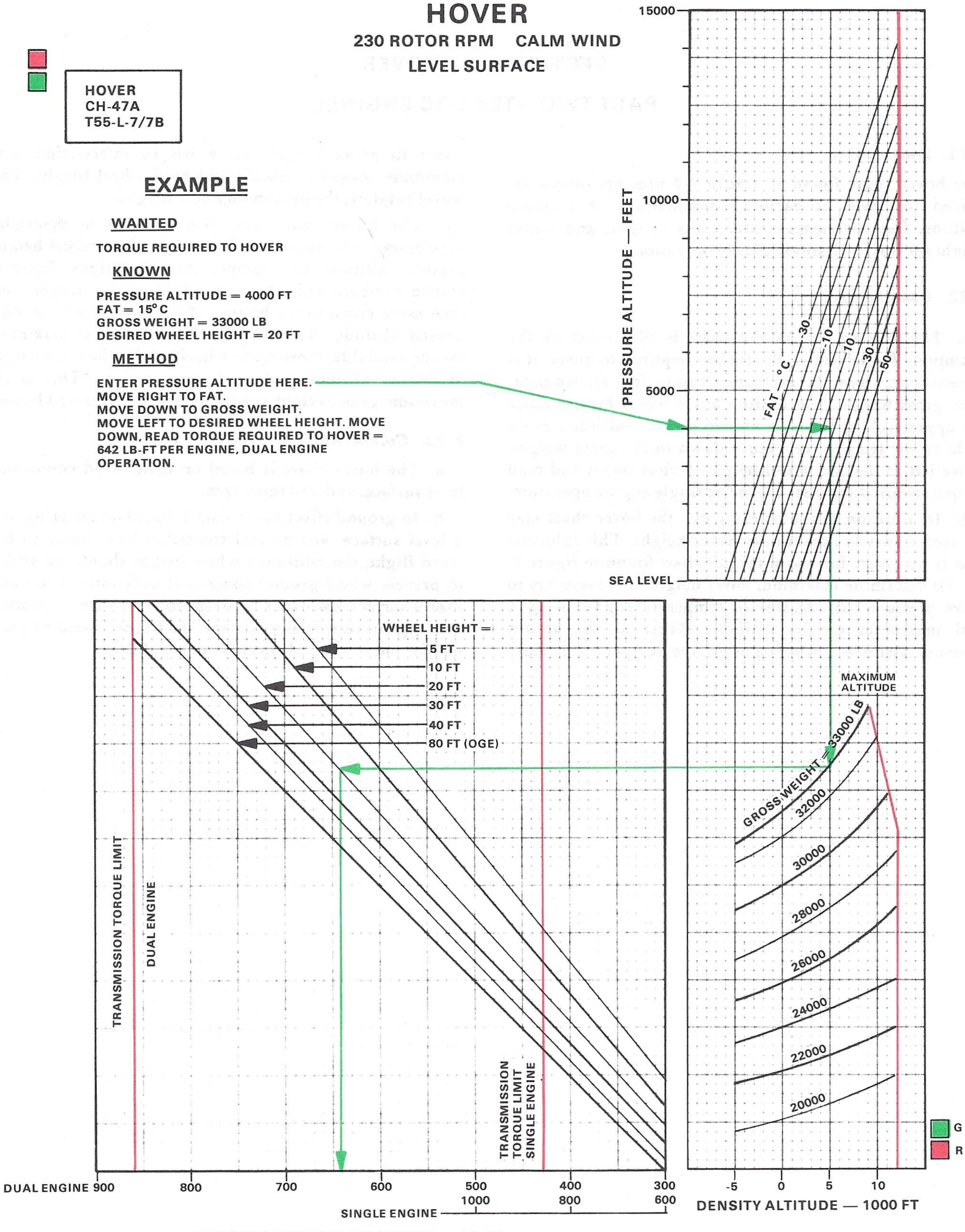
TORQUE REQUIRED TO HOVER

KNOWN

PRESSURE ALTITUDE = 4000 FT
FAT = 15° C
GROSS WEIGHT = 33000 LB
DESIRED WHEEL HEIGHT = 20 FT

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
MOVE DOWN TO GROSS WEIGHT.
MOVE LEFT TO DESIRED WHEEL HEIGHT. MOVE DOWN, READ TORQUE REQUIRED TO HOVER = 642 LB-FT PER ENGINE, DUAL ENGINE OPERATION.



DATA BASIS: FLIGHT TEST

Figure 7-8. Hover Chart

SECTION V HOVER

PART TWO—T55-L-7C ENGINES

7-31. Description.

The hover chart found in figure 7-9 presents torque required to hover at various combinations of pressure altitude, free air temperature, gross weight, and wheel height for dual and single engine operation.

7-32. Use of Chart.

a. The primary use of the chart is illustrated by the examples. To determine the torque required to hover, it is necessary to know the pressure altitude, free air temperature, gross weight, and desired hover wheel height. Enter the upper right grid at the known pressure altitude, move right to the temperature, move down to the gross weight. Move left to desired wheel height, deflect down and read torque required for dual engine or single engine operation.

b. In addition to the primary use, the hover chart may be used to predict maximum hover height. This information is necessary for use of takeoff chart found in figure 7-11. To determine maximum hover height, it is necessary to know pressure altitude, free air temperature, gross weight, and maximum torque available. Enter at the known pressure altitude, move right to the temperature, move down to gross weight, move left to intersection with maximum torque available and read wheel height. This wheel height is the maximum hover height.

c. The hover chart may also be used to determine maximum gross weight for hover at a given wheel height, pressure altitude, and temperature conditions. Enter at known pressure altitude, move right to the temperature, then move down to the bottom of the lower grid and read density altitude. Now enter lower left grid at maximum torque available, move up to wheel height, then move right to density altitude and read gross weight. This is the maximum gross weight at which the helicopter will hover.

7-33. Conditions.

a. The hover chart is based on calm wind conditions, level surface, and 230 rotor rpm.

b. In ground effect hover data is based on hovering over a level surface. For normal transition from hover to forward flight, the minimum wheel height should be 10 feet to prevent wheel ground contact. If helicopter is to hover over a surface known to be steep, covered with vegetation, or if type of terrain is unknown, the flight should be planned for out of ground effect hover capability.

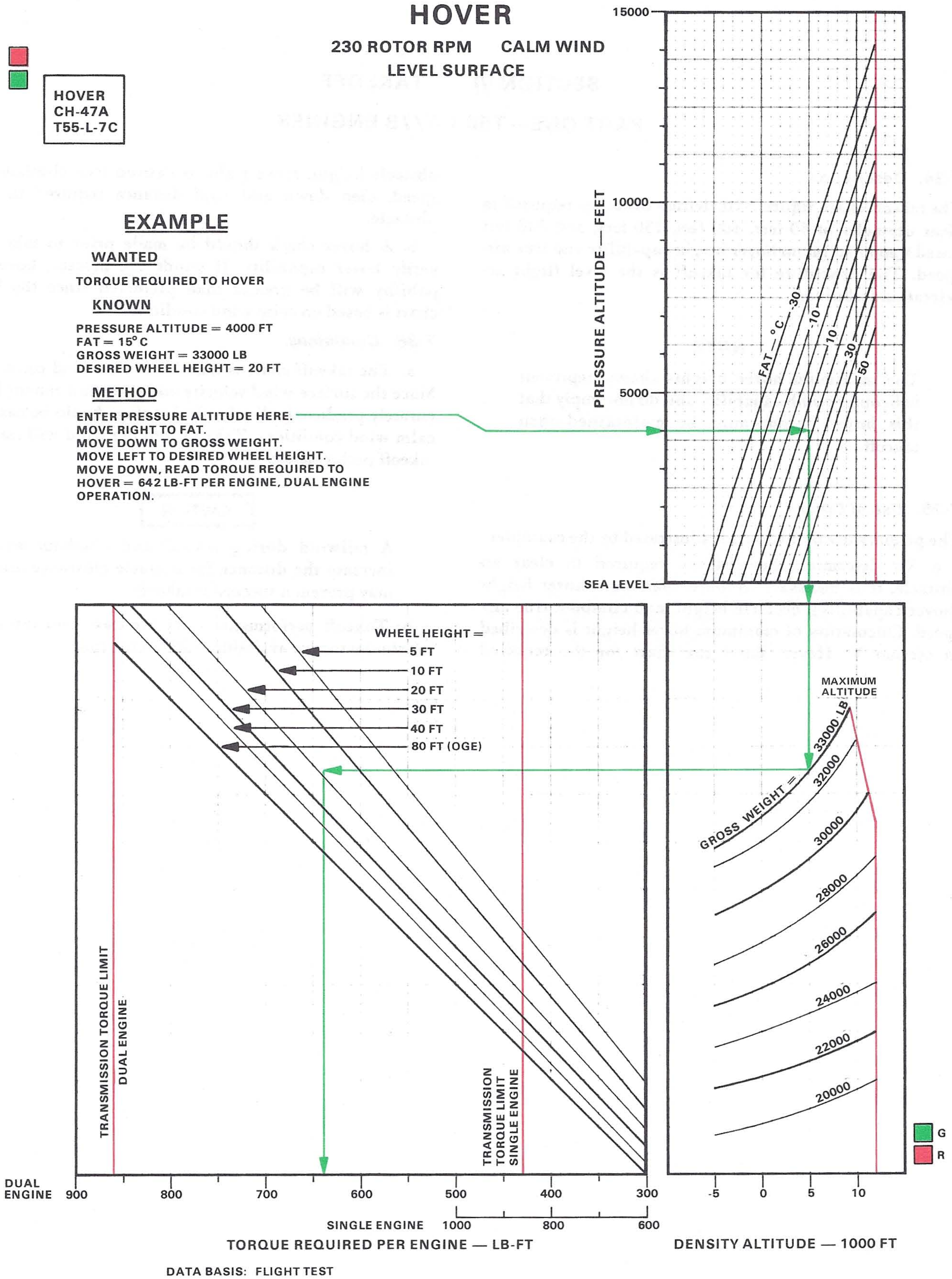


Figure 7-9. Hover Chart

SECTION VI TAKEOFF

PART ONE—T55-L-7/7B ENGINES

7-34. Description.

The takeoff chart, figure 7-10, defines distances required to clear obstacles of 50 feet, 100 feet, 150 feet, and 200 feet based upon maximum hover height capability and true airspeed. The procedure for takeoff is the level flight acceleration technique.

NOTE

The maximum hover heights shown represent helicopter climb capability and do not imply that this hover height must be maintained thru takeoff.

7-35. Use of Chart.

The primary use of the chart is illustrated by the examples.

a. To determine the distance required to clear an obstacle, it is necessary to know maximum hover height (hover capability), obstacle height, and climbout true airspeed. Calculation of maximum hover height is described in section V, Hover. Enter the chart for the required obstacle height, move right to desired true climbout airspeed, then down and read distance required to clear obstacle.

b. A hover check should be made prior to takeoff to verify hover capability. If winds are present, hover capability will be greater than predicted since the hover chart is based on calm wind conditions.

7-36. Conditions.

a. The takeoff chart is based on calm wind conditions. Since the surface wind velocity and direction cannot be accurately predicted, all takeoff planning should be based on calm wind conditions. Takeoff into the wind will improve takeoff performance.

CAUTION

A tailwind during takeoff and climbout will increase the distance for obstacle clearance and may prevent a successful takeoff.

b. Takeoff performance data are based on the use of maximum torque available at 230 rotor rpm.

TAKEOFF
LEVEL ACCELERATION TECHNIQUE
CALM WIND   LEVEL SURFACE   MAXIMUM TORQUE

TAKEOFF
CH-47A
T55-L-7/7B

EXAMPLE

WANTED

DISTANCE TO CLEAR OBSTACLE

KNOWN

MAXIMUM HOVER HEIGHT = 40 FT
OBSTACLE HEIGHT = 125 FT
CLIMBOUT AIRSPEED = 50 KTAS

METHOD 1 (Simplest)

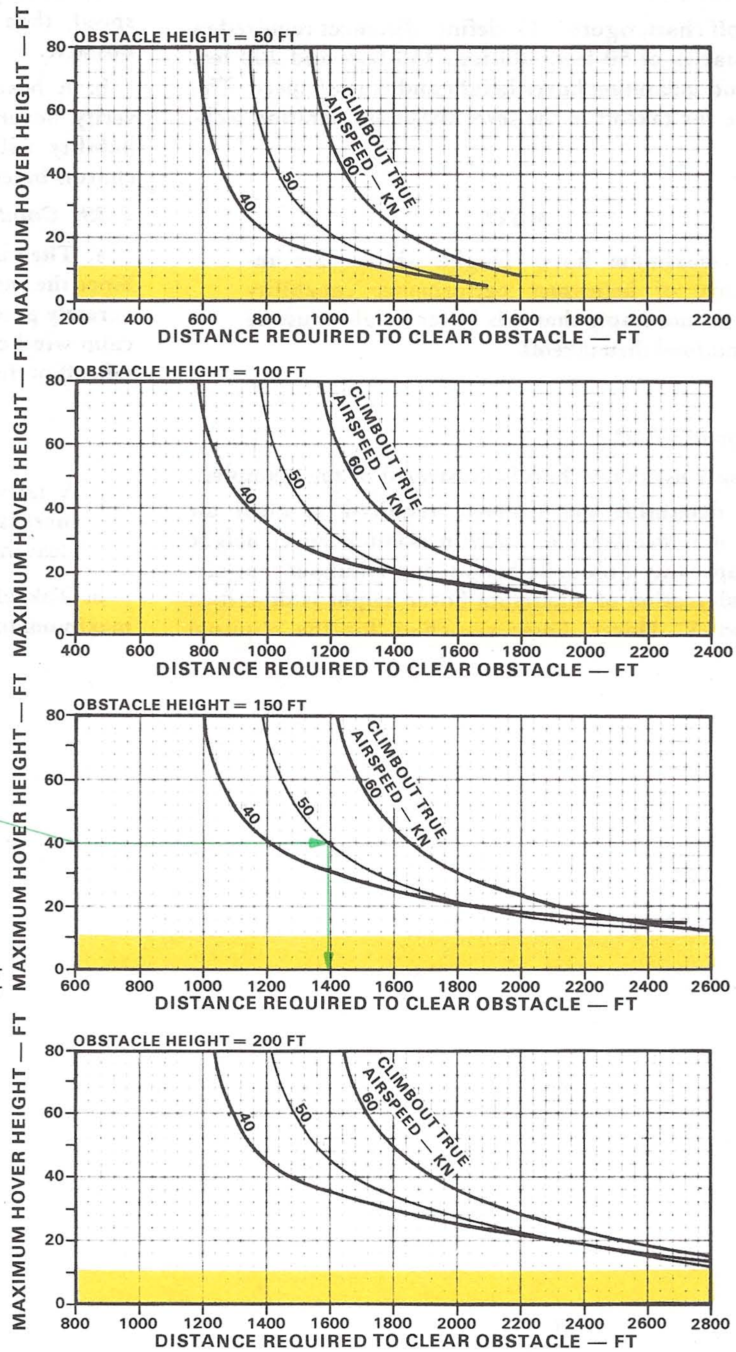
USE NEXT HIGHER OBSTACLE HEIGHT (150 FT).
ENTER MAX HOVER HEIGHT ON LEFT.
MOVE RIGHT TO CLIMBOUT TRUE AIRSPEED.
MOVE DOWN AND READ DISTANCE TO CLEAR OBSTACLE = 1390 FT.

METHOD 2 (Interpolate)

READ DISTANCE REQUIRED TO CLEAR OBSTACLE AT EACH ADJACENT OBSTACLE HEIGHT AND INTERPOLATE.

OBSTACLE HEIGHT =	100 FT	150 FT	125 FT
DISTANCE REQUIRED =	1120 FT	1390 FT	1255 FT

DATA BASIS: DERIVED FROM AFFTC FTC-TR-66-2 CATEGORY II PERFORMANCE TESTS OF THE CH-47A HELICOPTER



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G

Figure 7-10. Takeoff Chart

SECTION VI TAKEOFF

PART TWO—T55-L-7C ENGINES

7-37. Description.

The takeoff chart, figure 7-11, defines distances required to clear obstacles of 50 feet, 100 feet, 150 feet, and 200 feet based upon maximum hover height and true airspeed. The procedure for takeoff is the level flight acceleration technique.

NOTE

The maximum hover heights shown are indicative of helicopter performance capability and do not imply that this hover height must be maintained thru takeoff.

7-38. Use of Chart.

The primary use of the chart is illustrated by the examples.

a. To determine the distance required to clear an obstacle, it is necessary to know maximum hover height (hover capability), obstacle height, and climbout true airspeed. Calculation of maximum hover height is described in section V, Hover. Enter the chart for the required obstacle height, move right to desired true climbout airspeed, then down and read distance required to clear obstacle.

b. A hover check should be made prior to takeoff to verify hover capability. If winds are present, hover capability will be greater than predicted since the hover chart is based on calm wind conditions.

7-39. Conditions.

a. The takeoff chart is based on calm wind conditions. Since the surface wind velocity and direction cannot be accurately predicted, all takeoff planning should be based on calm wind conditions. Takeoff into the wind will improve takeoff performance.

CAUTION

A tailwind during takeoff and climbout will increase the distance required for obstacle clearance and may prevent a successful takeoff.

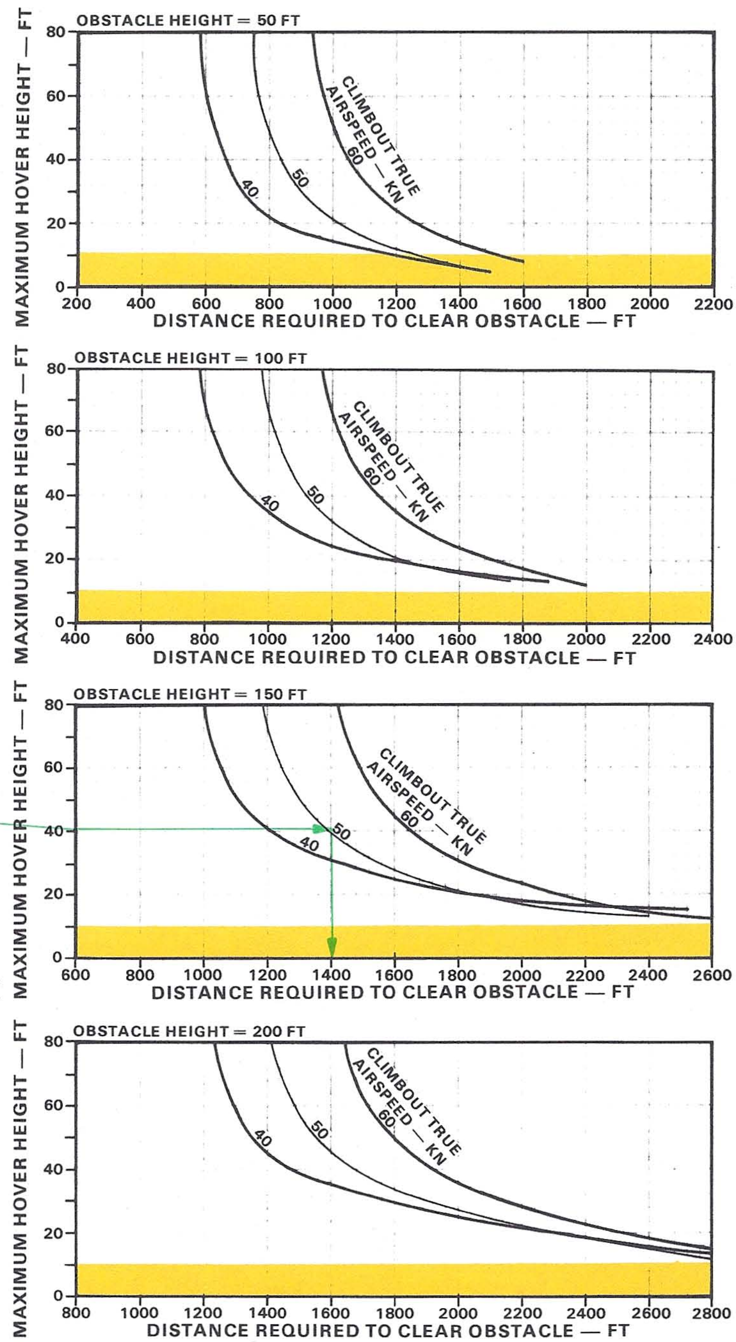
b. Takeoff performance data are based on the use of maximum torque available at 230 rotor rpm.

TAKEOFF

LEVEL ACCELERATION TECHNIQUE

CALM WIND LEVEL SURFACE MAXIMUM TORQUE

TAKEOFF
CH-47A
T55-L-7C



EXAMPLE

WANTED

DISTANCE TO CLEAR OBSTACLE

KNOWN

MAXIMUM HOVER HEIGHT = 40 FT
OBSTACLE HEIGHT = 125 FT
CLIMBOUT AIRSPEED = 50 KTAS

METHOD 1 (Simplest)

USE NEXT HIGHER OBSTACLE HEIGHT (150 FT).
ENTER MAX HOVER HEIGHT ON LEFT.
MOVE RIGHT TO CLIMBOUT TRUE AIRSPEED.
MOVE DOWN AND READ DISTANCE TO CLEAR OBSTACLE = 1390 FT.

METHOD 2 (Interpolate)

READ DISTANCE REQUIRED TO CLEAR OBSTACLE AT EACH ADJACENT OBSTACLE HEIGHT AND INTERPOLATE.

OBSTACLE HEIGHT =	100 FT	150 FT	125 FT
DISTANCE REQUIRED =	1120 FT	1390 FT	1255 FT

DATA BASIS: DERIVED FROM AFFTC FTC-TR-66-2 CATEGORY II PERFORMANCE TESTS OF THE CH-47A HELICOPTER

Y
R

Figure 7-11. Takeoff Chart

SECTION VII CRUISE

PART ONE—T55-L-7/7B ENGINES

7-40. Description.

The cruise charts, figures 7-13 thru 7-20, present torque requirements and fuel flow for cruise flight as a function of airspeed and gross weight for various combinations of pressure altitude and free air temperature.

7-41. Use of Charts.

The primary use of charts is illustrated by the example cruise chart, figure 7-12. To use the charts it is usually necessary to know the planned pressure altitude, estimated free air temperature, planned cruise tas, and the gross weight. First, select the proper chart based on pressure altitude and free air temperature. Enter the chart at the cruise tas, move right and read ias, move left to the gross weight, move down and read torque required, then move up and read associated fuel flow. Maximum performance conditions are determined by entering the chart where the maximum range line or maximum endurance and rate of climb line intersect the gross weight line; then read airspeed, fuel flow, and torque required. Normally, sufficient accuracy can be obtained by selecting the chart nearest to the planned cruising altitude and free air temperature, or more conservatively, by selecting the chart with the next higher altitude and free air temperature (example cruise chart, method one). If greater accuracy is required, interpolation between altitudes and/or temperatures is permissible (example cruise chart, method two). To be conservative, use the gross weight at the beginning of the cruise flight. For improved accuracy or long flights, it is preferable to determine cruise information for several flight segments to allow for decreasing gross weight.

a. Airspeed. True and indicated airspeeds are presented at opposite sides of each chart. On any chart, indicated airspeed can be directly converted to true airspeed (or vice versa) by reading directly across the chart without regard to other chart information. Maximum permissible airspeed (Vne) limits appear as red lines on each chart. (Refer to the airspeed operating limits found in chapter 5.)

b. Torque. Since pressure altitude and temperature are defined for each chart, torque required varies only with gross weight and airspeed (see example cruise chart, method three.) The torque limits shown are either transmission or engine torque limits (whichever is least).

c. Fuel Flow. Fuel flow scales are provided opposite the torque scales. Torque may be converted directly to fuel flow on any chart without regard to other chart information.

d. Maximum Range. Maximum range lines indicate optimum gross weight/cruise speed conditions with respect to distance covered per pound of fuel consumed for zero wind conditions.

e. Maximum Endurance and Rate of Climb. Maximum endurance and rate of climb lines indicate optimum gross weight/cruise speed conditions for maximum endurance and maximum rate of climb. These conditions require minimum fuel flow (maximum endurance) and provide maximum torque change for climb (maximum rate of climb).

7-42. Conditions.

The cruise charts are based on 230 rotor rpm.

EXAMPLE (Dual Engine)

WANTED

TORQUE REQUIRED FOR LEVEL FLIGHT, FUEL FLOW AND INDICATED AIRSPEED

KNOWN

GROSS WEIGHT = 28000 POUNDS
PRESSURE ALTITUDE = 1500 FEET
FAT = 7.5° C
DESIRED TRUE AIRSPEED = 115 KNOTS

METHOD 1 (Simplest)

USE NEXT HIGHER ALTITUDE AND TEMPERATURE (3000 FEET AND 15° C)
ENTER DESIRED TRUE AIRSPEED ON LEFT
MOVE RIGHT TO GROSS WEIGHT
MOVE DOWN, READ TORQUE = 400 LB-FT
MOVE UP, READ FUEL FLOW = 1775 LB/HR
MOVE RIGHT, READ IAS = 108 KNOTS

METHOD 2 (Interpolate)

READ TORQUE, FUEL FLOW AND IAS AT EACH ADJACENT ALTITUDE AND FAT THEN INTERPOLATE BETWEEN ALTITUDE AND FAT.

ALTITUDE	SEA-LEVEL		3000 FEET		1500 FEET
FAT	0° C	15° C	0° C	15° C	7.5° C
TORQUE (LB-FT)	410	404	402	400	404
FUEL FLOW (LB/HR)	1855	1860	1775	1775	1816
IAS (KNOTS)	120	117	112	108	114

EXAMPLE

WANTED

SPEED FOR MAXIMUM RANGE
SPEED FOR MAXIMUM ENDURANCE
AIRSPEED LIMIT (V_{NE})

KNOWN

GROSS WEIGHT = 28000 POUNDS
PRESSURE ALTITUDE = SEA-LEVEL
FAT = 0° C

METHOD

READ SPEEDS WHERE GROSS WEIGHT LINE INTERSECTS PERFORMANCE OR LIMIT LINE
MAXIMUM RANGE: TAS = 126 KNOTS, IAS = 132 KNOTS
MAXIMUM ENDURANCE: TAS = 74 KNOTS, IAS = 73 KNOTS
V_{NE}: TAS = 126 KNOTS, IAS = 132 KNOTS

EXAMPLE

WANTED

TORQUE AVAILABLE

KNOWN

PRESSURE ALTITUDE = 3000 FEET
FAT = 15° C TAS = 115 KNOTS

METHOD

ENTER TAS ON LEFT (OR IAS ON RIGHT)
MOVE RIGHT TO TORQUE LINE
MOVE DOWN, READ TORQUE AVAILABLE
CONTINUOUS TORQUE = 665 LB-FT
MAXIMUM TORQUE = 810 LB-FT (IF DUAL ENGINE TORQUE LIMIT IS NOT INDICATED, READ SINGLE ENGINE LIMIT ON DUAL ENGINE SCALE AND MULTIPLY BY 2)

Figure 7-12. Example Cruise Chart (Sheet 1 of 2)

CRUISE EXAMPLE

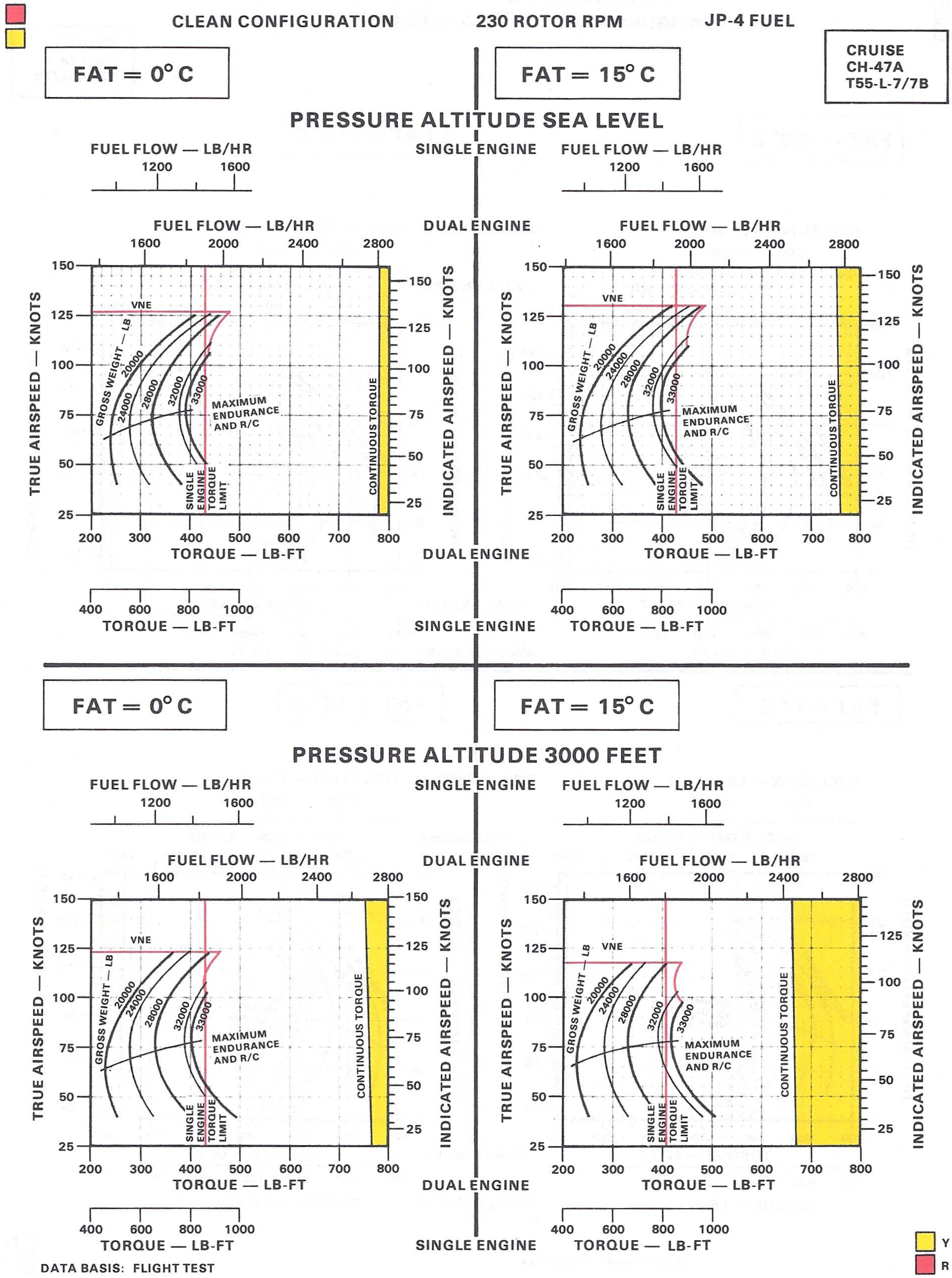


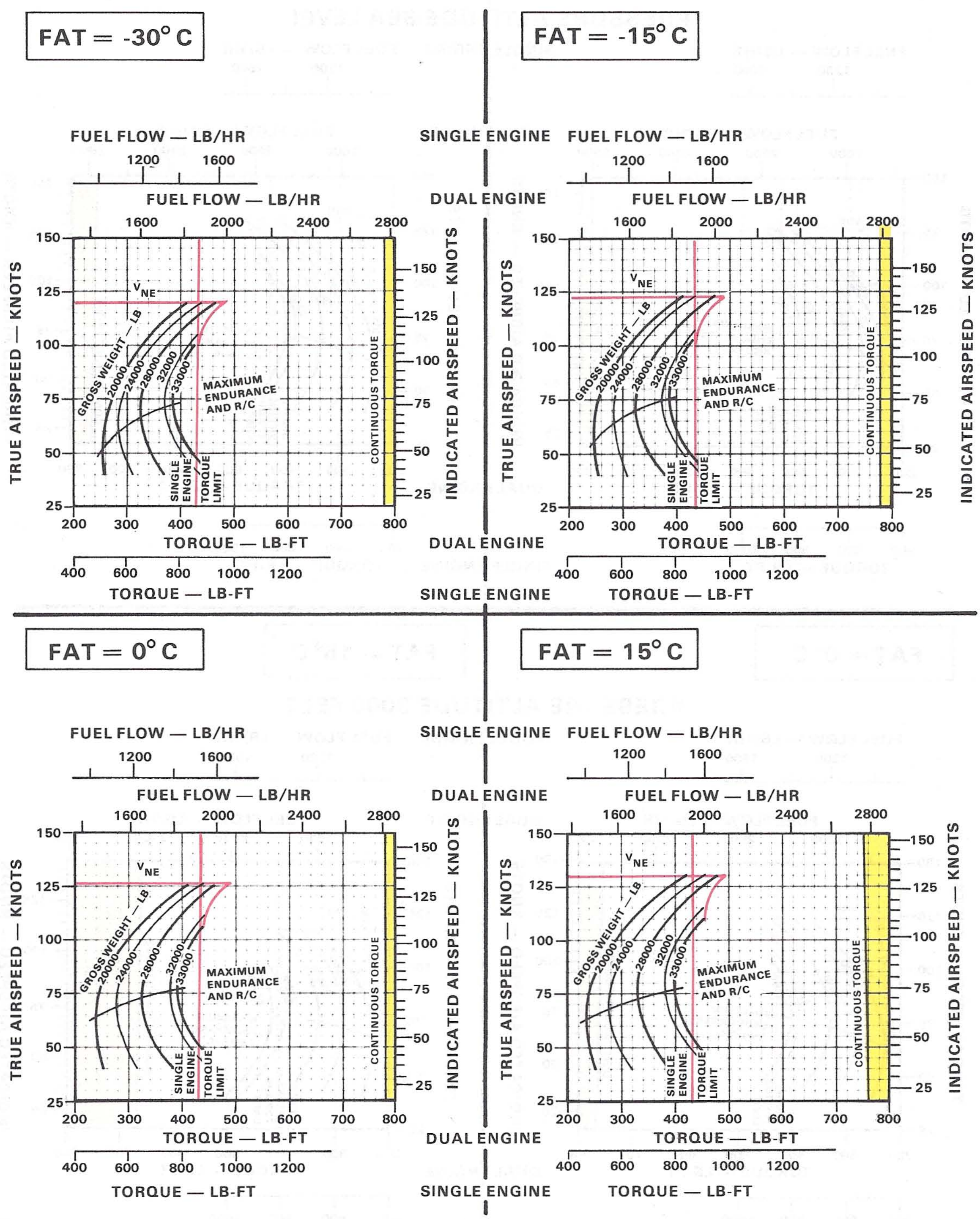
Figure 7-12. Example Cruise Chart (Sheet 2 of 2)

316-520 O - 80 - 16

CRUISE
PRESSURE ALTITUDE SEA LEVEL

CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B



DATA BASIS: FLIGHT TEST

Y
R

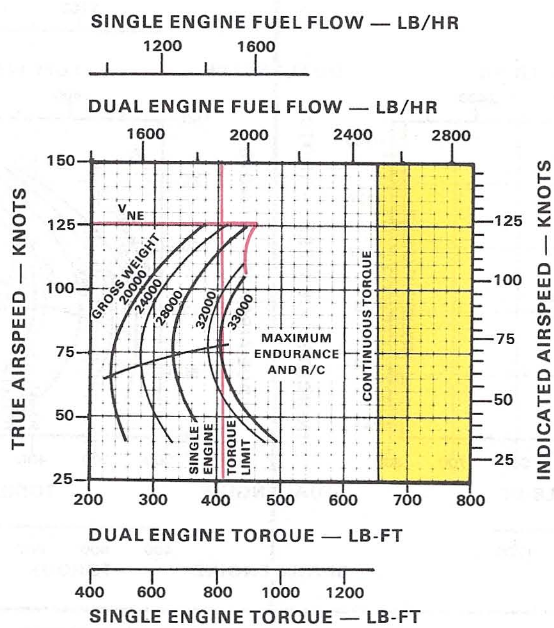
Figure 7-13. Cruise Chart −30°C, −15°C, 0°C, and 15°C, Sea Level

CRUISE
PRESSURE ALTITUDE SEA LEVEL

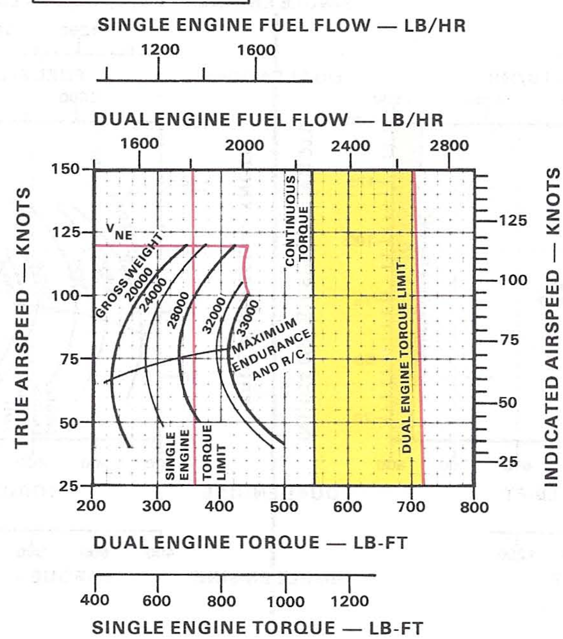
CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B

FAT = 30° C



FAT = 45° C



Y
R

DATA BASIS: FLIGHT TEST

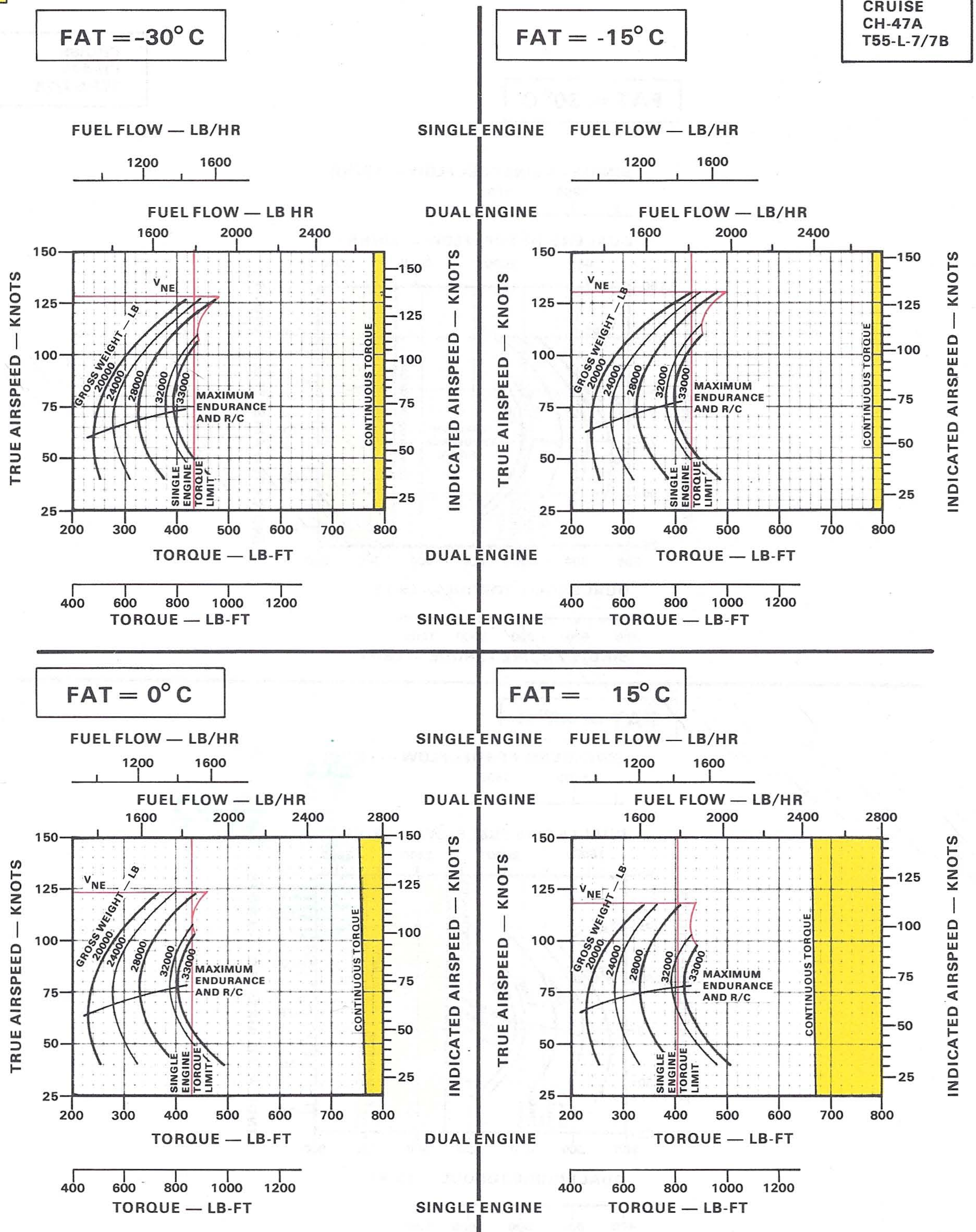
Figure 7-14. Cruise Chart 30°C and 45°C, Sea Level

CRUISE

PRESSURE ALTITUDE 3000 FEET

CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B



Y
R

Figure 7-15. Cruise Chart -30°C, -15°C, 0°C, and 15°C, 3,000 Feet

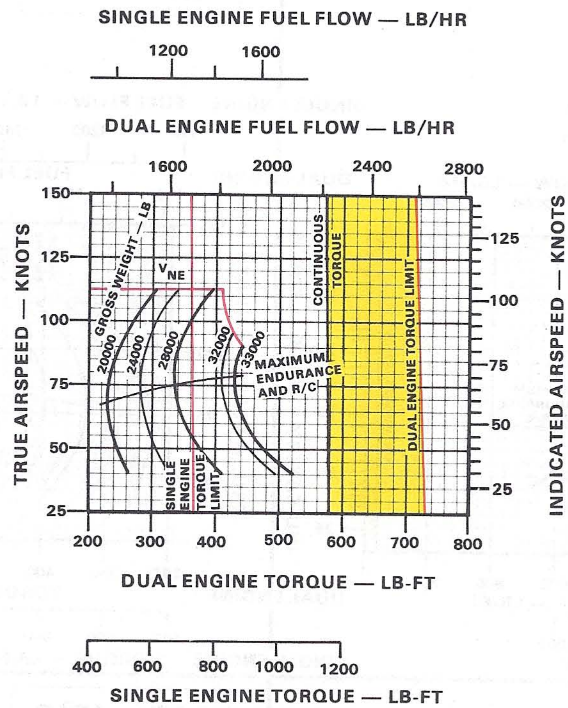
CRUISE

PRESSURE ALTITUDE 3000 FEET

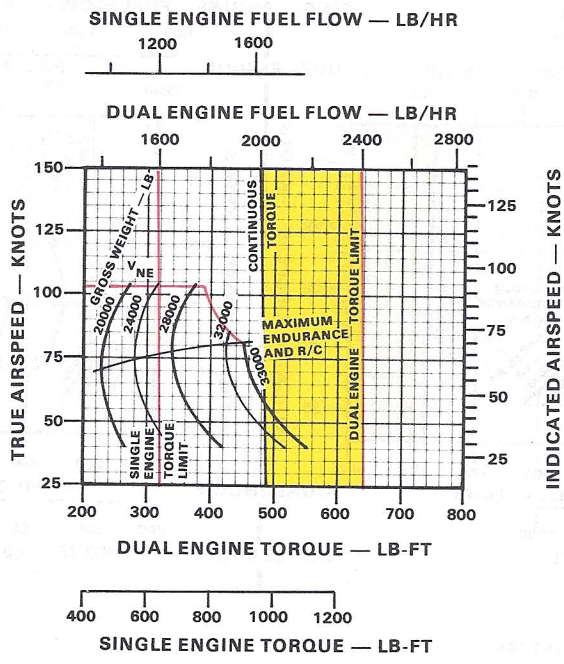
CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B

FAT = 30° C



FAT = 45° C



Y
R

DATA BASIS: FLIGHT TEST

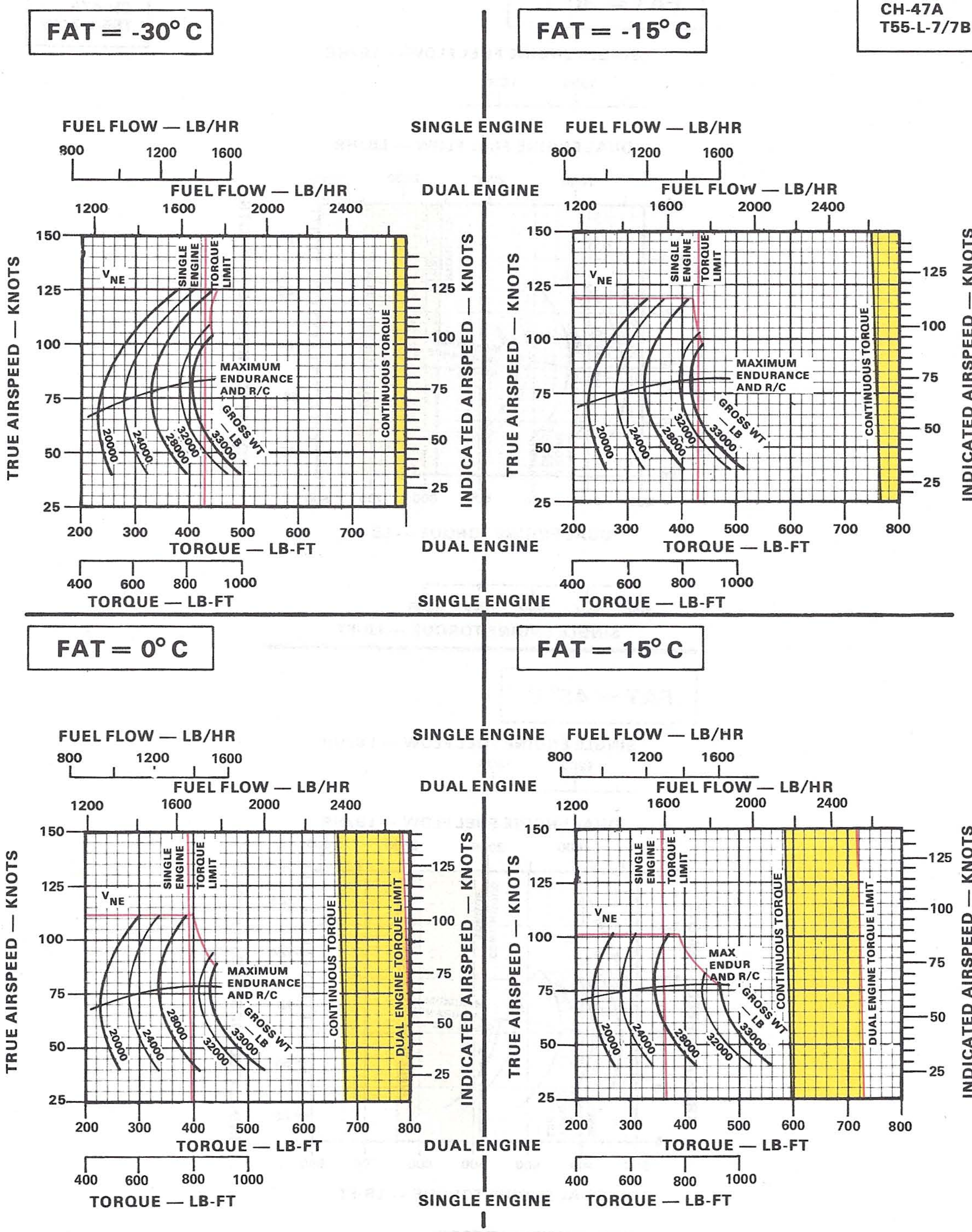
Figure 7-16. Cruise Chart 30°C and 45°C, 3,000 Feet

CRUISE

PRESSURE ALTITUDE 6000 FEET

CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B



DATA BASIS: FLIGHT TEST

Y
R

Figure 7-17. Cruise Chart -30°C, -15°C, 0°C, and 15°C, 6,000 Feet

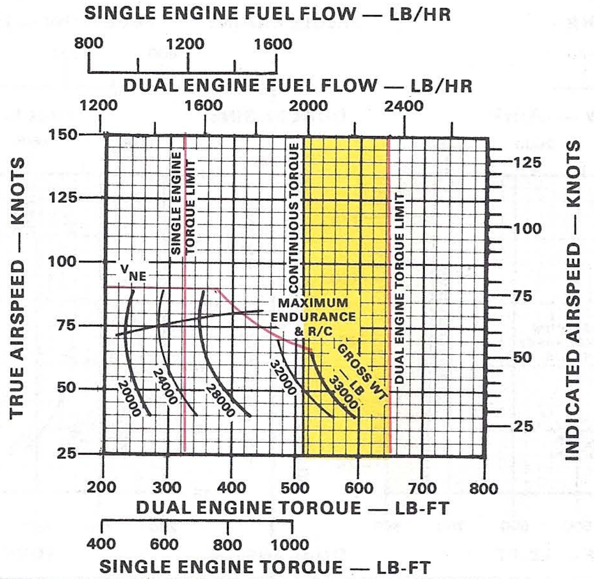
CRUISE

PRESSURE ALTITUDE 6000 FEET

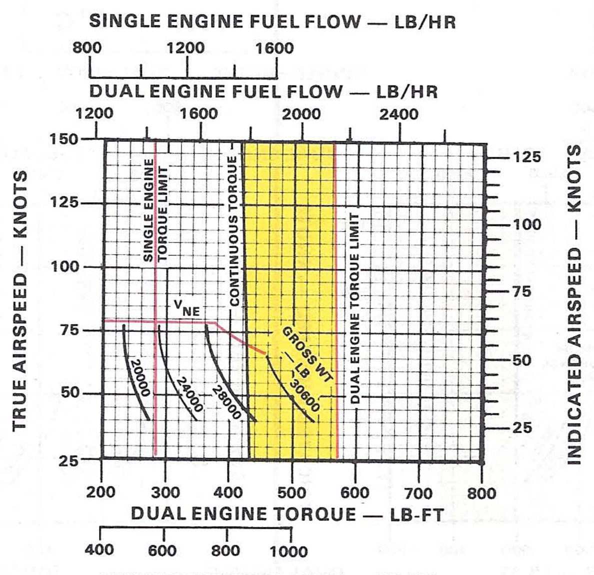
CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B

FAT = 30° C



FAT = 45° C



DATA BASIS: FLIGHT TEST

Y
R

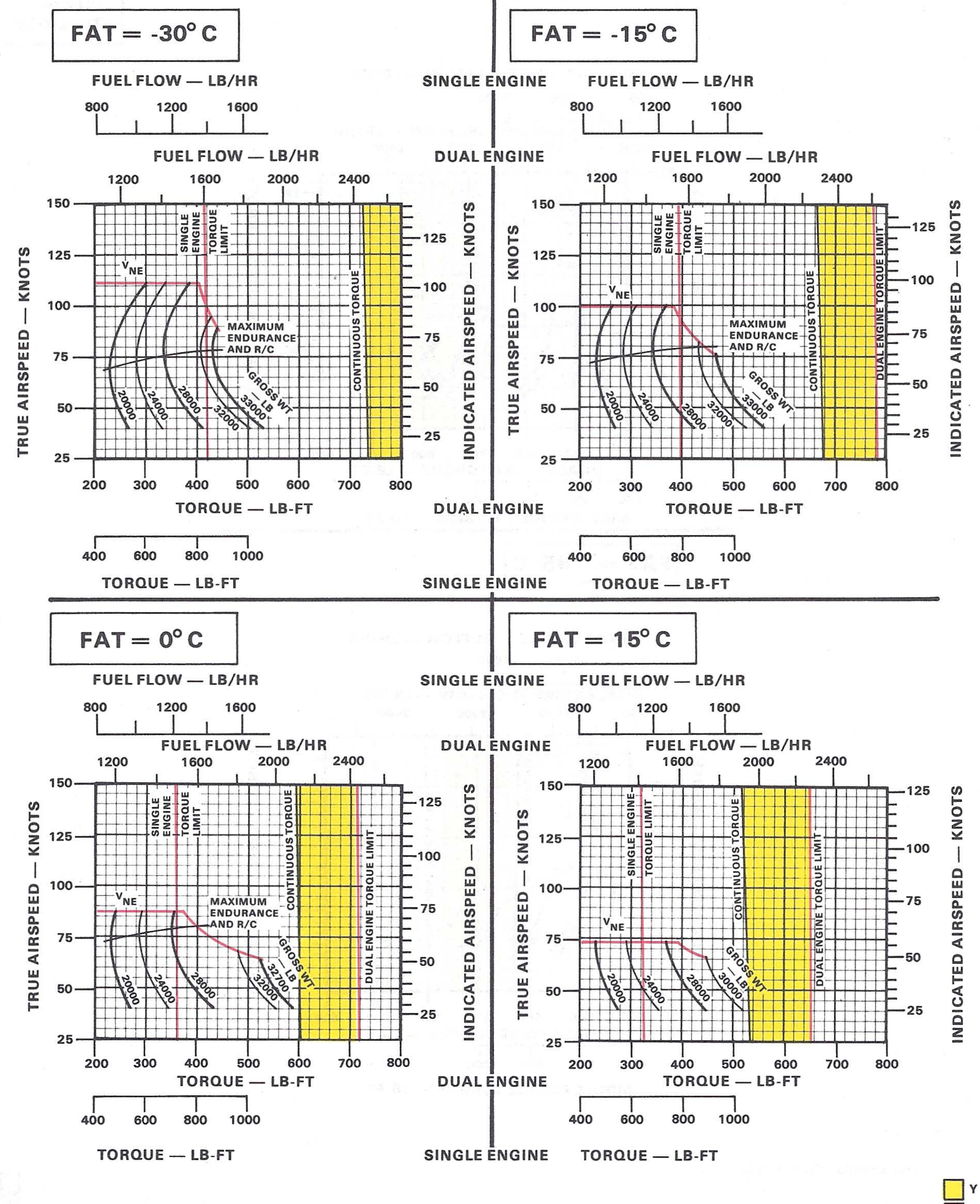
Figure 7-18. Cruise Chart 30°C and 45°C, 6,000 Feet

CRUISE

PRESSURE ALTITUDE 9000 FEET

CLEAN CONFIGURATION   230 ROTOR RPM   JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B



DATA BASIS: FLIGHT TEST

Figure 7-19. Cruise Chart -30°C, -15°C, 0°C and 15°C, 9,000 Feet

CRUISE

PRESSURE ALTITUDE 12000 FEET

CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7/7B

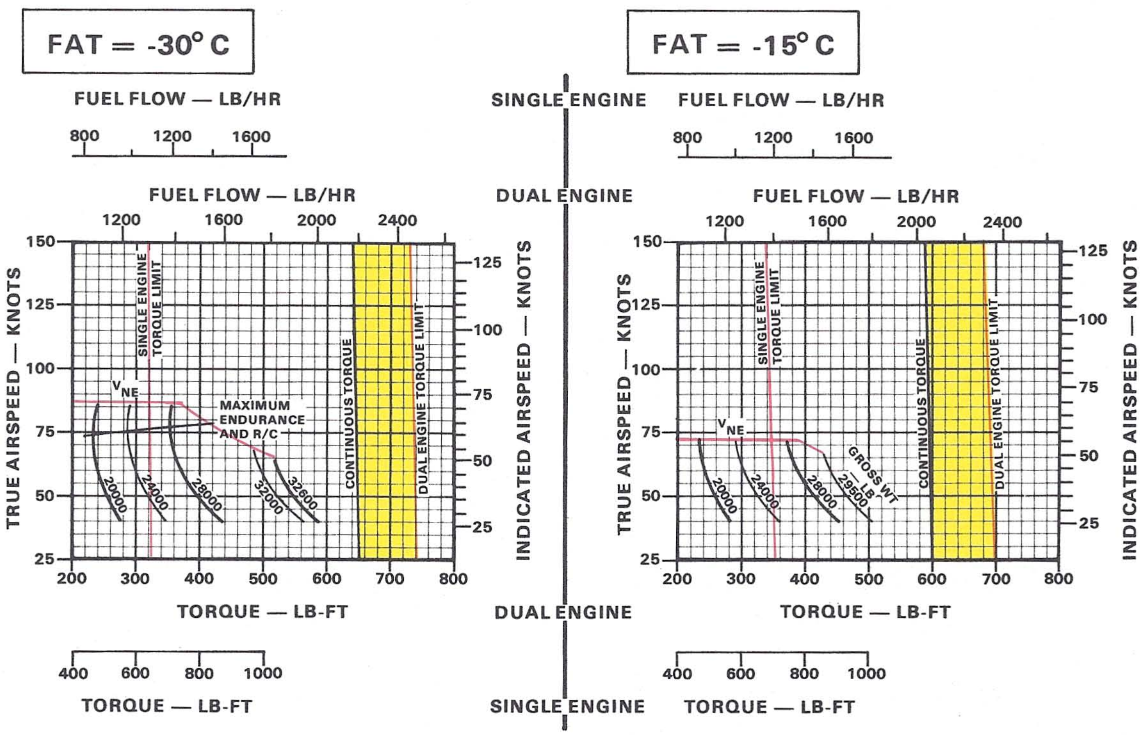


Figure 7-20. Cruise Chart –30°C and –15°C, 12,000 Feet

SECTION VII CRUISE

PART TWO—T55-L-7C ENGINES

7-43. Description.

The cruise charts found in figures 7-22 thru 7-29 present torque requirements and fuel flow for level flight as a function of airspeed and gross weight for various combinations of pressure altitude and free air temperature.

7-44. Use of Charts.

The primary use of the charts is illustrated by the example cruise chart, figure 7-21. To use the charts it is usually necessary to know the cruise pressure altitude, estimated free air temperature, cruise true airspeed, and gross weight. First, select the proper chart based on pressure altitude and free air temperature. Enter the chart at the cruise true airspeed, move right and read ias, move left to the gross weight, move down and read torque required, then move up and read fuel flow. Maximum performance conditions are determined by entering the chart where the maximum range line of maximum endurance and rate of climb line interesect the gross weight line; then read airspeeds, fuel flow, and torque required. Normally, sufficient accuracy can be obtained by selecting the chart nearest to the planned cruising altitude and free air temperature, or more conservatively, by selecting the chart with the next higher altitude and free air temperature (example cruise chart, method one). If greater accuracy is required, interpolation between altitudes and/or temperatures is permissible (example cruise chart, method two). To be conservative, use the gross weight at the beginning of the cruise flight. For improved accuracy on long flights, it is preferable to determine cruise information for several flight segments to allow for decreasing gross weight.

a. Airspeed. True and indicated airspeeds are presented at opposite sides of each chart. On any chart, indicated airspeed can be directly converted to true airspeed (or vice versa) by reading directly across the chart without regard to other chart information. Maximum permissible airspeed (Vne) limits appear as red lines on each chart.

b. Torque. Since pressure altitude and temperature are defined for each chart, torque required varies only with gross weight and airspeed. (See example cruise chart, method three.) The calibrated torque limits shown are either transmission or engine torque limits (whichever is least).

c. Fuel Flow. Fuel flow scales are provided opposite the torque scales. Torque may be converted directly to fuel flow on any chart without regard to other chart information.

d. Maximum Range. Maximum range lines indicate optimum gross weight and cruise speed conditions with respect to distance covered per pound of fuel consumed for zero wind conditions.

e. Maximum Endurance and Rate of Climb. Maximum endurance and rate of climb lines indicate optimum gross weight and cruise speed conditions for maximum endurance and maximum rate of climb. These conditions require minimum fuel flow (maximum endurance) and provide maximum torque change for climb (maximum rate of climb).

7-45. Conditions.

The cruise charts are based on 230 rotor rpm.

EXAMPLE (Dual Engine)

WANTED

TORQUE REQUIRED FOR LEVEL FLIGHT, FUEL FLOW
AND INDICATED AIRSPEED

KNOWN

GROSS WEIGHT = 28000 POUNDS
PRESSURE ALTITUDE = 1500 FEET
FAT = 7.5°C
DESIRED TRUE AIRSPEED = 115 KNOTS

METHOD 1 (Simplest)

USE NEXT HIGHER ALTITUDE AND TEMPERATURE
(3000 FEET AND 15°C)
ENTER DESIRED TRUE AIRSPEED ON LEFT
MOVE RIGHT TO GROSS WEIGHT
MOVE DOWN, READ TORQUE = 400 LB-FT
MOVE UP, READ FUEL FLOW = 1775 LB/HR
MOVE RIGHT, READ IAS = 108 KNOTS

METHOD 2 (Interpolate)

READ TORQUE, FUEL FLOW AND IAS AT EACH ADJACENT ALTITUDE
AND FAT THEN INTERPOLATE BETWEEN ALTITUDE AND FAT.

ALTITUDE	SEA-LEVEL		3000 FEET		1500 FEET
FAT	0°C	15°C	0°C	15°C	7.5°C
TORQUE (LB-FT)	410	404	402	400	404
FUEL FLOW (LB/HR)	1855	1860	1775	1775	1816
IAS (KNOTS)	120	117	112	108	114

EXAMPLE

WANTED

SPEED FOR MAXIMUM RANGE
SPEED FOR MAXIMUM ENDURANCE
AIRSPEED LIMIT (V_{NE})

KNOWN

GROSS WEIGHT = 28000 POUNDS
PRESSURE ALTITUDE = SEA-LEVEL
FAT = 0°C

METHOD

READ SPEEDS WHERE GROSS WEIGHT LINE INTERSECTS
PERFORMANCE OR LIMIT LINE
MAXIMUM RANGE: TAS = 126 KNOTS, IAS = 132 KNOTS
MAXIMUM ENDURANCE: TAS = 74 KNOTS, IAS = 73 KNOTS
V_{NE}: TAS = 126 KNOTS, IAS = 132 KNOTS

EXAMPLE

WANTED

TORQUE AVAILABLE

KNOWN

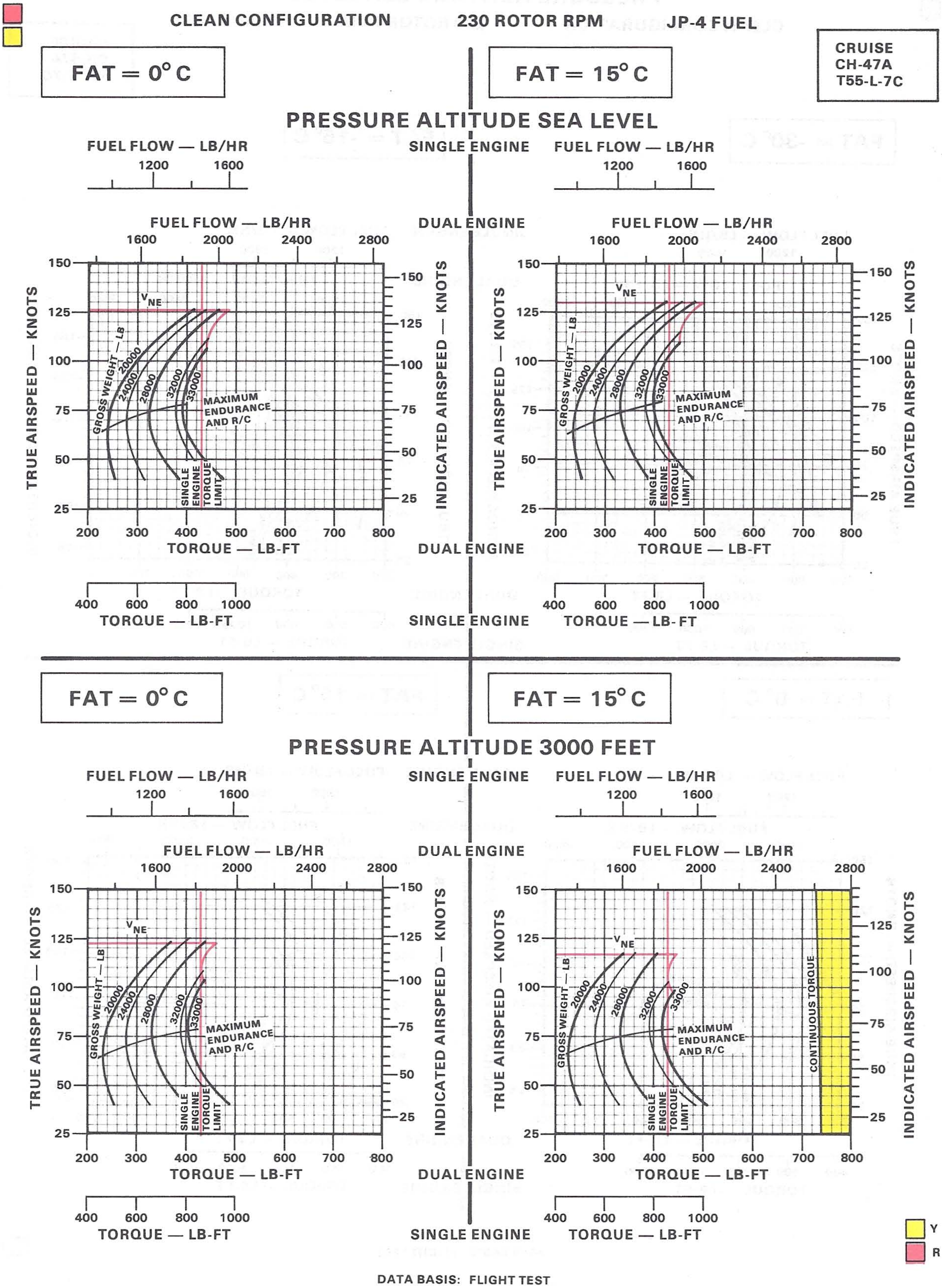
PRESSURE ALTITUDE = 3000 FEET
FAT = 15°C   TAS = 115 KNOTS

METHOD

ENTER TAS ON LEFT (OR IAS ON RIGHT)
MOVE RIGHT TO TORQUE LINE
MOVE DOWN, READ TORQUE AVAILABLE
CONTINUOUS TORQUE = 732 LB-FT
MAXIMUM TORQUE = 861 LB-FT (IF DUAL ENGINE TORQUE LIMIT
IS NOT INDICATED, READ SINGLE ENGINE LIMIT ON DUAL ENGINE SCALE
AND MULTIPLY BY 2)

Figure 7-21. Example Cruise Chart (Sheet 1 of 2)

CRUISE EXAMPLE



DATA BASIS: FLIGHT TEST

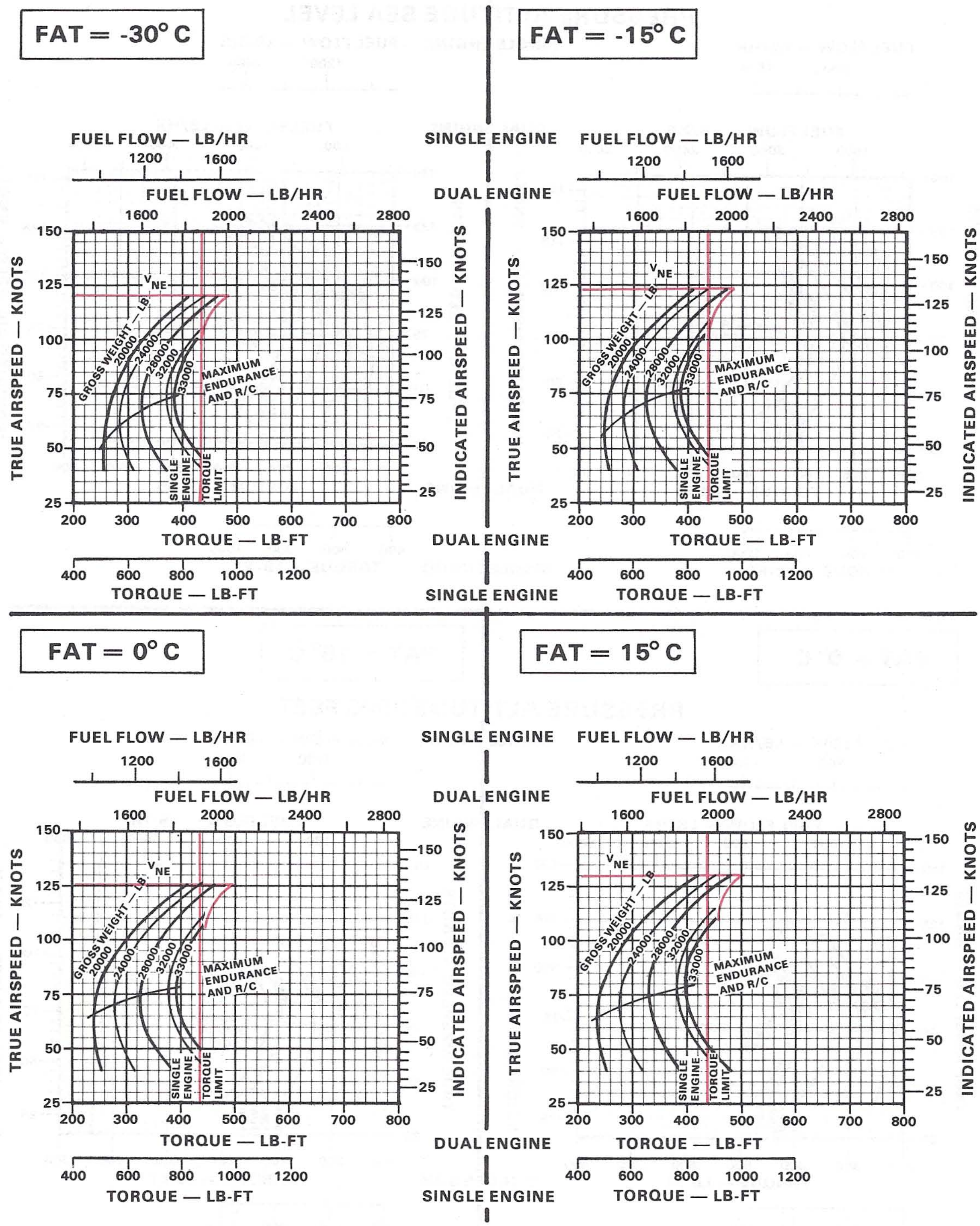
Figure 7-21. Example Cruise Chart (Sheet 2 of 2)

CRUISE

PRESSURE ALTITUDE SEA LEVEL

CLEAN CONFIGURATION   230 ROTOR RPM   JP-4 FUEL

CRUISE
CH-47A
T55-L-7C



DATA BASIS: FLIGHT TEST

Figure 7-22. Cruise Chart −30°C, −15°C, 0°C, and 15°C, Sea Level

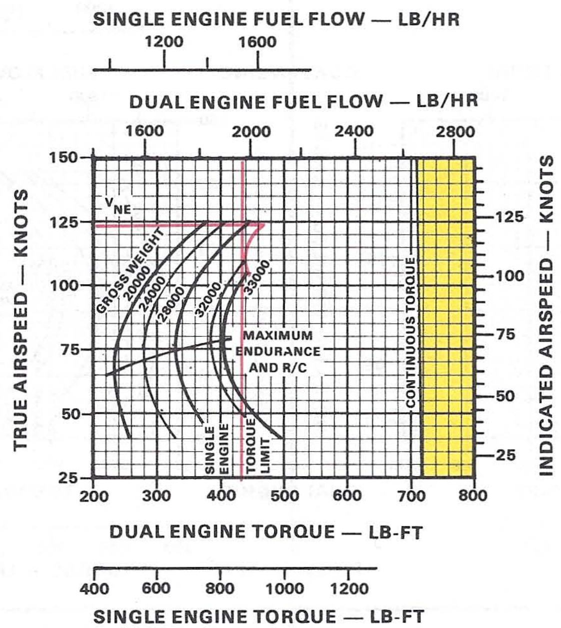
CRUISE

PRESSURE ALTITUDE SEA LEVEL

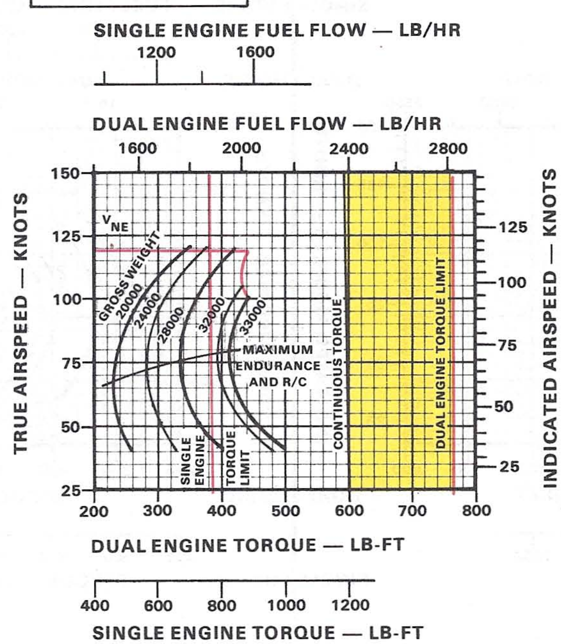
CLEAN CONFIGURATION **230 ROTOR RPM** **JP-4 FUEL**

CRUISE
CH-47A
T55-L-7C

FAT = 30° C



FAT = 45° C



DATA BASIS: FLIGHT TEST

Y
R

Figure 7-23. Cruise Chart 30°C and 45°C, Sea Level

CRUISE
PRESSURE ALTITUDE 3000 FEET

CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7C

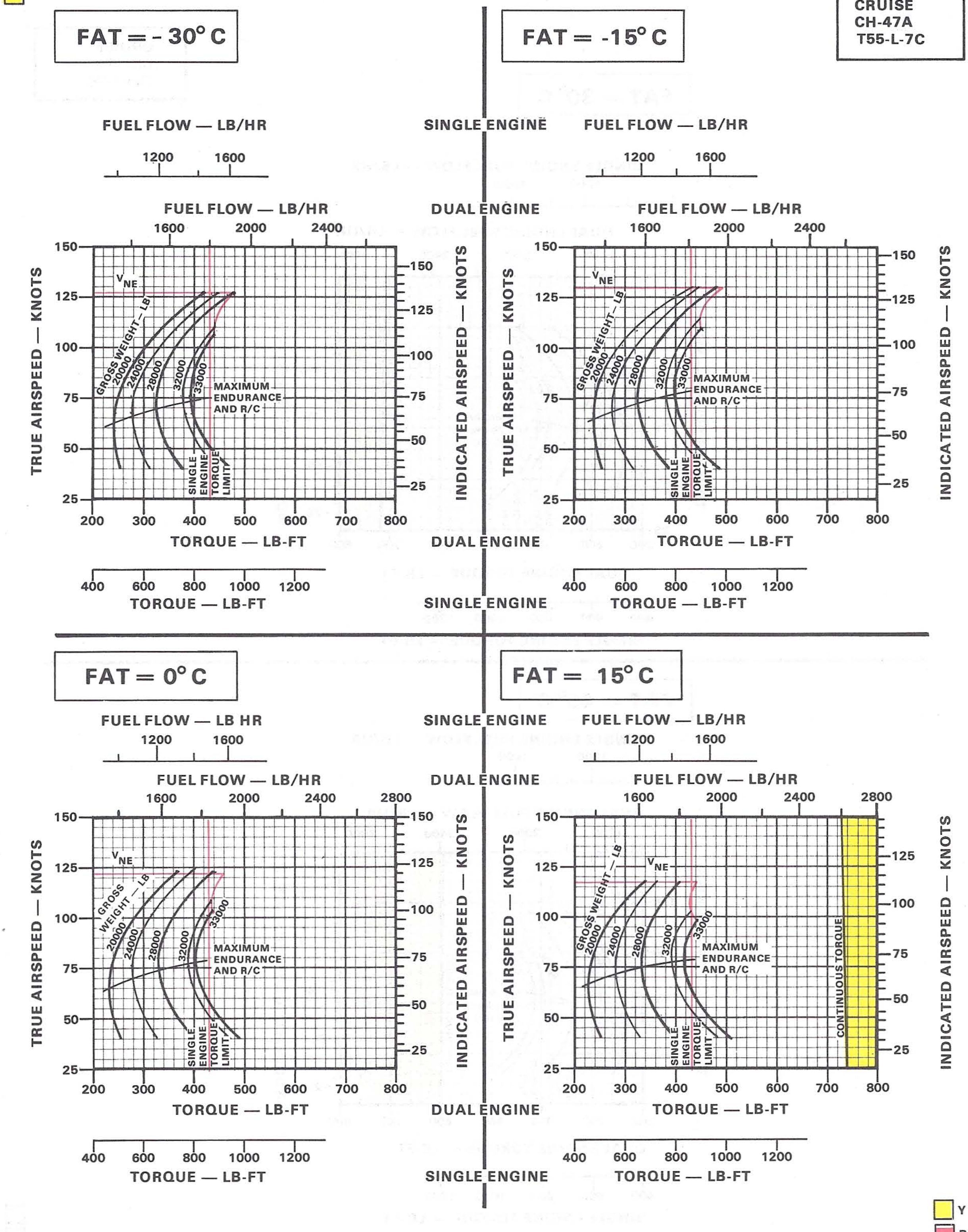


Figure 7-24. Cruise Chart -30°C, -15°C, 0°C, and 15°C, 3,000 Feet

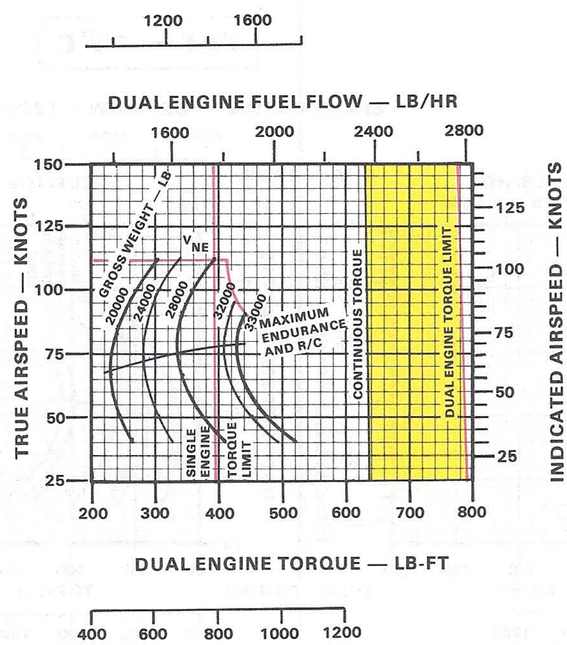
CRUISE

PRESSURE ALTITUDE 3000 FEET

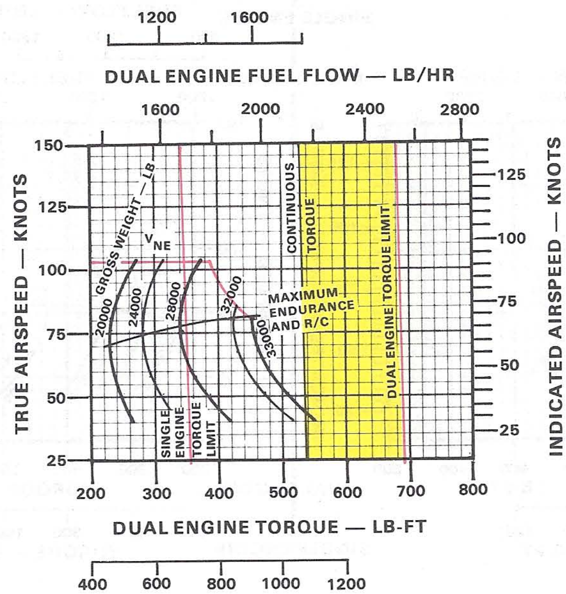
CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7C

FAT = 30° C



FAT = 45° C



DATA BASIS: FLIGHT TEST

Figure 7-25. Cruise Chart 30°C and 45°C, 3,000 Feet

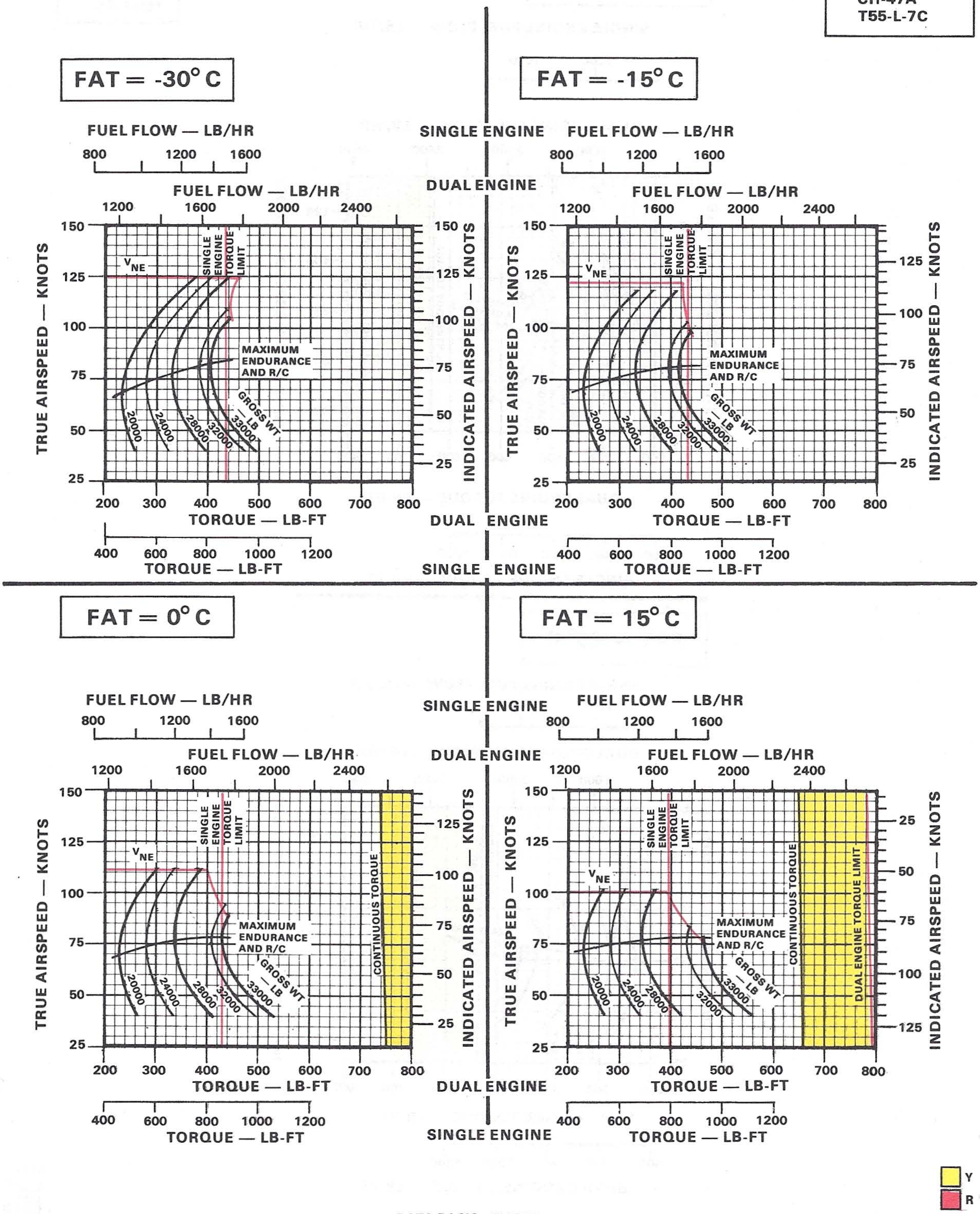
316-520 O - 80 - 17

CRUISE

PRESSURE ALTITUDE 6000 FEET

CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7C



DATA BASIS: FLIGHT TEST

Figure 7-26. Cruise Chart -30°C, -15°C, 0°C, and 15°C, 6,000 Feet

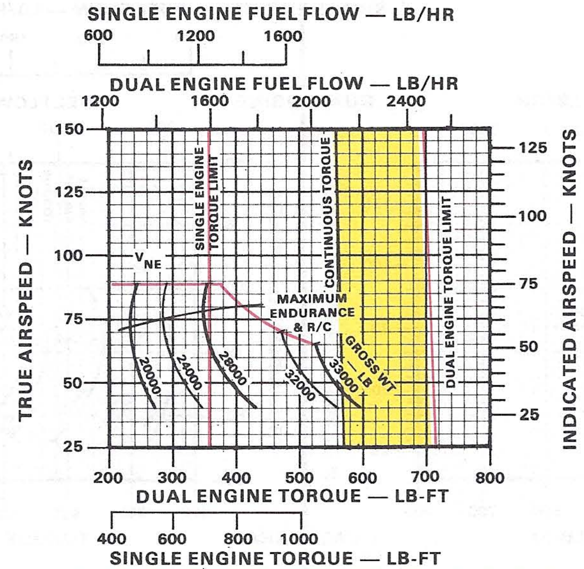
CRUISE

PRESSURE ALTITUDE 6000 FEET

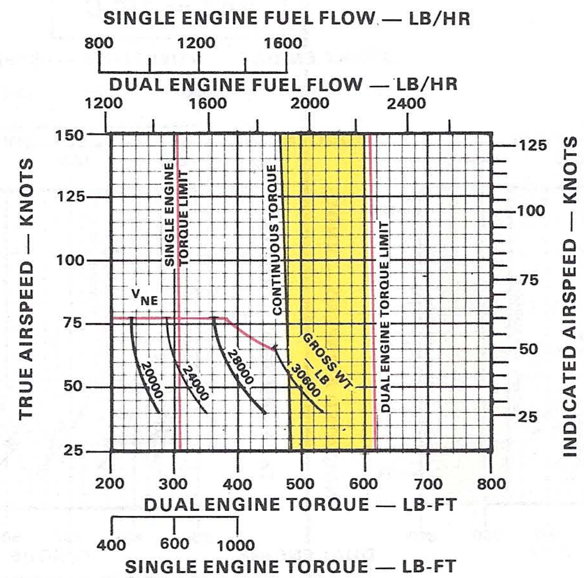
CLEAN CONFIGURATION 230 ROTOR RPM JP-4 FUEL

CRUISE
CH-47A
T55-L-7C

FAT = 30° C



FAT = 45° C



DATA BASIS: FLIGHT TEST

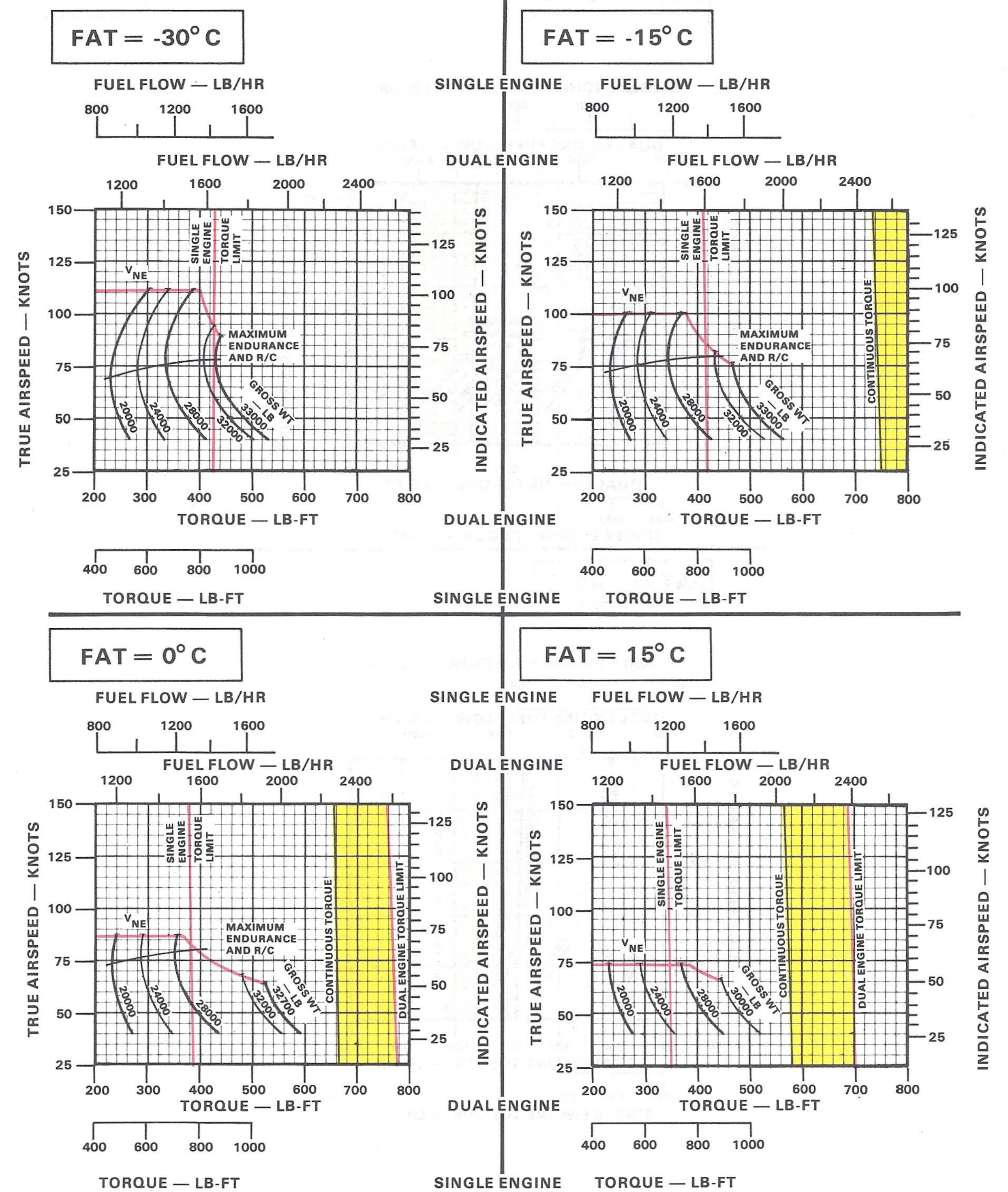
Y
R

Figure 7-27. Cruise Chart 30°C and 45°C, 6,000 Feet

CRUISE
PRESSURE ALTITUDE 9000 FEET

CLEAN CONFIGURATION | 230 ROTOR RPM | JP-4 FUEL

CRUISE
CH-47A
T55-L-7C



DATA BASIS: FLIGHT TEST

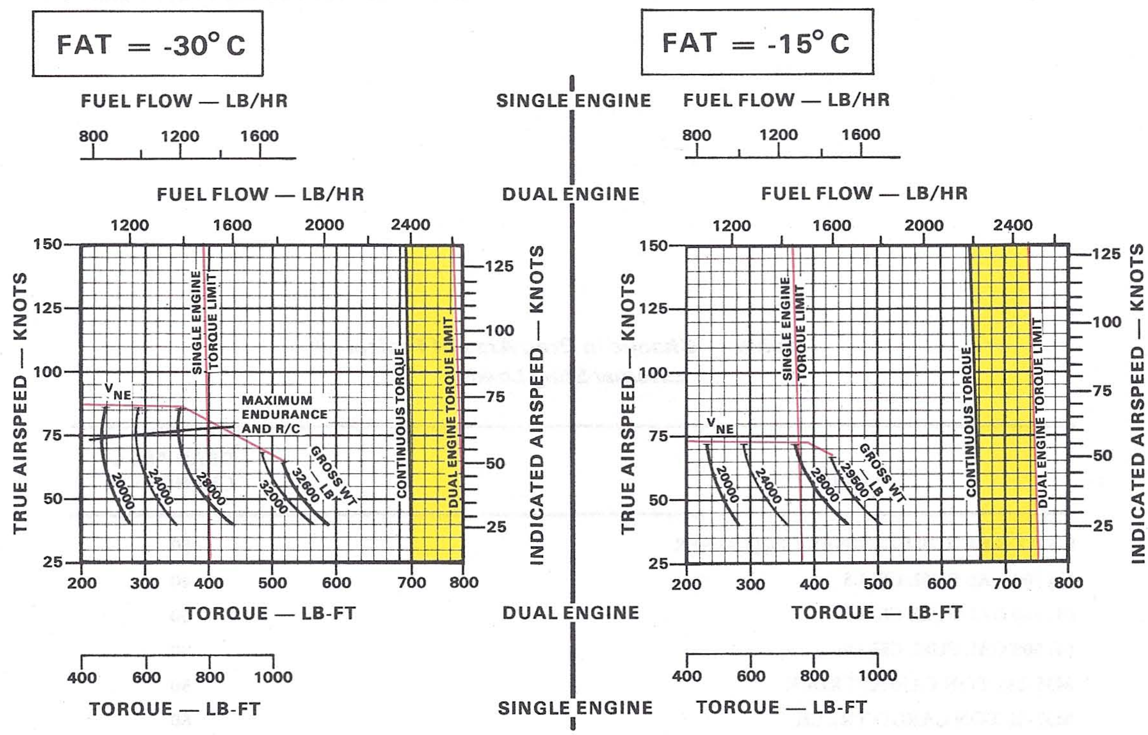
Figure 7-28. Cruise Chart −30°C, −15°C, 0°C, and 15°C, 9,000 Feet

CRUISE

PRESSURE ALTITUDE 12000 FEET

CLEAN CONFIGURATION **230 ROTOR RPM** **JP-4 FUEL**

CRUISE
CH-47A
T55-L-7C



Y
R

Figure 7-29. Cruise Chart –30°C and –15°C, 12,000 Feet

SECTION VIII DRAG

PART ONE—T55-L-7/7B ENGINES

7-46. Description.

The drag chart, figure 7-30, shows the additional torque change required for flight due to drag area change as a result of external configuration changes.

7-47. Use of Charts.

The primary use of the chart is illustrated by the example. To determine the change in torque, it is necessary to know the drag area change, true airspeed, pressure altitude, and free air temperature. From the table below find the drag area change associated with the configuration, or estimate if necessary. Enter chart at known drag area change, move right to true airspeed, move down to pressure altitude, move left to free air temperature, then move down and read change in engine torque.

7-48. Conditions.

The drag chart is based on use of 230 rotor rpm.

Table — Change in Drag Area of Typical External Sling Loads

LOAD	DRAG AREA CHANGE FT²
8 FT X 8 FT X 20 FT CONEX CONTAINER	150
(2) 500 GAL FUEL CELLS	40
(3) 500 GAL FUEL CELLS	60
(4) 500 GAL FUEL CELLS	80
M35-2½ TON CARGO TRUCK	80
M37-¾ TON CARGO TRUCK	60
M2A1-105MM HOWITZER	50
M102-105MM HOWITZER	50
OH-6 HELICOPTER	40 (1)
CH-47 HELICOPTER	230 (1)
OV-10 FIXED WING AIRCRAFT	80 (1)

(1) RIGGED IN ACCORDANCE WITH FM 55-413, JAN 1976

DATA BASIS: ESTIMATED

DRAG

230 ROTOR RPM

DRAG
CH-47A
T55-L-7/7B

EXAMPLE

WANTED

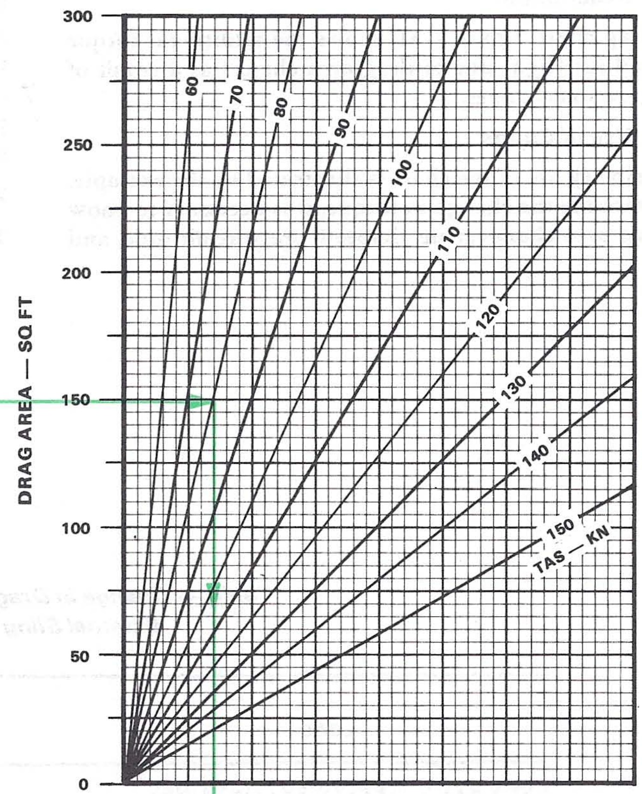
ADDITIONAL TORQUE REQUIRED FOR CRUISE WITH AN EXTERNAL LOAD

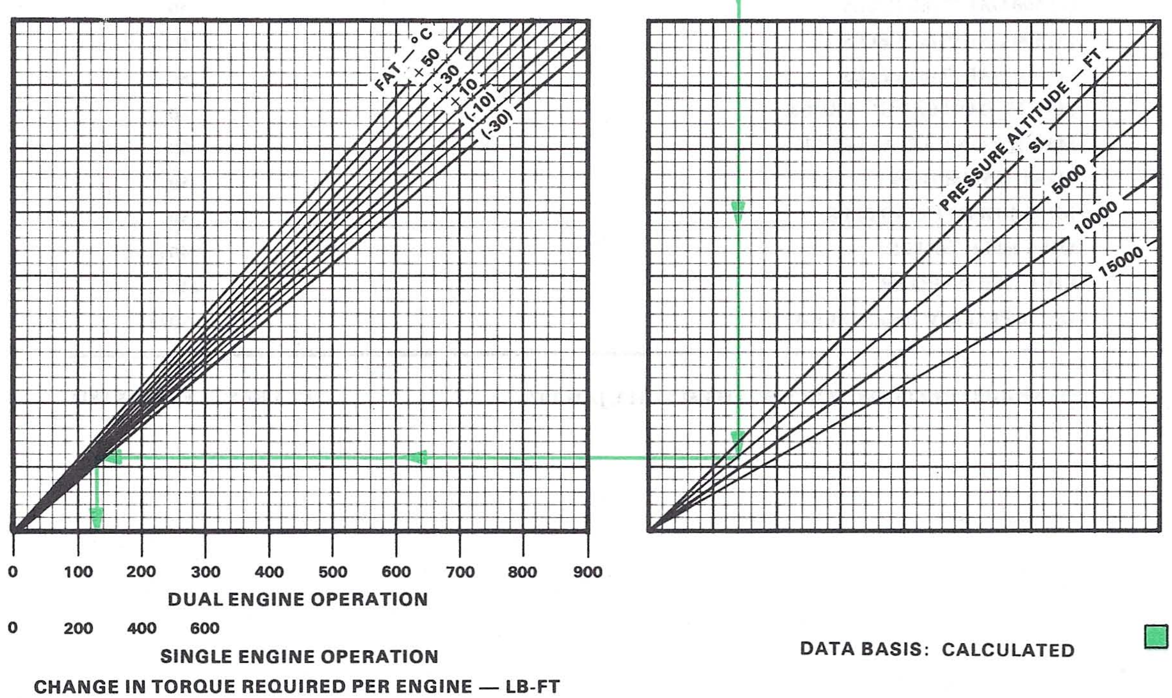
KNOWN

EXTERNAL LOAD — 8 X 8 X 20 FT CONEX CONTAINER
TRUE AIRSPEED = 80 KN
PRESSURE ALTITUDE = 5000 FT
FAT = -10°C

METHOD

FROM THE TABLE OPPOSITE DETERMINE THE EQUIVALENT DRAG AREA OF THE LOAD = 150 SQ FT.
ENTER THIS VALUE OF DRAG AREA HERE.
MOVE RIGHT TO DESIRED TRUE AIRSPEED = 80 KN.
MOVE DOWN TO PRESSURE ALTITUDE = 5000 FT.
MOVE LEFT TO FAT = -10° C.
MOVE DOWN, READ CHANGE IN TORQUE FOR TWO ENGINE OPERATION = 130 LB-FT.





DATA BASIS: CALCULATED

G

Figure 7-30. Drag Chart

SECTION VIII DRAG

PART TWO—T55-L-7C ENGINES

7-49. Description.

The drag chart, figure 7-31, shows the additional torque required for flight due to drag area change as a result of configuration changes.

7-50. Use of Charts.

The primary use of the chart is illustrated by the example. To determine the change in torque, it is necessary to know the drag area change, true airspeed, pressure altitude, and free air temperature. From the table below find the drag area change associated with the configuration, or estimate the change if necessary. Enter chart at known drag area change, move right to true airspeed, move down to pressure altitude, move left to free air temperature, then move down and read change in engine torque.

7-51. Conditions.

The drag chart is based on use of 230 rotor rpm.

Table — Change in Drag Area of Typical External Sling Loads

LOAD	DRAG AREA CHANGE FT^2
8 FT X 8 FT X 20 FT CONEX CONTAINER	150
(2) 500 GAL FUEL CELLS	40
(3) 500 GAL FUEL CELLS	60
(4) 500 GAL FUEL CELLS	80
M35-2½ TON CARGO TRUCK	80
M37-¾ TON CARGO TRUCK	60
M2A1-105MM HOWITZER	50
M102-105MM HOWITZER	50
OH-6 HELICOPTER	40 (1)
CH-47 HELICOPTER	230 (1)
OV-10 FIXED WING AIRCRAFT	80 (1)

(1) RIGGED IN ACCORDANCE WITH FM 55-413, JAN 1976

DATA BASIS: ESTIMATED

DRAG

230 ROTOR RPM

DRAG
CH-47A
T55-L-7C

EXAMPLE

WANTED

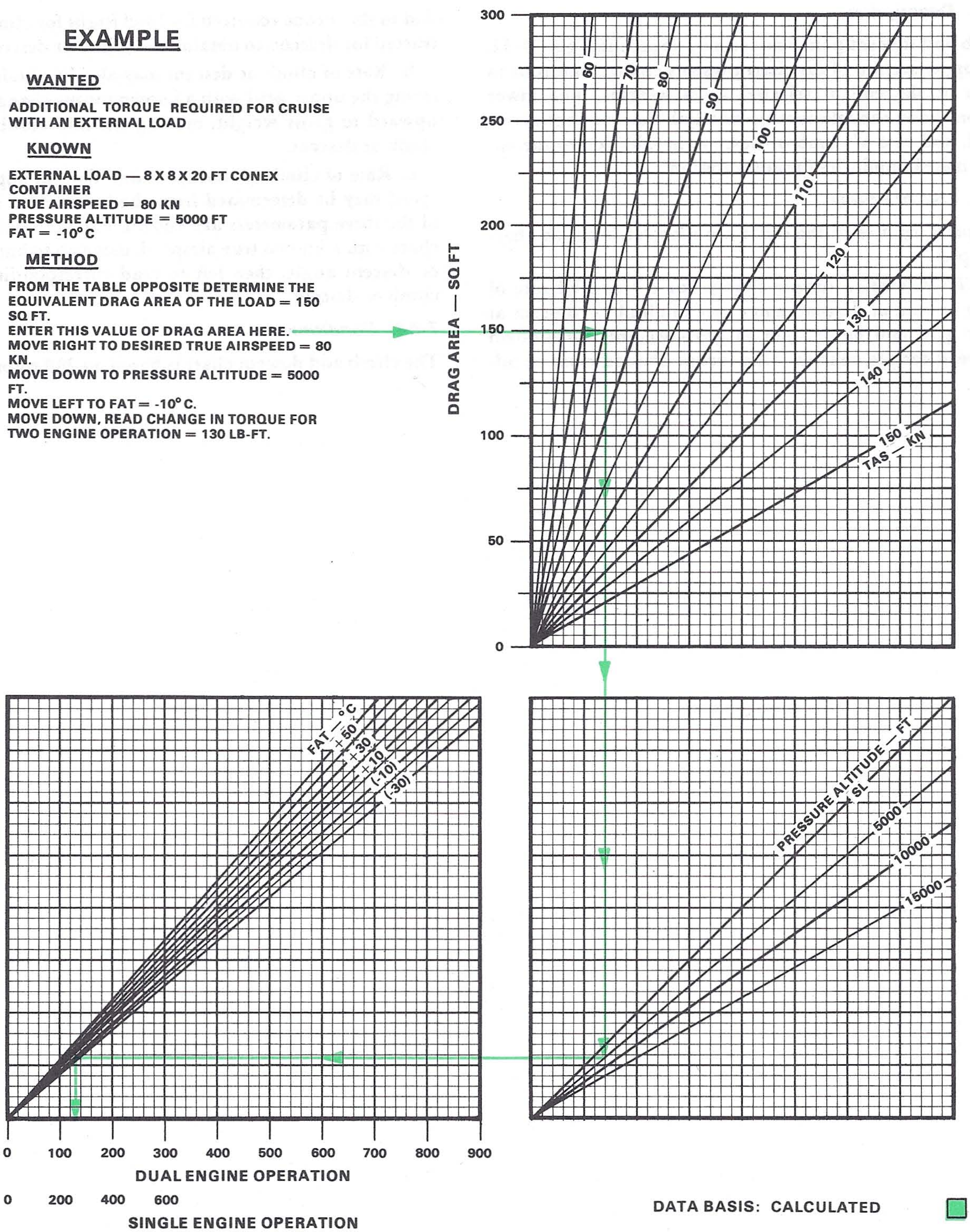
ADDITIONAL TORQUE REQUIRED FOR CRUISE WITH AN EXTERNAL LOAD

KNOWN

EXTERNAL LOAD — 8 X 8 X 20 FT CONEX CONTAINER
TRUE AIRSPEED = 80 KN
PRESSURE ALTITUDE = 5000 FT
FAT = -10° C

METHOD

FROM THE TABLE OPPOSITE DETERMINE THE EQUIVALENT DRAG AREA OF THE LOAD = 150 SQ FT.
ENTER THIS VALUE OF DRAG AREA HERE.
MOVE RIGHT TO DESIRED TRUE AIRSPEED = 80 KN.
MOVE DOWN TO PRESSURE ALTITUDE = 5000 FT.
MOVE LEFT TO FAT = -10° C.
MOVE DOWN, READ CHANGE IN TORQUE FOR TWO ENGINE OPERATION = 130 LB-FT.



DATA BASIS: CALCULATED

G

Figure 7-31. Drag Chart

SECTION IX CLIMB-DESCENT

PART ONE—T55-L-7/7B ENGINES

7-52. Description.

Climb and descent performance may be seen in figure 7-32. The upper section of the chart presents change in torque to climb or descend at selected gross weights. The lower section shows the relationship of climb-descent angles, airspeed, and rate of climb or descent, in addition to the approximate boundaries for autorotation.

7-53. Use of Charts.

The primary uses of the chart are illustrated by the chart examples.

a. To determine torque change for a specified rate of climb or rate of descent, enter rate of climb or descent at upper grid and move right to gross weight, move down and read torque change. This torque change must be added to the torque required for level flight for climb, or subtracted for descent, to obtain total climb or descent torque.

b. Rate of climb or descent may also be obtained by entering the upper grid with a known torque change, moving upward to gross weight, moving left and reading rate of climb or descent.

c. Rate of climb or descent, climb-descent angle, or airspeed may be determined from the lower chart if any two of the three parameters are known. For example, enter the chart with a known true airspeed, move up to known climb or descent angle, then left to read corresponding rate of climb or descent.

7-54. Conditions.

The climb and descent chart is based on 230 rotor rpm.

CLIMB-DESCENT

230 ROTOR RPM

CLIMB/DESCENT
CH-47A
T55-L-7/7B

EXAMPLE I

WANTED

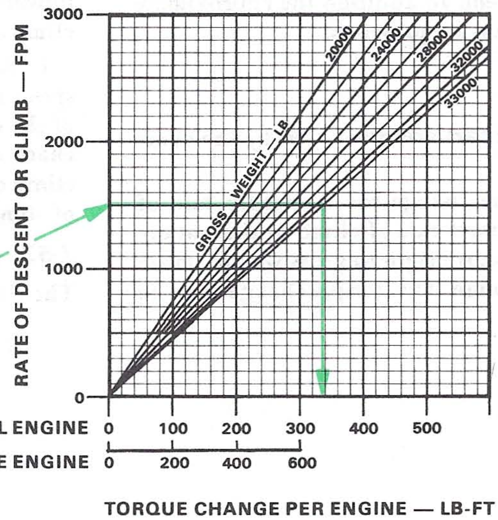
TORQUE CHANGE REQUIRED FOR DESIRED R/C OR R/D

KNOWN

GROSS WEIGHT = 33000 LB
DESIRED R/C = 1500 FPM

METHOD

ENTER DESIRED R/C HERE.
MOVE RIGHT TO GROSS WEIGHT.
MOVE DOWN, READ TORQUE CHANGE PER ENGINE = 338 LB/FT, DUAL ENGINE OPERATION, AND 676 LB/FT, SINGLE ENGINE OPERATION.



EXAMPLE II

WANTED

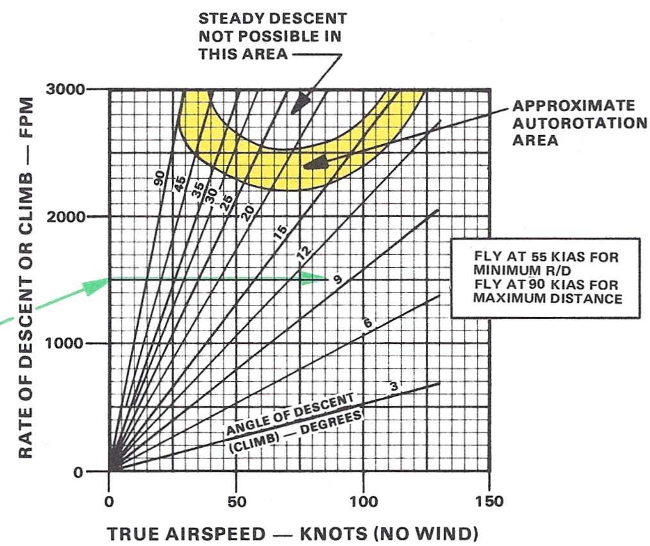
ANGLE OF DESCENT OR CLIMB

KNOWN

DESIRED R/D = 1500 FPM
DESIRED TAS = 85 KN

METHOD

ENTER R/D HERE.
MOVE RIGHT TO TAS.
INTERPOLATE TO READ ANGLE OF DESCENT = 10 DEGREES.



DATA BASIS: FLIGHT TEST

Figure 7-32. Climb-Descent Chart

SECTION IX CLIMB—DESCENT

PART TWO—T55-L-7C ENGINES

7-55. Description.

The upper section of the climb-descent chart (figure 7-33) presents change in torque for specific rates of climb or descent. The lower section of the climb-descent charts shows the relationship of climb-descent angles, airspeed, and rate of climb or descent. In addition the approximate boundaries for autorotation are presented.

7-56. Use of Charts.

The primary uses of the chart are illustrated by the chart example.

a. To determine torque change for a specific rate of climb or rate of descent, enter rate of climb or descent ordinate of upper grid and move right to gross weight, move down and read torque change. This torque change must be added to the torque required for level flight for climb, or subtracted for descent, to obtain total climb or descent torque.

b. Rate of climb or descent may also be obtained by entering the upper grid with a known torque change, moving upward to gross weight, moving left and reading rate-of-climb or descent.

c. Rate of climb or descent, climb-descent angle, or airspeed may be determined from the lower chart if any two of the three parameters are known. For example, enter the chart with a known true airspeed, move up to known climb or descent angle, then left to read corresponding rate of climb or descent.

7-57. Conditions.

The climb and descent chart is based on 230 rotor rpm.

CLIMB-DESCENT

230 ROTOR RPM

CLIMB/DESCENT
CH-47A
T55-L-7C

EXAMPLE I

WANTED

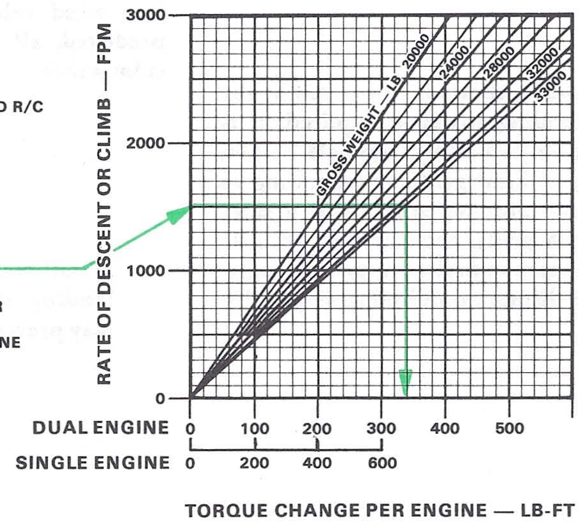
TORQUE CHANGE REQUIRED FOR DESIRED R/C OR R/D

KNOWN

GROSS WEIGHT = 33000 LB
DESIRED R/C = 1500 FPM

METHOD

ENTER DESIRED R/C HERE.
MOVE RIGHT TO GROSS WEIGHT.
MOVE DOWN, READ TORQUE CHANGE PER ENGINE = 338 LB/FT, DUAL ENGINE OPERATION, AND 676 LB/FT, SINGLE ENGINE OPERATION.



EXAMPLE II

WANTED

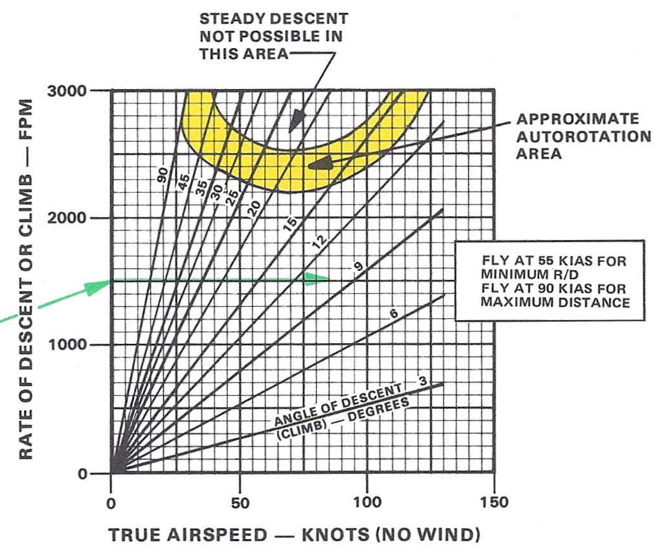
ANGLE OF DESCENT OR CLIMB

KNOWN

DESIRED R/D = 1500 FPM
DESIRED TAS = 85 KN

METHOD

ENTER R/D HERE.
MOVE RIGHT TO TAS.
INTERPOLATE TO READ ANGLE OF DESCENT = 10 DEGREES.



DATA BASIS: FLIGHT TEST

Figure 7-33. Climb-Descent Chart

SECTION X LANDING

PART ONE—T55-L-7/7B ENGINES

7-58. Description.

The landing charts, figure 7-34, present total distance required to stop at a 10-foot hover after clearing an obstacle as a function of hover capability and approach angle. The three grids display capability for 40-foot, 20-foot, and 10-foot hover for steep, normal, and shallow approach angles respectively.

7-59. Use of Charts.

The primary use of the landing charts is illustrated by the example. To determine landing distance required, it is necessary to know the hover capability, obstacle height, and desired approach angle. Find grid corresponding to hover capability (capability must be equal to or greater than that identified on each grid), enter grid at obstacle height to be cleared, move right to desired approach angle, move down and read total distance required to stop at 10-foot hover.

7-60. Conditions.

Distances shown are based on an angular approach distance plus a deceleration distance where airspeed is reduced from the initial approach speed to an ige hover wheel height of 10 feet. Landing performance shown in these charts are based on calm wind conditions. Since surface wind velocity and direction cannot be accurately predicted, all landing performance should be based on calm winds.

CAUTION

A tailwind during landing will increase the landing distance after obstacle clearance and may prevent a successful landing.

LANDING

LANDING
CH-47A
T55-L-7/7B

EXAMPLE

WANTED

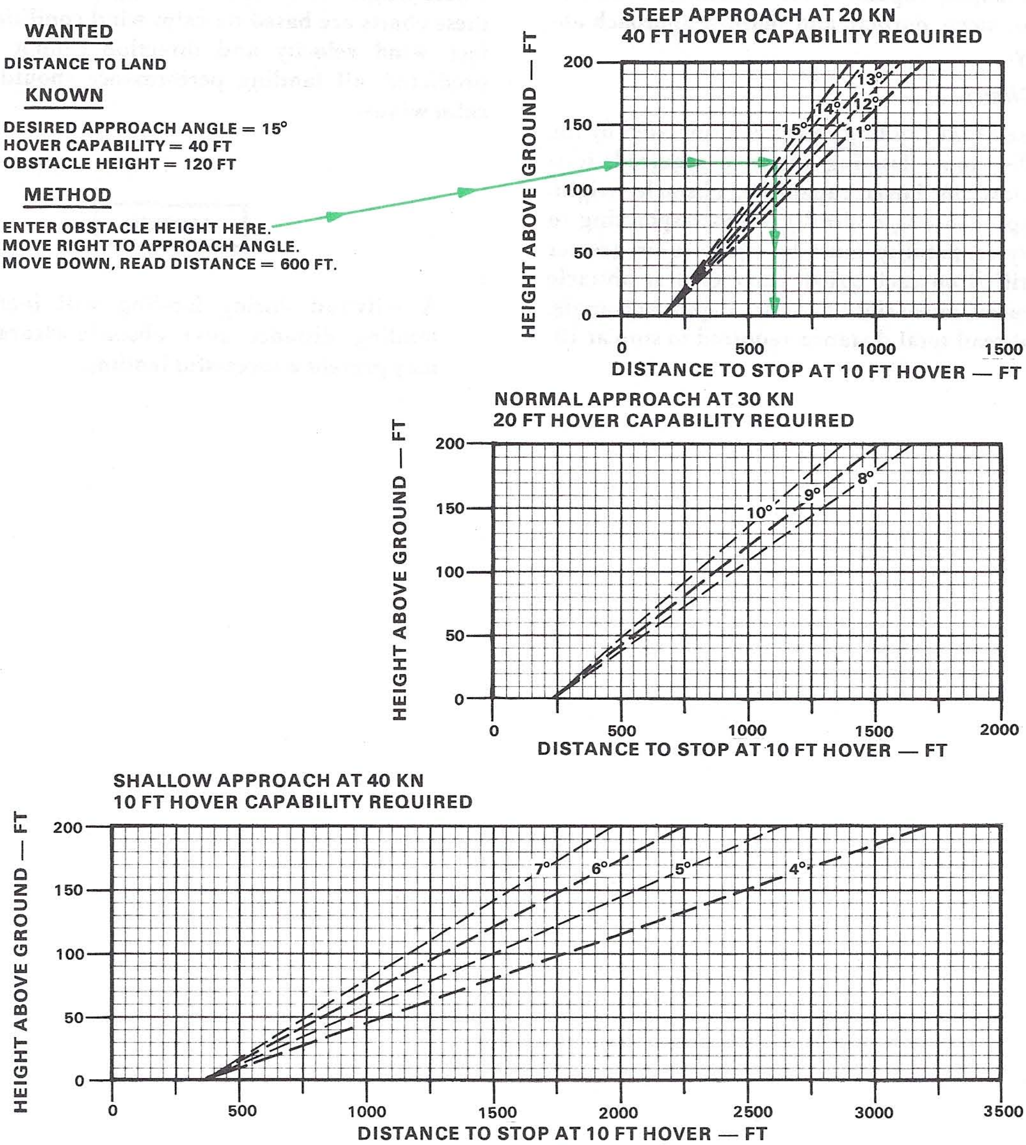
DISTANCE TO LAND

KNOWN

DESIRED APPROACH ANGLE = 15°
HOVER CAPABILITY = 40 FT
OBSTACLE HEIGHT = 120 FT

METHOD

ENTER OBSTACLE HEIGHT HERE.
MOVE RIGHT TO APPROACH ANGLE.
MOVE DOWN, READ DISTANCE = 600 FT.



DATA BASIS: ESTIMATED

Figure 7-34. Landing Chart

SECTION X LANDING

PART TWO—T55-L-7C ENGINES

7-61. Description.

The landing chart in figure 7-35 presents total distance, as a function of hover capability and approach angle, required to stop at a 10-foot hover after clearing an obstacle. The three grids display capability for 40-foot, 20-foot, and 10-foot hover for steep, normal, and shallow approach angles respectively.

7-62. Use of Charts.

The primary use of the landing charts is illustrated by the example. To determine landing distance required, it is necessary to know the hover capability, obstacle height, and desired approach angle. Find grid corresponding to hover capability (capability must be equal to or greater than that identified on each grid), enter grid at obstacle height to be cleared, move right to desired approach angle, move down and read total distance required to stop at 10-foot hover.

7-63. Conditions.

Distances shown are based on an angular approach distance plus deceleration distance when airspeed is reduced from the initial approach speed to an ige hover wheel height of 10 feet. Landing performance shown in these charts are based on calm wind conditions. Since surface wind velocity and direction cannot be accurately predicted, all landing performance should be based on calm winds.

CAUTION

A tailwind during landing will increase the landing distance after obstacle clearance and may prevent a successful landing.

LANDING

LANDING CH-47A T55-L-7C

EXAMPLE

WANTED

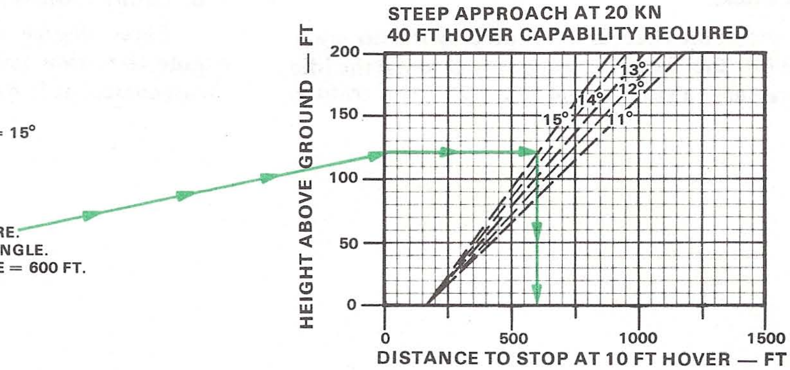
DISTANCE TO LAND

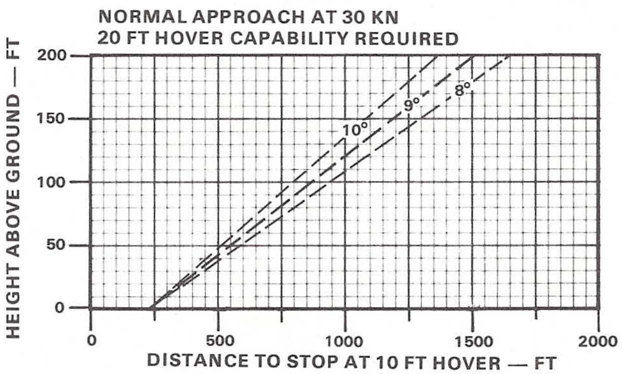
KNOWN

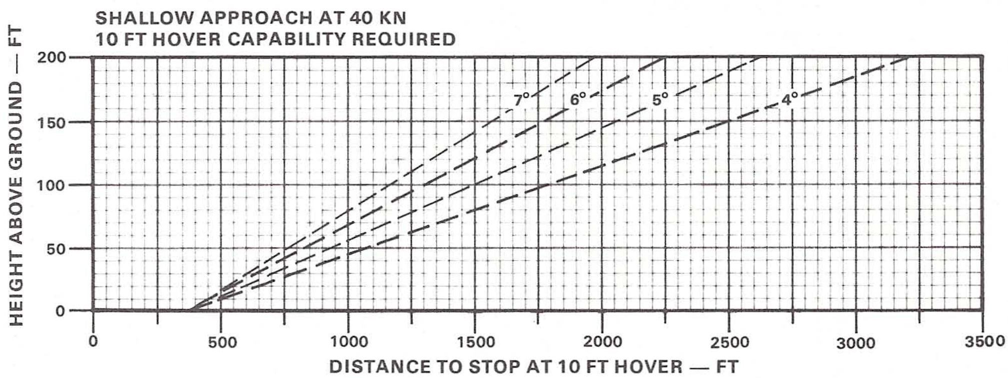
DESIRED APPROACH ANGLE = 15°
HOVER CAPABILITY = 40 FT
OBSTACLE HEIGHT = 120 FT

METHOD

ENTER OBSTACLE HEIGHT HERE.
MOVE RIGHT TO APPROACH ANGLE.
MOVE DOWN, READ DISTANCE = 600 FT.







DATA BASIS: ESTIMATED

G

Figure 7-35. Landing Chart

316-520 O - 80 - 18

SECTION XI IDLE FUEL FLOW

PART ONE— T55-L-7/7B ENGINES

7-64. Description.

The fuel flow chart, figure 7-36, presents engine fuel flow sensitivity to pressure altitude and free air temperature for ground idle and flight idle.

7-65. Use of Chart.

The primary use of the chart is illustrated by the example. To determine idle fuel flow, it is necessary to know the idle condition, pressure altitude, and free air temperature. Enter pressure altitude, move right to free air temperature, move down and read fuel flow.

7-66. Conditions.

a. Presented charts are based on the use of JP-4 fuel.

b. Ground idle is defined at 37.5 to 42.7 percent N1.

c. Three degree detent minimum beep is defined as engine condition levers at FLIGHT, minimum beep and thrust control at 3° detent.

IDLE FUEL FLOW

JP-4 FUEL

IDLE FUEL FLOW
CH-47A
T55-L-7/7B

EXAMPLE

WANTED

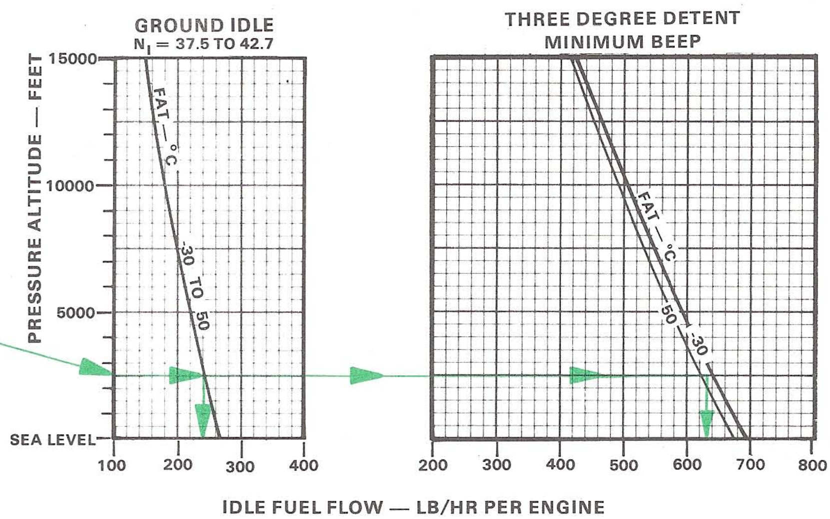
IDLE FUEL FLOW AT GROUND IDLE AND MINIMUM BEEP

KNOWN

PRESSURE ALTITUDE = 2500 FT
FAT = 15°C

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
FOR GROUND IDLE AND MINIMUM BEEP MOVE DOWN, READ GROUND IDLE FUEL FLOW = 241 LB/HR PER ENGINE AND MINIMUM BEEP FUEL FLOW = 632 LB/HR PER ENGINE.



DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.20-A

G

Figure 7-36. Idle Fuel Flow Chart

SECTION XI IDLE FUEL FLOW

PART TWO—T55-L-7C ENGINES

7-67. Description.

The fuel flow chart, figure 7-37, presents engine fuel flow sensitivity to pressure altitude and free air temperature for ground idle and flight idle.

7-68. Use of Charts.

The primary use of the chart is illustrated by the example. To determine idle fuel flow, it is necessary to know the idle condition, pressure altitude, and free air temperature. Enter pressure altitude, move right to free air temperature, move down and read fuel flow.

7-69. Conditions.

a. Presented charts are based on JP-4 fuel.

b. Ground idle is defined at 37.5 to 42.7 percent N1.

c. Three degree detent minimum beep is defined as engine condition levers at FLIGHT, minimum beep and thrust control at 3° detent.

IDLE FUEL FLOW

JP-4 FUEL

IDLE FUEL FLOW
CH-47A
T55-L-7C

EXAMPLE

WANTED

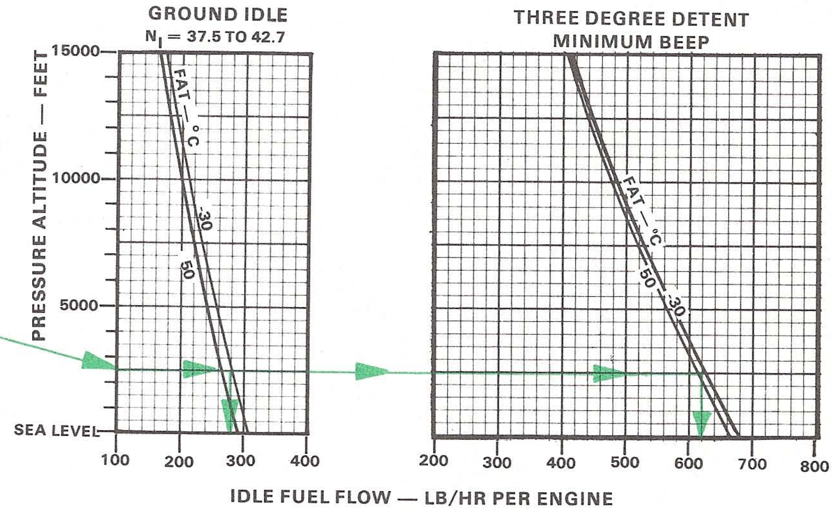
IDLE FUEL FLOW AT GROUND IDLE AND MINIMUM BEEP

KNOWN

PRESSURE ALTITUDE = 2500 FT
FAT = 15° C

METHOD

ENTER PRESSURE ALTITUDE HERE.
MOVE RIGHT TO FAT.
FOR GROUND IDLE AND MINIMUM BEEP MOVE DOWN, READ GROUND IDLE FUEL FLOW = 275 LB/HR PER ENGINE AND MINIMUM BEEP FUEL FLOW = 618 LB/HR PER ENGINE.



DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.31

Figure 7-37. Idle Fuel Flow Chart

SECTION XII AIRSPEED CALIBRATION

7-70. Description.

The airspeed calibration chart, figure 7-38, defines the relationship between indicated and calibrated airspeed for level flight, climb, and autorotation for helicopters with T55-L-7/7B or T55-L-7C engines.

7-71. Use of Chart.

The primary use of the chart is illustrated by the example. To determine calibrated airspeed, it is necessary to know indicated airspeed and flight regime. Enter chart at indicated airspeed, move right to appropriate flight regime, move down and read calibrated airspeed.

7-72. Conditions.

Presented airspeed calibration charts are for CH-47A helicopters with T55-L-7/7B or T55-L-7C engines.

AIRSPEED CALIBRATION

AIRSPEED
CH-47A

EXAMPLE

WANTED

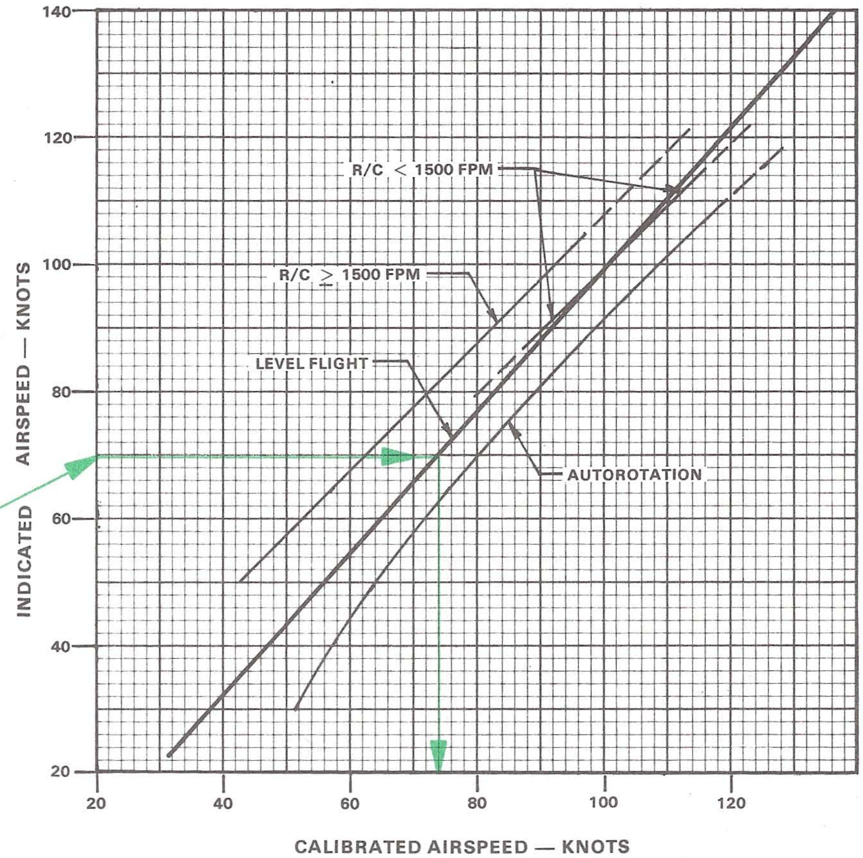
CALIBRATED AIRSPEED

KNOWN

INDICATED AIRSPEED = 70 KN
FLIGHT CONDITION = LEVEL FLIGHT

METHOD

ENTER INDICATED AIRSPEED HERE.
MOVE RIGHT TO FLIGHT CONDITION.
MOVE DOWN, READ CALIBRATED
AIRSPEED = 74 KN.



DATA BASIS: FLIGHT TEST

G

Figure 7-38. Airspeed Calibration Chart

CHAPTER 8
NORMAL PROCEDURES

SECTION I MISSION PLANNING

8-1. Mission Planning.

Mission planning begins when the mission is assigned and extends to the preflight check of the aircraft. It includes, but is not limited to checks of operating limits and restrictions; weight balance and loading; performance; publications; flight plan and crew and passenger briefings. The pilot in command shall ensure compliance with the contents of this manual that are applicable to the mission.

8-2. Operating Limits and Restrictions.

The minimum, maximum, normal, and cautionary operational ranges represent careful aerodynamic and structural calculations, substantiated by flight test data. These limitations must be adhered to during all phases of the mission. Refer to chapter 5, Operating Limits and Restrictions, for detailed information.

8-3. Weight, Balance and Loading.

The aircraft must be loaded, cargo and passengers secured, and weight and balance verified in accordance with chapter 6, Weight, Balance, and Loading. This aircraft is in weight and balance class II, and requires a weight and balance clearance for each flight in accordance with AR 95-16. The aircraft weight and center-of-gravity conditions must be within the limits prescribed in chapter 5, Operating Limits and Restrictions.

8-4. Performance.

Refer to chapter 7, Performance Data, to determine the capability of the aircraft for the entire mission. Consideration must be given to changes in performance resulting from variation in loads, temperatures, and pressure altitudes. Record the data on the Performance Planning Card for use in completing the flight plan and for reference throughout the mission.

8-5. Flight Plan.

A flight plan must be completed and filed in accordance with AR 95-1, DOD FLIP, and local regulations.

8-6. Crew and Passenger Briefings.

A crew briefing must be conducted to ensure a thorough understanding of individual and team responsibilities. The briefing should include, but not be limited to, copilot flight engineer, crew chief, mission equipment operators, and ground crew responsibilities and the coordination necessary to complete the mission in the most efficient manner. A review of visual signals is desirable when ground guides do not have a direct voice communications link with the crew. Refer to section V for passenger briefing.

SECTION II OPERATING PROCEDURES AND MANEUVERS

8-7. Operating Procedures and Maneuvers.

This section deals with normal procedures, and includes all steps necessary to ensure safe and efficient operation of the aircraft from the time a preflight begins until the flight is completed and the aircraft is parked and secured. Unique feel, characteristics and reaction of the aircraft during various phases of operation and the techniques and procedures used for taxiing, takeoff, climb, etc., are described including precautions to be observed. Your flying experience is recognized; therefore, basic flight principles are avoided. Only the duties of the minimum crew necessary for the actual operation of the aircraft are included.

8-8. Additional crew duties are covered as necessary in section V, Crew Duties. Mission equipment checks are contained in chapter 4, Mission Equipment. Procedures specifically related to instrument flight that are different from normal procedures are covered in this section following normal procedures. Descriptions of functions, operations, and effects of controls are covered in chapter 2, Aircraft and Systems Description and Operation, and are repeated in this section only when required for emphasis. Checks that must be performed under adverse environmental conditions, such as desert and cold weather operation, supplement normal procedures checks in this section and are covered in section IV, Adverse Environmental Conditions.

8-9. Checklist.

Normal procedures are given primarily in checklist form, and amplified as necessary in accompanying paragraph form when a detailed description of a procedure or maneuver is required. A condensed version of the amplified checklist, omitting all explanatory text, is contained in the Operators and Crewmembers Checklist, TM 55-1520-209-CL. To provide for easier cross-referencing, the procedural steps are numbered to coincide with the corresponding numbered steps in TM 55-1520-209-CL.

8-10. Checks.

The checklist includes items for day, night, and instrument flights with annotative indicators immediately preceding the check to which they are pertinent; (N) for night operations only; (I) for instrument operation only; and (O) to indicate a requirement if the equipment is installed. The symbol ★ preceding steps of the checklist indicate that detailed procedures for those checks are included in the performance checks section located at the back of the condensed checklist (TM 55-1520-209-CL). When an aircraft is flown by the same flight crew on a mission requiring intermediate stops it is not necessary to perform all of the normal checks. The steps that are essential for safe aircraft operation on intermediate stops are designated as THRU-FLIGHT checks. An asterisk (*) indicates that performance of steps is mandatory for all THRU-FLIGHTS when there has been no change in crew. The asterisk applies only to checks performed prior to takeoff.

8-11. Checklist Callout.

Pilots and crewmembers shall not rely on memory for accomplishment of prescribed operational checks except for those immediate action emergency procedures that shall be memorized for safe aircraft emergency operation. Oral callout and confirmation of checklist items shall be accomplished by pilot and crewmembers.

8-12. Preflight Check.

8-13. Before Exterior Check.

*1. Publications – Check DA Forms 2408-12, -13, -14, and -18; DD Form 365F Series and DD Form 1896 locally required forms and publications; and availability of operators manual (-10) and checklist (-CL).

*2. Ignition lock switch—On.

3. BATTERY switch—OFF.

4. Cockpit—Check condition.

8-14. Interior Check.

8-15. Forward Cargo Compartment.

1. Cabin and ramp lights switches—As required.

2. First aid kit—Check condition and security.

3. Lower transmission area—Check condition.

4. Transmission oil filter button—Check in.

5. Flight control hydraulic filter buttons—Check in.

6. Flight control closet—Check condition.

7. Troop commanders seat and belt—Check condition and security.

8. Cyclic trim amplifier box—Check pitot static lines and cable plug secure, and switch at AC. During flight, if the switch is left at AFT, FWD, A/S or MAN, longitudinal cyclic trim programming may be affected.

9. Heater compartment—Check security of components, vibrator contact position, ignition circuit fuse, and winch.

10. Cabin door—Check condition and security.

11. Emergency escape axe—Check condition and security.

12. SAS amplifier (box)—Check box, lines, cable plug secure, and switch at AC.

13. Avionic equipment—Check security of components and connections. Determine if both pilots vertical gyros are installed and connected. If only one gyro is installed, pull out the VGI ac circuit breaker for the missing gyro.

14. Troop alarm box—Check condition.

15. Fire extinguisher—Check seal not broken and security.

16. Cabin escape panel—Check security.

17. Transformer—rectifier air intake and exhaust screens—Check clear.

18. First aid kits—Check condition and security.

19. Cabin lights—Check condition.

20. Jettisonable cabin windows—Check condition and security.

*21. Seats, litters, or cargo—Check condition and security.

22. Utility hatch door—Check condition and position as required.

*23. Cargo hook—Check condition and position as required. Check 2,100 psi minimum charge.

24. Lower rescue door—Check condition and position as required.

25. Handcrank—Check stowed.

26. Hoist control panel—Check switches and stow grip.

*27. Cargo tiedowns—Check as required.

*28. Loose equipment—Stowed.

8-16. Aft Cargo Compartment.

1. Combining transmission area—Check condition.

2. Ramp—Check condition; raise ramp level with floor. Position lever at STOP.

3. Drive shaft, coupling, mounts, and aft spline—Check condition.

4. Control linkage—Check condition.

5. FIRE EXT circuit breakers—Check in.

6. Engine fire extinguisher bottles—Check condition and pressure.

7. Crossfeed fuel valve—Check condition, cable plug secure, and valve in closed position.

8. Engine No. 2 fuel valve—Check condition, cable plug secure, and valve in closed position.

9. Manual defueling valve—Close and cap secure.

10. Hand pump—Check condition.

11. Manual control valve—Check that valve is in normal position.

*12. Utility filler reservoir—Check condition, fluid level, and cover secure.

*13. Utility hydraulic accumulators—Check pressures. If pressure in the utility hydraulic 200-cubic-inch accumulator is below 3,000 psi, it is necessary to pressurize the system with the hand pump before attempting to start the apu.

14. Utility hydraulic filter buttons—Check in.

15. Engine start manifold—Check condition and cable plug secure.

*16. No. 2 flight control accumulator—Check. See figure 2-30 for normal pressures.

17. No. 2 hydraulic system manifold valve filter button—Check in.

18. Utility pressurized tank—Check rod extension.

*19. Transmission oil level—Check.

20. Transmission oil filter button—Check in.

21. Transmission areas—Check fluid lines and transmission mounts for condition.

22. Apu—Check condition.

23. Troop alarm box—Check condition.

*24. No. 1 flight control accumulator—Check. See figure 2-30 for normal pressures.

25. No. 1 hydraulic system manifold valve filter button—Check in.

26. Apu manual fuel shutoff valve—Check CLOSED.

27. Compass flux valve—Check condition and security.

(O)28. Crossfeed fuel valve—Check condition and cable plug secure.

29. Engine No. 1 fuel valve—Check condition, cable plug secure, and valve in closed position.

30. Fire extinguisher—Check seal not broken and security.

8-17. Exterior Check.

(See figure 8-1.)

8-18. Aft Cabin.

1. Apu exhaust outlet—Check unobstructed.
2. Navigation light—Check condition.
3. Apu air inlet—Check unobstructed.
4. Hydraulic oil cooler air inlet—Check unobstructed.
5. Hydraulic system test panel—Check all caps secure.
6. Fluid vent and drain lines—Check unobstructed.
7. Right aft landing gear area—Check condition and security of all components as follows:
   a. Gear support structure.
   b. Tire.
   c. Shock strut for inflation and static lock unlocked.
   d. Power steering actuator (if installed), brakes, and hoses.
   e. Fuel lines.
   f. Electrical wiring.
   g. Static ground wire for security and contact with ground.
8. Access doors and covers—Secure.

8-19. Top of Fuselage.

*1. No. 2 engine—Check as follows:

a. Inlet cover removed.

b. Inlet for foreign objects. (If screens installed—Check security and condition.)

c. Oil level and cap secure.

d. Fairing secure.

e. Tailpipe for cracks, hot spots, security, and cover removed.

*2. No. 2 flight control hydraulic reservoir—Check fluid level.

3. Hydraulic filter buttons—Check in.

4. Aft vertical shaft area compartments—Check condition.

5. Anticollision light—Check condition.

*6. Aft rotor (right side)—Check blades for condition, reservoir oil levels, droop stop assemblies, and ISIS indicators for condition. ISIS indicators must be checked every 2½ flight hours.

7. Right side access doors and work platforms—Check secure.

8. Transmission oil cooler fan—Check condition and security.

9. Aft pylon combining transmission area—Check as follows:

a. Combining and engine transmission oil levels.

b. Combining and engine oil filter buttons (3).

c. Dephasing handle up and safetied.

d. Fairing secured.

*10. Aft rotor (left side)—Check blades for condition, reservoir oil levels, droop stop assemblies, and ISIS indicators for condition. ISIS indicators must be checked every 2½ flight hours.

11. Aft vertical shaft area compartments—Check condition.

12. Hydraulic filter buttons—Check in.

13. Left side access doors and work platforms—Check secure.

*14. No. 1 engine—Check same as No. 2 engine.

15. Fuselage—Check condition.

*16. Rotors—Position 30° off centerline of helicopter.

17. Formation lights—Check condition.

18. Drive shaft area—Check condition and security as follows:

a. Drive shafts, couplings and mounts.

b. Wire bundles.

c. Fluid lines.

d. Control linkage.

19. Drive shaft fairing—Secure.

*20. Forward rotor (right side)—Check same as aft rotor.

21. Upper forward transmission area (right side)—Check condition.

*22. Forward rotor (left side)—Check same as aft rotor.

23. Upper forward transmission area (left side)—Check condition.

*24. Forward transmission oil level—Check.

25. Pylon fairings, work platforms and inspection panels—Check secure.

8-20. Right Cabin Fuselage.

1. Windows—Check condition.

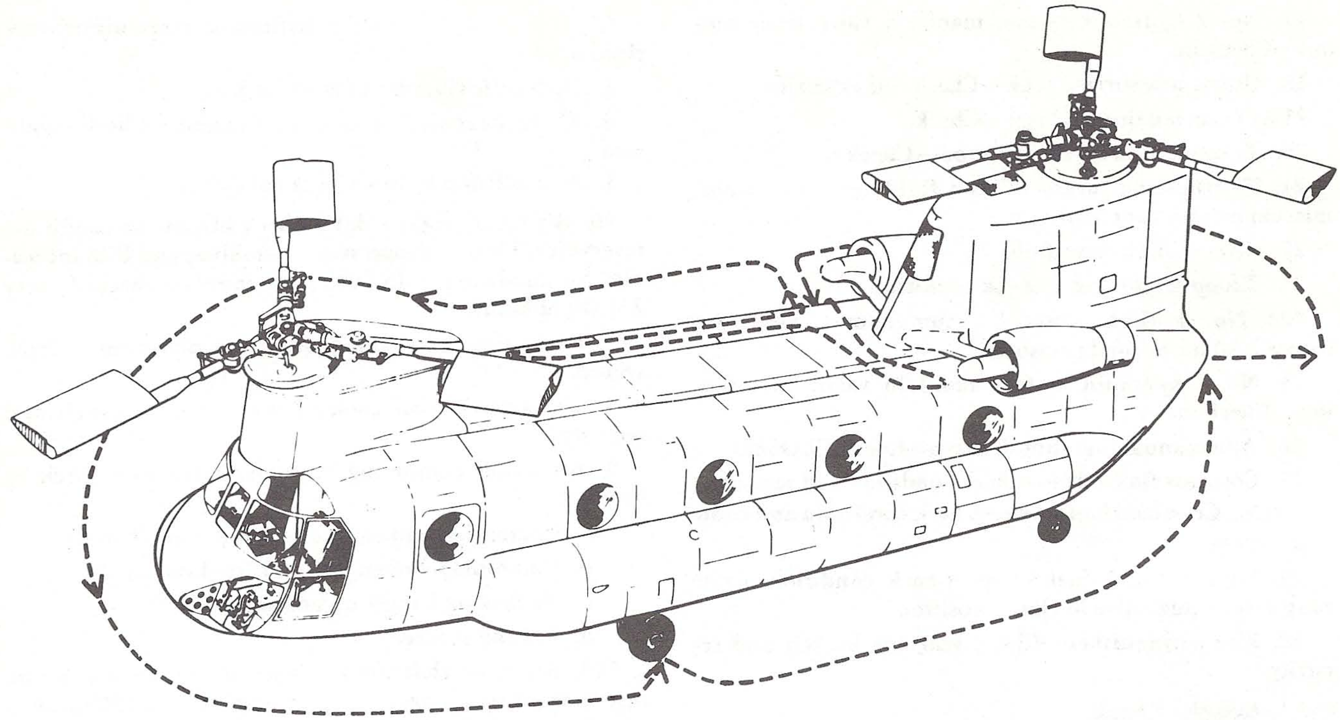


Figure 8-1. Exterior Check

2. Fuselage skin—Check condition.

*3. Fuel sample—Check for first flight of the day and when helicopter is refueled.

*4. Fuel system—Check vents clear, tank for condition, required servicing, and cap secure.

5. Lower rescue door and drains—Secure for water operations.

6. Forward landing gear area—Check condition and security of all components as follows:

a. Gear support structure.

b. Tire.

c. Shock strut for inflation.

d. Brakes and hoses.

(O)e. Fuel lines.

f. Electrical wiring.

7. Navigation light—Check condition.

8. Static port—Check unobstructed.

9. Antennas—Check condition.

10. Ac power equipment—Check components secure and secure access door.

8-21. Forward Cabin.

1. Heater intake, exhaust, and combustor drain—Check unobstructed.

2. Pilot's jettisonable door—Check condition and security.

3. Pilot's pedal area—Check condition.

4. Antennas—Check condition.

5. Searchlights—Check condition.

6. Nose access panel—Check secure.

7. Windshields—Check condition.

8. Windshield wipers—Check condition.

9. Free air thermometer—Check condition.

10. Pitot tube—Check unobstructed.

11. SAS yaw ports—Check unobstructed.

12. Copilot's pedal area—Check condition.

13. Copilot's jettisonable door—Check condition and security.

8-22. Left Cabin Fuselage.

1. Escape panel—Check secure.

2. Dc power equipment—Check battery connected, sump jar, and close access door.

3. Fuselage—Check condition.

4. Forward landing gear area—Check condition and security of all components as follows:

a. Gear support structure.

b. Tire.

c. Shock strut for inflation.

d. Brakes and hoses.

e. Electrical wiring.

5. Antennas—Check condition and security.

6. Anticollision light—Check condition.

7. Navigation light—Check condition.

8. Static port—Check unobstructed.

*9. Fuel system—Check vents clear, tank for condition, required servicing, and cap secure.

10. Windows—Check condition.

11. Left aft landing gear area—Check condition and security of all components as follows:

a. Gear support structure.

b. Tire.

c. Shock strut for inflation and static lock unlocked.

d. Brakes and hoses.

e. Static ground wire contacting the ground.

f. Fuel lines.

g. Electrical wiring.

12. Fluid vent and drain lines—Check unobstructed.

13. Access doors and covers—Check secure.

*14. Passenger briefing—Complete as required. (Refer to Passenger Briefing in section V.)

*15. Tiedowns, locking devices, covers, and grounding cables—Removed and secured.

8-23. Before Starting Engines.

*1. Seat belts and shoulder harness—Fasten and tighten.

2. Shoulder harness locks—Check operation and leave unlocked.

3. Seats and pedals—Adjust.

4. Dome and flood lights—Check condition; set as required.

5. Pilot's and copilot's utility lights—Check condition.

6. Jettisonable door release handles—Check that the top and bottom latches engage the door supports, locking devices removed.

6A. Jettisonable door latches-Check thru door latch plate inspection holes (upper and lower) that door latches are centered in the latch plate detents.

7. Pilot's and copilot's sliding windows—Check condition.

8. Ac and dc circuit breaker boxes—Check all circuit breakers in.

9. Fire extinguisher—Check seal not broken and security.

10. Mirror—Adjust.

11. FAT gage—Check FAT and condition.

12. Overhead circuit breakers—Check in.

13. Lighting switches—As required.

*14. EMER EXIT LTS switch—ARM.

15. APU switch—STOP.

16. UTILITY SYSTEM switch—OFF.

17. IGNITION switches—OFF.

18. START FUEL switches—CLOSE.

19. ANTI-ICE switches—OFF.

20. SAS switch—BOTH ON.

21. HYD BST switch—BOTH ON.

22. ENGINE FUEL VALVE switches—CLOSE.

23. CROSSFEED FUEL VALVE switch—CLOSE.

24. GEN CONTROL switches—OFF.

25. TROOP JUMP LTS switch—Check RED, GREEN then OFF. Observe the troop jump lights while moving the switch.

26. TROOP ALARM switch—ON; the alarm should sound; then OFF.

27. HEATING switches—OFF.

28. WINDSHIELD WIPERS switch—OFF.

29. FUEL PUMPS switches—OFF.

30. HOIST CONT AND CARGO HOOK switches—OFF.

31. Magnetic compass—Check full of fluid and deviation cards current.

32. FIRE EXT AGENT SWITCH—Check spring loaded to the neutral position.

33. Fire control handles—In.

34. Systems instruments—Check engine, transmission, rotor, hydraulic, electrical and fuel systems for static indication, slippage marks and operating range limits.

35. XMSN OIL PRESS switch—AFT.

*36. XMSN OIL TEMP switch—SCAN.

37. FUEL QUANTITY SELECTOR switch—LH tank.

38. Flight instruments—Check indications and set as follows:

a. Turn and slip indicators—Check race full of fluid.

b. Airspeed indicators—Check indications.

c. Vertical speed indicators—Check indications.

d. Gyrosyn compass indicators—Set selector as desired.

*39. VGI switches—NORM.

40. COMPASS SLAVING switches—IN.

41. Clocks—Wound and running.

42. STICK POSITIONER—ZERO.

43. Avionics equipment—OFF; set on desired frequencies.

44. NORM ENG TRIM switches—ON; covers down.

45. AFT WHEELS SWIVEL switch—LOCK.

46. ENGINE CONDITION levers—STOP.

47. EMER SAS REL switch—RELEASE.

48. Cyclic TRIM switch—AUTO.

*49. Personal equipment—Check.

8-24. Starting Engines.

*1. Ground power unit—Connect for GPU start.

*2. BATTERY switch—ON.

*3. Interphone—Check.

4. MASTER CAUTION LT TEST SWITCH—TEST. Check that all caution capsules and the two master caution lights on the instrument panel come on. Some of the caution capsules will be on prior to checking the system.

*5. Fire guard—Posted.

Refer to EMERGENCY PROCEDURES—paragraph 9-38.

★*6. Apu—Start as follows. (See figure 8-2.)

a. APU LOW OIL PRESS warning light—Press to test.

b. APU switch – APU; Check LOW OIL PRESS light out; HIGH EXH TEMP and OVSP warning lights on.

c. GND-APU-AGB switch—START.

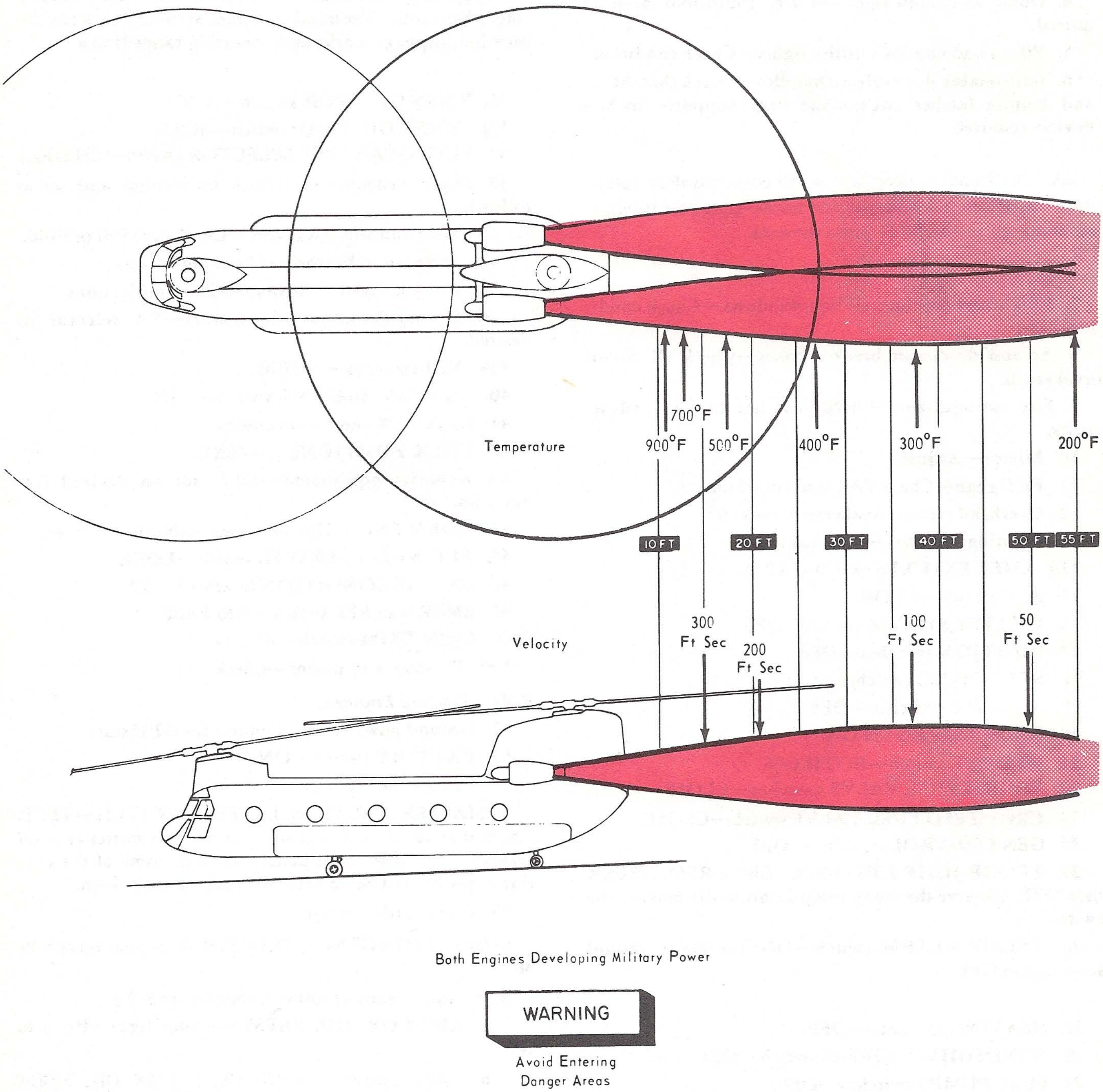


Figure 8-2. Danger Areas (Sheet 1 of 2)

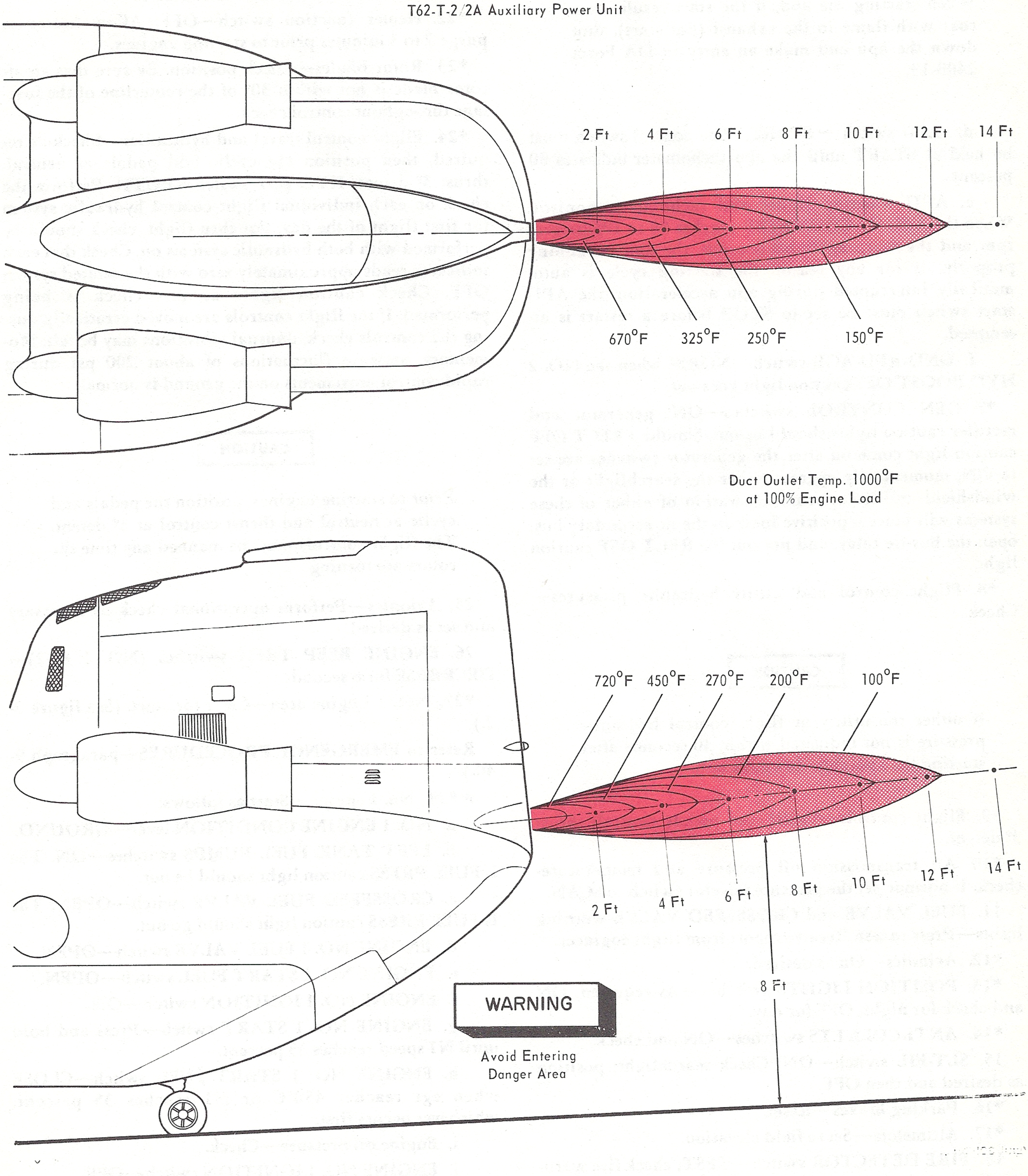


Figure 8-2. Danger Areas (Sheet 2 of 2)

316-520 O - 80 - 19

CAUTION

When starting the apu, if the start results in a roar with flame in the exhaust (hot start), shut down the apu and make an entry in DA Form 2408-13.

d. APU switch — START. The control switch must be held at START until the apu tachometer indicates 90 percent.

e. APU warning lights and tachometer-monitor. When the APU TACHOMETER reaches 98 to 106 percent rpm and the warning lights are out, the apu is running properly. If for any reason the starting cycle is automatically interrupted during apu acceleration, the APU start switch must be set to STOP before a restart is attempted.

f. GND-APU-AGB switch—NORM when the NO. 2 HYD BOOST OFF caution light goes out.

*7. GEN CONTROL switches—ON; generator and rectifier caution lights should be out. Should a RECT OFF caution light come on after the generator switches are set to ON, momentarily operate either the searchlight or the windshield anti-ice systems. Operation of either of these systems will place a positive load on the dc secondary bus, open the bus-tie relay, and put out the RECT OFF caution light.

*8. Flight control and utility hydraulic pressures—Check.

CAUTION

If either the utility or flight control hydraulic pressure is not indicated within 30 seconds after starting the apu, shut down the apu.

*9. Flight controls—Cyclic and pedals neutral; thrust 3° detent.

*10. Aft transmission oil pressure and temperature-check. If normal, set the pressure selector switch to SCAN.

11. FUEL VALVE and CROSSFEED VALVE warning lights—Press to test. Receive report from flight engineer.

*12. Avionics—On as desired.

*13. POSITION LIGHTS switches—As required. ON and check for night, OFF for day.

*14. ANTI-COLL LTS switches—ON and check.

15. SLT-FIL switch—ON. Check searchlight; position as desired and then OFF.

*16. Parking brakes—Reset.

*17. Altimeters—Set to field elevation.

18. FIRE DETECTOR switch—TEST; check fire warning lights on; release switch; and check fire warning lights out.

*19. Fuel quantity—Check as required.

20. STICK POSITIONER trim wheel—Check full travel.

21. Cyclic trim indicators—Check RET.

*22. Heater function switch—OFF. Allow heater to purge 2 to 3 minutes prior to starting engines.

*23. Rotor blades—Check position. Be sure that an aft rotor blade is not within 30° of the centerline of the fuselage throughout control check.

*24. Flight control travel and hydraulics—Check as required, then position the cyclic and pedals at neutral, thrust 3° detent. HYD BST switch—BOTH. Perform the check on each individual flight control hydraulic system for first flight of the day. For thru flight, check should be performed with both hydraulic systems on. Check that each indicator reads approximately zero with the related system OFF. Check caution lights as this check is being performed. If the flight controls are moved erratically during the controls check, unusual vibrations may be felt. Momentary pressure fluctuations of about 200 psi during rapid control movements on the ground is normal.

CAUTION

Prior to starting engines, position the pedals and cyclic at neutral and thrust control at 3° detent. The flight controls must be manned any time the rotors are turning.

25. Avionics—Perform operational check as necessary and set as desired.

26. ENGINE BEEP TRIM switches (NO. 1 & 2)—DECREASE for 8 seconds.

*27. NO. 1 Engine area—Clear for start. (See figure 8-2.)

Refer to EMERGENCY PROCEDURES—paragraph 9-40.)

★*28. No. 1 engine—Start as follows:

a. NO. 1 ENGINE CONDITION lever—GROUND.

b. LEFT TANK FUEL PUMPS switches—ON. The L FUEL PRESS caution light should be out.

c. CROSSFEED FUEL VALVE switch—OPEN. The R FUEL PRESS caution light should go out.

d. ENGINE NO. 1 FUEL VALVE switch—OPEN.

e. ENGINE NO. 1 START FUEL switch—OPEN.

f. ENGINE NO. 1 IGNITION switch—ON.

g. ENGINE NO. 1 START switch—Press and hold until N1 speed reaches 35 percent.

h. ENGINE NO. 1 START FUEL switch—CLOSE when egt reaches 450°C or N1 reaches 35 percent, whichever occurs first.

i. Engine oil pressure—Check.

j. ENGINE NO. 1 IGNITION switch—OFF.

k. Engine instruments—Check when stabilized at ground idle. The engine should accelerate to ground idle speed within 45 seconds. If the start is not normal, abort it by setting the condition lever to STOP. After an aborted start, if the temperature rises above 350°C, motor the engine immediately until temperature decreases below 260°C. If a second start is to be attempted, wait at least 15 seconds after the tachometer indicates zero before starting. This will allow sufficient time for fuel to drain from the combustion chamber.

Ground idle (37.5 to 42.7 percent N1) is the minimum speed at which the engine will operate satisfactorily for extended periods. If the engine speed stabilizes below ground idle, shut down the engine.

CAUTION

After No. 1 engine is started, do not delay starting No. 2 engine. The N2 section of the No. 2 engine starts turning when the No. 1 engine is started; however, the lubrication system of the No. 2 engine is driven by the N1 section, which does not begin to turn until the start sequence is initiated. Delay in starting the No. 2 engine will result in excessive wear on the N2 bearing package and seals (3 minutes maximum delay).

Refer to EMERGENCY PROCEDURES—paragraph 9-40.

★*29. No. 2 engine—Start by using the same procedures as No. 1 engine.

*30. Transmission oil pressure—Check for minimum of 10 psi.

*31. Rotor rpm—Check for minimum of 80 rpm.

*32. ENGINE CONDITION levers—FLIGHT. (Engine acceleration should be smooth with no indication of roughness or surging. Single engine rotor speed should stabilize at 204 to 212 rpm with L-7/7B engines or 209 to 217 rpm with L-7C engines. Helicopters with L-7C engines and rotary-type minimum beep potentiometers should stabilize between 204 to 212. (On helicopters with 114D2200 series aft transmissions, single engine rotor speed should stabilize at 214 to 218 rpm with all series engines.) Dual engine rotor rpm will be somewhat higher. The increase should not be considered as a requirement for adjustment.

*33. ENGINE BEEP TRIM switch (NO. 1 & 2)—Beep to 230 rotor rpm.

*34. Systems—Check.

CAUTION

Do not shut down the auxiliary power unit until rotor rpm has stabilized at 230 rotor rpm. Shock loads resulting from premature apu shutdown can shear the generator shafts and damage the quill shaft which drives the accessory gearbox.

*35. APU switch—STOP. Check apu decelerating to shutdown.

*36. Ground power unit—Disconnect.

8-25. Engine Ground Operation.

*1. VGI switches—As required. If operating with one vertical gyro inoperative, set the VGI switch of the inoperative gyro at EMER.

2. Generators—Check as follows:

a. No. 1 GEN switch—OFF, check that the ac loadmeter for the No. 2 generator indicates higher, the NO. 1 GEN OFF caution light comes on, and the NO. 1 RECT OFF caution light does not come on. Then ON.

b. NO. 2 GEN switch—OFF, check that the ac loadmeter for the No. 1 generator indicates higher, the NO. 2 GEN OFF caution lights come on, and the NO. 2 RECT OFF caution light does not come on. Then ON.

3. Anti-icing and pitot heat systems—Check as required as follows:

CAUTION

Do not check engine anti-ice system if engine inlet screens are installed.

a. ENGINE ANTI-ICE switch—ON. Check for a rise in egt and a drop in N1 speed. Then OFF.

b. PITOT HEAT switch—ON, check for an increase in the No. 2 AC loadmeter indication; then OFF.

4. Fuel pumps and crossfeed fuel valve(s)—Check operation as follows:

a. CROSSFEED FUEL VALVE switch—CLOSE. The R FUEL PRESS caution light should come on.

b. All FUEL PUMPS switches—OFF. L and R FUEL PRESS caution lights should come on.

c. L AFT PUMP switch—ON. The L FUEL PRESS caution lights should also go out. Then OFF.

d. Remaining FUEL PUMP switches—Check as in step c. above.

5. XMSN OIL TEMP and PRESS switches—Check all transmissions; TEST; then set switch to SCAN.

6. Flight instruments—Check as follows:

a. Gyrosyn compass indicators—Check synchronized. Cross-check with magnetic compass.

b. Attitude indicators—Adjust as required.

*7. VNE COMPUTER—Set as required.

*8. All FUEL PUMPS switches—ON. Check CROSSFEED CLOSED.

9. Emergency engine trim system—Check as follows:

a. NO. 1 EMER ENG TRIM switch—DEC momentarily; torque and N1 should decrease. INCR momentarily; torque and N1 should increase. NORM; torque and N1 should return to the normal setting.

b. NO. 2 EMER ENG TRIM switch—Check same as for No. 1.

*10. Copilot ENGINE BEEP TRIM—Check and set 230 rotor rpm.

*11. Systems instruments—Check engine, transmission, rotor, hydraulic, electrical and fuel systems indications.

*12. Altimeters—Set.

13. Health Indicator Test (HIT) check—Perform on first flight of the day. The HIT provides the pilot with a go-no-go check for engine condition prior to take-off. By logging egt deviations from the HIT egt baseline, the pilot provides the Maintenance Officer with the information to monitor egt trends. This can aid the Maintenance Officer to optimize the maintenance effort and ensure that engines receive attention as soon as performance degradation is noted. The HIT is accomplished as follows:

NOTE

The HIT should not be performed until completion of engine ground operation procedures. This assures that the engine is warmed and the instruments stabilized. Installation or removal of engine inlet screens will require egt baseline to be re-established.

a. Reduce engine not being HIT checked to zero torque using the emergency engine trim switch.

b. Rotor rpm—set at 230.

c. Turn off engine anti-ice.

d. Turn helicopter into the wind and read free air temperature.

e. Using the HIT EGT Log from the helicopter Log book, locate the FAT in the first column nearest the free air temperature obtained in the previous step.

f. Set N1% at the value indicated opposite this FAT. Allow egt to stabilize.

g. Read egt from indicator.

h. Compare this egt with the baseline egt adjacent to the FAT and N1% used.

i. Record aircraft hours and difference (±) between indicated egt and baseline egt.

j. If difference between indicated egt and baseline egt is -

(1) 20°C to 29°C enter on DA Form 2408-13.

(2) 30°C or greater, aircraft should not be flown. Enter on DA Form 2408-13.

k. Rotor rpm—Set as required.

*8-26. Before Taxi.

1. STEERING CONTROL PWR switch—ON. The switch must be on for all operations.

2. AFT WHEELS SWIVEL switch—As required.

3. EMER SAS REL switch—As required. RELEASE when power steering is used; ENGAGE for all other operations.

4. Chocks—Removed and secured.

5. Ramp and cabin door—Secured.

6. FUEL VALVE and CROSSFEED VALVE caution lights—Check all out. (Flight Engineer)

7. Cargo hook operation—Check as required. Refer to section III, chapter 4.

8. Crew, passengers, and mission equipment—Check ready for taxi.

9. Taxi director and blade watchers—Positioned as required.

10. PARKING BRAKE—Release. The PARK BRAKE ON caution light should be out.

8-27. Methods of Taxiing.

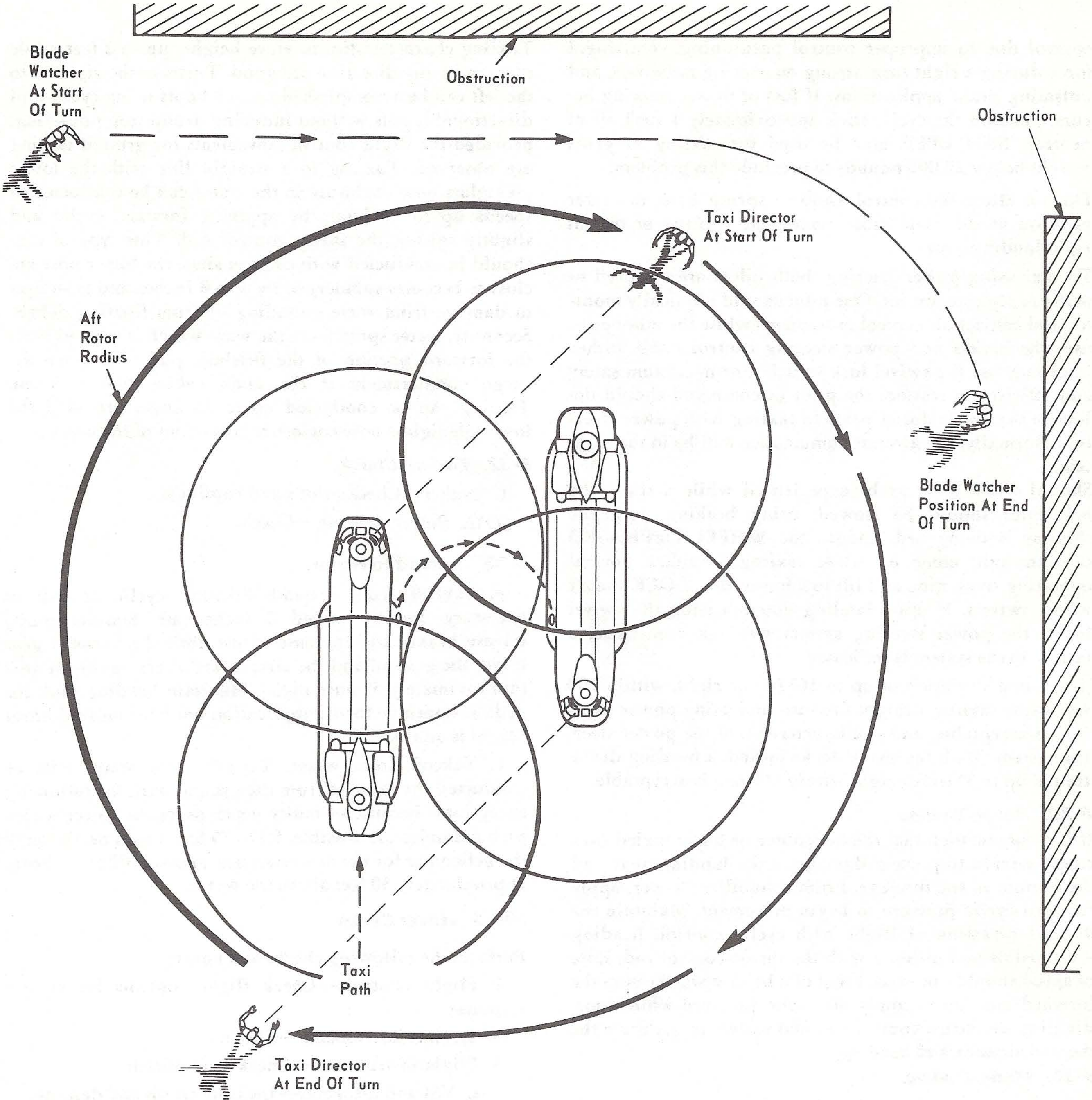
Four methods of taxiing are used while operating this helicopter. The helicopter can be taxied with all four landing gear on the ground using power steering (if installed), only the two aft landing gear in contact with the ground, hover taxi, or taxied on water. Any method can be used satisfactorily; however, one method may be more advisable depending on the area over which the operation is being conducted. Because of aft landing gear caster when turning, the aft rotor requires a larger turning area than the forward rotor. Avoid turning or maneuvering near obstructions when less than 75 feet will exist between the centerline of the helicopter and the obstructions. (See figure 2-3.) When taxiing in confined areas, use taxi directors and blade watchers familiar with CH-47 turning characteristics. Be sure the taxi director and blade watchers know the intended taxi path, use standard hand signals, and keep the taxi director in full view at all times. (See figure 8-3.) Do not start the apu while taxiing.

8-28. Two Aft Gear on the Ground.

Taxiing with the two aft landing gear on the ground should be used when a high degree of maneuverability is required or when taxiing on unprepared airfields. Displace the cyclic stick aft approximately 2 inches and increase thrust until the forward landing gear is off the ground and the helicopter begins to move. Maintain directional control with the directional pedals. Control taxi by adjusting the thrust control rod. The aft wheel swivels must be LOCKED and SAS ENGAGED to increase controllability. The forward wheels should be lowered to the ground only when taxiing straight ahead or when all motion is stopped.

8-29. Taxiing With Power Steering.

Power steering should be used as the primary method of maneuvering the helicopter on prepared or firm surfaces. After the helicopter has started to roll, the thrust control rod should be lowered to the 3° detent. This amount of thrust and moderate braking will maintain a reasonable taxi speed; however, during turns, slightly more thrust may be required. Turns are initiated by slowly rotating the control knob a small amount and then gradually increasing knob rotation until the desired turn is reached. When the turn has been completed, slowly return the control knob to the center position. While turning, if the tail should suddenly swing in the direction opposite to the turn as the wheels caster to the turn position, reduce power and apply brakes to stop the turn. When the helicopter is operated at light gross weights, it is possible for the aft right landing gear to become airborne and cause a loss of power steering



Notes:

1. Avoid turning or maneuvering near obstructions when less than 75 feet will exist between the centerline of the helicopter and the obstruction.
2. The taxi director must remain in full view of the pilot at all times and must not allow the helicopter to block his view of the blade watcher or obstructions.
3. The blade watcher must position himself so he has a clear view of the rotor blades and any obstructions, and the taxi director.
4. Use standard hand signals. Refer to TM 55-1500-204-25/1.

Figure 8-3. Taxi Director and Blade Watcher Positions control due to improper control positioning, centrifugal force during a right turn, strong quartering tailwinds, and pulsating brake applications. If loss of power steering occurs, position the cyclic stick approximately 1 inch aft of neutral. MIN BEEP may be used for taxiing at gross weight below 28,000 pounds to preclude this problem.

Do not allow the control knob to spring back to center position as this will cause immediate trailing of the aft right landing gear.

To taxi using power steering, both pilots are required to perform separate duties. One pilot should physically monitor and restrict all control movements while the other pilot uses the brakes and power steering control knob. Either pilot may use the swivel lock switch. For maximum safety and efficient operation, the pilot in command should delineate the above duties prior to taxiing with power steering. Normally, the aircraft commander will be in the right seat.

Should wheel shimmy be experienced while taxiing, the helicopter should be slowed, using braking until the shimmy is dampened. Should the WHEEL DEPHASED caution light come on while taxiing, establish normal operating rotor rpm, and lift to a hover, then LOCK the aft wheel swivels. If upon landing and releasing the swivel locks, the power steering system will not reenergize, a failure in the system is indicated.

A heading deviation of up to 10° left or right, within 100 feet while taxiing straight forward and using power steering, is acceptable, and is characteristic of the power steering system. With the swivel locks locked, a heading deviation of up to 5° left or right within 100 feet is acceptable.

8-30. Hover/Taxiing.

It is recommended that the helicopter be hover taxied over rough terrain to prevent damage to the landing gear and the bottom of the fuselage. From a stabilized hover, apply forward cyclic pressure to begin movement. Maintain the desired direction of flight with cyclic control, heading with pedals and altitude with the thrust control rod. Rate of speed should not exceed that of a brisk walk. To stop the forward movement, apply aft cyclic pressure while coordinating the thrust control rod and pedals to maintain the desired altitude and heading.

8-31. Water Taxiing.

Prior to water operation, set the pitot heat switch to ON. This procedure will minimize SAS inputs caused by water ingestion.

The stability and handling characteristics during water taxiing in conditions up to Sea State 2 are good up to 28,550 pounds gross weight. When the rotors are turning at normal operating rotor rpm, a forward speed of approximately 5 to 6 knots will result with the controls at neutral and the thrust control rod at the 3° detent. Forward speed can be reduced to 3 to 5 knots by reducing rotor rpm to minimum (MIN BEEP) with the condition levers at FLIGHT. The helicopter can be slowed or stopped by applying aft cyclic. This method should only be used when either MIN BEEP or normal operating rotor rpm is selected to avoid droop stop pounding.

Taxiing characteristics in wave heights up to 2 feet while turning in any direction are good. Turns to the right or to the left can be accomplished up to 5 knots using cyclic and directional inputs without inducing droop stop pounding, provided the flight control movements for ground taxiing are observed. Taxiing in a straight line with the lower plexiglass nose enclosure in the water can be conducted at speeds up to 10 knots by applying forward cyclic and slightly raising the thrust control rod. This type of taxi should be conducted with caution since the lower nose enclosure becomes submerged by 6 to 8 inches and is subject to damage from wave pounding or from floating debris. Secondly, water spray from the wave which is created from the forward portion of the fuselage pod will enter the cargo compartment if the main cabin door is open. Taxiing can be conducted up to 15 knots provided the lower plexiglass nose enclosure is kept out of the water.

8-32. Taxiing Check.

1. Brakes—Check pilot's and copilot's.

(O)2. Power steering—Check.

8-33. Takeoff to Hover.

a. Takeoff from ground. Position cyclic control as necessary, not to exceed 2 inches aft. Simultaneously release brakes and increase thrust until the forward gear leaves the ground and the aircraft stabilizes on the aft gear (approximately 5° nose high). Maintain heading with the pedals. Continue thrust application until the desired hover height is attained.

b. Takeoff from water. Takeoff from water will be conducted the same as from the ground with the following exceptions: because of faulty depth perception over water, pick out object, if possible, 50 to 75 feet ahead or abeam of the helicopter for use as a reference, and stabilize at a hover approximately 30 feet above the water.

**8-34. Hover Check.*

Perform the following checks at a hover:

1. Flight controls—Check flight controls for correct response.
2. Systems instruments—Check.
3. Flight instruments—Check as required:
    a. VSI and altimeter—Indicate climb and descent.
    b. Turn needles, heading indicators and magnetic compass—Indicate turns right and left.
    c. Slip indicator—Ball free in race.
    d. Attitude indicator—Indicate nose high, nose low, banks left and right; set as required.
    e. Airspeed indicator—Check airspeed.
4. Power—Check. The power check will determine if sufficient power is available for takeoff. It is performed by comparing torque required to hover with the predicted values from performance charts in chapter 7.
5. SAS—Check on first flight of the day as follows: Set the SAS switch from BOTH ON to NO. 1 ON. Retrim as necessary. Without pressing the centering device, pulse the cyclic stick and directional pedals about their respective

axes. A control pulse for SAS check is considered to be a control input of ½ inch, held for 1 second. Perform the same checks on the No. 2 system. When performing these checks, the helicopter should tend to dampen to a trimmed attitude. When one of the SAS is shut down, the respective SAS OFF caution light will come on.

8-35. Hovering Turns.

a. Around forward rotor. With helicopter at a stationary hover, pick a point under and slightly forward of the nose. Maintain a stationary position over pivot point with cyclic. Control direction and rate of turn with pedals and altitude with the thrust control rod.

b. Around cg of helicopter. With helicopter at a stationary hover and the cargo hook over the pivot point, add pedal into the direction of turn. Maintain stationary position over pivot point with cyclic. Rate of turn is controlled with pedals and altitude with the thrust control rod.

c. Around aft rotor. With helicopter at a stationary hover and the pivot point under the aft rotor, apply cyclic and pedal into direction of intended turn. Cyclic and pedal will be used to govern rate of turn and movement. Maintain hover altitude with the thrust control rod. Crewmembers may be used to aid in maintaining position-over-pivot point.

8-36. Sideward and Rearward Hovering Flight.

From a stabilized hover, apply cyclic control pressure in the desired direction of flight to begin sideward or rearward movement. Maintain the desired heading with pedals and altitude with the thrust control rod. Rate of speed should not exceed that of a brisk walk. To return to a stationary hover, apply cyclic pressure opposite the direction of movement while coordinating thrust control rod and pedals to maintain the desired altitude and heading.

**8-37. Before Takeoff.*

1. Systems—Check indications of the following:
   a. Rotor.
   b. Torque.
   c. Engine.
   d. Transmission.
   e. Hydraulic.
   f. Electrical.
   g. Fuel.
2. PARKING BRAKE—As required.
3. AFT WHEELS SWIVEL switch—LOCK.
4. EMER SAS REL switch—ENGAGE.
5. Cyclic trim—Check.
6. Transponder—As required.
7. Crew, passengers, and mission equipment—Check.

8-38. Takeoff.

Refer to EMERGENCY PROCEDURES—paragraphs 9-6 and 9-9.

8-39. Normal Takeoff.

Align the helicopter with the desired takeoff course at a stabilized hover of approximately 10 feet, or an altitude permitting safe obstacle and terrain clearance (pitch attitude at a hover is approximately 5° nose high). Smoothly apply forward cyclic pressure to level the helicopter and begin acceleration into effective translational lift. Control rate of acceleration and direction of flight with cyclic and altitude with thrust. As the aircraft accelerates thru effective translational lift, establish a pitch attitude and apply thrust that will result in a simultaneous gain in altitude and airspeed. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb.

Takeoff over water is begun from a hover height of approximately 30 feet and continued as above.

See the Height-Velocity Diagram, figure 5-9 and 5-10, for *avoid* areas. The height-velocity diagram assures the availability of a suitable landing area in the event of engine failure. Since suitable landing areas are often times not available, operating outside the *avoid* areas during takeoff and climb will provide the highest margin of safety. Additionally, autorotational landings can be made at minimum sink rate and low or zero forward speed, thereby minimizing damage and injuries, regardless of terrain.

A normal takeoff may be made from the ground by aligning the helicopter with the desired takeoff course on the ground and positioning the cyclic control in neutral. Smoothly increase thrust until the helicopter is airborne. As all four gear leave the ground, adjust cyclic pressure and thrust as necessary to begin acceleration. Continue the takeoff as from a hover.

8-40. Maximum Performance.

A takeoff that demands maximum performance from the aircraft is necessary because of various combinations of heavy aircraft loads, restricted performance due to high density altitudes, barriers that must be cleared, and other terrain features. The decision to use either of the following takeoff techniques must be based on an evaluation of the conditions and aircraft performance.

8-41. Coordinated Climb.

Align the helicopter with the desired takeoff course at a stabilized hover of approximately 5 feet. Apply forward cyclic pressure smoothly and gradually while simultaneously increasing thrust to begin a coordinated acceleration and climb. The climb may be made vertical with appropriate adjustment of the cyclic control. Maximum torque available should be applied (without exceeding aircraft limits) as the aircraft attitude is established that will permit safe obstacle clearance. The climbout is continued at that attitude and power setting until the obstacle is cleared. After the obstacle is cleared, adjust aircraft attitude and thrust as required to establish a climb at the desired rate and airspeed. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb. Takeoff may be made from the ground by positioning the cyclic control in neutral, prior to increasing thrust. Takeoff over water is begun from a hover height of approximately 30 feet and continued as above.

8-42. Level Acceleration.

Align the helicopter with the desired takeoff course at a stabilized hover of approximately 5 feet. Apply forward cyclic pressure smoothly and gradually while simultaneously increasing thrust to begin an acceleration at approximately 5 feet. Maximum torque available should be applied (without exceeding aircraft limits) prior to accelerating thru effective translational lift. Additional forward cyclic pressure will be necessary to allow for level acceleration to the desired climb airspeed. Approximately 5 knots prior to reaching the desired climb airspeed, gradually release forward cyclic pressure and allow the aircraft to begin a constant airspeed climb to clear the obstacle. Care must be taken not to decrease airspeed during the climbout since this may result in the helicopter descending (*falling thru*). After the obstacle is cleared, adjust aircraft attitude and thrust as required to establish a climb at the desired rate and airspeed. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb. Takeoff may be made from the ground by positioning the cyclic control in neutral prior to increasing thrust.

8-43. Rolling Takeoff.

Under certain operating situations of high gross weight and adverse atmospheric conditions, there may not be sufficient power available to accomplish a hovering takeoff. Under these conditions, it is necessary to use forward speed developed during ground roll to attain sufficient lift to become airborne. This type takeoff requires a large open area as considerable distance is covered during the ground roll and initial climb. Furthermore, it should only be performed from a smooth surface. After the helicopter is aligned with the desired takeoff course, simultaneously release the wheel brakes and raise the thrust control rod as necessary to accelerate during the ground roll. As speed increases, maintain directional control by using the directional pedals and cyclic stick. When sufficient speed (approximately 20 to 30 knots) is attained, raise the thrust control rod until the helicopter becomes airborne. Continue the takeoff as described for the Level Acceleration technique above.

8-44. Running Takeoff From the Water.

While taxiing at 5 to 6 knots into the wind, slowly raise the thrust control rod and slight aft cyclic pressure to keep the lower nose enclosure out of the water. As the helicopter accelerates to planing speed (10 to 15 knots), continue to raise the thrust control rod and start to apply forward cyclic. As effective translational lift occurs and the helicopter leaves the water, continue the takeoff as described for the rolling takeoff above.

8-45. Slingload.

The slingload is similar to the level acceleration technique except the takeoff is begun and the acceleration made at an altitude that will permit the slingload to clear obstacles. Obstacle heights include the additional height necessary for the slingload.

8-46. Crosswind Takeoff.

A crosswind takeoff does not require a significantly different technique than a takeoff into the wind. The primary difference is the requirement to hold the cyclic into the wind and opposite pedal pressure to prevent drift.

8-47. Comparison of Techniques.

Where the coordinated climb and level acceleration techniques yield the same distance over a 50-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 50 feet. The two techniques give approximately the same distance over a 50-foot obstacle when the helicopter can just hover out of ground effect. 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 attitudes which change with loading and airspeed is not required; (3) at the higher climbout airspeeds (30 knots or more), reliable indicated airspeeds are available for accurate airspeed reference from the beginning of the climbout, therefore, minimizing the possibility of *fall thru*. The main advantage of the coordinated climb technique is that the climb angle is established early in the takeoff and more distance and time are available to abort the takeoff if the obstacle cannot be cleared.

8-48. Climb.

After takeoff, select the airspeed necessary to clear obstacles. When obstacles are cleared, adjust the airspeed as desired at or above the maximum rate of climb airspeed. Refer to chapter 7 for recommended airspeeds.

8-49. Cruise.

When the desired cruise altitude is reached, adjust power as necessary to maintain the required airspeed. Refer to chapter 7 for recommended airspeeds, power settings, and fuel flow.

8-50. Cruise Check.

1. Systems—Check.

2. Ramp area—Check every 30 minutes of flight (flight engineer). (Refer to section V, Crew Duties.)

3. XMSN PRESS and TEMP—Check all positions every 30 minutes of flight.

8-51. Descent.

Adjust power and attitude as necessary to attain and maintain the desired airspeed and rate during descent. Refer to chapter 7 for power requirements at selected airspeeds and rates of descent. All checks of mission equipment that must be made in preparation for landing should be accomplished during descent for landing.

8-52. *Before Landing.*

The following checks must be accomplished prior to landing:

1. Systems—Check indications of the following:
   a. Rotor.
   b. Torque.
   c. Engine.
   d. Transmission.
   e. Hydraulic.
   f. Electrical.
   g. Fuel.
2. PARKING BRAKE—As required.
3. AFT WHEELS SWIVEL switch—LOCK.
4. EMER SAS REL switch—ENGAGE.
5. Cyclic trim—Check.
6. Crew, passengers, and mission equipment—Check.
7. Searchlights—As required.

8-53. Landing.

8-54. *Normal Approach.*

a. To a hover. The approach begins by adjusting power and attitude as required to establish an approach angle of approximately 8° to 10° at an airspeed above the minimum rate of descent airspeed specified in chapter 7. Maintain the entry airspeed until the apparent ground speed and rate of closure appear to increase. From this point, progressively decrease rate of descent and forward speed to stop all forward movement at an approximate 10-foot hover (or a height that permits obstacle clearance). As forward speed decreases below effective translational lift it will be necessary to gradually and smoothly increase thrust to terminate the approach. Refer to paragraph 8-57, Landing From a Hover. Refer to chapter 7 for airspeeds, rates of descent and power requirements. See the Height Velocity Diagram, figure 5-9 and 5-10, for *avoid* areas during the approach.

b. To the ground. A normal approach to the ground is accomplished in the same manner as a normal approach to a hover except for continuing thru the hovering altitude to touchdown initially on the aft landing gear with little or no forward roll. Maintain the landing attitude with thrust and aft cyclic (not to exceed 2 inches) until all forward movement is stopped; then, lower the forward landing gear to the ground. Apply brakes after all gears are on the ground to prevent forward movement.

c. To the water. A normal approach to the water is accomplished in the same manner as for a normal approach to a hover, except for terminating at an approximate 30-foot hover.

8-55. *Steep Approach.*

A steep approach is used as necessary to clear obstacles in the approach path. It is executed in the same manner as the normal approach except for the slower airspeeds that must be maintained during the approach. Approach angles may vary from that of a normal approach to a vertical descent. Because of the increased power requirements during termination, smooth and gradual thrust movements are very important.

8-56. *Shallow Approach.*

A shallow approach is used as necessary when instrument, tactical, or emergency requirements make it necessary to execute an approach at an angle less than that of a normal approach. It is executed in the same manner as a normal approach except that deceleration may be more rapid. Approach angles may vary from that of a normal approach to approximately zero.

8-57. *Landing From a Hover.*

a. Land. From a stabilized hover, decrease thrust for a smooth rate of descent until ground contact with the aft gear, coordinating thrust reduction with aft cyclic movement and maintaining pitch attitude until the cyclic is 2 inches aft. Continue thrust reduction until forward landing gear makes ground contact. The thrust is then lowered to the 3° detent, pedals and cyclic are neutral, and brakes are applied to prevent forward roll.

b. Water. Prior to landing, the PITOT HEAT switch must be ON. From a stabilized hover, decrease thrust for a smooth rate of descent. A vertical descent, rather than a descent with some forward movement, will tend to disperse the swirling water spray under a no-wind condition. As the aft wheels and then the fuselage enter the water, continue to lower the thrust control rod to the 3° detent. As more of the fuselage enters the water, buoyancy will level the helicopter attitude.

CAUTION

If contact is made with floating debris, take off immediately.

As the attitude approaches level, the helicopter will start moving forward and stabilize at a speed of approximately 5 to 6 knots. This speed will be attained with the controls in neutral and the thrust control rod at the 3° detent. The water level will not vary significantly because of gross weight or center of gravity. As observed from the cockpit, the water level will appear to intersect the fuselage below the lower nose enclosure.

8-58. *Running Landing.*

a. Land. A running landing is used when conditions do not permit landing to a hover and is made on a prepared surface. Prior to beginning the approach, the swivel switch must be at LOCK and the PARKING AFT WHEELS BRAKE at OFF. The approach is shallow and flown at an airspeed that provides safe aircraft control. Airspeed is maintained as for a normal approach except that touchdown is made at an airspeed above effective translational lift. At approximately 100 feet above the ground, or at a point from which obstacles in the flight path can be cleared, assume a decelerating attitude not to exceed 23° nose-high attitude. Maintain the desired angle of descent with thrust, and touch down on the aft gear prior to losing effective translational lift, using sufficient thrust to cushion the touchdown. Maintain the landing attitude as necessary (approximately 10° to 15° nose high) with cyclic and thrust until the forward speed is sufficiently slow. Smoothly lower thrust until the forward landing gear touches the ground. Continue to lower the thrust to the 3° detent, center the cyclic, and apply brakes as required.

b. Water. Running landings can be performed within the limitations stated in figure 5-1, but should only be performed during training missions, actual single-engine conditions when a hovering approach is not possible, or when atmospheric conditions dictate. Running landings for training should only be performed to calm water. (Sea State 1 or less) by qualified personnel.

Prior to performing a running landing to the water, the PITOT HEAT switch must be on, and the ramp and cargo door, both sections of the main cabin door, and the rescue hatch must be closed to prevent water from entering the cargo compartment.

The approach is shallow, and flown at an airspeed that provides safe aircraft control. Prior to water entry, it may be necessary to use the windshield wipers. Entry of the aft wheels into the water is easily recognized because the helicopter will decelerate noticeably. Touchdown attitude should be held constant until the apparent water speed has decreased below 10 knots. At or below 10 knots, the nose can be lowered to the water by lowering the thrust control rod and neutralizing the cyclic stick. A 5- to 6-knot forward speed will result when the helicopter is level and the controls are neutralized with the thrust control rod at the 3° detent.

When the helicopter is in the water and the antennas are submerged, two-way communication is lost. If the antenna which is mounted on the side of the helicopter is incorporated, the hf radio can be operated.

8-59. Up-Slope Landings.

Up-slope landings are recommended over cross-slope or down-slope landings. The landing is accomplished from a hover. The helicopter is lowered until the forward landing gear are firmly on the ground. The thrust control rod is lowered until the aft landing gear touch down. The controls can then be neutralized.

CAUTION

When performing slope landings, there is always a possibility of encountering ground resonance. Refer to paragraph 9-23 for a complete description of ground resonance and the method of correcting this condition.

8-60. Down-Slope Landings.

When performing a down-slope landing, the aft landing gear comes in contact with the ground first. Apply 2 inches of aft cyclic control and lower the forward gear to the ground with thrust. If the helicopter slides down the slope, bring it back to a hover and reposition it. Droop stop pounding may be encountered if aft cyclic control displacement exceeds 2 inches.

8-61. Cross-Slope Landings.

When performing a cross-slope landing, the upslope aft landing gear will contact the ground first. After both aft landing gear are firmly on the ground, slowly lower the thrust control rod and apply up-slope lateral cyclic control. When both forward landing gear are on the ground, center the controls.

8-62. After Landing.

1. EMER SAS REL switch—As required.
2. AFT WHEELS SWIVEL switch—As required.
3. Searchlights—As required.
4. Transponder—As required.

8-63. Engine Shutdown.

1. AFT WHEELS SWIVEL switch—LOCK.
2. PARKING BRAKE—Set.
3. Heating switches—OFF.
4. ANTI-ICE switches—OFF.
5. EMER EXIT LTS switch—DISARM.
6. Flight controls—Set. Position the pedals and cyclic at neutral and the thrust control rod at the 3° detent. These positions must be maintained during the shutdown.
7. EMER SAS REL switch—RELEASE.
8. Ramp—As required.
9. Wheels—Chocked.
10. EGT—Stabilize. Prior to securing either engine, it is necessary to operate at normal operating rotor rpm with the thrust control rod at the 3° detent until the temperature stabilizes. This procedure will reduce the possibility of internal engine warpage.
11. Fire guard—Posted.

★12. No. 2 Engine—Secure as follows: NO. 2 ENGINE CONDITION lever—GROUND. Wait until the temperature decreases and then begins to increase; then set the engine condition lever to STOP. Monitor temperature during shutdown. If temperature rises above 350°C, motor the engine immediately until temperature decreases below 260°C. Both engines cannot be motored at the same time. Refer to paragraph 8-98 for motoring procedures during high ambient air temperatures.

13. RIGHT TANK FUEL PUMPS switches—OFF.
14. ENG. NO. 2 FUEL VALVE switch—CLOSE.
15. ENGINE BEEP TRIM switch (NO. 1 & 2)—Beep to 230 rotor rpm and allow to stabilize.

★16. Apu—Start. For apu starting procedures, refer to paragraph 8-24. The APU-AGB switch is not used when the apu is started prior to engine shutdown, since the agb is already up to speed.

17. ENGINE BEEP TRIM switch (No. 1 & 2)—DECREASE for 8 seconds.

★18. No. 1 Engine—Secure as follows: NO. 1 ENGINE CONDITION lever—GROUND. Wait until the temperature decreases and then begins to increase, then set the engine condition lever to STOP. Monitor temperature during shutdown. If temperature rises above 350°C, motor the engine immediately until temperature decreases below 260°C. Both engines cannot be motored at the same time. Refer to paragraph 8-98 for the motoring procedure during high ambient air temperatures.

19. ENG. NO. 1 FUEL VALVE switch—CLOSE.

20. LEFT TANK FUEL PUMPS switches—OFF.

21. XMSN OIL PRESS switch—AFT.

22. Avionics—OFF.

23. GEN CONTROL switches—OFF.

24. APU switch—STOP. The apu may be shut down anytime there is no further need to motor the engines.

25. Light switches—OFF.

26. BATTERY switch—OFF after rotors have stopped.

27. Ignition lock switch—OFF, key removed as required.

8-64. Before Leaving Aircraft.

1. Conduct a thorough walk-around inspection of the aircraft, checking for damage, fluid leaks and levels.

2. Mission equipment—Secure.

3. Complete DA Forms 2408-12 and -13. In addition to established requirements for reporting any system defects and unusual and excessive operations, the flight crew will also make entries on DA Form 2408-13 to indicate when any limits in the operators manual have been exceeded.

The battery should be unplugged and the apu manual fuel shutoff valve should be closed if the total time before the next flight will exceed 4 hours.

An entry must be made in the DA Form 2408-13 any time water operations are conducted. This write-up will alert maintenance personnel that special inspections are required.

8-65. Instrument Flight—General.

This aircraft is qualified for operation in instrument meteorological conditions; however, flight with unstable external loads is not recommended. Flight handling, stability characteristics, and range are the same during instrument flight as for visual flight. Navigation and communication equipment are adequate for instrument flight. With both SAS operating, the helicopter does not exhibit any unusual flight characteristics. The helicopter shall not be scheduled for instrument flights when only one SAS is operating; however, should one SAS fail during flight, the flight may be continued to destination. Should both SAS fail during flight, a landing should be made as soon as possible. The CH-47A should not be scheduled for flight under IMC conditions unless two vertical gyros and two vertical gyro indicators (vgi) are installed and operative.

8-66. Instrument Flight Procedures.

Refer to FMI-5, FMI-30, FLIP, AR 95-1, FAR Part 91, and procedures described in this manual.

a. Instrument takeoff. Complete the normal checks prescribed in this chapter, to include a power check. An instrument takeoff should not be attempted with less than a hover out-of-ground effect capability. When ready for takeoff, align the aircraft with the takeoff course and set the gyrosyn compass indicator index to the takeoff heading. Set the attitude indicator miniature aircraft on the horizon. Using outside references to prevent movement of the aircraft, increase thrust sufficiently to get the aircraft light on the gear. Then, while referring to the aircraft instruments, continue to increase thrust smoothly and steadily until a minimum of 100 pound-feet above hover power is reached. Do not exceed engine transmission torque limits. During initial acceleration, maintain a *wings level* attitude and maintain heading with directional pedals until 30 to 40 knots; then transition to coordinated flight. When a positive rate of climb is indicated on the altimeter and vertical velocity indicator, displace the cyclic stick further forward until the miniature aircraft is one-bar width below the horizon and continue to accelerate. During initial climb and prior to reaching 35 knots, the vertical velocity, altimeter, and airspeed indicators are erroneous and unreliable. As the desired climb airspeed is reached, adjust aircraft attitude and power to maintain the desired airspeed and recommended rate of climb.

b. Instrument climb. Instrument climbs are normally performed at 80 KIAS; however, other airspeeds may be used when required. Refer to chapter 7 for airspeeds, power required, rates-of-climb and fuel consumption.

c. Instrument cruise. There are no unusual flight characteristics during cruise in IMC.

d. Speed range. Stability and flight characteristics are normal from maximum rate of climb airspeed thru the full speed range during instrument flight. Power settings during instrument flight should be in accordance with the cruise charts in chapter 7.

e. Communication and navigation equipment. No special technique in the use of avionics is required for instrument flight.

f. Instrument descent. When a descent at slower than cruise speed is desired, slow the aircraft to the desired speed before initiating the descent. Normal descent or radar controlled descent to traffic pattern altitude may be made using cruise airspeed. Normally, descent will be made at cruise speed by reducing power as required.

g. Holding. Holding enroute may be accomplished at cruise speed. Recommended speed when holding for an approach is 100 KIAS or Vne, whichever is slower. For extended holding patterns at maximum endurance airspeeds, consult the appropriate cruise chart in chapter 7. For descents in the holding pattern, decrease power and maintain the holding pattern airspeed.

h. Instrument approaches. Establish airspeed at 100 KIAS or Vne, whichever is slower, passing the initial approach fix. Continue with approach as depicted in instrument approach charts, or as instructed by the controller. Perform the before-landing check prior to beginning final descent. The aircraft may be decelerated during the approach, but should not be flown at airspeeds below 60 KIAS while in instrument flight conditions.

8-67. Night Flying.

Night flying is very closely related to instrument flying, and may often be conducted almost entirely under instrument conditions. Before takeoff, it is imperative that all lights, instruments, and avionics equipment are functioning properly. Generally, interior lighting should be kept to the minimum amount which will still allow complete visibility of all instruments and gages. Excessive cockpit lighting decreases outside visibility. Cabin and ramp lights may be in the red position to reduce the light level from the cabin fuselage section. Avoid using searchlights when in thick haze, smoke, or fog, as reflected light will reduce visibility and may affect depth perception. During ground operations, the aircraft should be hovered/taxied slowly, because it is difficult to judge actual ground speed and excessive speeds may be developed without realizing it.

WARNING

The use of night vision goggles is prohibited. Cockpit and crew station lighting is not compatible with night vision goggles. Use of them may result in excessive glare and/or obscure vision of certain flight instruments and other aircraft switches and controls.

SECTION III FLIGHT CHARACTERISTICS

8-68. General.

The flight characteristics of the helicopter throughout the flight envelope and at all gross weights are good. The flight characteristics remain essentially the same throughout the center-of-gravity and gross weight range. There is no marked degradation of flying qualities at high altitude.

8-69. SAS Off Flight Characteristics.

The SAS is required to provide the helicopter with adequate stability. Therefore, the stability of the helicopter will be reduced when operating with SAS off. With practice, the pilot will know in advance what to expect and should have little trouble controlling the helicopter as long as established limitations (refer to paragraph 5-36) and certain techniques are adhered to. SAS off flight will not be difficult when the following techniques are used:

a. Maintain airspeed below established limits.

b. Keep the flight controls trimmed.

c. All maneuvers should be entered smoothly and control movements should be kept coordinated.

d. The turn-and-slip indicator must be constantly scanned for indications of divergent yaw movements.

e. React positively but smoothly to divergent movements.

8-70. Settling With Power.

Power settling may occur when a helicopter is flown, using a high power setting and low airspeed, at relatively low rates of descent. Under this condition a helicopter is settling through the air displaced by its own rotor system. The downwash then recirculates through the helicopter rotor system, with the resultant that the rotors operate at reduced efficiency. Should this condition occur, it can be recognized by increased roughness, accompanied by rapid build up in rate of descent. Raising the thrust control rod only tends to aggravate the situation. Flight experience has shown that critical conditions of power settling seldom occur in tandem-rotor configured helicopters. If settling with power is experienced, it can easily be eliminated by transition into forward or sideward flight.

8-71. Flight With External Loads.

In general, the helicopter possesses excellent flight characteristics when performing an external load mission. The combination of power available, the load carried beneath the cg, and the design of the cargo hook system make loads of minimum or maximum weight relatively easy to carry and handle safely. The type loads carried can usually be broken down into three major groups: low density, high density, and aerodynamic. Each type load mentioned displays characteristics all its own and therefore must be discussed separately.

CAUTION

A nylon loop or metal shackle will be used between the cargo hook and sling. External loads must not be rigged entirely with steel cable (wire rope) slings. A nylon vertical riser of at least 6 feet in length must be placed between a steel cable sling and the nylon loop to dampen vibration tendencies. Nylon and chain leg slings and pure nylon slings must have at least 6 feet of nylon in each leg.

CAUTION

When combination internal and external loads are carried during the same flight and the external loads exceeds 12,000 pounds, position the internal load forward of the utility hatch. This procedure will preclude encountering an excessive aft center of gravity.

8-72. Low Density Loads.

When carrying low density loads, airspeed is limited by the amount of clearance which can be maintained between the load and the underside of the helicopter since the load will tend to trail aft as speed is increased.

8-73. High Density Loads.

High density loads can usually be flown at cruise airspeed and in some cases up to Vne depending on the configuration of the load, air turbulence, or accompanying virbration. Bank angles should not exceed the limitations set forth in chapter 5.

8-74. Aerodynamic Loads.

Aerodynamic loads, such as tow targets, drones, light aircraft, aircraft parts, wings, and tail sections have certain inherent dangers because of their lift capabilities; therefore, the aerodynamic lift capabilities of external loads must be destroyed when carrying aerodynamic loads. Airspeed and bank angles will be governed by the reaction of the load to the airspeed. Drogue chutes shall also be used to streamline the load. However, the chute must be attached to the load with a swivel fitting.

8-75. Technique.

It has been found that no firm limitations can be imposed for low density and aerodynamic loads. Airspeed, bank angles, and the degree of maneuvering must be left to the pilot's judgement. However, the following guidelines will serve to foster good techniques when flying all types external loads:

a. During the initial takeoff with an external load, lift the load smoothly to a height of approximately 10 feet. The pilot should then make a small thrust input to bounce the load and thereby determine the sling stability. If after a single input, the helicopter has a tendency to sustain an oscillation, the load should be landed and the natural frequency of the sling changed. This is accomplished by either of the following:

(1) Lengthen the nylon in each sling by an equal amount in increments of at least 1 foot.

(2) Increase the length of or add a nylon vertical riser of at least 5 feet in length between the original sling and the nylon loop or metal shackle which attaches to the cargo hook. Sling stability should then be reevaluated after each adjustment until the response is stable.

b. Controls should be displaced smoothly and cautiously to prevent over-controlling and subsequent oscillation of the load.

c. Airspeed should be slowly increased to determine the characteristics of the load and the speed at which it can be flown.

d. Airspeed is decreased and proper flight control displacement is used to reduce large load oscillations by high airspeed or turbulence.

SECTION IV ADVERSE ENVIRONMENTAL CONDITIONS

8-76. Cold Weather Operation.

8-77. General.

Operating the helicopter in an environment of extreme low temperature and the associated weather phenomena requires that certain techniques and operating procedures be implemented in addition to the normal operating procedures in section II. The following operating techniques and procedures have been developed from actual arctic flight testing and other pertinent information.

CAUTION

At temperatures below -18°C preheating aircraft for a minimum of one and one half hours is recommended. Emphasis should be placed on engine fuel control units and the AGB.

8-78. Preparation for Flight.

The following additional exterior checks are to be performed during cold weather operation.

a. Check that all ice, snow, and frost have been removed from the exterior surfaces, particularly the rotor blades.

CAUTION

Ice removal should never be accomplished by chipping or scraping. De-icing fluid or heat must be used.

b. Landing gear shock struts and flight control system actuators should be checked to ascertain that exposed shafts are free of dirt, ice, etc.

c. While checking the engines, the compressor should be manually checked for freedom of rotation. Heat must be applied if the compressor is frozen.

d. Check that the battery is installed. Maintenance personnel will remove the battery and store it in a warm area when temperatures of -40°C and below are expected and the helicopter is to be parked outside.

e. When operating the ramp, it may be necessary to cycle it once or twice to achieve proper closure.

f. Check that all hydraulic accumulators are precharged according to the graphs in figure 2-30.

g. Do not operate helicopters equipped with 114R 1002-113, -130, or -141 rotary wing blades at temperatures below -18°C.

8-79. Before Starting Engines.

Delay starting the heater until after main engine starting if the latter is to immediately follow apu starting. If extended apu and heater operation precedes main engine starting, shut down the heater 2 to 3 minutes prior to starting engines. The heater and blower are automatically cut off during engine starting and insufficient purging could result in backfire and damage to the heater. In the course of all lower temperature operations, conserve battery power by keeping electrical loads to an absolute minimum prior to apu starting.

8-80. APU Operation.

During initial apu/agb operations at very low temperatures (−29°C and below), the aft transmission oil pressure will exceed the gage limits. After a brief period of operation (up to 5 minutes), pressure indications will decrease below 100 psi. Takeoff should not be made until all transmission oil pressures are within normal operating limits.

8-81. Engine Starting.

Complete the STARTING ENGINES CHECK (refer to paragraph 8-24) up to the point of pressing the start pushbutton; then complete the following:

1. Start pushbutton—PRESS and HOLD.

2. Start fuel switch—CLOSE when the egt reaches 500°C. As the egt starts to decrease, set the start fuel switch to OPEN. Do not allow the temperature to decrease below 400°C before setting the start fuel switch to OPEN. Continuously monitor the egt while operating the start fuel switch.

3. Start pushbutton—Release after N1 has stabilized at ground idle 37.5 to 42.7 percent for 15 seconds. If N1 decreases below normal minimum ground idle, again press and hold the start pushbutton to assist in returning N1 to normal ground idle speed. Continue to hold the start pushbutton in for at least 15 seconds after attaining a stabilized ground idle speed.

4. After the engine start has been completed, allow the engine to run at ground idle for 2 to 3 minutes to stabilize temperature, whenever operational conditions permit.

5. ENGINE CONDITION levers—FLIGHT. When the engine condition lever is moved to FLIGHT, normal acceleration may not occur because of bleed band chatter (popping). If this occurs, return the engine condition lever to GROUND and move the engine anti-icing switch to ON. Then return the engine condition lever to FLIGHT. After the engine has stabilized at flight idle, the engine anti-icing system may be turned off.

8-82. Warmup and Ground Tests.

Allow the engine and transmission oil temperatures to stabilize prior to takeoff. This will require several minutes of operation at FLIGHT.

To prevent unnecessary scratches, allow electrical windshield heating to completely soften frost, snow, or ice before using the windshield wipers. Functionally check the engine anti-icing system. (Refer to paragraph 8-25.)

8-83. Taxiing.

Difficulty will be encountered when taxiing on ice and snow covered surfaces where braking action is poor. Taxiing on the aft gear (front wheels off the ground) is recommended; however, caution should be taken because of the poor visibility resulting from blowing snow.

8-84. Takeoff.

No unusual problems are associated with either the hovering, rolling, or vertical-type takeoffs other than the effects of blowing snow and slippery surfaces. Depending on the weight of snow and ice accumulated on or in the fuselage, takeoff and overall performance can be seriously affected.

8-85. During Flight.

Initial hovering with cold hydraulic fluid may produce insensitive control inputs. Hovering above 10 feet (aft wheel clearance) is recommended under these conditions until operation is normal. With SAS on, light pitch and roll oscillations can be expected during the first 10 or 20 minutes of flight.

8-86. Descent.

No unusual problems are encountered during a descent. Use windshield heat if necessary. If bleed band popping occurs during descent, set the engine anti-icing switch to ON.

8-87. Landing In Snow.

Landing in loose snow from a hover presents the unusual problem of low visibility caused by blowing snow. The helicopter does not produce this effect to any greater extent than other helicopters; however, caution should be exercised during this type landing.

8-88. After Landing.

Maneuvering the helicopter into a slippery parking area may be difficult to accomplish and towing may be necessary. Taxiing on the aft gear should not be used to position the helicopter among other parked aircraft.

8-89. Engine Shutdown.

No unusual problems are encountered during engine shutdown as long as the procedures in section II are adhered to.

8-90. Before Leaving Helicopter.

If the helicopter is to be parked outside for extended periods, maintenance personnel should install all protective covers and secure the rotor blades. When ambient temperatures of −40°C and below are expected and the helicopter is to be parked outside, maintenance personnel should also remove the battery and store it in a warm area until required for further operation.

8-91. Desert and Hot Weather Operation.

8-92. General.

The reduction in power available and the resulting decrease in helicopter performance due to reduced air density is the main consideration during desert and hot weather operation. Therefore, greater emphasis must be placed on determining performance during mission planning.

8-93. Preparation for Flight.

A normal preflight inspection is to be conducted as described in section II. Extra emphasis should be placed on equipment which may be affected by higher temperatures, such as tires, seals, and hydraulic components. In addition, check equipment for signs of deterioration or excessive abrasion from blowing dust or sand. Windows and doors should be opened to provide increased ventilation.

CAUTION

When acoustical insulation is installed around the avionic shelves, it must be removed when ambient temperature exceeds 27°C. When the AN/ARC-102 radio is operating, the insulation must be removed when ambient temperature exceeds 21°C.

8-94. Engine Starting.

The normal engine starting procedures in section II are to be used.

8-95. Taxiing.

Braking should be kept to a minimum to prevent overheating. Ground operation in general should be kept to a minimum.

8-96. Takeoff, Climb, Cruise, and Descent.

Helicopter performance may be reduced; therefore, techniques should be adjusted accordingly.

8-97. Landing.

The landing procedures in section II apply. Braking should be kept to a minimum to prevent overheating.

8-98. Engine Shutdown.

It may be necessary to motor the engines if temperature does not decrease below 350°C. It may not be possible to lower the temperature to 260°C. If the temperature will not decrease below 260°C, terminate motoring when the temperature indication stabilizes.

8-99. Before Leaving the Aircraft.

Leave all windows and doors open to increase ventilation but not during conditions of blowing dust or sand.

8-100. Turbulence and Thunderstorm Operation.

8-101. Flight in Turbulent Air.

Flying in areas where turbulence is forecast should be avoided. However, when forced to enter such an area, the following procedures are recommended.

8-102. Prior to Entering Turbulent Air.

CAUTION

Never enter forecast turbulence with an inoperative thrust control rod magnetic brake.

Prior to entering turbulent air, the following should be accomplished:

1. Rotor speed—230 rpm.
2. Crew—Alert.
3. Airspeed—Adjust as follows:

(1) In severe turbulence, decrease airspeed to Vne minus 15 knots or the recommended cruise speed, whichever is slower. (Refer to chapter 7.)

(2) In moderate turbulence, decrease airspeed to Vne minus 10 knots or the recommended cruise speed, whichever is slower. (Refer to chapter 7.)

4. Longitudinal cyclic trim—Select MAN; then adjust both actuators for the airspeed to be flown. This is accomplished to prevent the cyclic trim actuators from cycling when AUTO is selected.
5. Loose equipment—Secure.
6. Safety belts and shoulder harnesses—Tighten.
7. Attitude indicators—Set for level flight.

8-103. In Turbulent Air. The thrust control rod position, when adjusted for the airspeeds mentioned above, should be maintained and the attitude indicator should be used as the primary pitch instrument. The altimeter and vertical velocity indicator may vary excessively in turbulence and should not be relied upon. Airspeed may vary as much as 40 knots. By maintaining a constant thrust control rod position and a level flight attitude on the attitude indicator, airspeed will remain relatively constant even when erroneous readings are presented by the airspeed indicator.

8-104. Flight in Thunderstorms.

Flight in or in close proximity to thunderstorms is to be avoided because of the accompanying severe turbulence and restricted visibility. If a thunderstorm is inadvertently encountered during flight, the procedures for flight in turbulent air are to be followed and the flight path altered to leave the area. Should a thunderstorm be encountered during a night flight, the cockpit dome light should be turned on with the white lights selected to minimize the blinding effect of lightning.

8-105. Ice and Rain.

8-106. Ice.

The helicopter is equipped with adequate engine anti-icing, pitot tube and SAS yaw port heating, and windshield anti-icing systems to enable safe flight in light icing conditions. Operation of these systems is described in paragraph 2-144. Additional information and specific procedures are also included in this section under Cold Weather Operations. The greatest danger caused by ice accumulation is lowered rotor blade efficiency resulting in decreased range and endurance.

CAUTION

Helicopters equipped with engine inlet standard screens must have the screens removed before flight whenever the in-flight temperature will be below 4.4°C. Avoid areas where moderate to severe icing is known to exist or is forecast.

NOTE

If icing is encountered during IMC flight, consideration must be given to reduced range and endurance due to increased fuel consumption.

8-107. Exterior Inspection. Refer to paragraph 8-78.

8-108. Taxiing. Taxi at slow speeds to ensure positive braking action during turns. The forward tilt of the rotors will cause the helicopter to continue moving forward if icy conditions prevent braking.

8-109. Before Takeoff. When the takeoff is to be accomplished into possible icing conditions, the following are to be accomplished as part of the Before Takeoff Check.

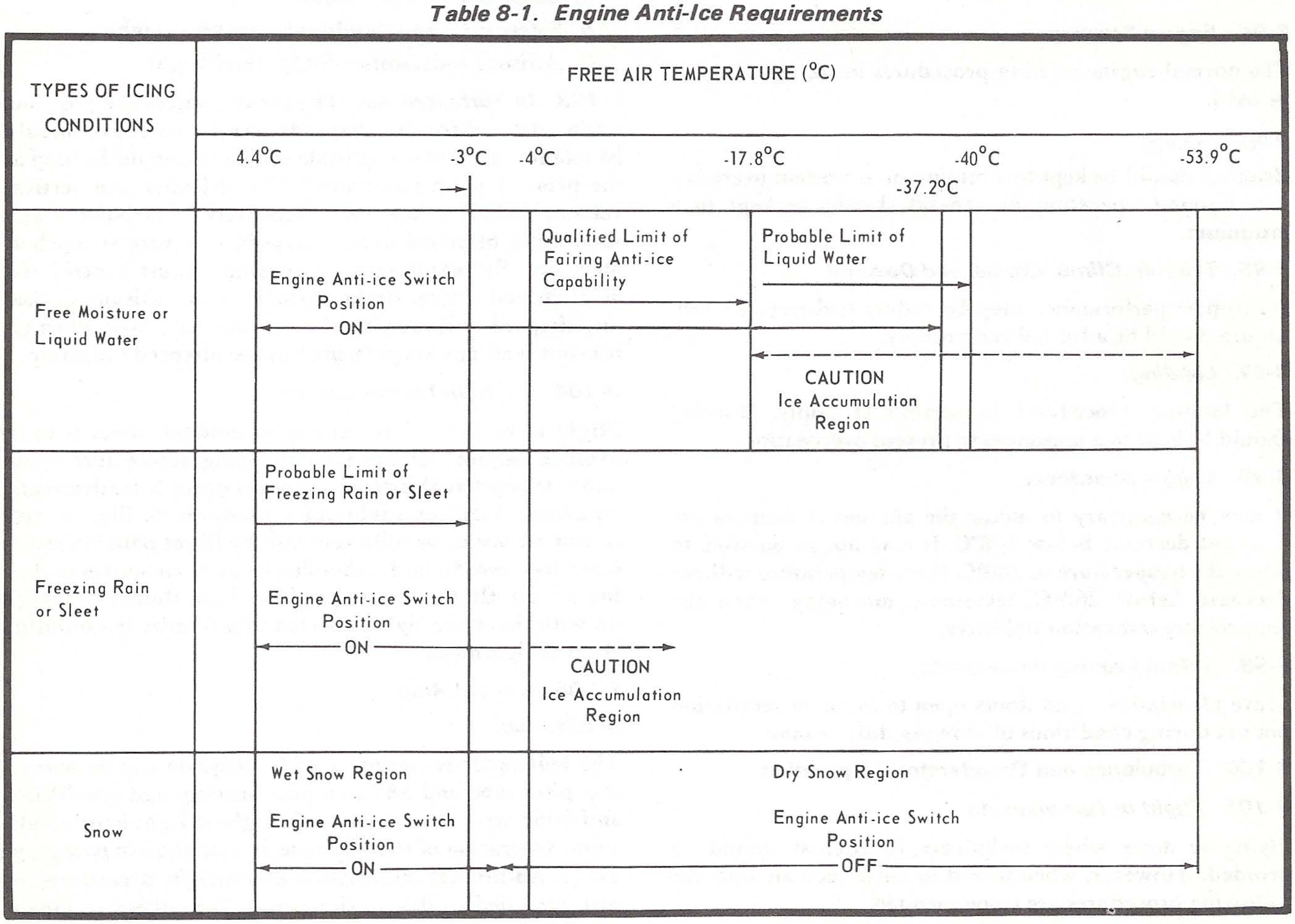
1. Engine anti-ice—ON (Refer to table 8-1.).
2. Windshield anti-icing—ON.
3. Pitot heat—ON.

8-110. During Flight. Since all of the systems on this helicopter are of the anti-icing rather than the de-icing type, always start systems at least 5 minutes before entering a suspect or forecast icing area. In addition, engine icing can occur at temperatures above freezing. Engine anti-icing should be used in accordance with table 8-1.

CAUTION

Extended flight in light icing conditions may result in lateral and vertical vibrations caused by asymmetric self-shedding of ice. When vibrations are encountered, airspeed should be reduced and the aircraft should be flown out of the icing area.

Table 8-1. Engine Anti-Ice Requirements



8-111. Approach and Landing. Accomplish a normal approach and landing; but if icing is present, increased power will be required. The forward and aft wheels accumulate ice which can result in the brakes freezing. If icing conditions have been encountered, a zero forward ground speed landing should be accomplished.

8-112. Rain.

It is considered that rain will have no detrimental effect on the flight characteristics or performance of the helicopter. The windshield wipers should be adjusted to FAST during an instrument approach in rain, as rain may present a restriction to visibility. Pitot heat should be used for flights in rain to prevent moisture from accumulating in the pitot tube and SAS yaw ports and tubing.

8-113. Salt Water Operation.

8-114. Power Deterioration.

Salt spray ingestion in turbine engines may result in a loss in performance as well as a loss in compressor stall margin. This reduction in stall margin makes the engine susceptible to stalls during accelerations, and more particularly under deceleration conditions. As the spray is ingested and strikes the compressor blades and stator vanes, salt is deposited. The resulting buildup gradually changes the airfoil sections, which in turn affects performance. This deterioration will be noticed as a decrease in torque and an increase in egt for a given N1. Should the deterioration reach the point where the compressor actually stalls, egt will increase, while the N1 and torque will decrease. The circumstances under which power deterioration may occur during salt water operation vary with a number of factors. The flight regime, gross weight, wind direction and velocity, pilot technique, duration of maneuver, salinity of the water, and the relative density of the salt spray, all have a bearing on performance deterioration. Intermittent operation in moderate salt spray conditions could expose the engines to enough salt spray to cause noticeable performances deterioration. During prolonged operations (such as low hovering) in heavier spray conditions, power deterioration will be apparent and is more critical. Maneuvers such as hovering close to the water in light winds (under about 8 knots), or low flights at low speeds will generate maximum rotor downwash spray conditions. Careful operation, following the procedures and limitations contained herein, in strict adherence to the prescribed maintenance procedures when operating in these conditions, should result in the preservation of rated engine power.

8-115. Hovering.

CAUTION

Prolonged hovering over salt water which results in spray ingestion, indicated by spray on the windshield, must be avoided. The amount of spray observed on the windshield is usually the best indication of spray ingestion into the engine inlets.

Hovering over salt water at altitudes which causes concentrated spray into the engine inlets results in gradual power deterioration and eventual reduction of compressor stall margin. Operation in these conditions should be avoided or minimized. The following procedures are grouped according to wind conditions. Maximum hovering altitude, consistent with safety and mission accomplishment, is recommended to reduce possibility of salt spray ingestion.

a. No wind. Hovering in a no-wind condition normally results in a relatively low spray concentration at all hovering altitudes.

b. Light winds (Approximately 5 to 16 knots). Hovering in these conditions results in the heaviest or most critical spray concentrations. Spray can be minimized by heading changes with reference to wind direction and ascertaining minimum spray concentration on windshield.

c. Moderate to heavy winds (15 knots and above). Higher winds normally result in the lowest of spray concentration at all hovering altitudes. In these conditions, hovering can be accomplished into the wind.

8-116. Following salt water operation, appropriate entries should be made in DA Form 2408-13, reflecting altitudes, power losses, etc.

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SECTION V CREW DUTIES

8-117. Responsibilities.

The minimum crew required to fly the helicopter under normal conditions is a pilot, a copilot, and a flight engineer. Additional crewmembers, as required, may be added at the discretion of the commander. The manner in which each crewmember performs his related duties is the responsibility of the pilot in command.

8-118. Pilot.

The pilot in command is responsible for all aspects of mission planning, preflight, and operation of the helicopter. He will assign duties and functions to all other crewmembers as required. Prior to or during preflight the pilot will brief the crew on the mission, performance data, monitoring of instruments, communications, emergency procedures, taxi, and load operations.

8-119. Copilot.

The copilot must be familiar with the pilot's duties and the duties of the other crew positions so that these tasks may be accomplished in the absence of a full crew. The copilot will assist the pilot as directed.

8-120. Flight Engineer.

The flight engineer will perform all duties as assigned by the pilot, in addition to the following specific duties:

a. Maintenance, servicing, inspection, loading, and security of the helicopter.

b. Completes the daily inspection (PMS) prior to the arrival of pilot for preflight. Helicopter will be serviced, log book current and correct, and equipment secured.

c. Accompanies pilot during preflight inspection, performs the inspection with the pilot.

d. Checks the security of each area inspected.

e. Assists in seating and securing passengers; checks load security.

f. Ensures the helicopter is clear during all starting procedures and informs pilot of any objects which would pose a hazard to the helicopter during all phases of ground operation.

g. Visually inspects engine and ramp area for proper operation.

h. Remove chocks and closes ramp door when called for by the pilot.

i. Observes and gives clearance to pilots during taxi and hover operation. Reports any object or condition which would pose a hazard to the helicopter. When the helicopter is being taxied in obstructed areas, the flight engineer or other crewmembers may be required to act as taxi director or blade watchers. Taxi directors and blade watchers must be familiar with CH-47 ground turning characteristics. (See figures 2-3 and 8-3.)

j. Perform check of ramp area every 30 minutes of flight.

k. Check all systems during flight.

8-121. Passenger Briefing.

The following is a guide that should be used in accomplishing required passenger briefings, when a unit passenger briefing is not available. Items that do not pertain to a specific mission may be omitted.

a. Crew introduction.

b. Equipment.

(1) Personal to include ID tags.
(2) Professional.
(3) Survival.

c. Flight Data.

(1) Route.
(2) Altitude.
(3) Time en route.
(4) Weather.

d. Normal Procedures.

(1) Entry and exit of helicopter.
(2) Seating.
(3) Seat belts.
(4) Movement in helicopter.
(5) Internal communications.
(6) Security of equipment.
(7) Smoking.
(8) Oxygen.
(9) Refueling.
(10) Weapons.
(11) Protective masks.
(12) Parachutes.

e. Emergency Procedures.

(1) Emergency exits.
(2) Emergency equipment.
(3) Emergency landing/ditching procedures.
(4) Bailout.

CHAPTER 9
EMERGENCY PROCEDURES

SECTION I HELICOPTER SYSTEMS

9-1. Helicopter Systems.

This section describes the helicopter systems emergencies that may reasonably be expected to occur and presents the procedures to be followed. Emergency procedures are given in checklist form when applicable. A condensed version of these procedures is contained in the Operators and Crewmembers Checklist, TM 55-1520-209-CL. Emergency procedures involving mission equipment are covered in section II, Mission Equipment, and are repeated in this section only insofar as they affect safety of flight. Emergency operations of avionics equipment are covered when appropriate in chapter 3, Avionics. See figures 9-1 and 9-2 for emergency equipment, exits, and entrance.

9-2. Immediate Action Emergency Checks.

These checks that must be performed immediately in an emergency procedure are underlined. These immediate action emergency checks shall be committed to memory.

NOTE

The urgency of certain emergencies requires immediate and instinctive action by the pilot. The most important single consideration is aircraft control. All procedures are subordinate to this requirement.

9-3. Emergency Warning Signals.

Since the helicopter is equipped with an emergency troop alarm and jump light system (chapter 2), the following standardized signals will be used to notify occupants of an emergency situation:

1. Prepare for ditching—3 short rings.
2. Prepare for bailout—3 short rings.
3. Prepare for crashlanding—3 short rings.
4. Water contact—One sustained ring.
5. Bailout—One sustained ring.
6. Crashlanding—One sustained ring.

9-4. After-Emergency Action.

After a malfunction of equipment has occurred, appropriate emergency actions have been taken and the aircraft is on the ground, an entry must be made in the Remarks Section of DA Form 2408-13 describing the malfunction.

9-5. Engine.

9-6. Flight Characteristics.

If an engine failure occurs, no control problems exist unless power from the remaining engine is not sufficient to maintain the selected rotor rpm. If sufficient power is not available to maintain altitude, descend to an altitude where single-engine flight can be accomplished. (Refer to chapter 7 for single-engine performance data). The best indication of engine failure is decreased torque on the failed engine and a compensating increase in torque on the remaining engine accompanied by a droop in rotor rpm. A supporting indication of engine failure will be a decrease in N1 speed. An engine failure will have no effect on any of the helicopter systems as long as the rotor rpm is maintained above the minimum speed. When one engine fails, rotor speed can be expected to drop as much as 10 to 15 rpm. The desired rotor rpm can be regained, if sufficient power is available, by using engine beep trim on the operating engine. If power is not available, desired rotor rpm is regained by lowering the thrust control rod. Procedures to be followed after engine failure will be governed by the altitude and airspeed available for aircraft control and for maintaining sufficient rotor rpm for continued flight and landing.

Decrease in thrust after engine failure will vary with altitude and airspeed at the time of the occurrence. For example, thrust must not be decreased when an engine (or engines) fail at a hover in-ground-effect; whereas, during cruise flight conditions, altitude and airspeed are sufficient for a significant reduction in thrust, thereby allowing rotor speed to be maintained in the safe operating range.

Cyclic control is adjusted as necessary to remain over the desired point after engine failure at a hover or to control airspeed and flight path after engine failure in forward flight.

Pedal pressure is applied as necessary to control aircraft trim.

Airspeed should be maintained at the optimum for existing conditions for continued flight (single engine) or for autorotational descent (dual engine failure). As airspeed increases above 55 KIAS in autorotation there is a corresponding increase in rate of descent. Airspeed up to 85 KIAS or Vne whichever is slower, will increase glide distance but should be avoided at low altitude because the time available to decelerate is critical. At airspeeds below 55 KIAS, rate of descent in autorotation increases and glide distance decreases. Gliding the helicopter in autorotation out-of-trim will also increase rate of descent and decrease glide distance; therefore, pedal control immediately after engine failure and during descent is important. If time permits during the autorotational descent transmit a *Mayday* call, set transponder to the appropriate emergency mode and code and lock shoulder harness.

9-7. Minimum Rate Of Descent—Power Off. The power off minimum rate of descent is attained at an indicated airspeed of approximately 55 knots and 230 rotor rpm. (See figure 9-3.)

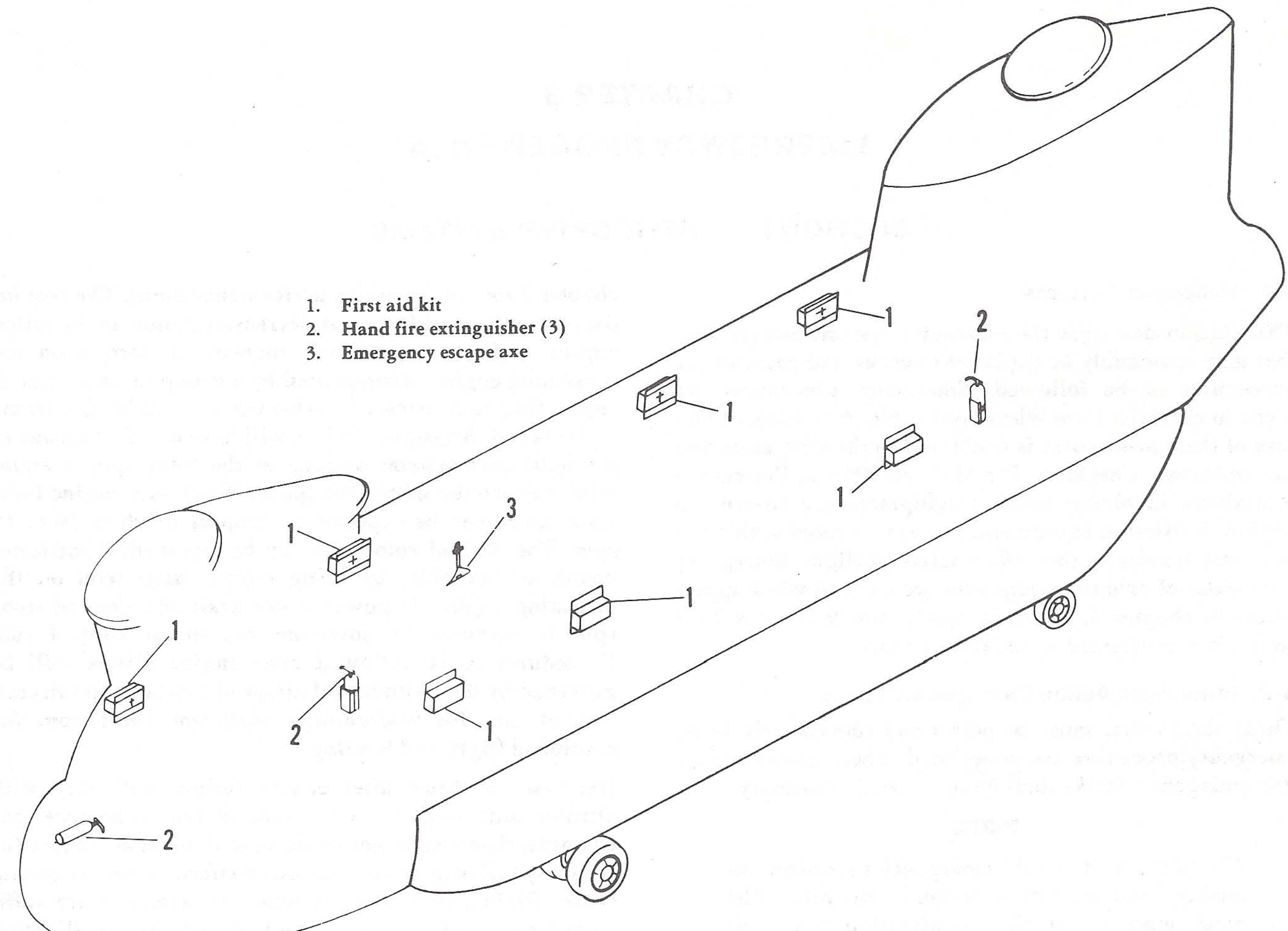


Figure 9-1. Emergency Equipment

9-8. Maximum Glide Distance—Power Off. The maximum glide distance is attained at an indicated airspeed of 90 knots or Vne, whichever is slower, and 230 rotor rpm. (See figure 9-3.)

9-9. Failure Of Two Engines—Low Altitude/Low Airspeed.

Should both engines fail at low altitude and low airspeed (the *avoid* area of the Height Velocity Diagram, figure 5-9), sufficient altitude is not available to increase rotor rpm. Establish the best autorotational airspeed and decelerate effectively prior to touchdown. Initial thrust reduction will vary from no reduction at zero airspeed below 20 feet to completely down at higher airspeeds and altitude. Intermediate airspeeds and altitudes require a partial reduction in thrust in order to reach the termination point without excessive rotor speed decay. Attempt to maintain at least 215 rotor rpm. At slow airspeeds when altitude permits, apply forward cyclic as necessary to increase airspeed to approximately 55 KIAS. Jettison external cargo as soon after engine failure as possible. This will aid in preventing damage to the aircraft during touchdown and will reduce weight and drag, thereby improving autorotational performance. When both engines fail at low altitude/low airspeed, proceed as follows:

1. Thrust—Adjust as necessary; establish autorotational glide.
2. External cargo—Jettison.
3. Land.
4. Engines—Secure by using the Engine Cleanup Procedure (paragraph 9-17).
5. All electrical switches—OFF.

9-10. Failure Of Two Engines—Takeoff.

Refer to Failure of Two Engines—Low Altitude/Low Airspeed (paragraph 9-9).

9-11. Failure Of Two Engines—Cruise.

In cruise flight at airspeeds up to Vne, reduce thrust immediately to full down position in order to regain rotor rpm. Adjust cyclic pressure as necessary to attain and maintain the required airspeed. A landing area must be selected as soon as the engine failure is recognized and control movements made as necessary to fly to the intended site. Throughout the descent, adjust thrust as necessary to maintain the rotor rpm in the normal operating range. At high gross weights, the rotor may tend to overspeed and require thrust application to maintain the rpm below the upper limit. Thrust should never be applied to reduce rpm for extending glide distance because of the reduction in rpm available for use during touchdown. Jettison external cargo as soon after engine failure as possible. This will aid in preventing damage to the aircraft during touchdown and will reduce weight and drag, thereby, improving autorotational performance. When both engines fail at cruise, proceed as follows:

1. Thrust—Down; establish autorotational glide.
2. External cargo—Jettison.
3. Land.
4. Engines—Secure by using the Engine Cleanup Procedure (paragraph 9-17). If time permits during descent, the engines should be secured (Engine Cleanup) to reduce the possibility of fire.
5. All electrical switches—OFF.

If time permits, an attempt may be made to restart the engines in flight if there are no indications of fire or mechanical malfunctions.

9-12. Failure Of One Engine.

The action taken after one engine fails will depend on altitude, airspeed, phase of flight, areas available for landing, and single engine capability of the aircraft. Flight will be discontinued if the aircraft lacks the capability to continue flight on single engine or when terrain and environmental conditions permit an immediate landing.

Thrust control rod adjustments will depend on altitude at the time of the engine failure. For example, at a hover below 20 feet, maintain thrust control rod position as the operative engine beep trim is increased. At a hover above 20 feet, the thrust should be lowered slightly to maintain at least 215 rotor rpm. If altitude permits, the thrust may be lowered sufficiently to maintain normal rotor rpm.

Cyclic inputs will depend on altitude and airspeed. At an in-ground-effect hover, the aircraft should be maintained in hovering to level attitude. In forward flight at low altitude (below 50 feet), when single engine flight is not possible, a decelerating attitude should be assumed to dissipate airspeed and aid in cushioning the aircraft. If airspeed is slow and altitude permits, the aircraft should be placed in an accelerating attitude of up to 30, nose low to gain airspeed as the operative engine beep trim is increased. This nose low attitude should not be used at an extremely low altitude because of reduced reaction time, rate of descent, and the response of the aircraft. Any time the aircraft assumes a decelerating attitude in close proximity to the ground, avoid rotating the aft gear into the ground at touchdown. Jettison external cargo as soon after engine failure as possible. This will aid in preventing damage to the aircraft during touchdown and will reduce weight and drag for improved single-engine performance.

9-13. Failure Of One Engine—Low Altitude/Low Airspeed.

If an engine fails under conditions that will permit single engine flight, thrust must be adjusted as required to maintain safe rotor rpm. Initial thrust reduction will vary from no reduction at zero airspeed below 20 feet to a significant reduction at higher altitudes and airspeeds. The operative engine beep trim must be increased immediately and simultaneously with thrust adjustment. Attempt to maintain at least 215 rotor rpm. If the aircraft is below the best single-engine climb airspeed, forward cyclic must be applied to attain that speed. When hovering out of ground effect, the forward cyclic pressure must be applied to attain a nose low attitude of up to 30, in order to gain airspeed. As the airspeed increases to 30 knots, adjust the pitch attitude of the aircraft to accelerate to the best single engine climb speed.

If an engine fails under conditions that will *not* permit single-engine flight, the procedures will be essentially the same as for flight continued except that cyclic pressures are applied to decelerate the aircraft for touchdown, rather than continued acceleration. During the flare, just prior to touchdown, avoid rotating the aft landing gear into the ground.

When an engine fails at low altitude/low airspeed, proceed as follows:

1. Thrust—Adjust as necessary to maintain rotor rpm.
2. ENGINE BEEP TRIM switches—RPM INCREASE as required.
3. External cargo—Jettison as required.
4. Land. Perform an approach and landing with power. Refer to paragraph 9-66, Landing with One Engine Inoperative.
5. Engine—Secure by using the ENGINE CLEANUP Procedure (paragraph 9-17). If time permits, the inoperative engine should be secured (Engine Cleanup) while in flight to reduce the possibility of fire.

In the event single-engine flight can be maintained, an attempt may be made to restart the inoperative engine if there is no evidence of fire or mechanical malfunction. Refer to paragraph 9-16, Engine Restart During Flight.

9-14. Failure Of One Engine—Takeoff.

Refer to Failure Of One Engine—Low Altitude/Low Airspeed. (paragraph 9-13).

9-15. Failure Of One Engine—Cruise.

In cruise flight at airspeeds up to Vne, the thrust control rod should be lowered only enough to keep rotor rpm within normal limits as the operative engine beep trim is increased. Airspeed should be maintained at or above minimum single-engine climb speed for the existing conditions. External cargo should be jettisoned as required in order to sustain single-engine flight. After single-engine flight has been established, secure the inoperative engine (Engine Cleanup) if time permits and land as soon as practicable.

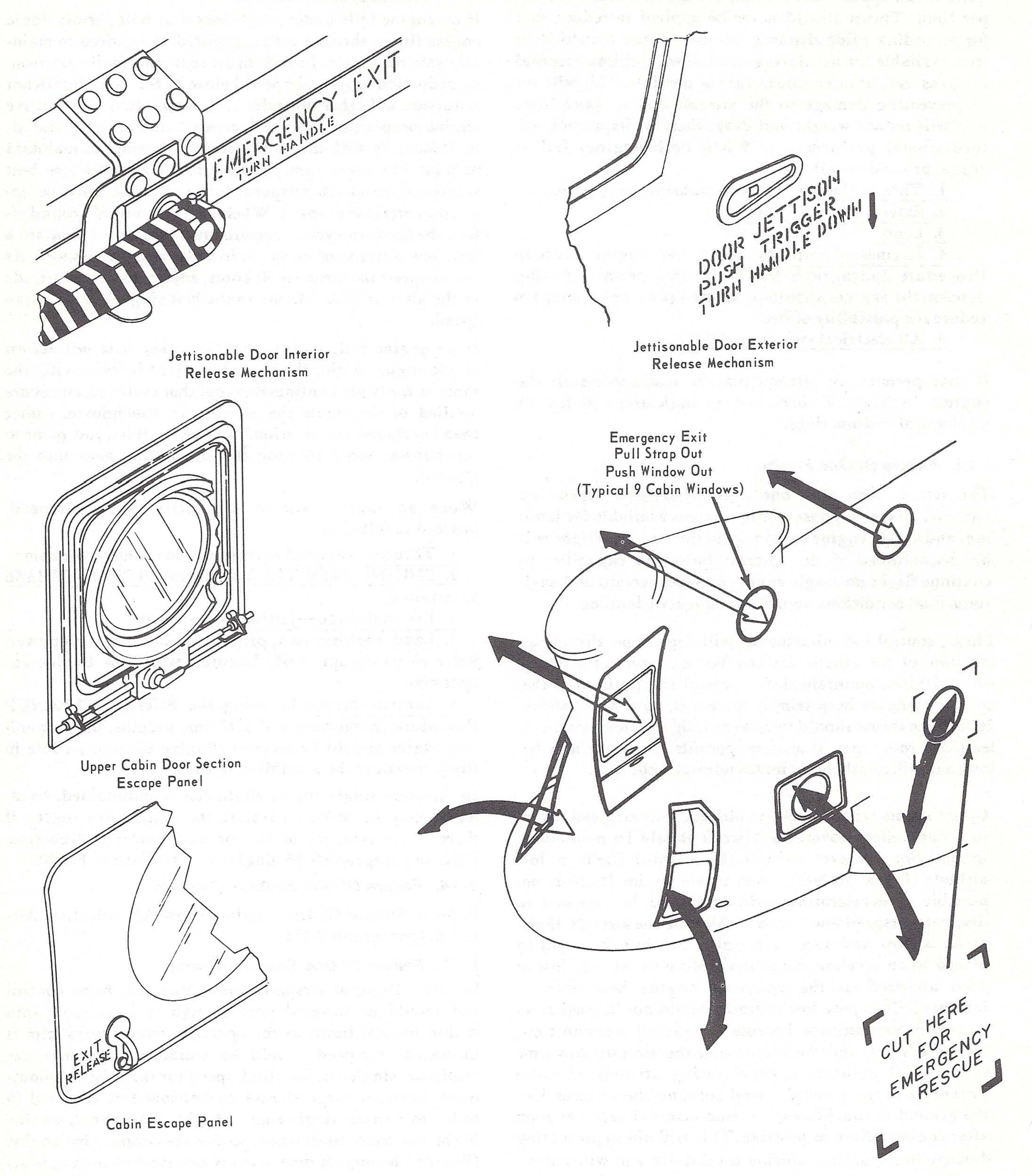


Figure 9-2. Emergency Entrance and Escape Routes (Sheet 1 of 2)

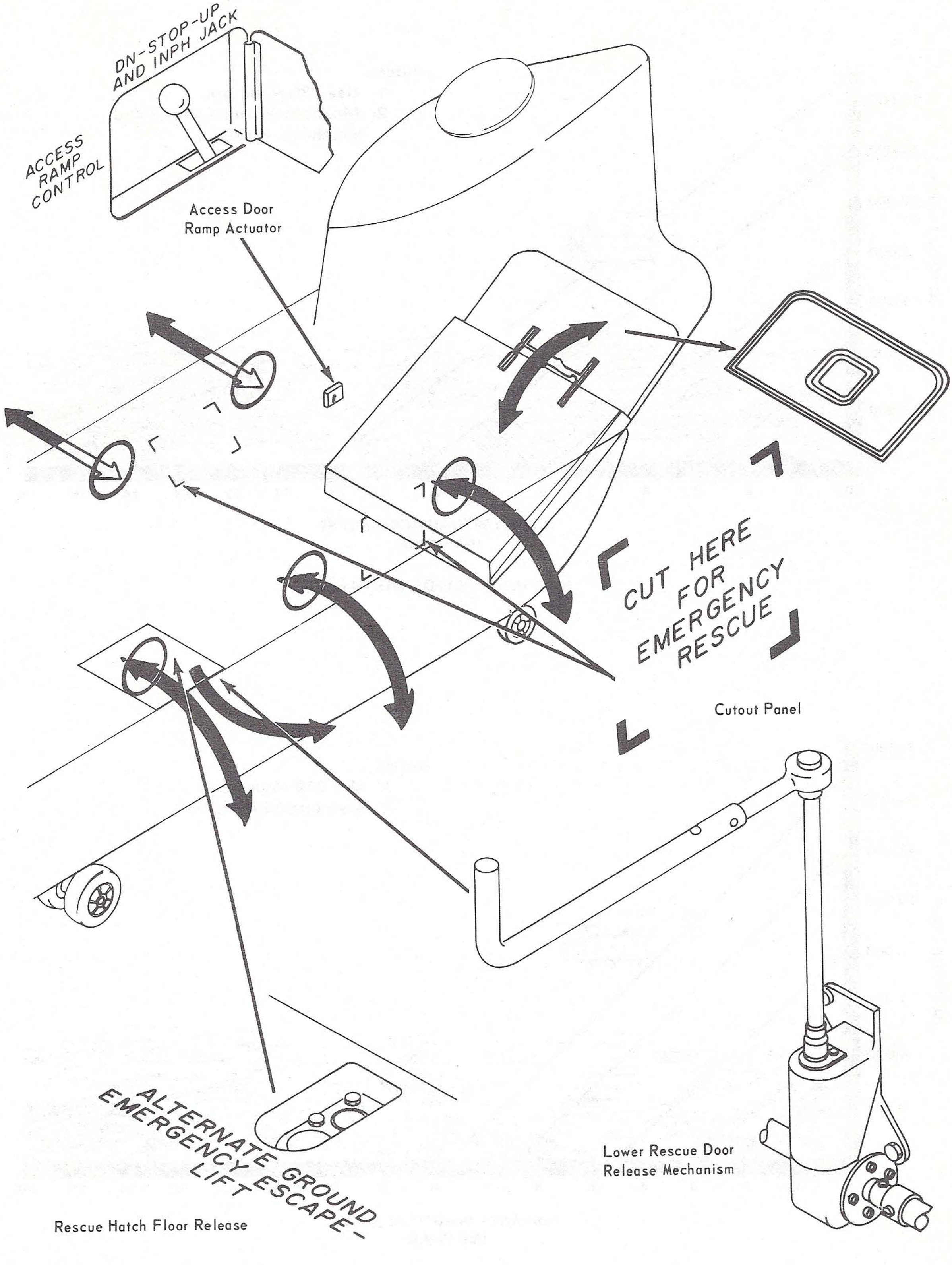
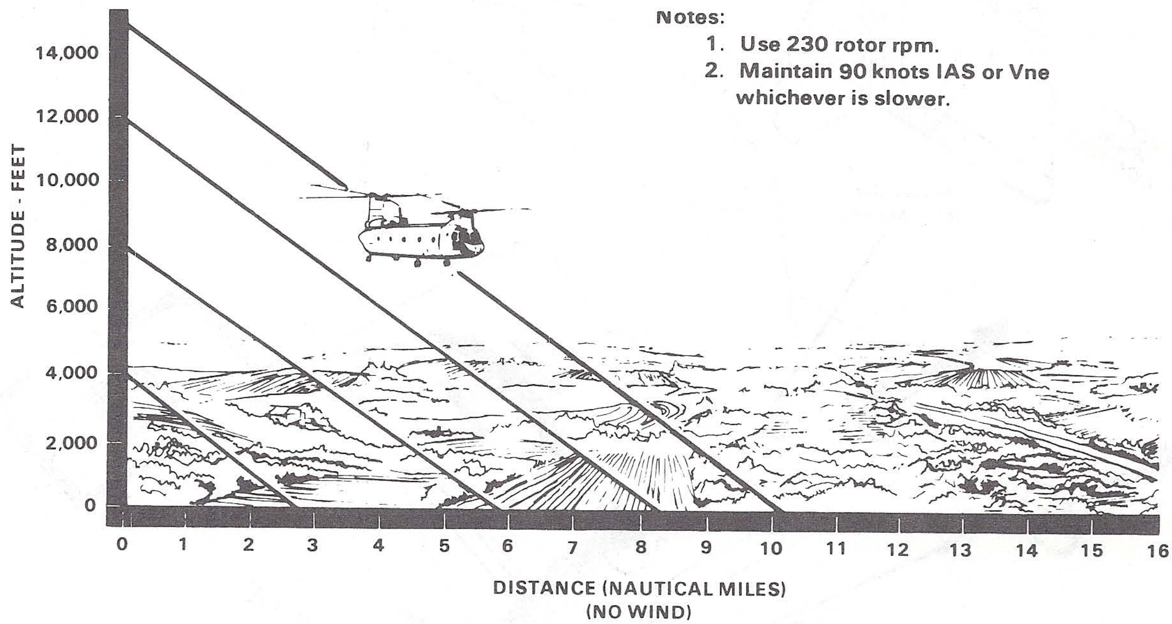
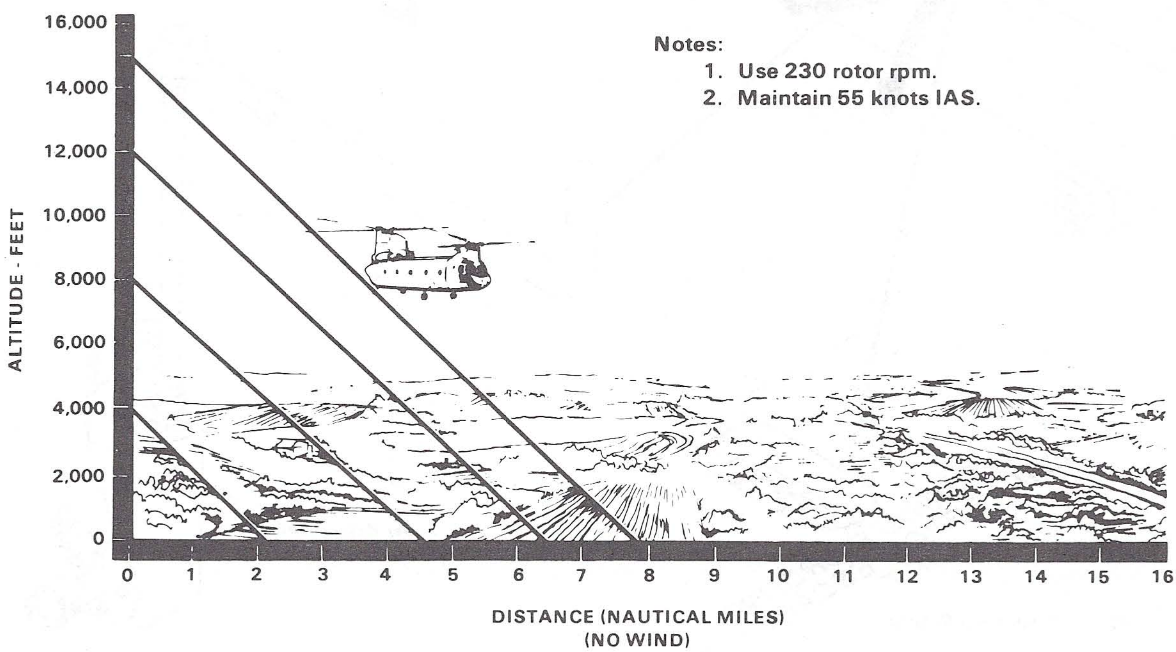


Figure 9-2. Emergency Entrance and Escape Routes (Sheet 2 of 2)



MAXIMUM GLIDE DISTANCE



MINIMUM RATE OF DESCENT

Figure 9-3. Maximum Glide Distance/Minimum Rate of Descent in Autoration

When an engine fails in cruise flight, proceed as follows:

1. Thrust—Adjust as necessary to maintain rotor rpm.

2. ENGINE BEEP TRIM switches—RPM INCREASE as required.

3. External cargo—Jettison as required.

4. Land. Perform an approach and landing with power. Refer to paragraph 9-66, Landing with One Engine Inoperative.

5. Engine—Secure by using the Engine Cleanup Procedure (paragraph 9-17). If time permits, the inoperative engine should be secured (Engine Cleanup) while in flight to reduce the possibility of fire.

In the event single-engine flight can be maintained, an attempt may be made to restart the inoperative engine if there is no evidence of fire or mechanical malfunction. Refer to paragraph 9-16, Engine Restart During Flight.

9-16. Engine Restart During Flight.

If one engine fails during flight and there is no indication of mechanical malfunction or of engine fire, the pilot may make an attempt to restart the inoperative engine. Proceed as follows:

> If abnormal indications are present during the restart, shut down the engine immediately and continue flight on one engine if conditions allow or land as soon as practicable.

1. ENGINE CONDITION lever inoperative engine—GROUND.

2. Fire control handle—In.

3. All FUEL PUMPS switches—ON.

4. CROSSFEED FUEL VALVE switch—As required.

5. FUEL VALVE switch—OPEN.

6. START FUEL switch—OPEN.

7. IGNITION switch—ON.

8. START switch—Press and hold until N1 speed reaches 35 percent.

9. START FUEL switch—CLOSE when egt reaches 600 or N1 reaches 35 percent, whichever occurs first. A higher temperature during an engine restart precludes encountering a hanging start.

10. Engine oil pressure—Check.

11. IGNITION switch—OFF.

12. Engine instruments—Check when stablized at ground idle.

13. ENGINE CONDITION lever—FLIGHT.

14. Rotor rpm—230 rpm.

15. Engine torque match. Cross-check with gas producer speed. Matched engine torques will usually result in a slight gas producer speed mismatch. If the start is unsuccessful, wait at least 15 seconds for fuel to drain from the combustion chamber before attempting another start.

9-17. Engine Cleanup Procedure.

The following procedures will be used to secure the inoperative engine (engines) after engine failure, time permitting:

1. ENGINE CONDITION lever(s)—STOP.

2. Fire control handle(s)—Pull.

3. CROSSFEED FUEL VALVE switch—As required. Close if crossfeeding fuel to the operative engine is not required and when both engines fail.

4. FUEL PUMPS switch(es)—As required.

9-18. Takeoff With One Engine Inoperative.

It is possible when operating at certain gross weights, temperatures, and density altitude to perform a takeoff with one engine operating. The decision to perform a single-engine takeoff is left to the pilot's discretion. Refer to chapter 7 for single-engine maximum gross weight takeoff charts. Refer to chapter 8 for normal takeoff procedures.

9-19. Normal Engine Beep Trim System Failure (High Side).

Failure of the normal engine beep trim system to the high side may be recognized by increasing torque on the affected engine, decreasing torque on the unaffected engine, an increase in rotor rpm, and a lack of response to normal engine beep trim. These indications should be confirmed by observing all the engine instruments. If a malfunction of the normal engine beep trim system to the high side occurs, perform the following:

1. Thrust—Adjust as necessary to maintain rotor rpm within limits.

2. EMER ENG TRIM-N2 switch (affected engine)—DEC.

3. NORM ENG TRIM disable switch (affected engine)—OFF.

4. EMER ENG TRIM-N2 switch (affected engine)—Adjust in coordination with the ENGINE BEEP TRIM, No. 1 & 2 switch to normal operating rotor rpm and match torque.

Care should be exercised when controlling the rotor rpm with the emergency beep trim system; engine response is much faster. It is possible to beep the rotor rpm below safe operating speed and low enough to cause the generators to be disconnected from the buses.

If the thrust control rod is moved with the NORM ENG TRIM disable switch actuated, it will be necessary to control rotor rpm by use of the appropriate emergency engine trim switch, since the droop eliminator will be disabled.

If corrective action for normal engine beep trim system failure (high side) does not control the engine, the failure may be caused by a N2 governor drive shaft failure.

9-20. N2 Governor Failure.

Should the N2 overspeed drive shaft fail, the engine fuel control no longer receives a reference speed input which it requires to maintain a governed N2 rpm. The indications of this condition are the same as for Normal Engine Beep Trim System Failure (High Side) (paragraph 9-19). If the procedure in paragraph 9-19 does not control the engine, complete the following:

1. ENGINE CONDITION lever (affected engine)—GROUND.

2. Thrust control rod—Lower until rotor rpm is regained.

3. ENGINE BEEP TRIM switch (unaffected engine)—Adjust to normal operating rotor rpm.

9-21. Normal Engine Beep Trim System Failure Static (Or Low Side).

Failure of the normal engine beep trim system to the low side may be recognized by decreasing torque on the affected engine, increasing torque on the unaffected engine, a loss of rotor rpm, and a lack of response to normal engine beep trim. These indications also accompany an engine failure; therefore, engine instruments must be monitored to determine which event has occurred. A static failure may be recognized by failure of one or both engines to respond to normal beep commands or may resemble a high or low side failure when the thrust is lowered or raised. Perform the following:

1. EMER ENG TRIM-N2 switch (affected engine)—Adjust.

2. NORM ENG TRIM disable switch (affected engine)—OFF.

3. EMER ENG TRIM-N2 switch (affected engine)—Adjust in coordination with the ENGINE BEEP TRIM NO. 1 & 2, switch to normal operating rotor rpm and match torque.

If the thrust control rod is moved with the NORM ENG TRIM disable switch actuated, it will be necessary to control the rotor rpm and torque by use of the appropriate emergency engine trim switch.

9-22. Engine Shutdown—Complete Electrical Failure.

Should a complete electrical failure be experienced, use the following procedure to shut down the engines:

1. Fuel valves—CLOSE. The flight engineer manually closes the fuel valves which are located in the aft cargo compartment. Since the fuel valves are located approximately halfway between the engines and the fuel tank, the engines will continue to operate for a period of time, depending on the power setting when the fuel valves are closed.

2. Continue with normal shutdown.

9-23. Engine Shutdown—Condition Lever Failure.

Should the engine condition lever fail to shut down or control an engine, use the following procedure for engine shutdown.

1. Fire control handle (affected engine)—Pull.

2. Continue with normal shutdown.

9-24. Engine Shutdown with APU Inoperative.

CAUTION

When the rotors stop turning, no hydraulic pressure is available to motor the engines. In the event of internal engine fire when engine motoring cannot be accomplished, use fire extinguishing equipment as necessary to extinguish the fire.

Apply external electrical and hydraulic power (if available) and continue with a normal shutdown. If external electrical and hydraulic power is not available, proceed as follows:

1. No. 2. Engine—Perform a normal shutdown.

2. ENGINE BEEP TRIM NO. 1 & 2 switch—RPM DECREASE for 8 seconds.

3. All unnecessary electrical switches—OFF. The BATTERY switch shall be left ON.

4. LEFT TANK FUEL PUMPS switches — OFF.

5. NO. 1 and NO. 2 GEN CONTROL switches—OFF.

6. NO. 1 ENGINE CONDITION lever—GROUND. Wait until egt decreases and then begins to increase; then, move the engine condition lever to STOP.

7. ENGINE NO. 1 START button—Press and hold until rotors stop.

8. Continue with normal engine shutdown.

9-25. Engine Oil—Low Quanity/High Temperature/High Or Low Pressure.

A low engine oil quanity condition will be indicated by the lighting of the OIL LOW NO. 1 ENG or OIL LOW NO. 2 ENG caution light. When either one of both of these caution lights have come on, about 2 quarts of usable oil remain in the respective engine oil tank. If one or both of the caution lights come on, check oil temperature and oil pressure indicators (affected engine) for any abnormal indications. If the indication on the oil temperature indicator is high and/or that on the oil pressure indicator exceeds limits, either high or low, land as soon as practicable. Be prepared to shut down the affected engine.

9-26. Engine Chip Detector Caution Light ON.

If either NO. 1 or NO. 2 ENG CHIP DET caution lights comes on, land as soon as practicable. Be prepared to shut down the affected engine.

9-27. Torque Measuring System Malfunctions.

Malfunctions in the torque measuring system can be reflected in the torquemeter reading as fluctuations, a zero-torque indication, sluggish movement, indications which are 120°/180° out-of-phase, or a stationary indication. Fluctuations in torque in excess of 100 lb-ft when operating at steady state is indicative or an internal failure in the mechanical portion of the torque measuring system within the engine. If fluctuations are followed by abnormal indications on the other engine instruments, i.e., gas producer tachometer, egt indicator, land as soon as practicable. Be prepared to shut down the affected engine. If indications on the other instruments are normal, it is recommended that the gas producer tachometer be monitored when changing power or matching power output.

If either a zero torque or stationary torque is indicated, check that the ENG TORQUE circuit breakers on the overhead circuit breaker panel are in.

9-28. Rotor, Transmission, And Drive Systems.

9-29. Transmission Oil Temperature Or Pressure Caution Light Illumination.

Trouble developing in one of the five transmissions can be identified by an excessively high oil temperature or an excessively high or low pressure, as indicated by the transmission temperature and pressure indicators which will light the TRANS OIL PRESS or TRANS OIL TEMP caution light. The TRANS OIL PRESS and TRANS OIL TEMP caution lights are a function of the indicator pointers, and are not an additional indication of low pressure or high temperature.

Should the pressure or temperature indicator caution lights come on, immediately begin a descent for landing. Check transmission oil temperature and pressure indicators to determine the malfunctioning transmission. If the malfunction is associated with the forward, combining, or aft transmissions, land. If the malfunction is associated with either engine transmission, be prepared to shut down the affected engine. If the engine transmission oil temperature does not exceed 140°C, the engine may be operated for 1 hour. The decision to land or continue flight on one engine will be left to the discretion of the pilot. When a landing is made, use minimum power. Should a warning occur in the forward, aft, or combining transmissions while over water or very rough terrain, attempt to reach the closest suitable landing area at a minimum altitude (10 to 25 feet) and a low airspeed. This low altitude and airspeed will lessen the chance of injury to personnel or damage to the helicopter in event of complete transmission failure. If a severe transmission oil leak occurs, it is possible to lose oil pressure and not experience a rise in oil temperature. The flight engineer should assess the condition.

9-30. Transmission Chip Detector Caution Light Illumination.

When the transmission chip detector caution light comes on, it indicates that ferrous particles are present in the oil of the forward, combining, or aft transmissions, or the aft vertical shaft thrust bearing, and that excessive wear has taken place. Should the caution light come on during flight, perform an approach and landing with power immediately.

9-31. Rotor Blade Or Drive Shafting Failure.

If a rotor blade or the drive shafting fails, attempt to maintain control and start an emergency descent.

9-32. Rotor Speed Measuring System Failure.

If all indications of rotor speed are lost on both indicators during flight, it could be caused by failure of the rotor tachometer generator or the rotor tachometer indicators. If this malfunction should occur, do not attempt to make any further changes in rotor speed. It is recommended that practice autorotational descents not be performed and that all maneuvers requiring the use of the thrust control rod be made as smoothly as possible to prevent rotor rpm droop or overspeed. Monitor N1 and torque to prevent exceeding limits.

9-33. Ground Resonance.

The CH-47A employs devices and design features which are aimed at preventing or controlling ground resonance. The incorporation of shock absorbers on the rotor blades and air-oil shock struts in the landing gear have a combined energy dissipation capacity which is sufficient to prevent instability from occurring under most conditions. The helicopter can be forced into a slightly unstable condition when all landing gear are on the ground with the forward landing gear in light contact during takeoffs and landings. The response of the helicopter would be neutral or slowly divergent should this occur. The pilot should be familiar with this condition and immediately raise the forward landing gear clear of the ground by applying aft cyclic stick until the condition is damped, or hover immediately. In no case should the rotor rpm be decreased to control the instability, nor should a full set-down be attempted since divergency can occur under these circumstances.

9-34. Blade Stall.

Blade stall is indicated by a progressive increase of *1-per-rev* and *3-per-rev* vibrations. The severity of the vibrations will increase as the helicopter is flown further into blade stall. If a blade stall condition is experienced, executing one or more of the following will alleviate the condition:

1. Lower the thrust control rod.
2. Increase rotor rpm.
3. Decrease airspeed.
4. Minimize maneuvering.
5. Descend to a lower altitude (if practicable).

9-35. Fire.

The safety of aircraft occupants is the primary consideration when a fire occurs; therefore, it is imperative that every effort be made by the flight crew to put out the fire. On the ground, it is essential that the engines be shut down, crew and passengers evacuated and fire fighting begun immediately. If time permits, a *Mayday* radio call should be made before the electrical power is OFF to expedite assistance from airfield fire fighting equipment and personnel. *If the aircraft is airborne when a fire occurs, the most important single action that can be taken by the pilot is to land the aircraft immediately.*

CAUTION

Use fire extinguishers only in well ventilated areas because the toxic fumes of the extinguisher agent can cause injury.

9-36. Engine Fire.

9-37. Engine Residual Fire During Starting And Shutdown.

A residual engine fire may occur during a start or shutdown. It is caused by residual fuel igniting in the combustion chamber. The fire will be detected by a rapid and abnormal rise in egt or by observing flames and black smoke coming from the engine tail pipe. Should a fire occur, complete the following on the affected engine.

1. ENGINE CONDITION lever—STOP.
2. ENGINE START switch—Press and hold until EGT indicates approximately 260°C.
3. Fire control handle—Pull.
4. Continue with a normal shutdown.

9-38. Auxiliary Power Unit (APU) Fire.

Normally an overtemperature condition will cause the overtemperature switch to stop apu operation; however, should a fire occur in the apu, complete the following:

1. APU switch—STOP.
2. ENGINE CONDITION levers—STOP. If engines are operating.
3. Fire control handles—Pull.
4. Engines—Motor with starters as required to prevent internal fire.
5. All electrical switches—OFF.
6. Clear the aircraft of all passengers and crew as required.

9-39. Engine Fire—Flight.

Fire will be noted by visible flames or smoke on the outside of the engine or by the lighting of the respective fire detector light in the cockpit. If an engine compartment fire occurs, perform the following on the affected engine:

1. ENGINE CONDITION lever—STOP.
2. Fire control handle—Pull.
3. FIRE EXT AGENT switch—Select BOTTLE NO. 1 or BOTTLE NO. 2. Depending upon the severity of the fire, it may be necessary to use both bottles.
4. Windows and cockpit air handle—Close.
5. CROSSFEED FUEL VALVES switch—As required.
6. FUEL PUMPS switches—As required.
7. Land as soon as possible.
8. Secure remaining engine after landing.
9. All electrical switches—OFF.
10. Clear the aircraft of all passengers and crew immediately.

9-40. Engine Fire—Ground.

If an engine compartment fire occurs, perform the following on the affected engine.

1. ENGINE CONDITION levers—STOP.
2. Fire control handle—Pull.
3. FIRE EXT AGENT switch—Select BOTTLE NO. 1 or BOTTLE NO. 2. Depending upon the severity of the fire, it may be necessary to use both bottles.
4. All electrical switches—OFF.
5. Clear the aircraft of all passengers and crew immediately.

9-41. Fuselage Fire—Ground.

If fire is observed in any part of the fuselage during ground operations, proceed as follows:

1. ENGINE CONDITION levers—STOP.
2. Fire control handles—Pull.
3. All electrical switches—OFF.
4. Clear the aircraft of all passengers and crew immediately.

9-42. Fuselage Fire—Flight.

If fire is observed in any part of the fuselage during flight, attempt to control it by using portable hand fire extinguishers and proceed as follows:

1. Land immediately—Perform a power-on approach and landing without delay. Close cockpit windows and air control handles.
2. ENGINE CONDITION levers—STOP as soon as the aircraft is on the ground.
3. Fire control handles—Pull.
4. All electrical switches—OFF.
5. Clear the aircraft of all passengers and crew immediately.

9-43. Electrical Fire.

9-44. Electrical Fire—Flight.

In the event of electrical fire or suspected electrical fire in flight, attempt to control it by using portable hand fire extinguishers and proceed as follows:

1. Land immediately—Perform a power-on approach and landing without delay. Close cockpit windows and air control handles.
2. BATTERY switch—EMERGENCY.
3. Airspeed—100 knots or below.
4. GEN CONTROL switches—OFF. Airspeed should be below 100 knots prior to turning the switches OFF. If the flight is being conducted above 6,000 feet pressure altitude, delay turning the generators off until below 6,000 feet pressure altitude since the fuel booster pumps will become deenergized and a dual flameout could possibly result. Do not turn off the generators when IMC.
5. ENGINE CONDITION levers—STOP as soon as the aircraft is on the ground.
6. Fire control handles—Pull.

7. All electrical switches—OFF.

8. Clear the aircraft of passengers and crew immediately.

9-45. Electrical Fire—Flight Continued.

If landing cannot be made immediately and flight must be continued, the defective equipment must be identified and disabled.

9-46. Electrical Fire—Ground.

In the event of electrical fire or suspected electrical fire during ground operations, attempt to control it by using portable hand fire extinguishers and proceed as follows:

1. ENGINE CONDITION levers—STOP.
2. Fire Control handles—Pull.
3. All electrical switches—OFF.
4. Clear the aircraft of passengers and crew immediately.

9-47. Smoke And Fume Elimination.

Once the fire has been extinguished, the following procedure should be used to evacuate smoke or fumes:

1. Airspeed—80 to 100 knots.
2. Cargo loading ramp—Open.
3. Upper half of main cabin door—Open.
4. Helicopter attitude—20° left yaw.
5. Pilot's sliding window—Open. Simultaneous opening of the pilot's sliding window and the main cabin door and cargo loading ramp may cause a smoldering fire to intensify. If the source of the smoke cannot be ascertained, opening the main cabin door only will minimize the draft.
6. Copilot's sliding window—Closed.

9-48. Fuel System.

9-49. Single Fuel Pump Failure.

Should only one fuel pump fail in the main tank, it will have no effect on the operation of the fuel system. Any inoperative boost pump should be shut down.

9-50. Fuel Pump System Failure.

Should both main tank pumps fail, fuel will be drawn from the main tank as long as the helicopter is operated below 6,000 feet pressure altitude. If all pumps in one fuel system fail, proceed as follows:

1. CROSSFEED FUEL VALVES switch—OPEN above 6,000 feet pressure altitude.
2. FUEL PUMPS switches (affected pumps)—OFF.

9-51. Fuel Low Caution Light Illumination.

When the L FUEL LOW or R FUEL LOW caution lights come on, monitor fuel quantity and balance as necessary. When operating with one aft fuel pump inoperative and/or a low fuel quantity, open the crossfeed during the approach. With both aft fuel pumps inoperative and a low fuel quantity, avoid nose-high attitudes.

9-52. Electrical System.

9-53. Failure of One Generator.

Should one ac generator fail, the remaining generator will assume the entire load. This condition will be indicated by the lighting of a GEN OFF caution light. If a GEN OFF caution light comes on, set the affected GEN CONTROL switch to TEST. If the caution light goes out, move the switch to ON. If the caution light remains on, move the switch to OFF.

9-54. Failure Of Both Generators.

Should both generators fail, both transformer-rectifiers will also be disabled; consequently, the only electrical power available will be 24-volt dc from the battery. This condition will be indicated by loss of both SAS and the lighting of both SAS OFF, GEN OFF, and RECT OFF caution lights. A simultaneous failure of both SAS can also result in an abrupt aircraft attitude change as the SAS extensible links recenter. Perform the following:

1. Airspeed—100 knots or below. This represents the best SAS off airspeed.
2. Altitude—Descend below 6,000 feet pressure altitude.
3. BATTERY switch—As required. (EMERGENCY or ON.)
4. EMER ENG TRIM-N2 switches. As required.
5. Land as soon as practicable. If unable to land, proceed with the following steps:
6. EMER SAS REL switch—RELEASE.
7. GEN CONTROL switches—TEST. Move each GEN CONTROL switch to TEST and observe the GEN OFF caution light. If the caution light goes out, the generator is delivering proper voltage and frequency and a short circuit on a bus is indicated. If the caution light remains on, the generator is inoperative. If one or both of the generators are delivering proper voltage and frequency, continue as follows:
8. AC BUS CONT circuit breaker—Pull out. When this circuit breaker is out, the bus-tie relay is disabled. This is done to prevent either generator from being disabled again by a bus fault on a non-associated bus.
9. GEN CONTROL switch—RESET then ON. The generator which will not stay on the line indicates the bus on which the short has occurred. There is a possibility that the source of electrical difficulty may be isolated to a faulty system or circuit breaker.
10. Generator system fault—Isolate as follows.
    a. GEN CONTROL switch—OFF.
    b. Circuit breakers—Pull out all circuit breakers associated with the disabled bus.
    c. GEN CONTROL switch—RESET then ON.
    d. Circuit breakers—Push in one circuit breaker at a time until the malfunctioning equipment can be identified.
    e. AC BUS CONT circuit breaker—Push in.

9-55. *Single Transformer Rectifier Failure.*

Should a transformer-rectifier fail, the remaining transformer-rectifier will assume the load. This condition will be indicated by the lighting of either the NO. 1 RECT OFF or NO. 2 RECT OFF caution lights for the affected transformer-rectifier. A RECT OFF caution light may come on even though the transformer-rectifier has not failed. To check this, operate either the windshield anti-ice or searchlight and note whether the caution light goes out.

9-56. *Failure Of Both Transformer Rectifiers.*

Failure of both transformer-rectifiers will be indicated by the NO. 1 and NO. 2 RECT OFF caution lights coming on. In this situation, the remaining source of dc power will be supplied by the battery. Should both transformer-rectifiers fail, perform the following:

1. Airspeed—100 knots or below.
2. Land as soon as practicable. If unable to land, proceed with the following.
3. BATTERY switch—As required. (EMERGENCY or ON.)
4. All dc equipment not essential to flight — off. Pull out circuit breakers if necessary to disable equipment.

9-57. *Battery Relay Failure.*

Should the battery relay fail, the battery will not receive a charge and will completely discharge. The items of equipment on the battery bus will be disabled. This condition can be recognized by inability to operate control centering. Should this condition occur, land as soon as practicable.

9-58. Hydraulic System.

9-59. *Failure of One Flight Control Hydraulic System.*

When one flight control hydraulic system fails, it will be noticed by the lighting of the respective caution light (NO. 1 HYD BOOST OFF or NO. 2 HYD BOOST OFF) and a decreased pressure indication on the hydraulic pressure gage for that system. When one of the flight control hydraulic systems fails, the corresponding SAS will also be disabled, and the applicable SAS OFF caution light will come on. Should this occur, proceed as follows:

1. HYD BST switch—Select good system.
2. Land Immediately. Perform a power-on approach and landing without delay.

9-60. *Failure Of Both Flight Control Hydraulic Systems.*

Simultaneous failure of both flight control systems will be caused by a failure of the quill shaft. Indications of the failure are lighting of all GEN OFF, RECT OFF, FUEL PRESS, SAS and HYD BOOST OFF caution lights. Should this condition exist, proceed as follows:

1. Apu—Start.
2. Regain aircraft control.
3. Land immediately—Perform a power-on approach and landing without delay.

If complete pressure loss is encountered on both flight control hydraulic systems, it is impossible to move the flight controls.

9-61. *Failure Of Utility Hydraulic System.*

The only cockpit indication of a utility hydraulic system failure is a decreased pressure indication on the utility hydraulic system pressure indicator. Depending upon the nature and location of the system failure, it may or may not be possible to operate the following items of equipment: auxiliary power unit, engine starters, ramp and cargo door, wheel brakes, swivel locks, power steering, cargo hook, and winch. Prior to landing, the pilot should direct the flight engineer to determine if sufficient pressure (3,000 psi) is available in the utility hydraulic system accumulator. If the accumulator pressure has decreased, the flight engineer should attempt to repressurize it using the hand pump. It will be necessary to continue pumping to maintain pressure. If accumulator pressure is available, the cockpit UTILITY SYSTEM switch must be at ON to use this source, except for the cargo hook. The cargo hook will operate regardless of switch position. In the event of a complete loss of fluid or a hydraulic cooler malfunction, perform an approach and landing with power as soon as possible.

Landing from a hover is recommended. A running landing without the use of wheel brakes and swivel locks operating is not recommended because it may require large directional pedal inputs, resulting in damage to or loss of the droop stops.

After the landing, the wheels should be chocked immediately.

9-62. Landing and Ditching

9-63. *Emergency Descent.*

An emergency descent is a maximum performance maneuver in which damage to the helicopter or powerplants must be considered secondary to getting the helicopter on the ground. The following technique is recommended:

1. Thrust control rod — Lower. Allow the rotor rpm to increase to a maximum of 261 rpm; then adjust the thrust control rod to maintain 261 rpm.
2. Airspeed—Adjust to an airpseed which will produce the maximum rate of descent.

9-64. *Autorotative Landing.*

An autorotative landing will be accomplished after failure of both engines. Maintain the desired airspeed at or above the minimum rate of descent airspeed in autorotation with cyclic and rotor rpm below 261 by adjusting the thrust as necessary.

At approximately 50 to 75 feet above ground level, apply aft cyclic control as necessary (not to exceed 20° nose-high attitude) to initiate a smooth deceleration. Maintain alignment of the helicopter with the landing area by application of the pedals and cyclic control. Position thrust as required to prevent rotor rpm from increasing above the maximum.

At approximately 15 feet aft gear height, apply sufficient thrust to slow the rate of descent, assist deceleration, and effect a smooth touchdown in effective translational lift. The amount of thrust applied and the rate at which it is applied will vary depending upon the wind, load, and other influencing factors. Maintain the landing attitude, if possible, with cyclic and thrust until the forward speed has ceased, then smoothly lower thrust until the forward landing gear touches the ground. Apply brakes as required.

Whenever a touchdown into the wind under fully controlled conditions cannot be made, execute a crosswind landing. It is better to perform a crosswind landing, which can be executed from sufficient altitude to stop drift and reduce the rate of descent, than to continue a turn into the wind with the great possibility of a hard landing and damage to the helicopter. Decelerate the helicopter at the same altitude as though the helicopter were making the entire approach into the wind.

Stop all drift and perform the initial touchdown on the upwind aft landing gear. In a strong wind it may be necessary to hold the helicopter in what is, in effect, a slip by cross control.

After touchdown, allow the helicopter to settle on the other landing gear. Perform the ground roll in the same manner as a landing made into the wind.

9-65. Landing With Flat Tires.

Should a tire or tires become deflated during flight or on touchdown, do not attempt a roll-on landing. Land on sod or dirt, whenever possible, to prevent damage to the wheels.

9-66. Landing With One Engine Inoperative.

When committed to a single-engine landing, it is not always possible to terminate the approach at a hover; therefore, it is recommended that a running landing or an approach which terminates on the ground be used if terrain conditions allow. Establish a shallow angle of descent at approximately 70 knots airspeed using maximum normal operating rotor rpm for maximum inertia. Govern the rate of descent and airspeed according to gross weight, density altitude and terrain. At approximately 100 feet, initiate a cyclic flare and begin a slow deceleration while reducing the rate of descent. Prior to touchdown, make sure the helicopter is aligned with the direction of movement. After touchdown has been made on the aft landing gear, maintain this attitude until speed is sufficiently slow. Then lower the thrust control rod smoothly until the forward landing gear are on the ground. Apply brakes as required.

9-67. Landing In Trees.

a. Power on. If a landing in a heavily wooded area is imminent, it is best to land while power is still available. Make a power-on approach, bringing the helicopter to a hover at treetop level. Move the ENGINE CONDITION lever to STOP. Raise the thrust control rod before contact and allow the helicopter to settle into the trees.

b. Power off. If it is necessary to make an autorotative landing in a heavily wooded area, perform the cyclic flare in such a manner that all forward speed is stopped at treetop level. Raise the thrust control rod before contact and allow the helicopter to settle vertically into the trees.

9-68. Emergency Entrance.

(See fig. 9-2.)

Access to cockpit is accomplished thru the pilot and copilot jettisonable doors.

Entry to the cargo compartment can be accomplished by opening the cabin door, upper cabin door escape hatch, cabin escape hatch, ramp escape hatch, and cutout panels. All escape hatches can be opened by pulling the yellow tab out and pushing the panel in.

Entry to the aft cargo compartment may be made by manually positioning the ramp control (exterior access) to the open position.

9-69. Ditching.

There is sufficient bouyancy and lateral righting moment to remain afloat and upright for a sufficient length of time to permit the crew and passengers safe egress. (See figure 9-4 for crew ditching duties).

9-70. Ditching—Power ON.

When ditching is to be accomplished while power is still available, plan the approach so that the final descent is made parallel to the primary wave pattern and terminates in a hover 5 to 10 feet above the water. When stabilized in a hover, the pilot may at his discretion order the passengers to commence egress or wait until the helicopter is in the water and the rotors have stopped turning. As water contact is made, apply forward cyclic stick to level the fuselage. When settled in the water, shut down both engines and move the battery switch to OFF. When the rotors have stopped turning, the passengers and crew will exit the helicopter. See figure 9-5 for the recommended ditching exits.

9-71. Ditching-Power OFF.

If dual engine failure occurs over water and ditching is imminent execute an autorotational descent, maintaining the desired airspeed at or above the minimum rate of descent airspeed and rotor rpm in the normal operating range by adjusting the thrust as necessary.

At approximately 100 feet above the water, perform a gradual longitudinal flare to reduce the airspeed and rate of descent. During the flare, the rotor rpm will start to increase. Allow the rotor rpm to increase to the upper limit so that maximum benefit can be gained from the inertia to cushion the touchdown.

At approximately 30 feet above the water, the final attitude should be adjusted, but not to exceed 23° noseup. An excessive noseup attitude will reduce the clearance between the water and the aft rotor, and concentrate impact forces on the aft fuselage.

Rate of descent should be the minimum attainable at water

	PILOT	COPILOT	FLIGHT ENGINEER/ TROOP COMMANDER
DUTY	1. Notify the crew on interphone of the decision to ditch. 2. Adjust shoulder harness, life vest, and lock inertia reel. 3. Coordinate with the flight engineer/troop commander as required.	1. Notify the passengers of the decision to ditch by ringing the alarm bell 3 times. 2. Set the transponder (IFF) at EMER. 3. Initiate a distress message on the assigned frequency or a frequency on which previous contact has been made. 4. Relieve the pilot of the controls while he adjusts his shoulder harness. 5. Adjust shoulder harness, life vest, and lock the inertia reel. 6. Just prior to water contact, ring the alarm bell continuously.	1. Notify the passengers of the impending ditching and check that each is properly strapped in. 2. If cargo is to be jettisoned, coordinate on interphone with the pilot. 3. If the cargo is not to be jettisoned, check it for proper restraint. 4. Close the ramp and cargo door and all hatches and doors. 5. Assemble all emergency equipment and distribute it among the passengers. 6. Fasten safety belt and advise the pilot that the cabin is prepared for ditching.
PROVIDE	—	—	1. Emergency equipment.
POSITION	1. Pilot's seat.	1. Copilot's seat.	1. Cabin seat, near ramp or cabin door.
EXIT	1. Pilot's jettisonable door.	1. Pilot's jettisonable door.	1. Ramp or cabin door. See figure 9-5 for recommended emergency exits for ditching.

Figure 9-4. Ditching Chart

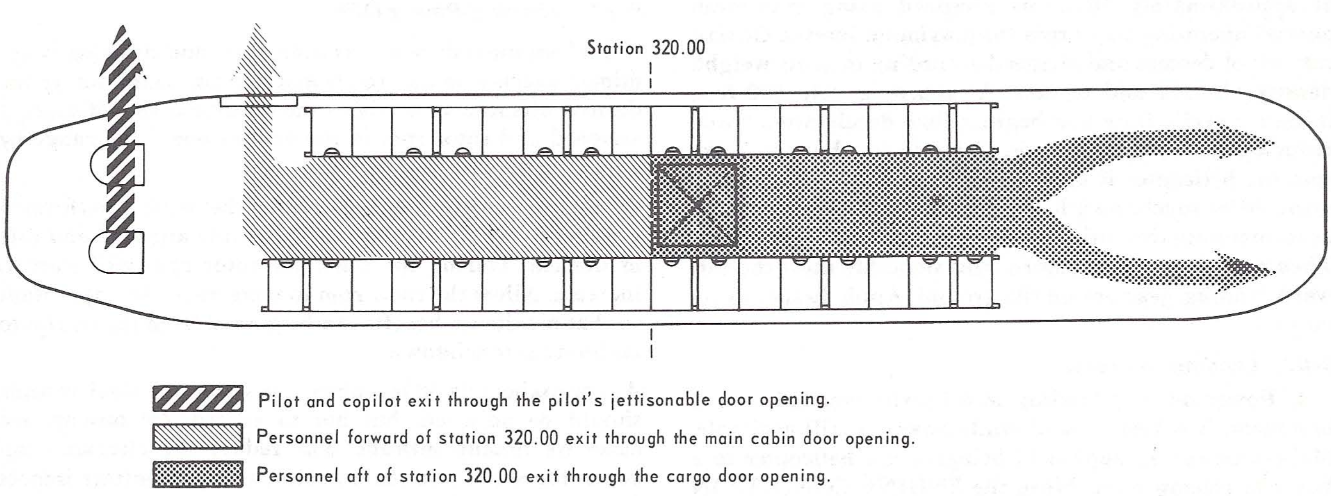


Figure 9-5. Ditching Exits

entry and must be considered regardless of water entry speed.

The water entry speed is equally important and should be as slow as possible without sacrificing aircraft control.

Aircraft attitude at water entry is very important and relates directly to water entry speed. At zero entry speed or at speeds up to 30 knots, the pitch attitude at water entry is dictated primarily by the clearance between the water and the aft rotor blades and should not exceed 23° noseup. Entry speeds up to approximately 40 knots require a pitch attitude of approximately 15° to prevent high concentrated impact loads on the extreme aft bottom of the fuselage. However, it is also important not to allow the pitch attitude to become less than approximately 5° at the higher water entry speeds since there is a possibility of breaking the lower nose enclosure plastic panels.

The actual touchdown on the water will probably be governed by one of two conditions: high wind and rough water or low wind and calm water.

a. High wind and rough water. Use thrust as necessary to minimize rate of descent at water entry. Do not hesitate to use the remaining thrust at water entry if the rate of descent is judged to be excessive.

b. Low wind and calm water. Follow the procedure above to the point of the landing flare. Reduce speed to approximately 40 knots and then establish a noseup attitude of approximately 5° to 10°. Just prior to water entry, increase thrust to cushion the aft landing gear contact with water. Attempt to have the rate of descent as low as possible when using this technique. As the helicopter decelerates, attempt to hold the nose out of the water. As the speed diminishes to 10 knots or less, lower the thrust control smoothly and return the controls to neutral. The helicopter does not display any tendency to pitch down upon water entry. Also, the aft landing gear acts to create a decelerating force on the water.

9-72. Duties After Ditching.

The pilot in command is responsible for the overwater mission briefing to ensure that each individual has a knowledge of what he is expected to do after leaving the helicopters.

9-73. Flight Controls.

9-74. Longitudinal Cyclic Trim System Failure.

Should the system fail during cruise, with the cyclic trim system programed for maximum forward tilt of the rotors, an abnormal nose-high attitude will result with decreasing airspeed. Should one or both actuators fail in the full retract position, airspeed must be limited according to Vne for retracted longitudinal cyclic trim. Should the longitudinal cyclic trim system fail, perform the following:

1. Airspeed—Adjust. Airspeed must be below Vne for retracted cyclic trim if the failure occurs RETRACTED. Maintain airspeed above 80 knots until landing approach if the failure occurs EXTENDED.

2. Cyclic TRIM function switch—Select other function and check for proper operation. If one or both cyclic actuators fail, move the function switch to MAN and attempt to control the cyclic trim. If only one actuator fails and cannot be controlled, return the switch to AUTO to allow the other operational cyclic trim to program. If both actuators are retracted, the landing will be normal. If one or both actuators fail in the extended position, the pitch attitude of the aircraft will be higher than normal during the approach and will be dependent upon the amount of actuator extension at the time of the failure. Execute a shallow approach to a hover or to the ground with a normal touchdown, avoiding large cyclic changes. When the aft gear are on the ground apply brakes and lower the nose. As the forward gear touch the ground, the aircraft will tend to accelerate more than normal. Continue to apply brakes as necessary to prevent forward movement. If the helicopter is taxied with the actuators failed in the extend position, use minimum control applications and adjust the thrust control at the 3° detent or higher. There is an increased susceptibility to droop-stop pounding with this condition.

9-75. Differential Collective Pitch Trim Failure.

Should a malfunction occur, the speed stability will change from positive to slightly unstable. If the dcp actuator fails in the retracted (low speed) position, the cyclic stick will be positioned farther aft than normal at cruise. If the dcp actuator fails in the extended (high) speed position, the cyclic stick will be farther forward than normal at airspeeds below 80 knots. If the dcp trim actuator fails in the extended position during flight at the most aft center of gravity position, sufficient forward cyclic stick travel may not be available at airspeeds below 30 knots. To provide adequate forward cyclic stick travel, the cyclic stick must be trimmed aft by using the stick positioner trim wheel prior to decreasing airspeed to 30 knots or below.

9-76. Single SAS Failure—Both ON.

A malfunction of the SAS can usually be detected by an abrupt attitude change (hardover) or unusual oscillations in one or more of the flight control axes or lighting of the SAS OFF caution light. Should a malfunction occur, perform the following: (If any of the following steps result in regained control, do not continue with the remaining steps.)

1. Airspeed—Adjust as necessary to a speed below 100 KIAS.
2. SAS switch—NO. 1 ON.
3. SAS switch—NO. 2 ON.
4. Malfunctioning SAS DC circuit breaker—Pull out.

9-77. Dual SAS Failure.

If the second SAS fails, while operating with one SAS (one system inoperative), *set the EMER SAS RELEASE switch to RELEASE.*

9-78. VGI Malfunction.

A vgi malfunction will be noticed by an attitude indicator failure. If a vgi malfunction occurs perform the following:

1. Affected VGI switch—EMER.
2. Affected VGI AC circuit breaker—Pull out.

9-79. Thrust Control Rod Magnetic Brake Failure.

If the thrust brake malfunctions, pull out the THRUST BRAKE circuit breaker. If the brake releases, push in or pull out the circuit breaker as required. If the brake will not slip, break the shear with an upward force on the thrust control rod. Should the thrust brake fail or should the shear section be broken, the pilot or copilot should apply lateral pressure (using hand or leg) on the thrust control rod to provide friction.

9-80. Bailout—Crew/Passengers.

Refer to exits available for bailout in figure 9-2. For rapid crew emergency exit, jettison the pilot's and copilot's jettisonable doors and release the safety belt and shoulder harness. When releasing the safety belt for emergency exit, throw the ends outward so that the parachute harness will not catch on the adjustment buckles of the shoulder harness. Bail out by grasping the door frame with both hands, pull out of the seat, and exit head first. An alternate method is to grasp the upper door frame and exit backwards. Make a short free fall before opening the parachute to prevent the possibility of entanglement with the helicopter. Passengers should bail out thru nearest available exit after being notified by a crewmember.

When the pilot in command determines that bailout is necessary, accomplish the following:

1. Doors—Jettison or open.
2. Airspeed—80 knots.
3. Alarm Bell—Ring to notify passengers.
4. Crew (except pilot) and passengers—Bail out through nearest exit.
5. Flight controls—Trim.
6. Pilot—Bail out.

SECTION II MISSION EQUIPMENT

9-81. Armament.

9-82. Armament Subsystems—M24 And M41.

9-83. Misfire.

Should the weapon fail to fire due to expected hangfire or cookoff, proceed as follows:

1. Area—Clear. Keep the weapon trained on the target and all personnel clear of the muzzle.

2. Bolt—Retract, remove cartridge. After removal from the weapon, the cartridge must be kept separate from all other ammunition until it has been determined whether the cartridge or the firing mechanism was at fault. If it is determined that the cartridge is at fault, it will be retained separate from other cartridges until disposed of. On the other hand, if examination reveals that the firing mechanism was at fault, the cartridge may be reloaded and fired, after correction of the cause for failure to fire.

WARNING

Do not retract the bolt assembly immediately when a hangfire or cook-off is suspected. A hangfire will normally occur within 5 seconds from the time the primer is struck, and a cook-off after 10 seconds of contact with the chamber of a hot barrel. If 150 cartridges are fired in a 2-minute period, the barrel will be hot enough to produce a cook-off.

9-84. Runaway.

If the machine gun continues to fire after the trigger assembly has been released, open the feed cover immediately, permitting the bolt assembly to go underneath the cartridge and stop in the forward position.

9-85. Cargo.

9-86. Jettisoning Internal Cargo.

If it becomes necessary to jettison internal cargo to reduce gross weight for improved single engine performance or because of other inflight emergencies, jettison as appropriate thru nearest exit.

9-87. Jettisoning External Cargo.

9-88. Cargo Hook.

The following methods should be used when jettisoning external cargo.

1. PRIMARY METHOD (HYDRAULIC)
   a. CARGO HOOK MASTER switch—ARM.
   b. CARGO HOOK RELEASE button—Press.
   c. Load—Check released.
2. SECONDARY METHOD (PNEUMATIC)
   a. CARGO HOOK EMERGENCY switch—RELEASE.
   b. Load—Check released.

When using the emergency cargo hook release switch (pneumatic) to release or jettison external cargo, the switch must be left at RELEASE until it has been determined that the cargo has been dropped. Rapid switching from OFF to RELEASE to OFF will result in partial air bleedoff without fully actuating the release mechanism. Also, crewmembers must remain clear of the cargo hook when it is loaded. If jettisoning becomes necessary, the hook may spring back when the load is released, resulting in injury.

3. ALTERNATE METHOD (MANUAL).
   a. Manual Emergency Release Handle ("D" Ring)—Pull.
   b. Load—Check released.

When the manual release has been used to open the cargo hook, no attempt should be made to close the hook hydraulically. When the manual release has been used to open the cargo hook with the load clear of the ground, make an entry of DA form 2408-13.

9-89. Hoist.

Use the following procedures when jettisoning cargo on the hoist:

1. Personnel—Clear. Personnel must remain aft of the rescue hatch and face away from the cable cutter. The hoist cable may whip forward when it is cut and particles may be ejected from the cable cutter.
2. CABLE CUTTER switch—ON.
3. Load—Check released.

APPENDIX A
REFERENCES

This appendix contains a list of official publications referenced in this manual and available to and required by CH-47 helicopter operating activities. The publications listed are directly related to flight operation and maintenance of CH-47 helicopters.

AR70-50	Designating and Naming Military Aircraft, Rockets, and Guided Missiles
AR 95-1	Army Aviation — General Provisions and Flight Regulations
AR 95-16	Weight and Balance Army Aircraft
AR 385-40	Accident Reporting and Records
FMI-5	Instrument Flying and Navigation for Army Aviators
FMI-30	Meteorology for Army Aviation
TM 9-1005-224-10	Machine Gun, 7.62 MM, M60
TM 38-250	Preparation of Hazardous Materials for Military Air Shipment
TM 38-750	The Army Maintenance Management System (TAMMS)
TM 55-405-9	Army Aviation Maintenance Engineering Manual: Weight and Balance
TM 55-1500-204-25/1	General Aircraft Maintenance Manual
TM 55-1500-210-ESC	Equipment Serviceability Criteria for Cargo Helicopter CH-47
TM 55-1500-210-L	List of Applicable Publications for CH-47 Helicopters
TM 55-1520-209-CL	Operators and Crewmembers Checklist
TM 750-244-1-5	Procedures for the Destruction of Aircraft and Associated Equipment to Prevent Enemy Use
TB 55-1500-334-24	Conversion of Aircraft to Fire Resistant Hydraulic Fluid
TB 55-9150-200-24	Engine and Transmission Oils, Fuels, and Additives for Army Aircraft

APPENDIX B
GLOSSARY

ABBREVIATION	TERM
ac	alternating current
adf	automatic direction finding
aft	the after end
agb	accessory gearbox
AIMS	altitude information monitoring system
alt	altitude
am	amplitude modulated
amp	ampere
ant.	antenna
apu	auxiliary power unit
approx	approximately
as	airspeed
ASTM	American Society for Testing Materials
auto.	automatic
auto. sync	automatic synchronization
aux.	auxiliary
avail	available
bcn	beacon
bfo	beat-frequency oscillator
brt	bright
btry	battery
btu	British thermal unit
C	Celsius
carr	carrier
cas	calibrated airspeed
$CBrF_3$ or CF_3Br	bromotrifluoromethane
cdr's	commander's
C.G.	center-of-gravity
cgi	cruise guide indicator
chan	channel
chk	check
ckpt	cockpit
℄	center line
comp	compass
comp't	compartment
cont	control
ctr	center
dc	direct current
dcp	differential collective pitch
dec.	decrease
det	detector
dim.	dimensions
dis	disable
dn	down
egt	exhaust gas temperature
emer	emergency
eng	engine
exh	exhaust
ext	extend, extinguisher, or external
f	fast
fat	free air temperature
fdr	feeder
fig.	figure
fil	filament
fl	flow
flt	flight
flt cont	flight control
fm	frequency modulated
fpm or ft/min	feet per minute
ft	feet
fuse.	fuselage
fwd	forward
g	green
g's	gravity
gals.	gallons
gca	ground controlled approach
gd xmit	guard transmitter
gen	generator
grd	ground
gr wt	gross weight
gyro(s)	gyroscope(s)
hdg	heading
hf	high frequency
hg	mercury
hgt	height
hi	high
HIGE	hover in ground effect
HOGE	hover out of ground effect
hr	hour
htr	heater
hyd	hydraulic
ias	indicated airspeed
ident	identification
iff	identify friend or foe
ifr	instrument flight regulations
ige	in ground effect
ign	ignition
ils	instrument landing system
IMC	instrument meteorological conditions
in. or "	inch
inc	increase
ind	indicator
inst	instruments
int or inph	interphone

ABBREVIATION	TERM
ISIS	Integral Spar Inspection System
ito	instrument takeoff
JP-4 or JP-5	jet petroleum
kHz	kilohertz
kn	knots
lb	pound(s)
lb-ft	pound-feet (torque)
lb/gal	pounds per gallon
lb/hr	pounds per hour
lg	length
lh	left-hand
loc	location
long. cyc	longitudinal cyclic
lts	lights
lvl	level
man	manual
max	maximum
MHz	megahertz
med	medium
mil.	angular measurement, military
min	minute(s) or minimum
mkr bcn	marker beacon
mm	millimeter
mom.	momentary
mom. on	momentary on
mwo	modification work order
N	North
nac	nacelle
nav	navigation
no.	number
norm	normal
N1	gas producer (speed)
N2	power turbine (speed)
obs	omni bearing selector
obst	obstacle
oge	out-of-ground effect
op	operate
outb'd	outboard
ovhd or ovrhd	overhead
ovsp	overspeed
para	paragraph
ph	phase
plt	pilot
P/N	Part Number
pnl	panel
press.	pressure
pri	primary
psas	pitch stability augmentation system
psf	pounds per square foot
psi	pounds per square inch
pt	pint
ptit	power turbine inlet temperature
ptt	push-to-talk
pvt	private
pwr	power
PWR	Proximity Warning System
qt	quart

ABBREVIATION	TERM
qty	quantity
r	red
r or rt	right
rad	radar
rc	rate of climb
rcvr	receiver
rd	rate of descent
recp or rec	receptacle
rect	rectifier
ref	reference
rel	release
ret or retr	retract
retrans or re-x	retransmission
rev cur	reverse current
rf	radio frequency
rh	right-hand
rmi	radio magnetic indicator
rpm	revolutions per minute
s/op	slow operation
sas	stability augmentation system
sec	secondary
sect.	section
shp	shaft horsepower
sif	selective identification feature
sl	sea level
S/N	serial number
slt	searchlight
spec	specification
sq	squelch or square
sq ft	square feet
sta	station
stby	standby
sys	system
t/r + g	transmit/receive plus guard channel
tach	tachometer
tas	true airspeed
tck	track
temp	temperature
tor/eng	torque per engine
warn.	warning
wshld	windshield
wt	weight
uhf	ultra high frequency
ut or util	utility
vac	volts alternating current
vdc	volts direct current
vent.	ventilate
vfr	visual flight regulations
vhf	very high frequency
vgi	vertical gyro indicator
Vne	velocity never exceed
vol	volume
vor	very high frequency omni-directional range
x	times or by
x-feed	crossfeed
xmit	transmit

ABBREVIATION	TERM
xmsn	transmission
wt	weight
°	degrees or temperature
°C	degrees Celsius
°/kts	degrees per knots
%	percent
3/rev	three vibrations for each revolution of the rotor

ALPHABETICAL INDEX

316-520 O - 80 - 22

Subject	Para, Fig., Table Number

U.S. GOVERNMENT PRINTING OFFICE : 1980 O - 316-520

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL MANUALS

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PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
6	2-1 a			In line 6 of paragraph 2-1a the manual states the engine has 6 cylinders. The engine on my set only has 4 cylinders. Change the manual to show 4 cylinders
81		4-3		Callout 16 on figure 4-3 is pointing at a bolt. In the key to fig. 4-3, item 16 is called a shim. Please correct one or the other.
125	line 20			I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got what I ordered so the NSN is wrong. Please give me a good NSN

SAMPLE

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RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL MANUALS

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FROM: (YOUR UNIT'S COMPLETE ADDRESS)

DATE

PUBLICATION NUMBER	DATE	TITLE
TM 55-1520-209-10	9 Jan 79	Operator's Manual CH-47A Helicopter

BE EXACT. . .PIN-POINT WHERE IT IS				IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER	SIGN HERE:

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REVERSE OF DA FORM 2028-2 (TEST)

The Metric System and Equivalents

Linear Measure

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

Weights

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

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 38.82 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 10 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	3.94
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton meters	1.365	metric tons	short tons	1.102
pound-inches	newton-meters	.11375			

Temperature (Exact)

°F Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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