TM 55-1520-203-10

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR'S MANUAL

ARMY MODEL CH-37B HELICOPTER

This copy is a reprint which includes current pages from Changes 1, 2, and 3

HEADQUARTERS, DEPARTMENT OF THE ARMY

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *28 June 1965*

TM 55-1520-203-10 is published for the use of all concerned.

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-31 requirements for operator and crew maintenance instructions for CH-37 aircraft.

This manual supersedes TM 55-1520-203-10, 2 August 1963, including C1, 23 September 1964.

TM 55-1520-203-10
Changes No. 3

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

SAFETY OF FLIGHT

OPERATOR'S MANUAL

Army Model

CH-37B Helicopter

Headquarters, Department of the Army, Washington D.C.
1 March 1967

NOTE: COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SAFETY INFORMATION TO THE ATTENTION OF ALL PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

TM 55-1520-203-10, 28 June 1965, is changed as follows:

1. Purpose. To restrict rolling take-offs, rolling landings and taxiing of the aircraft pending development of modification instructions for the main landing gear trunnion and fork assembly and compliance therewith.

2. Instructions. The instructions in this change will be used until the information is incorporated in the basic manual.

a. Reference paragraphs 3-34, 3-51 and 3-54, section II, chapter 3. Incorporate the following warning in each of the cited references:

WARNING

Rolling take-offs, rolling landings and taxiing are restricted. See paragraph 7-38, chapter 7.

b. Reference section II, chapter 7, paragraph 7-38 is added as follows:

7-38. Landing Gear Limitations. Operation of the CH-37 helicopter will be restricted as follows to avoid landing gear failures:

a. Vertical or hovering take-offs and landings only. (Rolling take-offs and landings impose additional loads on the gear. Further, gear failure during a ground run is likely to result in a more severe incident.)

b. Operating on level surfaces only.

c. Taxiing will be held to a minimum and will be done only at slow speeds over smooth surfaces.

NOTE

These restrictions no longer apply when landing gear has been modified.

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff.

Official:
KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31 requirements for Operator and Crew Maintenance Instructions for CH-37 aircraft.

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

Section I Scope

IMPORTANT

In order to obtain complete information and derive maximum benefits from this manual, it is necessary to read this chapter carefully and thoroughly.

1–1. Purpose. This manual, issued expressly for operators, is an official document for Army Model CH-37B helicopters, serial No. 54-993 through 54-1000, 55-610 through 55-613, 55-615 through 55-632, 55-635 through 55-650, 57-1642 through 57-1661, and 58-983 through 58-1006. The purpose of this manual is to supply you with the latest information and performance data derived from flight test programs and operational experiences. The study and use of this manual will enable you to perform the assigned missions and duties with maximum efficiency and safety.

a. Your ability and experience are recognized. It is not the function of this manual to teach the pilot how to fly; basic flight principles and elementary instructions are not included. The contents of this manual will provide you with a general knowledge of Army Model CH-37B helicopter, its flight characteristics, and specific normal and emergency operating procedures.

b. Reports necessary to comply with the Army Safety Program are prescribed in detail in AR 385-40.

1–2. Appendix I. This appendix consists of a list of references applicable and available to the operator. The list includes official publications directly applicable to the Operator's Manual. All references called out in the text are reflected in this appendix.

1–3. Appendix II. This appendix consists of a page titled Appendix II, Maintenance Allocation Chart, and references the Maintenance Allocation Chart contained in TM 55-1520-203-20.

1–4. Appendix III. This appendix consists of a page titled Appendix III, Aircraft Inventory Master Guide, and references Appendix III, TM 55-1520-203-20.

1–5. Appendix IV. This appendix consists of a page titled Appendix IV, Operator's and Crewmember's Checklist. The checklist contains normal and emergency procedures to be performed by the pilot (and/or crewmember). The applicable checklist is not presented in this manual, but is printed as a separate publication.

1–6. Index. The index lists, in alphabetical order, every important subject under the topic which may be of significance to the operator. This listing is not a repetition of paragraph titles, but an extensive listing of subjects which will aid the operator in his use of the manual.

Section II General

1–7. Scope. The contents of this manual are arranged under chapters and sections as indicated in the Table of Contents. A brief description of each chapter is provided in Section I of the applicable chapters.

1–8. General. *a.* Distribution, revision, and mandatory requirements are accomplished in accordance with AR 310-1.

b. Authorization for issue is accomplished in accordance with AR 310-3.

c. Notes, cautions, and warnings shall be used to emphasize important and critical instructions and shall be used for the following conditions:

Note

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

Caution

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

Warning

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

d. The direct reporting of errors, omissions, and recommendations for improving this manual by the individual user is authorized and encouraged. DA Form 2028 will be used for reporting these improvements. This form may be completed using pen, pencil, or typewriter. DA Form 2028 will be completed by the individual using this manual and forwarded directly to: Commanding General, U. S. Army Aviation Materiel Command, P. O. Box 209, Main Office, St. Louis, Missouri 63166.

CHAPTER 2
DESCRIPTION

Section I Scope

2–1. Purpose. This chapter provides the operator with information that will familiarize him with the CH-37B helicopter and all the systems, controls, and indicators which contribute to the physical act of flying the helicopter.

2–2. Extent of Coverage. This chapter contains only descriptive information and does not contain procedures for operation of the helicopter. These procedures are contained within the appropriate chapters throughout the manual. This chapter also contains all of the emergency equipment that is not part of an auxiliary system. This chapter is not designed to provide instructions on the complete mechanical and electrical workings of the various systems; therefore, each is described only in enough detail to make comprehension of that system sufficiently complete to allow for its safe and efficient operation.

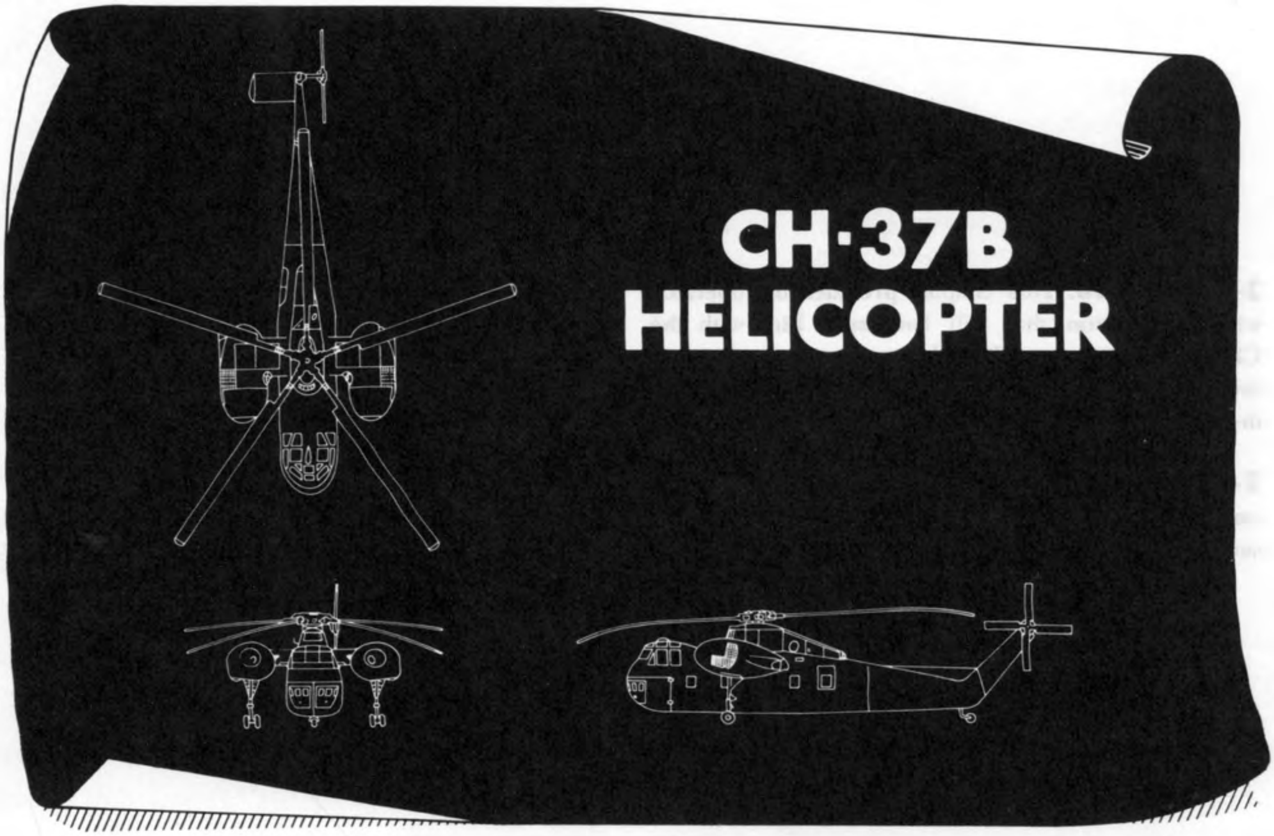


Figure 2—1. The helicopter

Section II Systems and Controls Description

2–3. The Helicopter. The CH-37B helicopter (figure 2–1), manufactured by Sikorsky Aircraft, Division of United Aircraft Corporation, Stratford, Connecticut, is a twin-engine, all-metal helicopter designed for the transport of cargo and troops and for the evacuation of casualties. The rotor system is composed of a single, five-bladed main rotor and a four-bladed, antitorque tail rotor. The engines are located in nacelles at the tips of a short high wing. Fuel is carried in wing and nacelle tanks, and the retractable main landing gear is located in the nacelles. Thus, the forward section of the fuselage is clear for loading and unloading of troops or cargo. The lower portion of the nose of the fuselage consists of "clamshell" type cargo loading doors and a cargo loading ramp. The pilots' compartment, located in the upper portion of the nose of the helicopter, contains seats, controls, and instruments for a pilot and a copilot. The large windshield, side windows, and top windows in the pilots' compartment, together with the windows in the "clamshell" doors, provide excellent visibility from the pilots' compartment. Electronic equipment is located behind the pilot's and copilot's seats. The main gear box is located in the main transmission compartment, over the center section of the wing aft of the pilots' compartment. The engines are installed in the nacelles with the engine shafts extending aft and inboard within the wing. Hydromechanical rotor clutches connect the engine shafts to main drive shafts extending through the wing from the base of the main gear box. Power is transmitted from the engines to the main and tail rotor by a transmission system. A conventional 28 volt dc system furnishes electrical power. Inverters convert dc power to ac power where required. The main rotor assembly, with its five fully articulated, folding blades, is located on top of the main rotor drive shaft. The two-cell fuel tank for each engine is located in the aft portion of the engine nacelle and in the adjacent wing section. To increase the range of the helicopter, jettisonable fuel tanks may be mounted below the wing, one inboard of each nacelle. The cabin of the helicopter is entered through the "clamshell" nose doors or through the sliding cargo door on the right side of the fuselage. The cabin is capable of carrying a flight engineer and 23 fully equipped troops, or 24 litters, or equipment up to a 105 mm howitzer and trailer. A cargo hatch is located in the center of the cabin floor. A cargo sling capable of carrying 10,000 pounds may be attached to the fuselage directly below the floor hatch. A traversing electric cargo hoist winch, capable of lifting 2000 pounds, may be used for loading at either the nose door, side cargo door, or floor hatch. Behind the cabin aft bulkhead is the aft fuselage compartment. The intermediate gear box is located in the aft end of the fuselage. The tail rotor pylon supports the tail rotor assembly and also functions as a fin. It is located at the aft end of the fuselage and is hinged at its right-hand attachment point to permit the pylon to be folded forward along the rear portion of the fuselage. The tail rotor assembly, consisting of four fully articulated blades and the tail gear box, is located on the upper end of the tail rotor pylon. The stabilizer is a fixed type located on the upper right-hand side of the pylon. The tail wheel is full-castering and self-centering. Familiarity with the configuration of the helicopter may be obtained by referring to the exterior and interior general arrangement illustrations, figure 2–2 and 2–3, and the minimum turning radius and ground clearances, figure 2–4.

2–4. Dimensions. The principal dimensions of the helicopter are as follows:

Length	Maximum (both rotors at extreme positions)	88 feet 0 inches.
Length:	Minimum (main rotor blades and pylon folded)	55 feet 8 inches.
Width:	Blades and pylon folded	27 feet 4 inches.
Height:	Maximum to top of tail rotor blade (pylon unfolded)	22 feet 0 inches.
Height:	Minimum to top of main rotor (pylon folded)	17 feet 2 inches.
Main rotor disc diameter		72 feet 0 inches.
Tail rotor disc diameter		15 feet 0 inches.
Main rotor ground line clearance: Minimum (forward sector)		11 feet 6 inches.
Tail rotor ground line clearance		6 feet 6 inches.
Tread of main wheels		19 feet 9 inches.

2–5. Gross Weight. The design gross weight of the helicopter is 30,342 pounds. The maximum alternate gross weight is 31,000 pounds.

2–6. Engines. The helicopter is powered by two Pratt & Whitney R-2800-54, 18-cylinder, twin-row, radial engines (12, figure 2–3), each equipped with a single-stage, single-speed supercharger. The engines are located in separate nacelles, one at each outboard end

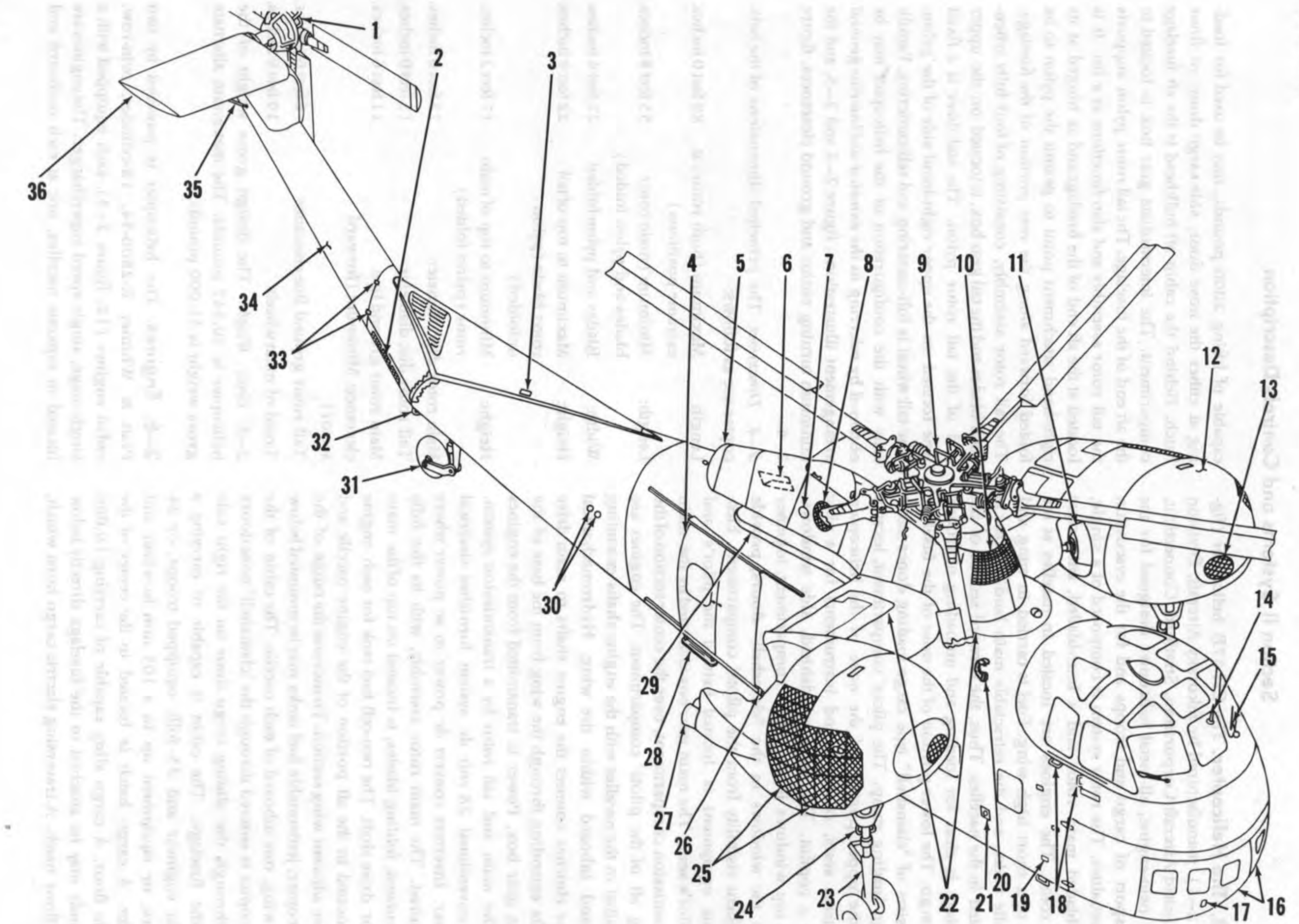


Figure 2–2. General arrangement – exterior (Sheet 1 of 2)

1. Tail rotor assembly
2. Intermediate gear box cooling air screen (right and left)
3. Pylon fold jury strut
4. Cargo – passenger door
5. Ventilating air intake (left side)
6. Service platform
7. Engine preheat duct connections
8. Main gear box oil cooling air outlet
9. Main rotor assembly
10. Main gear box oil cooling air intake
11. Rotor clutch and fan (right and left)
12. Engine access door (right and left)
13. Induction cold air intake (right and left)
14. Free-air temperature gage
15. Windshield wiper (right and left)
16. Cabin nose door (right and left)
17. Nose door gun ports (right and left)
18. Hand grips
19. Pilots' compartment access footwells (right and left)
20. Pitot tubes
21. External interphone receptacle (right and left)
22. Walkway
23. Main landing gear (right and left)
24. Mooring fittings – forward (right and left)
25. Engine cooling air outlets (right and left)
26. External power receptacle
27. Engine exhaust ejectors (right and left)
28. Step
29. Walkway
30. Static ports (right and left)
31. Tail wheel
32. Mooring fitting – aft
33. Pylon hinges
34. Pylon
35. Truss assembly
36. Stabilizer

Figure 2–2. General arrangement – exterior (Sheet 2 of 2)

of the wing. The engines are mounted with the drive shafts slanting inboard at an angle of approximately 80 degrees and pointing upward at an angle of approximately 12.5 degrees. A hydromechanical rotor clutch is splined to each engine drive shaft. A main drive shaft connects each clutch to the main gear box. Engine oil coolers are located outboard of the engines. Cooling air enters a duct at the bottom of each nacelle and passes upward through the oil cooler where it is accelerated and ejected aft by the engine exhaust. The engine exhaust ejectors (27, figure 2–2) also provide exhaust flame dampening. Access to all parts of each engine is provided by a bottom-hinged engine access door (12, figure 2–2).

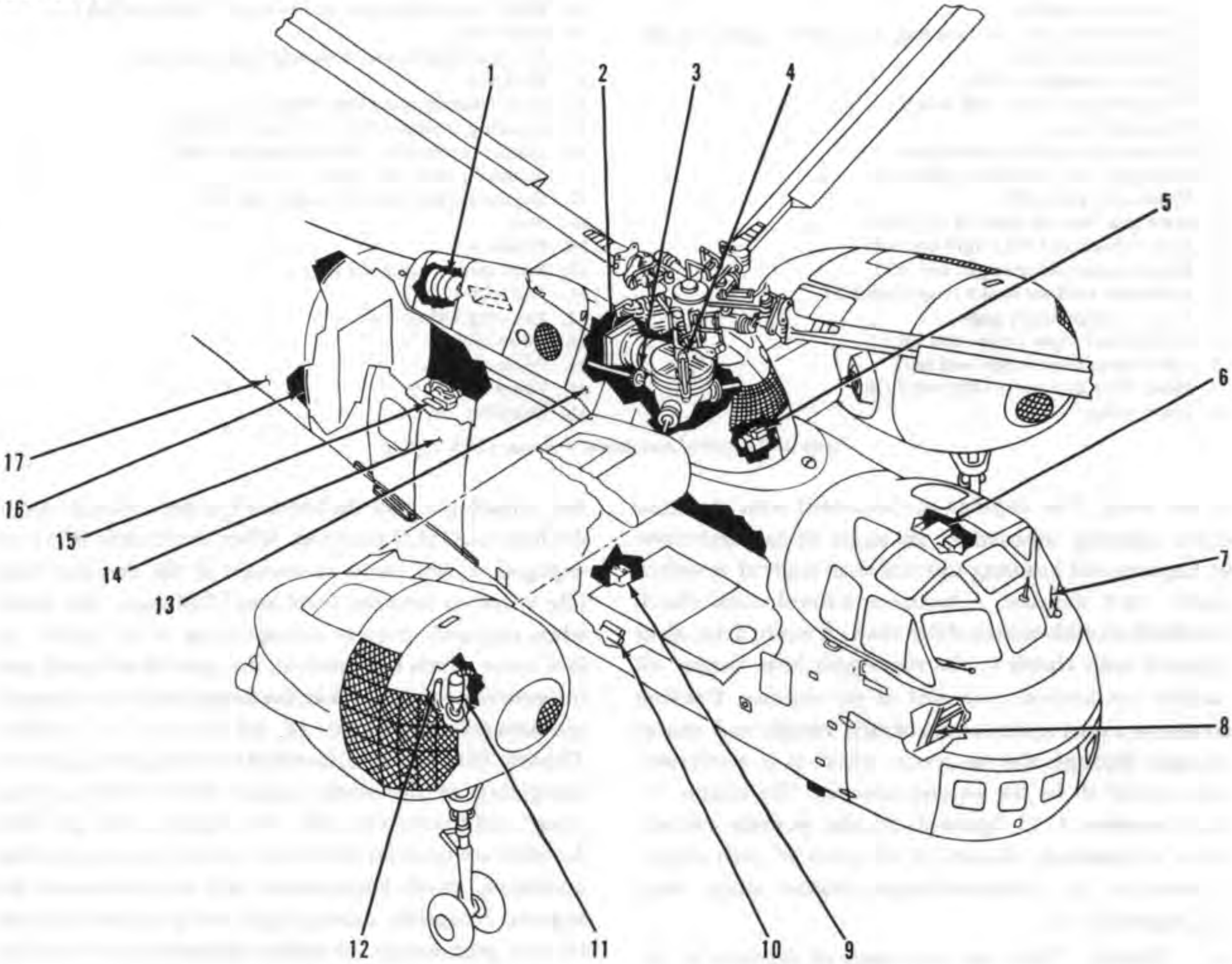
2–7. Throttles. There are two types of throttles in the pilots' compartment; the quadrant throttles and the twist-grip throttles. The quadrant throttles are used for ground operation and for equalizing manifold pressures before takeoff and during flight. The twist-grip throttles are used during flight and automatically synchronize the power settings of both engines with changes in collective pitch. For a detailed discussion of each type throttle, refer to paragraph 9–17.

a. Quadrant throttles. Two quadrant throttles (figure 2–5) one mechanically controlling each engine, are located on the engine control quadrant which is mounted at the forward end of the overhead switch panel in the center of the pilots' compartment. The quadrant is marked THROTTLE and is graduated in increments of 2 degrees from zero, CLOSED, to 90 degrees, OPEN. Each throttle is equipped with a lock which is controlled by a lock lever mounted on the throttle. The throttle lock is engaged by pressing downward on the lock lever, moving the throttle to the fully CLOSED position, and releasing. The throttle lock is disengaged by pressing downward on the lock lever and releasing it after the throttle has been moved out of the fully CLOSED position. When the throttle locks are engaged, a cam limits movement of the throttles from idle speed to between 1600 and 1700 rpm. The locks, when engaged, prevent overspeeding of the engine before rotor clutch engagement, but provide adequate rpm for generator cut-in. When the throttle locks are released, unrestricted movement of the throttle is available. Throttle limit switches, installed on the quadrant, prevent energizing of the starter unless the throttles are fully closed and the throttle locks are engaged. The quadrant throttles are used for individual engine starting, ground operation, clutch engagement, and to synchronize the engines. Normally, during flight, the quadrant throttles are not used except for minor adjustments to manifold pressure for engine synchronization or for single-engine operation.

After synchronization, the throttles of both engines are controlled simultaneously by the twist-grip throttles on the collective pitch levers. Since the quadrant throttles are connected directly to the carburetors by control cables, the position of the quadrant throttles is a direct indication of the amount of throttle being used.

Caution

When either quadrant throttle is in full CLOSED position, any movement of either collective pitch or twist-grip throttle, which would further retard this quadrant lever (reduce collective pitch lever or back off on twist-grip throttle), may cause quadrant throttle to bind. If this binding condition occurs, care must be taken when advancing quadrant throttle to avoid too rapid advancement when it suddenly becomes free. This is to preclude overstressing freewheeling unit by too rapid engagement or inadvertent engine overspeed by hitting and advancing other quadrant throttle.



1. Ventilating fan
2. Main gear box oil cooler
3. Rotor brake
4. Main rotor servo units
5. Inverters
6. Radio equipment
7. Pilots' compartment
8. Pilots' compartment ladder
9. Battery
10. Auxiliary fuel tank emergency jettison handle and safety pin release handle (both sides)
11. Generator (both engines)
12. Engine
13. Transmission compartment (cannot be entered during flight)
14. Cabin
15. Auxiliary power unit (APU)
16. Cabin aft bulkhead
17. Aft fuselage section

Figure 2–3. General arrangement – interior

b. Twist-grip throttles. The handgrips, located on the forward end of the pilot's and copilot's collective pitch levers are rotatable and form the twist-grip throttles. Each twist-grip throttle (3, figure 2–24) mechanically and hydraulically controls the output of both engines simultaneously and are used for normal flight. The throttle is synchronized with the operation of the collective pitch lever so that increasing collective pitch, while holding the twist-grip throttle to prevent rotation, automatically increases manifold pressure a sufficient amount to maintain a constant rpm; and decreasing collective pitch, decreases manifold pressure a sufficient amount to maintain a constant rpm. The twist-grip throttle may be rotated at any time for finer throttle adjustment at any position of the collective pitch lever. When the twist-grip throttle is rotated to the left, throttle control is increased and when rotated to the right, throttle control is decreased. A twist-grip throttle position indicator, located at the control console, indicates the amount of twist-grip throttle being applied. A knurled throttle friction nut (4) on the pilots' collective pitch lever prevents throttle creeping. The twist-grip throttles are connected by cabling and linkage to the overhead quadrant which permit equalizing the manifold pressure

NOTE
MINIMUM GROUND CLEARANCES

MAIN ROTOR BLADES STATIONARY	11 FEET 6 INCHES
MAIN ROTOR BLADES CLUTCH — ENGAGED COLLECTIVE PITCH — MINIMUM CYCLIC PITCH — NEUTRAL	14 FEET 4 INCHES
TAIL ROTOR BLADES STATIONARY OR ENGAGED	7 FEET
BOTTOM OF FUSELAGE	1 FOOT 6 INCHES *

*CHECK ANTENNAS THAT MAY PROTRUDE LOWER

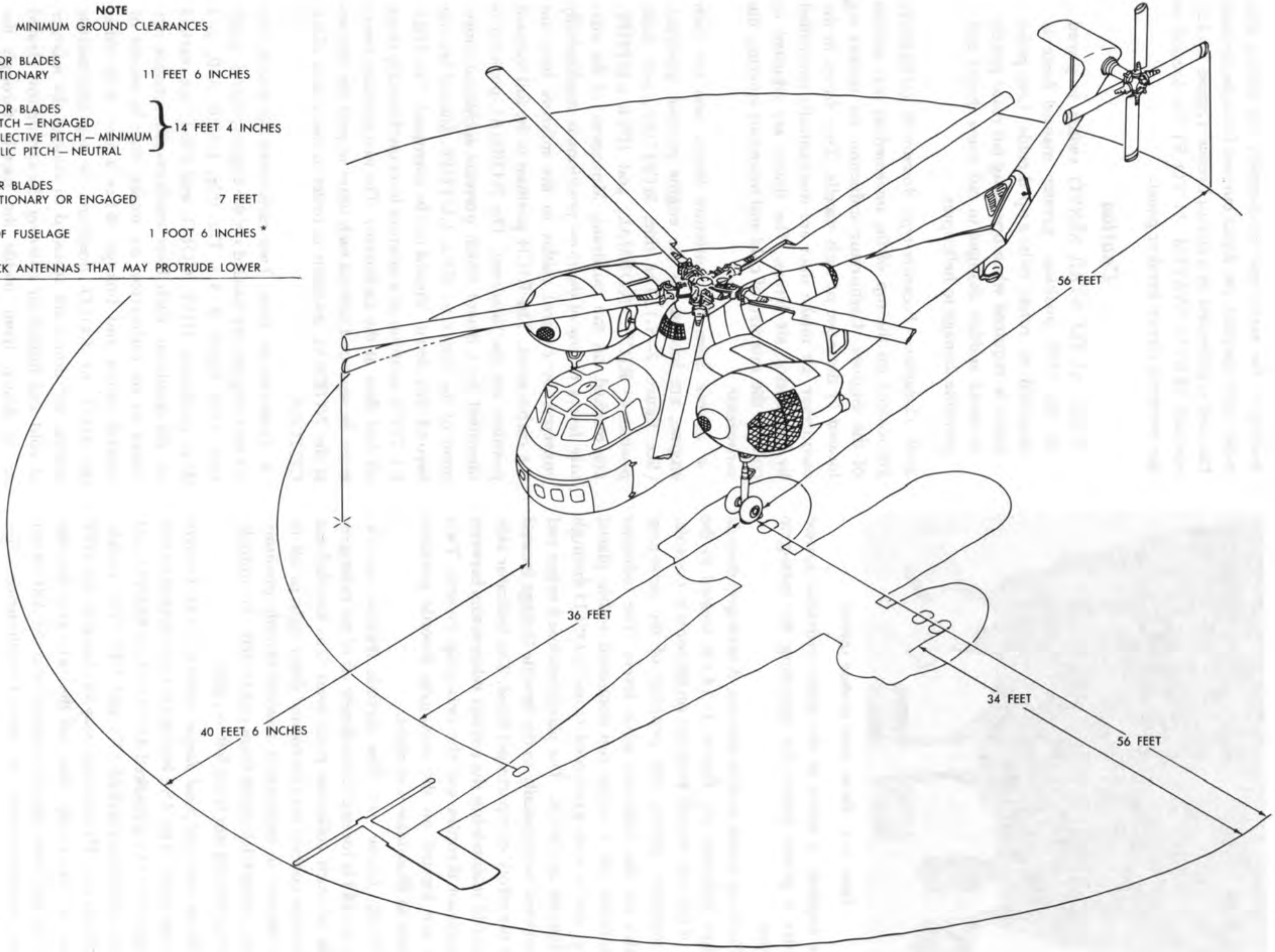


Figure 2—4. Minimum turning radius and ground clearances

Figure 2–5. Engine control quadrant (typical)

of the engines. A servo in the utility hydraulic system provides a power boost for operating the twist-grip throttles.

c. Twist-grip throttle position indicator. A twist-grip throttle position indicator (5, figure 2–14) is located to the right of the fuel shutoff switches on the control console. The indicator shows the position of the twist-grip throttles on the collective pitch levers. The indicator components are a nylon rod contained within plastic tubing, and a scale graduated from CLOSED through 120 degrees to OPEN. The plastic-enclosed nylon rod is connected mechanically to the throttle linkage located under the pilots' compartment floor. The indicator aids the pilot in maintaining the correct relationship between the quadrant throttles and the twist-grip throttle. Two lights are located on the twist-grip throttle position indicator to illuminate it at night.

d. Throttle friction nut. The throttle friction nut (4, figure 2–24) is located immediately aft of the twist-grip throttle on each collective pitch lever. The knurled-nut friction-type control may be rotated from right to left to apply friction to maintain a selected throttle position. To lock, rotate friction nut from right to left. To unlock, rotate the friction nut from left to right.

e. Throttle servo and pedal damper switch and ASE hydraulic servo system switch. The ASE hydraulic servo system switch (49, figure 2–13) is marked AUTO STAB SERVO, and has two positions marked ON and OFF. The switch, normally in the ON position, may be placed in the OFF position to electrically shut off the twist-grip throttle servo, the tail rotor pedal damper, and the ASE servo pressure simultaneously in case of malfunction. Hydraulic pressure is reduced from 1500 psi to 1000 psi. Wiring from the primary bus goes through the switch to a solenoid valve in the utility hydraulic system line leading to the servo and the damper. The system solenoid valve operates on direct current from the primary bus and is protected by a circuit breaker (figure 2–22), marked SERVO SYSTEM AUTO STAB, located on the overhead circuit breaker panel.

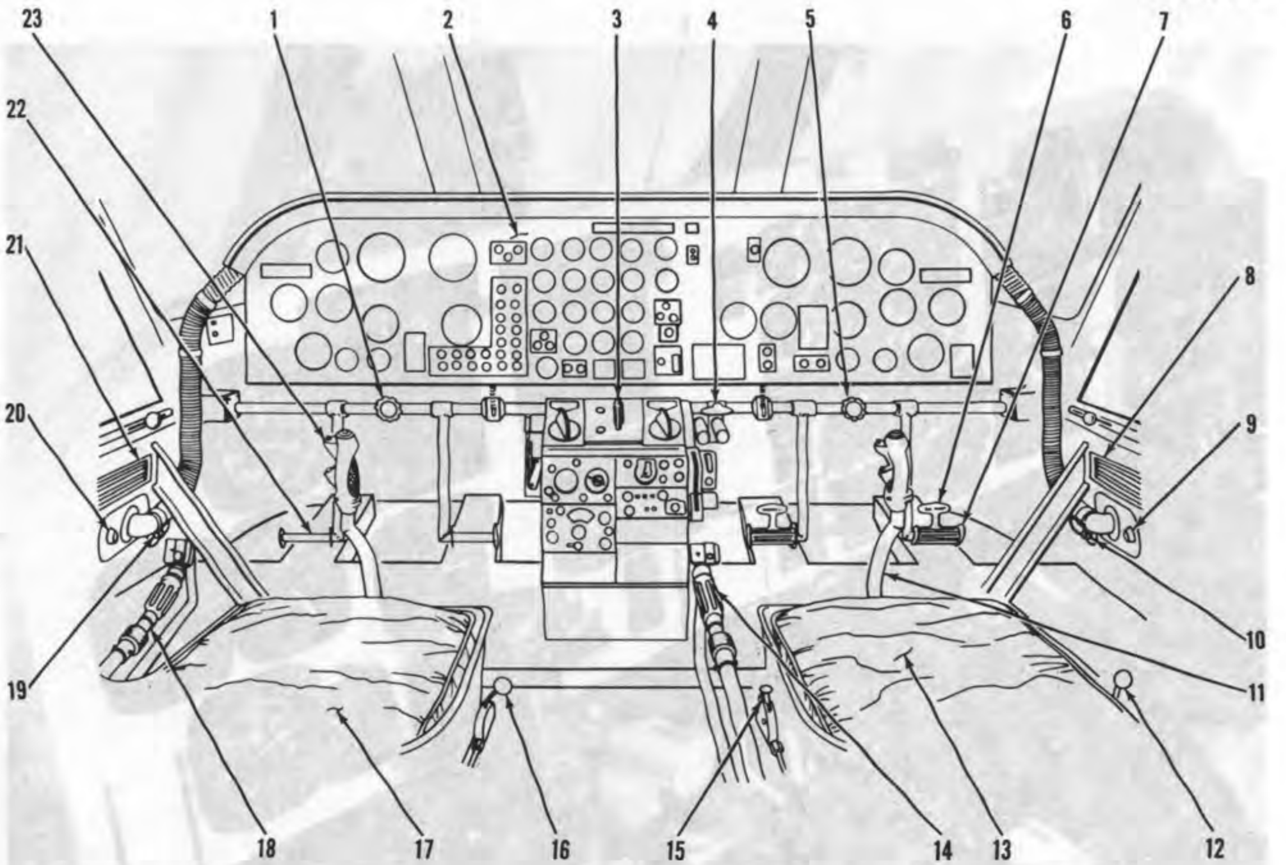
Caution

When AUTO STAB SERVO switch is placed in the OFF position, greater manual force is required to rotate twist-grip throttle. Less pedal force is required when operating tail rotor pedals to avoid sudden changes in tail rotor thrust and possible damage to helicopter.

2–8. *Carburetors.* Pressure-type downdraft carburetors are located on the top of the intermediate rear section of the engines. Carburetor induction air intakes are located in the nose of each nacelle. Two doors in the carburetor air intake duct are mechanically controlled by carburetor air levers. The doors are adjusted to control the mixture of cold and heated air entering the carburetor.

a. Mixture levers. Two mixture levers, one for each engine, are located on the engine control quadrant. (See figure 2–5.) The title, MIXTURE, and three positions, RICH, NORMAL, and IDLE CUTOFF, are marked on the quadrant. Movement of the mixture levers to any of the three positions is mechanically conveyed by control cables to the mixture lever on the carburetors. The RICH position is the full forward position on the quadrant. The NORMAL position is identified by a detent which prevents accidental movement of the levers to IDLE CUTOFF. Manual leaning beyond this detent should not be attempted. The IDLE CUTOFF position of a mixture lever mechanically shuts off fuel flow at the carburetor. The two mixture levers must be squeezed toward each other to pass the detents at the NORMAL position in order to move into IDLE CUTOFF.

b. Carburetor air levers. Two carburetor air levers, one for each engine, are located on the engine control quadrant. (See figure 2–5.) The title, CARB AIR, and three positions, HOT, COLD, and FILT. are marked on the quadrant. Each lever mechanically actuates two doors in its carburetor air intake duct by means of control cables and linkage. When a lever is in either the HOT or COLD position, or any intermediate setting, the doors are adjusted to control the mixture of cold and heated air entering the carburetor. Heated air is drawn from inside the nacelle through the induction hot air intake, and cold air is drawn into the induction cold air intake directly through the carburetor air intake. (See figure 2–11.) Each carburetor



1. Copilot's tail rotor pedal adjustment knob
2. Instrument panel
3. Control console
4. Parking handle
5. Pilot's tail rotor pedal adjustment knob
6. Brake pedals
7. Pilot's tail rotor pedals
8. Heater register
9. Pilot's windshield defrosting knob
10. Pilot's nose door window defrosting knob
11. Pilot's cyclic stick
12. Pilot's seat height adjustment lever
13. Pilot's seat
14. Pilot's collective pitch lever
15. Pilot's shoulder harness inertia reel lock lever
16. Copilot's seat height adjustment lever
17. Copilot's seat
18. Copilot's collective pitch lever
19. Copilot's nose door window defrosting knob
20. Copilot's windshield defrosting knob
21. Heater register
22. Copilot's tail rotor pedals
23. Copilot's cyclic stick

Figure 2–6. Pilots' compartment (typical)

air lever also mechanically operates a filter bypass door in the corresponding cold air duct. When the lever is placed in the FILT. position, the door is closed and cold carburetor air passes through the filter. When the lever is out of the FILT. position, the door is open and unfiltered air is drawn directly into the carburetor.

2–9. Engine Cooling Air System. (See figure 2–11.) An engine cooling air system is necessary as ram air is not available during hovering and ground operation. Cooling air is drawn in through cooling air intakes on the inboard sides of the nacelles. Engine-driven fans force the cooling air over the engines and out through screened cooling air outlets on the outboard sides and tops of the engine nacelles. The outlets are fixed and cannot be controlled.

2–10. Ignition System. a. A separate but identical low-tension type ignition system is provided for both the left and right engines. Operating power for the ignition system is supplied by the primary bus, through the starter circuit breaker (figure 2–22), marked ENG START, PRIM & OIL DIL, located on the overhead circuit breaker panel. Direct current flows from the circuit breaker to the starter relay, to the induction vibrators, and then to the ignition switch. After the engine is started, the magneto supplies power to the spark plugs.

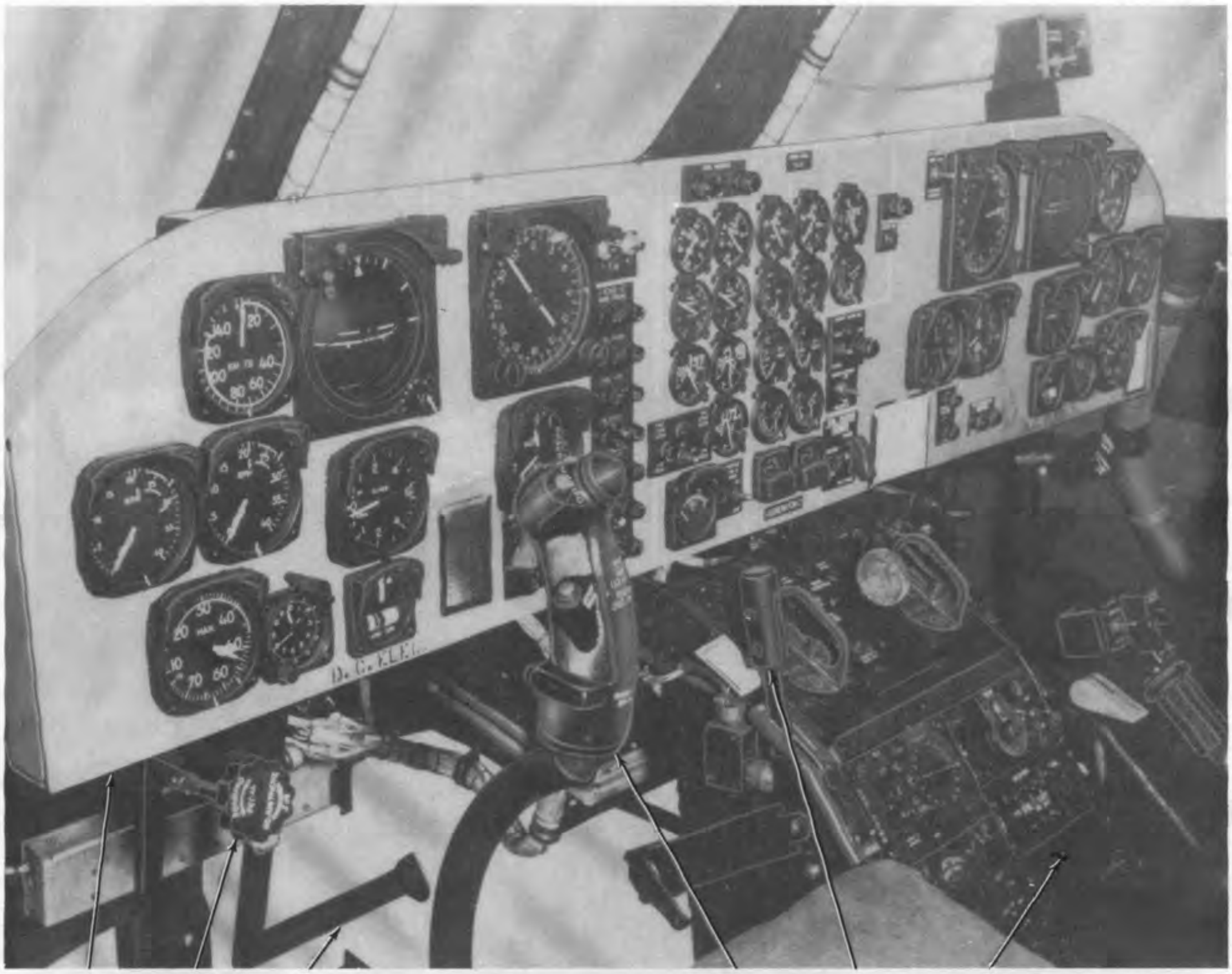
1. **Instrument panel**
2. **Pilot's tail rotor pedal adjustment knob**
3. Brake pedal
4. **Pilot's tail rotor pedal**
5. Pilot's cyclic stick
6. Parking brake handle
7. **Pilot's collective pitch lever**
8. Control console

Figure 2–7. Pilots' compartment – pilot's side (typical)

b. Ignition switches. Two ignition switches, one for each engine, are located on each side of the overhead switch panel (figure 2–12) which is immediately aft of the engine control quadrant. Each ignition switch has four marked positions; OFF, R, L, and BOTH. Two induction vibrators for each engine supply pulsating current to the primary coil of the magneto to aid in providing sufficient current when starting the engine. Operating power for the induction vibrators is supplied by the primary bus through four circuit breakers (figure 2–22) marked IGNITION VIBRATOR 1, L and R, and 2, L and R, located on the battery bus circuit breaker panel on the cabin ceiling just forward of the cargo door. The circuit of the vibrators is energized only when the starter switch is actuated. After the engine starts, spark is developed by the engine-driven magnetos.

2–11. Fuel Priming System. a. The fuel priming system is furnished with, and is an integral part of, the carburetor. The priming system receives direct current from the primary bus and is protected by a circuit breaker (figure 2–22), marked ENG START, PRIM & OIL DIL, located on the overhead circuit breaker panel. Solenoids on the carburetors direct fuel to discharge nozzles upstream of the impeller section of the engine. Fuel pressure for priming is supplied by fuel booster pumps.

b. Fuel priming switches. Two pushbutton-type fuel priming switches are located on the overhead switch panel



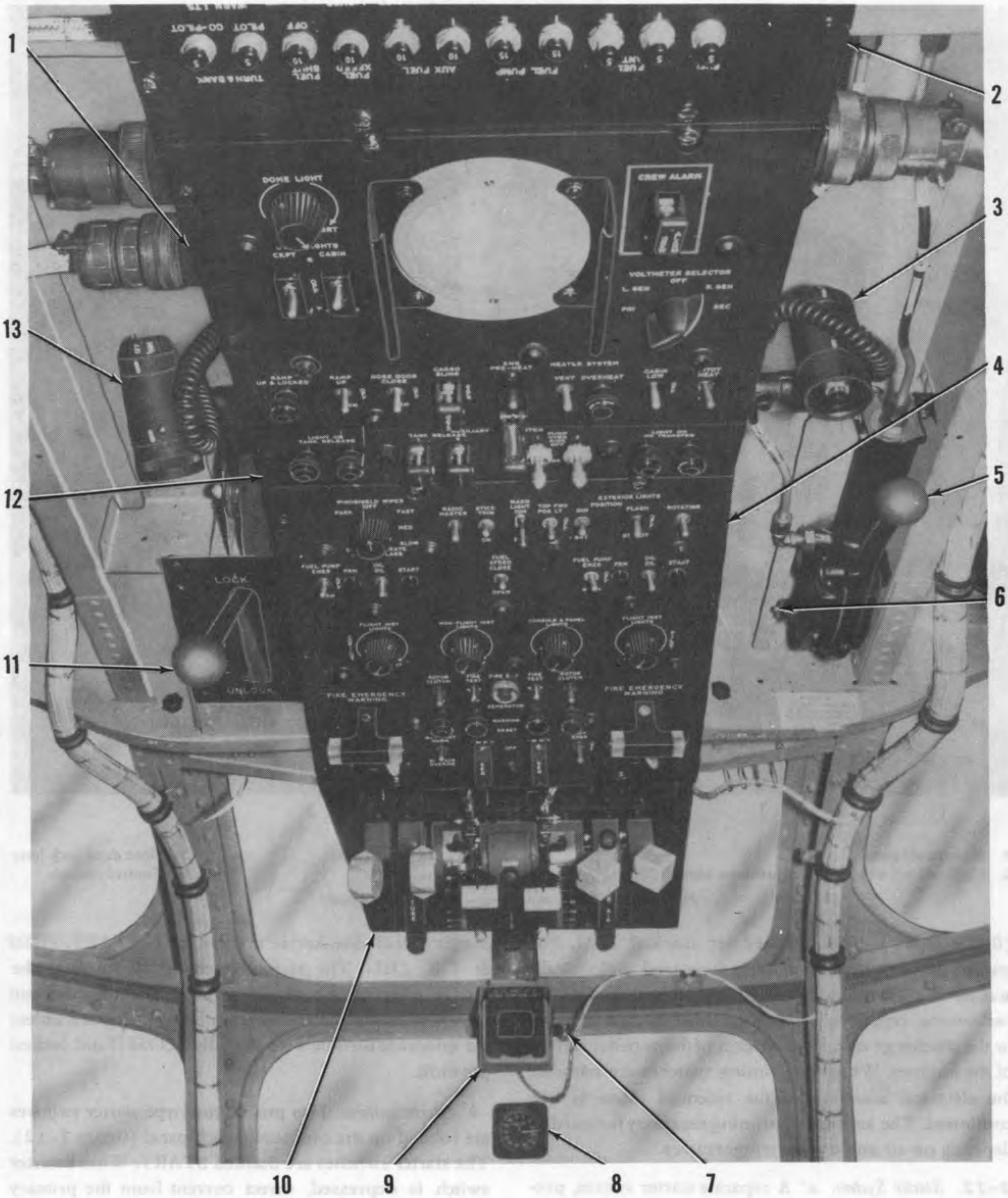
1. Instrument panel
2. Copilot's tail rotor pedal adjustment knob
3. Copilot's tail rotor pedal
4. Copilot's cyclic stick
5. Nose door lock lever
6. Control console

Figure 2–8. Pilots' compartment – copilot's side (typical)

(figure 2–12). The switches are marked PRM. For engine priming the switches are depressed to electrically actuate the solenoid valves which are attached to the carburetor regulator assemblies. Fuel is then diverted to the discharge nozzles upstream of the impeller section of the engines. When the priming switches are released, the electrical actuation of the solenoid valves is discontinued. The amount of priming necessary for starting depends on air and engine temperatures.

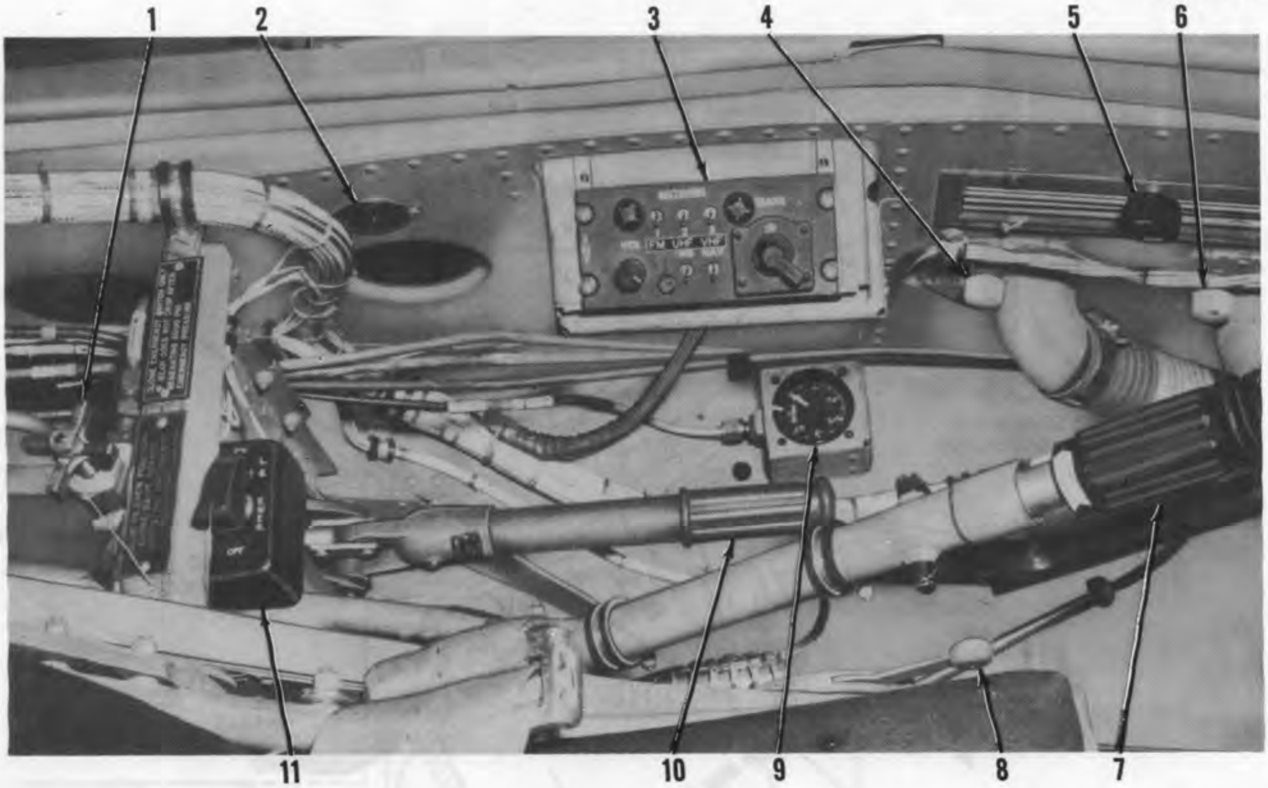
2–12. Starter System. a. A separate starter system, provided for both the left and right engines, consists of the 28 volt direct cranking starter, starter relay, starter switch, and a quadrant throttle limit switch. The primary source of power for the starter system is the primary bus through the starter circuit breaker (figure 2–22), located on the overhead circuit breaker panel. The starter circuit breaker is marked ENG START, PRIM & OIL DIL. The starter is energized through the starter relay by the starter switch. The throttle limit switch prevents the starter from being energized unless the quadrant throttle is in the fully CLOSED and locked position.

b. Starter switches. Two pushbutton-type starter switches are located on the overhead switch panel (figure 2–12). The starter switches are marked START. When a starter switch is depressed, direct current from the primary bus energizes the starter relay which then allows direct current to flow from the primary bus to the starter and the induction vibrators. The starter jaw engages the engine jaw and cranks the engine. When the engine starts, the engine jaw overrides the starter jaw and disengagement is automatic. After the engine is started and



1. **Pilot's compartment dome light panel**
2. Overhead circuit breaker panel
3. Pilot's map light
4. Overhead switch panel
5. Rotor brake lever
6. Rotor brake lever lockpin
7. Standby magnetic compass light switch
8. Free-air temperature gage
9. Standby magnetic compass
10. Engine control quadrant
11. Tail wheel lock lever
12. Auxiliary fuel system control panel
13. Copilot's map light

Figure 2–9. Pilots' compartment – overhead (typical)



1. Emergency hydraulic valve handle
2. Electrical utility receptacle
3. Copilot's signal distribution panel
4. Copilot's windshield defrosting knob
5. Copilot's heater register knob
6. Copilot's nose door defrosting knob
7. Copilot's collective pitch lever
8. Copilot's shoulder harness inertia reel lock lever
9. Emergency hydraulic pressure gage
10. Emergency hydraulic pump lever
11. Main landing gear emergency valve switch

Figure 2–10. Controls at left of copilot's seat (typical)

the starter switch is released, the circuit to the ignition vibrators is broken and ignition system voltage is provided by the engine-driven magnetos. Before operating the starters, the collective pitch lever must be in the MINIMUM PITCH (down) position and the quadrant throttles in the fully CLOSED and locked position. The limit switches on the engine control quadrant prevent the accidental engagement of the starters when the quadrant throttles are not in the fully CLOSED and locked position. The limit switches are enclosed in the quadrant housing.

2–13. Engine Instruments. The engine instruments are located on the instrument panel (figure 2–13).

a. Engine-rotor tachometer. Four dual tachometers (2, 28, 31, and 60, figure 2–13) are located on the instrument panel. The pointer, marked R, on each dual tachometer indicates main rotor rpm. The scale and No. 1 pointer on the copilot's tachometer and on the pilot's left-hand tachometer indicate left engine rpm. The scale and No. 2 pointer on the pilot's right-hand tachometer indicate right engine rpm. The dual tachometers are graduated in 100 rpm units, and are connected through independent electrical circuits to three tachometer-generators driven by the main gear box and left and right engines. Rotor speed cannot be read directly from the tachometer scales as the engine-to-rotor rpm ratio of the scales is not the same as the gear reduction of the main gear box. To determine rotor speed for equivalent engine rpm, see table 14–2. When the rotor tachometer pointer lines directly with the engine rpm pointer and travels with it after clutch engagement, it signifies that mechanical clutch coupling is completed. During autorotation, rotor rpm should be maintained within the inner green arc of the instrument range markings.

b. Manifold pressure gages. Two dual manifold pressure gages (30 and 59, figure 2–13) are located on the instrument panel. The gages indicate the intake manifold pressure in inches of mercury and operate on alternating current from the 26 volt ac bus. Each indicator is protected by a fuse marked 1-ENG-2 MANF. PRESS, located on the ac instrument fuse panel (53).

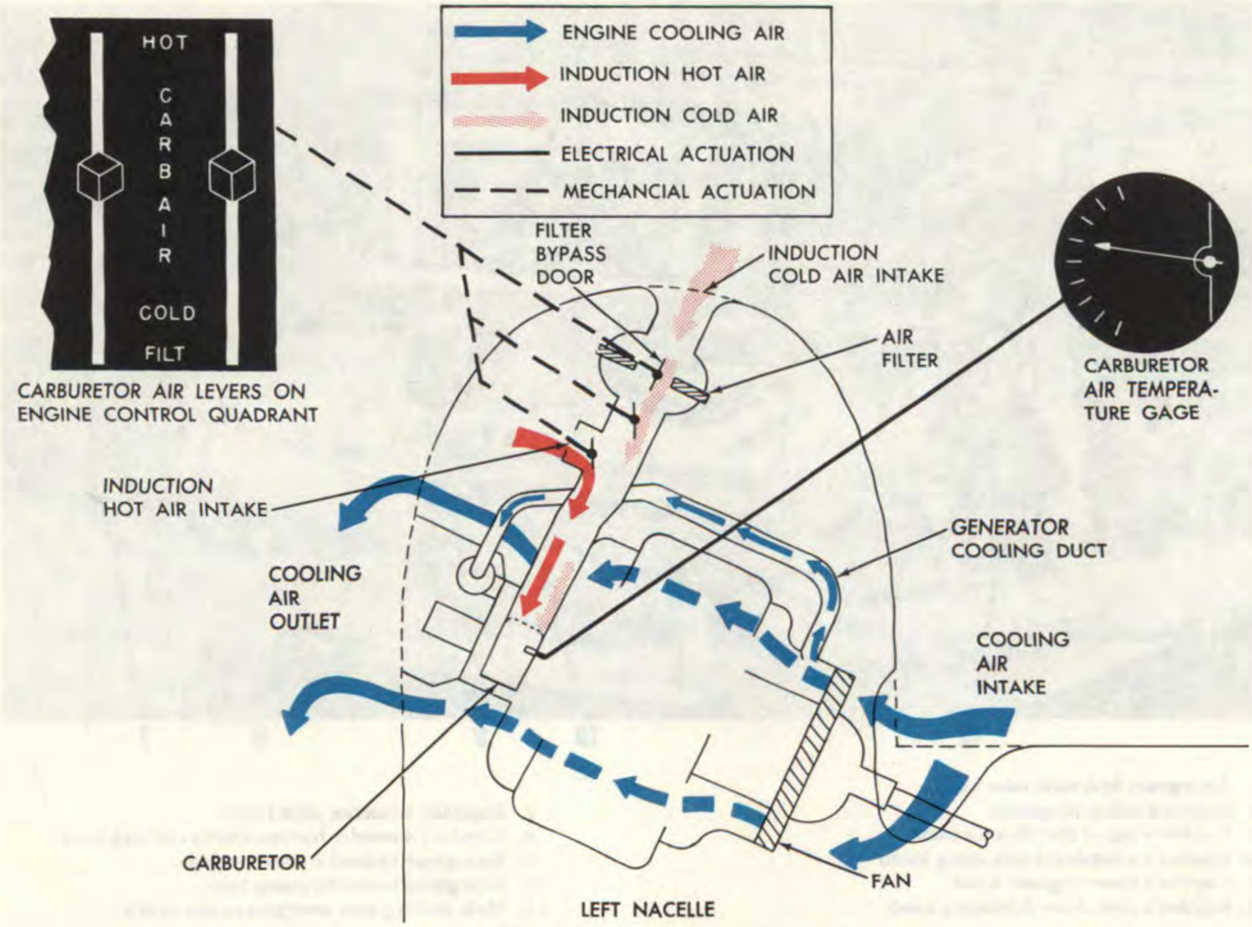


Figure 2–11. Engine cooling and induction air system

c. Cylinder head temperature gages. Two cylinder head temperature gages (42 and 47, figure 2–13), located on the instrument panel, indicate right and left engine cylinder head temperatures in degrees centigrade. The gages are connected by wiring to bayonet-type thermocouples located on the hottest operating cylinder of each engine. The gages operate on direct current from the primary bus and are protected by circuit breakers (figure 2–22), marked ENGINE TEMPERATURE CYL, 1, 2, located on the overhead circuit breaker panel.

d. Carburetor air temperature gages. Two carburetor air temperature gages (43 and 45, figure 2–13), one for each engine, are located on the instrument panel between the pilot and the copilot. The gages are connected to bulb-type thermocouples in the induction system upstream from the carburetors and measure the carburetor air intake temperature in degrees centigrade. The gages operate on direct current from the primary bus through two circuit breakers (figure 2–22), marked ENGINE TEMPERATURES, CARB AIR, 1, 2, located on the overhead circuit breaker panel. Carburetor air may be regulated by the carburetor air levers on the engine control quadrant.

e. Engine oil temperature gages. Two engine oil temperature gages (13 and 16, figure 2–13), one for each engine, are located on the instrument panel. A temperature bulb adjacent to the oil inlet port of each engine indicates oil temperature in degrees centigrade. The gages operate on direct current from the primary bus, and are protected by two circuit breakers (figure 2–22), marked OIL INLET, 1, 2, under the group marked ENGINE TEMPERATURES, located on the overhead switch panel.

f. Engine oil pressure gages. Two engine oil pressure gages (14 and 15, figure 2–13) are located above the oil temperature gages on the instrument panel. An oil pressure transmitter is connected to the oil inlet pressure port of each engine and operates on current from the 26 volt alternating current bus. The transmitters are protected by two fuses (figure 2–22), marked 1-ENG-2, OIL PRESS, located on the ac instrument fuse panel mounted on the instrument panel. The gages are graduated in pounds per square inch.

g. Fuel Pressure Gages. Two fuel pressure gages (9 and 11, fig. 2-13) are located on the instrument panel. The gages indicate fuel pressure in pounds per square inch at the fuel inlet port of the carburetors. The fuel pressure gages operate on power from the 26-volt alternating current bus and are protected by two fuses (fig. 2-22), marked 1-ENG-2, FUEL PRESS., located on the ac instrument fuse panel.

2-14. Transmission System
(fig. 2-15)

The transmission system consists of three gearboxes with connecting shafts, two hydromechanical rotor clutches, and auxiliary drives. The purpose of the transmission system is to reduce engine speed and to drive the main and tail rotors. A hydromechanical rotor clutch mounted between each engine and the main gearbox permits the engines to be started, stopped, or operated while completely disengaged from the transmission system. In the event engine rpm decreases below that of the transmission system during flight, automatic free-wheeling units permit the main and tail rotor to autorotate without drag from the engines. A main drive shaft extends inboard from each clutch to drive the main gearbox. The main gearbox, in turn, transmits engine torque upward to drive the main rotor, and aft, by means of the tail rotor drive shaft, to drive the intermediate gearbox. From there the pylon drive shaft extends upward to the tail gearbox which drives the tail rotor. All shafts are equipped with rubber couplings to reduce shock loads. A rotor brake is located on the tail rotor drive shaft just aft of the main gearbox. An automatic shaft coupling is located at the aft end of the intermediate gearbox to disconnect the pylon drive shaft when the pylon is folded.

2-15. Main Gearbox

The main gearbox (fig. 2-15) is mounted above the center section of the wing over the cabin. The main gearbox contains a two-stage planetary gear system which reduces engine rpm approximately 14 to 1 for driving the main rotor. The tail rotor is also driven through the main gearbox. A tail rotor drive shaft extends aft from the lower housing of the gearbox. In addition to driving the main and tail rotors, the main gearbox drives the first stage servo hydraulic pump, the rotor tachometer-generator, and the main gearbox oil pump, all located at the rear of the lower housing. The main gearbox has its own pressure oil system for lubrication and cooling.

2-16. Intermediate Gearbox

The intermediate gearbox (fig. 2-15) is located at the base of the tail rotor pylon. The gearbox contains a bevel gear direct drive system to change the direction of the shafting that transmits engine torque to the tail rotor. The intermediate gearbox is splash-lubricated. Cooling air screens (2, fig. 2-3) in the pylon fairing, fore and aft, permit the gearbox to be cooled by the main rotor downwash.

2-17. Tail Rotor Gearbox

The tail rotor gearbox (fig. 2-15) is located at the upper end of the tail rotor pylon, and contains a bevel gear reduction drive system to transmit engine torque to the tail rotor. The tail rotor gearbox also contains part of the tail rotor pitch change linkage which extends through the hollow gearbox output shaft to the tail rotor head. The tail rotor gearbox is splash-lubricated.

2-18. Rotor Clutches

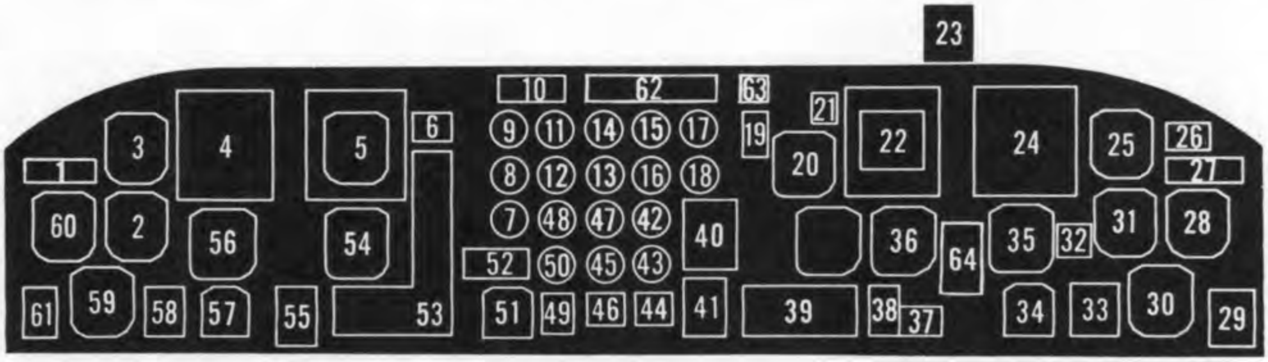
Rotor clutches permit engine starting without imposing the load of the rotor drive system upon the engines. Two hydromechanical rotor clutches, one for each engine, are installed between the engines and the main gearbox. One end of the clutch is bolted to the engine cooling fan hub at the engine shaft, and the other end is connected by a rubber coupling to the outboard end of the main drive shaft. Each clutch is composed mainly of a rotor clutch fluid coupling and a rotor clutch mechanical coupling. Each clutch has its own oil system located behind a removable panel on the inboard side of the engine nacelle. Oil is pumped from the reservoir into the fluid coupling by a rotor clutch pump. The pumps operate on direct current from the primary bus and are protected by circuit breakers (fig. 2-22), marked ENG CLUTCH, 1 and 2, located on the overhead circuit breaker panel. Switches in the pilots' compartment actuate the pumps. For a detailed discussion of the clutches, refer to paragraph 9-13.

Figure 2–12. Overhead switch panel (typical).

For clutch oil specification and grade, see table 2–2.

a. Rotor Clutch Fluid Coupling. The functions of the rotor clutch fluid coupling are to permit the engine to be started and operated while completely disengaged from the transmission system, and to provide a smooth and rapid acceleration of the transmission system during clutch engagement.

b. Rotor Clutch Mechanical Coupling. The rotor clutch mechanical coupling provides a direct mechanical drive between the engine and transmission system upon engagement. Freewheeling units, which are part of the mechanical couplings, eliminate engine drag on the transmission system during autorotation or single-engine operation. The units automatically disengage one or both engines from the transmission system when main rotor speed exceeds the equivalent engine driving speed.



1 Airspeed indicator correction card
2 Dual tachometer (right engine and rotor)
3 Airspeed indicator
4 B-1A attitude indicator
5 Directional indicator (ID 250/ARN)
6 Fuel quantity gage test switches
7 First stage servo hydraulic pressure gage
8 Fuel quantity gage (left fuel tank)
9 Fuel pressure gage (left engine)
10 Fuel low level warning lights
11 Fuel pressure gage (right engine)
12 Fuel quantity gage (right fuel tank)
13 Engine oil temperature gage (left engine)
14 Engine oil pressure gage (left engine)
15 Engine oil pressure gage (right engine)
16 Engine oil temperature gage (right engine)
17 Main gearbox oil pressure gage
18 Main gearbox oil temperature gage
19 Main gearbox oil-low pressure warning light
20 Course indicator ID 453/ARN
21 Compass slaving switch
22 Gyro-magnetic compass indicator—model C-6H
23 Performance indicator
24 4005H attitude indicator
25 Airspeed indicator
26 Rotor brake warning light
27 Airspeed correction card
28 Dual tachometer (right engine and rotor)
29 Cargo hoist shear panel
30 Dual manifold pressure gage
31 Dual tachometer (left engine and rotor)
32 Vertical gyro indicator light fuse
33 Clock
34 Turn-and-bank indicator
35 Vertical velocity indicator
36 Altimeter
37 Engine fire warning lights
38 Marker beacon volume knob and light, AN/ARN-32
39 Control panel assy
40 Inverter switch and warning lights
41 Tail rotor blades coning switch and warning lights
42 Cylinder head temperature gage (right engine)
43 Carburetor air temperature gage (right engine)
44 Ammeter (right engine)
45 Carburetor air temperature gage (left engine)
46 Ammeter (left engine)
47 Cylinder head temperature gage (left engine)
48 Second stage servo hydraulic pressure gage
49 ASE hydraulic servo system switch
50 Utility hydraulic system pressure gage
51 Voltmeter
52 Servo shutoff switch and warning lights
53 AC instrument fuse panel
54 Altimeter
55 Gyro-magnetic compass indicator correction card
56 Vertical velocity indicator
57 Turn-and-bank indicator
58 Clock
59 Dual manifold pressure gage
60 Dual tachometer (left engine and rotor)
61 Landing gear emergency valve warning light
62 Magnetic chip detector warning lights
63 Radio call name plate
64 Gyro-magnetic-compass indicator correction card

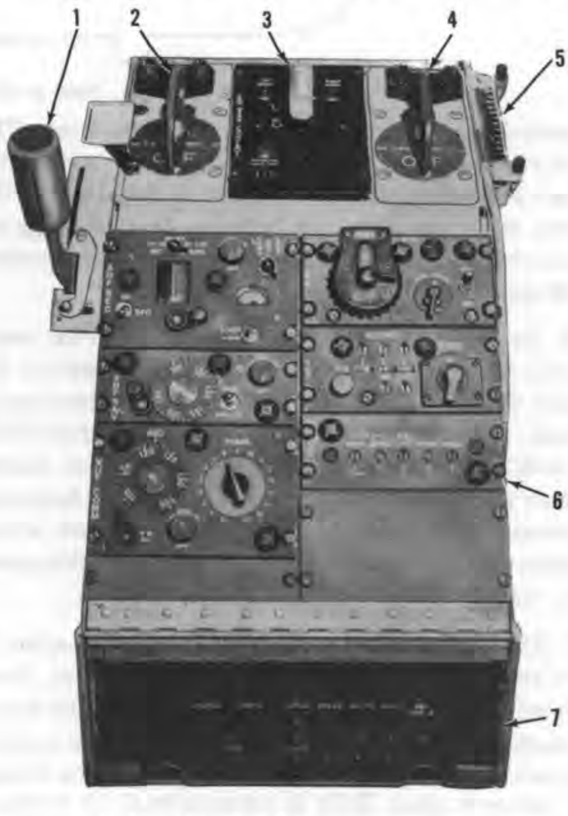
Figure 2-13. Instrument panel (typical).

c. Rotor clutch oil reservoirs. A rotor clutch oil reservoir (11, figure 2–30) for each rotor clutch is located behind a removable panel, aft of the fire wall on the inboard side of each nacelle. A filler cap, with a dipstick attached to it for checking the oil level in the reservoir, is located at the top of each reservoir. Each reservoir has a capacity for 1.5 US gallons. Tubing extends from each reservoir to the fluid coupling of the rotor clutches.

d. Rotor clutch switches and warning lights. Two rotor clutch switches are located on the forward end of the overhead switch panel. (See figure 2–12.) The switches, marked ROTOR CLUTCH, electrically control the rotor clutch oil pumps. A red press-to-test warning light, forward of the switch, illuminates when the clutch switch is placed at ON. When either switch is placed ON after the engines have been started, oil is pumped into the fluid coupling to accelerate the transmission system before mechanical engagement can be accomplished. When the switches are placed at OFF (center), the electrical circuit to the clutch pumps is broken. The primary bus direct current circuit to the switch is interlocked in such a way that the clutch switches receive no power unless the pylon is locked in the unfolded position, the rotor brake is off, and the tail rotor blades are unconed. The warning lights operate on direct current from the primary bus and are protected by circuit breakers (figure 2–22), marked WARN LTS, TEST, and PWR, located on the overhead circuit breaker panel.

2–19. Rotor Brake. A mechanically actuated hydraulic rotor brake, utilizing fluid from the utility hydraulic system reservoir, is used to stop the rotation of the rotors and to prevent rotation of the rotors when the helicopter is parked. The brake cylinder is located in the pilots' compartment ceiling, and the brake disc is mounted on the tail rotor drive shaft aft of the main gear box. A small accumulator charged with air at 300 psi prevents a surge in hydraulic pressure when the rotor brake is applied. The rotor brake is designed to bring the rotors to a dead stop from hovering rpm within 15 seconds, although normally the brake should be applied more gradually. Do not apply the brake while the rotors are being engine-driven.

a. Rotor brake lever. The manually operated rotor brake lever (5, figure 2–9), which connects directly to the rotor brake hydraulic cylinder, is located on the pilots' compartment ceiling to the right of the switch panel. To apply the rotor brake, the lever is pulled down and swung forward. A rotor brake warning light, located on the instrument panel, will illuminate when the rotor brake lever is moved to the ON (down) position. The rotor brake lever is automatically locked in the ON (down) position by a spring-loaded rotor brake lever lockpin (6), located at the forward inboard side of the cylinder. The lockpin is equipped with a small toggle handle which points inboard in line with the pin when the rotor brake lever is locked. This handle must be pushed forward or aft to extract the lockpin before the rotor brake lever may be released. The lockpin is free to rotate in its housing; if the handle will not actuate in a fore-and-aft direction, push it up or down. The lockpin handle may be left in the forward or aft position to render the lockpin inoperative, or it may be returned to the neutral in-line position to allow the lockpin to retract into the housing where it will automatically lock the rotor brake lever at the next application. When the rotor brake is ON, hydraulic pressure in the line actuates a pressure switch which breaks the circuit to the hydromechanical rotor clutch, making it impossible to engage the clutch. To release the rotor brake, the lever is unlocked, then pulled aft and swung



1. Nose door lock lever
2. Left engine fuel shutoff valve switch
3. Main landing gear actuating lever
4. Right engine fuel shutoff valve switch
5. Twist-grip throttle position indicator
6. Radio control panels
7. Radio circuit breaker panel

Figure 2–14. Control console (typical)

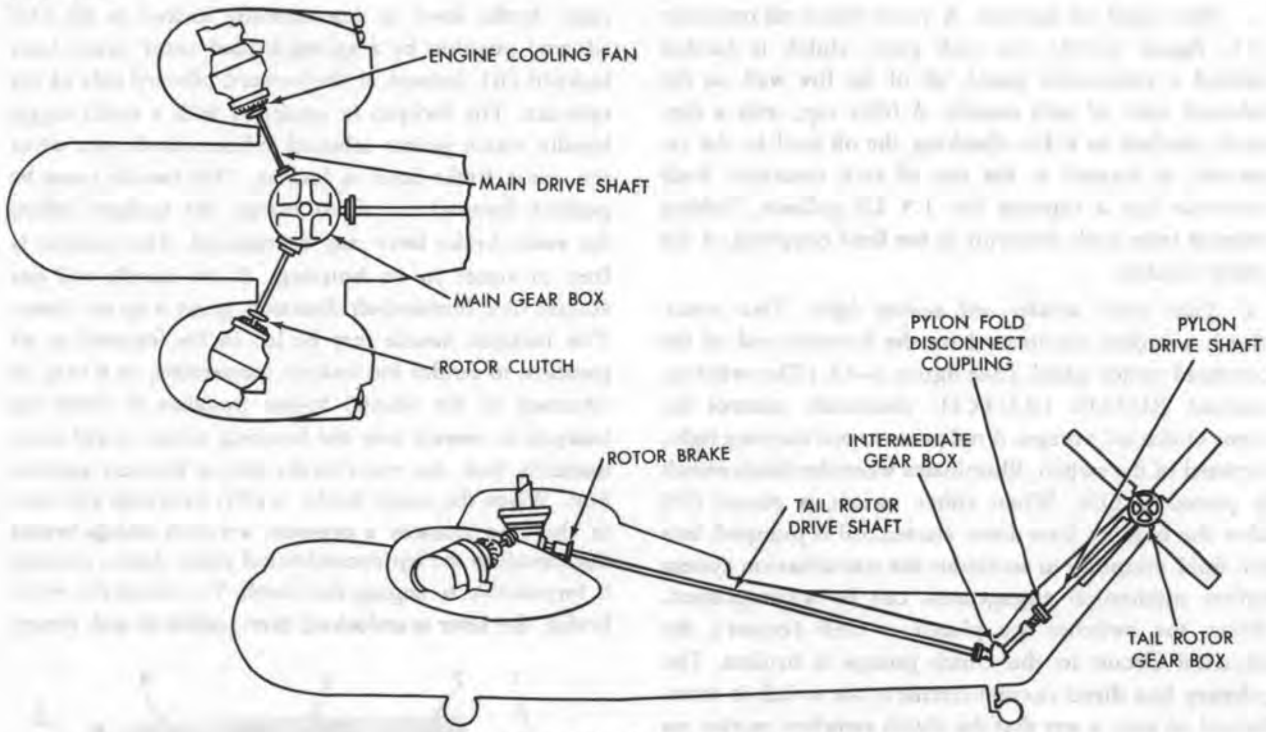


Figure 2–15. Transmission system

upward where it is locked in an automatic detent. The rotor brake lever should be held securely in the OFF (up) position by the detent, otherwise the weight of the lever will cause the rotor brake to drag. A dragging rotor brake, besides cutting down effective engine power, will soon wear out.

b. Rotor brake warning light. A red press-to-test rotor brake warning light (26, figure 2–13) is located on the right of the pilot's airspeed indicator on the instrument panel. The rotor brake warning light is marked ROTOR BRAKE ON. When the rotor brake lever is moved down and forward toward the ON position, hydraulic pressure in the line actuates a pressure switch which allows direct current from the primary bus to illuminate the rotor brake warning light.

2–20. Rotor System. The rotor system consists of the main rotor system and the tail rotor system. Both systems are driven by the engines through the transmission system and are controlled by the flight control system. The main rotor blades and pylon may be folded to conserve space. Refer to paragraphs 6–70 through 6–75.

2–21. Main Rotor System. The main rotor system consists of the main rotor blades, the main rotor assembly, and the linkage necessary to transmit main rotor flight control movement to the blades. The main rotor assembly (9, figure 2–2), consisting of a main rotor hub assembly and a star assembly, is located directly above the main gear box which is splined to the main drive shaft. (See figure 2–15.) The five all-metal main rotor blades are hinged at the main rotor hub assembly in such a way that each blade is free to flap vertically, hunt horizontally, and rotate about its span-wise axis to change the angle of incidence. Droop restrainers attached to the hub limit the downward movement; the antiflapping restrainers limit the upward movement of the blades about the flapping hinges when the blades are stopped or are turning at low speed. When rotor speed is increased to approximately 50 rpm, centrifugal force automatically releases the antiflapping restrainers and the blades are supported by the combination of centrifugal force and lift. At approximately 70 to 80 rpm, centrifugal force automatically releases the droop restrainers. Hydraulic dampers, connected between each blade and the rotor hub, minimize hunting movement of the blades about the vertical hinge as they rotate, prevent shock to the blades when the rotor is started or stopped, and aid in the prevention of ground resonance. The angle of incidence, or pitch, of the main rotor blades is controlled by the main rotor flight control system which connects to the blades through the star assembly at the lower section of the main rotor head. The star assembly consists of a rotating upper star and a stationary lower star. Both stars are mounted on a ball ring and socket assembly which keeps them parallel while allowing them to be tilted, raised, or lowered simultaneously by the main rotor flight control system that connects to arms on the lower (stationary) star assembly. Linkage on the rotating star transmits the control motion to the blades. The five all metal main rotor blades are constructed of aluminum alloy except the forged steel cuffs which attach the root ends of the blades to the sleeve-spindle assemblies on the main rotor hub assembly. The main rotor blades have a chord length of 23.65 inches. Each blade consists of a hollow extruded aluminum spar, 27 aluminum pockets bonded to the trailing edge of the spar, an aluminum tip cap fastened with screws to the spar and tip pocket, an aluminum root cap installed at the root end of the spar and a steel cuff bolted to the root end of the spar to provide the means for attaching the blade to the main rotor head. The aluminum spar forms the leading edge of the blade. A stainless steel abrasion strip is adhesive-bonded to the outboard leading edge of the spar to protect the blades from abrasive action and adverse weather conditions. Vent holes are provided on the underside of the trailing edge of the 27 pockets to prevent the accumulation of moisture inside the pockets. The tip cap has 2 vent holes. The vented pockets are reinforced by rib-type construction. Each blade weighs approximately 350 pounds.

2-22. Tail Rotor System

The tail rotor system consists of four all metal rotor blades, the tail rotor assembly (1, fig. 2-2), and the pitch-change mechanism. The tail rotor hub is splined to the tail rotor gearbox drive shaft which transmits engine torque to the blades. The blades are attached to the tail rotor hub in such a way that they are free to flap, hunt, and rotate about their axis for pitch vibration. They are also connected to each other by shock absorbers which help distribute varying air loads and reduce vibration. The blade pitch-change mechanism transmits tail rotor flight control movement through the hollow tail rotor drive shaft to the blades. Each tail rotor blade consists of a single-ribbed trailing edge pocket, bonded to a hollow leading edge spar.

a. Tail Rotor Coning System. To prevent the tail rotor blades from flapping when the helicopter is parked on the ground, the tail rotor blades are coned against their stops by an electrically operated coning device, located on the tail rotor gearbox. The tail rotor blades may be coned at any time the helicopter is parked, whether the pylon is folded or not; however, they must be unconed before positioning the main rotor blades for folding. The system operates on direct current from the primary bus and is protected by a circuit breaker (fig. 2-22) marked TAIL ROTOR CONING, located on the overhead circuit breaker panel. Power is available for blade coning only if the main rotor is stopped or turning at less than 6 rpm (transmission oil low pressure warning light is illuminated), otherwise the blade coning system is inoperative. An electrical interlock will also prevent engaging either rotor clutch if the tail rotor blades are coned, as indicated by illumination of the tail rotor blades coned warning light.

b. Tail Rotor Blades Coning Switch. A tail rotor blades coning switch (41, fig. 2-13) is located in the center of the instrument panel. The switch is marked TAIL ROTOR CONING, with two marked positions, CONED and FLT POSIT. When the switch is placed in the CONED position, an electric actuator will cone the tail rotor blades. A limit switch will automatically turn off the actuator when coning is accomplished. When the switch is placed in the FLT POSIT, the tail rotor blades will uncone; a limit switch will automatically turn off the actuator when unconing is accomplished.

c. Tail Rotor Blades Coned Warning Light. A tail rotor blades coned warning light (41, fig. 2-13) is located to the left of the tail rotor blades coning switch on the instrument panel. The warning light is marked BLADES CONED. The function of the light is to warn the pilot that the blades are not in the flight position. The light is illuminated while the blades are coned and during the coning and unconing process. The light will extinguish when the blades are in the flight position. The warning light test circuit operates on direct current from the primary bus and is protected by the circuit breakers (fig. 2-22), marked WARN, TEST, located on the overhead circuit breaker panel. The warning light power circuit operates on direct current from the primary bus. The warning light power circuit is protected by the circuit breaker (fig. 2-22), marked CKPT TAIL ROTOR CONING, located on the overhead circuit breaker panel under the general heading UT TECP.

2-23. Engine Oil System

The oil system for each engine includes a rigid fiberglas-type engine oil tank (10, fig. 2-30), with an internal hopper assembly, located within each wheel well against the inboard bulkhead, and a cooling system located just aft of the firewall on the outboard side. The oil tank has a normal capacity of 30 gallons, with approximately 9 gallons of this total in the hopper assembly, and a 10 gallon expansion space, for a total volume of 40 gallons. The tank is filled through a filler tube on the top of the nacelle. The hopper assembly is automatically filled when the oil tank is filled. The oil filler cap is marked OIL-30 U.S. GALLONS, and has arrows showing the direction to OPEN and CLOSE the filler cap. The oil filler cap is secured to the helicopter with a 6-inch bead chain. A dipstick which indicates the oil level in gallons is to the right of the filler tube. A hand-operated drain valve is located on the bottom of the oil tank sump. Only the oil tank and sump may be drained by opening this valve. The entire oil system, including the hopper assembly and tank, are drained by opening the "Y" drain valve located on the inboard bulkhead in each wheel well. The "Y" drain valve is in the engine oil inlet line. Oil flow to the engine is cut off at the firewall, in event of fire, by an electrically operated valve actuated by the engine fire emergency shutoff handle on the overhead switch panel. Flexible hose leads from the firewall to the engine inlet port. After circulating through the engine, the oil is directed through the firewall to the oil cooling system and then returned to the tank. An oil dilution system permits 30 percent of the oil supply to be diluted with engine fuel for cold weather starting.

2-24. Engine Oil Cooling System

The oil cooler for each engine is mounted horizontally just aft of the firewall on the outboard side. Cooling air enters a duct at the bottom of the nacelle and is led upward through the horizontally mounted oil cooler. Above the oil cooler, the air enters a changer and is led out of the aft end of the nacelle through two engine exhaust ejectors (27, fig. 2-2). Engine exhaust enters the forward end of the chamber and is expelled through the same engine exhaust ejectors. The exhaust creates a partial vacuum and accelerates the flow of air through the oil cooler. The oil cooling system provides a positive flow of cooling air when the engine is running. Panels, located just forward of the landing gear, practically inclose the opening beneath each nacelle, preventing hot engine air from entering the oil cooler. A thermostatic valve at the oil cooler inlet port automatically controls the circulation of oil returning from the engine. If oil temperature is normal, the thermostatic valve returns the oil directly to the oil tank. If oil temperature is above approximately 63.9°C. (147°F.), the thermostatic valve bypasses the oil through the core of the oil cooler and then back to the oil tank. The specification and grade for engine oil is shown in table 2-2.

2-25. Oil Dilution System

The oil dilution system supplies fuel from the fuel pressure indicator line to the engine oil system drain valve in the engine oil inlet line to decrease oil viscosity at low ambient temperatures. The flow of fuel is controlled by a solenoid valve which is actuated electrically by the oil dilution switch located on the overhead switch panel. The solenoid valve operates on direct current from the primary bus and is protected by a circuit breaker (fig. 2-22), marked ENG START, PRIM & OIL DIL, located on the overhead circuit breaker panel. A manually operated shutoff valve is installed in the oil dilution line at the oil system drain valve. A check valve is installed in the oil dilution line between the solenoid valve and the manually operated shutoff valve. For oil dilution procedure and dilution time refer to paragraph 10-30.

a. Oil Dilution Switches. Two spring-loaded oil dilution switches are located on the overhead switch panel (fig. 2-12). The switches are marked OIL DIL and have positions ON and OFF (center). When the switch is held at ON, the electrically actuated solenoid valve admits fuel to the engine oil inlet to accomplish oil dilution. When released, the switch automatically returns to the OFF (center) position, the circuit to the solenoid valve is broken and oil dilution stops.

b. Oil Dilution Manual Shutoff Valve Handles. Two oil dilution manual shutoff valve handles (2, fig. 2-16), one on each manual shutoff valve, are located in each oil dilution line on the inboard side of each wheel well above the "Y" oil system drain valve. The shutoff valve is installed to prevent accidental dilution of engine oil. The valve is open when the handle is in the OPEN (vertical) position and closed when the handle is in the CLOSED (horizontal) position. The shutoff valve handle should be left in the OPEN position at all times when operating in climatic conditions requiring oil dilution.

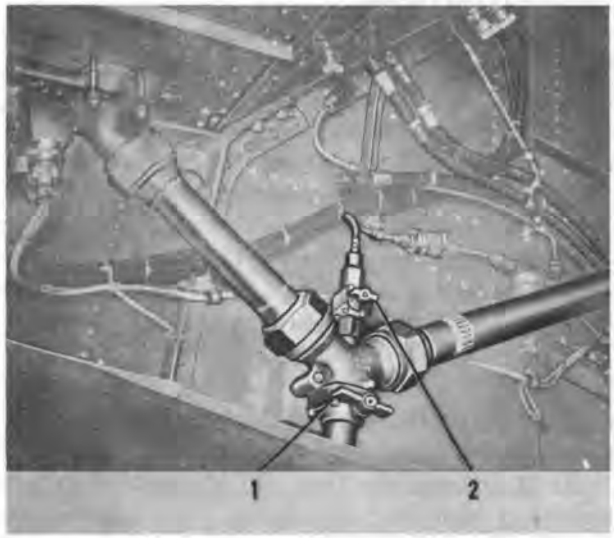
c. Engine Magnetic Chip Detector Warning System. The engine chip detector warning lights are located directly above the engine oil pressure gages on the instrument panel and provide a visual indication to the pilot or copilot of a possible impending engine failure due to material failure. It indicates that a precautionary landing should be accomplished as soon as possible. A magnetic chip detector plug is installed in each of the engine oil sump drains. The plug is connected electrically to the warning light. The magnet in the chip detector attracts metal particles which appear in the lubricant. These particles bridge an electrically insulted gap, completing a circuit which activates the warning light on the instrument panel.

2-26. Transmission Oil System

Each of the three transmission gearboxes has an individual oil system. The main gearbox is pressure-lubricated, and the intermediate and tail rotor gearboxes are splash-lubricated. Gearbox oil specification and grade is shown in table 2-2.

2-27. Main Gearbox Oil System

Pressure for lubricating the main gearbox is supplied by a gearbox driven pump located on the gearbox lower housing. Oil is pumped from the gearbox sump, through a hose, to a main gearbox oil cooler (2, fig. 2-3) located behind the main gearbox. Cooling air enters the forward end of the main gearbox fairing through the main gearbox oil cooling air intake (10, fig. 2-2) and is forced through the oil cooler by a blower driven by belts from the tail rotor drive shaft. The air is then exhausted through the louvered main gearbox oil cooling air outlet (8) on the right side of the fairing. After passing through the oil cooler, the oil returns to the main gearbox where it is sprayed onto the gears and bearings through jets built into the gearbox castings. An oil filler is located on the left side of the gearbox. A window in the gearbox below the oil filler provides a sight check for the oil level in the main gearbox. An inspection light is located next to the sight gage. The light is controlled by a switch inside the cabin forward of the cargo door.



1 Oil system drain valve handle
2 Oil dilution manual shutoff valve handle

Figure 2-16. Oil dilution manual shutoff valve handle.

a. Transmission (Main Gearbox) Oil Pressure Gage and Warning Light. The main gearbox oil pressure gage (17, fig. 2-13) is located on the instrument panel. The gage operates on current from the 26-volt ac bus, and is protected by a fuse (fig. 2-22), marked XMSN OIL PRESS., located on the ac instrument fuse panel. The gage is graduated in pounds per square inch and is actuated by a pressure transmitter connected to the gearbox oil inlet port. A red main gearbox oil low-pressure warning light (19, fig. 2-13) is located at the right of the pressure gage. The warning light is marked LOW PRESS XMSN OIL. The light, of the press-to-test type, operates on direct current from the primary bus and is protected by circuit breakers (fig. 2-22), marked WARN LTS, TEST, PWR, located on the overhead circuit breaker panel. The warning light will illuminate when low pressure in the main gearbox is sensed by a pressure switch and the pressure gage reads in the area of 12 to 18 psi.

***Warning:* If main gearbox oil pressure gage reads less than 25 psi, or main gearbox oil low-pressure warning light illuminates, it indicates a loss of pressure in system and improper lubrication of main gearbox. An immediate landing should be made and flight not resumed until trouble is corrected.**

b. Transmission (Main Gearbox) Oil Temperature Gage. The main gearbox oil temperature gage (18, fig. 2-13), located on the instrument panel, is graduated in degrees centigrade. The gage is connected by a direct current circuit to an oil temperature bulb adjacent to the main gearbox oil outlet port and is protected by a circuit breaker (fig. 2-22), located on the overhead circuit breaker panel, marked XMSN OIL TEMP. The direct current circuit is supplied power by the primary bus.

***Warning:* If main gearbox oil temperature gage reads more than 140° C., it indicates a malfunction in main gearbox or in oil cooling system; it is possible that main gearbox is not receiving proper lubrication. An immediate landing should be made and flight not resumed until trouble is corrected.**

c. Main Gearbox Magnetic Chip Detector Warning System. The main transmission chip detector warning light is located directly above the transmission oil pressure gage on the instrument panel and provides a visual indication to the pilot or copilot of a possible impending transmission failure due to material failure. It indicates that a precautionary landing should be accomplished as soon as possible. A magnetic chip detector plug is installed in transmission drain. The plug is connected electrically to the warning light. The magnet in the chip detector attracts metal particles which appear in the lubricant. These particles bridge an electrically insulated gap, completing a circuit which activates the warning light on the instrument panel.

2-28. Intermediate and Tail Rotor Gearbox Oil Systems

Both the intermediate and the tail rotor gearboxes are splash-lubricated from individual sump systems. Internal spiral channels insure oil circulation to all bearings. An oil filler plug, drain plug, and oil level window are located in each gearbox casting. A light, operated from the battery bus, is located beside each window to aid in oil level inspection. All gearbox oil level inspection lights are controlled by an oil level inspection light switch, located inside the cabin forward of the cargo door.

2-29. Fuel System
(fig. 2-17)

The fuel system consists of two independent pressure-type fuel systems, a right engine fuel system, and a left engine fuel system. The fuel tank for each engine is located in the wing and nacelle behind the engine firewall. Electrically operated sump-mounted booster pumps in each tank supply fuel under pressure to the system. The booster pumps operate on direct current from the primary bus through two circuit breakers (fig. 2-22), marked FUEL PUMP, 1, 2, located on the overhead circuit breaker panel. Fuel flows from the tank through a check valve, fuel shutoff valve, manual shutoff valve and fuel strainer to the engine-driven fuel pump and then to the carburetor. A crossfeed system connects the two independent systems. Fuel for the cabin heater and auxiliary powerplant is drawn from the left tank. Droppable auxiliary fuel tanks may be installed under each wing (refer to para 2-35). Fuel quantities for all tanks are shown in table 2-1. Fuel specifications and grades and alternate fuel specifications and grades are shown in table 2-2.

2-30. Fuel Tanks

Each fuel tank consists of two interconnected bladder-type fuel cells, one located in the wing section and the other located in the nacelle. The wing cell is self-sealing. Both cells are filled through a filler located in the nacelle cell. The filler caps are accessible from the top of the nacelles. Fuel flows by gravitational force from the nacelle cell into the wing cell. Flap valves in the cell interconnects prevent reversal of flow from the wing cell to the nacelle cell during extreme helicopter attitudes. The fuel booster pumps are located in the sumps of the wing cells.

2-31. Fuel Shutoff Valve Switches

Two rotary fuel shutoff valve switches (2 and 4, fig. 2-14), one for each tank, are located on the control console just aft of the instrument panel. The switches have two marked positions, ON and OFF. Each switch actuates an electrically operated shutoff valve in the fuel line immediately aft of the fire wall. The valves operate on direct current from the primary bus supplied through a circuit breaker (fig. 2-22), marked FUEL SHUT-OFF, located on the overhead circuit breaker panel. When the switch handles are placed in the ON position, fuel flows from each tank to the engine in front of it; when the handles are rotated to the OFF position, fuel is cut off from the engine. The fuel shutoff valves are also electrically actuated by the engine fire emergency shutoff handles, located on the overhead switch panel.

2-32. Fuel Crossfeed Switch

A fuel crossfeed switch is located on the overhead switch panel (fig. 2-12). The switch, marked FUEL XFEED, has two marked positions, CLOSE and OPEN (fig. 2-17). The switch electrically actuates valves in the fuel lines by direct current from the primary bus supplied through a circuit breaker (fig. 2-22), marked FUEL XFEED, located on the overhead circuit breaker panel. Normally, the switch is in the CLOSE position and each engine obtains fuel from the tank directly behind it. Placing the switch in the OPEN position electrically opens valves in the crossfeed line which connects the fuel systems. The crossfeed system may be used to supply fuel under pressure from both tanks to any one or both engines and from any one tank to either one or both engines. The crossfeed system does not transfer fuel between tanks. For additional information on this system, refer to paragraph 9-15.

2-23. Fuel Booster Pump Switches

Two fuel booster pump switches are located on the overhead switch panel (fig. 2-12). The switches are marked FUEL PUMP. Each switch has three positions: NORM, OFF, and EMER. The NORM position is used for starting and during flight, while the EMER position is used for rotor engagement, takeoff, approach, landing, and event of failure of the engine-driven fuel pumps. Should an engine-driven fuel pump fail, placing the fuel booster pump switch in the EMER position enables the electrically operated sump booster pump to deliver sufficient fuel pressure to the carburetor. The fuel booster pumps are turned off when the switches are placed in the OFF position.

Note. If EMER position of fuel booster pumps is to be selected prior to starting engines, it is recommended that NORM position be selected first to minimize initial fuel pressure surge.

2-34. Fuel Quality Gage

Two fuel quantity gages (8 and 12, fig. 2-13), one for each fuel tank, are located on the instrument panel. The gages are connected through self-balancing capacitance bridge circuits to tank capacitance units, one in each fuel tank. The capacitance system of fuel quantity gaging is practically unresponsive to volumetric changes resulting from changes in temperature. Moving parts are not used in the fuel tanks; instead, the dielectric properties of the fuel and air between two

Table 2-1. Fuel Quantity

Fuel tanks	Usable		Unusable		Fully serviced	
	U.S. gallons	Pounds	U.S. gallons	Pounds	U.S. gallons	Pounds
LEFT MAIN	199	1, 194	2	12	201	1, 206
RIGHT MAIN	199	1, 194	2	12	201	1, 206
TOTAL MAIN	398	2, 388	4	24	402	2, 412
LEFT AUXILIARY:						
150 gal	148	888	2	12	150	900
300 gal	297	1, 782	3	18	300	1, 800
RIGHT AUXILIARY:						
150 gal	148	888	2	12	150	900
300 gal	297	1, 782	3	18	300	1, 800

TOTAL USABLE FUEL	WITHOUT AUXILIARY TANKS	398 gal	2, 388 lb
TOTAL USABLE FUEL	WITH 2—150 GAL AUXILIARY TANKS	694 gal	4, 164 lb
TOTAL USABLE FUEL	WITH 2—300 GAL AUXILIARY TANKS	992 gal	5, 952 lb

NOTES

1. Usable fuel determined at 3 degree nose down attitude.
2. Fuel density 6.0 lb/Gal Standard Day temperature.

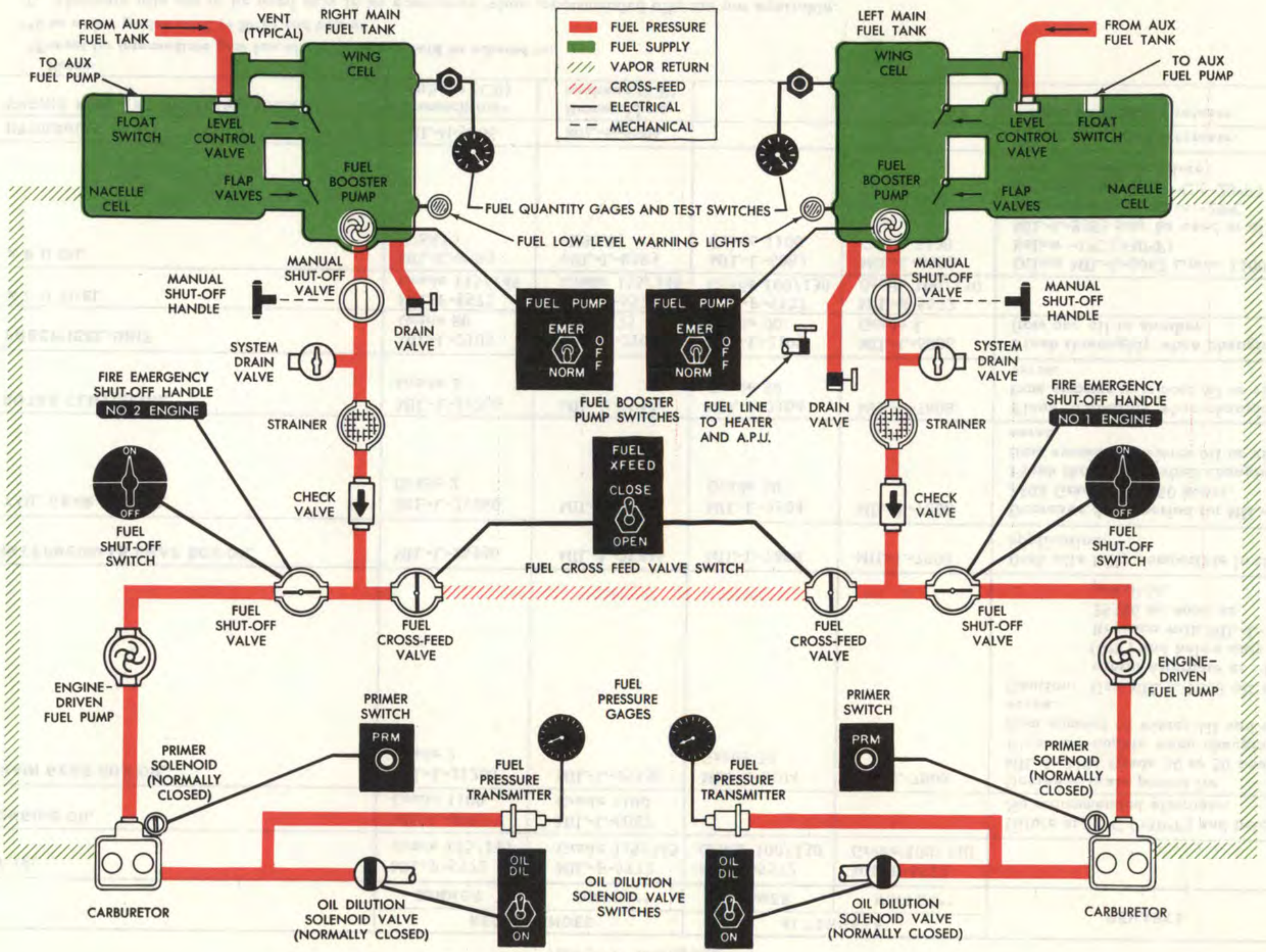


Figure 2—17. Fuel system

Table 2–2. Servicing data

	RECOMMENDED		ALTERNATE*		REMARKS
	SUMMER	WINTER**	SUMMER	WINTER**	
FUEL	MIL-F-5572 Grade 115/145	MIL-F-5572 Grade 115/145	MIL-F-5572 Grade 100/130	MIL-F-5572 Grade 100/130	
ENGINE OIL	MIL-L-6082 Grade 1100	MIL-L-6082 Grade 1100			Dilute at −1°C (+30°F) and below. No recommended alternate.
MAIN GEAR BOX OIL	MIL-L-21260 Grade 2	MIL-L-25336	MIL-L-2104 Grade 30	MIL-L-7808	Decrease drain period for MIL-L-2104 Grade 30 to 50 hours. Flush thoroughly when changing from summer to winter oil and vice versa. Caution: Use MIL-L-7808 oil as winter alternate at −18°C (0°F) and below only. Replace with MIL-L-25336 as soon as possible.
INTERMEDIATE GEAR BOX OIL	MIL-L-25336	MIL-L-25336	MIL-L-7808	MIL-L-7808	Both oils fully compatible in this application.
TAIL GEAR BOX OIL	MIL-L-21260 Grade 2	MIL-L-25336	MIL-L-2104 Grade 30	MIL-L-7808	Decrease drain period for MIL-L-2104 Grade 30 to 50 hours. Flush thoroughly when changing from summer to winter oil or vice versa.
ROTOR CLUTCH OIL	MIL-L-21260 Grade 2	MIL-L-25336	MIL-L-2104 Grade 30	MIL-L-7808	Flush thoroughly when changing from summer to winter oil or vice versa.
FREEWHEEL UNIT	MIL-L-2105 Grade 80	MIL-L-2105 Grade 75	MIL-L-2105 Grade 90	MIL-L-6086 Grade L	Flush thoroughly when changing from one oil to another.
A P U FUEL	MIL-F-5572 Grade 115/145	MIL-F-5572 Grade 115/145	MIL-F-5572 Grade 100/130	MIL-F-5572 Grade 100/130	
A P U OIL	MIL-L-8383 (USAF)	MIL-L-8383 (USAF)	MIL-L-6082 Grade 1100	MIL-L-6082 Grade 1100	Dilute MIL-L-6082 Grade 1100 below −1°C (+30°F) MIL-L-8383 may be used at all temperatures down to −29°C (−20°F). Below −29°C (−20°F) apply preheat or dilute.
HYDRAULIC FLUID	MIL-H-5606	MIL-H-5606			No recommended alternate.
ENGINE FIRE EXTINGUISHER AGENT	Bromochloromethane (CB)	Bromochloromethane (CB)			No recommended alternate.

Notes:

***Except for intermediate gear box oil, following should be adhered to:**

****Use winter grades −1°C (+30°F) and below:**

1. Alternate oils are to be used only in an emergency when recommended oils are not available.
2. Alternate oils are to be drained and flushed thoroughly and recommended oil applied at earliest opportunity.

electrodes within each fuel tank capacitance unit are used to furnish a measurement of fuel quantity. As the fuel level of each tank varies from full quantity to empty, a change occurs in the capacitance between its electrodes for each specific level. This change of capacitance is transmitted to the fuel quantity gages which indicate fuel quantity in pounds of fuel. The fuel quantity indicating circuits operate on current from the 115 volt ac bus and are protected by fuses (figure 2–22), marked FUEL QTY, located on the ac instrument fuse panel. The gages operate on alternating current from the 115 volt ac bus and direct current from the primary bus and are protected by circuit breakers (figure 2–22), marked FUEL QUANTITY, 1, 2, located on the overhead circuit breaker panel.

Warning

If power to gages fails, gages will continue to indicate quantity of fuel shown at time of power failure.

a. Fuel quantity gage test switches. Two fuel quantity gage test switches (6, figure 2–13) are located on the instrument panel to the left of the fuel pressure gages. The switches are marked FUEL GAGE TEST. To test the gages, pressing the respective test switch for approximately 10 seconds will induce a current reversal in the system and cause the pointer to turn counterclockwise toward zero. Upon release of the pushbutton switch, the pointer will return to previous reading. This test shows that the fuel quantity gages are operating correctly. The test circuits operate on direct current from the primary bus and are protected by circuit breakers (figure 2–22), marked FUEL QUANTITY, 1, and 2, located on the circuit breaker panel.

b. Fuel low-level warning lights. (See figure 2–13.) Two red fuel low-level warning lights (10) are located at the top of the instrument panel. The warning lights are marked FUEL WARNING 20 MIN. Each press-to-test light is connected to one of the fuel tanks. Either light will illuminate when there is approximately 78 gallons of fuel remaining in the respective tank. This fuel is sufficient for approximately 20 minutes of flight at METO (maximum except takeoff power). The lights operate on direct current from the primary bus and are controlled by low level sensors which are part of the fuel quantity gages tank unit. The circuit is protected by a circuit breaker (figure 2–22), marked FUEL LEVEL, located on the overhead circuit breaker panel. The warning lights are protected by circuit breakers (figure 2–22), marked WARN LTS, TEST, and PWR.

2–35. Auxiliary Fuel System. (See figure 2–18.) An auxiliary fuel system may be installed to increase the range or endurance of the helicopter. The system consists of a jettisonable auxiliary fuel tank, auxiliary fuel pump, hoses, and tubing. The fuel tank is located on the fuselage below each wing and is mounted on a bomb rack which is attached to removable struts and cables extending from the wing root and lower portion of the fuselage. The auxiliary fuel pump is mounted in the fairing containing the bomb rack. Removable fuel hoses lead from the auxiliary fuel pumps to disconnect fittings on the inboard sides of the nacelles. Tubing then conducts auxiliary fuel into the top of the nacelle fuel cells of the main fuel system. Auxiliary fuel is supplied to the engines through the main fuel system. An automatic float valve in each nacelle fuel tank mechanically shuts off auxiliary fuel and prevents overflowing the main tanks, even though the auxiliary fuel pumps are operating; thus, it is possible to keep the main fuel tanks full until all fuel from the auxiliary fuel tanks is consumed. A float switch provides additional protection against overflow by shutting off the pump and illuminating the LIGHT ON NO TRANSFER warning light if the automatic float valve malfunctions. All auxiliary fuel system controls are located in the pilots' compartment on an overhead auxiliary fuel system control panel (figure 2–19), marked AUXILIARY FUEL SYSTEM. The auxiliary fuel pumps operate on direct current from the primary bus through two circuit breakers (figure 2–22) marked AUX FUEL, 1, 2 located on the overhead circuit breaker panel.

2–36. Auxiliary Fuel Tanks. Two standard types of jettisonable auxiliary fuel tanks, a small tank with a capacity of 150 US gallons or a larger tank with a capacity of 300 US gallons, may be hung on the bomb racks. The jettisonable fuel tanks are equipped with internal baffles. When installed, the fuel tanks are positioned approximately at cabin floor level and extend slightly forward of the wing.

2–37. Auxiliary Fuel Pump Switches. Two auxiliary fuel pump switches are located on the auxiliary fuel system control panel (figure 2–19). The switches, marked PUMP, control the electrical operation of the auxiliary fuel pumps, one for each auxiliary fuel tank. The switch marked 1 operates the pump for the left auxiliary fuel tank, and the switch marked 2 operates the pump for the right auxiliary fuel tank. The two three-position switches (figure 2–19) are also marked OVERRIDE, OFF, and NORM. When the switches are placed in the ON or NORM position, fuel is pumped from the auxiliary fuel tanks into the respective main fuel tank. When the main

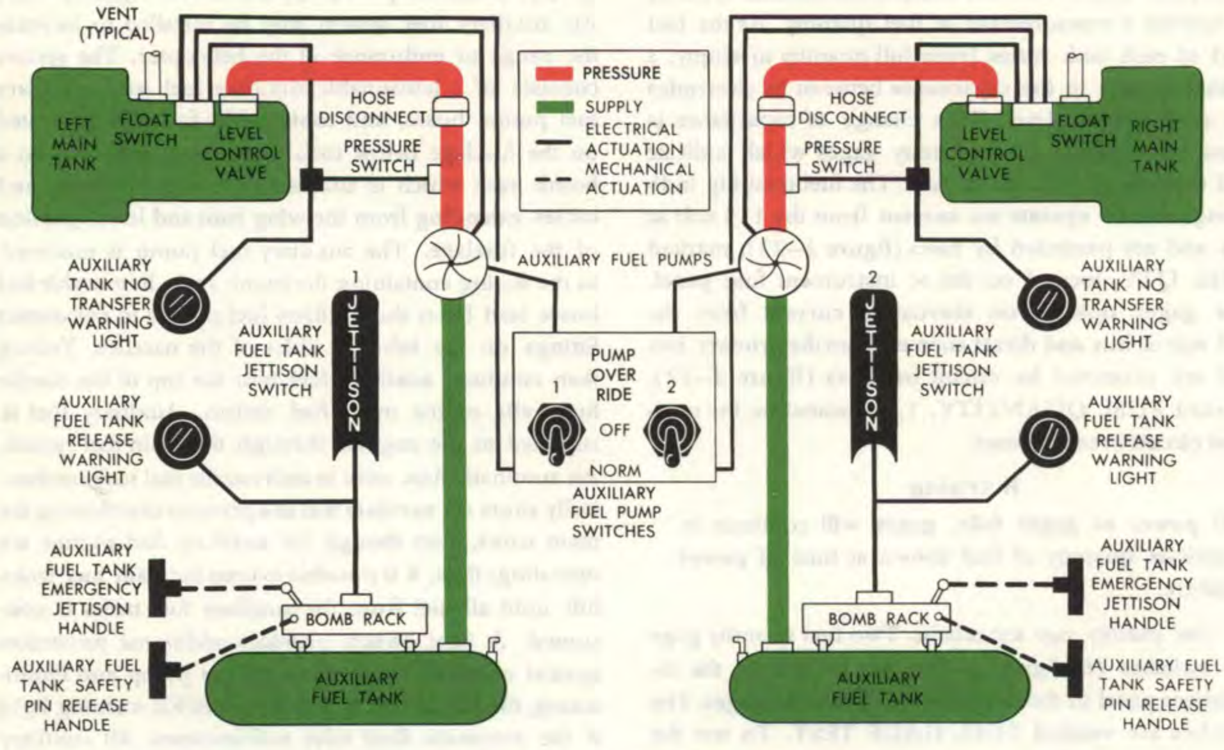


Figure 2–18. Auxiliary fuel system

fuel tanks are full, the float valves will close and the auxiliary fuel pumps will continue to operate; however, fuel will be bypassed internally. Should the auxiliary fuel pumps be shut off by action of the float switches, the LIGHT ON NO TRANSFER warning lights will illuminate. If a float switch jams in the pump's OFF position, placing the pump switch in the OVERRIDE position will restore electrical current to the pump and fuel transfer may be continued, even though the LIGHT ON NO TRANSFER warning light remains illuminated. The OVERRIDE position will also allow the auxiliary fuel pump to be operated for a ground check of the fuel system when the main fuel tanks are full enough to open the float switch. Fuel cannot be transferred from an auxiliary fuel tank to the main fuel tank on the opposite side of the helicopter. Either auxiliary fuel pump may be operated separately, if desired.

Warning

If OVERRIDE position is used to transfer fuel from an auxiliary fuel tank to its respective main tank, because of malfunction of both float valve float switches, monitor fuel quantity gage to preclude overflowing of main tank. Fuel transfer can be controlled by periodic use of OVERRIDE and OFF positions of auxiliary fuel pump switch.

Caution

Shut off auxiliary fuel pumps when LIGHT ON NO TRANSFER light indicates empty auxiliary fuel tank. Dry operation of pumps will damage carbon bearings in pumps. Check LIGHT ON NO TRANSFER lights frequently when auxiliary fuel tanks are low.

2–38. Auxiliary Fuel Tank Safety Pin Release Handle. An auxiliary fuel tank safety pin release handle (10, figure 2–3), where installed, is located in the cabin on each side panel directly above the auxiliary fuel tank emergency jettison handle. The release handles, connected to the bomb rack safety pins by means of cables, must be pulled prior to electrically or mechanically jettisoning fuel tanks.

Warning

On helicopters equipped with safety pins, safety pins must be released before auxiliary fuel tanks can be jettisoned electrically or mechanically.

2–39. Auxiliary Fuel Tank Jettison Switches and Warning Lights. Two auxiliary fuel tank jettison switches are located on the auxiliary fuel system control panel (figure 2–19). The switches are marked TANK RELEASE, 1, and 2, with switch guards marked JETTISON. When a jettison switch is placed in the ON (unguarded) position, an electrically operated release solenoid opens the bomb rack to jettison the auxiliary fuel tank. When the spring-loaded jettison switch is released and returns to the OFF position, one of two red press-to-test warning lights, marked LIGHT ON TANK RELEASE, 1, and 2, located on the auxiliary fuel system control panel, will illuminate to indicate that the fuel tank has been released. The warning light will remain illuminated even after the auxiliary fuel pump has been turned OFF. The switch and light marked 1 are connected to the left bomb rack and the switch and light marked 2 are connected to the right bomb rack. The auxiliary fuel tank jettison circuits and warning lights operate on direct current from the primary bus and are protected by circuit breakers (figure 2–22), marked AUX FUEL, 1, 2, and WARN LTS, TEST, and PWR, located on the overhead circuit breaker panel.

2–40. Auxiliary Fuel Tank Emergency Jettison Handles. (See figure 2–3.) In case of electrical failure of the auxiliary tank jettison system, the jettisonable fuel tank may be manually released by pulling two auxiliary fuel tank emergency jettison handles (10, figure 2–3), located in the cabin on either side panel directly inboard of the auxiliary fuel tanks. The handles are stowed in spring-clips, and are attached to cables that trip the manual release levers on the bomb racks and jettison the auxiliary fuel tanks.

2–41. Auxiliary Fuel Tank No Transfer Warning Lights. Two auxiliary fuel tank no transfer warning lights are located on the auxiliary fuel system control panel (figure 2–19). The red, press-to-test lights are marked LIGHT ON NO TRANSFER, 1, and 2. Either light will illuminate when a pressure switch, located in each auxiliary fuel tank outlet line, senses a drop in pressure below the normal operating level. A loss of pressure is normally the result of exhausting the fuel supply in the auxiliary tank; however, the light will also indicate failure of the auxiliary fuel pump or the shutting off of the pump by the float switch in the nacelle fuel cell. The light extinguishes when the auxiliary fuel pump is turned OFF. The tank LIGHT ON NO TRANSFER warning lights may be tested for operation only when their fuel pump switches are turned ON. The lights operate on direct current from the primary bus and are protected by two circuit breakers (figure 2–22), marked WARNING LTS, TEST, and PWR, located on the overhead circuit breaker panel.

2–42. Electrical Power Supply System.

Electrical power is supplied by two basic systems: a 28 volt direct current power supply system and a 115 volt alternating current power supply system.

2–43. Direct Current Power Supply System. (See figure 2–20.) The primary sources of power for the operation of all electrical equipment are two generators. Secondary power sources are a battery, an external power receptacle, and an auxiliary power unit. Power is distributed through three dc buses; the primary, secondary, and battery buses. The power sources are connected to the buses through automatic relays and switches, the functions of which are covered in paragraphs 2–43 through 2–57. All individual circuits for the operation of dc equipment are connected to the buses through circuit breakers.

a. Generators. A 30 volt, 200 ampere generator (11, figure 2–3) is mounted on and driven by the accessory section of each engine. The generators are connected in parallel. After the engines are started and operating at approximately 1200 to 1400 rpm, the generator switches are turned on and the generators supply power for the operation of all electrical equipment. Full generator output will be attained at approximately 1750 engine rpm. Normally, both generators are used. When operating on one generator, all nonessential equipment should be turned off to prevent overloading the remaining generator. The output of each generator is controlled by a voltage regulator, a reverse current cutout, an overvoltage relay, and a field control relay. The voltage regulator maintains constant generator output voltage, regardless of engine speed and electrical load requirements, by automatically controlling the generator field current. The reverse current cutout prevents the battery from discharging through the generator when the generator is not running or its voltage is below that of the battery. The overvoltage relay automatically energizes

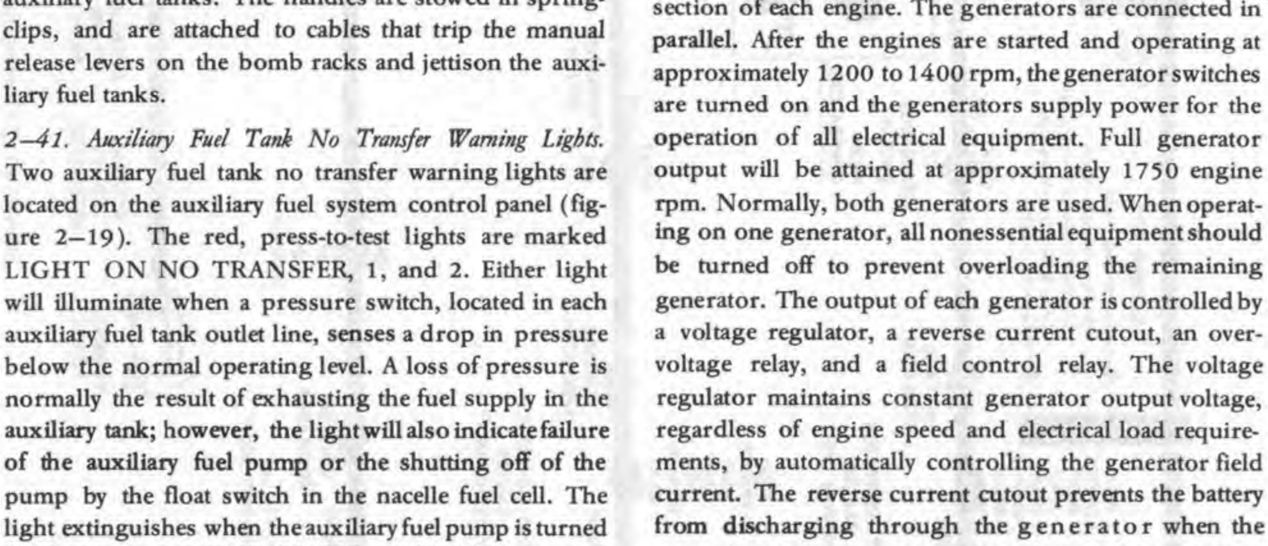


Figure 2–19. Auxiliary fuel system control panel (typical)

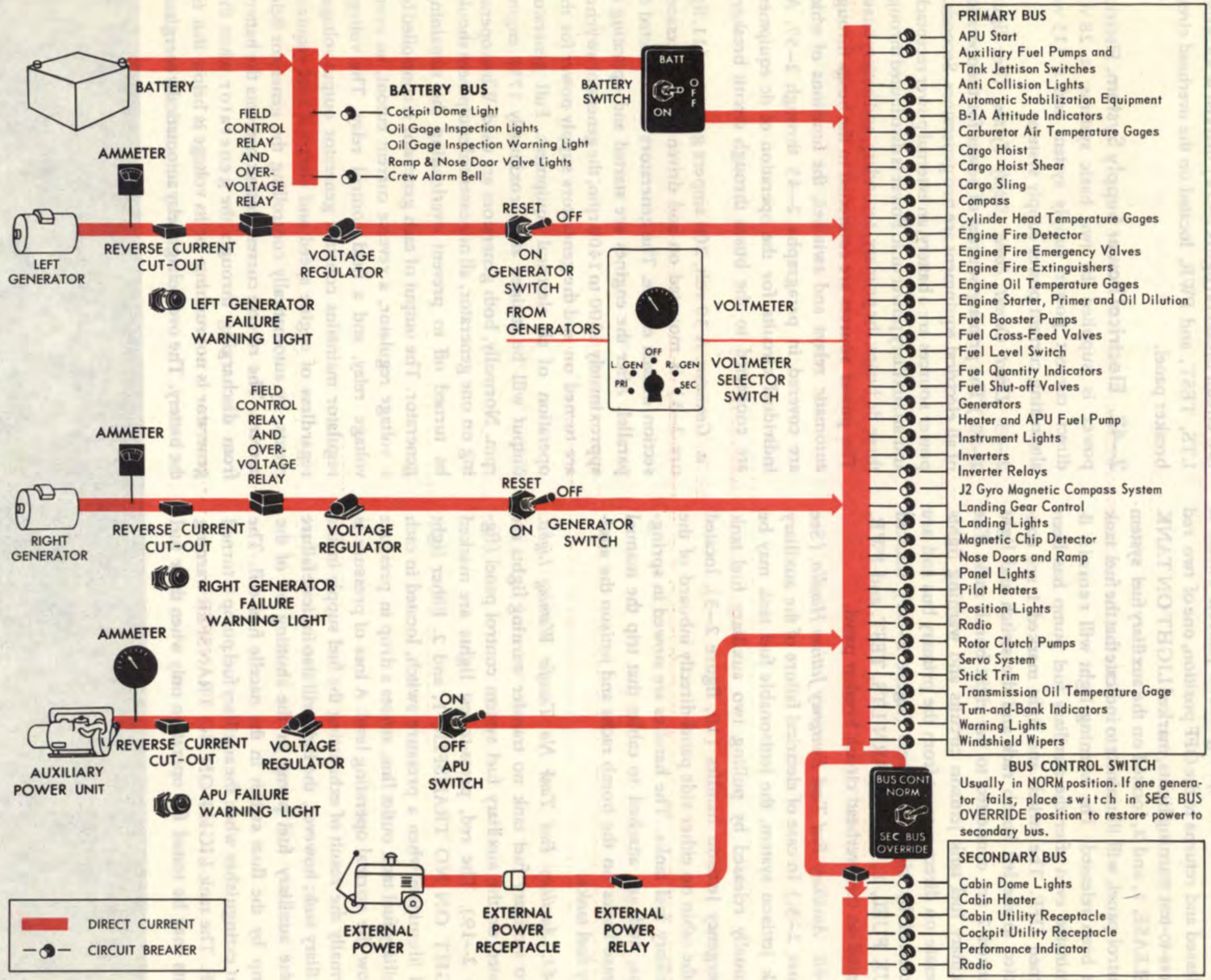


Figure 2–20. DC electrical system (typical)

the field control relay which cuts the generator out of the electrical circuit if generator output voltage should exceed approximately 31 volts. An equalizer circuit connects the two overvoltage relays to equalize the load carried by each generator. Either generator may be reset in case it should cut out because of excessive overvoltage condition.

b. Battery. The 24 volt, 24 ampere-hour battery (9, figure 2–3) is located below the cabin floor aft of the cargo hatch. Battery power is used for limited ground operations, including emergency starting of the engine when no external source is available, and as an emergency source of power for the primary bus in event of failure of both generators during flight. The battery bus is always energized by the battery regardless of the position of the battery switch. The following equipment is connected to the battery bus: cockpit dome light, crew alarm bell, and oil level inspection lights.

c. External power receptacle. The 28 volt external power receptacle (26, figure 2–2) is located on the right-hand side of the fuselage forward of the cabin door and is accessible from outside the helicopter through an access door marked EXTERNAL POWER 28 VOLTS. An external power relay in the dc power junction box serves to keep the external power receptacle from being energized when it is not in use. The relay is energized automatically when the external power plug is placed in the receptacle and the primary bus is energized or when external power is applied. To prevent draining the battery, external power or the auxiliary power unit should be used for all ground operation until the engines are started and the generators reach operating speed (approximately 1200 to 1400 engine rpm). Since both generators are engine-driven, external power may be disconnected before the rotor clutches are engaged. If external power is disconnected before an engine is started, all electrical operations, including engine starting, will be performed with battery power or with power from the auxiliary power unit. The secondary bus may be energized when the helicopter is on the ground by placing the BUS CONT switch on the overhead switch panel in the SEC BUS OVERRIDE position.

d. Auxiliary power unit. The 28 volt, 175 ampere auxiliary power unit (APU) (15, figure 2–3) is located in the left rear of the cabin. The auxiliary power unit may be used for operation of the cargo hoist, testing of equipment on the ground, and for starting the engines when no external power source is available. For further description and operating procedures, refer to paragraph 6–40. The automatic control relays which connect the power sources to the buses are contained in the dc power junction box, located in the cabin ceiling forward of the cargo door.

2–44. Direct Current Distribution. Power for operation of dc electrical equipment is distributed through three buses; primary bus, secondary bus, and battery bus.

a. Primary bus. The primary bus supplies power for the operation of the dc flight instruments and equipment most essential for safety of flight. The primary bus may be energized from all four power sources. When external power is plugged in or when the auxiliary power unit is operating, they connect directly to the primary bus. Battery power is supplied to the primary bus when the battery switch is placed in the ON position. Generator power is supplied to the primary bus when a generator switch is placed in the ON position and the corresponding generator has reached operating speed. Should both generators fail during flight, battery power will be automatically distributed to the primary bus if the battery switch is ON. The APU may be started to aid the battery in energizing the primary bus.

b. Secondary bus. The secondary bus supplies power for auxiliary equipment less essential for safety of flight. The secondary bus is connected to the primary bus by the left and right generator bus-tie relays which are closed by power from the primary bus under any of the following circumstances:

(1) When both generator switches are ON and both generators are at operating speed.

(2) When the primary bus is energized and the bus control switch is in the SEC BUS OVERRIDE position.

(3) When the helicopter is on the ground, the primary bus is energized when the bus control switch is in the SEC BUS OVERRIDE position.

The arrangement of the secondary bus permits the nonessential equipment connected to the secondary bus to be operated by all power sources while the helicopter is on the ground. The secondary bus will become inoperative during flight if one generator fails, but it may be reenergized by the primary bus if the bus control switch is placed in the SEC BUS OVERRIDE position. All unnecessary electrical equipment should be shut off. In case of failure of both generators during flight, the secondary bus will become inoperative, but it may be restored to operation by placing the bus control switch in the SEC BUS OVERRIDE position.

c. Battery bus. The battery bus supplies power to the oil level inspection light, oil gage inspection warning light, nose door and ramp manual override controls light, and the emergency alarm bell, and is continually energized regardless of the position of the battery switch.

2–45. *Generator Switches.* Two guarded generator switches are located on the overhead switch panel (figure 2–12). The generator switches marked GEN 1 and GEN 2 with the marked positions RESET, OFF, and ON, control operation of the two generators. Switch 1 is for the generator driven by the left engine and switch 2 is for the generator driven by the right engine. After each generator reaches operating speed and its switch is placed in the ON position, it supplies electrical power to the primary bus. When a generator switch is placed in the OFF position, no power is being supplied by that generator even though it is rotating. When a generator switch is held in the momentary RESET position (after the generator warning light has illuminated indicating that the generator has been cut out because of an overvoltage condition), the field control relay is actuated to place the generator back into operation.

2–46. *Bus Control Switch.* A bus control switch is located on the overhead switch panel (figure 2–12). The switch, marked BUS CONT has two positions marked NORM and SEC BUS OVERRIDE. If the secondary bus becomes automatically deenergized through failure of one generator, it may be reenergized by placing this switch in the SEC BUS OVERRIDE position. The switch is usually in the NORM position; if it is kept there with one generator not operating, all equipment connected to the secondary bus will be inoperative.

2–47. *Battery Switch.* The battery switch is located at the right of the generator switches on the overhead switch panel (figure 2–12). The switch is marked BATT and has positions ON and OFF (center). When placed in the ON position, the switch closes a circuit from the battery directly to the primary bus. The circuit is protected by a circuit breaker marked BATT RELAY on the battery bus circuit breaker panel. When placed in the OFF (center) position the switch disconnects the battery from the primary bus, but does not disconnect the battery bus to which the oil inspection lights, the oil gage inspection warning light, the cockpit dome light, the nose door and ramp manual override controls light, and the emergency crew alarm bell are connected. These items all have battery power regardless of the battery switch position. No damage will result if the battery switch is ON while using external power between 24 and 30 volts; however, using external power lower than 24 volts with the battery switch ON will cause unnecessary drainage of the battery.

Caution

Using external power over 30 volts with battery switch ON will cause battery to boil over and possibly explode.

2–48. *Direct Current Circuit Breakers.* Direct current circuit breakers (figure 2–22), protecting the various dc circuits, are located on four panels in various parts of the helicopter. The battery bus circuit breaker panel is located in the cabin ceiling inboard of the dc power junction box. The two engine ignition vibration circuit breakers (primary bus) are also located on this panel. The overhead circuit breaker panel is located aft of the overhead switch panel in the pilots' compartment. The six rows of circuit breakers on the forward part of this panel are for equipment operating from the primary bus, and the row on the aft part of the panel is for equipment operating from the secondary bus. The hoist and blower circuit breakers (secondary bus) are located on a high amperage circuit breaker panel aft of the battery bus panel in the cabin ceiling. The two inverter circuit breakers are located on the cover of the dc power junction box. Radio equipment circuit breakers are located on the radio circuit breaker panel on the aft face of the control console in the pilots' compartment. All circuit breakers are marked as to the operating circuit they protect and are of the push-pull type which may be reset. Any malfunctioning operating circuit may be isolated from the dc power supply by pulling out its circuit breaker.

2–49. *Voltmeter and Voltmeter Selector Switch.* A voltmeter (51, figure 2–13) is located at the bottom center of the instrument panel. A rotary switch, marked VOLTMETER SELECTOR, is located on the right side of the pilots' compartment dome light panel. The switch has five positions, marked PRI, L GEN, OFF, R GEN, and SEC. When the selector switch is rotated to any of the operating positions (primary bus, left generator, right generator, or secondary bus), the voltmeter will indicate the voltage of the corresponding equipment. The voltmeter should read approximately 28.5 volts at all positions when one or both generators are operating. Primary and secondary bus voltage should be approximately 28.5 volts when operating from the auxiliary power unit and between 2 and 24 volts when operating from the battery. The voltmeter is protected by a circuit breaker (figure 2–22) marked VOLTMETER located on the overhead circuit breaker panel.

2–50. *Ammeters.* Two ammeters (44 and 46, figure 2–13) are located at the bottom center of the instrument panel. The left ammeter indicates the amperage load carried by the left generator and the right ammeter indicates the load carried by the right generator. The ammeters are graduated in decimals with an indication of 1.0 indicating 100 percent load (200 amperes). Both ammeters should indicate alike, with the loads increasing as more electrical equipment is turned on.

2–51. *Generator Failure Warning Lights.* Two red generator failure warning lights, one for each generator, are located behind the generator switches on the overhead switch panel (figure 2–12). The lights are of the press-to-test type and are marked GENERATOR WARNING. Each generator failure warning light indicates a generator failure only if the respective generator switch is in the ON position. If a generator or an engine becomes inoperative, or if generator voltage falls below battery voltage, the corresponding generator failure warning light will illuminate. Should both warning lights illuminate in flight, the secondary bus will be deenergized and all nonessential equipment on the primary bus should be turned off to minimize the load on the battery. If both generators fail, the secondary bus may be energized by placing the bus control switch to SEC BUS OVERRIDE. The APU should be started to supply power to the primary bus. The warning lights operate on power from the primary bus and are protected by two circuit breakers (figure 2–22), marked WARN LTS, TEST, and PWR, located on the overhead circuit breaker panel.

2–52. *Alternating Current Power Supply System.* (See figure 2–21.) The ac power supply system supplies power for the operation of pressure gages, gyro instruments, and the fuel quantity indicators. Power is provided by the No. 1 and the No. 2 inverters, the operation of which is controlled by a switch on the instrument panel. The inverter output is distributed through a 115 volt and 26 volt ac bus system to a fuse panel, then through fuses to the individual instrument circuits.

2–53. *Inverters.* Alternating current is supplied by two 115 volt, 400 cycle, 750 VA inverters located in the forward part of the main gear box fairing. Both inverters (5, figure 2–3) are powered by direct current from the primary bus and are protected by circuit breakers, marked INVERTERS NO. 1 INV PWR, and NO. 2 INV PWR, located on the dc power junction box circuit breaker panel. Three circuit breakers (figure 2–22), marked AC ALT PWR INST PWR FAIL WARN, and INV FAIL WARN, located on the overhead circuit breaker panel, protect the inverters which operate on direct current from the primary bus. Normally, both inverters are operating, each supplying ac power to its respective bus. The No. 1 inverter supplies ac power to all ac loads except the B-1A attitude indicator which is powered by the No. 2 inverter. In the event of No. 1 inverter failure, the No. 2 inverter assumes all loads; and in the event of No. 2 inverter failure, the No. 1 inverter assumes all loads.

2–54. *Alternating Current Distribution.* Alternating current is distributed through one bus system that is powered by either inverter. Power is supplied at 115 volts for the operation of the attitude indicators, the fuel quantity indicators, and the J-2 gyromagnetic compass system; and at 26 volts for the pressure gages. Transformers are used to reduce the voltage to 26 volts. Interlock relays are provided to assure that ac and dc voltages are provided simultaneously for the J-2 compass system and the B-1A attitude indicator. Interlock, emergency release, and time delay relays are provided to assure that ac and dc voltages provide simultaneously for the automatic stabilization equipment (ASE) and the vertical gyro indicator.

2–55. *Inverter Switch.* The inverter switch (40, figure 2–13) is located in the center of the instrument panel. The switch, marked AC POWER, has three positions: NORM, OFF, AND INST EMER. Normally, the switch is in the NORM position when the two inverters are operating. If failure of one inverter should occur, the affected loads will be automatically transferred to the remaining inverter. If the automatic transfer system should fail and the No. 1 inverter should fail, the pilot may override this condition by manually placing the inverter switch in the INST EMER position.

2–56. *AC Fuses.* All ac fuses, located on the instrument fuse panel on the left side of the instrument panel (figure 2–22), are of 1 ampere rating and are marked as to the ac circuits they protect. Spare fuses are provided on the panel and on the forward portion of the control console.

2–57. *Inverter Failure Warning Lights.* Three red inverter failure warning lights (40, figure 2–13) are located in the center of the instrument panel. The press-to-test lights, marked AC POWER INST PWR FAILURE NO. 1 INV and NO. 2 INV, are protected by two circuit breakers (figure 2–22), marked TEST and PWR, under the general heading WARN LTS, located on the overhead circuit breaker panel. With the inverter switch in the NORM position, the lights will remain extinguished as long as the dc primary supply system is energized, and power is available for operation of the ac instruments. If the NO. 1 INV light illuminates during flight or ground operation, it indicates failure of the No. 1 inverter. If the NO. 2 INV light illuminates during flight or ground operation, it indicates failure of the NO. 2 inverter. If either inverter fails, the INST PWR light will flicker and then extinguish as soon as the automatic load transfer system transfers the load to the other inverter. Should the No. 1 inverter fail and the INST PWR warning light remain illuminated, indicating failure of the automatic load transfer system, placing the inverter switch in the INST EMER position will manually transfer power. If the INST PWR warning light remains illuminated after placing the inverter switch in the INST

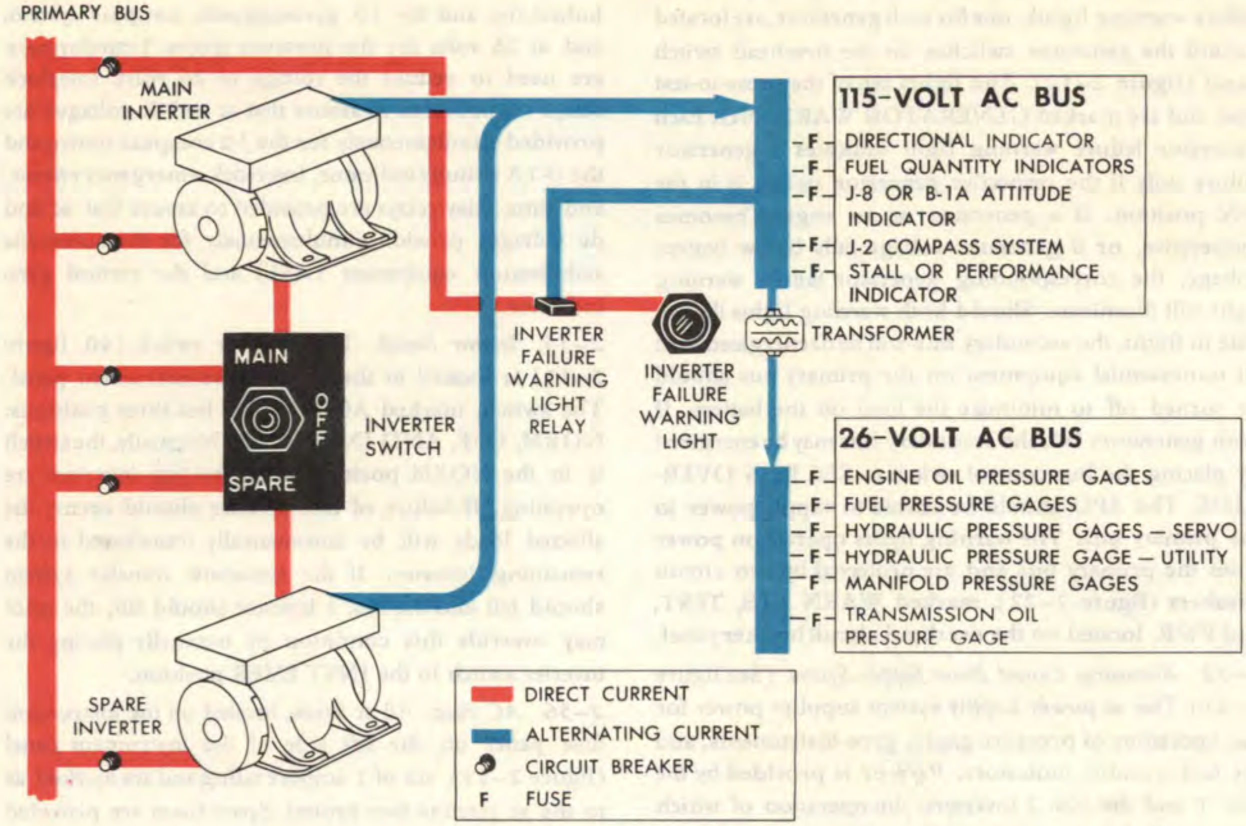


Figure 2–21. AC electrical system

EMER position, a loss of all ac power is indicated and the instruments will then be inoperative.

2–58. Hydraulic Power Supply Systems. The four separate hydraulic power supply systems installed in the helicopter are: The flight control first stage servo hydraulic system, the flight control second stage servo hydraulic system, the landing gear and ramp emergency hydraulic system, and the utility hydraulic system. The first and second stage flight control servos operate from independent self-contained hydraulic systems described in paragraphs 2–66*a* and 2–66*b*.

2–59. Utility Hydraulic System. a. Pressure for the utility hydraulic power supply system (figure 2–23) is supplied by a 3000 psi hydraulic pump mounted on and driven by the left engine. The utility hydraulic reservoir (3, figure 2–30) for this system has a capacity of approximately 2.78 gallons plus expansion space and is located in the forward part of the main gear box fairing. The reservoir filler is accessible through a door at the top of the left fairing. Hydraulic fluid in the line leading from the reservoir to the pump on the left engine is cut off by an electrically actuated emergency shutoff valve at the firewall when the left engine fire emergency shutoff handle on the overhead switch panel is pulled. Hydraulic power is distributed to the actuating cylinders of equipment throughout the helicopter by means of a 3000 psi and a 1500 psi supply line; and through a 1000 psi supply line to the ASE SERVO, throttle servo, and pedal damper system, though actual operating pressures vary because of resistors placed in the individual lines to govern the action time of the various components. An external source of hydraulic power for ground operation may be connected to the utility hydraulic system through two receptacles located on the inboard side of the left main landing gear wheel well. The specification for hydraulic fluid is shown in table 2–2.

b. Utility hydraulic system pressure gage. The utility hydraulic system pressure gage (50, figure 2–13), located at the bottom center of the instrument panel, indicates utility hydraulic system pressure in psi. The gage operates on alternating current and is protected by a fuse (figure 2–22), marked HYDRAULIC PRESS. UTILITY, located on the ac instrument fuse panel.

2–60. ASE Servo, Throttle Servo, and Pedal Damper System. The automatic stabilization equipment (ASE) hydraulic servo system includes the pedal damper and throttle servo. The ASE servo receives signals from the ASE and translates them into mechanical action that operates the

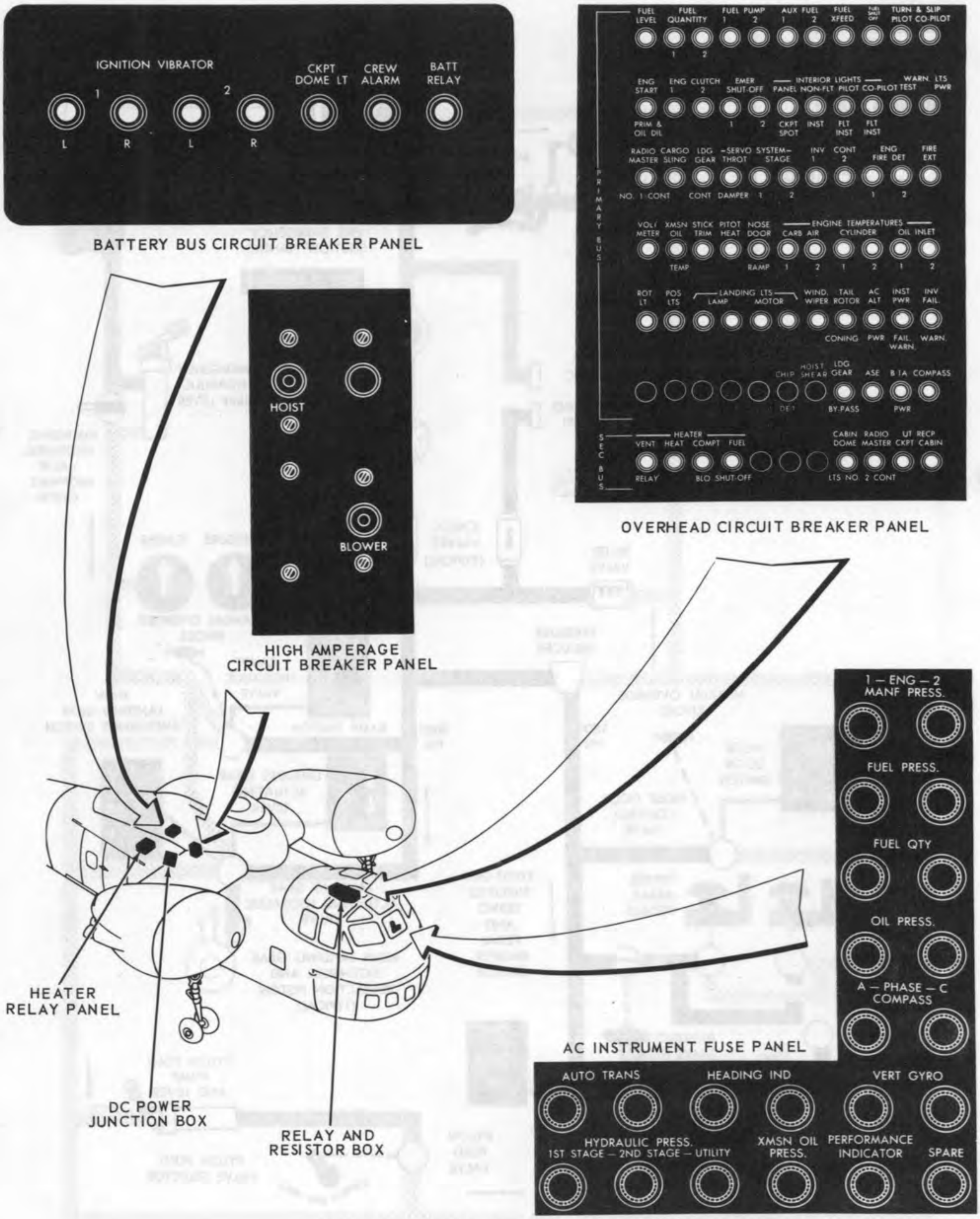


Figure 2–22. Circuit breaker and fuse panels (typical)

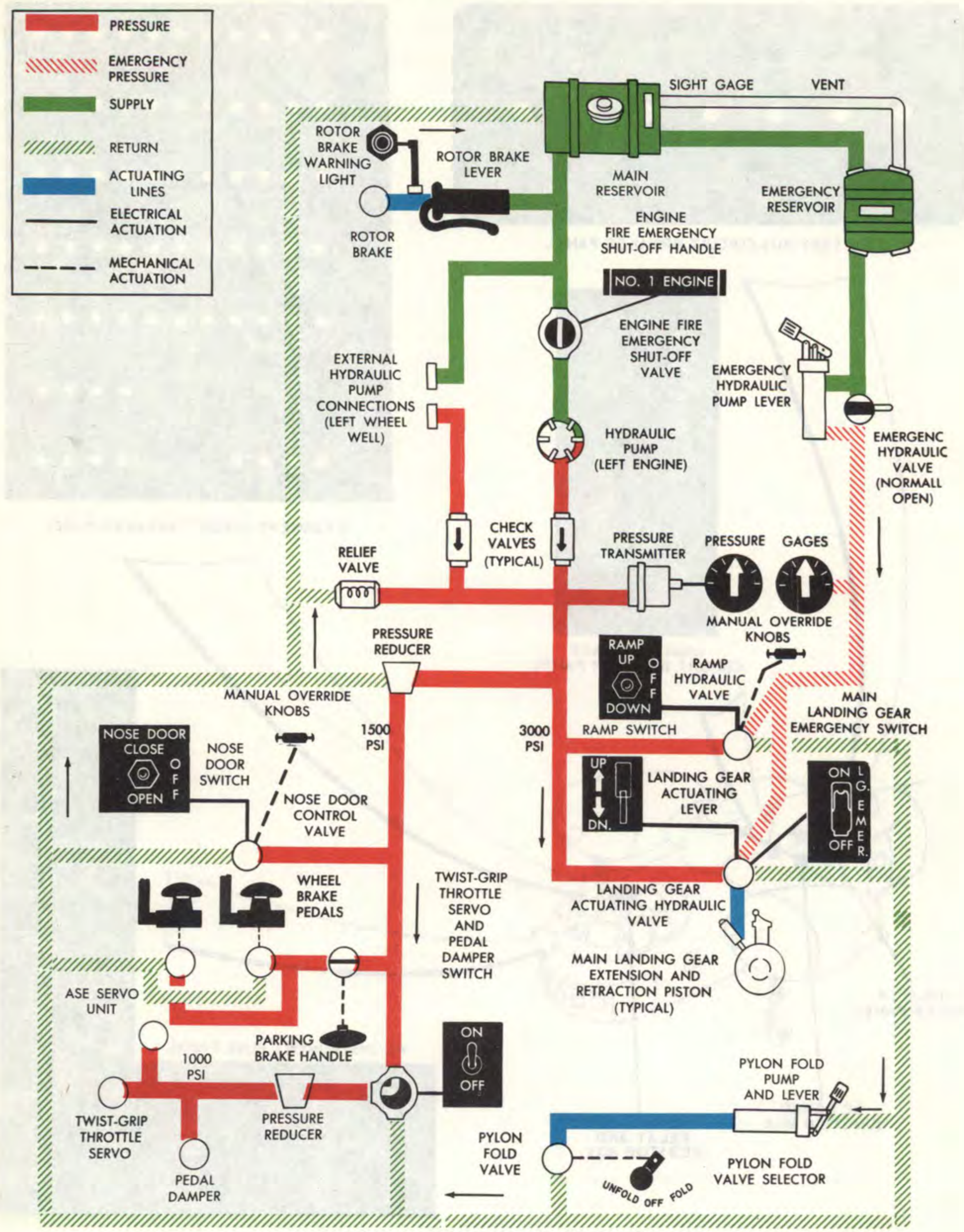


Figure 2–23. Utility hydraulic system

main rotor controls and the tail rotor controls. The system operates on a pressure of 1000 psi delivered from the utility system through a pressure-reducing valve. The system is normally in operation when the utility system is operating, but it may be shut off with the AUTO STAB SERVO switch on the instrument panel. (Refer to paragraphs 9–18 and 9–19.)

2–61. Landing Gear Emergency Hydraulic System. The emergency system (figure 2–23) lowers the main landing gear. The emergency hydraulic system consists of an 0.8 gallon reservoir which is located in the cabin ceiling and is automatically filled from the utility hydraulic system reservoir, and a manually operated hydraulic pump and valve located to the left of the copilot's collective pitch lever. If the emergency hydraulic system fails to lower the landing gear in flight due to a jammed landing gear solenoid valve the main landing gear emergency valve switch, located forward of the emergency hydraulic system valve handle, must be placed in the ON position. (Refer to paragraph 2–70*c* and paragraph 4–45.)

a. Emergency hydraulic valve handle. A manually operated emergency hydraulic valve handle (1, figure 2–10) is located aft of the copilot's collective pitch lever. The handle is in the OPEN position when rotated counterclockwise and in the CLOSED position when rotated fully clockwise. Closing the valve enables the emergency hydraulic system lines to be pressurized by the emergency hydraulic system pump. The emergency hydraulic system valve is normally open and the handle must be rotated to the CLOSED position before operating the emergency hydraulic system pump.

b. Emergency hydraulic pump lever. The emergency hydraulic pump lever (10, figure 2–10) is located to the left of the copilot's seat. The telescoping lever, which extends forward, is manually moved up and down to operate the emergency hydraulic system pump. Do not exceed 1500 psi as indicated on the emergency hydraulic system pressure gage, when using the pump lever, as excessive pressure is likely to cause leaks at the tubing connections.

Note

If extending telescoping lever, care must be used to avoid striking collective pitch lever.

c. Emergency hydraulic pressure gage. An emergency hydraulic pressure gage (9, figure 2–10), located on the floor at the copilot's left outboard of the emergency hydraulic system pump lever, indicates pressure of the emergency hydraulic system in pounds per square inch. The gage is connected directly to the emergency hydraulic tubing and functions only when the emergency hydraulic system is in operation.

Caution

After utilizing emergency system to lower landing gear, do not return main landing gear emergency valve switch to OFF position or open emergency hydraulic system shutoff valve handle until left engine is stopped (to shut off utility hydraulic pressure). If this procedure is not followed, and utility landing gear hydraulic failure was caused by landing gear valve being jammed in the UP position, restoration of utility hydraulic power will cause retraction of landing gear in spite of electrical interlocks at landing gear control. Before restarting left engine (and restoring utility hydraulic pressure) be sure that cause of utility hydraulic failure has been found and corrected.

2–62. Flight Control System. For descriptive purposes, the flight control system is divided into several systems as follows: the main rotor flight control system, the cyclic stick trim system, the tail rotor flight control system, the flight control servo hydraulic system, and automatic stabilization equipment (ASE).

2–63. Main Rotor Flight Control System. The main rotor flight control system mechanically and hydraulically provides both vertical control and directional control. Vertical control is accomplished by raising or lowering the collective pitch lever (figure 2–24) which changes the collective pitch of the main rotor blades to increase or decrease the angle of attack and consequently the lift developed by the blades. Directional control is accomplished by movements of the cyclic stick (5, figure 2–7 and 4, figure 2–8) which varies the pitch of each blade individually as it rotates, thus causing it to rise and fall cyclically and, in effect, tilting the tip-path plane of the rotating main rotor blades to obtain a horizontal, as well as a vertical, component of thrust. The horizontal component of thrust will move the helicopter horizontally in whichever direction the plane of rotation is tilted. Cyclic stick movements are transmitted from the pilots' compartment to the main rotor head through mechanical linkage. Control action is assisted by hydraulically operated flight control servos. The control system is designed so that a change in either collective pitch for vertical control or cyclic pitch for directional control will not alter previous adjustment of the other. The main rotor flight controls terminate at the lower stationary star on the main rotor head. Control action is transmitted through the rotating star and linkage on the rotor head to the main rotor blades.

a. Cyclic sticks. A manually operated cyclic stick (5, figure 2–7 and 4, figure 2–8) is located in front of each seat in the pilots' compartment. The stick provides the means of directionally controlling the helicopter.

Moving the cyclic stick in any direction, mechanically and hydraulically tilts the tip-path plane of rotation of the main rotor blades in that direction and moves the helicopter in the same direction. The cyclic stick grip (figure 2–25) of each cyclic stick contains a two-position microphone trigger switch connected to the interphone system and to the radio transmitters. The upper end of each cyclic grip contains a stick trim release switch, a cargo release switch, and an ASE release switch.

b. Collective pitch lever. (See figure 2–24.) Two manually operated collective pitch levers are located in the pilots' compartment, one to the left of the pilot's seat and the other to the left of the copilot's seat. Both levers operate simultaneously to change the collective pitch of the main rotor blades. From the minimum pitch position, the levers travel upward through an arc of 10.5 degrees to the maximum pitch position. A collective pitch lever lock (5) on a telescoping rod, attached to the pilot's collective pitch lever, may be pulled aft to apply friction to stiffen the lever action or to prevent creeping while in flight. The rotatable hand-grip of each collective pitch lever is the twist-grip throttle which is partially synchronized to the vertical movement of the collective pitch levers as described in paragraph 2–7. The landing light switches are located above the twist-grip throttle on the forward end of each collective pitch lever.

Caution

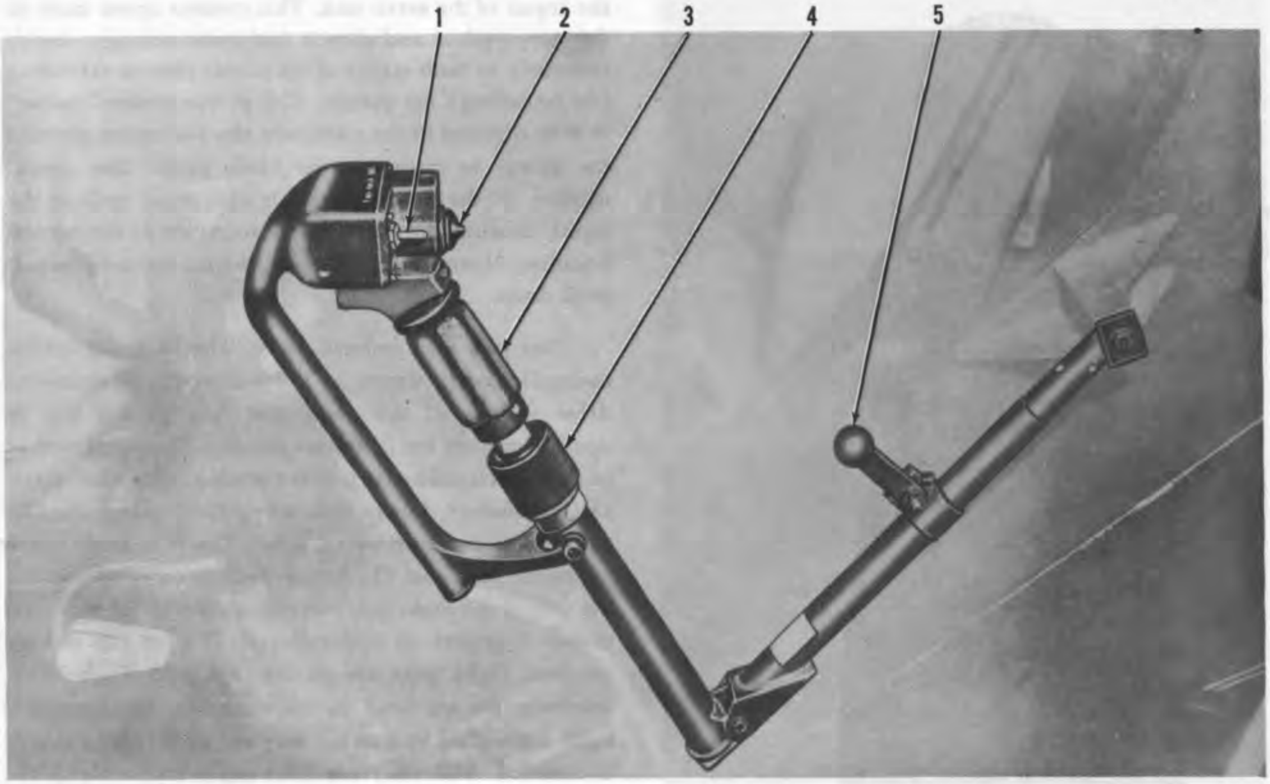
If quadrant throttles are in extreme opposite positions, collective pitch lever and twist-grip throttle cannot be moved. Locking either quadrant throttle will also restrict, if not prevent, movement of collective pitch lever and twist-grip throttle.

2–64. Cyclic Stick Trim System. A cyclic stick trim system, mechanically and electrically operated, is installed to permit trimming the cyclic stick in a desired position. The system consists of two spring-loaded struts connected to magnetic brakes. When the magnetic brakes are energized electrically, the spring-loaded struts are free to follow the movements of the cyclic stick. This renders the cyclic stick trim system inoperative and allows the cyclic stick to be moved in all directions with practically no resistance. When the magnetic brakes are deenergized, the struts are held in a fixed position and the springs create a resistance to cyclic stick displacement. The system exerts an initial force of approximately 2 pounds to hold the cyclic stick in position. This force increases proportionally to the distance the cyclic stick is displaced from the initial position. The initial position may be moved to the center trimming force about any position of the cyclic stick by energizing the magnetic brakes and then deenergizing them after the cyclic stick is moved to the desired position. The electrical circuits of the system are protected by a circuit breaker, marked STICK TRIM, located on the overhead circuit breaker panel. (See figure 2–22.) The system derives direct current from the primary bus.

a. Cyclic stick trim master switch. A cyclic stick trim master switch is located on the overhead switch panel. The switch is marked STICK TRIM with the positions ON and OFF (center). When the switch is placed in the ON position, the magnetic clutches are deenergized electrically and the cyclic stick trim system is placed in operation. The cyclic stick may then be manually positioned and electrically locked in the trimmed position by use of the thumb switches on the pilot's and copilot's cyclic stick grips. When the master switch is placed in the OFF (center) position, the magnetic clutches are energized by direct current from the secondary bus and the stick trim system is inoperative. The circuit is protected by a circuit breaker (figure 2–22), marked STICK TRIM, located on the overhead circuit breaker panel. The switch is normally kept in the ON position.

b. Cyclic stick trim release switches. Cyclic stick trim release switches (figure 2–25) are located on both cyclic trim grips. The switches, marked TRIM REL, enable the pilot or copilot to electrically trim the cyclic stick in a desired position. The thumb switches are inoperative unless the master switch is placed in the ON position. Depressing the thumb switch on either cyclic stick renders the trim system inoperative by energizing the magnetic brakes. When the thumb switch is released, the trim system is in operation. To trim the stick position, depress the thumb switch, move the cyclic stick to the desired position, and then release the thumb switch. Stick trim will then be centered about the desired stick position.

2–65. Tail Rotor Flight Control System. The function of the tail rotor flight control system is to compensate for main rotor torque and to provide a means of changing the heading of the helicopter. The torque developed by the main rotor blades turning counterclockwise tends to rotate the fuselage in a clockwise direction. Gross weight, altitude, rate of climb, airspeed, and the corresponding power and collective pitch settings will vary the amount of the main rotor torque. To compensate for torque variations, the pitch, and therefore the thrust, of the tail rotor blades can be increased or decreased collectively. Turns are accomplished by increasing tail rotor thrust which overcompensates for main rotor torque and turns the helicopter to the left, or by decreasing the tail rotor thrust which undercompensates for main rotor torque and turns the helicopter to the right. Tail rotor pedal movements are transmitted to



1. Landing light master switch
2. Extend-retract right-left landing light switch
3. Twist-grip throttle
4. Throttle friction nut
5. Collective pitch lever lock

Figure 2–24. Pilot's collective pitch lever

the tail rotor assembly by mechanical linkage and cables. Control action is assisted by hydraulically operated flight control servos. A pedal damper, connected to the utility hydraulic system, prevents abrupt movements of the tail rotor pedals and damage to the helicopter. In case of malfunction, the pedal damper may be shut off by actuating the ASE hydraulic servo system switch (49, figure 2–13) which closes an electrically actuated valve, thereby preventing the flow of utility hydraulic fluid to the pedal damper. (Refer to paragraph 2–7*e.*)

Caution

With pedal damper inoperative care should be exercised in operating pedals to avoid sudden changes in tail rotor thrust.

a. Tail rotor pedals and adjustment knobs. The tail rotor pedals (4, figure 2–7 and 2, figure 2–8), one set in front of the pilot and the other in front of the copilot, mechanically change the pitch and thrust of the tail rotor and, consequently, the heading of the helicopter. Pressing the left pedal increases the tail rotor pitch and thrust which turns the helicopter to the left. Pressing the right pedal decreases tail rotor pitch and thrust which allows main rotor torque to turn the helicopter to the right. Tail rotor pedal adjustment knobs (2, figure 2–7 and 2, figure 2–8), used to adjust the pedals for leg length, are located below the instrument panel. Toe-operated brake pedals, for the main landing gear wheel brakes, are mounted on the pilot's tail rotor pedals.

b. Tail rotor control pedal ASE switches. (See figure 2–26.) A tail rotor control pedal switch, one on each pedal, is located on the pilot's and copilot's tail rotor control pedals. These switches are normally closed and connected in series. Breaking the contacts of any one of these switches (when a pilot controlled condition is desired) opens the yaw control channel of the ASE, preventing opposition by the ASE to the manual turn being executed. Removing the feet from the tail rotor control pedals at the completion of a turn closes the pedal switches, reengaging the yaw channel of the ASE.

2–66. *Flight Control Servo Hydraulic System.* (See figure 2–27.) A flight control servo hydraulic system eliminates stick forces required by the pilot to operate the controls and those caused by main rotor vibratory loads. (Refer to paragraph 2–64.) The servo system utilizes four hydraulic piston units to vary the main and tail rotor blades pitch. Each servo unit consists of two

Figure 2–25. Cyclic stick grip (typical)

independent stages connected to two completely independent hydraulic systems, each with its own pump, pressure control circuit, and reservoir. Only the piston rod and housing is common to the two stages of the unit. The hydraulic system for the first stage is powered by a pump driven by and mounted on the main gear box. The hydraulic system for the second stage is powered by a pump driven by and mounted on the right engine. With this arrangement the pilot is assured of having the servo system, not only prior to and during rotor head engagement, but also in the event of engine failure during autorotative landings. Three main rotor servo units are mounted between the main gear box and the main rotor stationary star. A two-stage tail rotor servo unit is mounted on the tail gear box. Under normal conditions both stages will be in operation. Each servo unit has two servo valves actuated by a common input. In operation, input signals introduced by the pilot are transmitted through the control system to the input of the servo unit. This motion opens both of the servo valves and directs hydraulic pressure simultaneously to both stages of the power piston, extending (or retracting) the piston. The power piston "output" is then directed to the stationary star linkage to provide the power to change rotor blade pitch. The output motion of the power piston is connected back to the input, causing the servo valves to return to the neutral position. Normally, both servo systems are in operation at all times.

a. First stage servo hydraulic system. The first stage servo hydraulic pump (figure 2–27) is driven by the accessory drive section of the main gear box so that it is in operation when the rotors are turning. The pump output of 3000 psi is utilized to power the main rotor first stage servo cylinders, but is reduced to 1500 psi for the tail rotor first stage servo cylinder. The first stage servo hydraulic reservoir (5, figure 2–30), mounted on the left side of the main gear box, has a capacity of approximately 2 quarts of hydraulic oil. A filler cap and an oil level sight gage are on the reservoir. To facilitate checking the oil level in the reservoir, an inspection light, controlled by a switch forward of the cargo door, is installed. The reservoir filler cap is accessible by removing the left-hand gear box fairing. The sight gage is visible through a window in the fairing.

b. Second stage servo hydraulic system. The second stage hydraulic pump (figure 2–27) is driven by the accessory drive section of the right engine; if the right engine fails, the second stage servos are inoperative. The pump output of 2000 psi is utilized to power the main rotor second stage servo cylinders, but is reduced to 1500 psi for the tail rotor second stage servo cylinder. Hydraulic fluid in the line leading from the reservoir to the pump on the right engine is cut off at the firewall by an electrically operated valve when the right engine fire emergency shutoff handle (figure 2–12), located on the overhead switch panel, is pulled. The second stage servo hydraulic reservoir (2, figure 2–30), mounted in the forward part of the main gear box fairing, has a capacity of approximately 2 quarts of hydraulic fluid. A filler cap and an oil level sight gage are on the reservoir. The filler cap is accessible through a door in the fairing. The sight gage, with the aid of an oil level inspection light, is visible through a window in the fairing.

c. Servo shutoff switch. Hydraulic pressure to both the first stage and the second stage servo cylinders is controlled by a three-position servo shutoff switch (52, figure 2–13), marked SERVO SYS, located on the center section of the instrument panel. The switch has three marked positions: ON, FIRST STAGE OFF, and SECOND STAGE OFF. Both servo hydraulic systems are in operation with the switch in the center ON position. With the switch in the ON position, the electrically operated shutoff valves to the first stage servo cylinders and the second stage servo cylinders are opened and both systems are receiving hydraulic power. When the switch is placed in the FIRST STAGE OFF position, the shutoff valve to the first stage hydraulic system is closed and the second stage hydraulic system is operating the servo cylinders. When the switch is placed in the SECOND STAGE OFF position, the shutoff valve to the second stage hydraulic system is closed and the servo cylinders are operating on hydraulic power from the first stage system. However, the two systems are interconnected electrically with pressure switches in such a way that is is impossible to turn either one off, unless there is as least 1500 psi in the remaining system for proper operation. If hydraulic pressure drops below 1500 psi in either system that is in operation, the remaining system will automatically continue to maintain hydraulic pressure to the flight control servos. The servo hydraulic shutoff valves operate on direct current from the primary bus and are protected by circuit breakers (figure 2–22), marked SERVO SYSTEM, STAGE, 1 and 2, located on the overhead circuit breaker panel.

d. Servo hydraulic pressure gages. Two servo hydraulic pressure gages (7 and 48, figure 2–13), located on the instrument panel, operate on alternating current from the 26 volt ac bus. The left-hand gage indicates the pressure in the first stage servo system; the right-hand gage indicates the pressure in the second stage servo system. Both gages are graduated in pounds per square inch. The gages are protected by fuses (figure 2–22), marked HYDRAULIC PRESS, 1st STAGE – 2nd STAGE, located on the ac instrument fuse panel.

e. Servo hydraulic low pressure warning lights. Two red servo hydraulic low pressure warning lights (52, figure 2–13) are located on the instrument panel and will illuminate if hydraulic pressure in the corresponding servo hydraulic system should drop to 1500 psi. The lights are marked SERVO SYS LOW PRESS, FIRST STAGE, and SECOND STAGE. When either light is illuminated during flight, it also indicates that the remaining servo hydraulic system cannot be shut off. The lights are of the press-to-test type and operate on direct current from the primary bus and are protected by two circuit breakers (figure 2–22), marked WARN LTS, TEST, and PWR, located on the overhead circuit breaker panel.

2–67. Automatic Stabilization Equipment (ASE). The automatic stabilization equipment (ASE) (figure 2–28) improves the handling characteristics of the helicopter to permit automatic cruising flight and hands off hovering by introducing rigid static and dynamic stability within the center of gravity limitations of the helicopter. While the ASE is engaged, changes in pitch roll or heading attitude may be introduced into the system through normal use of flight controls. The control action of the ASE is limited to approximately 25 percent of the range of the helicopter flight control system authority. This limited authority of the system in all channels gives the pilot maximum opportunity to override the ASE in event of a failure while allowing sufficient ASE authority to overcome any amount of helicopter displacement ordinarily encountered. Controls used in the operation of the ASE are located on the ASE control panel and the cyclic control stick grip. Mounted on the ASE control panel are the ASE engage and disengaged switches, the center of gravity trim control, and the yaw trim control. Mounted on the cyclic stick control stick grip is the ASE release switch used to disengage the ASE and render it inoperative. Release switches on

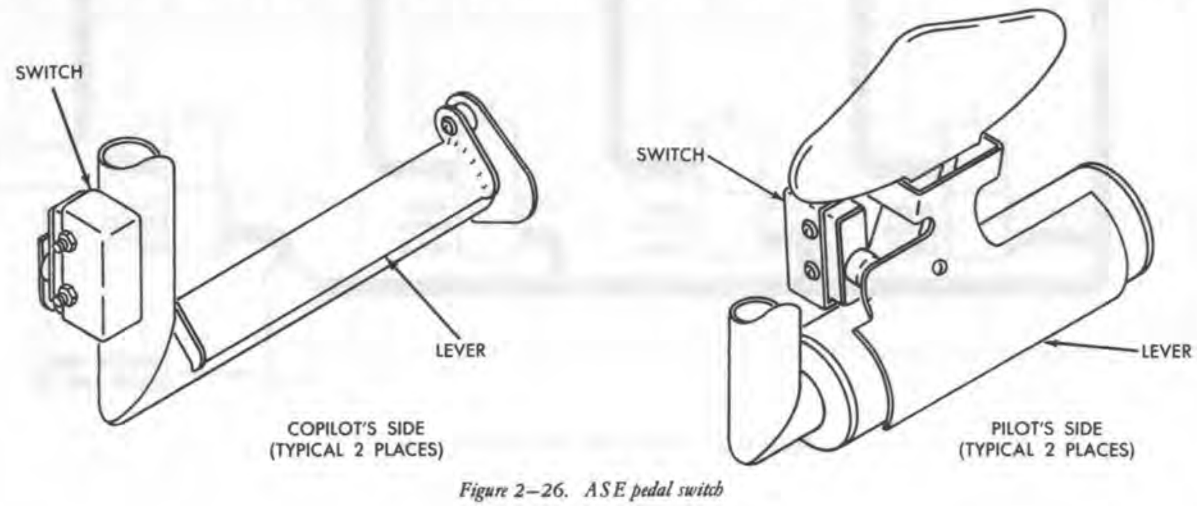


Figure 2–26. ASE pedal switch

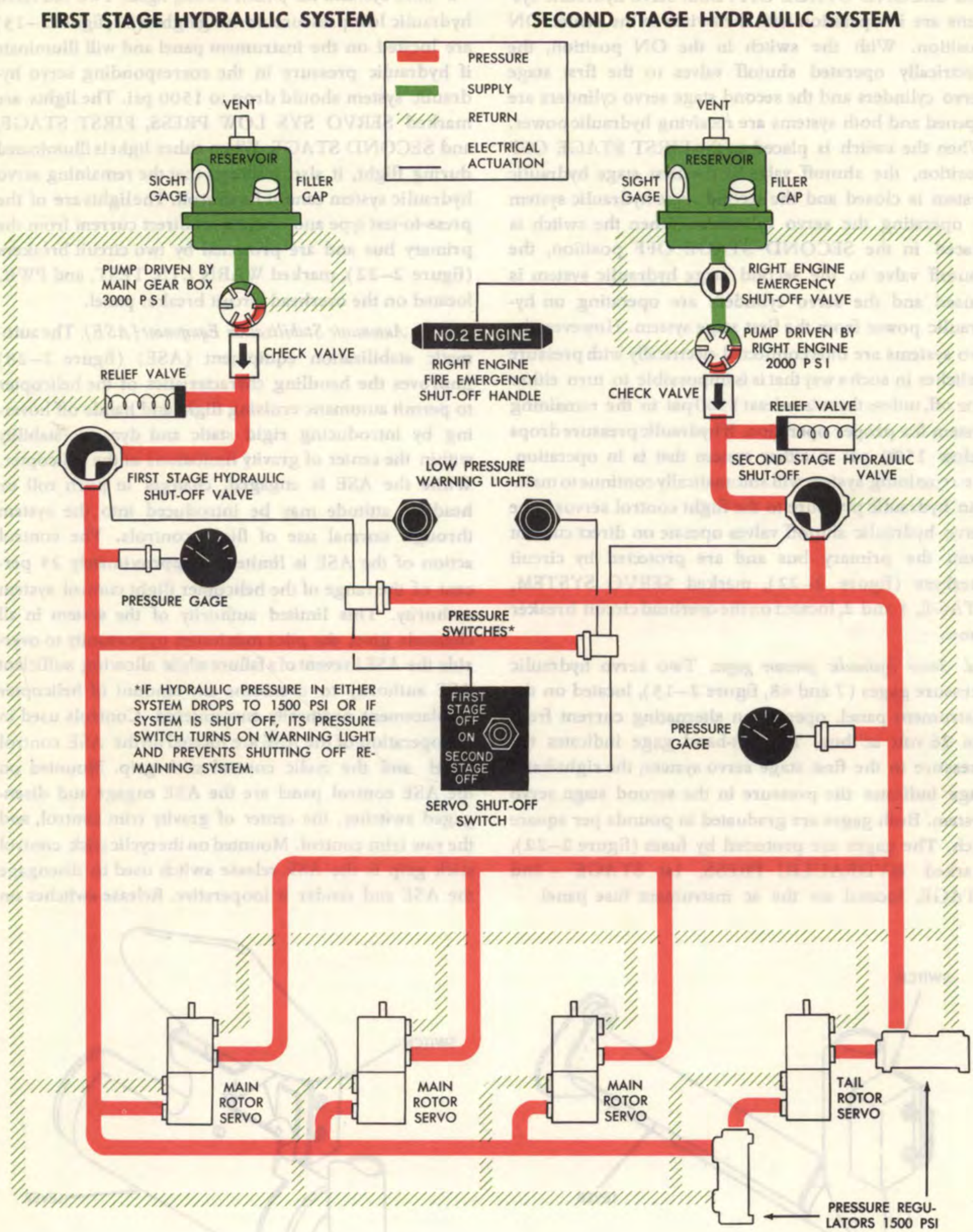


Figure 2—27. Flight control servo hydraulic system

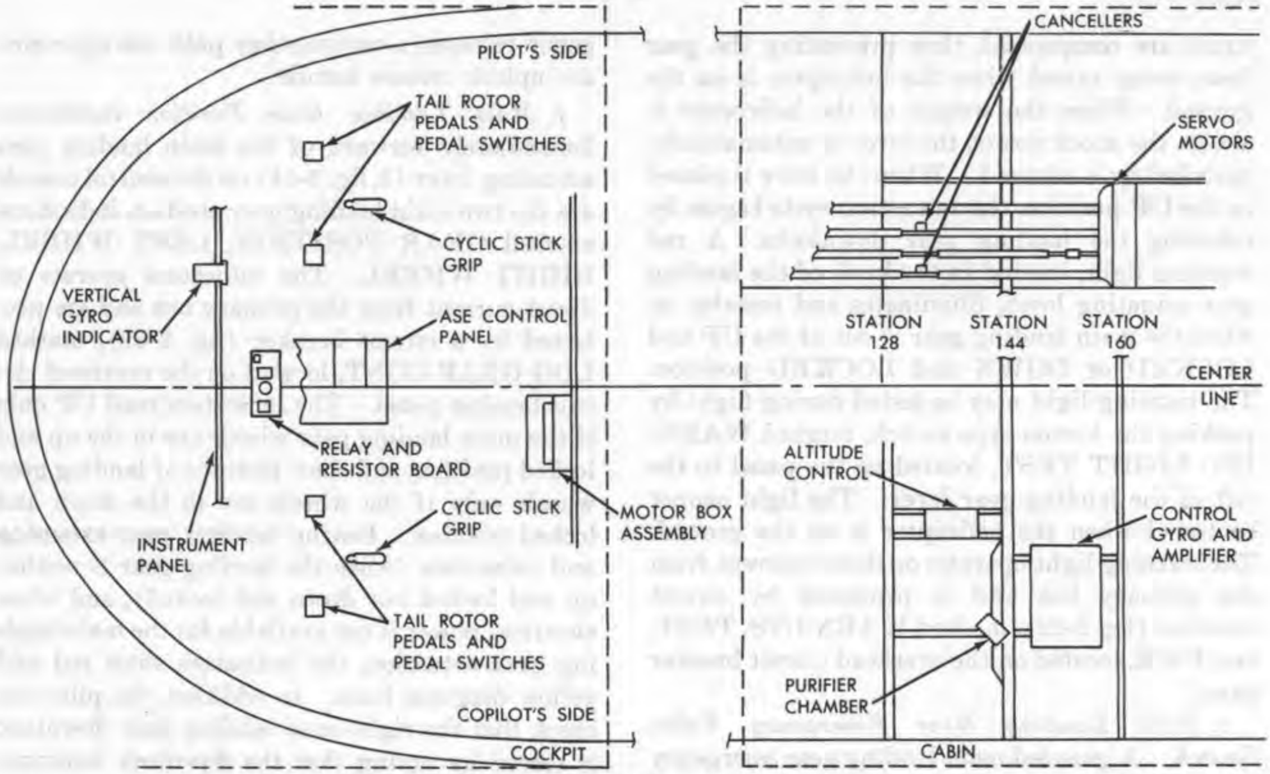


Figure 2–28. Automatic stabilization equipment components location

the tail rotor pedals render the yaw channel inoperative while the switches are depressed.

2–68. Fixed Stabilizer. A fixed stabilizer (36, figure 2–2) is attached to the top right-hand side of the pylon at a 10 degree dihedral angle. Truss assemblies to support the stabilizer and reduce vibration are attached between the bottom of the stabilizer and the pylon, and between the inboard end of the stabilizer and the pylon. A small turnbuckle assembly serves to tighten the stabilizer in the fixed position. The fixed stabilizer has a 0 degree leading edge position and is not adjustable.

2–69. Landing Gear System. The landing gear system consists of two retractable main landing gear assemblies and a nonretractable full-swiveling tail wheel.

2–70. Main Landing Gear. The two main landing gears (23, figure 2–2) are located below the engine nacelles and retract rearward and upward into the engine nacelles. The wide tread affords excellent lateral stability for landing and ground handling. The dual main landing gear wheels are equipped with tubeless tires and hydraulic brakes. The main landing gear actuating system retracts and extends the main landing gear with power from the utility hydraulic system.

a. Main landing gear actuating system. The main landing gear actuating system operates on 3000 psi hydraulic pressure, obtained from the utility hydraulic system, to raise or lower the main landing gear. Electrical power is supplied from the primary bus through a circuit breaker (figure 2–22), marked LDG GEAR CONT, located on the overhead circuit breaker panel. The main landing gear actuating lever electrically controls the retraction and extension of the landing gear by energizing an actuating hydraulic valve. Microswitches in the system open and close the circuit to the gear position indicators on the control console and deenergize the actuating valve when a cycle has been completed. The time required for the extension or retraction of the main landing gear is approximately 11 seconds. When the helicopter is on the ground, the primary bus is energized when the bus control switch is in the SEC BUS OVERRIDE position. An emergency actuating system permits the landing gear to be lowered using an emergency hydraulic system.

b. Main landing gear actuating lever. The main landing gear actuating lever (3, figure 2–14), which controls the retraction and extension of the main landing gear, is located on the forward section of the control console marked LDG GEAR CONTROL. The lever, with a knob shaped like a miniature wheel, is pushed forward to the UP position to raise the gear and pulled aft to the DN position to extend the gear. The lever is locked in the DN position when the landing gear oleo shock struts are compressed, thus preventing the gear from being raised when the helicopter is on the ground. When the weight of the helicopter is not on the shock struts, the lever is automatically unlocked by a solenoid. When the lever is placed in the UP position, the retraction cycle begins by releasing the landing gear downlocks. A red warning light, located in the knob of the landing gear actuating lever, illuminates and remains on when the main landing gear is out of the UP and LOCKED or DOWN and LOCKED position. The warning light may be tested during flight by pushing the button-type switch, marked WARNING LIGHT TEST, located on the panel to the left of the landing gear lever. The light cannot be tested when the helicopter is on the ground. The warning light operates on direct current from the primary bus and is protected by circuit breakers (fig. 2-22), marked WARN LTS, TEST, and PWR, located on the overhead circuit breaker panel.

c. Main Landing Gear Emergency Valve Switch. A guarded main landing gear emergency valve switch (11, fig. 2-10) that is marked LG EMER and has three positions, ON, OFF, and RESET, is provided at the left of the copilot's seat to energize the emergency valve, which will bypass the landing gear actuating hydraulic valve in case it should jam in the UP position during flight and prevent lowering the landing gear. The circuit operates on direct current from the primary bus through the two circuit breakers (fig. 2-22), marked WARN LTS, TEST, and PWR, located on the overhead circuit breaker panel. (For further description, refer to para 2-61.)

d. Landing Gear Emergency Valve Warning Light. A red landing gear emergency valve warning light (61, fig. 2-13) marked LDG. GEAR EMER. VALVE IN USE, located on the bottom left side of the instrument panel, illuminates when the landing gear emergency valve switch is ON.

e. Uplock Emergency Release. A right and a left landing gear manually operated uplock emergency release permits lowering of the landing gear in case of a malfunction of the uplock mechanism. The two T-shaped release handles are located on the upper right and left sides of the cabin walls aft of the rear wing beam. To operate the emergency releases, a crewmember pulls the appropriate uplock release handle.

f. Main Landing Gear Position Indicators. Immediately forward of the main landing gear actuating lever (3, fig. 2-14) on the control console are the two main landing gear position indicators, marked GEAR POSITION, LEFT WHEEL, RIGHT WHEEL. The indicators operate on direct current from the primary bus and are protected by a circuit breaker (fig. 2-22), marked LDG GEAR CONT, located on the overhead circuit breaker panel. The indicators read UP only if the main landing gear wheels are in the up and locked position, and show pictures of landing gear wheels only if the wheels are in the down and locked position. During landing, gear extension and retraction (when the landing gear is neither up and locked nor down and locked), and when electrical power is not available for the main landing gear actuation, the indicators show red and yellow diagonal lines. In addition, the pilot can check that the right-hand landing gear downlock is seated by noting that the downlock indicator pin, located just above the folding joint at the midpoint of the right landing gear drag strut, is extended and pointing inboard. The left-hand downlock indicator pin is not visible to the copilot because it extends outboard from the drag strut. The crew chief can check that the right-hand landing gear downlock is seated by looking through a cabin window, and noting that the downlock pin, located just below the folding joint at the mid point of the right-hand landing gear drag strut is seated in the upper fitting of the lower drag link. The left-hand landing gear downlock pin is not visible from this point.

2-71. Tail Wheel

a. The nonretractible tail wheel (31, fig. 2-2) is located in the conventional position underneath the aft section of the fuselage. The tail wheel is full-swiveling and self-centering. The tail wheel may be mechanically locked to prevent the aft end of the fuselage from swinging around under windy conditions on the ground.

b. The tail wheel lock lever (11, fig. 2-9) that controls the tail wheel centering lock operates in a quadrant, located on the ceiling to the left of the overhead switch panel. The quadrant is marked TAIL WHEEL, with the positions, LOCK and UNLOCK. Pushing the lever forward to the UNLOCK position pulls the lockpin from the tail wheel swivel joint and permits the tail wheel to swivel through 360 degrees. Pulling the lever aft to the LOCK position slackens the control cable and permits the spring-loaded lockpin to engage after the tail wheel is centered. As the lockpin engages, a small tail wheel lock flag indicator (red), marked TAIL WHEEL LOCKED, protrudes from the bottom of the fuselage forward of the tail wheel. The lever must be pushed to the left to clear detents at each position. After placing the lever in the LOCK position, taxi slowly until the tail wheel is centered and locked to avoid shearing the lockpin by rapid swiveling of the tail wheel.

2-72. Brake System

The main landing gear wheels are equipped with hydraulic power brakes which are

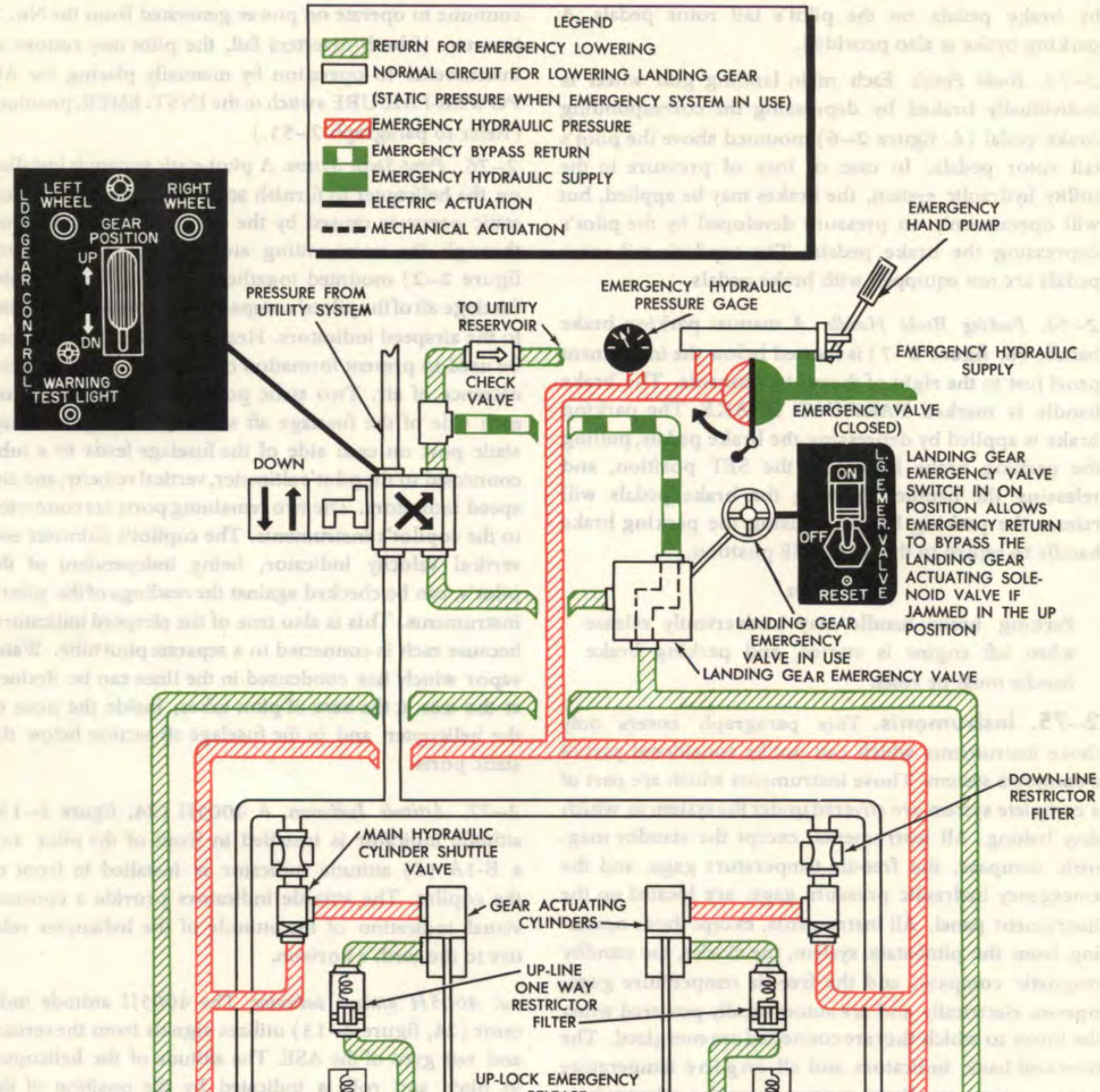


Figure 2–29. Landing gear emergency hydraulic diagram

connected to the utility hydraulic system and operated by brake pedals on the pilot's tail rotor pedals. A parking brake is also provided.

2–73. Brake Pedals. Each main landing gear wheel is individually braked by depressing the corresponding brake pedal (6, figure 2–6) mounted above the pilot's tail rotor pedals. In case of loss of pressure in the utility hydraulic system, the brakes may be applied, but will operate only on pressure developed by the pilot's depressing the brake pedals. The copilot's tail rotor pedals are not equipped with brake pedals.

2–74. Parking Brake Handle. A manual parking brake handle (6, figure 2–7) is located below the instrument panel just to the right of the control console. The brake handle is marked PARKING BRAKE. The parking brake is applied by depressing the brake pedals, pulling the parking brake handle to the SET position, and releasing the handle. Pressing the brake pedals will release the parking brakes, causing the parking brake handle to return to the RELEASE position.

Caution

Parking brake handle may inadvertently release when left engine is started, and parking brake handle must be reset.

2–75. Instruments. This paragraph covers only those instruments which can not be considered part of a complete system. Those instruments which are part of a complete system are covered under the system to which they belong. All instruments, except the standby magnetic compass, the free-air temperature gage, and the emergency hydraulic pressure gage, are located on the instrument panel. All instruments, except those operating from the pitot-static system, the clocks, the standby magnetic compass, and the free-air temperature gage, operate electrically and are automatically powered when the buses to which they are connected are energized. The turn-and-bank indicators and all engine temperature gages operate on direct current from the primary bus. These instruments are protected by circuit breakers (figure 2–22) located on the overhead circuit breaker panel. All pressure gages and all gyro instruments, except the turn-and-bank indicator, operate on alternating current and are protected by fuses (figure 2–22) on the ac instrument fuse panel in front of the copilot. The J-2 compass system operates on both direct current from the primary bus and alternating current from the 115 volt ac bus. Should a generator fail, all flight instruments will continue to operate. Should both generators fail, all flight instruments will continue to operate on battery power if the battery switch is turned on. Should the No. 1 inverter fail, the ac instrument will continue to operate on power generated from the No. 2 inverter. If both inverters fail, the pilot may restore ac instruments to operation by manually placing the AC POWER-FAILURE switch to the INST. EMER. position. (Refer to paragraph 2–55.)

2–76. Pitot-Static System. A pitot-static system is installed on the helicopter to furnish accurate values of the pitot-static pressure caused by the motions of the helicopter through the surrounding air. Two pitot tubes (20, figure 2–2) mounted together on the right side of the fuselage aft of the pilots' compartment are each connected to the airspeed indicators. Heaters in the pitot tubes can be used to prevent formation of ice which would restrict entrance of air. Two static ports (30) are mounted on each side of the fuselage aft section. Tubing from one static port on each side of the fuselage leads to a tube connected to the pilot's altimeter, vertical velocity, and airspeed indicators. The two remaining ports are connected to the copilot's instruments. The copilot's altimeter and vertical velocity indicator, being independent of the pilot's, can be checked against the readings of the pilot's instruments. This is also true of the airspeed indicators, because each is connected to a separate pitot tube. Water vapor which has condensed in the lines can be drained at the tees at the base of pitot tubes, inside the nose of the helicopter and in the fuselage aft section below the static ports.

2–77. Attitude Indicators. A 4005H (24, figure 2–13) attitude indicator is installed in front of the pilot and a B-1A (4) attitude indicator is installed in front of the copilot. The attitude indicators provide a constant visual indication of the attitude of the helicopter relative to the earth's horizon.

a. 4005H attitude indicator. The 4005H attitude indicator (24, figure 2–13) utilizes signals from the vertical and rate gyro of the ASE. The attitude of the helicopter in pitch and roll is indicated by the position of the attitude bar with respect to the white horizon line. When the pitch of the helicopter exceeds a 45 degree nose-high attitude, the word CLIMB appears on the light-grey part of the sphere within the indicator, and when the pitch exceeds a 45 degree nose-down attitude, the word DIVE appears on the black part of the sphere. A trim pitch knob at the lower right corner of the instrument has a single dot, indicating whether the helicopter is in level flight, a right bank, or left bank attitude. A roll trim knob, at the upper right corner of the instrument, has a roll reference scale to show both right and left roll. A pointer attached to the gyro indicates the angle of bank. With the inverter switch in either the NORM or INST. EMER position, placing the battery switch in the ON position will energize the gyros. Approximately 3 minutes are required for the gyros to come up to erection for accurate readings. There is no manual caging device. When power is turned off the gyro gimbal is supported, and when power is applied the gyro gimbal is released. The 4005H attitude indicator operates on 115 volt alternating current and 28 volt direct current from the primary bus. The direct current circuit is protected by a circuit breaker (figure 2–22), marked ASE, located on the overhead circuit breaker panel. The alternating current circuit from the 115 volt ac bus is protected by a fuse (figure 2–22), marked VERT. GYRO, located on the ac instrument panel. A flag alarm, marked OFF, is visible through the cover of the indicator when power is cut off. When power is applied the flag remains visible for 3 minutes. When the flag is no longer visible, the indicator is ready for operation. The flag alarm will appear in case of a complete ac or dc power failure. However, a slight reduction in ac or dc power or failure of certain electrical components within the system will not cause the flag alarm to appear, even though the system is not functioning properly.

Note

Since the 4005H attitude indicator operates in conjunction with the ASE installation, the ASE system is also ready for operation when the flag alarm is no longer visible.

b. B-1A attitude indicator. The attitude of the helicopter in pitch and roll is indicated by the position of an attitude bar with respect to a horizon bar on the B-1A indicator (4, figure 2–13). When the pitch of the helicopter exceeds a 27 degree nose-high attitude, the word CLIMB appears on the lower part of the sphere within the indicator; and when the pitch exceeds a 27-degree nose-down attitude, the word DIVE appears on the upper part of the sphere. A pitch trim knob at the lower right corner of the instrument positions the horizon bar. The top of the instrument has a bank reference scale to show both right and left bank, and a pointer attached to the gyro indicates the angle of bank. With the inverter switch in either the MAIN or SPARE position, placing the battery switch in the ON position will energize the gyros. Ten minutes are required for the gyros to come up to erection for accurate indications. There is no manual caging device. When power is turned off the gyro gimbal is supported and when power is applied the gimbal is released. The B-1A attitude indicator operates on 115 volt alternating current and 28 volt direct current received simultaneously. The indicator operates on direct current from the primary bus protected by a circuit breaker (figure 2–22), marked B1A PWR, located on the overhead circuit breaker panel, and on alternating current from the 115 volt ac bus protected by a fuse (figure 2–22) marked VERT GYRO, located on the ac instrument fuse panel. A flag-alarm, marked OFF, is visible through the cover of the indicator when power is cut off and remains visible for 2 minutes after power is applied. The flag-alarm will appear in case of a complete ac or dc power failure. However, a slight reduction in ac or dc power, or failure of certain electrical components within the system will not cause the flag alarm to appear, even though the system is not functioning properly.

Warning

It is possible that a malfunction of the attitude indicator might be determined only by checking it with gyro magnetic compass and turn-and-bank indicator.

During all known instrument flight conditions and night flights, where no visible ground reference exists, a hazardous condition exists as a result of B-1A attitude indicator failure when ac power is lost on main inverter. When switching to spare inverter, flag on both horizons drops and stays down for more than 1 minute. Bar horizon deflects 5 bar widths downward giving unreliable pitch indication. If a bank is assumed at this time, horizon bar will follow attitude of helicopter and indicate a level condition while helicopter is in a bank. If instrument conditions are inadvertently encountered, monitor all flight instruments closely and establish a systemized cross-check of all flight instruments and inverter failure warning light to determine proper operation of B-1A attitude indicator. If a malfunction of B-1A attitude indicator is suspected when flying under instrument conditions, disregard indications of attitude indicator.

Note

A 60 second time delay relay in ac-dc interlock relay circuitry will prevent interruption of dc power to the B-1A system when switching inverters. Momentary interruption of ac power will cause flag-alarm to appear; however, uninterrupted flow of dc power prohibits automatic caging of the gyros and thereby prevents 2 minute reset time delay from taking place.

Warning

A slight amount of pitch error in indication of type B-1A attitude indicator will result from accelerations or decelerations. It will appear as a slight climb indication after a forward acceleration and as a slight dive indication after deceleration when helicopter is flying straight and level. This error will be most noticeable at time helicopter breaks ground during takeoff run. At this time, a climb indication error of about 1.5 bar widths will normally be noticed, however, exact amount of error will depend upon acceleration and elapsed time of each individual takeoff. Erection system will automatically remove the error after the acceleration ceases.

2–78. *Turn-and-Bank Indicators.* Two identical turn-and-bank indicators (34 and 57, figure 2–13) are installed on the instrument panel. The angle of bank is indicated by the pointer of an electrically driven turn indicator in the instrument. Stability of the turn indicator gyro resists the motion of the helicopter and keeps the pointer vertical with respect to the horizon. As the helicopter is banked, the angle of bank is indicated by the pointer against the scale of the instrument. An inclinometer, consisting of a curved glass tube containing a black glass ball and a damping fluid is mounted on the face of the instrument. The ball moves according to the resultant gravitational and centrifugal forces acting upon it. A coordinated turn is indicated by the ball when it remains centered in the tube during a turn. If the ball is not in the center of the tube during a turn, a slip or skid is indicated. The gyros operate on direct current from the primary bus and are protected by circuit breakers (figure 2–22), marked TURN & SLIP, PILOT and COPILOT, located on the overhead circuit breaker panel.

2–79. *Vertical Velocity Indicators.* Two vertical velocity indicators (35 and 56, figure 2–13) are located on the instrument panel and indicate the rate of ascent or descent in feet-per-minute up to 6000 feet-per-minute. The vertical velocity indicators are connected to the same static lines as the altimeters and the airspeed indicators.

2–80. *J-2 Gyro-Magnetic Compass System.* The J-2 gyro-magnetic compass system provides stabilized compass indications by combining the advantages of the remote indicating magnetic compass with the gyro compass. The oscillations of the magnetic compass and the drift error of the directional gyro are eliminated when operating as a gyro-magnetic compass and an accurate stabilized magnetic heading is indicated. In magnetically unreliable regions, such as encountered in high latitudes, the gyro may be unslaved from the compass system to act as a free directional gyro. The system consists of a magnetic flux valve located in the tail cone, a directional gyro and amplifier located in the nose of the helicopter, and a compass indicator located on the instrument panel in front of the pilot. The system operates on direct current from the primary bus and alternating current from the 115 volt ac bus. An interlock relay assures that both ac and dc reach the system at the same time. The ac relay which is part of the interlock relay is operated on alternating current from the 115 volt ac bus and is protected by two fuses (figure 2–22), marked COMPASS, located on the ac instrument fuse panel on the instrument panel. The dc relay which is part of the interlock relay and the inverter starter relay are operated on direct current from the primary bus and are protected by either one of the INV CONT circuit breakers (figure 2–22), marked 1 and 2, depending upon the position of the inverter switch. If the No. 1 inverter fails, causing the No. 1 inverter control circuit breaker to open, an automatic switchover to No. 2 inverter will prevent loss of the J-2 compass system.

Note

If circuit breaker fails to open, the J-2 compass system will continue to operate due to the automatic switchover. If the automatic switchover fails, then the pilot must manually place the inverter switch in the INST. EMER. position.

a. Gyro-magnetic compass indicator. The Model C-6H gyro-magnetic compass indicator (22, figure 2–13) is located on the instrument panel in front of the pilot. The adjustable dial is graduated in 5 degree increments from 0 to 360. The dial and pointer together may be set with respect to eight triangular markers fixed at 45 degree intervals around the indicator bezel. Heading synchronization is controlled by a push-to-set knob in the lower right corner of the indicator. Heading selection is controlled by a SET HDG knob in the lower left corner of the indicator. Turning the knob clockwise or counterclockwise drives a selector pointer against the dial and also rotates the heading selector transmitter synchro in the indicator. This pointer can also be used as a heading reminder. The VOR-ADF selector knob in the upper left corner of the indicator provides visual indication of whether ADF or VOR heading information is appearing on the No. 1 pointer. A failure warning flag is located at the lower right corner of the indicator.

b. Compass slaving switch. A compass slaving switch (21, figure 2–13) is located at the left of the compass indicator. The switch marked J-2 COMPASS, has two marked positions: FREE D. G. and COMPASS CONTROL. When the switch is placed in the COMPASS CONTROL position, the directional gyro is electrically slaved to the remote compass transmitter and the indicator pointer gives a gyro-stabilized magnetic heading. When the switch is placed in the FREE D. G. position, the C-6H indicator functions as a free directional gyro.

2–81. *Directional Indicator.* An ID 250/ARN directional indicator (5, figure 2–13) is installed on the instrument panel in front of the copilot. The indicator consists of a circular scale calibrated in 2 degree increments from 0 to 360 degrees, a fixed index, a double-barred pointer, numbered 2, and a single-barred pointer, numbered 1. The circular scale, coupled to the compass, rotates in the face of the instrument and indicates the magnetic head of the helicopter on the scale underneath the fixed index at the top of the indicator. The single-barred pointer, numbered 1, indicates navigational bearing on the circular scale. The double-barred pointer, numbered 2, indicates the bearing received from the automatic direction finder equipment.

2–82. *Standby Magnetic Compass.* A standby magnetic compass (9, figure 2–9) is located at the top of the windshield on the centerline of the helicopter. A compass correction card and a radio frequency card are attached to the standby magnetic compass mounting bracket. The standby magnetic compass light may be turned on or off, as desired, with the standby magnetic compass light switch (7) at the right of the compass when the flight instrument lights are on.

2–83. *Performance Indicator System.* The performance indicator system assists the pilot in obtaining efficient performance from the helicopter. This is accomplished by measuring the vibratory loads imposed on the stationary star, which are influenced by varying conditions of rpm, gross weight, altitude, temperature, load factor, airspeed, and fuselage attitude. These loads are a direct indication of the onset of blade stall or the degree of blade stall encountered during flight. The system utilizes a transducer enclosed within the piston of the right lateral main rotor servo. For a given load change on the piston rod the transducer modulates a carrier signal to an amplitude proportional to the piston deflection. The modulated carrier signal is fed through an electronic circuit to the indicator. The performance indicator system operates on current from the 115 volt ac bus and is protected by a fuse, marked PERFORMANCE INDICATOR, located on the ac instrument fuse panel.

a. Performance indicator. The performance indicator (23, figure 2–13) is located on the instrument panel in front of the pilot. The performance indicator is calibrated in proportion to the vibratory load level measured by the servo transducer. In addition to indicating the approach of blade stall, the system provides continual information to the pilot, enabling him to obtain efficient performance for various conditions of flight. Short rapid lateral motion of the cyclic stick, at a rate that would not exceed full travel in 1 second, will cause low transient readings on the performance indicator. When the inverter switch is turned on, the indicator needle may momentarily sweep to a maximum reading, finally reading between 0 and 2. This is normal for the instrument and should not be interpreted as a malfunction.

b. Amplifier assembly. The amplifier assembly, located between the radio decks directly aft of the pilot's compartment, consists of a demodulator, filter, attenuator, amplifier, and a voltage regulator. The amplifier assembly transmits power to the performance indicator, giving a visual indication to the pilot. There are four fuses located on the amplifier assembly. The fuse marked LVDT is for the transducer, and the fuse marked LINE, is for the amplifier assembly. A spare fuse is provided for each system. The input voltage to the amplifier assembly is 115 volts ac.

2–84. *Free-air Temperature Gage.* A bimetallic free-air temperature gage (14, figure 2–2) is located in the windshield just below the standby magnetic compass. The gage indicates outside air temperature in degrees centigrade.

2–85. *Clocks.* Two 8 day, 12 hour clocks (33 and 58, figure 2–13) are located on the instrument panel, one in front of the pilot, and one in front of the copilot. Each clock is equipped with a sweep second hand and a totalizer minute hand which may be started, stopped, or reset to zero by successive pushes on a small knob at the upper left of the case. The clocks are wound and set by knobs at the lower right of the cases.

2–86. Emergency Equipment. All emergency equipment, except that considered a part of a complete system, is covered in paragraphs 2–87 through 2–95. Emergency equipment which is a part of a complete system is covered under the system to which it belongs.

2–87. *Engine Fire Detectors.* Two electrically actuated engine fire detectors, one for each engine, are installed to warn the pilot of an engine fire. Three continuous-element fire detector cables are located in each nacelle around the engine accessory shroud, the carburetor air intake, and the oil cooler duct. They are wired into a closed series loop connected to a relay which illuminates a warning light in the pilots' compartment in the event of a fire. The fire detectors operate on direct current from the primary bus and are protected by two circuit breakers (figure 2–22), marked ENG FIRE DET, 1 and 2, located on the overhead circuit breaker panel.

a. Engine fire warning lights. On helicopters serial No. 54-993 through 55-618, two red engine fire warning lights, one for each engine, are installed on the instrument panel in front of the pilot. The lights are marked FIRE WARNING, LEFT ENGINE, and RIGHT ENGINE. On helicopters serial No. 55-619 and subsequent, the engine fire warning lights (37, figure 2—13) are marked FIRE DETECTOR WARN, ENG, NO. 1, and NO. 2. Two additional red engine fire warning lights (figure 2—11), one for each engine, are installed in the engine fire emergency shutoff handles located on the overhead switch panel. A light on the instrument panel and a light in one of the engine fire emergency shutoff handles will illuminate in event of a fire in the corresponding engine compartment. The warning lights operate on direct current from the primary bus and are protected by the two circuit breakers (figure 2—22), marked WARN LTS, TEST, and PWR, located on the overhead circuit breaker panel.

b. Fire detector test switches. Two fire detector test switches, located inboard of the engine fire emergency shutoff handles on the overhead switch panel (figure 2—12), are used to test the electrical circuit of the engine fire detectors. The fire detector test switches are marked FIRE TEST, with the marked position ON. The switches are normally in the OFF (up) position. To test the electrical circuit of either engine fire detector, place the spring-loaded switch in the ON (down) position. The corresponding fire warning lights should illuminate. The switch will return to the OFF position when released, and the light will extinguish. The fire detector test switch circuits operate on direct current from the primary bus and are protected by the circuit breakers (figure 2—22), marked ENG FIRE DET, 1 and 2, located on the overhead circuit breaker panel.

2—88. *Engine Fire Emergency Shutoff Handles.* Two T-shaped engine fire emergency shutoff handles are located on the overhead switch panel (figure 2—12) under the general headings, FIRE EMERGENCY WARNING. The handles have the positions ON (full out) and OFF (full in). The handle, marked NO. 1 ENGINE, is for the left engine and the handle, marked NO. 2 ENGINE, is for the right engine. When either handle is pulled out, direct current actuates a valve on the fuel line, a valve on the oil line, and another valve on the hydraulic fluid line; these shutoff valves then cut off fuel, oil, and hydraulic fluid from the engine at the engine compartment fire wall. When either the left or right handle is pulled out, it also electrically preselects either the left or right nacelle discharge valve of the engine fire extinguisher for discharge when the engine fire extinguisher switch is subsequently pushed to ON. The ends of the handles house the engine warning lights. A fire emergency procedure placard, giving procedures to be followed in case of an engine fire, is located on each side of the overhead switch panel. The circuit that actuates the emergency shutoff valves operates on direct current from the primary bus and is protected by circuit breakers (figure 2—22), marked EMER SHUTOFF, 1 and 2, located on the overhead circuit breaker panel.

2—89. *Engine Fire Extinguisher. a.* A liquid bromochloromethane (CB), one-shot engine fire extinguisher, electrically actuated, is installed to enable the pilot to extinguish an engine fire in either nacelle during flight. The liquid is stored under pressure in a spherical engine fire extinguisher container (13, figure 2—30) mounted in the forward left-hand side of the cabin ceiling. Each of two valves on the container contains a disc which is broken by an explosive cartridge. Either cartridge is fired, after it has been preselected by pulling the corresponding engine fire emergency shutoff handle, when the fire extinguisher switch is turned on. The fire extinguisher is discharged by direct current from the primary bus and is protected by a circuit breaker (figure 2—22), marked FIRE EXT, located on the overhead circuit breaker panel. Tubing extends from one valve to the left engine compartment and from the other valve to the right engine compartment. Within each engine compartment, the tubing divides into perforated distribution lines which extends along both sides of the engine, over the engine accessory section and duct, and over the oil cooler. The extinguishing liquid, when released through the perforations, turns to vapor which smothers the fire. The spherical container is equipped with a pressure gage and a safety valve which will discharge the contents of the sphere overboard out the left side of the helicopter if the pressure of the sphere becomes excessive due to overheating. When the sphere is properly charged, the pressure gage should indicate a value within the range shown on the decal adjacent to the gage.

Warning

Repeated or prolonged exposure to high concentrations of bromochloromethane (CB) or decomposition products should be avoided. CB is a narcotic agent of moderate intensity but of prolonged duration. It is considered less toxic than carbon tetrachloride, methylbromide, or usual products of combustion. It is safer to use than previous fire extinguishing agents. However, normal precautions should be taken including use of oxygen when available.

Caution

CB is a powerful solvent affecting rubber, insulation, lubricants, etc. If fire extinguisher has been discharged, remove empty container and purge all lines and engine compartment with dry compressed air as soon as fire has been extinguished or immediately after landing.

b. Engine fire extinguisher switch. A spring-loaded engine fire extinguisher switch is located on the overhead switch panel (figure 2–12) in the pilots' compartment. The switch is marked FIRE EXTINGUISHER, with the position ON. When the switch is pushed to the ON position, the content of the engine fire extinguisher sphere is discharged into the engine compartment that has been preselected by pulling one of the fire emergency shutoff handles. On helicopters serial No. 55-619 and subsequent, a guarded push-button fire extinguisher switch, marked FIRE EXT, replaces the toggle-type switch. The fire extinguisher switch is inoperative unless either the left or right fire emergency handle has been pulled. If both fire emergency shutoff handles are pulled before the fire extinguisher switch is turned on, the fire extinguisher sphere will discharge into both nacelles, probably in too small a quantity to extinguish a fire in either nacelle.

2–90. *Portable Fire Extinguishers.* Three portable, hand-operated fire extinguishers (1, 5, and 6, figure 4–5), either type A-20 or CF3Br, are installed in the helicopter; one in the cabin section, one aft of the cargo door, and one in the pilots' compartment on the copilot's inboard seat support.

2–91 *Alarm Bell Switch.* A guarded alarm bell switch (3, figure 4–5) is located at the aft end of the pilots' compartment dome light panel. The switch is marked CREW ALARM and is encircled by an orange stripe. Lifting the guard and placing the switch in the ON position rings a bell, located in the cabin ceiling, to alert the occupants of the cabin in case of emergency. When the guard is closed the switch will return to the OFF position. The alarm bell operates on direct current from the battery bus and is protected by a circuit breaker (figure 2–22), marked CREW ALARM, located on the battery bus circuit breaker panel. The alarm bell circuit is operative regardless of the battery switch position.

Note

Alarm bell will be checked before battery is turned on or external power is connected to determine that bell will ring in an emergency when battery switch must be OFF. Alarm bell will be tested after engines are started and before taxiing to determine audibility and acquaint personnel with sound of bell.

2–92. *Magnetic Chip Detector Warning Lights.* (See figure 2–13.) Three red warning lights (62, figure 2–13), one for each engine and one for the main transmission, are installed on the instrument panel in front of the pilot. The lights are marked ENG WARN NO. 1 and NO. 2 and XMSN WARN. The lights operate on direct current from the primary bus and are protected by a circuit breaker (see figure 2–22) marked CHIP DET located on the overhead circuit breaker panel. Their illumination warns the pilot of internal engine and main transmission breakdown.

2–93. *First Aid Kits.* One first aid kit (2, figure 4–5) is mounted on the left side of the cabin aft bulkhead. A second first aid kit (4) is installed in the pilots' compartment above the emergency hydraulic pump at the copilot's left.

2–94. *Emergency Escape Axes.* Two emergency escape "pick axes" (7 and 8, figure 4–5) are provided in the forward and aft sections of the cabin, thereby affording a means of escape in an emergency situation where no exit is accessible.

2–95. *Emergency Exits and Entrances.* (See figure 4–4.) Descriptions of emergency exits and entrances are as follows:

a. Pilots' compartment emergency panels. Two pilots' compartment emergency panels each consisting of the sliding window, the triangular window forward of the sliding window, and window tracks are located on each side of the pilots' compartment. The triangular shaped window on each jettison panel is equipped with a snap vent for ventilation. Each panel, regardless of the position of the sliding window, can be mechanically jettisoned to provide an emergency exit or entrance. The manual emergency release handles inside the pilots' compartment, marked EMERGENCY EXIT, PULL, are located outboard of the instrument panel. When the handle is pulled aft, the panel drops outward and downward. The panels can be released from the outside by pulling down on the handle, marked PULL DOWN, EXIT RELEASE, located below the lower sliding window track.

b. Cabin emergency hatch. The cabin emergency hatch located on the aft side of the fuselage can be released to provide a cabin emergency exit and entrance. The inside emergency manual release handle, marked PULL DOWN, EMERGENCY EXIT, is located at the lower aft corner of the hatch and is indicated by a luminescent marker. To open the emergency hatch, swing the handle down and forward and push the hatch out. A handle, marked TURN, EXIT RELEASE, is also provided to open the emergency hatch from outside the helicopter. Turn the handle clockwise and pull the hatch outward.

c. Nose door emergency panels. Nose door emergency panels, the upper portion of each nose door, can be mechanically jettisoned to provide an emergency exit from the forward end of the cabin. The nose door emergency panel release handles inside the cabin, marked EMERGENCY EXIT, TO JETTISON PULL, are located at the top center of each door. When the manual release handle is pulled outboard, the top of the door falls out. The panel may also be opened from the outside by pulling out on the handle, marked EXIT RELEASE, PULL TO JETTISON, located above the center window of each door.

d. Cargo and Passenger Sliding Doors. The aft cargo sliding door if in forward flight, or both cargo doors if in hover, may be opened to provide additional emergency exits.

e. Cabin Windows. All cabin windows, three on each cabin side panel and the cabin emergency hatch window, may be manually pushed out to provide additional emergency exists. Each of the cabin windows is equipped with a pull tape outside at the lower aft corner, marked PULL TAB EXIT RELEASE, by which the locking strip may be pulled out of the rubber seal surrounding the window pane. The panes may then be removed to provide emergency openings. Because of their small size the cabin windows are not suitable as bail-out hatches; use the emergency exists. The plastic escape hatch window is equipped with a plastic snap vent for ventilation.

2-96. Pilot's, Copilot's, and Flight Engineer's Seats

The pilot's and copilot's seats (13 and 17, fig. 2-6) are located side-by-side in the pilots' compartment with the pilots' compartment access ladder between them. The pilot's seat is on the right. The seats are designed to accommodate back-type parachutes and pararafts. Both seats have a 5-inch range of height adjustment and are equipped with safety belts and shoulder harnesses. The seats are also equipped with seat and back cushions. The flight engineer's seat (fig. 13-10) is one of the single troop seats equipped with a safety belt, either just forward or aft of the cargo door on the right-hand side of the cabin.

2-97. Seat Height Adjustment Levers

Seat height adjustment levers (12 and 16, fig. 2-6), one each located low on the right side of each seat, are pulled up to manually release the seat lockpins. The seat aided by a spring-loaded bungee can then be adjusted for height by varying the weight upon it. The lockpins will automatically engage in any of the six positions when the adjustment lever is released.

2-98. Shoulder Harness Inertia Reel Lock Lever

A manual two-position shoulder harness inertia reel lock lever (15, fig. 2-6 and 8, fig. 2-10) is located below on the left side of each seat. The lever has positions LOCKED (forward) and UNLOCKED (aft). By pressing down on the top of the lever, a latch is mechanically released and the lever may then be moved from one position to the other. When the lever is in the UNLOCKED (aft) position, the shoulder harness cable will extend to allow the occupant to lean forward; however, the cable reel will automatically lock if impact force of 2 or 3 G's in a forward direction is encountered. The cable reel will remain locked until the lever is moved to the LOCKED position and then returned to the UNLOCKED position. When the lever is in the LOCKED (forward) position, the shoulder harness cable is locked so that the occupant is prevented from leaning forward. The LOCKED position is used only when a crash landing or ditching is anticipated to provide an added safety precaution over that of the automatic lock; however, if critical controls cannot be reached, the lever should remain in the UNLOCKED position. When anticipating a crash landing or ditching, and time permitting, locking of the shoulder harness provides an added safety precaution over that of the automatic lock. However, depending on pilot's seat adjustment and cockpit configuration, certain controls and switches may become inaccessible with the harness locked. Each pilot should determine for himself to what extent, in each type aircraft he flies, a locked shoulder harness would interfere with aircraft and system controls.

2-99. Auxiliary Equipment

The following items are covered in chapter 6:

- Heating and ventilating system.
- Pitot heaters
- Ventilating system
- Lighting equipment
- Instrument lights and rheostats
- Auxiliary power system

Cargo loading equipment
Troop carrying equipment
Casualty carrying equipment
Miscellaneous equipment
Main rotor blade folding and unfolding
Pylon folding

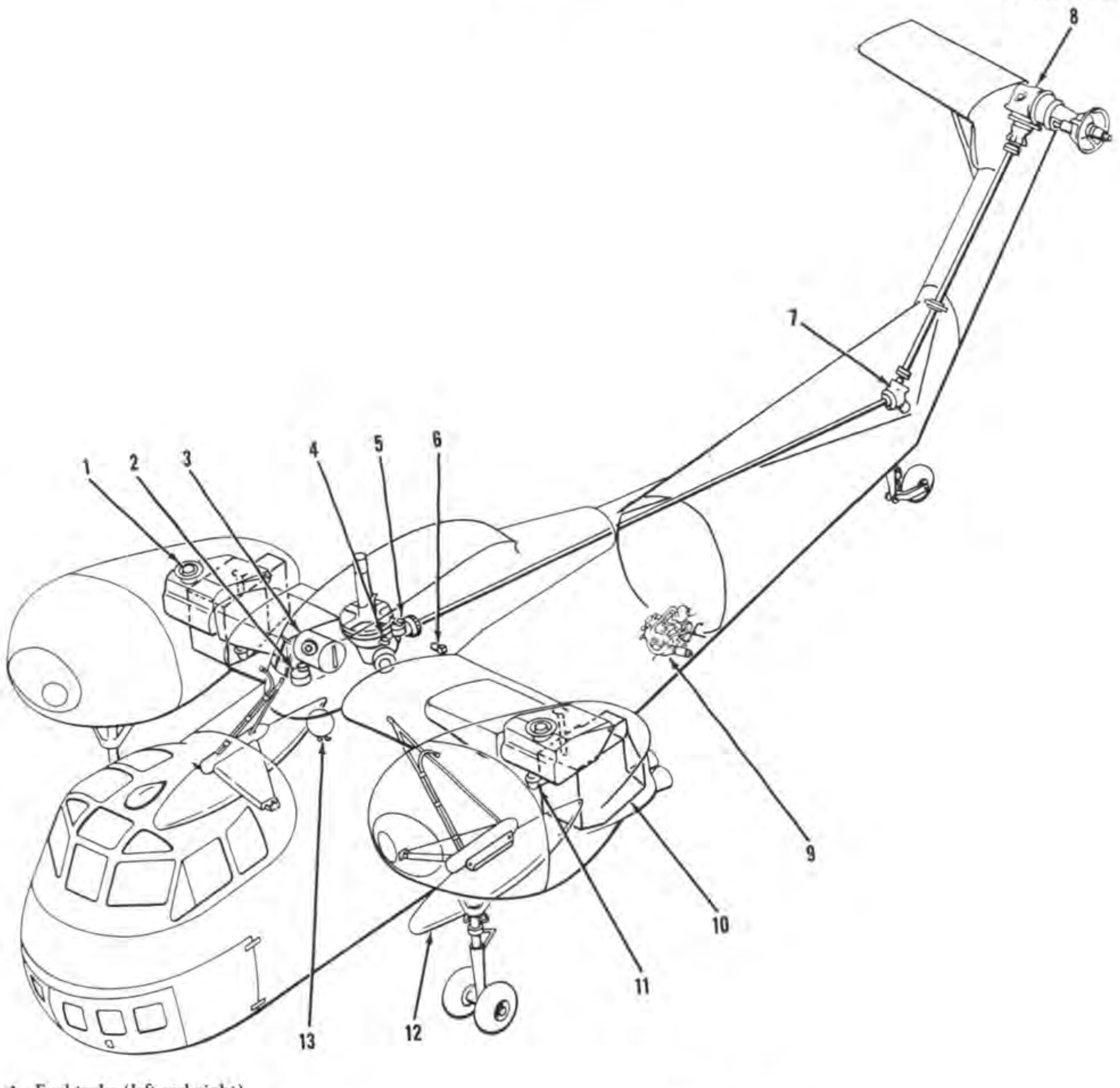
2-100. Destruction of Helicopter

If there is a possibility of the helicopter falling into the hands of the enemy after abandonment, destroy the helicopter sufficiently to deny use or technical intelligence to the enemy. There is no set procedure for destroying the helicopter. One method is as follows:

a. Open fuel drain valves, puncture a fuel cell, or break a fuel line.

b. From a safe distance, ignite fuel.

Note. **Fuel may possibly be ignited from a safe distance by firing flares into dripping fuel.**



1. Fuel tanks (left and right)
2. Second stage servo hydraulic reservoir
3. Utility hydraulic reservoir
4. Main gear box
5. First stage servo hydraulic reservoir
6. Rotor brake accumulator
7. Intermediate gear box
8. Tail gear box
9. Auxiliary power plant
10. Engine oil tanks (left and right)
11. Rotor clutch oil reservoir (left and right)
12. Auxiliary fuel tanks (left and right)
13. Engine fire extinguisher container

Figure 2–30. Servicing diagram

CHAPTER 3
NORMAL PROCEDURES

Section I Scope

3—1. Purpose. This chapter provides the crew with steps of procedure (amplified checklists) which will be employed from the time a flight is planned until the flight is completed and the helicopter is left properly parked and secure.

3—2. Extent of Coverage. This chapter contains in checklist form an envisioned flight, which is of a nontactical nature and considered to be accomplished under normal conditions. The checklists include all steps and precautions necessary to insure safe flight under all conditions (night, instrument, etc.). This chapter also contains the unique "feel" characteristics and the reaction of the helicopter during specific phases of operation, plus the technique to be employed in accomplishing such operations as taxiing, takeoff, climb, etc.

Section II Flight Procedures

3—3. Preparation for Flight. Prior to flight, the pilot should assure that all information in this manual that is applicable to the proposed mission is complied with.

3—4. *Flight Restrictions.* For limitations imposed on the helicopter, refer to Chapter 7.

3—5. *Flight Planning.* The required fuel, airspeed, and power settings for takeoff, climb, cruising, hovering, and landing may be determined by reference to the performance data charts in Chapter 14. Fuel consumption by the heater must be considered since it will reduce the range of the mission. (Refer to Chapter 6.)

3—6. *Takeoff and Landing Data Card.* (See figure 14—1.) The takeoff and landing data card is contained in TM 55-1520-203-10CL. Refer to Chapter 14, Performance Data, for detailed operating information when planning various types of missions that require use of the data cards.

3—7. *Weight and Balance.* With improper loading, it is possible to exceed the cg limits of this helicopter. The takeoff gross weight and balance, and the anticipated landing gross weight and balance should be determined before takeoff and checked against the weight limitations and center-of-gravity limitation. (Refer to Chapter 7.) Reference should be made to Chapter 12 and to DD Form 365F for loading information. A balance computer is stowed on the copilot's inboard seat support.

3—8. *Entrance.* (See figure 3—1.) Entrance is made through the sliding cargo door. A step is installed under the aft door. The cabin may also be entered through the hydraulically operated nose doors if they are open; however, they are used primarily for troop or cargo loading. The pilots' compartment may be entered by means of a pilots' compartment ladder (figure 3—1) located at the forward end of the cabin. The ladder is hinged at its upper end. The pilots' compartment may also be entered from outside the helicopter by climbing up the pilots' compartment access footwells on the right side of the fuselage aft of the nose door and entering through the sliding window.

3—9. Preflight Check. The preflight checks consist of the exterior and interior checks as follows:

3—10. *Before Exterior Check.* For safety reasons and status of the helicopter, the following steps should be accomplished prior to performing the exterior check.

a. DA Form 2408 — CHECK.

b. Ignition switches — OFF.

c. Battery switch — OFF.

d. Fuel shutoff switches — OFF.

3—11. *Exterior Check.* Perform exterior check as follows: (See figure 3—2.)

a. Right rear of fuselage:

(1) Static ports — UNOBSTRUCTED.

(2) Rotor blades — CHECK.

(3) Fuselage skin — CHECK FOR CRACKS AND POPPED RIVETS.

b. Right side of pylon:

(1) Tail wheel tire — CHECK.

Figure 3–1. Entrance to the helicopter

(2) Tail wheel oleo strut – PROPER EXTENSION AND NO LEAKS.

(3) Intermediate gear box and air vent – PROPER OIL LEVEL, VENT FREE, AND SIGHT GAGE FOR CRACKS.

(4) Pylon swivel joint assembly – CHECK.

(5) Pylon – CHECK.

(6) Tail gear box – PROPER OIL LEVEL AND NO LEAKS.

(7) Stabilizer – CHECK FOR SECURITY.

c. Left side of pylon:

(1) Tail rotor head – CHECK.

(2) Tail rotor blades – CHECK.

(3) Tail rotor blades – UNCONED AND PROPER CLEARANCE.

(4) Pylon – CHECK.

(5) Pylon lockpin indicator – RETRACTED AND PYLON LOCKPIN POSITIONED.

(6) Pylon lockpin ratchet handle – SECURED.

(7) Drive shaft lock and arm – DISENGAGED.

(8) Pylon fold valve switch – UNFOLD POSITION, PUMP HANDLE STOWED, ACCESS FAIRING SECURED.

(9) Static ground wire – SECURED.

(10) Deleted.

(11) Radio antennas – VISUALLY CHECK.

d. Left rear of fuselage:

(1) Make same inspection as on right rear.

(2) Heater and APU vents – NO LEAKS.

(3) APU exhaust – CONDITION.

(4) Cabin emergency hatch – SECURED.

e. Main rotor head:

Note

Check rotor head for security of all components. If blades have been folded and unfolded, check that all blade leading edges are up in the proper angle of attack position (no red painted sector is visible at the sleeve assemblies). Check that all sleeve locks are secured and that all blade hinge pins and hinge pin nuts are installed.

(1) First stage reservoir – FULL.

(2) Rotor head assembly – SECURED, BLADES AT PROPER ANGLE.

(3) Antiflap restrainers – CHECK.

(4) Sleeve locks – SECURED.

(5) Bonding wires (blade cuff to rotor head) – SECURED.

(6) Blade hinge pins and nuts – INSTALLED.

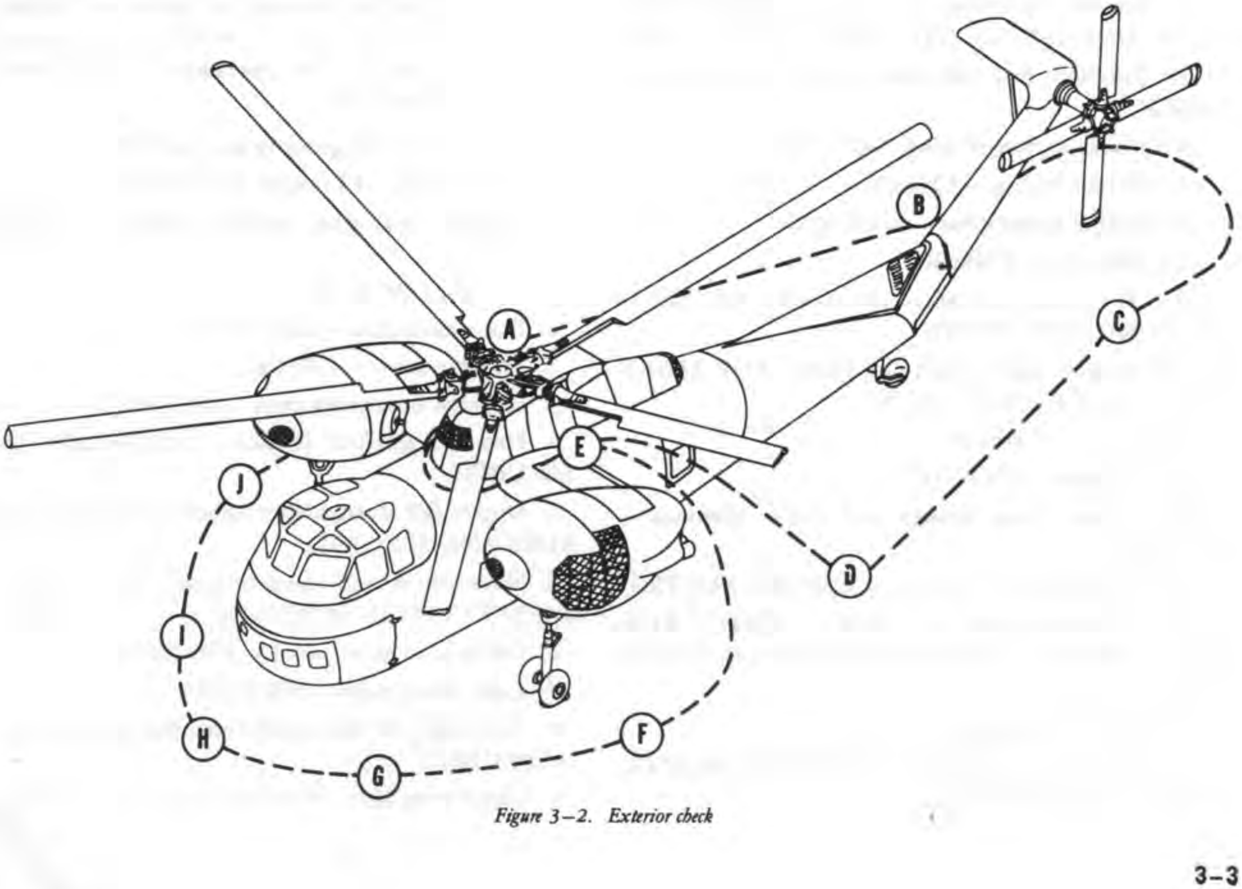


Figure 3–2. Exterior check

(7) Droop stops – IN POSITION.

(8) Left engine fan and clutch housing – CHECK.

(9) Left main fuel tank – CHECK.

(10) Left oil tank – CHECK.

(11) Blade dampers – SECURED, OIL LEVEL, LEAKS.

(12) Second stage and utility reservoirs – FULL.

(13) Upper surface of blades – CHECK.

(14) Main rotor servo units – NO LEAKS.

(15) Pilot valves and boots – SECURED.

Warning

Do not operate the helicopter with damaged or deteriorated servo boots because of the danger of water being trapped around the servo pilot valves causing corrosion or freezing of the flight controls.

(16) Main gear box fairing and housing – SECURED.

(17) Right engine fan and clutch housing – CHECK.

(18) Right main fuel tank – CHECK.

(19) Right oil tank – CHECK.

f. Left wing and nacelle:

(1) Battery vent, fuel drain, hydraulic and oil filler drain – CHECK.

(2) Auxiliary fuel tanks and supports – SECURED, VENT UNOBSTRUCTED, CHECK QUANTITY.

(3) Auxiliary fuel tank safety lockpin and cable – CHECK.

(4) Under surface of wing – CHECK.

(5) Nacelle fairing – CHECK.

(6) Engine access door – SECURED.

(7) Diffusers – CHECK.

(8) Oil cooling air intake and exhausts – SECURED AND UNOBSTRUCTED.

(9) Landing gear system – CHECK FOR LEAKS AND LOOSE CONNECTIONS.

(10) Tires – CHECK.

(11) Chocks – IN PLACE.

(12) Cargo sling fittings and radio antennas – SECURED.

(13) Induction air intake – UNOBSTRUCTED.

(14) Understructure and ground – CHECK FOR SIGNS OF OIL, FUEL, OR HYDRAULIC FLUID LEAKS.

g. Left front of fuselage:

(1) Fuselage – CHECK FOR POPPED RIVETS, CRACKS, AND BUCKLES.

(2) Ramp – UP AND LOCKED.

(3) Copilot's window – SECURED, HANDLE IN HORIZONTAL POSITION.

(4) Rotor blades – CHECK.

h. Nose section:

(1) Covers removed, windshields clean – CHECK.

(2) Landing lights – CHECK.

i. Right front of fuselage:

(1) Make same inspections as on left front of fuselage (in reverse).

(2) Pitot tubes – COVERS REMOVED, SECURED, AND FREE OF OBSTRUCTIONS.

j. Right wing and nacelle:

(1) Make same inspection as on the left side (in reverse).

(2) External power receptacle – CHECK.

(3) Right heater vent and exhaust – UNOBSTRUCTED.

(4) Cargo door and step – SECURED.

(5) Inspection light in cargo compartment – OFF.

3–12. Interior Check (All Flights). Perform interior checks as follows:

Note

The fuel system check may be accomplished at this time after performing the following: Battery switch – ON, APU – START, and inverter switch – MAIN. For operation of APU, refer to paragraph 6–40.

a. Nose door emergency exits – SECURED.

b. Nose doors – CLOSED AND LOCKED.

c. Throttle twist-grip indicator tubing – CHECK FOR KINKS.

d. Ramp – LOCKED.

e. Ramp extension – SECURED.

f. Throttle servo – CHECK.

g. Forward emergency exits – SECURED.

h. Fire extinguisher (hand) – CHARGED AND SECURED.

i. Engine fire extinguisher sphere – CHECK PRESSURE AND SECURED.

j. Nose doors and ramp hydraulic bypass valves – SAFETY CLIPS IN POSITION.

k. Cabin floor access door – SECURED.

l. Cabin floor hatch – SECURED.

m. Auxiliary fuel tank jettison handles and safety lines – SECURED.

n. Cargo sling line – STOWED AND SECURED.

o. Troop seats, litters, cargo, etc. – SECURED.

p. Main transmission area – CHECK PROPER OIL LEVEL, EXCESSIVE LEAKS,

q. Oil cooler fan belts – VISUAL CHECK.

r. Winterization kit – SECURED.

(1) Directing plenum under main gear box – SECURED.

(2) Gear box preheat registers – CLOSED.

s. Battery bus circuit breakers – CHECK.

t. Cargo hoist winch (when installed) – LOCKED.

u. Aft emergency exits – SECURED.

v. Hanger bearing support brackets – CHECK FOR CRACKS.

w. Inner race of hanger bearings – CHECK SLIPPAGE MARKS.

x. Hydraulic lines – CHECK FOR LEAKS.

y. APU – SECURED AND NO LEAKS.

z. First aid kit – SEALED AND SECURED.

aa. Tail section – FREE OF EQUIPMENT

ab. Access door – CLOSED AND SECURED.

ac. Fire extinguisher (hand) – CHARGED AND SECURED.

3–13. Interior Check (Night Flights). Prior to planning a night flight, the following items shall be checked:

a. Flashlights – AVAILABLE.

b. All interior lights – CHECK.

c. All exterior lights – CHECK.

3–14. Before Starting Engines. Procedures to be accomplished before starting engines are as follows:

a. Seat height adjustment lever and tail rotor pedal adjustment knob – ADJUST.

b. Parking brake handle – SET.

c. Safety belts – SECURE.

d. Shoulder harness – ADJUST.

e. Shoulder harness inertia reel lock lever – CHECK. Test operation of shoulder harness in both the LOCKED (forward) and UNLOCKED (aft) positions.

f. Radio equipment (rear of cockpit) – CHECK FOR SECURITY.

g. Overhead circuit breakers – CHECK.

h. Switches on overhead switch panel – OFF. Except:

(1) Cyclic stick trim master switch – ON.

(2) Fuel crossfeed switch – CLOSED.

(3) Engine fire emergency shutoff handles – OFF (FULL IN).

Note

Visually check engine fire emergency shutoff valves for proper operation and position.

(4) Bus control switch – NORM.

(5) Voltmeter selector switch – PRI.

(6) Cargo sling switch – SAFE.

i. Tail wheel lock lever – LOCKED.

j. Mixture levers – IDLE CUTOFF.

k. Quadrant throttles – CLOSED.

l. Carburetor air levers – COLD.

m. Rotor brake lever – AS DESIRED.

n. Free-air temperature gage and magnetic compass – CHECK.

o. Radio circuit breakers – CHECK.

p. Radio switches – OFF.

q. Nose door lock handle – LOCKED.

r. Fuel shutoff switches – OFF.

s. Main landing gear actuating lever – DN.

t. Twist-grip throttle – ROTATE THROUGH FULL TRAVEL.

u. Twist-grip throttle position indicator – 40 to 60 DEGREES.

v. Quadrant throttles – CLOSED AND LOCKED.

w. Landing light switch – OFF.

x. Twist-grip throttle friction nut – ADJUST.

y. Collective pitch lever lock – ON.

z. Copilot's window – CHECK FOR SECURITY.

aa. First aid kit – SEALED AND SECURED.

ab. Landing gear emergency hydraulic valve handle – OPEN AND SAFETIED.

ac. Landing gear emergency valve switch – GUARD DOWN AND SAFETIED.

ad. Emergency hydraulic pump lever and pressure gage – CHECK.

ae. Copilot's instruments – CHECK RANGE MARKINGS AND SLIPPAGE MARKS.

af. Servo switches – ON.

ag. Engine instruments – CHECK RANGE MARKINGS AND SLIPPAGE MARKS.

ah. Inverter switch – OFF.

ai. Tail rotor blade coning switch – FLT POSIT.

Note

Check that circuit breaker, marked LDG GEAR CONT, is set. If circuit breaker is out, secondary bus is inoperative, tail rotor blades cannot be unconed, and warning light, marked BLADES CONED, will not illuminate.

aj. Pilot's instruments – CHECK RANGE MARKINGS AND SLIPPAGE MARKS.

ak. Compass slaving switch – COMPASS CONTROL.

al. Pilot's window – CHECK FOR SECURITY.

am. Alarm bell switch – ON.

Note

To start APU, battery switch must be ON. If APU is not available, have external power connected.

an. Battery switch – ON (IF APU IS USED); OFF (IF EXTERNAL POWER IS USED).

ao. Warning lights on overhead switch panel – CHECK.

(1) Ramp up and locked warning light – PRESS-TO-TEST.

(2) Heater overheat warning light – PRESS-TO-TEST.

(3) Auxiliary fuel tank release warning light – PRESS-TO-TEST.

(4) Auxiliary fuel tank no transfer warning light – PRESS-TO-TEST.

(5) Rotor clutch switch warning lights – PRESS-TO-TEST.

(6) All lights – CHECK OPERATION.

Note

When auxiliary fuel tanks are installed, auxiliary fuel tank pump switches must be turned ON to test press-to-test NO TRANSFER warning lights. If warning lights illuminate and stay illuminated, it indicates a malfunction or that main fuel tanks have been filled to level of float switches.

ap. Engine fire detector system – CHECK.

(1) Fire test switches – ON.

(2) Engine fire emergency shutoff handle warning lights – ILLUMINATED.

(3) Engine fire warning lights (instrument panel) – ILLUMINATED.

aq. Radio master switch – ON (AFTER APU STARTS).

ar. J-8 attitude gyro (if installed) – CAGED.

as. Inverter switch – NORM.

at. Main landing gear position indicators – WHEELS DOWN.

au. Instruments – CHECK STATIC POSITION. Note manifold pressure gage for field barometric pressure.

av. Radios – PUT ON HEAD SET AND TUNE RADIOS.

3–15. Fuel Pressure Check. a. Fuel shutoff switches – OFF.

b. Fuel booster pump switches – NORM.

c. Fuel pressure gages – NO RISE. Any increase in fuel pressure indicates a leaking fuel shutoff valve.

d. Fuel shutoff switches – ON.

e. Fuel pressure gages – CHECK FOR A SUDDEN RISE.

f. Engine fire emergency shutoff handles – ON (FULL OUT).

g. Fuel booster pump switches – EMER.

h. Fuel pressure gages – NO RISE.

i. Engine fire emergency shutoff handles – OFF (FULL IN).

j. Fuel pressure gages – CHECK FOR A SUDDEN RISE TO 17 TO 25 PSI.

k. Fuel booster pump switches – OFF. Check fuel pressure gages. A drop in fuel pressure when pumps are turned off indicates a leaking check valve or mixture control valve. A slow drop is normal due to bleed holes in check valve. When a fuel pressure drop is encountered, place fuel shutoff switch in the OFF position. If the pressure drop ceases, it indicates a normal check valve. If pressure drop continues unabated, it indicates a leaking check valve or a leaking shutoff valve.

l. Fuel shutoff switches – OFF.

m. Mixture levers – NORMAL.

n. Fuel pressure gages – CHECK FOR A DROP OF 8 TO 10 PSI. A drop in pressure to near zero psi indicates a sticking fuel feed valve.

Note

To conduct this step, fuel pressure must be above fuel feed valve setting of 8 to 10 psi.

3–16. Fuel Crossfeed Check. a. Mixture levers – IDLE CUTOFF.

b. Fuel shutoff switches – ON.

c. Crossfeed switch – OPEN.

d. Left fuel booster pump switch – NORM.

e. Fuel pressure gages – CHECK FOR EQUAL FUEL PRESSURE.

f. Right fuel booster pump switch – EMER.

g. Fuel pressure gages – CHECK FOR RISE AND EQUAL FUEL PRESSURE.

h. Fuel booster pump switches – OFF.

i. Crossfeed switch – CLOSED.

3–17. Starting Engines. Start the left engine first. The left engine drives the utility hydraulic system pump which supplies hydraulic pressure for the operation of the nose doors and ramp.

Note

For procedure to be followed in event of fire, refer to Chapter 4.

3–18. Starting Procedure. The procedures to be accomplished in starting the engines are as follows:

a. Fire guard – POSTED.

b. Quadrant throttle – FULLY CLOSED and LOCKED.

Note

Throttle limit switch on engine control quadrant renders starter inoperative unless throttle is in FULLY CLOSED and LOCKED position. LOCKED position permits throttle movement up to approximately 1600 to 1700 engine rpm.

c. Fuel shutoff switch – ON.

d. Fuel booster pump switch – NORM.

e. Starter switch – DEPRESS. Check for hydraulic lock.

Caution

Fire guard should signal pilot if any signs of starter hesitation or overspeeding (clutch slipping) occur. Should starter hesitation or overspeeding occur, disengage starter and place both booster pump switch and fuel shutoff switch in OFF position. Do not attempt a restart until cause has been determined and eliminated.

f. Ignition switch – BOTH. After at least 10 seconds of cranking for cold engine, or 5 seconds of cranking if engine has been operated within last hour.

g. Primer switch – DEPRESS. Prime with short rapid pulses if engine is warm, and longer sustained pulses if the engine is cold.

Caution

Continuous direct cranking should not exceed 30 seconds. If engine does not start after 30 seconds, allow at least 1 minute for the starter to cool. A maximum of three consecutive attempts are allowed.

Note

Do not pump quadrant throttle as it frequently causes backfiring which may result in damage to induction system or an engine fire.

Pumping throttle will also disengage starter circuit.

h. Mixture lever – IDLE CUTOFF. Prime as required until engine is started and operates smoothly on prime at 1000 engine rpm, then slowly move mixture lever to RICH. Discontinue priming when engine rpm begins to drop.

Caution

If priming is discontinued before carburetor is metering normally, excessive leanness may cause backfiring and serious damage to engine. Backfiring and rapid acceleration or deceleration should be avoided at all times. Their effect on this engine installation is particularly serious with rotor clutch disengaged and without benefits of loading usually provided by rotor.

If, for any reason, engine should stop, immediately move mixture lever to IDLE CUTOFF and continue to operate starter and primer until engine starts.

If engine should stop, do not release throttle lock when opening quadrant throttle to clear the engine without first placing ignition switch in OFF position; serious overspeeding and destruction of engine could result if engine should fire and start to run.

If a start is not accomplished in a reasonable time, an investigation should be made to ascertain cause.

i. Engine oil pressure gage – CHECK.

Caution

If oil pressure does not register on gage almost immediately, stop engine and investigate.

j. Utility hydraulic pressure gage – CHECK.

k. Carburetor air lever – CLIMATIC.

(1) Normal conditions – COLD.

(2) Icing conditions – HOT (carburetor air temperature 20° to 30°C).

(3) Dust conditions – FILTER.

l. Quadrant throttle – 1000 ENGINE RPM.

m. Mixture lever – NORMAL.

n. Ignition switch check – ACCOMPLISH AT 1000 ENGINE RPM. Move ignition switch from BOTH to L to BOTH, and then from BOTH to R to BOTH. A slight drop in rpm when operating on L or R magnetos indicates proper connection of ignition leads.

Turn ignition switch to OFF, momentarily, and note that engine ceases to fire completely.

Caution

Perform ignition switch check as rapidly as possible to prevent severe backfire when switch is turned to BOTH.

Ground operation with clutches disengaged should be held to a minimum; during engine operation with relatively light loading, tendency toward spark plug fouling increases greatly.

Prolonged ground operation with clutches disengaged is not recommended; however, when necessary, engine speed should be held to between 1500 and 1600 engine rpm to minimize the possibility of clutches overheating. For additional limitations on ground operation due to clutch overheating, refer to Chapter 7.

When prolonged ground operation of engine at high rpm is anticipated, it is suggested that rotor brake be released and rotors allowed to rotate as a result of normal seal and bearing friction. This is to minimize leakage of freewheel oil into clutch oil.

o. Fuel booster pump switch – OFF.

p. Engine-driven fuel pump – CHECK FUEL PRESSURE OF 21 TO 23 PSI.

q. Right engine – START. Follow the same procedure for starting right engine with exception of checking utility hydraulic pressure.

3–19. Starting Procedure Using Battery. If neither external nor APU electrical power is available, use the normal starting procedure to start the left engine. Power will be supplied by the battery. After starting the left engine, start the right engine on electrical power developed by the left generator by proceeding as follows:

a. Left generator switch – ON.

b. Left quadrant throttle – 1200 TO 1500 ENGINE RPM. Do not exceed 100 psi engine oil pressure. At 1200 to 1500 engine rpm, left generator will be supplying sufficient current to primary bus to start right engine.

Note

A rise in engine oil temperature and cylinder head temperature should be noted before increasing left quadrant throttle to 1500 engine rpm.

3–20. Rotor Clutch Engagement. Procedures for rotor clutch engagement are as follows:

a. Collective pitch lever – MINIMUM PITCH AND LOCKED.

b. Quadrant throttles – 2000 ENGINE RPM (MOMENTARILY), THEN 1500 ENGINE RPM. Disengage throttle locks before advancing throttles. Throttles should be advanced slowly and engine oil pressure gages should be monitored to insure that maximum allowable oil pressure is not exceeded. Minimum oil temperature is 40°C.

c. Tail rotor – CHECK VISUALLY.

d. Blades coned warning light – EXTINGUISHED.

e. Signals – COORDINATE WITH GROUND CREWMEMBER.

Warning

Check that area is clear of personnel and obstructions for proper rotor clearances.

f. Rotor brake lever – OFF (UP).

Note

Rotor clutch switches are inoperative until pylon is locked in unfolded position, tail rotor blades are in flight position, and rotor brake is off.

g. Fuel booster pump switches – EMER.

h. Mixture levers – RICH.

i. Quadrant throttles – MAINTAIN 1500 ENGINE RPM.

j. Rotor clutch switches – ON.

k. Rotor clutch switch warning lights – ILLUMINATED.

Note

Clutch pumps should not be energized continuously for more than 60 seconds. If clutch pumps are energized for 60 seconds, allow 20 to 30 minutes cooling time before reenergizing.

l. Quadrant throttles – 1800 TO 2000 ENGINE RPM. Advance slowly and maintain engine rpm by increasing both throttles until transmission system accelerates to 100 rotor rpm (rotor tachometer pointer will indicate approximately 1400 rpm on engine scale).

m. Cyclic stick – CHECK RESPONSE. During clutch engagement, as rotor speed accelerates to approximately 50 rpm, actuate cyclic stick a slight amount in all directions and check for proper response by observing tip-path plane of main rotor.

Warning

If flight controls do not respond correctly, do not complete clutch engagement. Shut down by placing rotor clutch switches in OFF position. This condition may be due to ice formation within flight control servo unit boots (if boot is deteriorated and allows moisture to enter) rendering servo pilot valves inoperative.

n. Left rotor clutch – ENGAGE AT 100 ROTOR RPM (1400 RPM ON ENGINE SCALE). Engage left clutch by backing off on left quadrant throttle to allow rpm of left engine to drop below corresponding rotor rpm (engine tachometer pointer will drop below rotor tachometer pointer). To complete mechanical engagement, advance left quadrant throttle to line up left engine and rotor tachometer pointers. Simultaneously, with advance of left quadrant throttle, retard right quadrant throttle to prevent overspeeding of right engine; direct mechanical drive of left engine will take over most of transmission system load.

o. Rotor clutch switches – OFF.

p. Rotor clutch warning lights – EXTINGUISHED. Check circuit breakers.

q. Right rotor clutch – ENGAGE AT 100 ROTOR RPM (1400 RPM ON ENGINE SCALE). Right quadrant throttle should be retarded a sufficient amount to allow rpm of right engine to drop below corresponding rotor rpm and then slowly advanced to complete mechanical engagement of right clutch.

Note

Engine power should be held high enough to hold rotor speed above 80 rpm (1120 on engine tachometer scale) or mechanical couplings of clutches will not engage.

If desired, above procedure can be reversed by engaging right clutch first and then left.

r. Quadrant throttles – 2000 ENGINE RPM.

s. Manifold pressure gages – EQUALIZE.

t. First stage servo pressure gage – CHECK.

u. Low-pressure warning light – EXTINGUISHED.

v. Transmission oil pressure gage – CHECK.

w. Low-pressure warning light – EXTINGUISHED.

3–21. Engine Ground Operation. Procedures for engine ground operation are as follows:

a. Quadrant throttles – 1200 to 1500 ENGINE RPM. Advance slowly for warmup. Engine rpm should be advanced slowly enough to prevent engine oil pressure from exceeding 100 psi. Before increasing engine rpm, check engine oil temperature and cylinder head temperature for a slight rise.

b. APU – OFF. Flight engineer will turn off APU when notified by pilot.

c. Voltmeter – CHECK FOR DECREASE IN VOLTAGE.

Note

Disconnect external power if used for starting, and place battery switch – ON.

d. Generator switches – ON.

e. Voltmeter – CHECK. Rotate voltmeter selector switch through all four positions to check that voltage is equal from both generators and that both primary and secondary buses are energized. Voltages should be approximately 28.5 volts in all four positions.

f. Auxiliary fuel pump – CHECK FOR PROPER OPERATION.

g. Fuel booster pump switches – CHECK.

(1) Fuel booster pump switches – OFF.

(2) Fuel pressure gages – CHECK FOR PRESSURE IN NORMAL RANGE.

(3) Fuel booster pump switches – NORM.

(4) Fuel pressure gages – CHECK FOR PRESSURE IN NORMAL RANGE. An increase or decrease of 1 psi or a stabilization of pressure may be experienced. Any of these conditions is normal.

(5) Fuel booster pump switches – EMER.

(6) Fuel pressure gages – CHECK FOR AN INCREASE WHICH MAY EXCEED THE NORMAL RANGE.

(7) Fuel booster pump switches – OFF.

h. Engine fire detector system – CHECK.

(1) Fire test switches – ON.

(2) Engine fire emergency shutoff handles warning light – ILLUMINATED.

(3) Engine fire warning lights (instrument panel) – ILLUMINATED.

i. Quadrant throttles – 1500 ENGINE RPM. Continue warmup until oil temperature rises to a minimum of 40°C.

j. Mixture levers – RICH. Note rpm drop; return mixture levers to NORMAL.

k. Carburetor air lever – CHECK OPERATION. Move to HOT, FILTER, and COLD.

l. Copilot's instruments – CHECK AND SET.

m. Fuel quantity gage test switches – CHECK. Push switches to test fuel quantity indicating system for proper operation.

n. Second stage servo hydraulic system – CHECK.

(1) Second stage servo hydraulic pressure gage – CHECK, PRESSURE SHOULD BE WITHIN NORMAL OPERATING RANGE AT 1500 ENGINE RPM.

(2) Servo shutoff switch – SECOND STAGE OFF.

(3) Second stage servo hydraulic pressure gage – CHECK, NO DECREASE IN PRESSURE. Pressure

switch in inoperative first stage servo system should prevent second stage servo system from being shut off.

Note

To accomplish this check, pressure should not exceed 1500 psi in the first stage servo system.

o. Servo switch – ON.

p. Performance indicator – CHECK. Short rapid lateral motion of cyclic stick, at a rate that would not exceed full travel in 1 second, will cause low transient readings on performance indicator.

q. Throttle servo and pedal damper switch – OFF, CHECK, ON. Slowly check full travel of tail rotor pedals, then return switch to ON.

r. Engine instruments – CHECK FOR PROPER INDICATIONS.

s. Inverters – CHECK.

(1) Inverter switch – NORM.

(2) Instrument inverter warning light – EXTINGUISHED.

(3) Inverter switch – OFF.

(4) Instrument inverter warning light – ILLUMINATED.

(5) Inverter switch – INST. EMER.

(6) Instrument inverter warning light – EXTINGUISHED.

(7) Inverter switch – NORM.

(8) Instrument inverter warning light – EXTINGUISHED.

t. Pilot's instruments – CHECK AND SET.

u. Cyclic stick trim system – CHECK.

(1) Cyclic stick – CENTERED.

(2) Cyclic stick trim master switch (on overhead switch panel) – ON. Check for resistance to movement of cyclic stick in all directions. Resistance should increase as displacement of stick is increased.

(3) Cyclic stick – CENTERED. Depress cyclic stick trim release switch. No resistance should be felt to movement of cyclic stick in any direction.

(4) Cyclic stick trim release switch – DEPRESS. Depress switch and move cyclic stick to full left position. Release switch. Stick should remain in position.

(5) Cyclic stick – CHECK. Move to full opposite position. Check that resistance to movement of stick increases as displacement increases. Return stick to starting (full left) position.

Caution

It is permissible to move cyclic stick from one extreme position to another extreme position with stick trim system operating, but cyclic stick trim release switch must not be depressed under these conditions. Trimming cyclic stick in one extreme position and then moving cyclic stick to opposite extreme position causes maximum extension of force on gradient spring. When cyclic stick trim release switch is depressed, spring tension is released. Force created by releasing spring at maximum extension may cause damage to flight control system.

Note

Perform check outlined in steps (4) and (5) starting with cyclic stick in each of following positions: FULL RIGHT, FULL FORWARD, FULL AFT.

(6) Cyclic stick trim release switch – DEPRESS. Depress switch and move stick to center position. Release switch.

3–22. Automatic Stabilization Equipment {ASE} Check. For an operational check of the (ASE) equipment, the following procedures are to be performed:

a. Channel selector – LOCKED IN PITCH POSITION.

b. Override check switch – CENTER POSITION.

Warning

Do not operate OVERRIDE CHECK switch in flight, since this introduces simultaneous hard over signals in all channels, whether or not ASE is engaged. Results of using this switch are quite severe and should not be demonstrated.

c. All channel disengage switches – ON.

d. CG trim – CENTERED.

e. ASE ENG button – DEPRESS. Allow 2-1/2 minutes warmup time after power is on. If light does not stay on, wait an additional 1/2 minute and depress ENG button again.

f. Channel selector switch – PITCH. Check pitch channel by moving cyclic stick fore and aft, and noting that null indicator needle moves to left when cyclic stick is moved forward, and to right when cyclic stick is moved aft.

g. Channel selector switch – ROLL. Check roll channel by moving cyclic stick laterally, and noting that null indicator needle follows movement of cyclic stick.

h. Channel selector switch – YAW. Remove feet from tail rotor pedals and rotate YAW TRIM knob in either direction. Tail rotor pedals should jump slightly.

Warning

The YAW TRIM knob should be moved only a very small amount as excessive movement will cause a violent reaction in tail rotor system and possible damage to it.

i. CHANNEL SELECTOR switch – PITCH.

(1) Pilot's cyclic stick – DISPLACE.

(2) Automatic stabilization release switch – PRESS. Reengage ASE, and press AUTO STAB RELEASE on copilot's stick.

(3) ASE ENG switch – PRESS.

(4) STANDBY switch – PRESS.

(5) Rotate channel selector through ALT-ROLL-YAW channels (null indicator should remain centered) and return to PITCH.

3–23. *Nose Door and Ramp Check.* If the nose doors and ramp are to be used, perform the following checks for proper operation:

Warning

Before operating ramp and nose doors, check that area is clear of personnel and be sure that ground below ramp is level and free from obstructions that would damage ramp. Check that troop seats, litter straps, and cargo tie-down straps are disconnected from ramp floor.

a. Quadrant throttles – 1500 ENGINE RPM.

b. Pilots' compartment ladder – FOLDED.

c. Nose door manual catch – UNLOCKED.

d. Nose door lock lever – UNLOCKED.

e. Nose door switch – OPEN.

f. Ramp switch – DOWN.

Note

Steps *e* and *f* can be accomplished simultaneously due to sequence switches in system.

g. Ramp switch – UP, THEN OFF (AFTER RAMP UP AND LOCKED INDICATOR LIGHT IS ON). Ramp locks checked for locked position.

h. Nose door switch – CLOSE.

i. Nose door lock lever – LOCKED.

j. Nose door manual catch – LOCKED.

k. Nose door switch – OFF.

l. Pilots' compartment ladder – UNFOLD.

3–24. *Ground Tests.* The procedures to be accomplished during ground tests are as follows:

a. Cyclic stick trim master switch – OFF.

b. Collective pitch lever lock – OFF.

c. Servos – CHECK.

(1) Servo shutoff switch – FIRST STAGE OFF.

(2) First stage servo hydraulic pressure gage – CHECK. First stage servo hydraulic pressure gage should indicate a pressure drop.

(3) First stage servo hydraulic warning light – ILLUMINATED.

(4) Second stage servo hydraulic system – CHECK. Check flight controls for proper operation.

(5) Servo shutoff switch – ON. Check first stage servo hydraulic pressure gage for use to normal operating range.

(6) Servo shutoff switch – SECOND STAGE OFF.

(7) Second stage servo hydraulic pressure gage – CHECK. Second stage servo hydraulic pressure gage should indicate a pressure drop.

(8) Second stage servo hydraulic pressure warning light – ILLUMINATED.

(9) First stage hydraulic servo system – CHECK. Check flight controls for proper operation.

(10) Servo shutoff switch – ON.

(11) Servo hydraulic pressure gages – CHECK. Both servo hydraulic pressure gages should indicate normal pressure.

(12) Servo hydraulic pressure warning light – EXTINGUISHED.

(13) Throttle servo and pedal damper switch – OFF. Do not apply pressure on tail rotor pedals.

(14) Twist-grip throttle – CHECK THAT RESISTANCE TO ROTATION CAN BE OVERCOME.

(15) Throttle servo and pedal damper switch – ON.

Caution

To prevent inadvertent overspeeding of engine, remove hand from twist-grip throttle prior to placing throttle servo and pedal damper switch in ON position.

d. All servo switches – ON.

e. Cyclic stick trim master switch – ON.

f. ASE ENG button – DEPRESS. ASE possesses ample authority to compensate main rotor torque during takeoff and landings.

Caution

If any erratic behavior in control system is encountered when ASE is engaged, press AUTO STAB RELEASE button on cyclic stick grip.

Note

Any tendency for tail rotor pedals to creep should have corrected itself by this time, whether ASE is engaged or not.

3–25. Before Taxiing. The following steps should be completed prior to taxiing:

a. Crew and passengers – IN ASSIGNED POSITIONS.

b. Chocks – REMOVED.

c. Parking brakes – LOCKED.

d. Flight controls – CHECKED in accordance with paragraph 3–24.

e. Ramp and nose doors – SECURE in accordance with paragraph 3–23.

f. Safety belts and shoulder harness – FASTENED.

g. Taxi clearance – RECEIVE taxi clearance from control tower.

h. Area – AREA ALL CLEAR. This should be checked with ground alert crew prior to moving the helicopter.

3–26. Taxiing. Taxiing in congested parking areas should be held to a minimum. For ground clearances and for clearance required to execute a 180 degree taxiing turn, see figure 2–4.

Note

If taxing is not to be performed, accomplish necessary steps in paragraphs 3–24 and 3–25 prior to performing procedures outlined in paragraphs 3–28 and 3–29.

ASE will hold a steady heading while taxiing if feet are removed from tail rotor pedals; however, ability of ASE to hold a heading will depend on rotor rpm, wind velocity, and runway conditions. A tendency to overshoot while taxiing does not indicate malfunctioning and can be easily suppressed by foot pressure on tail rotor pedal switches.

Caution

During taxiing, copilot will monitor quadrant throttles.

Avoid taxiing in vicinity of other aircraft during engine runup; their prop wash will cause excessive blade flapping and may upset helicopter; also to preclude damage to other aircraft.

Maintain a minimum of 2400 to 2600 engine rpm while taxiing; thus an immediate takeoff can be accomplished if a crosswind should tilt helicopter.

Hold cyclic stick slightly into wind when taxiing crosswind.

Avoid taxiing rearward whenever possible; visibility is limited and damage to tail rotor may result.

a. Flight engineer's report – CLEAR TO TAXI.

(1) Ramp – RETRACTED.

(2) Nose doors – LOCKED.

(3) Cargo sling hook – STOWED.

(4) Chocks – REMOVED.

(5) Cabin door – CLOSED.

b. Tail wheel lock lever – AS DESIRED.

c. Parking brake handle – RELEASE.

d. Quadrant throttles – 2400 TO 2600 ENGINE RPM. Equalize manifold pressures. If further power changes are required after synchronizing engines, control both engines simultaneously with twist-grip throttle.

e. Flight controls – COORDINATE TO TAXI. Move cyclic stick forward. Slightly increase collective pitch lever and hold when forward motion is obtained.

Caution

Use minimum collective pitch required for forward motion. This should be enough to prevent main rotor blades from hitting droop stops, but not enough to extend landing oleo struts.

Regulate taxi speed with fore-and-aft movements of cyclic stick. Maintain directional control by use of tail rotor pedals and, if necessary, wheel brakes.

f. Wheel brakes – CHECK. As soon as taxiing has been initiated, lightly apply wheel brakes to determine if they are operating properly.

g. Compass and directional indicators – CHECK. Observe that indicators register in taxi turns.

h. Tail wheel lock lever – LOCKED. Before stopping, place lever in the LOCKED position and taxi in a straight line for a sufficient distance to straighten out tail wheel and permit lockpin to drop in place.

i. Stop helicopter.

(1) Cyclic stick – CENTERED.

(2) Wheel brakes – APPLY.

3–27. Crosswind Effect. When taxiing crosswind, the helicopter will have a tendency to weathercock into the wind. This condition is the result of the wind striking the tail cone and pylon, and can be corrected with proper application of tail rotor pedals and wheel brakes. The cyclic stick should be held into the wind to prevent excessive coning of the main rotor blades which would create a tendency for the helicopter to tip over during strong winds.

Warning

Concentration of carbon monoxide gas may increase rapidly in the flight compartment when hovering with engine exhaust to windward.

3–28. Engine Runup. Perform the following steps:

a. Parking brake handle – SET.

b. Carburetor air levers – CLIMATIC.

(1) Normal conditions – COLD or FILTER.

(2) Icing conditions – HOT (CARBURETOR AIR TEMPERATURE 20° to 30°C).

(3) Dust conditions – FILTER.

c. Mixture levers – RICH.

d. Fuel booster pump switches – EMER.

e. Tail wheel lock lever – LOCKED.

f. Engine and transmission temperature and pressure gages – CHECK. All indications should be within the normal operating range.

g. Ignition system (left engine) – CHECK. Accomplish at 2200 engine rpm and manifold pressure equal to field barometric pressure.

(1) Right quadrant throttle – RETARD.

Note

Check operation of freewheel unit of right clutch by noting that right engine rpm drops to 1500 when right quadrant throttle is retarded.

Warning

If engine rpm does not drop to 1500 rpm when throttle is retarded, freewheeling unit is inoperative. Do not attempt takeoff; autorotation, and possibly single engine flight, would be impossible with freewheeling unit of failed engine malfunctioning.

(2) Left quadrant throttle and collective pitch lever – 2200 ENGINE RPM AND A MANIFOLD PRESSURE EQUAL TO THE FIELD BAROMETRIC PRESSURE. Maintain 1500 engine rpm on the right quadrant throttle. Note engine rpm. Place the ignition switch to L, note rpm drop, return to BOTH and allow rpm to stabilize. Move ignition switch to R, note rpm drop. The maximum allowable drop on either L or R magneto is 100 rpm. Difference in drop between L and R should not exceed 40 rpm. There should be no engine roughness.

Caution

Engine roughness, such as that caused by ignition malfunction, is transmitted directly to rotor and causes abnormal vibration in form of twitching or lashing of helicopter structure. It stresses transmission and rotor, and may cause damage or failure of these components.

Warning

If ignition system check is not satisfactory, do not attempt takeoff until condition is remedied.

h. Ignition system (right engine) – CHECK. Accomplish at 2200 engine rpm and manifold pressure equal to field barometric pressure.

(1) Left quadrant throttle – RETARD.

Note

Check operation of freewheeling unit of left clutch by noting that left engine rpm drops to 1500 when left quadrant throttle is retarded.

Warning

If engine rpm does not drop to 1500 when throttle is retarded, freewheeling unit is inoperative. Do not attempt takeoff; autorotation, and possibly single engine flight, would be impossible with freewheeling unit of failed engine malfunctioning.

(2) Right quadrant throttle and collective pitch lever – 2200 ENGINE RPM AND A MANIFOLD PRESSURE EQUAL TO FIELD BAROMETRIC PRESSURE. Maintain 1500 engine rpm on left quadrant throttle. Note engine rpm. Then place ignition switch to L, note rpm drop, return to BOTH and allow rpm to stabilize. Move ignition switch to R, note rpm drop. Maximum allowable drop on either L or R magneto is 100 rpm. Difference in drop between L and R should not exceed 40 rpm. There should be no engine roughness.

Caution

Engine roughness, such as that caused by ignition malfunction, is transmitted directly to the rotor and causes abnormal vibration in form of twitching or lashing of helicopter structure. It stresses transmission and rotor, and may cause damage, or lead to failure of these components.

Warning

If ignition system check is not satisfactory, do not attempt takeoff until condition is remedied.

i. Quadrant throttles – 2400 ENGINE RPM. Equalize manifold pressures of both engines with quadrant throttles while holding twist-grip throttle at approximately a 40 degree position and collective pitch lever at minimum pitch. Accomplish subsequent power changes, using twist-grip throttle.

j. ASE ENG button – DEPRESSED.

3–29. Before Takeoff. The following procedures must be accomplished before takeoff:

Note

Check that crew briefing was accomplished.

a. Cabin heater switch – AS DESIRED.

b. Pitot heater switch – CLIMATIC.

(1) Normal conditions – OFF.

(2) Icing conditions – ON.

c. Anticollision light switch – ON.

Note

Use of anticollision light on ground should be kept to an absolute minimum to avoid excessive heat created on ground which is detrimental to bulb life and increases maintenance problems, and to prevent possible confusion of rescue operations since emergency ground vehicles use a similar light.

Rotating anticollision light should be turned off during flight under actual instrument conditions. With light on during instrument conditions, the pilot could experience vertigo as a result of the rotating reflections of the light against the clouds. In addition, the light would be ineffective as an anticollision light during instrument conditions since it could not be observed by pilots of other aircraft.

d. Tail wheel lock lever – AS DESIRED.

e. Fuel booster pump switches – EMER.

f. Mixture levers – RICH.

g. Twist-grip throttle position indicator – 40 TO 60 DEGREES.

h. Parking brake handle – RELEASED.

i. Manifold pressure gages – EQUALIZE. Use quadrant throttles.

j. Instruments – CHECK READINGS IN THE OPERATING RANGE.

k. Cyclic stick trim master switch – AS DESIRED.

l. Flight controls – CHECK. Free and correct movement.

Caution

Restrict control movements to a small range to prevent lifting or tilting helicopter.

m. Flight engineer's report – RECEIVED AND ACKNOWLEDGED.

3–30. Takeoff. Because of the versatility of helicopters and their ability to take off from small areas, conditions at the time of takeoff will be the governing factors in the type of takeoff to be accomplished. The factors governing the type of takeoff to be accomplished are the gross weight of the helicopter; the density altitude at which takeoff is to be accomplished; and the size and condition of the takeoff area.

Caution

During all phases of flight, copilot will monitor quadrant throttles.

3–31. Normal Takeoff to a Hover. (See figure 3–3.) The normal takeoff to a hover is the most common type of takeoff since it may be used when operating at normal gross weights and at moderate altitudes. Gross weight, altitude, and temperature conditions at which normal takeoff to a hover can be accomplished may be determined by reference to paragraph 14–13. The values not marked with an asterisk in the column headed IAS KN, of the takeoff distances table (table 14–5), show normal takeoff's to a hover, using maximum power. Normal takeoff's to a hover are accomplished in the following manner: Place the collective pitch lever in the minimum pitch position and advance the twist-grip throttle to 2600–2700 engine rpm. Then raise the collective pitch lever steadily until the helicopter becomes airborne. While increasing collective pitch, be sure to hold the helicopter steady with the tail rotor pedals, and level with the cyclic stick until a hover is reached at approximately 10 feet wheel clearance. This type of takeoff provides a high safety factor as the helicopter is lifted vertically from the ground to a hover at approximately 10 feet wheel clearance, and the flight controls and engines may be checked for normal operation before beginning to climb.

Note

ASE will maintain a constant heading within 5 degrees in either direction through a power increase or decrease of 7 inches Hg manifold pressure. Prevent helicopter from swerving by use of tail rotor pedals if ASE is not used. As collective pitch is increased, helicopter will have a tendency to swing to right which should be counteracted by additional pressure on left tail rotor pedal.

Caution

Rapid increase in pitch of main rotor blades may result in excessive torque in main rotor drive. During takeoff, allow a minimum of 2 seconds to move collective pitch lever from low to high pitch.

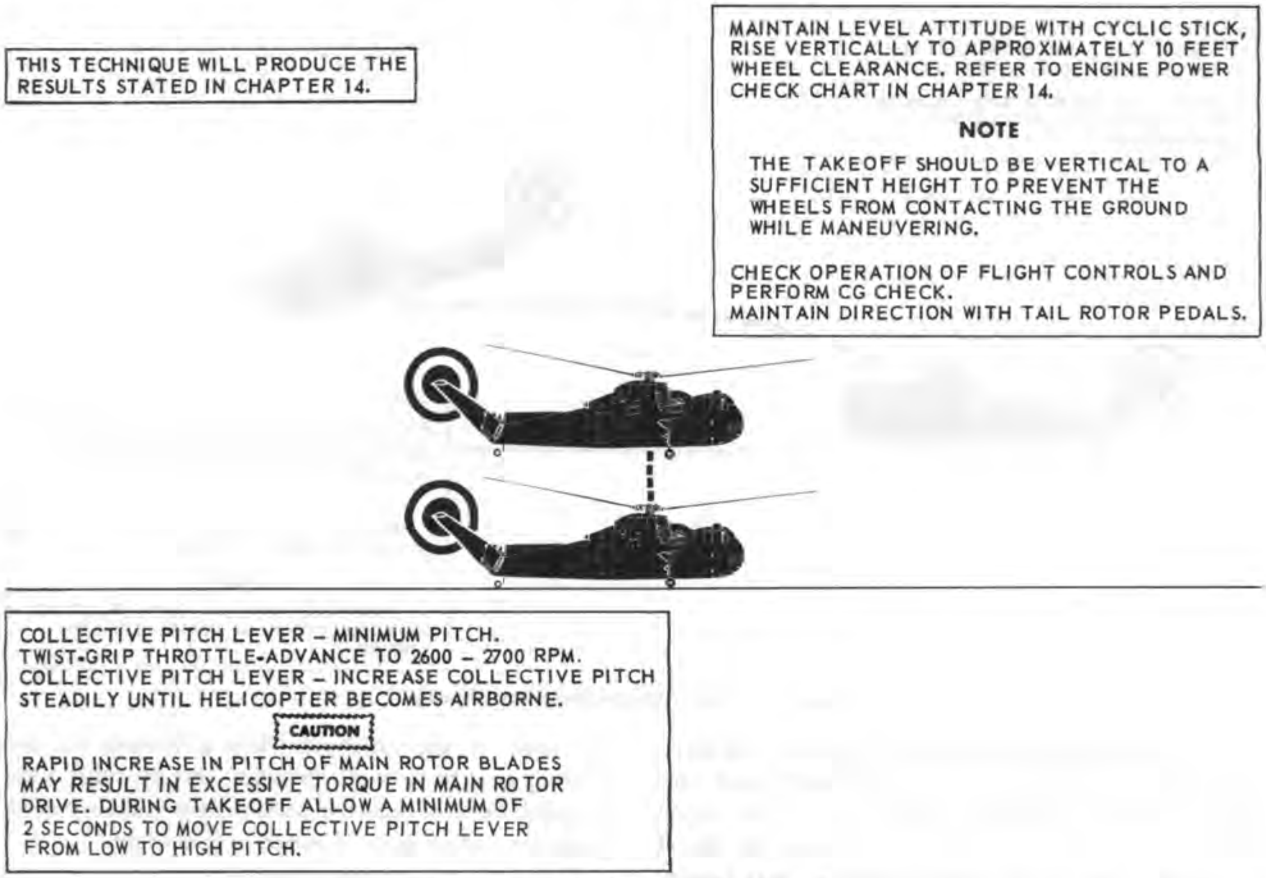


Figure 3–3. Normal takeoff to a hover (typical)

a. Collective pitch lever – MINIMUM PITCH.

b. Twist-grip throttle – 2600 TO 2700 ENGINE RPM.

c. Collective pitch lever – INCREASE.

d. Tail rotor pedals – MAINTAIN HEADING.

e. Cyclic stick – MAINTAIN LEVEL ATTITUDE.

f. While at approximately 10 foot hover:

(1) Flight controls and cg – CHECK.

(a) Establish desired heading.

(b) Adjust CG TRIM knob to approximately center the cg null indicator.

(c) Utilize cyclic stick trim system to remove stick forces. The helicopter should stabilize at the desired attitude without additional cyclic control being applied by the pilot.

(d) Remove feet from tail rotor pedals; no change in heading should occur. Make a definite power change; no appreciable change in heading should occur.

(2) Engine instruments and power – CHECK.

3–32. Normal Takeoff Without Hover. (See figure 3–4.) A normal takeoff without hover can be accomplished in the following manner. Apply sufficient collective pitch to extend the main landing gear oleo struts. With the helicopter light on the main landing gear, apply sufficient collective pitch and forward cyclic stick to pivot off the main landing gear, accelerating into forward flight as the helicopter pivots. Maintain heading with tail rotor pedals. Maintain hovering altitude with collective pitch until effective translational lift has been obtained and the ascent has begun. Then lower the nose, accelerating to 65 knots as soon as possible without placing the helicopter in an excessive nose low attitude.

3–33. Maximum Performance Takeoff. (See figures 3–5 and 3–6.) Maximum performance takeoffs enable the helicopter to take off at a high gross weight or high altitude when hovering performance is marginal. This type of takeoff should be accomplished when the gross weight or altitude makes hovering impossible without the assistance of ground effect. Normal flight above the limits of ground effect can be sustained only by the added lift of forward flight. This is accomplished by rising vertically, but remaining in the ground effect limits and commencing forward flight so that the gradual loss of assistance from ground effect in a climb is compensated for by the gradual increase in assistance from increasing forward flight acceleration. Each of the following factors,

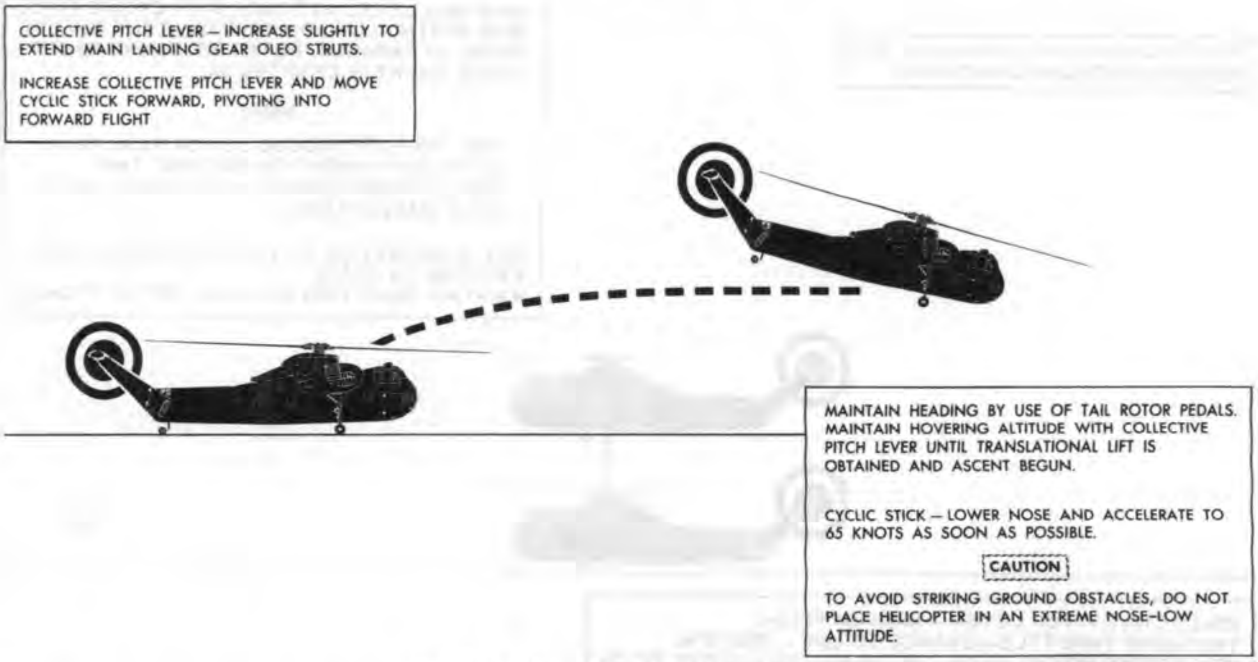


Figure 3–4. Normal takeoff without a hover (typical)

gross weight, density altitude, wind speed, wind direction, wind variability, size of takeoff area, and area available for air acceleration and climb out, are critical and must be carefully studied to determine that takeoff and acceleration can be accomplished. Gross weight, temperature and altitude conditions requiring maximum performance takeoffs are shown on the takeoff distances table (table 14–5). When values other than zero appear in the column of table 14–5, headed IAS KN, maximum performance takeoffs are necessary.

Note

Maximum performance takeoffs are performed after cg and power checks are accomplished.

This technique will produce results stated in Chapter 14.

Head the helicopter into the wind with the collective pitch lever in the minimum pitch position. Rotate the twist-grip throttle to maximum engine rpm, and then start increasing collective pitch until the helicopter becomes airborne. It may even be necessary to increase the collective pitch until maximum manifold pressure is obtained. Maintain maximum engine rpm until autorotative altitude and airspeed have been reached.

Caution

Rapid increase in collective pitch may result in excessive torque in main rotor drive. During takeoff allow a minimum of 2 seconds to change from low to high collective pitch.

As soon as the helicopter rises sufficiently for the landing gear to clear all obstacles, ease the cyclic stick forward, increase collective pitch to maximum manifold pressure, and accelerate forward in level flight.

Caution

During takeoff, if maximum manifold pressure is used to become airborne, a slight settling may be encountered when cyclic stick is moved forward. This is due to tilting of tip-path plane of main rotor blades and a decrease in ground effect as helicopter moves forward. Care should be taken to prevent striking landing gear wheels on ground should settling occur.

While increasing collective pitch, be sure to hold the helicopter on a steady heading into the wind by use of the tail rotor pedals. Accelerate in level flight until the airspeed increases to the IAS value shown in table 14–5 for the gross weight and altitude conditions at the time of takeoff. When the proper IAS value is obtained, start to climb. After clearing all ground obstructions, increase airspeed to approximately 70 knots for the best rate of climb. Distances required at zero wind velocity to attain these airspeeds and distances to clear 50 foot obstacle are shown in the column of table 14–5 headed ACCEL DIST.

a. Helicopter – HEAD INTO WIND.

b. Collective pitch lever – MINIMUM PITCH.

c. Twist-grip throttle – MAXIMUM ENGINE RPM.

d. Collective pitch lever – INCREASE.

NOTE

THE TAKEOFF SHOULD BE VERTICAL TO A SUFFICIENT HEIGHT TO PREVENT THE WHEELS FROM CONTACTING THE GROUND WHILE MANEUVERING.

AS THE HELICOPTER BECOMES AIRBORNE, MOVE THE CYCLIC STICK FORWARD TO ACCELERATE INTO FORWARD FLIGHT WHILE ESTABLISHING A CLIMB

CAUTION

A SLIGHT SETTLING MAY BE ENCOUNTERED WHEN CYCLIC STICK IS EASED FORWARD. AVOID STRIKING THE LANDING GEAR WHEELS ON THE GROUND

A SAFE AUTOROTATIVE AIR SPEED SHOULD BE OBTAINED AS SOON AS POSSIBLE

MAINTAIN HEADING BY USE OF THE TAIL ROTOR PEDALS

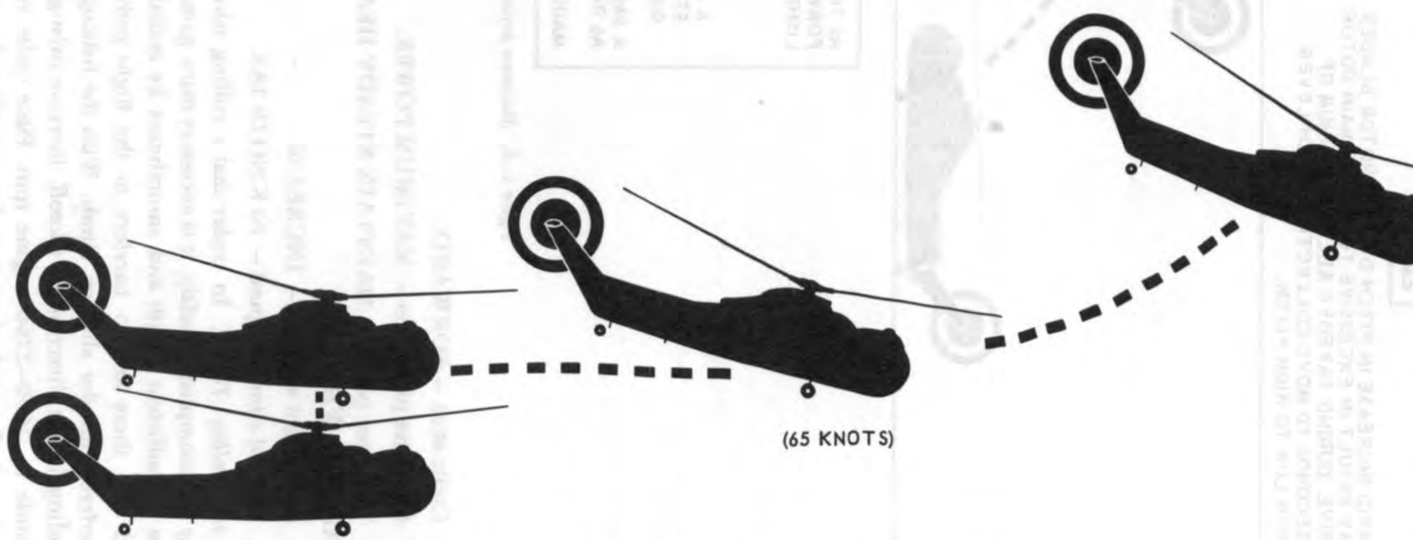


Figure 3–5. Maximum performance takeoff (typical) (high gross weight or high density altitude conditions)

HEAD HELICOPTER INTO THE WIND.
COLLECTIVE PITCH LEVER – MINIMUM PITCH.
THROTTLE–ADVANCE TO MAXIMUM RPM.
COLLECTIVE PITCH LEVER – INCREASE COLLECTIVE PITCH STEADILY UNTIL HELICOPTER BECOMES AIRBORNE.

CAUTION

RAPID INCREASE IN PITCH OF MAIN ROTOR BLADES MAY RESULT IN EXCESSIVE TORQUE IN MAIN ROTOR DRIVE. DURING TAKEOFF ALLOW A MINIMUM OF 2 SECONDS TO MOVE COLLECTIVE PITCH LEVER FROM LOW TO HIGH PITCH.

AS THE HELICOPTER BECOMES AIRBORNE, MOVE THE CYCLIC STICK FORWARD TO ACCELERATE INTO FORWARD FLIGHT WHILE ESTABLISHING A CLIMB.

CAUTION

A SLIGHT SETTLING MAY BE ENCOUNTERED WHEN CYCLIC STICK IS EASED FORWARD. AVOID STRIKING THE LANDING GEAR WHEELS ON THE GROUND.

A SAFE AUTOROTATIVE AIRSPEED SHOULD BE OBTAINED AS SOON AS POSSIBLE AFTER CLEARING OBSTACLES.

MAINTAIN HEADING BY USE OF THE TAIL ROTOR PEDALS.

Figure 3–6. Maximum performance takeoff (typical) (to clear an obstacle)

e. Cyclic stick – FORWARD.

f. Collective pitch lever – MAXIMUM POWER.

g. Tail rotor pedals – MAINTAIN STEADY HEADING INTO WIND.

h. Level flight airspeed – INCREASE.

i. Normal climb airspeed – 70 KNOTS IAS.

3–34. Rolling Takeoff. In order that a rolling takeoff may be accomplished safely, it is necessary that a ground area of sufficient length and smoothness be available, and that there are no barriers in the flight path to interfere with the shallow climb. With the helicopter heading in the direction of takeoff, increase twist-grip throttle to 2600–2700 engine rpm. Place cyclic stick moderately forward of neutral. Do not allow the main rotor to contact the stops. If the helicopter does not start forward, collective pitch may be increased to start forward movement and to accelerate smoothly forward into effective translational lift. When the helicopter has accelerated to the airspeed shown in the IAS KN column of the Takeoff Distance chart, Chapter 14, collective pitch will be smoothly increased simultaneously with the application of aft cyclic stick, causing the helicopter to leave the ground in a near level attitude with little or no pitching tendency. Apply only enough collective pitch and throttle to ascend to and maintain an altitude that will safely clear any obstructions in the flight path. When the helicopter has accelerated to normal climb speed, a normal climb will be established. Directional control during ground run is accomplished primarily with the tail rotor pedals; however, in a crosswind condition, a straight course will be maintained by application of cyclic stick in the direction of the wind while the directional alignment is maintained with the tail rotor pedals.

3–35. After Takeoff. After attaining translational lift, a safe altitude, and the desired climb speed, the following procedure may be followed for a climb at normal gross weights:

a. Twist-grip throttle and collective pitch lever – ADJUST POWER AS NECESSARY TO PRODUCE DESIRED RATE OF CLIMB.

b. Main landing gear actuating lever – UP.

c. All instruments – CHECK.

d. Mixture lever – NORMAL.

e. Fuel booster pump switches – NORMAL.

3–36. Climb. The airspeed that will produce the best rate of climb for various gross weights and altitudes may be determined by reference to the climb table for recommended METO power (table 14–6). While establishing a climb, raise the landing gear after safe single engine airspeed has been established. Approximately 11 seconds are required for the landing gear to retract, at which time the landing gear position indicator should indicate both wheels UP and LOCKED. Power settings should be adjusted in accordance with the climb table for recommended METO power (table 14–6). Equalize manifold pressures by adjusting the quadrant throttles.

Note

This technique will produce results stated in Chapter 14.

Caution

Vertical climbs to clear ground obstructions can be accomplished after normal takeoff to a hover for normal operation; however, airspeeds between 0 and 50 knots should be avoided at low altitudes as a safe autorotative landing would be difficult to perform should engine failure occur at low altitude and low airspeed.

3–37. ASE Operation. Paragraphs 3–38 through 3–40 list ASE checks that should be accomplished during cruise flight.

3–38. Barometric Altitude Control. a. Cyclic stick – ADJUST. Reposition cyclic stick for cruise.

b. Altitude – STABILIZE.

c. Airspeed – STABILIZE.

d. Throttle – STABILIZE.

e. ASE BAR ALT-OFF button – DEPRESS.

f. Collective pitch lever locknut – APPLY FRICTION.

3–39. Altitude Changes. a. ASE BAR ALT-OFF button – DEPRESS.

b. Climb or descend to desired altitude.

c. Altitude – STABILIZE.

d. Airspeed – STABILIZE.

e. Throttle – STABILIZE.

f. ASE BAR ALT-OFF button – DEPRESS.

g. Collective pitch lever locknut – APPLY FRICTION.

3–40. Turns. Turns using ASE may be effected in one of two ways:

a. By actuating tail rotor pedals; after turn is completed and helicopter is on desired course, feet should be removed from tail rotor pedals and helicopter will maintain new heading. A slow or fast turn may be made by depressing tail rotor control pedals accordingly.

b. By using the YAW TRIM knob; for turns while hovering, rotate the YAW TRIM knob left or right slowly and smoothly to produce the desired turn. With forward speed, this control will be very convenient for small turns from zero to 10 degrees. Turns greater than 10 degrees can be made, but will cause the helicopter to skid unless they are made very slowly or the pilot banks the helicopter while the YAW TRIM knob is being rotated.

3–41. Flight Characteristics. Information pertaining to flight characteristics is covered in Chapter 8.

Note

When operating with approximately 30 inches of manifold pressure and NORMAL mixture, engine surging in excess of 100 rpm can be encountered. This surging can be eliminated either by moving into RICH mixture or by changing power setting.

3–42. Descent. Because of the versatility of helicopters and their ability to land in small areas, the conditions at the time of landing are the governing factors in the type of descent to be accomplished. These governing factors are the gross weight of the helicopter, the density altitude at which the descent is to be accomplished, the size and condition of the landing area, or a time element factor. The cruising descent is the most common type of descent and should be used whenever possible. The rapid or autorotative descent is used whenever a fast descent is desired, or when the size and condition of the landing area are the governing factors. The following procedures describe the descent to be accomplished under various conditions:

3–43. Cruising Descent. Perform the following procedures when making a cruising descent:

a. Fuel booster pump switches – EMER.

b. Mixture levers – RICH.

c. Collective pitch lever and twist-grip throttle – REDUCE. Establish desired rate of descent.

d. Twist-grip throttle – CRUISING RPM.

e. Carburetor air temperature levers — ADJUST. Maintain normal carburetor air temperatures.

f. ASE BAR ALT-OFF button — DEPRESS.

3—44. Rapid Descent (Autorotative With Power Recovery). The procedures for a rapid descent are as follows:

Note

Prolonged engine operation at low manifold pressure and high engine rpm may result in master rod bearing distress. When helicopter maneuvers dictate such combinations, their duration should be held to a minimum. As a rule of thumb, it is desirable to maintain at least 1 inch of manifold pressure for each 100 engine rpm.

a. Crew — ALERTED.

b. Fuel booster pump switches — EMER.

c. Mixture levers — RICH.

d. Collective pitch lever — REDUCE. Establish autorotative glide at 70 to 80 knots and 190 to 200 rotor rpm.

e. Twist-grip throttle — DECREASE ENGINE RPM. Split engine and rotor tachometer needles by 200 engine rpm so that the freewheeling units will remain disengaged. Equalize engine rpm 2000 to 2200 rpm by using quadrant throttles.

f. Collective pitch lever — REGULATE. Control rate of descent by varying airspeed and rotor rpm between 190 and 200 rpm.

g. Collective pitch lever and twist-grip throttle — 2600 ENGINE RPM. To engage freewheeling units for recovery from rapid autorotative descent, simultaneously raise the collective pitch lever and increase twist-grip throttle to join needles at 2600 engine rpm.

3—45. Pre-Traffic Pattern Checklist. Check to determine if adequate fuel is available to accomplish a landing.

a. Crew — ALERTED.

b. Seat safety belts and shoulder harness — TIGHTENED.

c. Inertia reel lock lever — UNLOCKED.

d. Cabin heater switch — OFF. Switch is turned off prior to final landing to allow heater fan to continue to operate and lower air temperature in plenum chamber before shutdown.

e. Fuel quantity gages — CHECK.

3—46. Traffic Pattern Checklist. *a.* Tail wheel lock lever — AS DESIRED.

b. Cabin heater switch — OFF.

c. Auxiliary fuel pump switches — OFF.

d. Fuel booster pump switches — EMER.

e. Mixture levers — RICH.

f. Carburetor air levers — COLD or FILTER.

g. Main landing gear actuating lever — DN. Warning light in lever should light while gear is extending. When gear is fully extended and down locks are in place, warning light will go out and landing gear position indicators will indicate down. Landing gear should extend fully in approximately 11 seconds.

h. Twist-grip throttle — SET.

i. Twist-grip throttle position indicator — APPROXIMATELY 40 DEGREES.

j. Parking brake handle — RELEASE.

k. Instruments — CHECK ALL READINGS WITHIN THE PROPER OPERATING RANGE.

l. Flight engineer's report — CHECK GEAR DOWN AND LOCKED.

m. Cargo sling hook — STOWED.

Caution

During all phases of flight and taxiing, quadrant throttles are to be monitored by copilot to prevent throttle movement in either direction due to vibration induced by maneuver.

3—47. Landing. Landing procedures for the various types of landings are as follows:

Warning

There is a tendency for pilot to apply aft cyclic stick as contact with ground is anticipated and immediately after landing. Excessive aft displacement of cyclic stick prior to landing will result in a dangerously nose-high landing attitude, which may cause tail wheel to strike ground and result in a rapid nose-down pitching which may cause main rotor blades to strike tail cone. Immediately after touchdown, cyclic stick should be moved slightly forward of neutral position, and collective stick should be lowered slowly to maintain a controlled coning angle. This will place weight on main wheels and eliminate possibility of tipping main rotor blades into tail cone.

3—48. Normal Approach to a Hover. When sight picture is attained, reduce collective pitch as required to establish and maintain the desired angle of descent. Entry airspeed will be maintained to an altitude of approximately 100 feet. From this point, forward speed will be gradually dissipated to obtain zero airspeed when terminating approach at hovering altitude over point of intended landing. Throughout the approach, the ground track, airspeed, and attitude is maintained with the cyclic stick, heading is maintained with the tail rotor pedals, and the angle of descent is maintained with the collective pitch lever.

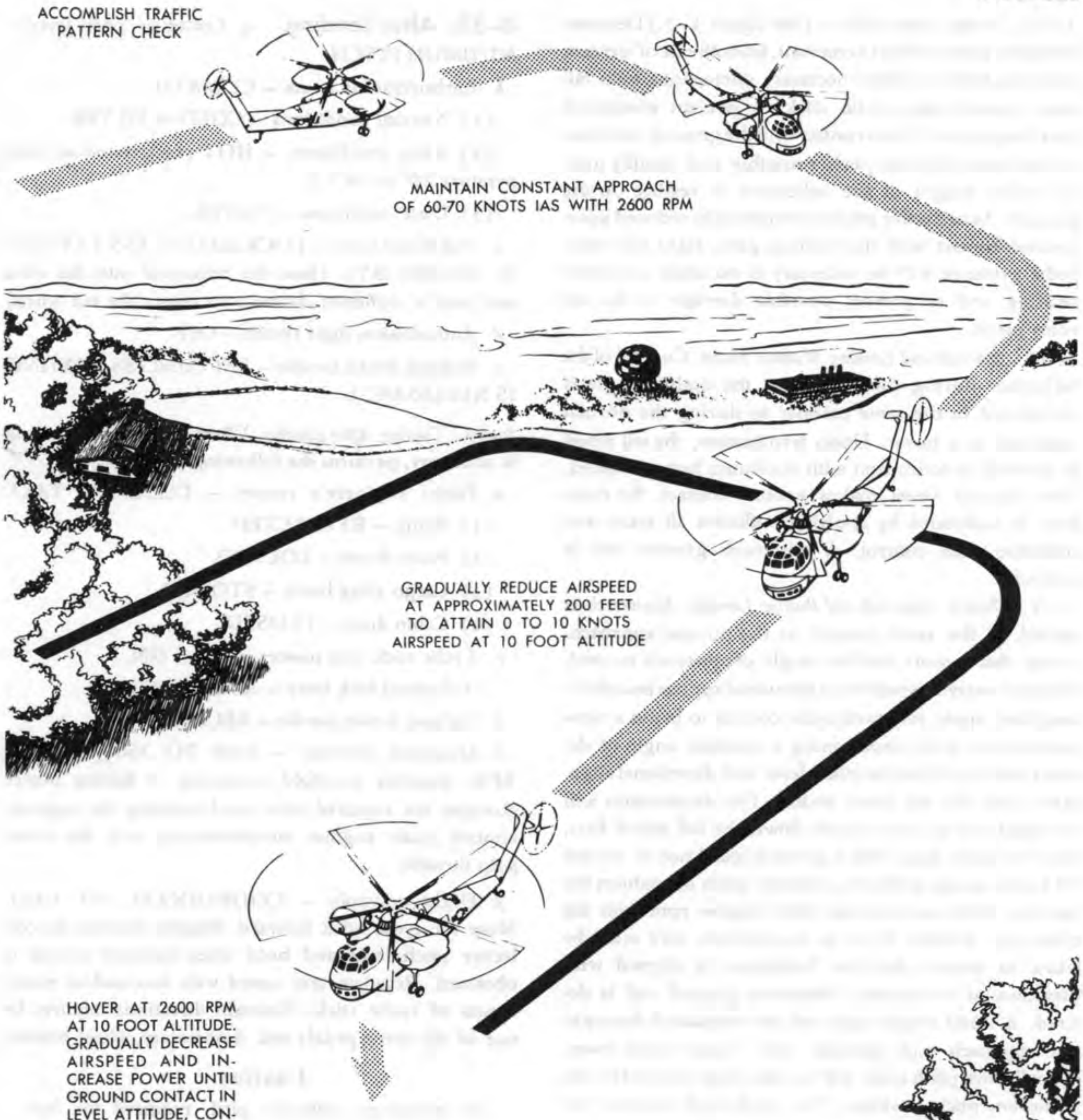


Figure 3–7. Power-on landing (typical)

3–49. Landing From a Hover. (See figure 3–7.) Decrease collective pitch to effect a constant, smooth rate of descent until touchdown. Make necessary corrections with tail rotor pedals and cyclic stick to prevent movement over the ground. Upon contact with the ground, continue to decrease collective pitch smoothly and steadily until the entire weight of the helicopter is resting on the ground. As collective pitch continues to be reduced upon ground contact with the landing gear, right tail rotor pedal pressure will be necessary to maintain a constant heading and to prevent possible damage to the tail rotor pylon.

3–50. Approach and Landing Without Hover. Control of the helicopter during the descent at the desired angle is maintained in the same manner as during the normal approach to a hover. Upon termination, the tail wheel is allowed to touch first with minimum forward speed. After the tail wheel makes ground contact, the main gear is cushioned by applying sufficient aft cyclic and collective pitch control. A minimum ground roll is desired.

3–51. Shallow Approach and Rolling Landing. Approach is started in the same manner as the normal approach, except that a more shallow angle of approach is used. Maintain entry airspeed to an altitude of approximately 50 feet, then apply rearward cyclic control to begin a slow deceleration while maintaining a constant angle of descent with the collective pitch lever and directional alignment with the tail rotor pedals. The deceleration will be regulated so as to touch down the tail wheel first, then the main gear with a ground speed not to exceed 30 knots, using sufficient collective pitch to cushion the landing while maintaining 2600 engine rpm with the twist-grip throttle. Prior to touchdown, care must be taken to assure that the helicopter is aligned with direction of movement. Minimum ground roll is desired. A 2600 engine rpm will be maintained throughout approach and ground roll. Upon touchdown, the collective pitch lever will be smoothly reduced to the minimum pitch position. The copilot will monitor the quadrant throttle throughout the maneuver.

3–52. Go-Around. (See figure 3–8.) Procedures for go-around are as follows:

a. Twist-grip throttle and collective pitch lever – INCREASE TO MAXIMUM POWER, IF NECESSARY, TO CLEAR OBSTRUCTIONS.

b. Cyclic stick – FORWARD. Attain forward speed and establish a climb.

c. Twist-grip throttle and collective pitch – REDUCE POWER. After attaining climbing airspeed, reduce power to maintain desired rate of climb. (Refer to table 14–6.)

3–53. After Landing. *a.* Collective pitch lever – MINIMUM PITCH.

b. Carburetor air levers – CLIMATIC.

(1) Normal conditions – COLD or FILTER.

(2) Icing conditions – HOT (carburetor air temperature 20° to 30°C).

(3) Dust conditions – FILTER.

c. Tail wheel lever – LOCKED (UNLESS TAXIING IS NECESSARY). Head the helicopter into the wind and taxi a sufficient distance to center the tail wheel.

d. Anticollision light switch – OFF.

e. Parking brake handle – SET (UNLESS TAXIING IS NECESSARY).

3–54. Taxiing After Landing. When taxiing after landing is necessary, perform the following steps:

a. Flight engineer's report – CLEAR TO TAXI.

(1) Ramp – RETRACTED.

(2) Nose doors – LOCKED.

(3) Cargo sling hook – STOWED.

(4) Cabin door – CLOSED.

b. Cyclic stick trim master switch – ON.

c. Tail wheel lock lever – AS DESIRED.

d. Parking brake handle – RELEASE.

e. Quadrant throttles – 2400 TO 2600 ENGINE RPM. Equalize manifold pressures. If further power changes are required after synchronizing the engines; control both engines simultaneously with the twist-grip throttle.

f. Flight controls – COORDINATE TO TAXI. Move the cyclic stick forward. Slightly increase the collective pitch lever and hold when forward motion is obtained. Regulate taxi speed with fore-and-aft movements of cyclic stick. Maintain directional control by use of tail rotor pedals and, if necessary, wheel brakes.

Caution

Use minimum collective pitch required for forward motion. This should be enough to prevent main rotor blades from hitting droop stops, but not enough to extend landing gear oleo struts.

After reaching the parking area:

g. Tail wheel lock lever – LOCKED.

h. Cyclic stick – CENTERED.

i. Wheel brakes – APPLY.

3–55. Postflight Engine Check. Perform the following engine check after landing and prior to engine shutdown:

a. Parking brake handle – SET.

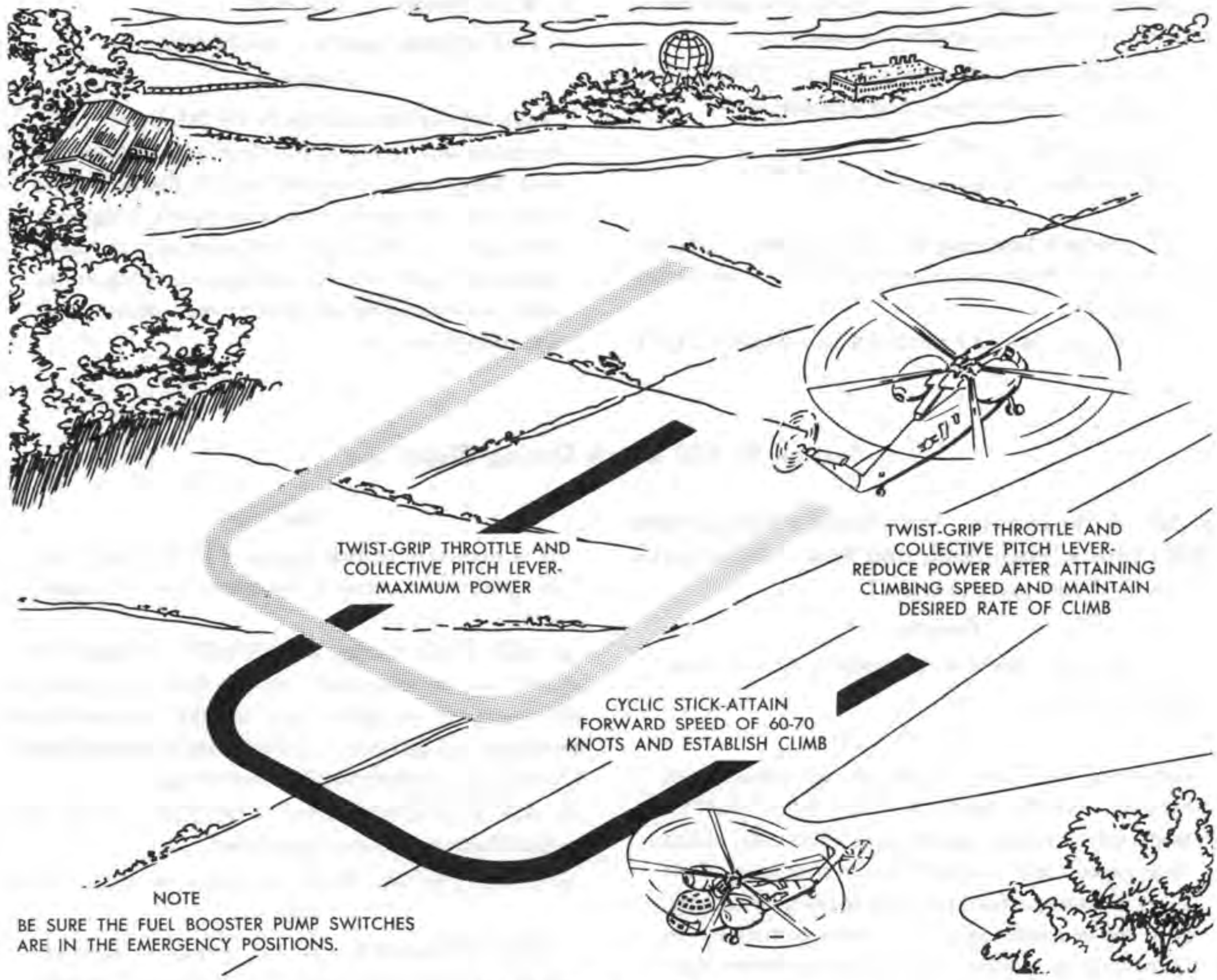


Figure 3–8. Go-around (typical)

b. Cyclic stick trim master switch – ON.

c. Ignition system – CHECK. (Refer to paragraph 3–28.)

d. Mixture levers – NORMAL.

e. Fuel booster pump switches – OFF.

f. Quadrant throttles – RETARD SLOWLY TO 1000 ENGINE RPM. Allow engine rpm and rotor rpm to decrease simultaneously. Pilot shall check rotor head by looking back to insure that all droop stops are in the DOWN position. Maintain 1000 engine rpm until rotor rpm drops below engine rpm (needles split). Then advance quadrant throttles sufficiently to keep generators in operation.

g. Collective pitch lever – LOCKED (MINIMUM PITCH).

Note

Rotor brake may be applied at this time if desired.

h. Ignition switches – CHECK (1300 ENGINE RPM).

3–56. Engine Shutdown. Procedures for engine shutdown are as follows:

a. Right mixture lever – IDLE CUTOFF. After cylinder head temperature drops below 200°C.

b. Left mixture lever – IDLE CUTOFF.

c. Radio master switch – OFF.

d. Ignition switches – OFF.

e. Generator switches – OFF.

f. Inverter switches – OFF.

Note

Prior to turning off inverter switches, check all pressure gages for zero reading.

g. Fuel shutoff switches – OFF.

h. Radio switches (console) – OFF.

i. Rotor brake lever – ON. Apply gradually below 70 rotor rpm (980 on engine tachometer).

j. Tail rotor blades coning switch – CONED. Visually check tail rotor coning ring in position.

k. Battery switch – OFF.

l. All switches and rheostats – OFF.

3–57. Before Leaving the Helicopter. The following steps shall be accomplished prior to leaving the helicopter:

a. DA Forms 2408-12 and 2408-13 – COMPLETED.

b. Wheel chocks – IN PLACE.

c. Parking brake handle – RELEASED.

Caution

Make appropriate entries in the DA Form 2408, covering any limits in Pilot's Flight Information that have been exceeded during flight. Entries must also be made when, in pilot's judgment, helicopter has been exposed to unusual or excessive operations such as hard landings, exceeding engine rpm, overspeeding of rotor system, contact with salt water spray, etc.

Section III ASE Check During Flight Test

3–58. Automatic Stabilization Equipment (ASE) Check (Pitch, Roll, and Yaw). Perform the following checks prior to flight:

Caution

The following check to be made only by a qualified test pilot.

Note

Following check for proper linkage adjustments between controls and servo pilot valves must be made with engines operating at 1600 rpm, clutch disengaged, and external power connected. This check is to be performed prior to flying helicopter, after maintenance work has been performed on flight control system, auxiliary servo system linkage, or on automatic stabilization equipment ASE servo motors. It may also be performed when a check of ASE is desired. During override check, keep hand on collective pitch lever and apply friction to restrain any tendency of collective pitch lever to rise. If collective pitch lever is allowed to rise, engine overspeed may result.

a. Throttle – 1600 ENGINE RPM.

b. ASE circuit breakers – SET.

c. Cyclic stick – CENTERED.

d. Tail rotor control pedals – CENTERED, FEET ON PEDALS.

e. Collective pitch lever – MINIMUM.

Note

All four channels of ASE are not tested at same time to avoid possibility of damage to helicopter.

f. ALT. disengage switch on motor box – OFF.

Note

It is necessary to first engage ASE and then place in standby to connect ac operating power to equipment.

g. ASE ENG button – DEPRESS. Engage button should not be depressed sooner than 2-1/2 minutes after power is on; green light in ENG button should illuminate. If light does not illuminate, wait an additional 1/2 minute and depress ENG button again.

h. ASE STANDBY button – DEPRESS. Green light in ENG button will be extinguished.

i. PITCH, ROLL, YAW disengage switches – ON.

Note

When OVERRIDE CHECK switch is actuated, ASE introduces a steady full authority signal in one direction to pitch, roll, and yaw servo motors simultaneously. Prepare to resist a pedal force of approximately 50 pounds. Null indicator needle on the ASE control panel should swing full left.

j. OVERRIDE CHECK switch – LEFT FWD. DOWN INCR.

Note

No forces should be fed back through pitch or roll channels. If any resistance or seizing is felt, control linkage is improperly adjusted.

k. CHANNEL SELECTOR switch – ROTATE THROUGH THE PITCH, ROLL, AND YAW POSITIONS. Check that servo motors are at their extreme positions. Null indicator needle should indicate full left travel for these channels.

l. Tail rotor pedals – MOVE TO EXTREME POSITIONS OF TRAVEL IN BOTH DIRECTIONS. A force of not more than 50 pounds will be required on right pedal in addition to normal pedal restraint.

Note

Maximum rate of control movement for the cyclic stick right and aft (against ASE) will be slower than in opposite directions, but should not be less than a rate corresponding to full stick travel in approximately 1 second.

m. Cyclic stick – DEPRESS TRIM RELEASE BUTTON AND MOVE STICK RAPIDLY TO EXTREMES.

n. OVERRIDE CHECK switch – RIGHT AFT UP DECR.

Note

No forces should be fed back through pitch or roll channels. If any resistance or seizing is felt, control linkage is improperly adjusted.

o. CHANNEL SELECTOR switch – ROTATE THROUGH PITCH, ROLL, and YAW POSITIONS. Check that servo motors are at their extreme positions. Null indicator needle should indicate full travel right.

Note

When OVERRIDE CHECK switch is actuated to the right position, same conditions noted during left position check should be experienced except that slower rates of cyclic stick travel will be in left and forward directions. A 50 pound holding force will be on left tail rotor pedal. Null indicator needle should swing full right for all channels.

p. Tail rotor pedals – MOVE TO EXTREME OF TRAVEL IN BOTH DIRECTIONS. A force of 50 pounds will be required on left pedal in addition to normal damper restraint.

q. Cyclic stick – DEPRESS TRIM RELEASE BUTTON AND MOVE STICK RAPIDLY TO EXTREMES.

r. OVERRIDE CHECK switch – CENTER OFF position.

s. CHANNEL SELECTOR switch – PITCH position.

Caution

Do not operate OVERRIDE CHECK switch in flight since this introduces simultaneous hardover signals in all channels whether or not ASE is engaged. Results of using this switch are quite severe and should not be demonstrated.

3–59. Automatic Stabilization Equipment Override Check (Altitude). Perform the following for automatic stabilization equipment override check:

Caution

When performing this check, keep finger on AUTO STAB SERVO switch and prepare to place it in OFF position in an emergency to avoid possible engine overspeed.

a. Throttle – 2000 ENGINE RPM.

b. ASE STANDBY button – DEPRESSED.

c. PITCH, ROLL, AND YAW CHANNEL DISENGAGE switches – OFF.

d. ALT. – CHANNEL DISENGAGE switch – ON.

e. OVERRIDE CHECK switch – LEFT FWD. DOWN INCR.

f. CHANNEL SELECTOR switch – ALT. Null indicator needle should indicate full left.

g. Collective pitch lever – RAISE UP AND THEN LOWER RAPIDLY. Back off throttle when increasing pitch to prevent engine overspeed.

Note

Maximum rates of control movement for collective pitch lever up (against ASE signals) will be slower than in opposite directions, but should not be less than a rate corresponding to full control travel in approximately 1 second. No forces should be fed back through altitude channel. If any resistance or seizing is felt, control linkage is improperly adjusted.

h. OVERRIDE CHECK switch – RIGHT AFT UP DECR.

i. CHANNEL SELECTOR switch – ALT. Null indicator needle should indicate full travel to right.

j. Collective pitch lever – RAISE UP AND THEN LOWER RAPIDLY. Back off throttle when increasing pitch to prevent engine overspeed.

Note

Maximum rates of control movement for collective pitch lever down (against ASE signals) will be slower than in opposite directions, but should not be less than a rate corresponding to full control travel in approximately 1 second. No forces should be fed back through altitude channel. If any resistance or seizing is felt, control linkage is improperly adjusted.

k. ALT. – CHANNEL DISENGAGE switch – OFF.

l. OVERRIDE CHECK switch – CENTER OFF POSITION.

m. CHANNEL SELECTOR switch – PITCH.

3–60. *Automatic Stabilization Equipment Checks (Pitch, Roll, and Yaw).* Under normal conditions, it is necessary only to set cg trim, slave the gyro magnetic compass, and engage ASE. For night or instrument flight, the following checks may be performed on ground before takeoff or while taxiing.

Note

If these checks are being performed when not taxiing, tail wheel should be unlocked and all tie-downs removed.

a. PITCH, ROLL, AND YAW CHANNEL DISENGAGE switches – ON.

b. CHANNEL SELECTOR switch – ROLL. Check roll channel by moving cyclic stick laterally and noting that the null indicator needle follows movement of cyclic stick.

c. CHANNEL SELECTOR switch – PITCH. Check pitch channel by moving cyclic stick fore and aft and noting that null indicator needle moves to left when cyclic stick is moved forward, and to right when cyclic stick is moved aft.

Caution

Before accomplishing the following check, be sure there is adequate clearance for shift in fuselage direction.

d. CHANNEL SELECTOR switch – YAW. Check yaw channel by either of following methods. While taxiing, remove feet from tail rotor pedals and slowly rotate YAW TRIM knob on ASE panel in either direction. Slight changes should be noted in heading of helicopter. Adjust YAW TRIM knob to guide helicopter in desired direction with feet removed from tail rotor pedals. When not taxiing, unlock tail wheel, remove feet from tail rotor pedals, and rotate YAW TRIM knob in either direction. Tail rotor pedals should jump slightly, and tail of helicopter will shift an amount corresponding to amount of yaw trim applied.

e. CHANNEL SELECTOR switch – PITCH.

CHAPTER 4

EMERGENCY PROCEDURES

Section I. SCOPE

4-1. Purpose

This chapter covers in detail the procedure to be followed in meeting emergencies (except those associated with the auxiliary equipment) that can reasonably be expected to be encountered.

4-2. Extent of Coverage

Emergency operation of the auxiliary equipment will be included in the chapter only if it affects the safety of flight. All other emergency operation of auxiliary equipment is covered in chapter 6. Emergency systems and equipment are described in chapters 2 and 6.

Section II. ENGINE

4-3. General

The various conditions under which engine failure may occur preclude dictating a standard procedure to be followed. A thorough knowledge of emergency procedures and the flight characteristics of the helicopter will enable the pilot to respond correctly and automatically to the emergency. Electrical power to the secondary bus will be cut off automatically if either engine fails. The utility hydraulic system will be inoperative if the left engine fails, and the second stage servo hydraulic system will be inoperative if the right engine fails.

4-3.1 Activation of Chip Detector Warning Light on Engines

a. If the magnetic chip detector warning light comes on while operating on the ground, proceed as follows:

(1) Shut down immediately.

(2) Remove the chip detector plug.

(3) Determine the safety of further operations contained in chapter 5, section II, paragraphs 5-134 through 5-137 of TM 55-1520-203-35.

b. If the warning light comes on during flight, proceed as follows:

(1) When operating under VRF conditions make a precautionary landing at nearest suitable landing area.

(2) When operating under IFR conditions declare an emergency, make an approach, and land at the nearest facility.

(3) After landing and shutting down, remove the chip detector plug and determine the safety of further operation per instructions contained in chapter 5, section II, paragraphs 5-134 through 5-137 of TM 55-1520-203-35.

4-4. Flight Characteristics Under Partial Power Conditions

The altitude, airspeed, and gross weight at which engine failure occurs will dictate the action to be followed to effect a safe landing. Level flight can be maintained at sea level, standard day conditions when operating at normal gross weight. As altitude increases above sea level, maximum gross weight at which level flight can be maintained decreases. When one engine fails, immediately increase the rpm and manifold pressure of the operating engine to maximum power and increase or decrease airspeed to between 60 and 70 knots IAS, which is the airspeed range requiring the least amount of power. If maximum power is excessive, reduce power to maintain level flight at 60 to 70 knots IAS. If level flight cannot be maintained, possibly level flight can be maintained at a lower altitude, depending on the height above the ground and the nature of the terrain below. The helicopter can also be lightened to maintain altitude, when flight is over unpopulated areas, by dumping internal cargo overboard, releasing cargo sling loads, or jettisoning the auxiliary fuel tanks.

When one engine fails, a landing should be made as soon as possible due to the high power required from the remaining engine. The landing site should be a smooth surface such as a runway or road with clear approaches.

4-5. Equipment Inoperative With Failure of One Engine

The equipment which will become inoperative when there is a failure of one engine is as follows:

a. Left Engine.

(1) Utility hydraulic system.

(2) Twist-grip throttle servo.

(3) Pedal damper.

(4) Landing gear.

(5) Wheel brakes (hydraulic boost).

(6) Ramp and nose doors.

(7) Left generator.

b. Right Engine.

(1) Second stage servo hydraulic system.

***Caution:* If the first stage servo hydraulic system has failed previously, loss of the right engine will result in loss of the second stage servo hydraulic system and complete loss of flight control.**

(2) Right generator.

4-6. Engine Failure During Takeoff or While Hovering

a. Collective pitch lever—REDUCE MOMENTARILY (IF ALTITUDE PERMITS). Retain rotor rpm.

b. Twist-grip throttle and collective pitch lever—MAXIMUM POWER. Use quadrant throttle if necessary.

c. Cyclic stick—MAINTAIN LEVEL ATTITUDE. If engine failure occurs while hovering, hold helicopter on a level attitude as it settles to ground.

d. Forward airspeed (if possible)—60 TO 70 KNOTS IAS. If hovering at a sufficient height, attempt to gain some forward airspeed (maximum of 70 knots IAS) and accomplish a partial flare to cushion landing.

Note. If an immediate landing is not practical due to terrain or other reasons, do not lower landing gear because of reduction of performance due to increased drag. If 60 to 70 knots IAS can be attained, forward flight may be continued to a safe landing area.

4-7. Engine Failure During Flight (One Engine)

a. Collective pitch lever—REDUCE MOMENTARILY. Retain rotor rpm.

b. Twist-grip throttle and collective pitch lever—MAXIMUM POWER. Use quadrant throttle if necessary.

c. Passengers and crewmembers—ALERTED.

Note. **Procedures in the *a* and *b* above are performed as a continuous coordinated operation.**

d. Main landing gear actuating lever—DN.

e. Airspeed—60 TO 70 KNOTS IAS.

f. Mixture lever (for good engine)—RICH.

g. Fuel booster pump switch (for good engine)—EMER.

h. Altitude—MAINTAIN IF POSSIBLE.

4-8. If Altitude Cannot Be Maintained

Three courses of action can be followed if altitude cannot be maintained. The altitude at which engine failure occurs and the nature of the terrain below should be the deciding factors in which course of action to follow.

a. Engine restart—ACCOMPLISH IF POSSIBLE. If altitude permits, determine which engine has failed by reference to the engine tachometers. Try to determine the cause of failure and if it is safe to attempt a restart. (Refer to para 4-11.)

b. Vertical velocity indicator—CHECK RATE OF DESCENT. If rate of descent is slow and altitude permits, level flight could possibly be maintained after a loss of several hundred feet of altitude.

c. Helicopter gross weight (if both of the above fail)—DECREASE. Unload internal cargo, release cargo sling loads, or jettison auxiliary fuel tanks.

Note. If engine cannot be restarted and altitude cannot be maintained, accomplish a single engine landing. (Refer to para 4-19.)

4-9. If Altitude Can Be Maintained

a. Quadrant throttle and twist-grip throttle—ADJUST FOR PROPER RELATIONSHIP.

b. Twist-grip throttle and collective pitch lever—ADJUST POWER. Adjust power on remaining engine to sustain level flight at 60 to 70 knots IAS.

c. Engine shutdown—ACCOMPLISH. Determine which engine has failed by reference to engine tachometers and proceed as instructed in paragraph 4-10.

d. Engine restart—ACCOMPLISH IF POSSIBLE. Try to determine cause of engine failure and if it is safe to attempt to restart engine. If decision is to restart, proceed as instructed in paragraph 4-11.

Note. If decision was not to attempt a restart or restart was not successful, look for a landing site or proceed to destination. This decision would be influenced by terrain below; however, a landing should be accomplished as soon as it is practical to do so because of high power required from one engine. (Refer to para 4-19.)

4-10. Engine Shutdown in Flight

a. Quadrant throttle (failed engine)—CLOSED.

b. Mixture lever—IDLE CUTOFF.

c. Engine fire emergency shutoff handle—ON (FULL OUT).

d. Ignition switch—OFF.

e. Fuel booster pump switch—OFF.

f. Quadrant throttle (failed engine)—OPEN TO ATTAIN RELATIONSHIP WITH OTHER QUADRANT THROTTLE.

Note. If either engine fails and quadrant throttle of failed engine is placed in CLOSED position, friction load in throttle system will increase when twist-grip throttle is moved toward CLOSED position. For this reason, relationship of quadrant throttles should be maintained after accomplishing an engine shutdown.

4-11. Engine Restart During Flight

a. Engine fire emergency shutoff handle—OFF (FULL IN).

b. Quadrant throttle (for inoperative engine) – CLOSED AND LOCKED.

Warning

A failed engine should not be restarted in flight unless it can be determined that it is reasonably safe to do so.

Caution

Required power (twist-grip throttle and application of collective pitch) for the operating engine must be established before the quadrant throttle for the failed engine is closed and locked. Power changes may be difficult with one quadrant throttle closed and locked.

c. Mixture lever – IDLE CUTOFF.

d. Fuel shutoff switch – ON.

e. Fuel booster pump switch – NORM.

f. Starter switch – DEPRESS.

g. Ignition switch – BOTH.

h. Primer switch – DEPRESS (AT SAME TIME AS STEP *f*) Prime with short, rapid pulses if engine is warm and longer, sustained pulses if engine has cooled off. Continue intermittent priming until engine operates at 1000 engine rpm.

i. Mixture lever – NORMAL.

j. Engine oil pressure gage – CHECK.

Note

If oil pressure does not register on gage almost immediately after engine starts, stop engine.

k. Engine warmup – ACCOMPLISH. If time and altitude permit, warm up engine in a normal manner.

l. Quadrant and twist-grip throttles – REGULATE ENGINE RPM. Advance throttle slowly to driving speed. As quadrant throttle is advanced, back off on twist-grip throttle to prevent overspeeding of engines.

Note

It is not necessary to reengage hydromechanical clutch as mechanical coupling will remain engaged and in freewheeling position due to high rotor rpm.

4–12. Fuel Pressure Drop – Engine Operating Normally. If a check of the fuel pressure gages reveals that fuel pressure of one engine has dropped below the normal operating range, but the engine affected appears to operate normally, a potentially dangerous engine fire situation is indicated. Do not move the fuel booster pump switch to EMER in an attempt to raise pressure if the pressure gage reads below the normal operating range. The pressure drop may be caused by a leaking primer valve or bypass valve on engine-driven pump, a leaking oil dilution valve, or a broken fuel line.

4–13. Leaking Primer on Pump Bypass Valve. Fuel leaking through the primer valve or through the pump bypass valve is not critical; the carburetor will be receiving a fuel mixture richer than that indicated by the position of the mixture lever.

4–14. Leaking Oil Dilution Valve. Losing fuel through the oil dilution valve will thin the oil, which in time will destroy its lubricating qualities and produce a combustible mixture in the crankcase and oil system. The likelihood of this happening is minimized in warm weather because the oil dilution manual shutoff valve in each nacelle will be closed. If the oil is diluted often, in cold weather, the manual shutoff valve may be left open, allowing fuel from a leaking oil dilution solenoid valve to enter the oil system. A possible drop in engine oil pressure will indicate this situation.

4–15. Broken Fuel Line. A broken or leaking fuel line or fitting which releases fuel and gasoline fumes into the nacelle presents a fire hazard.

4–16. Fuel Pressure Drop During Ground Operation. Place the mixture levers of both engines in the IDLE CUT-OFF position and both quadrant throttles in the CLOSED position. Next turn off the fuel booster pump switches, fuel shutoff switches, and ignition switches. Then proceed to pull out engine fire emergency shutoff handle for affected engine and be prepared to use fire extinguisher switch, if necessary.

Note

Do not restart engine until cause of fuel pressure drop has been found and corrected.

4–17. Fuel Pressure Drop During Flight. If a fuel pressure drop occurs during flight, the safest procedure to prevent fire would be to shut down the affected engine and either continue flight on one engine or land immediately. Proceed as follows. Place the mixture lever in the IDLE CUTOFF position. Pull out the engine fire emergency shutoff handle. Turn off the ignition switch, and fuel booster pump switch. Maintain the relationship of both quadrant throttles; be prepared to use the fire extinguisher switch if necessary. Retain rotor rpm by reducing collective pitch momentarily, and continue flight at 65 to 75 knots IAS with maximum power and rich mixture for the good engine.

Caution

If nature of terrain or urgency of mission demands that both engines be continued in operation, plan flight to be as short as possible, maintain a constant fire watch, and disturb engine cruise power settings as little as possible. If no further ill effects of low fuel pressure have developed, a normal landing may be made.

4–18. Chip Detector Warning Light – On. If the chip detector warning light comes on during flight, prepare to land as soon as possible even though a power loss may not be experienced.

4–19. Landing With One Engine Inoperative. Select for a landing site a smooth surface such as runway, road, or a surface suitable to accomplish a landing.

a. Crew – ALERTED.

b. Carburetor air lever – CLIMATIC.

c. Mixture lever – RICH.

d. Parking brake handle – UNLOCKED.

e. Tail wheel lock lever – AS DESIRED.

f. Main landing gear actuating lever – DN. Gear should fully extend in 11 seconds.

Caution

Throttle and pedal damper servos will be inoperative if left engine fails.

Note

Emergency hydraulic system must be used to lower gear if left engine should fail. Landing gear can be lowered with the emergency system in 30 seconds.

g. Twist-grip throttle – 2600 TO 2700 ENGINE RPM.

h. Approach airspeed – 65 to 75 KNOTS IAS.

i. Cyclic stick – TRIM. Use cyclic trim release switch to trim to desired position.

j. Cabin heater switch – OFF.

k. Normal approach – ACCOMPLISH AT 65 TO 75 KNOTS IAS.

l. Partial flare at approximately 100 feet.

(1) Airspeed and rate of descent – REDUCE.

(2) Twist-grip throttle – MAXIMUM POWER (IF NECESSARY).

m. Level off.

(1) Airspeed – APPROXIMATELY 30 KNOTS IAS.

Note

For landing on an unprepared surface, a zero ground speed is desired.

(2) Twist-grip throttle – MAXIMUM POWER (IF NECESSARY).

n. Ground contact.

(1) Attitude – LEVEL.

(2) Collective pitch lever – REDUCE STEADILY. Reduce collective pitch almost to a minimum to prevent gusts of wind from tipping helicopter.

4–20. Go-Around With One Engine Inoperative. A go-around on one engine should not be attempted after airspeed has been reduced to below 60 knots IAS. Apply maximum power to the good engine and establish a shallow climb at between 60 to 70 knots IAS.

4–21. Failure of Both Engines. (See chart 7–1.) Should both engines fail, a safe autorotative landing can be accomplished except when flying at low airspeed and altitude combinations.

4–22. Engine Failure During Takeoff or While Hovering at Low Altitude. Little can be done to avoid a hard landing if both engines fail at low altitude. Maintain a level attitude and increase collective pitch to maximum before ground contact. If altitude permits, attempt to gain as much forward speed as possible (70 knots IAS maximum) and proceed as instructed in paragraph 4–8.

4–23. Engine Failure During Flight (Both Engines). (See figure 4–1.) *a.* Collective pitch lever – REDUCE IMMEDIATELY. Retain rotor rpm.

Note

Alert the flight engineer.

b. Establish glide.

(1) Airspeed – 70 TO 80 KNOTS IAS.

(2) Collective pitch lever – 190 TO 200 ROTOR RPM. Increase or decrease collective pitch to retain rotor speed.

c. Auxiliary fuel tanks and cargo sling load – JETTISON (IF PRACTICAL).

d. To lower landing gear (if altitude permits) using emergency hydraulic system.

(1) Main landing gear actuating lever – DN.

(2) Main landing gear emergency valve switch – ON.

(3) Emergency hydraulic system valve handle – CLOSED (ROTATE CLOCKWISE).

(4) Emergency hydraulic system pump lever – PUMP (UP AND DOWN).

Caution

Do not actuate pump lever to produce more than 1500 psi.

Note

Landing gear can be lowered with emergency hydraulic system in 30 seconds.

e. Mixture levers – IDLE CUTOFF.

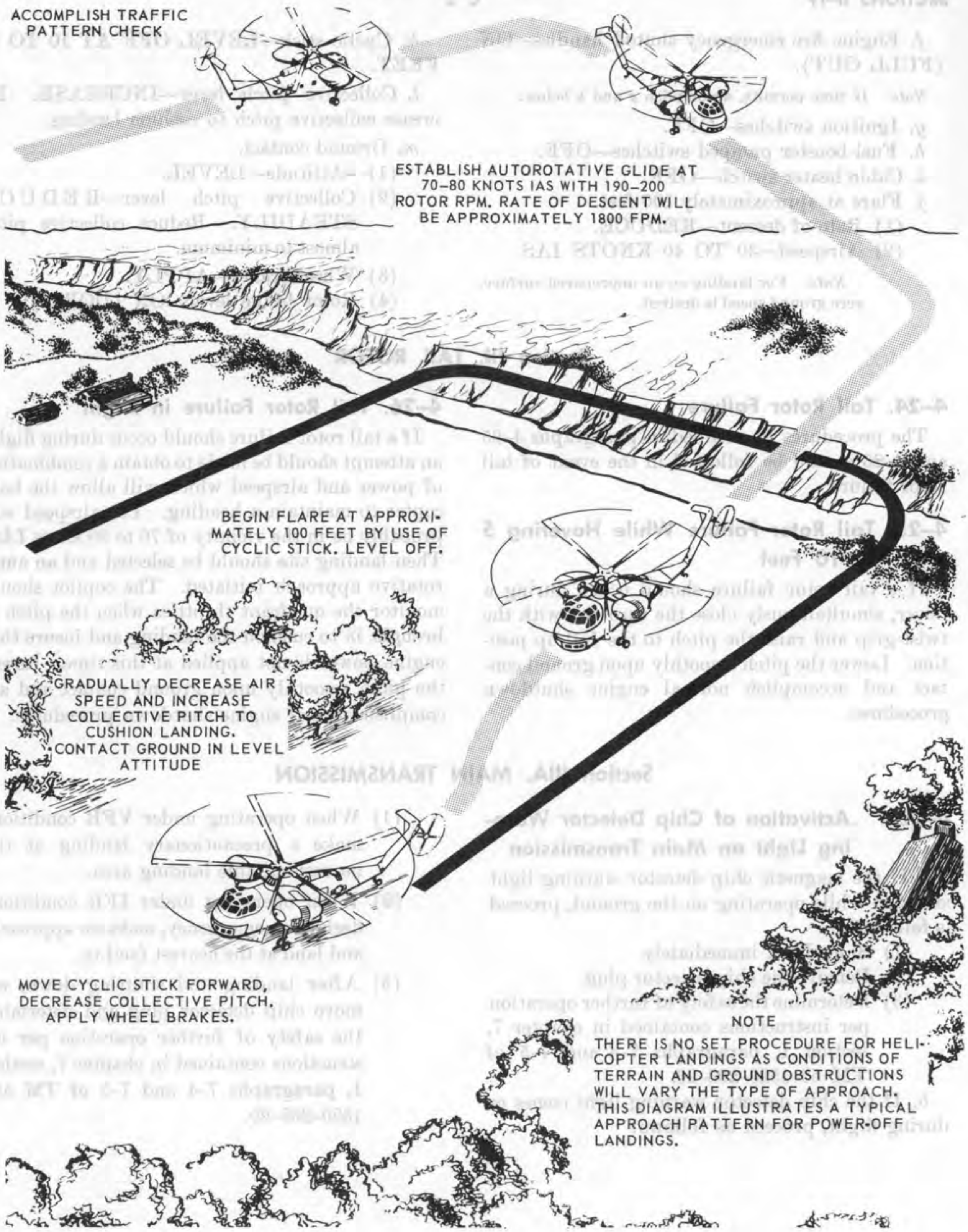


Figure 4–1. Landing diagram (autorotative).

f. Engine fire emergency shutoff handles—ON (FULL OUT).

Note. If time permits, accomplish *g* and *h* below.

g. Ignition switches—OFF.

h. Fuel booster pumped switches—OFF.

i. Cabin heater switch—OFF.

j. Flare at approximately 100 feet.

(1) Rate of descent—REDUCE.

(2) Airspeed—30 TO 40 KNOTS IAS.

Note. For landing on an unprepared surface, zero ground speed is desired.

k. Cyclic stick—LEVEL OFF AT 10 TO 15 FEET.

l. Collective pitch lever—INCREASE. Increase collective pitch to cushion landing.

m. Ground contact.

(1)—Attitude—LEVEL.

(2) Collective pitch lever—REDUCE STEADILY. Reduce collective pitch almost to minimum.

(3) Wheel brakes—APPLY.

(4) Rotor brake lever—ON (DOWN).

Section III. TAIL ROTOR

4–24. Tail Rotor Failure

The procedures as outlined in paragraphs 4–25 and 4–26 should be followed in the event of tail rotor failure.

4–25. Tail Rotor Failure While Hovering 5 to 10 Feet

If a tail rotor failure should occur during a hover, simultaneously close the throttles with the twist-grip and raise the pitch to the full up position. Lower the pitch smoothly upon ground contact and accomplish normal engine shutdown procedures.

4–26. Tail Rotor Failure in Flight

If a tail rotor failure should occur during flight, an attempt should be made to obtain a combination of power and airspeed which will allow the helicopter to maintain a heading. The airspeed will probably be in the vicinity of 70 to 80 knots IAS. Then landing site should be selected and an autorotative approach initiated. The copilot should monitor the quadrant throttles when the pitch is brought in to cushion the landing and insure that engine power is not applied at this time. Lower the pitch smoothly upon ground contact and accomplish normal engine shutdown procedures.

Section IIIA. MAIN TRANSMISSION

4–26.1 Activation of Chip Detector Warning Light on Main Transmission

a. If the magnetic chip detector warning light comes on while operating on the ground, proceed as follows:

(1) Shut down immediately.

(2) Remove the chip detector plug.

(3) Determine the safety of further operation per instructions contained in chapter 7, section I, paragraphs 7–4 and 7–5 of TM 55–1520–203–20.

b. If the chip detector warning light comes on during flight, proceed as follows:

(1) When operating under VFR conditions make a precautionary landing at the nearest suitable landing area.

(2) When operating under IFR conditions declare an emergency, make an approach, and land at the nearest facility.

(3) After landing and shutting down, remove chip detector plug and determine the safety of further operation per instructions contained in chapter 7, section I, paragraphs 7–4 and 7–5 of TM 55–1520–203–20.

Section IV. FIRE

4-27. Engine Fire

The procedures for engine fires are as follows:

4-28. Engine Fire While Starting

a. Starting procedure—CONTINUE CRANKING ENGINE IF ENGINE FIRE IS CONFINED TO INDUCTION OR EXHAUST SYSTEM, AND MOVE MIXTURE LEVERS TO IDLE CUTOFF. If engine does not start or fire is not blown out, proceed as follows:

b. Quadrant throttle—CLOSED.

c. Mixture lever—IDLE CUTOFF.

d. Engine fire emergency shutoff handle—ON (FULL OUT). This shuts off fuel and oil and selects nacelle for fire extinguisher.

e. Ignition switch—OFF.

f. Fuel booster pump switch—OFF.

g. Fuel shutoff switch—OFF.

h. Ground crew—ALERT.

i. Engine fire extinguisher switch—ON (IF GROUND CREW CANNOT EXTINGUISH FIRE).

Warning: Repeated or prolonged exposure to high concentrations of bromochloromethane (CB) or decomposition products should be avoided. CB is a narcotic agent of moderate intensity, but of prolonged duration. It is considered less toxic than carbon tetrachloride, methyl-bromide, or the usual products of combustion. It is safer to use CB than previous fire extinguishing agents. However, normal precautions should be taken, including the use of oxygen when available.

Caution: If engine fire extinguishing system has been used, replace discharged spherical container, purge all lines, and thoroughly clean and ventilate all contaminated areas as soon as possible, as action of fire extinguisher agent on metal is corrosive.

4–29. *Engine Fire After Starting.* If an engine fire develops after starting, advance the throttle to attempt to blow out the fire. If the fire continues to burn, proceed as instructed in paragraph 4–28.

4–30. *Engine Fire in Flight. a.* Crew – ALERT.

b. Airspeed – 65 TO 75 KNOTS IAS. Attain safe single engine airspeed.

c. Mixture lever – IDLE CUTOFF.

d. Engine fire emergency shutoff handle – ON(FULL OUT). This shuts off fuel and oil and selects nacelle for fire extinguisher.

e. Ignition switch – OFF.

f. Fuel booster pump switch – OFF.

g. Engine fire extinguisher switch – ON.

Note

Land as soon as possible. Determine cause of fire before continuing flight.

4–31. Fuselage Fire. *a.* Pilots' compartment sliding windows – CLOSED.

b. Cabin doors – CLOSED.

c. Ventilating blower switch – OFF (CENTERED).

d. Portable fire extinguisher – USE.

Note

Land as soon as possible. Determine cause of fire before continuing flight.

4–32. Electrical Fire. Possibilities of electrical fires are slight because the generators are equipped with overvoltage relays, and each electrical circuit is protected from overload by circuit breakers. However, in event of an electrical fire, attempt to isolate the circuits affected by pulling circuit breakers. If fire persists, land as soon as possible. While in flight, accomplish the following:

a. Circuit breaker (for affected circuits) – PULL.

b. Prepare to land – IF FIRE PERSISTS.

c. Generator switches – OFF.

d. Battery switch – OFF (AFTER LOWERING LANDING GEAR).

e. Portable fire extinguisher – USE.

4–33. Smoke Elimination. After a fire is extinguished, smoke may be eliminated by opening the pilots' compartment sliding windows and turning on the ventilating fan. Adjust the ventilating registers in the pilots' compartment and cabin as required. Open the door in the cabin aft bulkhead. Do not push out windows or open the cargo door while the helicopter is in flight because of the possibility of their being carried into the tail rotor blades by the airstream.

VARIOUS ENGINE MALFUNCTIONS ARE OFTEN INDICATED BY CHARACTERISTIC SMOKE AND FLAME PATTERNS. THIS CHART IS PROVIDED SO THAT THE FLIGHT CREW MAY MORE ACCURATELY IDENTIFY DIFFERENT ENGINE FLAME AND SMOKE CONDITIONS AND KNOW AT ONCE THE CAUSE AND THE REMEDIAL ACTION TO BE UNDERTAKEN.

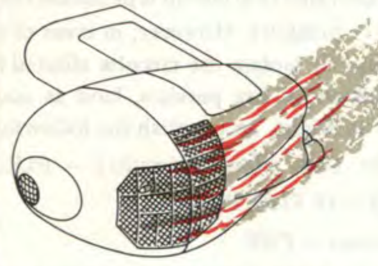
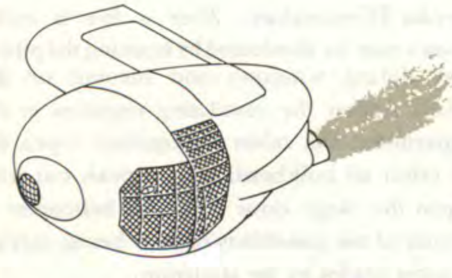
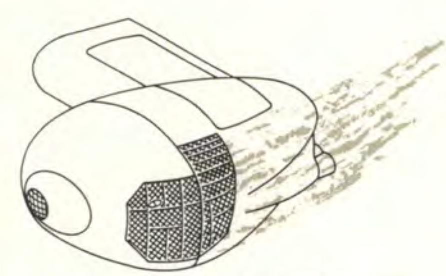
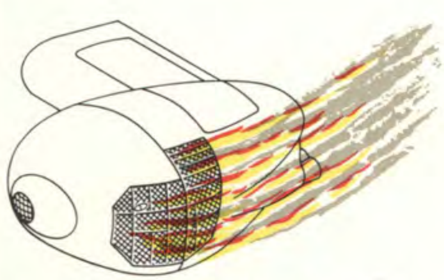
	CAUSE	ACTION
 VARIABLE QUANTITY OF GREY SMOKE AND POSSIBLY LIGHT FLAME FROM ENGINE COOLING AIR OUTLETS	CYLINDER HEAD OR EXHAUST FAILURE INDICATED BY HIGH CYLINDER HEAD TEMPERATURE, LOSS OF POWER AND POSSIBLE ILLUMINATION OF ENGINE FIRE WARNING LIGHT. IF THIS CONDITION IS ALLOWED TO CONTINUE, ENGINE FAILURE AND FIRE MAY RESULT.	PERFORM ENGINE FIRE IN FLIGHT PROCEDURE. ALERT CREW.
 HEAVY BLACK SMOKE FROM EXHAUST EJECTOR	INITIAL INDUCTION FIRE FROM BURNING FUEL POSSIBLY INDICATED BY HIGH CYLINDER HEAD TEMPERATURE AND A SUDDEN LOSS OF POWER. AN UNCONTROLLED FIRE MAY DEVELOP.	PERFORM ENGINE FIRE IN FLIGHT PROCEDURE. ALERT CREW.
 DENSE WHITE SMOKE FROM ENGINE COOLING AIR OUTLETS	INDUCTION FIRE IN ADVANCED STAGE. POSSIBLY VERY HIGH CYLINDER HEAD TEMPERATURE AND CARBURETOR AIR TEMPERATURE, FLUCTUATING ENGINE INSTRUMENTS AND ILLUMINATION OF ENGINE FIRE WARNING LIGHT. UNCONTROLLED FIRE MAY DEVELOP.	PERFORM ENGINE FIRE IN FLIGHT PROCEDURE. IF FIRE DOES NOT GO OUT, THE FIRE HAS PROGRESSED TO EXTREMELY DANGEROUS STAGE. THERE IS NO REMEDIAL ACTION. ALERT CREW AND PREPARE TO BAIL OUT.
 BLACK SMOKE WITH ORANGE AND YELLOW FLAME FROM ENGINE COOLING AIR OUTLETS	FUEL LEAK AND FIRE, POSSIBLY VARIABLE FUEL PRESSURE, HIGH CYLINDER HEAD TEMPERATURE, AND ILLUMINATION OF ENGINE FIRE WARNING LIGHT. AN UNCONTROLLED FIRE MAY DEVELOP.	PERFORM ENGINE FIRE IN FLIGHT PROCEDURE. ALERT CREW.

Figure 4–2. Engine flame and smoke identification chart {Sheet 1 of 2}

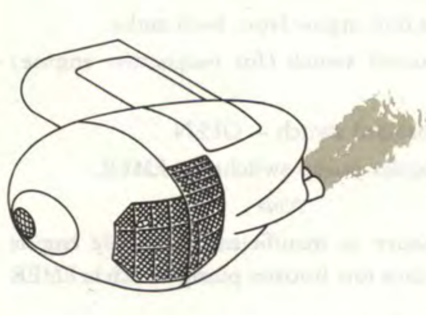
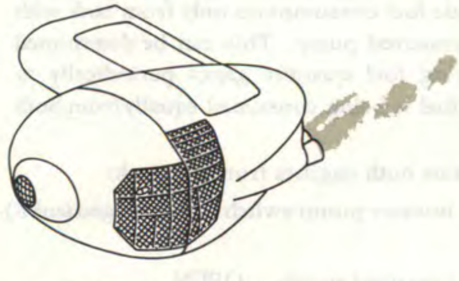
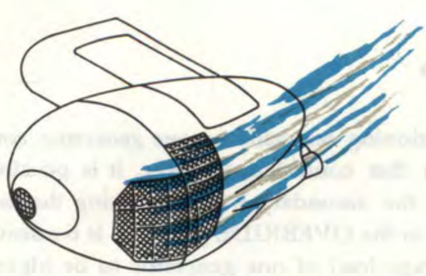
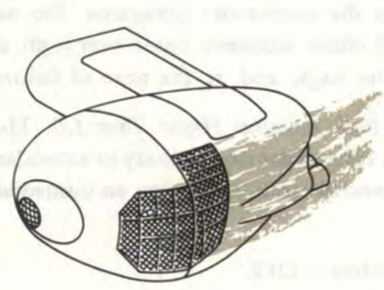
	CAUSE	ACTION
 BLACK SMOKE FROM EXHAUST EJECTOR	USUALLY OCCURS AT HIGH POWER SETTINGS AND INDICATES TOO RICH CARBURETOR MIXTURE. THERE WILL BE NO INSTRUMENT INDICATIONS EXCEPT THAT FUEL WILL BE CONSUMED AT A FASTER RATE THAN NORMAL.	MANUAL LEANING BEYOND NORMAL SHOULD NOT BE ATTEMPTED. REDUCE POWER.
 PUFFS OF BLACK SMOKE FROM EXHAUST EJECTOR	DETONATION, AND/OR BACKFIRE. INDICATED BY ROUGH RUNNING ENGINE, HIGH CYLINDER HEAD TEMPERATURE AND CARBURETOR AIR TEMPERATURE, AND LOSS OF POWER. IF THIS CONDITION CONTINUES, ENGINE FAILURE IS IMMINENT.	ENRICH MIXTURE, REDUCE POWER, MONITOR ENGINE INSTRUMENTS.
 THIN WISPS OF BLUE-GRAY SMOKE FROM ENGINE COOLING AIR OUTLETS	SLIGHT OIL LEAK. POSSIBILITY OF FIRE EXISTS, BUT NO ACTION NECESSARY UNLESS FIRE DEVELOPS.	WATCH CLOSELY AND LAND AS SOON AS POSSIBLE IF VOLUME OF SMOKE INDICATES THE NECESSITY.
 BLACK SMOKE FROM ENGINE COOLING AIR OUTLETS	OIL LEAK AND OIL FIRE, POSSIBLY VARIABLE OIL PRESSURE, HIGH CYLINDER HEAD TEMPERATURE, AND ILLUMINATION OF ENGINE FIRE WARNING LIGHT. AN UNCONTROLLED FIRE MAY DEVELOP.	PERFORM ENGINE FIRE IN FLIGHT PROCEDURE. ALERT CREW.

Figure 4–2. Engine flame and smoke identification chart (Sheet 2 of 2)

Section V Fuel System

4–34. Fuel Booster Pump Failure. If a fuel booster pump should fail, gravity feed and the engine-driven fuel pump should supply fuel under sufficient pressure for normal engine operation. If there should be insufficient fuel pressure to operate the engine and the failure can definitely be traced to a faulty booster pump, place the booster pump switch in the EMER position. If pressure is not restored, shut off the pump; low fuel pressure can be caused by a fuel leak. (Refer to paragraph 4–12.) If a booster pump has failed and the engine is not receiving fuel properly, the fuel crossfeed system may be used to supply both engines from one tank; however, usable fuel will be cut in half as the fuel cannot be used from the tank with the inoperative booster pump.

4–35. Use of Crossfeed System. Each engine has a separate fuel system which consists essentially of a tank, an electrically operated fuel booster pump, and an engine-driven pump. The only connection between the two systems is the crossfeed system. The crossfeed system enables the pilot to operate one engine on fuel from both tanks during single engine operation, or to operate both engines from one tank in event of damage to, or loss of, fuel from one tank.

a. To operate one engine from both tanks:

(1) Fuel shutoff switch (for inoperative engine) – OFF.

(2) Fuel crossfeed switch – OPEN.

(3) Fuel booster pump switches – EMER.

Note

If fuel pressure is insufficient for single engine operation, place fuel booster pump switch in EMER position.

If a noticeable difference in fuel pressure exists due to uneven output of booster pumps, it may be more satisfactory to operate from one tank at a time to preclude fuel consumption only from tank with higher pressured pump. This can be determined by checking fuel quantity gages periodically to ascertain fuel is being consumed equally from both tanks.

b. To operate both engines from one tank:

(1) Fuel booster pump switch (for damaged tanks) – NORM.

(2) Fuel crossfeed switch – OPEN.

(3) Fuel booster pump switch (for good tank) – EMER.

Section VI Electrical System

4–36. Generator Failure. Indications of generator malfunction are the lighting of either or both generator failure warning lights or excessively low or high amperage indicated on either or both ammeters. Although a voltmeter is also provided, generally enough immediate indications of trouble can be obtained from the lights and the ammeters. The voltmeter may be used later for checking generator or bus voltage as selected by the voltmeter selector switch on the overhead dome light panel. Since the generators are driven by the engines and are inaccessible in flight, and since helicopter flights are of comparatively short duration, it is not recommended that attempts be made to repair the electrical system in flight. The electrical system is designed to function on one generator if a malfunctioning generator can be shut off successfully. Note that if one engine fails, its generator is inoperative. With one generator failed or inoperative, the secondary bus will be automatically disconnected. For equipment operating from the secondary bus, see figure 2–20. If the electrical system is functioning normally on one generator, continue flight in that condition; however, it is possible to reenergize the secondary bus by placing the bus control switch in the OVERRIDE position. It is normal for the amperage load of one generator to be higher than usual when operating under these conditions, but it should not be higher than 1.0 (100 percent load). If the flight is of longer duration, it may be desirable, if possible, to reset the inoperative generator. Do not reset a generator if either ammeter reads very high or off the scale at the high end at the time of failure.

4–37. Procedure – Both Ammeters Higher Than 1.0. This condition indicates either a shorted primary or secondary bus or generator control circuits, causing an immediate fire hazard.

a. Generator switches – OFF.

b. Battery switch – OFF.

c. Portable fire extinguishers – PREPARE TO USE.

d. Main landing gear actuating lever – DN. Use emergency hydraulic system. (Refer to paragraph 4–45.)

e. Prepare to land – AS SOON AS POSSIBLE.

Caution

If secondary bus is shorted, an attempt may be made to regain primary bus. However, delay performing following procedure as long as possible to permit cooling of shorted equipment because a hazardous fire condition exists.

f. Bus control switch – NORMAL.

g. Either generator switch – ON. Keep a hand on generator switch and observe ammeter as the switch is turned on. If ammeter reads higher than 1.0, turn off generator switch immediately. If ammeter reads below 1.0, continue flight with single generator operation.

4–38. Procedure – One Ammeter Higher Than 1.0 With Other Ammeter Normal. An ammeter reading higher than 1.0 indicates a shorted generator control circuit. As the other generator is operating normally, flight may be continued on one generator.

a. Generator switch (shorted circuit) – OFF.

b. All unnecessary equipment – OFF.

c. Voltmeter and ammeter (operative generator) – CHECK.

4–39. Procedure – One Ammeter Zero, Generator Warning Light Illuminated. This condition indicates failure of one engine, an open generator winding or control circuit, or mechanical failure of the generator cutout because of a temporary overvoltage condition. There is no immediate electrical danger and flight may be continued on one generator.

a. Generator switch (failed generator) – OFF.

b. All unnecessary electrical equipment – TURN OFF.

c. Voltmeter and ammeter (operative generator) – CHECK. Note that voltage and amperage loads of remaining generator are normal. (Amperage load will be high, but should not be higher than 1.0.)

d. Generator switch (failed generator) – RESET. If both generators are needed for longer flight or greater electrical loads, an attempt to reset generator may be made.

4–40. Resetting Generator or Reenergizing Secondary Bus.

a. Generator switch (failed generator) – RESET, THEN ON.

b. Voltmeter and ammeter (both generators) – CHECK. Note that voltage and amperage loads of both generators are normal. If they are normal, both generators are functioning and secondary bus will have been reenergized automatically.

c. Bus control switch – SEC BUS OVERRIDE. If an attempt to reset inoperative generator is not to be made or was unsuccessful, secondary bus may be reenergized if operation of equipment connected to secondary bus is required.

d. Voltmeter and ammeter (operative generator) – CHECK. Note that voltage and amperage loads of operating generator are normal.

4–41. Procedure – Both Ammeters Zero, One Generator Off, Second Generator Fails, or Failure of Both Generators. If both generators fail (ammeters indicating zero amperages), or one generator fails and the other is shut off, an attempt to reset one generator may be made. If the attempt is unsuccessful, prepare to land as soon as possible.

a. Battery switch – ON.

b. Both generator switches – OFF.

c. All unnecessary electrical equipment – TURN OFF.

d. APU – ON.

e. Main landing gear actuating lever – DN.

4–42. Inverter Failure. When the inverter switch is in the NORMAL position, both inverters are operating. Should the main inverter fail, power can be restored to the spare inverter by placing the inverter switch in the EMERGENCY position. Should the spare inverter fail, the circuit breaker for the spare inverter should be pulled, and the inverter selector switch reset to NORMAL. If both inverters fail, all pressure gages, gyros, and fuel quantity gages will be inoperative. (See figure 2–21.)

Section VII Hydraulic System

4–43. Hydraulic Pressure Failure. The utility hydraulic system receives pressure from a pump driven by the left engine. In event of a failure of this hydraulic pump, or loss of the left engine or hydraulic pressure in the system, the following equipment will be inoperative: landing gear, ramp, nose doors, tail rotor pedal damper, and the twist-grip throttle servo. The landing gear can be lowered by means of the emergency hydraulic system as covered in paragraph 4–45. The ramp can be lowered by actuating the emergency lock levers; the nose doors can be opened and closed manually. Care should be exercised in using the tail rotor pedals to avoid abrupt changes in tail rotor pitch due to failure of the pedal damper, and greater force will be required to operate the twist-grip throttle. The rotor brake may be inoperative if there is excessive loss of fluid from the utility hydraulic system. Although the hydraulic power boost will be unavailable to the wheel brakes, they will be operative to the extent that the pilot can exert foot pressure on the brake pedals.

4–44. Electrical Failure of Hydraulic Valves. In the event of electrical power failure, the hydraulic valves of equipment operating from the utility system cannot be actuated electrically. The landing gear can be lowered by use of the emergency hydraulic system. The hydraulic valve manual override controls can be actuated to position the nose doors and ramp. (See figure 13–10.)

4–45. Landing Gear Failure. In the event of failure of the left engine, with consequent loss of the utility hydraulic system, if the utility hydraulic system itself should fail, or if the electrical circuit to the landing gear actuating valve fails, the landing gear cannot be retracted; however, it can be lowered by use of the emergency hydraulic system. (See figure 4–3.) To lower the landing gear, proceed as follows:

a. Main landing gear actuating lever – DN.

b. Emergency hydraulic system valve handle – CLOSE (ROTATE CLOCKWISE).

c. Emergency hydraulic pump lever – EXTEND LEVER AND ACTUATE.

Note

If the gear does not fall free prior to obtaining 1500 psi with the emergency hydraulic pump, a sticking actuating valve may be suspected. Place the landing gear emergency valve switch in the ON position. In case of a malfunction of the uplock mechanism, the landing gear may be lowered by having a crewmember pull the appropriate uplock emergency release handle (figure 4–3), one each of which is located on the left and right side of the inside cabin walls just aft of the rear wing beam.

d. After gear drops:

(1) Emergency hydraulic pump lever – CONTINUE TO ACTUATE.

(2) Emergency hydraulic system pressure gage – ATTAIN 1500 PSI. Approximately 50 strokes of pump lever (which can be accomplished in approximately 30 seconds) are required to obtain 1500 psi to lower landing gear and seat down-locks.

Caution

Do not exceed 1500 psi while actuating emergency pump.

e. Emergency hydraulic system pressure gage (during landing procedure) – MAINTAIN 1500 PSI.

f. Down-lock pins – CHECK. After landing, ascertain that down-lock pins are firmly extended before opening emergency hydraulic valve.

Warning

If landing gear emergency valve switch has been utilized, keep emergency hydraulic valve closed, emergency switch ON, and maintain electrical power until left engine is cut and utility hydraulic pressure subsides.

g. Flight engineer – ALERT. Notify crew chief that helicopter must be put on jacks until malfunction is located and corrected.

4–46. Landing Gear – Electrical Malfunction. (Refer to table 4–1.) In general, any departure from normal

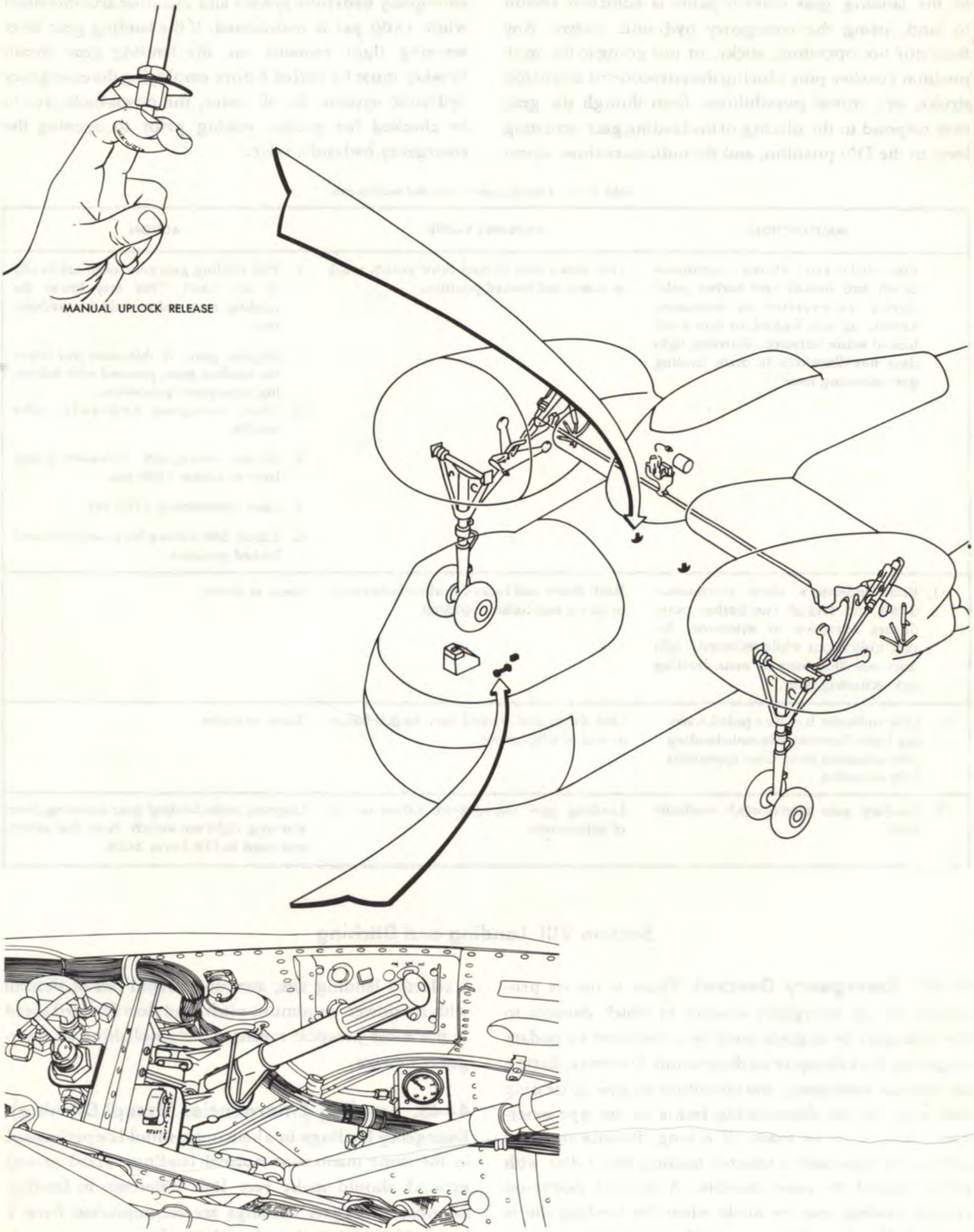


Figure 4–3. Emergency landing gear system

in the operation of the landing gear or the indications in the landing gear control panel is sufficient reason to land, using the emergency hydraulic system. Any indicator not operating, sticky, or not going to the mid-position (barber pole) during the retraction or extension stroke, are typical possibilities. Even though the gear may respond to the placing of the landing gear actuating lever in the DN position, and the indicators show down and locked, any abnormality will warrant the use of the emergency hydraulic system and a landing accomplished while 1500 psi is maintained. If the landing gear lever warning light remains on, the landing gear circuit breaker must be pulled before employing the emergency hydraulic system. In all cases, the down-locks are to be checked for proper seating prior to opening the emergency hydraulic valve.

Table 4–1. Landing gear – electrical malfunction

MALFUNCTION	PROBABLE CAUSE	ACTION
I. One indicator shows continuous down and locked (no barber pole) during retraction or extension. Erratic, up and locked, or down and locked while retracted. Warning light does not illuminate in main landing gear actuating lever.	One down and locked limit switch stuck in down and locked position.	1. Pull landing gear control circuit breaker and reset. This may lower the landing gear and remedy the malfunction. 2. Recycle gear. If this does not lower the landing gear, proceed with following emergency procedure. 3. Close emergency hydraulic valve handle. 4. Actuate emergency hydraulic pump lever to obtain 1500 psi. 5. Land maintaining 1500 psi. 6. Check down-locks for actual down and locked position.
II. Both indicators show continuous down and locked (no barber pole) during retraction or extension. Erratic indications while retracted. Light does not illuminate in main landing gear actuating lever.	Both down and locked limit switches stuck in down and locked position.	Same as above.
III. One indicator barber poled warning light illuminated in main landing gear actuating lever. Gear apparently fully extended.	One down and locked limit switch failure or out of adjustment.	Same as above.
IV. Landing gear microswitch malfunction.	Landing gear microswitch failure or out of adjustment.	Depress main landing gear actuating lever warning light test switch. Note that switch was used in DA Form 2408.

Section VIII Landing and Ditching

4–47. Emergency Descent. There is no set procedure for an emergency descent in which damage to the helicopter or engines must be considered secondary to getting the helicopter on the ground. However, during an extreme emergency, the condition or type of landing area may be the determining factor in the type emergency descent to be made. If a long distance must be covered to approach a selected landing site, a dive with power would be most feasible. A normal power-on vertical landing may be made when the landing site is reached. If a short distance must be covered to approve a selected landing site, attaining a rapid rate of descent with no power, minimum pitch, and slow forward speed is the most practical means of accomplishing an emergency descent.

4–48. Landing Emergencies (Except Ditching). Emergency landings in a helicopter should be performed in the same manner as normal landings. Hard or soft ground should make very little difference in landing as most helicopter landings are accomplished from a hover. If the terrain is soft or the surface is unprepared, rolling landings are not recommended as the main wheels may sink into the ground and cause the helicopter to nose over. The following should be accomplished before emergency landings:

a. Crew – ALERTED (by use of interphone or the alarm bell).

b. Passengers – Seated in troop seats with safety belts fastened.

c. Approach and landing – Proceed with normal approach and landing.

4–49. Landing With Wheels Retracted or Improperly Lowered. To make a successful landing with improperly lowered landing gear is not as difficult with a helicopter as with a conventional aircraft. By proper selection of a landing site and careful hovering and letdown, it is possible to land with minimum danger to personnel or damage to the helicopter. If all attempts to lower the landing gear by actuation of the emergency hydraulic system are unsuccessful, it may be possible to jar the gear loose by an abrupt increase in collective pitch after a shallow dive.

4–50. Landing With Both Wheels Retracted or With Down-Locks Not Seated. If a landing must be made with both wheels retracted or with one or both wheels down but not locked, choose a level spot with no obstructions and preferably with a soft surface such as sand, grass, or bushes. Hover at high power and let down slowly and smoothly with no forward or sideward motion. As soon as the wheels (or wheel) touch, they will be pushed backward as in partial retraction. The helicopter will settle on the bottom structure. Reduce rotor speed slowly to note which way, if any, the helicopter will tilt. The greatest damage with a nonwheel landing will occur to the rotor head and blades if the helicopter tips to one side and the blades strike the ground. The blades will touch the ground even if the helicopter rests on the bottom and one nacelle. Maintain control as long as possible with the cyclic stick as the rotors slow down. Apply the rotor brake gradually when control is no longer effective and the helicopter starts to tip.

4–51. Landing With One Wheel Retracted or One Down-Lock Not Seated. If only one wheel is down and locked, and the other wheel fails to lower or to lock down even when the emergency hydraulic system is actuated, attempt to raise or unlock the wheel that is down by utility system hydraulic power to provide a symmetrical configuration for a safer landing. If the down-lock will not release or the utility hydraulic system is inoperative, head the helicopter into the wind and attempt to touch down as gently as possible on the one wheel and the opposite side of the fuselage bottom structure. Since there is a probability that the helicopter will tip over upon landing, or that the impact will be severe, secure or jettison all loose equipment and hover near the ground to evacuate all cabin personnel. When leaving the helicopter, personnel should stay clear of main and tail rotor blades, especially under windy conditions. Crewmembers remaining in the helicopter should lock their shoulder harness inertia reels.

4–52. Landing With Flat Tire. Landing with a flat tire should be with little or no forward speed as the added weight on the second tire, especially during a hard landing, may cause a blowout which would cause the wheel to sink into the ground.

4–53. Emergency Entrances. (See figure 4–4.) Emergency entrances to the pilots' compartment are the jettisonable side windows. Emergency entrances to the cabin are the nose door emergency panels, the forward sliding cargo door, the emergency hatch on the left side of the fuselage, and the cabin windows. All emergency entrance handles are marked.

4–54. Ditching. (Refer to table 4–2.) The helicopter is excellent in ditching performance since it is capable of contacting the water with little or no forward speed; however, it has poor floating tendencies. By virtue of its versatility, most landings may be accomplished safely, either by briefing the crew or by ditching drills prior to all overwater flights. For miscellaneous emergency equipment see figure 4–5.

4–55. Planned Ditching – (Power On) Procedures. In the event of unanticipated fuel shortage during overwater flights, or for any other unforeseen reasons when ditching the helicopter is imminent but not immediate, much can be done to further protect personnel by having a planned ditching procedure. Remain in area of ditching to facilitate search and rescue.

a. Crew – ALERTED. When a ditching appears inevitable, notify crew over interphone.

b. Sea survival gear – PREPARE FOR AERIAL DROP.

c. Distress message – TRANSMIT.

d. Life vests – CHECK SECURITY. Do not inflate.

e. Hover helicopter.

(1) Pilots' compartment sliding windows – JETTISON.

(2) Emergency hatch (cabin) – JETTISON.

(3) Cargo doors – SLIDE OPEN.

(4) Survival equipment – DROP INTO WATER.

(5) All personnel (including copilot) – ABANDON HELICOPTER.

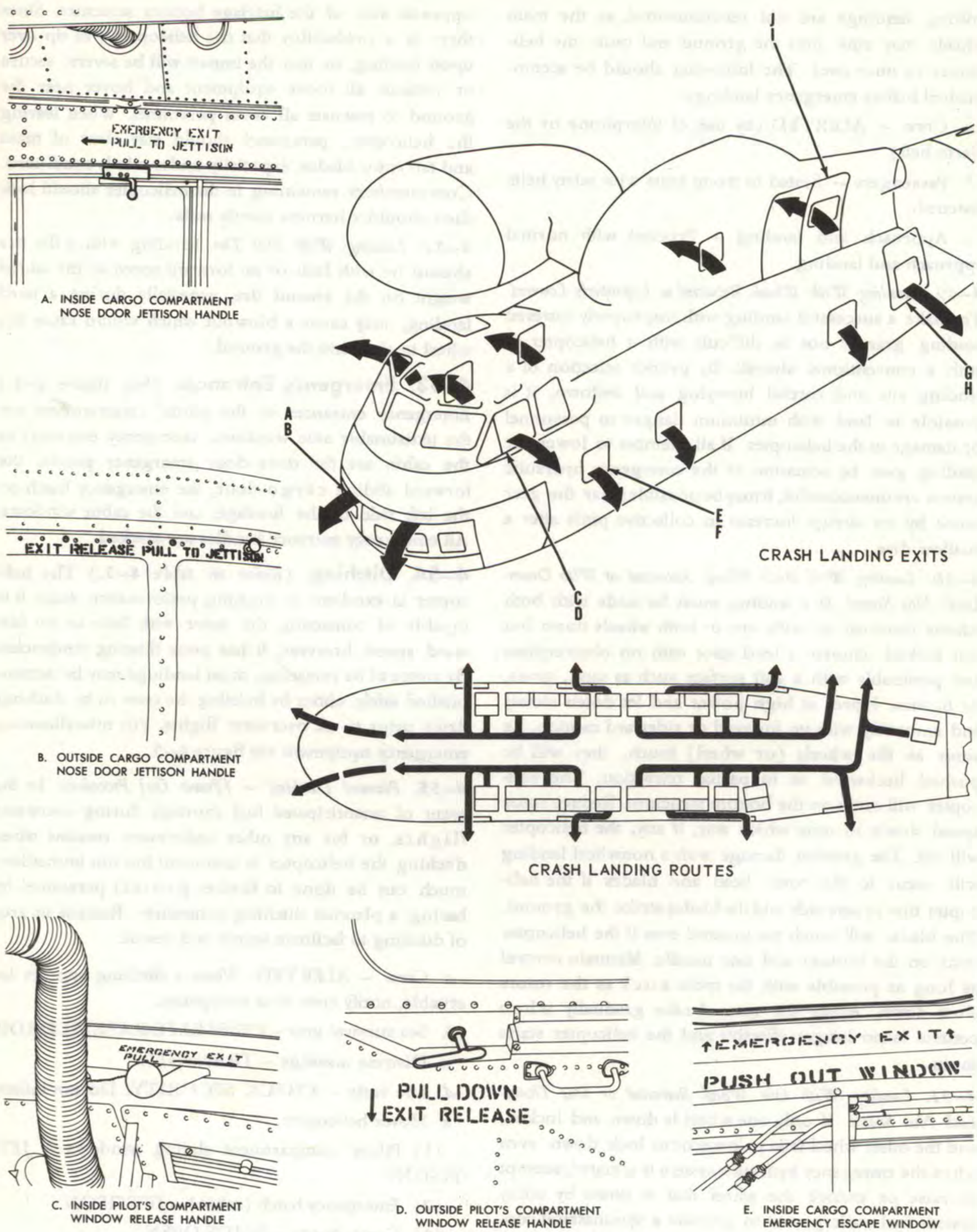


Figure 4–4. Emergency entrance and exit (Sheet 1 of 2)

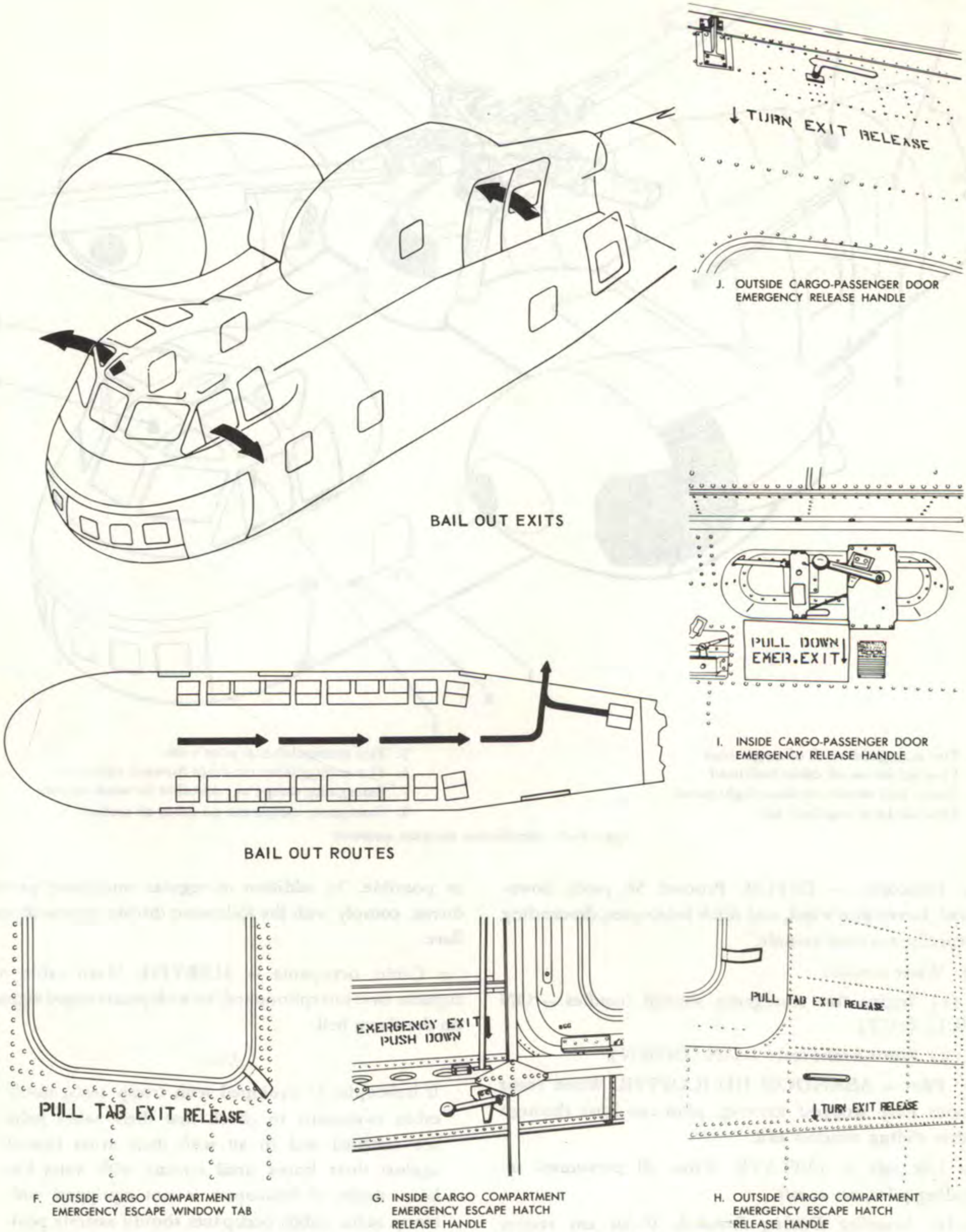
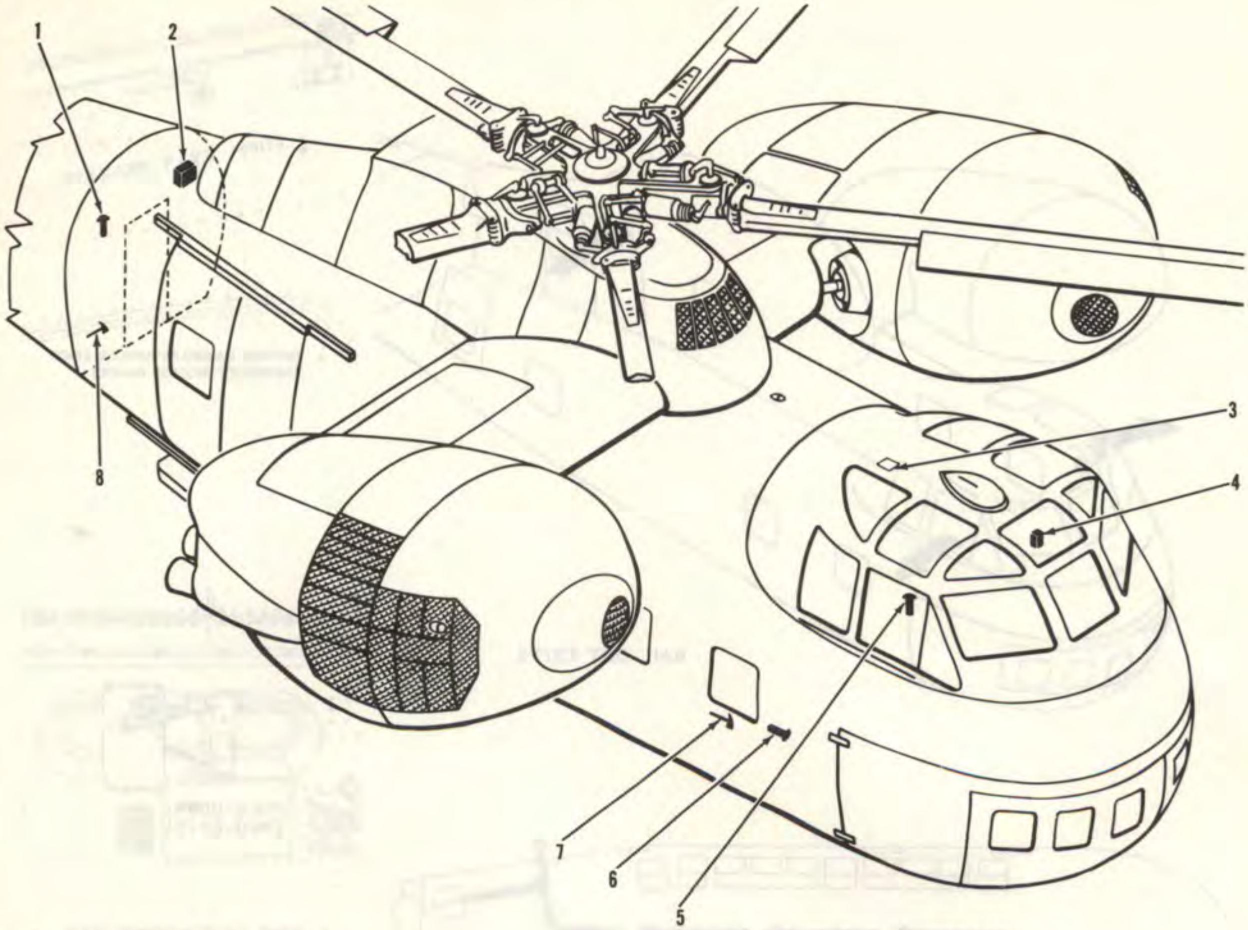


Figure 4–4. Emergency entrance and exit (Sheet 2 of 2)



1. Fire extinguisher aft of cargo door
2. First aid kit on aft cabin bulkhead
3. Alarm bell switch on dome light panel
4. First aid kit at copilot's left
5. Fire extinguisher at pilot's left
6. Fire extinguisher on cabin forward right side
7. Emergency escape axe on cabin forward section
8. Emergency escape axe on cabin aft section

Figure 4–5. Miscellaneous emergency equipment

f. Helicopter – DITCH. Proceed 50 yards downwind, hover into wind, and ditch helicopter, descending vertically in a level attitude.

g. Water contact.

(1) Engine fire emergency shutoff handles – ON (FULL OUT).

(2) Rotor brake lever – ON (DOWN).

h. Pilot – ABANDON HELICOPTER. When rotor blades have stopped turning, pilot can leave through either sliding window exit.

i. Life raft – INFLATE. When all personnel, including pilot, are at raft.

4–56. Immediate Ditching Procedures. If for any reason further flight is not advisable or possible, proceed as instructed in the appropriate emergency procedures in this section. However, contact with the water should, in every instance, be made with as little forward speed as possible. In addition to regular emergency procedures, comply with the following during approach and flare.

a. Cabin occupants – ALERTED. Warn cabin occupants over interphone and/or with prearranged signals on the alarm bell.

Note

If helicopter is equipped with troop seats, notify cabin occupants to check that their safety belts are fastened and to sit with their arms braced against their knees until contact with water has been made. If helicopter is not equipped with troop seats, cabin occupants should assume positions aft of any cargo that might be present. If there is no cargo, cabin occupants should brace themselves in any possible manner to prevent or retard any forward movement.

b. Distress message – TRANSMIT.

c. Shoulder harness inertia reel lock levers – LOCKED.

d. Life vests – CHECK SECURITY. DO NOT INFLATE.

e. During an autorotative landing, accomplish before flare:

(1) Cabin occupants – ALERTED TO BRACE FOR DITCHING. Warn cabin occupants over interphone or by prearranged signals on alarm bell.

(2) Fuel shutoff switches – OFF.

(3) Ignition switches – OFF.

(4) Generator switches – OFF.

f. On water contact (autorotative landing). Rotor brake lever – ON (DOWN). Apply gradually.

g. Water contact (power-on landing).

(1) Engine fire emergency shutoff handles – ON (FULL OUT).

(2) Battery switch – OFF.

(3) Rotor brake lever – ON (DOWN). Apply gradually.

h. Pilots' compartment sliding windows and cabin emergency hatch – JETTISON.

i. Aft cargo sliding door if in forward flight, or both cargo sliding doors if in hover – SLIDE OPEN.

j. Helicopter – ABANDON. When rotor blades have stopped turning, pilot and copilot leave through either sliding window exit in pilots' compartment and cabin occupants leave through cargo sliding doors or cabin emergency hatch.

Table 4–2. Ditching procedure (Sheet 1 of 2)

PLANNED DITCHING	DITCHING POSITION	IMMEDIATE DITCHING
PILOT	PILOT'S SEAT	PILOT
a. Ditching plan – BRIEF CREW PRIOR TO FLIGHT		*a.* Ditching plan – BRIEF CREW PRIOR TO FLIGHT
b. Crew – ALERT		*b.* Distress message – TRANSMIT
c. Sea survival gear – ORDER TO PREPARE FOR AERIAL DROP		*c.* Shoulder harness inertia reel lock lever – LOCKED
d. Distress message – TRANSMIT		*d.* Life vest – CHECK, DO NOT INFLATE
e. Life vest – CHECK, DO NOT INFLATE		*e.* During autorotative landing
f. Hover Helicopter		(1) Crew – ALERT TO BRACE FOR DITCHING
(1) Sliding window – JETTISON		(2) Fuel shutoff switches, ignition switches, generator switches – OFF
(2) Emergency hatch – ORDER TO JETTISON		*f.* During power on landing, water contact
(3) Sea survival gear – ORDER TO DROP		(1) Engine fire emergency shutoff handles – ON (full out)
(4) Cargo doors – SLIDE OPEN		(2) Battery switch – OFF
(5) All personnel, including copilot – ORDER TO ABANDON HELICOPTER		(3) Rotor brake lever – APPLY
g. Helicopter – DITCH 50 YARDS DOWNWIND		*g.* After water contact
h. Helicopter – ABANDON THROUGH EITHER SLIDING WINDOW EXIT AFTER ROTOR BLADES HAVE STOPPED TURNING		(1) Sliding window – JETTISON
		(2) Emergency hatch – ORDER TO JETTISON
		(3) Cargo doors – SLIDE OPEN
		h. After rotor blades have stopped turning
		(1) All personnel, including copilot – ORDER TO ABANDON HELICOPTER
		(2) Helicopter – ABANDON THROUGH EITHER SLIDING WINDOW EXIT

Table 4–2. Ditching procedure (Sheet 2 of 2)

PLANNED DITCHING	DITCHING POSITION	IMMEDIATE DITCHING
COPILOT	COPILOT'S SEAT	**COPILOT**
a. Sliding window – JETTISON *b.* Life vest – CHECK, DO NOT INFLATE *c.* Sea survival gear (if no cabin occupants on flight) – DROP *d.* Helicopter – ABANDON THROUGH SLIDING WINDOW, AFT CARGO SLIDING DOOR IF IN FORWARD FLIGHT OR BOTH CARGO SLIDING DOORS IF IN HOVER AFTER NOTIFYING PILOT		*a.* Shoulder harness inertia reel lock lever – LOCKED *b.* Life vest – CHECK, DO NOT INFLATE *c.* Sliding window – JETTISON *d.* Helicopter – ABANDON THROUGH SLIDING WINDOWS AFT CARGO SLIDING DOOR IF IN FORWARD FLIGHT OR BOTH CARGO SLIDING DOORS IF IN HOVER AFTER ROTOR BLADES HAVE STOPPED TURNING AND AFTER NOTIFYING PILOT
FLIGHT ENGINEER OR PASSENGER	TROOP SEAT OR CABIN FLOOR	**FLIGHT ENGINEER OR PASSENGER**
a. Emergency hatch – JETTISON *b.* Sea survival gear – PREPARE FOR AERIAL DROP *c.* Life vest – CHECK, DO NOT INFLATE *d.* Sea survival gear – DROP *e.* Helicopter – ABANDON THROUGH AFT CARGO SLIDING DOOR IF IN FORWARD FLIGHT OR BOTH CARGO SLIDING DOORS IF IN HOVER		*a.* Emergency hatch – JETTISON *b.* Ditching position – STRAPPED IN TROOP SEAT, OR IF NONE, SITTING ON CABIN FLOOR WITH BACK FORWARD AND BRACED, AFT OF CARGO IF PRESENT *c.* On pilot's signal – BRACE FOR DITCHING *d.* Helicopter – ABANDON THROUGH AFT CARGO SLIDING DOOR IF IN FORWARD FLIGHT OR BOTH CARGO SLIDING DOORS IF IN HOVER AFTER ROTOR BLADES HAVE STOPPED TURNING.

4–57. Emergency Exits. (See figure 4–4.) The emergency exits in the helicopter may be used as emergency entrances. The location and use of these emergency exits by compartment are as follows:

Caution

In flight, avoid jettisoning cargo door, escape hatches, and windows, if possible, as these items may rise into the rotor blades, causing additional damage and adding to emergency.

4–58. Pilots' Compartment Emergency Exits. (See C and D, figure 4–4.) A panel on each side of the pilots' compartment, composed of the sliding window and the window tracks, can be jettisoned to provide an emergency exit. The panel will jettison with the sliding window in any position. The emergency release handles are located inside the pilots' compartment outboard of the instrument panel. The handles are marked EMERGENCY EXIT, PULL. When the handle is pulled aft, the panel drops outward and downward. The panels can be released from the outside by pulling down on the handle, marked PULL DOWN, EXIT RELEASE, located below the lower sliding window track.

4–59. Cargo Compartment Emergency Escape Hatch and Cargo Passenger Door. (See G, H, I, and J, figure 4–4.) The aft cargo compartment window on the left side of the fuselage provides an emergency exit for the occupants of the cargo compartment. The emergency release handle is located at the lower aft corner of the hatch and is indicated by a luminescent marker. The inside emergency release handle is marked EMERGENCY EXIT, PUSH OUT. To open the emergency hatch swing the handle down and forward and push the hatch out. A handle, marked TURN, EXIT RELEASE, is also provided to open the emergency hatch from outside the helicopter. Turn the handle clockwise and pull the hatch outward. Yellow dashes painted around the outside of the emergency hatch indicate where the outer skin may be cut to open the hatch if the releases are jammed.

4–60. Nose Door Emergency Panels. (See A and B, figure 4–4.) The upper portion of each nose door can be jettisoned to provide emergency exit from the forward end of the cargo compartment. The nose door emergency panel release handles inside the cargo compartment are located at the top center of each door. The nose door emergency panel release handles are marked EMERGENCY EXIT, PULL TO JETTISON. When the release handle is pulled outboard, the top of the door falls out. The panel may also be opened from the outside by pulling out on the handle, marked EXIT RELEASE, PULL TO JETTISON, located above the center window of each door.

4–61. Cargo Compartment Windows. (See E and F, figure 4–4.) The four forward windows, two on each cargo compartment side panel, may be pushed out to provide additional emergency exits. They are marked EMERGENCY EXIT, PUSH OUT WINDOW. Each of the cargo compartment windows is equipped with a pull tape outside at the lower aft corner, marked PULL TAB EXIT RELEASE, by which the locking strip may be pulled out of the rubber seal surrounding the window pane. The panes may then be removed to provide emergency openings. Because of their small size, the cargo compartment windows are not suitable as bail-out hatches; for bail-out use the emergency exits shown in figure 4–4.

Section IX Flight Controls

4–62. Flight Control Failure. In the event a flight control failure is encountered under any of the following conditions, the procedures as outlined will be followed.

4–63. Pedal Damper Failure. If the pedal damper should clog, the tail rotor pedals will be restricted in their movement. To free the pedals, place the throttle servo and pedal damper switch in the OFF position. If hard left pedal was being applied at the time of restriction, left pedal force must be released momentarily in order to clear the damper. After the damper has been cleared, the throttle servo and pedal damper switch may be turned on again at the discretion of the pilot. If pedal restriction reoccurs, turn off the throttle servo and pedal damper switch again. With the pedal damper turned off, operate the tail rotor pedals slowly and smoothly to avoid sudden changes in tail rotor thrust. When the pedal damper is turned off, the twist-grip throttle servo is also turned off, and greater force will be required to operate the twist-grip throttle.

4–64. Flight Control Servo Hydraulic System Failure. Control of the helicopter can be maintained through either the first stage or the second stage flight control servo hydraulic system if one or the other should fail; however, prolonged operation on one servo system is not recommended. Land as soon as practicable because control is impossible with both servo systems inoperative. In event of failure of the right engine, the second stage servo system will be inoperative as the second stage servo hydraulic pump is driven by the right engine.

4–65. Servo Hydraulic Pressure Failure. Loss of hydraulic pressure in either the first or second stage servo system will be indicated by the lighting of either of the servo hydraulic low-pressure warning lights and a lower than normal operating pressure on the corresponding servo hydraulic pressure gage. When this condition occurs, position the servo shutoff switch to turn off the affected system and continue flight on the remaining system. Reduce airspeed to between 60 and 70 knots IAS and land as soon as practicable because of the serious control problems that would arise should the remaining servo system fail.

4–66. Servo Unit Malfunction. Malfunction of the main or tail rotor servo units during flight will result in erratic behavior of the helicopter, roughness, uncontrollable maneuvers, or locking of the cyclic stick. At times it is difficult to determine which servo unit is responsible, or whether the first or second stage is causing the trouble. Both systems may be operating at normal hydraulic pressure and the system that is operating normally will tend to mask the effects of the malfunctioning system. When any of the signs of malfunction are experienced, reduce airspeed to between 60 and 70 knots IAS to lessen the effects of the malfunction. First turn off one servo system, then the other, by positioning the first and second stage servo shutoff switch, and continue flight on that system which is operating normally.

Caution

Abrupt maneuvers of helicopter may develop when operating system is turned off. When first and second stage servo shutoff switch is actuated, be prepared to return it to ON (center) position instantly, since control of helicopter will be lost very quickly when functional servo system is shut off.

Note

Because of pressure switch interlock, it is impossible to turn off one servo system, even if it is malfunctioning, if pressure in other servo system is below 1500 psi.

Section X Bail-Out or Ejection

4–67. Bail-Out. (See figure 4–4.) **If there are cabin occupants, appoint one person to be jumpmaster. He should monitor the interphone to receive the bail-out orders; notify the pilot when cabin occupants are prepared to jump; direct the orderly abandonment of the cabin, and be the last to leave the cabin; notifying the pilot just before he jumps.**

4–68. Bail-Out Procedure. a. Airspeed – 60 TO 70 KNOTS IAS.

b. Attitude – LEVEL.

c. Cyclic stick – TRIM. Adjust stick trim system to hold helicopter level.

d. Cabin occupants – ALERTED. Warn cabin occupants over interphone or with prearranged signals on the alarm bell.

e. Pilots' compartment sliding windows – JETTISON.

f. Aft cargo sliding door if in forward flight, or both cargo sliding doors if in hover – SLIDE OPEN.

g. Jumpmaster's report – RECEIVED. Confirmation that cabin occupants are prepared to jump.

h. Bail-out order – GIVEN BY PILOT.

Note

Decision to bail out is pilot's, based upon evaluation of all factors at time of emergency.

i. Cabin occupants – BAIL OUT. Cabin occupants dive out of cargo sliding door. Wait until clear of helicopter before pulling rip cord to avoid fouling parachute.

j. Pilot and copilot – BAIL OUT. Pilot and copilot will bail out of their respective sliding window exits in following manner:

(1) Each pilot will crouch in cockpit.

(2) Pilot will place his left foot on seat, and copilot will place his right foot on seat.

(3) Each pilot will place heel of his other foot on respective window ledge.

(4) Each pilot will kick away from helicopter.

Note

This procedure prevents copilot from sitting on his collective pitch lever prior to kicking away from helicopter.

CHAPTER 5
AVIONICS

Section I General

5-1. Scope. This chapter covers the electronic equipment configuration installed in the Army Model CH-37B helicopter. It includes a brief description of the electronic equipment, their technical characteristics, capabilities, and location. This chapter also contains complete operating instructions for all electronic equipment installed in the Army Model CH-37B helicopter.

5-2. Nomenclature and Common Names. A list of the common name assignments for the communication, navigation, radar identification, and automatic stabilization equipment covered in this chapter are listed in table 5-1.

Table 5-1. Nomenclature and common names

NOMENCLATURE	COMMON NAMES
Radio Set AN/ARC-44	FM liaison set
Receiver-Transmitter RT-294/ARC-44	FM receiver-transmitter
Control Panel SB-327/ARC-44	FM control panel
Signal Distribution Panel SB-329/AR	Signal distribution panel
Antenna AT-454/ARC	FM antenna
Radio Set AN/ARC-55	UHF command set
Receiver-Transmitter RT-349/ARC-55	UHF receiver-transmitter
Control Panel C-1287/ARC-55	UHF control panel
Antenna AT-450/ARC-45	UHF antenna
Radio Set AN/ARC-73	VHF command set
Receiver 51X-2B	VHF receiver
Transmitter 17L-7A	VHF transmitter
Control Panel 614U-6	VHF receiver control panel
Control Panel 614U-6	VHF transmitter control panel
Antenna 37R-2	VHF antenna
Transmitter T-366( )/ARC	Emergency VHF transmitter
Control Panel	Emergency VHF control panel
Radio Receiver AN/ARN-59	Automatic direction finder
Receiver R-836/ARN-59	ADF receiver
Control Panel C-2275/ARN-59	ADF control panel
Indicator IN-12	Azimuth indicator
Antenna AT-780/ARN	ADF loop antenna
Wire Antenna	ADF sense antenna
Radio Receiver AN/ARN-32	Marker beacon
Receiver R-666A/ARN-32	Marker beacon receiver
Antenna 37X-2	Marker beacon antenna
Automatic Pilot AN/ASN-23	Automatic stabilization equipment
Control Panel 2560E	ASE control panel
Motor Box S1645-61145	Motor box assembly

Section II Description and Data

5–3. Purpose and Use. The purpose and use of the electronic equipment installed in the CH-37B helicopter are described in paragraphs 5–4 through 5–16.

5–4. FM Liaison Set. The FM liaison set provides the pilot and copilot with two-way voice communication between aircraft and ground stations and aircraft to aircraft on the tactical military FM channels. The frequency range of the FM liaison set permits the pilot or copilot of this helicopter to communicate with armored, artillery, or infantry units in the field. The FM liaison set provides these communication facilities within a frequency range of 24.0 to 51.9 megacycles on 280 preset channels. The distance range is limited to line of sight up to distances of approximately 50 miles. Interphone is also provided by this radio set.

5–5. UHF Command Set. The UHF command set provides the pilot and copilot with short-range, two-way voice communication through the UHF command channels specifically set aside for military airways traffic communications. Two receivers and one transmitter are provided for communication between aircraft and ground stations and aircraft to aircraft for both normal and emergency operation. Normal communications are provided on a frequency of 225.0 to 399.9 megacycles. Emergency communications are provided on a frequency of 243.0 megacycles. The distance range is limited to line of sight up to distances of approximately 50 miles.

5–6. VHF Command Set. The VHF command set, when installed, provides the pilot and copilot with short-range, two-way voice communication within a frequency range of 116.00 to 151.95 megacycles. The transmitter of the VHF command set may be operated on any one of the 680 available channels within a frequency range of 116.00 to 149.95 megacycles. The receiver may be tuned to any one of the 720 available channels within a frequency range 116.00 to 151.95 megacycles. The distance range is limited to line of sight up to approximately 50 miles.

5–7. HF Command Set. Space, weight, and power provisions are provided for the HF command set.

5–8. Emergency VHF Transmitter. The emergency VHF transmitter is provided for use as an emergency communication system using the omni receiver (when installed) as a VHF receiver. The frequency range of this transmitter is from 116.0 to 132.0 megacycles. The distance range is limited to line of sight up to approximately 50 miles.

5–9. Auxiliary FM Receiver. Complete provisions are provided for the auxiliary FM receiver.

5–10. Omni Radio. Complete provisions are provided for the omni radio.

5–11. Automatic Direction Finder. The automatic direction finder is used for homing and direction finding on low-frequency radio ranges or standard broadcast stations. The frequency range of the automatic direction finder is from 190.0 to 1750.0 kilocycles. This set provides an automatic visual indication of the direction from which an incoming signal is received. This set also provides for the reception of voice and code signals. The distance range is dependent upon the altitude of the aircraft and atmospheric conditions.

5–12. Marker Beacon. The marker beacon provides both a visual and aural indication when the helicopter flies directly over a marker beacon transmitter. The receiver is fixed tuned to the marker beacon frequency of 75.0 megacycles. This set enables the pilot to accurately determine his position and make use of the marker signals employed by instrument approach systems. The range of this set is vertical to 50,000 feet.

5–13. IFF Transponder. Complete provisions are provided for the IFF transponder.

5–14. Interphone. Interphone facilities are provided by the FM liaison set. The interphone is provided for intercommunication within the helicopter.

5–15. Automatic Stabilization Equipment. The automatic stabilization equipment is provided to improve the handling characteristics of the helicopter to permit automatic cruising flight and hands-off flight. This automatic stabilization equipment operates in conjunction with the flight control system in such a manner that the pilot has complete control of the helicopter through normal use of the flight controls.

5–16. Communication and Associated Electronic Equipment. Table 5–2 consists of a complete list of the communication and associated electronic equipment that may be found in the CH-37B helicopter.

5–17. Technical Characteristics. The technical characteristics of the electronic equipment installed in the CH-37B helicopter are listed in paragraphs 5–18 through 5–24.

5–18. Technical Characteristics of FM liaison Set.

Frequency range................24.0 to 51.9 megacycles
Type of emission...............Frequency modulation
Type of transmission.........Voice.
Range..............................Line of sight to 50 miles

Table 5–2. Communication and associated electronic equipment.

FACILITY	NOMENCLATURE	USE	RANGE	LOCATION OF CONTROLS	REMARKS
FM liaison set	AN/ARC-44	Two-way voice communication	Line of sight	Figure 5–2	REM-LOCAL switch inoperative and should remain in the LOCAL position.
UHF command set	AN/ARC-55	Two-way voice communication	Line of sight	Figure 5–5	Has additional receiver to monitor emergency frequency of 243.0 megacycles.
VHF command set	AN/ARC-73	Two-way voice communication	Line of sight	Figure 5–6	
HF command set	AN/ARC-( )	Two-way voice communications	Long range		Provisions
Emergency VHF transmitter	T-366-( )/ARC	Voice communications	Line of sight	Figure 5–7	
Omni radio	AN/ARN-30D	Navigation and voice reception	Line of sight		Provisions
Automatic direction finder	AN/ARN-59	Navigation and direction finding	Long range	Figure 5–8	
Marker beacon	AN/ARN-32	Navigation	Vertical to 50,000 feet	Figure 2–12	
IFF transponder	AN/APX-44	Identification friend or foe	Line of sight		Provisions
Auxiliary FM receiver	AN/ARR-46( )	Auxiliary receiver	Line of sight		Provisions
Interphone		Intercommunication	Interior of helicopter	Figures 5–3 and 5–4	
Automatic stabilization equipment	AN/ASN-23	Automatic stabilization		Figures 5–10 and 5–11	

5–19. Technical Characteristics of UHF Command Set.

Frequency range................225.0 to 399.9 megacycles
Type of emission..............Amplitude modulation
Type of transmission.........Voice
Range..............................Line of sight to 50 miles

5–20. Technical Characteristics of VHF Command Set.

Frequency range..............116.0 to 151.95 megacycles
Type of emission..............Amplitude modulation
Type of transmission.........Voice
Range..............................Line of sight to 50 miles

5–21. Technical Characteristics of Emergency VHF Transmitter.

Frequency range...............116.0 to 132.0 megacycles
Type of emission..............Amplitude modulation
Type of transmission.........Voice
Range..............................Line of sight to 50 miles

5–22. Technical Characteristics of Automatic Direction Finder.

Frequency range...............190 to 1750 kilocycles
Type of reception.............Amplitude modulation
Range..............................Long range

5–23. Technical Characteristics of Marker Beacon.

Frequency range...............Fixed at 75 megacycles
Type of reception.............Amplitude modulation
Range..............................Vertical to 50,000 feet

5–24. Technical Characteristics of Automatic Stabilization Equipment.

Altitude hold limits..............................Within 40 feet
Yaw, pitch, and roll hold limits............................±1%

5–25. Description of Configuration. The CH-37B helicopter has two communication, two navigation, and an automatic stabilization facility installed to provide the pilots with voice communication, homing and direction finding, and automatic stabilized flight. Voice communication is available on the FM liaison set and the UHF command set or VHF command set. The navigation facilities consist of an automatic direction finder and a marker beacon. Automatic stabilization is provided by the automatic stabilization equipment. Provisions are provided for a HF command set, auxiliary FM receiver, omni radio, and a IFF transponder.

5–26. Description of Major Components. A description of the major components is given in paragraphs 5–27 through 5–33.

5–27. FM Liaison Set. The FM liaison set provides two-way, air-to-air or air-to-ground communications on any one of 280 preset channels. The frequency range of the FM liaison set permits communication with armored, artillery, or infantry units in the field. The interphone facility is also provided by this radio set.

5–28. UHF Command Set. The UHF command set provides two-way, air-to-air or air-to-ground communications on any one of the 1750 available UHF frequencies. A guard receiver, separate from the main receiver, makes possible the constant monitoring of the guard frequency of 243.0 megacycles.

Note

No transmissions other than emergencies shall be made on the guard frequency.

5–29. VHF Command Set. The VHF command set is an alternate for the UHF command set. The VHF command set provides two-way, air-to-air or air-to-ground communications on any one of the 680 preset channels.

5–30. Emergency VHF Transmitter. The emergency VHF transmitter provides VHF communications should the normal communication system fail.

5–31. Automatic Direction Finder. The automatic direction finder is an airborne navigational aid which operates in the frequency range of 190.0 to 1750.0 kilocycles. The function of this set is to automatically provide a visual indication of the direction from which an incoming signal is received, and aurally indicate amplitude – modulated signals. This set may also be used for homing and position fixing.

5–32. Marker Beacon. The marker beacon is an airborne, pretuned, radio navigational aid receiver which receives an amplitude-modulated signal on a fixed frequency of 75.0 megacycles. The function of this receiver is to receive signals transmitted by a ground beacon transmitter and deliver an aural and visual indication of the received signal.

5–33. Automatic Stabilization Equipment. The automatic stabilization equipment improves the handling characteristics of the helicopter and provides the pilot with automatic cruising flight and hands-off flight. When the automatic stabilization equipment is engaged, the pilot will still have complete control of the helicopter through normal use of the flight controls.

5–34. Description of Minor Components and Installation Items. A description of the minor components and installation items is given in paragraphs 5–35 through 5–41.

5–35. FM Liaison Set. The FM liaison set consists of a receiver-transmitter, a control panel, three signal distribution panels, a switch panel, and an antenna.

a. Receiver-transmitter. The receiver-transmitter contains the circuits for reception and transmission of FM liaison communication. The receiver-transmitter unit tuning drive mechanism, which is remotely controlled by the control panel, automatically tunes the receiver and transmitter to the frequency selected on the control panel.

b. FM control panel. The FM control panel is a separately housed unit containing the receiver-transmitter frequency selector, power switch, remote-local switch, and volume control. The frequency selector provides a means of selecting the desired frequency. The power switch turns the FM liaison set on or off as desired. The remote-local switch is inoperative in this installation and should remain in the LOCAL position. The volume may be adjusted to the desired level by rotating the volume control.

c. Signal distribution panels. Three signal distribution panels are installed to provide simplified control and simultaneous operation of all electronic equipment installed in the CH-37B helicopter. The signal distribution panel consists of five receiver switches and one transmitter selector switch which are used for selecting the desired facility.

d. Switch panel. The switch panel provides a means of selecting FM homing facility (when installed) or FM communications, energizing the squelch circuit of the FM liaison set, turning on the interphone, and energizing the squelch circuit of the auxiliary FM receiver (when installed).

e. FM antenna. The FM antenna (4, figure 5–1) is a tapered whip approximately 7-1/2 feet long. This antenna is used for both transmission and reception of FM liaison communication.

5–36. UHF Command Set. The UHF command set consists of a receiver-transmitter, a control panel, and an antenna.

a. Receiver-transmitter. The receiver-transmitter provides reception and transmission of continuous wave (cw) or voice communication. Two receivers are contained in the receiver-transmitter, a main receiver and a guard receiver. These receivers operate independently of each other, except for a common audio output circuit.

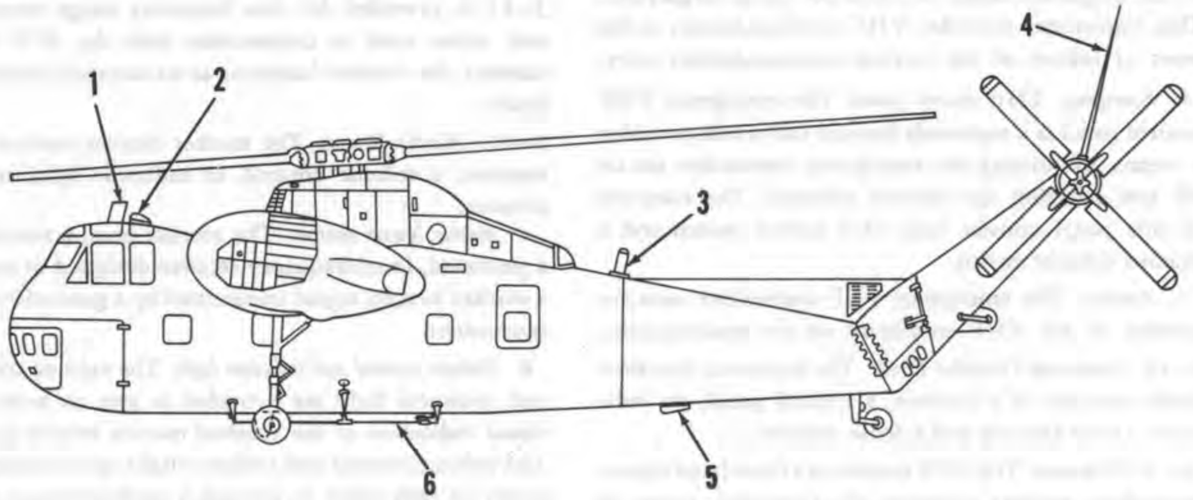
b. UHF control panel. The UHF control panel is a separately housed unit containing the receiver-transmitter frequency selectors, a function switch, a volume control, and a sensitivity control. The frequency selectors provide a means of selecting any one of the available frequencies. The desired function of this set may be selected by the use of the function switch. Volume may be adjusted to the desired level by rotating the volume control. The sensitivity control may be rotated to adjust the receiver to the desired sensitivity.

c. UHF antenna. The UHF antenna (3, figure 5–1) is an airfoil-shaped antenna which is used for both transmission and reception.

5–37. VHF Command Set. The VHF command set consists of a receiver, a transmitter, two control panels (one receiver and one transmitter), and an antenna.

a. VHF receiver. The VHF receiver is a crystal-controlled, double-conversion superheterodyne receiver that operates in the frequency range of 116.0 to 151.95 megacycles. A receiver autopositioner, controlled by the receiver control panel, tunes the receiver to any one of the 720 available receiving channels.

b. VHF transmitter. The VHF transmitter is a crystal-controlled transmitter which converts audio signals



1. VHF antenna
2. ADF loop antenna
3. UHF antenna
4. FM antenna
5. Master beacon antenna
6. ADF sense antenna

Figure 5–1. Antenna locations.

into amplitude-modulated VHF radio signals for transmission in the frequency range of 116.00 to 149.95 megacycles. The transmitter may be tuned to any one of the 680 available transmitting channels.

c. VHF receiver control panel. The VHF receiver control panel is a separately housed unit consisting of a power switch, a volume control, a squelch control, and two frequency selector controls. The power switch is used to energize the receiver and transmitter. Volume may be adjusted to the desired level by rotating the volume control. If static and background noise is excessive, it may be reduced by adjusting the squelch control. This permits medium and strong signals to be heard with decreased static and background noise. Weak signals may be heard along with increased static and background noise by adjusting the squelch control. The frequency of the receiver may be selected by use of the frequency selectors.

d. VHF transmitter control panel. The VHF transmitter control panel is identical to the VHF receiver control panel. The only operating controls that are operative on this panel are the frequency selectors which select the desired frequency of the transmitter.

e. VHF antenna. The VHF antenna (1, figure 5–1) is an airfoil-shaped antenna which is used for both transmission and reception of VHF communication.

5–38. Emergency VHF Transmitter. The emergency VHF transmitter consists of a transmitter, a control panel and an antenna.

a. Emergency transmitter. The emergency transmitter is an amplitude-modulated voice transmitter which operates in the frequency range of 116.0 to 132.0 megacycles. This transmitter provides VHF communication in the event of failure of the normal communication units.

b. Emergency VHF control panel. The emergency VHF control panel is a separately housed unit which provides a means of turning the emergency transmitter on or off and selecting the desired channel. The controls of this panel consist only of a power switch and a channel selector switch.

c. Antenna. The emergency VHF transmitter uses the antenna of the VHF command set for transmission.

5–39. Automatic Direction Finder. The automatic direction finder consists of a receiver, a control panel, an indicator, a loop antenna and a sense antenna.

a. ADF receiver. The ADF receiver is a three-band superheterodyne receiver covering the frequency range of 190.0 to 1750.0 kilocycles. The desired band is selected through remote control facilities provided by the ADF control panel. For automatic direction finding, the receiver uses both the loop and sense antenna. For all other functions the receiver uses either the loop or sense antenna. Beat frequency oscillator (bfo) circuits are provided for the identification of continuous wave (cw) stations.

b. ADF control panel. The ADF control panel is installed to provide remote control facilities for the ADF receiver. This panel consists of a combination volume control and power switch, a function switch, a band selector control, a tuning crank, a tuning meter, a loop antenna control switch, and a bfo switch. Rotation of the volume control and power switch turns the ADF receiver on and adjusts the volume. The desired function may be selected by the use of the function switch. Frequency selection is accomplished by positioning the band selector switch as desired and rotating the tuning crank. The selected frequency will be indicated on the frequency indicating dial. The tuning meter indicates when the ADF receiver is accurately tuned. The loop antenna may be rotated by the use of the loop antenna control switch. The bfo switch turns the bfo circuit on or off as desired.

c. Azimuth indicator. The azimuth indicator is provided to visually indicate the direction from which an incoming signal is received. The scale of the azimuth indicator may be positioned to indicate relative bearings, magnetic bearings, or true bearings by rotating the east-west variation knob.

d. ADF loop antenna. The ADF loop antenna (2, figure 5–1) is a hermetically sealed antenna designed to provide directional information for homing, direction finding, or position fixing.

e. ADF sense antenna. The ADF sense antenna (6, figure 5–1) is provided for low frequency range reception and when used in conjunction with the ADF loop antenna the receiver functions as an automatic direction finder.

5–40. Marker Beacon. The marker beacon consists of a receiver, a volume control, an indicator light and an antenna.

a. Marker beacon receiver. The marker beacon receiver is a pretuned, fixed-frequency receiver designed to receive a marker beacon signal transmitted by a ground beacon transmitter.

b. Volume control and indicator light. The volume control and indicator light are provided to give an aural and visual indication of the received marker beacon signal. The volume control and indicator light operate independently of each other to provide a marker beacon indication should one or the other fail.

c. Marker beacon antenna. The marker beacon antenna (5, figure 5–1) is provided for the reception of marker beacon signals.

5–41. Automatic Stabilization Equipment. The automatic stabilization equipment consists of two components which are of significance to the pilot. These components are the ASE control panel and motor box assembly.

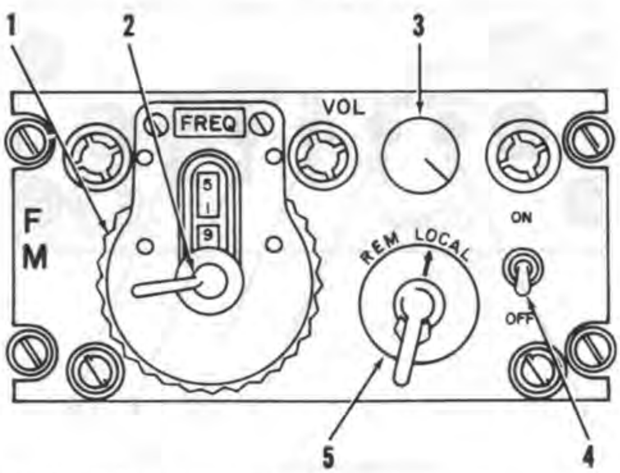
a. ASE control panel. Operational controls for the system are located on the front panel. The controls are used by the pilot during routine operation of the equipment. The two push-button switches in the upper right-hand corner of the panel and the two push-button switches marked OFF directly below are not used in this installation.

b. Motor box assembly. The motor box assembly front panel contains system controls for use by the pilot and maintenance personnel, and adjustment potentiometers for use by the maintenance personnel only.

Section III Operating Controls

5–42. FM Control Panel. The FM control panel (figure 5–2), marked FM, provides the controls for the FM liaison set operation. These controls consist of a power switch (4) marked ON-OFF, a volume control (3) marked VOL, two frequency selectors (1 and 2) marked FREQ, and a remote-local switch (5) marked REM-LOCAL. The controls and their function are as follows:

CONTROL	FUNCTION
ON-OFF switch	Energizes the FM liaison set when in the ON position. In the OFF position, all power is removed from the FM liaison set.
VOL control	Controls the volume of the FM receiver.
FREQ selectors	Outside selector selects the first two digits of the desired frequency. Inside selector selects the third digit (1/10 megacycle) of the desired frequency.
REM-LOCAL switch	Inoperative in this installation and should remain in the LOCAL position.

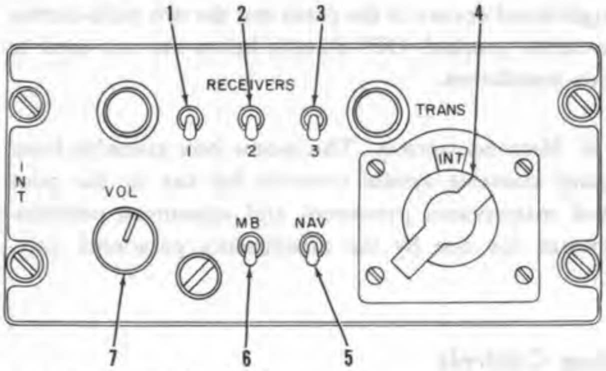


1. Outside frequency selector
2. Inside frequency selector
3. Volume control
4. Power switch
5. Remote local switch

Figure 5–2. FM control panel

5–43. Signal Distribution Panels. The signal distribution panels (figure 5–3), marked INT, provide the controls for selecting the desired facility. The controls consist of five receiver switches (1, 2, 3, 5, and 6) marked RECEIVERS -1 -2 -3, MB, and NAV, a transmitter selector switch (4), marked TRANS, and a volume control (7) marked VOL. The controls and their function are as follows:

RECEIVERS -1 switch	In the up position, the audio output of the FM receiver is connected to the headset. In the down position, the FM receiver audio is removed.
RECEIVERS -2 switch	In the up position, the audio output of the UHF receiver is connected to the headset. In the down position, the UHF receiver audio is removed.
RECEIVERS -3 switch	In the up position, the audio output of the VHF receiver is connected to the headset. In the down position, the VHF receiver audio is removed.
MB switch	In the up position, the audio output of the marker beacon receiver is connected to the headset.



1. Receiver switch No. 1
2. Receiver switch No. 2
3. Receiver switch No. 3
4. Transmitter selector switch
5. NAV receiver switch
6. MB receiver switch
7. Volume control

Figure 5–3. Signal distribution panel

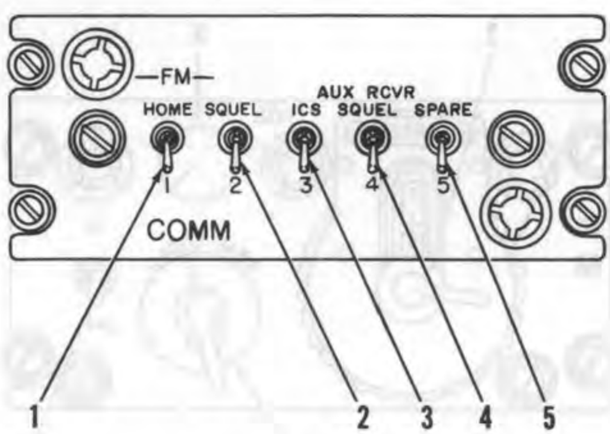
CONTROL	FUNCTION
	In the down position, the marker beacon receiver audio is removed.
NAV switch	In the up position, the audio output of the ADF receiver is connected to the headset. In the down position, ADF receiver audio is removed.
TRANS selector switch	In the INT position, interphone facilities are available. In the No. 1 position, FM transmission is available. In the No. 2 position, UHF transmission is available. In the No. 3 position, VHF transmission is available.
VOL control	Adjust the volume of the set selected at the signal distribution panel.

Note

The audio output of the ADF receiver bypasses the volume control of the signal distribution panel. All adjustments of the volume for this set must be made at the ADF control panel.

5–44. Switch Panel. The switch panel (figure 5–4) consists of five switches, four operative and one inoperative. The operational switches consist of a FM homing switch (1) marked FM HOME COMM, a squelch switch (2) marked FM SQUEL, an interphone switch (3) marked ICS, and an auxiliary receiver squelch switch (4) marked AUX RCVR SQUEL. The remaining switch (5) is inoperative and is marked SPARE.

CONTROL	FUNCTION
FM HOME COMM switch	In the up position, the homing circuit of the FM receiver is energized. In the down position, the FM receiver returns to normal operation.
FM SQUEL switch	In the up position, the FM receiver squelch circuit is energized to reduce the static and background noise allowing only medium and strong signals to be heard. In the down position, the FM receiver, is in normal operation and weak signals may be heard along with increased static and background noise.
ICS switch	In the up position, the interphone is operative without the FM liaison set being on. In the down position, interphone is inoperative.
AUX RCVR SQUEL switch	In the up position, the auxiliary FM receiver squelch circuit is energized. In the down position, the squelch circuit of the auxiliary FM receiver is returned to normal operation.
SPARE switch	Inoperative.



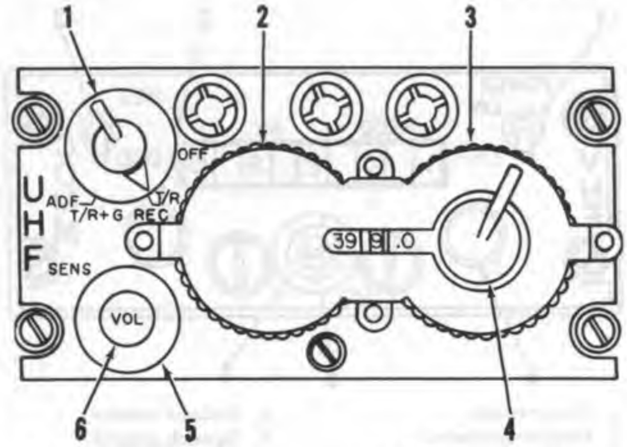
1. FM homing switch
2. Squelch switch
3. ICS
4. Auxiliary receiver squelch switch
5. Spare

Figure 5–4. Switch panel

5–45. UHF Control Panel. The UHF control panel (figure 5–5), marked UHF, provides the controls for the UHF command set operation. These controls consist of a function switch (1) marked OFF, T/R, T/R+G REC, and ADF, a sensitivity control (5) marked SENS, a volume control (6) marked VOL, and three frequency selectors (2, 3, and 4). These controls and their function are as follows:

CONTROL	FUNCTION
Function switch	OFF position, power is removed from the UHF command set. T/R position, the main UHF receiver is on and the UHF transmitter is on in standby. T/R+G REC position, the main UHF receiver is on, the guard receiver is on, and the UHF transmitter is on in standby. ADF position is inoperative.
SENS control	Controls the sensitivity of the main UHF receiver.
VOL control	Controls the volume of both the main UHF receiver and the guard receiver.
Frequency selectors	Left selector selects the first two digits of the desired frequency. Right outside selector selects the third digit of the desired frequency. Right inside selector selects the fourth digit of the desired frequency.

5–46. VHF Control Panel. Two VHF control panels (figure 5–6), marked VHF COMM, provide the controls for the VHF command set operation. The controls consist of a power switch (1) marked POWER-OFF-ON, a volume control (4) marked VOL, a squelch control (5) marked SQ, two frequency selectors (2 and 6), and a mode selector switch (3) marked SCS-DCD. The mode selector switch on both control panels is inoperative and should remain in the SCS position. The VHF receiver control panel controls and their function are as follows:



1. Function switch
2. Frequency selector
3. Frequency selector
4. Frequency selector
5. Sensitivity control
6. Volume control

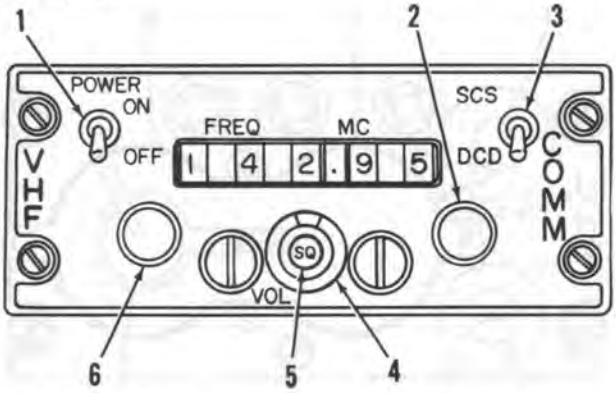
Figure 5–5. UHF control panel

CONTROL	FUNCTION
POWER-OFF-ON switch	Energizes the VHF command set when in the ON position. Power is removed when in the OFF position.
VOL control	Controls the volume of the VHF receiver.
SQ control	Adjust the squelch level of the VHF receiver.
Frequency selectors	Left selector selects the desired VHF receiver frequency in megacycles. Right selector selects the desired VHF receiver frequency in kilocycles.
SCS-DCD switch	Inoperative.

The VHF transmitter control panel controls and their function are as follows:

CONTROL	FUNCTION
POWER-OFF-ON switch	Inoperative.
VOL control	Inoperative
SQ control	Inoperative.
Frequency selectors	Left selector selects the desired VHF transmitter frequency in megacycles. Right selector selects the desired VHF transmitter frequency in kilocycles.
SCS-DCD switch	Inoperative.

5–47. Emergency VHF Control Panel. The emergency VHF control panel (figure 5–7), marked VHF, provides a means of turning the emergency VHF transmitter on or off and selecting the desired channel. These controls consist of a power switch (2), marked ON, and a channel selector switch (1). The controls and their function are as follows:



1. Power switch
2. Frequency selector
3. Mode selector switch
4. Volume control
5. Squelch control
6. Frequency selector

Figure 5–6. VHF control panel

CONTROL	FUNCTION
Power switch	In the ON position, power is supplied to the emergency VHF transmitter. In the OFF position, no power is available to the emergency VHF transmitter
Channel selector switch	Selects the desired channel of the emergency VHF transmitter.

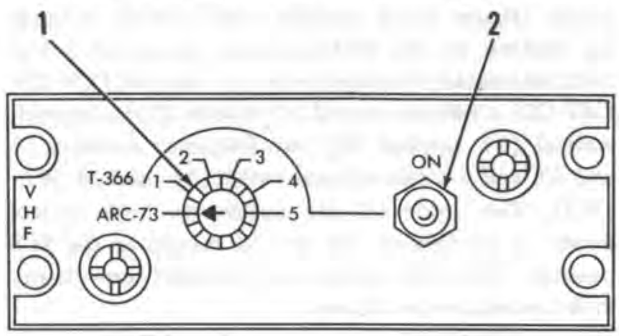
5–48. ADF Control Panel. The ADF control panel (figure 5–8), marked ADF REC, provides the controls for the automatic direction finder set operation. These controls consist of a combination power switch and volume control (2) marked VOL-OFF, a function switch (3) marked COMP-ANT-LOOP, a band selector switch (1) marked MC BAND, a tuning crank (6), a tuning meter (4), a loop antenna control switch (5), marked LOOP, and a bfo switch (7) marked BFO-ON. These controls and their function are as follows:

CONTROL	FUNCTION
VOL-OFF control	Turns set on or off and adjusts volume to the desired level.
Function switch	COMP position, the receiver uses both the loop and sense antenna to operate as an automatic radio compass. ANT position, the receiver operates as a low frequency receiver using only the sense antenna. LOOP position, the receiver operates as an automatic direction finder using only the loop antenna.
Band selector switch	Selects the frequency band in which the ADF receiver will operate.
Tuning crank	Tunes the receiver through the frequency range selected by the band selector control.
Tuning meter	Indicates when receiver is accurately tuned.
LOOP switch	Left position, loop antenna rotates counterclockwise. Right position, loop antenna rotates clockwise. Center position, off.
BFO-ON switch	In the ON position, a beat note is heard when the receiver is tuned to a transmitted signal.

5–49. Azimuth Indicator. The azimuth indicator (figure 5–9), located on the flight instrument panel, consists of an indicator pointer (1) and an azimuth scale control knob (2), marked E-W-VAR. The indicator and its function are as follows:

INDICATOR	FUNCTION
Indicator pointer	Indicates the direction from which an incoming signal is being received.
E-W-VAR knob	Rotates azimuth scale to the desired position.

5–50. Marker Beacon Indicator Light and Volume Control. The marker beacon indicator light and volume control knob (38, figure 2–13), marked MARKER, is located on the instrument panel. The vol-



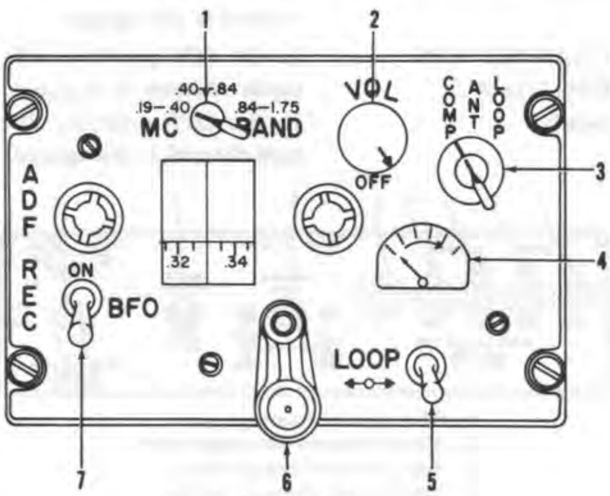
1. Channel selector
2. Power switch

Figure 5–7. Emergency VHF control panel ume control is a combination volume control and power switch, marked MARKER BEACON-OFF-VOL. These controls and their function are as follows:

CONTROL OR INDICATOR	FUNCTION
Indicator light	Visually indicates marker beacon information received by marker beacon receiver.
OFF-VOL control	Turns marker beacon receiver on or off and adjusts the volume to the desired position.

5–51. Interphone. Refer to paragraphs 5–43 and 5–44 for operating controls for the interphone.

5–52. ASE Control Panel. The ASE control panel (figure 5–10) provides the controls for the automatic stabilization equipment operation. The controls and indicators consist of a null indicator (9), marked NULL INDIC; an energizing switch and indicator light (1), marked ENG; an altitude switch and indicator light (2), marked BAR ALT; a standby switch (11), marked STANDBY; an off switch (3), marked OFF; a center of gravity trim control (10), marked CG TRIM; a yaw trim control (7), marked YAW TRIM; and four push-button switches (4, 5, 6, and 8) which are inoperative. These controls and indicators and their function are as follows:



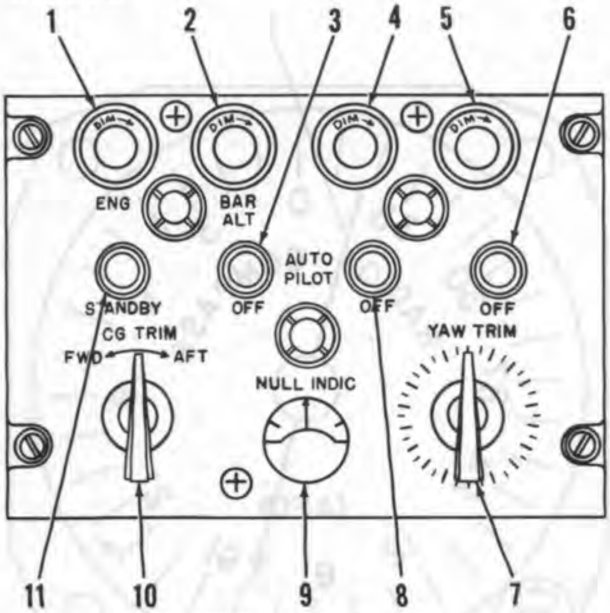
1. Band selector switch
2. Power switch and volume control
3. Function switch
4. Tuning meter
5. Loop antenna control switch
6. Tuning crank
7. BFO switch

Figure 5–8. ADF control panel

1. Indicator pointer
2. Azimuth scale control knob

Figure 5–9. Azimuth indicator

CONTROL	FUNCTION
NULL INDIC meter	Provides a reference for adjusting the center of gravity location and for monitoring system operation.
ENG switch and indicator light	Switch engages pitch, roll, and yaw channels and engagement is indicated by the indicator light.
BAR ALT switch and indicator light	Switch engages the altitude channel and engagement is indicated by the indicator light.
STANDBY switch	Disconnects all four channels and places equipment in standby condition after engagement.
OFF switch	Disengages altitude channel only when the pitch, roll, and yaw channels are engaged.
CG TRIM control	Used to compensate for any pitch displacement signal caused by shifts in helicopter center of gravity.



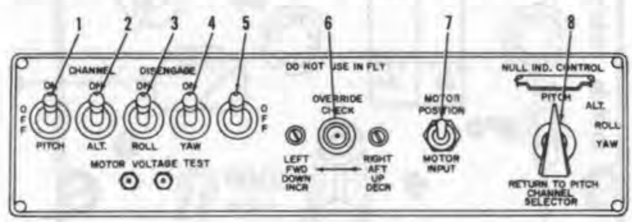
1. Energizing switch and indicator light
2. Altitude switch and indicator light
3. Off switch
4. Inoperative
5. Inoperative
6. Inoperative
7. Yaw trim control
8. Inoperative
9. Null indicator
10. Center of gravity trim control
11. Standby switch

Figure 5–10. ASE control panel

CONTROL	FUNCTION
YAW TRIM control	Used for making small heading corrections of the helicopter without using tail rotor pedals.

5–53. Motor Box Assembly. The motor box assembly (figure 5–11) provides controls for system operation for both the pilot and maintenance personnel. The controls which are used by the pilot consist of a motor position-input switch (7), marked MOTOR POSITION-MOTOR INPUT; a channel selector switch (8), marked CHANNEL SELECTOR; an override switch (6), marked OVERRIDE CHECK; a yaw channel disengage switch (4), marked CHANNEL DISENGAGE-YAW; a roll channel disengage switch (3), marked CHANNEL DISENGAGE-ROLL; an altitude channel disengage switch (2), marked CHANNEL DISENGAGE-ALT; and a pitch channel disengage switch (1), marked CHANNEL DISENGAGE-PITCH. The switches and controls that are used by the maintenance personnel are not listed. The controls and their function are as follows:

CONTROL	FUNCTION
MOTOR POSITION-MOTOR INPUT switch	In the MOTOR POSITION position, servo motor position is indicated on the NULL INDIC meter. In the MOTOR INPUT position, the servo motors input voltage is indicated on the NULL INDIC meter.
CHANNEL SELECTOR switch	Selects pitch, altitude, roll, or yaw channel to be monitored on NULL INDIC meter.
OVERRIDE CHECK switch	Used to simultaneously drive the pitch, altitude, roll, and yaw servo motors to their extreme position to check for proper linkage adjustments. **_Warning_** Do not operate this switch in flight.
CHANNEL DISENGAGE-YAW switch	In the ON position, yaw channel is engaged. In the OFF position, yaw channel is disengaged.
CHANNEL DISENGAGE-ROLL switch	In the ON position, roll channel is engaged. In the OFF position, roll channel is disengaged.
CHANNEL DISENGAGE-ALT switch	In the ON position, altitude channel is engaged. In the OFF position, altitude channel is disengaged.



1. Pitch channel disengage switch
2. Altitude channel disengage switch
3. Roll channel disengage switch
4. Yaw channel disengage switch
5. Inoperative
6. Override switch
7. Motor position-input switch
8. Channel selector switch

Figure 5–11. Motor box assembly

CONTROL	FUNCTION
CHANNEL DIS-ENGAGE-PITCH switch	In the ON position, pitch channel is engaged. In the OFF position, pitch channel is disengaged.

5–54. Radio Master Circuit Breakers. Two radio master circuit breakers (figure 2–22) are provided for the electronic equipment. These circuit breakers are marked RADIO MASTER NO. 1 CONT and RADIO MASTER NO. 2 CONT.

CONTROL	FUNCTION
RADIO MASTER NO. 1 CONT circuit breaker	Pushed in, power is supplied to the radio master switch from the primary bus. Pulled out, no power is available to the radio master switch from the primary bus.
RADIO MASTER NO. 2 CONT circuit breaker	Pushed in, power is supplied to the radio master switch from the secondary bus. Pulled out, no power is available to the radio master switch from the secondary bus.

5–55. Radio Master Switch. The radio master switch (figure 2–12) is provided to energize the two relays which supply power to the electronic equipment from the primary and secondary busses. The radio master switch is marked RADIO MASTER-OFF-ON.

CONTROL	FUNCTION
RADIO MASTER-OFF-ON switch	In the ON position, power is supplied to the relay which supplies power to the electronic equipment. *Note* The relay which is energized when the radio master switch is in the ON position is dependent on which radio master circuit breaker is energized. In the OFF position, no power is available to the relays.

5–56. Radio Bus Circuit Breakers. Two radio bus circuit breakers (figure 2–22) are provided for the protection of the electronic equipment. These circuit breakers are marked NO. 1 RADIO BUS and NO. 2 RADIO BUS.

CONTROL	FUNCTION
NO. 1 RADIO BUS circuit breaker	Pushed in, power is supplied to the electronic equipment from the primary bus. Pulled out, no power is available from the primary bus.
NO. 2 RADIO BUS circuit breaker	Pushed in, power is supplied to the electronic equipment from the secondary bus. Pulled out, no power is available from the secondary bus.

5–57. Circuit Breakers. Circuit breakers are provided for individual equipment. When these circuit breakers are pushed in, power is supplied to the individual equipment. When pulled out, no power is available to the equipment.

5–58. Microphone Switches. A microphone switch is installed in each pilots cyclic stick grip. This switch has two positions. The first position is for interphone and the second position is for radio.

5–59. Microphone Foot Switch. Two microphone foot switches are provided for interphone only. Depressed, communication is available on interphone only.

5–60. Cabin Communication Station. Two cabin communication stations are provided for intercommunications. The signal distribution panel which is located at the forward end of the cabin is identical to the pilots' except that the transmitter selector switch is operative in the INT position only. The other cabin communication station is located just forward of the cargo door. This station has a portable microphone switch and an extension cord so that the operator may move about and maintain communications.

5–61. Hot Mike Switch. A hot mike switch is provided to relieve the operator of having to hold the portable switch in the ON position. This switch is marked HOT MIKE-MOMENT ON-NORM-ON. This control and its function are as follows:

CONTROL	FUNCTION
HOT MIKE switch	MOMENT ON position, communication is available only as long as this switch is in this position.

CONTROL	FUNCTION
	NORM position, normal communication is available by using the portable microphone switch. ON position, the microphone is on and will remain on until switch is placed in the NORM position.

5–62. External Interphone Receptacle and Extension Cord. The external interphone receptacle and extension cord provide an interphone communication facility from the exterior of the helicopter.

Section IV Types of Operating Facilities

5–63. Communication Equipment. The types of operating facilities for the communication equipment are as follows:

5–64. FM Liaison Set. The FM liaison set provides FM communication in the frequencies assigned to military tactical units (armored, artillery, and infantry). In addition to radio communications, this set also provides interphone facilities. Refer to paragraph 5–77 for operating procedures for the FM liaison set.

5–65. UHF Command Set. The UHF command set provides UHF communications in the UHF command frequencies. Refer to paragraph 5–78 for operating procedures for the UHF command set.

5–66. VHF Command Set. The VHF command set provides VHF communications in the VHF command frequencies. Refer to paragraph 5–79 for operating procedures for the VHF command set.

5–67. Emergency VHF Transmitter. The emergency VHF transmitter provides VHF communication in the VHF command frequencies. Refer to paragraph 5–91 for operating procedures for the emergency VHF transmitter.

5–68. Interphone. Interphone facilities are provided for intercommunication by the FM liaison set. Refer to paragraph 5–85 for operating procedures for the interphone.

5–69. Navigation Equipment. The types of operating facilities for the navigation equipment are as follows:

5–70. Automatic Direction Finder. The automatic direction finder provides homing and position fixing using standard broadcast or low frequency radio range stations. Refer to paragraph 5–82 for operating procedures for the automatic direction finder.

5–71. Marker Beacon. Marker beacon fan-type or Z-type information is provided by the marker beacon. This information is presented aurally and visually. Refer to paragraph 5–82 for operating procedures for the automatic direction finder.

5–72. Automatic stabilization Equipment. The operating facility for the automatic stabilization equipment is as follows. Automatic stabilization provides improved handling characteristics and hands-off flight. Refer to paragraphs 3-38 through 3-40 for operating procedures for the automatic stabilization equipment.

a. Description. AN/ARC-102 Radio Set is an airborne SSB transceiver which transmits and receives in the 2 to 30 megacycle frequency range. The primary operating mode for the AN/ARC-102 is the SSB mode. The AN/ARC-102 can also transmit a compatible AM signal (the upper side band and carrier inserted) so that communications with stations having only AM capability is possible. This set, tunable in one kilocycle steps, transmits and receives in any one of 28,000 directly selectable frequencies in a frequency range of 2.0 to 29.999 megacycles in the SSB mode with 400 watts PEP, or in the AM mode with 100 watts of carrier power. The AN/ARC-102 provides reliable, long range communications to airborne, portable, mobile or fixed stations. Power is supplied from the 28 volt DC electrical system.

(1) SSB is a new mode of voice communication having many important advantages over the AM (amplitude modulation) mode.

(2) AM. An AM signal is made by mixing the voice signal with r.f. (radio frequency) signal. The AM signal consists of three components, two side bands and the original r-f signal. The upper side band frequency is the sum of the voice signal and the r-f signal frequencies. The lower side band frequency is the difference of the voice signal

and the r-f signal frequencies. The original r-f signal (carrier) contains no intelligence. The intelligence to the transmitter is contained in either side band so only one of them has to be transmitted.

(3) SSB. An SSB transmitter will transmit only one side band (upper or lower). The carrier and unused side band are suppressed and all the power available in the transmitter is used to amplify the single side band being transmitted. The SSB mode provides more effective and reliable communications than the conventional AM mode because the entire power of the transmitter amplifies just one component rather than three, as is done in the conventional AM mode.

b. Operation of AN/ARC-102 Radio Set.

(1) Close AN/ARC-102 circuit breaker, R-T (50 amp) and coupler (5 amp).

(2) Turn the function switch on the HF control panel (C-3940/ARC-94) to the USB position. Check operation of the blower in the receiver-transmitter. CAUTION: If blower doesn't operate, turn the switch off immediately. Allow 5 minutes warm-up time.

(3) Set the function selector to the desired operating mode.

(4) Select the desired operating frequency, using the frequency select knobs.

NOTE

If the function selector is moved from the OFF position to an operating mode and the desired operating frequency is already set up on the control panel, rotate the 10 kilocycle select knob one digit off frequency and then back to the operating frequency. This will allow the system to return to the frequency.

(5) When the receiver-transmitter is no longer muted, depress the push-to-talk button momentarily and wait for the receiver-transmitter to tune. A 1000 CPS tone will be heard in the headphones until tuning is complete.

(6) When the receiver-transmitter is tuned, adjust the RFSENS knobs so that the noise in the earphones is barely audible.

c. Emergency Operation.

(1) The power supply in the receiver-transmitter contains a circuit which turns off the R–T when a short circuit exists on its output. To restore the R-T to operation, it is necessary to move the function selector to the OFF position and then back to the desired operating mode.

(2) Another fault condition may occur when the associated antenna coupler is required to complete several consecutive tuning cycles. A thermal relay in the coupler unit de-energizes the RCUR-XMTR. If this occurs, set the function selector to the OFF position for two minutes to allow the thermal relay to cool. Then return the function selector to the desired operating mode.

(3) If the above procedures do not return the R-T 618T-2 to normal operation, place the function selector in the OFF position and report failure to the maintenance personnel.

Section V Preliminary Starting Procedure

5–73. Communication Equipment. The preliminary starting procedures for the communication equipment are as follows:

a. RADIO MASTER NO. 1 CONT circuit breaker–DEPRESSED.

b. RADIO MASTER NO. 2 CONT circuit breaker–DEPRESSED.

c. RADIO MASTER switch–OFF.

d. NO. 1 RADIO BUS circuit breaker– DEPRESSED.

e. NO. 2 RADIO BUS circuit breaker–DEPRESSED.

f. Radio circuit breakers–DEPRESSED.

g. ON-OFF switch (FM control panel)–OFF.

h. VOL control (FM control panel)–ROTATE FULLY COUNTERCLOCKWISE.

i. Function switch (UHF control panel)–OFF.

j. VOL control (UHF control panel)–ROTATE FULLY COUNTERCLOCKWISE.

k. ON-OFF switch (VHF receiver control panel)—OFF.

l. VOL control (VHF receiver control panel)—ROTATE FULLY COUNTERCLOCKWISE.

m. FM-HOME-COMM switch (switch panel)—COMM POSITION.

n. FM-SQUEL switch (switch panel)—DOWN POSITION.

o. ICS switch (switch panel)—ICS POSITION.

p. AUX-RCVR-SQUEL switch (switch panel)—DOWN POSITION.

q. SPARE switch—DOWN POSITION.

r. RECEIVERS-1 -2 -3 switches (signal distribution panel)—DOWN POSITION.

s. Transmitter selector switch (signal distribution panel)—INT POSITION.

t. VOL control (signal distribution panel)—ROTATE TO MID POSITION.

5—74. Navigation Equipment. The preliminary starting procedures for the navigation equipment are as follows:

a. Perform steps outlined in paragraph 5—74 steps *a* through *f.*

b. VOL-OFF control (ADF control panel)—OFF.

c. MARKER BEACON VOLUME control (instrument panel)—ROTATE FULLY COUNTERCLOCKWISE.

d. MB switch (signal distribution panel)—DOWN POSITION.

e. NAV switch (signal distribution panel)—DOWN POSITION.

f. VOL control (signal distribution panel)—ROTATE TO MID POSITION.

5—75. Automatic Stabilization Equipment. Refer to paragraph 3—58 Normal Procedure for the applicable starting procedures.

Section VI Operating Procedures

5—76. Communication Equipment Operation. The operating procedures for the communication equipment are as follows:

5—77. FM Liaison Set. a. To turn set on and receive:

(1) RADIO MASTER NO. 1 CONT circuit breaker—DEPRESSED.

(2) RADIO MASTER switch—ON.

(3) NO. 1. RADIO BUS circuit breaker—DEPRESSED.

(4) ARC-44 circuit breaker—DEPRESSED.

(5) RECEIVERS switch No. 1 (signal distribution panel)—ON. Up position.

(6) VOL control (signal distribution panel)—MID POSITION.

(7) TRANS selector switch (signal distribution panel)—NO. 1 POSITION.

(8) FM-HOME-COMM switch (switch panel)—COMM POSITION.

(9) FM-SQUEL switch (switch panel)—OFF. Down position.

(10) ON-OFF switch (FM control panel)—ON POSITION.

(11) REM-LOCAL switch—LOCAL POSITION.

(12) VOL control—MID POSITION.

(13) Frequency selectors—AS DESIRED.

(14) VOL control (signal distribution panel)—ADJUST TO DESIRED LEVEL.

(15) FM SQUEL switch (switch panel)—AS DESIRED.

b. To transmit: Microphone switch (cyclic stick grip)—DEPRESS. Speak into microphone.

c. To turn set off:

(1) ON-OFF switch (FM control panel)—OFF.

(2) RECEIVERS switch No. 1. (signal distribution panel)—OFF. Down position.

(3) TRANS selector switch (signal distribution panel)—INT POSITION.

5—78. UHF Command Set. a. To turn set on and receive:

(1) RADIO MASTER NO. 1 CONT circuit breaker—DEPRESSED.

(2) RADIO MASTER switch—ON.

(3) NO. 1 RADIO BUS circuit breaker—DEPRESSED.

(4) ARC-55 circuit breaker—DEPRESSED.

(5) RECEIVERS switch No. 2 (signal distribution panel)—ON. Up position.

(6) VOL control (signal distribution panel)—MID POSITION.

(7) TRANS selector switch (signal distribution panel)—NO. 2 POSITION.

(8) Function switch (UHF control panel)—T/R+ G REC.

(9) Frequency selectors—AS DESIRED.

(10) VOL control—MID POSITION.

(11) SENS control—AS DESIRED.

(12) VOL control (signal distribution panel)—ADJUST TO DESIRED LEVEL.

b. To transmit: Microphone switch (cyclic stick grip)—DEPRESS. Speak into microphone.

c. To turn set off:

(1) Function switch (UHF control panel)—OFF.

(2) RECEIVERS switch No. 2 (signal distribution panel)—OFF. Down position.

(3) TRANS selector switch (signal distribution panel)—INT POSITION.

5–79. *VHF Command Set. a.* To turn set on and receive:

(1) RADIO MASTER NO. 1 CONT circuit breaker—DEPRESSED.

(2) RADIO MASTER switch—ON.

(3) NO. 1 RADIO BUS circuit breaker—DEPRESSED.

(4) ARC 73 RCVR circuit breaker—DEPRESSED.

(5) ARC 73 XMTR circuit breaker—DEPRESSED.

(6) POWER-ON-OFF switch (VHF receiver control panel)—ON.

(7) Frequency selectors (VHF receiver control panel)—AS DESIRED.

(8) VOL control (VHF receiver control panel)—MID POSITION.

(9) SQ control (VHF receiver control panel)—AS DESIRED.

(10) RECEIVERS switch No. 3 (signal distribution panel)—ON. Up position.

(11) TRANS selector switch (signal distribution panel)—NO. 3 POSITION.

(12) VOL control (signal distribution panel)—ADJUST TO DESIRED LEVEL.

b. To transmit:

(1) Frequency selectors (VHF transmitter control panel)—AS DESIRED.

(2) Microphone switch (cyclic stick grip)—DEPRESS. Speak into microphone.

c. To turn set off:

(1) POWER-ON-OFF switch (VHF receiver control panel)—OFF.

(2) RECEIVERS switch No. 3 (signal distribution panel)—OFF. Down position.

(3) TRANS selector switch (signal distribution panel)—INT POSITION.

5–80. *Emergency VHF Transmitter.* Refer to paragraph 5–91 for operation of the emergency VHF transmitter.

5–81. Navigation Equipment Operation. The operating procedures for the navigation equipment are as follows:

5–82. *Automatic Direction Finder.* The operating procedures for the automatic direction finder consist of operation for automatic direction finding, as a low-frequency receiver, homing, and position fixing.

a. To turn set on:

(1) RADIO MASTER NO. 2 CONT circuit breaker—DEPRESSED.

(2) RADIO MASTER switch—ON.

(3) NO. 2 RADIO BUS circuit breaker—DEPRESSED.

(4) ARN 59 circuit breaker—DEPRESSED.

(5) NAV switch (signal distribution panel)—ON. Up position.

(6) VOL-OFF control (ADF control panel)—ON. Rotate to the midposition.

(7) Function switch—ANT POSITION.

b. To operate set as automatic direction finder or radio compass:

(1) Band selector switch—SELECT DESIRED BAND.

(2) Function switch—COMP POSITION.

(3) Tuning crank—TUNE TO DESIRED STATION. Tune for maximum deflection on tuning meter.

(4) VOL-OFF control—ADJUST VOLUME TO DESIRED LEVEL.

Note

If signal strength is too weak for easy identification when the function switch is at the COMP position, temporarily switch to ANT position to increase signal strength and permit a more accurate station identification.

(5) E-W-VAR control (azimuth indicator)—MAGNETIC HEADING FOR ADF OPERATION; ZERO AT INDEX FOR RADIO COMPASS.

Note

With azimuth indicator at zero index, all station bearings will be relative to aircraft heading.

(6) Azimuth indicator (instrument panel)—READ BEARING.

c. To operate set as a low-frequency receiver:

(1) Band selector switch—SELECT DESIRED BAND.

(2) Function switch—ANT POSITION.

(3) BFO-ON switch—ON POSITION FOR AURAL RECEPTION OF SIGNALS AS A TUNING AID.

(4) Tuning crank—TUNE TO DESIRED STATION. Tune for maximum deflection on tuning meter.

(5) VOL-OFF control—ADJUST VOLUME TO DESIRED LEVEL.

d. To operate set for aural-null direction finding:

(1) Band selector switch—SELECT DESIRED BAND.

(2) Function switch—LOOP POSITION.

(3) BFO-ON switch—ON.

(4) Tuning crank—TUNE TO DESIRED STATION. Tune for maximum deflection on tuning meter.

(5) VOL-OFF control—ADJUST VOLUME TO DESIRED LEVEL.

(6) LOOP switch—SWITCH LEFT OR RIGHT FOR MINIMUM HEADSET VOLUME.

e. To operate set for position fixing:

(1) Band selector switch—SELECT DESIRED BAND.

(2) Function switch—COMP POSITION.

(3) E-W-VAR control (azimuth indicator)—ROTATE FOR TRUE MAGNETIC HEADING AT INDEX.

(4) Tuning crank—TUNE TO DESIRED STATION. Tune for maximum deflection on tuning meter.

(5) VOL-OFF control—ADJUST VOLUME TO DESIRED LEVEL.

(6) Azimuth indicator (instrument panel)—READ BEARING.

Note

Steps (4), (5), and (6) should be repeated to obtain a minimum of three different bearings for a more accurate position fix.

f. To operate set for aural-null position finding:

(1) E-W-VAR control (azimuth indicator)—ROTATE FOR TRUE MAGNETIC HEADING AT INDEX.

(2) Band selector switch—SELECT DESIRED BAND.

(3) Function switch—ANT POSITION.

(4) Tuning crank—TUNE TO DESIRED STATION. Tune for maximum deflection on tuning meter.

(5) Function switch—LOOP POSITION.

(6) LOOP switch—SWITCH LEFT OR RIGHT FOR MINIMUM HEADSET VOLUME.

(7) Azimuth indicator (instrument panel)—READ BEARING.

Note

Steps (2) through (7) should be repeated to obtain a minimum of three different bearings for a more accurate position fix.

Caution

The general location of the radio station must be known because the loop antenna is bidirectional and two null points will occur.

g. To turn set off:

(1) VOL-OFF control—OFF. Rotate fully counterclockwise.

(2) NAV switch (signal distribution panel)—OFF. Down position.

5–83. *Marker Beacon. a.* To turn set on:

(1) RADIO MASTER NO. 2 circuit breaker—DEPRESSED.

(2) RADIO MASTER switch—ON.

(3) NO. 2 RADIO BUS circuit breaker—DEPRESSED.

(4) VOLUME-OFF control (instrument panel)—ON. Rotate clockwise to the midposition.

(5) MB switch (signal distribution panel)—ON. Up position.

(6) VOL control (signal distribution panel)—ADJUST VOLUME TO DESIRED LEVEL.

b. To turn set off:

(1) MB switch (signal distribution panel)—OFF. Down position.

(2) VOLUME-OFF control (instrument panel)—OFF. Rotate fully counterclockwise.

5–84. Automatic Stabilization Equipment Operation. Refer to paragraphs 3–38 through 3–40 for operation of the automatic stabilization equipment.

5–85. Interphone Operation. The dynamotor of the FM liaison set must be in operation for interphone operation.

a. To turn interphone on and transmit:

(1) ICS switch (switch panel)—ON. Up position.

(2) TRANS selector switch (signal distribution panel)—INT POSITION.

(3) VOL control (signal distribution panel)—ADJUST AS DESIRED.

(4) Microphone switch—DEPRESS. Speak into microphone.

b. To turn interphone off:

(1) ICS switch (switch panel)—OFF. Down position.

(2) TRANS selector switch (signal distribution panel)—RETURN TO DESIRED TRANSMITTER POSITION.

5–86. Dual Operating Controls. The only dual operating which is available on this helicopter is that of the signal distribution panel. Operation for all signal distribution panels is the same except for the cabin communication station which has the TRANS selector switch operative for interphone only.

5–87. Emergency Operation. Emergency operation which is applicable to the CH-37B helicopter is as follows:

5–88. Generator Failure. In the event of generator failure, turn off all nonessential radio equipment to prevent excessive drainage on the battery.

5–89. Emergency Standby Audio System. Should the signal distribution panels become inoperative, the emergency standby audio system automatically routes all microphone and headset audio signals around the signal distribution panel directly to the microphone and headset. The operating procedures for the radio equipment will remain the same, except for the controls which are applicable to the signal distribution panel.

5–90. Emergency Transmission and Reception. The UHF command set is provided with a guard receiver which provides for the reception of emergency transmissions on a fixed frequency of 243.0 megacycles.

Note

No transmissions will be made on the emergency frequency except for actual emergencies.

5–91. Emergency VHF Transmitter Operation. The operation of the emergency VHF transmitter is as follows:

a. To operate emergency VHF transmitter:

(1) Power switch (emergency VHF control panel)—ON.

(2) Channel selector switch—AS DESIRED.

(3) Microphone switch—DEPRESS. Speak into microphone.

b. To turn transmitter off:

(1) Channel selector switch—ARC 73 POSITION.

(2) Power switch—OFF. Down position.

Section VII Inspections

5–92. Power Off Inspection. The power off inspection consists of an exterior and interior inspection.

5–93. Exterior Inspection. The exterior inspection consists of visually inspecting the electronic equipment antennas for conditions which could prevent proper operation.

5–94. Interior Inspection. Visually inspect the electronic equipment for evidence of damage, security of mounting, loose or binding knobs, and the presence of appropriate frequency card.

5–95. Power On Inspection. The power on inspection consists of an operational check of the electronic equipment to insure that proper operation is obtainable. Refer to the operating procedures for the individual equipment in paragraphs 5–76 through 5–91.

Note

When auxiliary power is used in starting the engine, power on inspection is to be performed before starting engine. If auxiliary power is not used, perform power on inspection during engine warmup.

5–96. Flight Checks. If power on inspection cannot be performed prior to flight, it must be accomplished as soon as possible after takeoff.

Section VIII Operation of Electronic Equipment in Conjunction With Other Items

Not Applicable.

CHAPTER 6
AUXILIARY EQUIPMENT

Section I Scope

6—1. Purpose. The purpose of this chapter is to provide information on all auxiliary equipment, that is, any equipment that is not electronically operated and does not affect the flying characteristics of the helicopter. The information is of a nontechnical nature, being designed merely to instruct the crew on the basic operation of the equipment and any emergency instructions that may apply.

6—2. Extent of Coverage. When the equipment discussed contributes to the ability of the helicopter to perform a specialized mission, a description of that mission is also included. Much of the equipment discussed in this chapter is highly specialized or used interchangeably in many aircraft. Coverage of equipment in these categories will be brief since complete coverage is appropriately available in publications devoted entirely to that equipment.

Section II Heating, Ventilation, and Pressurization Systems

6—3. Heating System. (See figure 6—1.) The helicopter air heating system consists of a gasoline heater, electrically-powered blower, and ducting. The heater, located in the rear main rotor fairing, is a 200,000 BTU combustion type burner. Fuel for the heater is supplied from the left fuel tank by a heater fuel pump installed in the left engine nacelle. Air for circulation, provided by the blower, passes over the combustion chamber, is heated and then blown through the ducting to various parts of the helicopter. Electrical power for the heating system is supplied from the secondary bus through the circuit breakers (figure 2—22), marked VENT-RELAY, HEAT, COMPT-BLO, and FUEL SHUT-OFF. These circuit breakers are under a general heading marked HEATER. The electrical power for the blower is supplied from the secondary bus through a circuit breaker (figure 2—22), marked BLOWER, located on the circuit breaker panel on the cargo compartment ceiling.

Note

Fuel consumed by the cabin heater must be considered on flights requiring use of the heating system, since the range of the helicopter will be reduced. The heater consumes 1.3 gallons per hour at low operation and 2.6 gallons per hour at high operation.

6—4. Heater Vent Fan. The heater compartment vent fan is located on the right side of the helicopter to provide explosion-proof protection for the heater compartment. This fan is turned on through the vent control relay when the heater switch is either in the HI or LOW position and will continue to run as long as the heater compartment temperature is above 48.9°C (120°F). The heater vent fan operates on power from the secondary bus through a circuit breaker marked COMPT BLO (figure 2—22), located on the overhead circuit breaker panel.

6—5. Heater Switch. (See figure 6—2.) The heater switch is located on the pilots' compartment dome light panel. The switch is marked CABIN-LOW, HI, and OFF. When the engine preheat switch is off, the heater switch controls the system for high and low heater operations. When placed in the HI position for heating or defrosting, the heater switch actuates the fuel pump relay to open the fuel shutoff valve and start the fuel pump; starts the ignition unit; and trips the blower relay and vent control relay to start the cabin heater blower and the heater compartment vent fan to produce heat at 140°C (285°F) in the plenum chamber. When the switch is in the LOW position, the system operates the same as in HI except that heat is produced at only 66°C (150°F). When the heater switch is turned to the OFF position, both the blower and the heater compartment vent fan continue to run until the heat in the plenum chamber dissipates and the temperature reduces to 50°C (122°F), at which time both the blower and the heater compartment vent fan are automatically shut off.

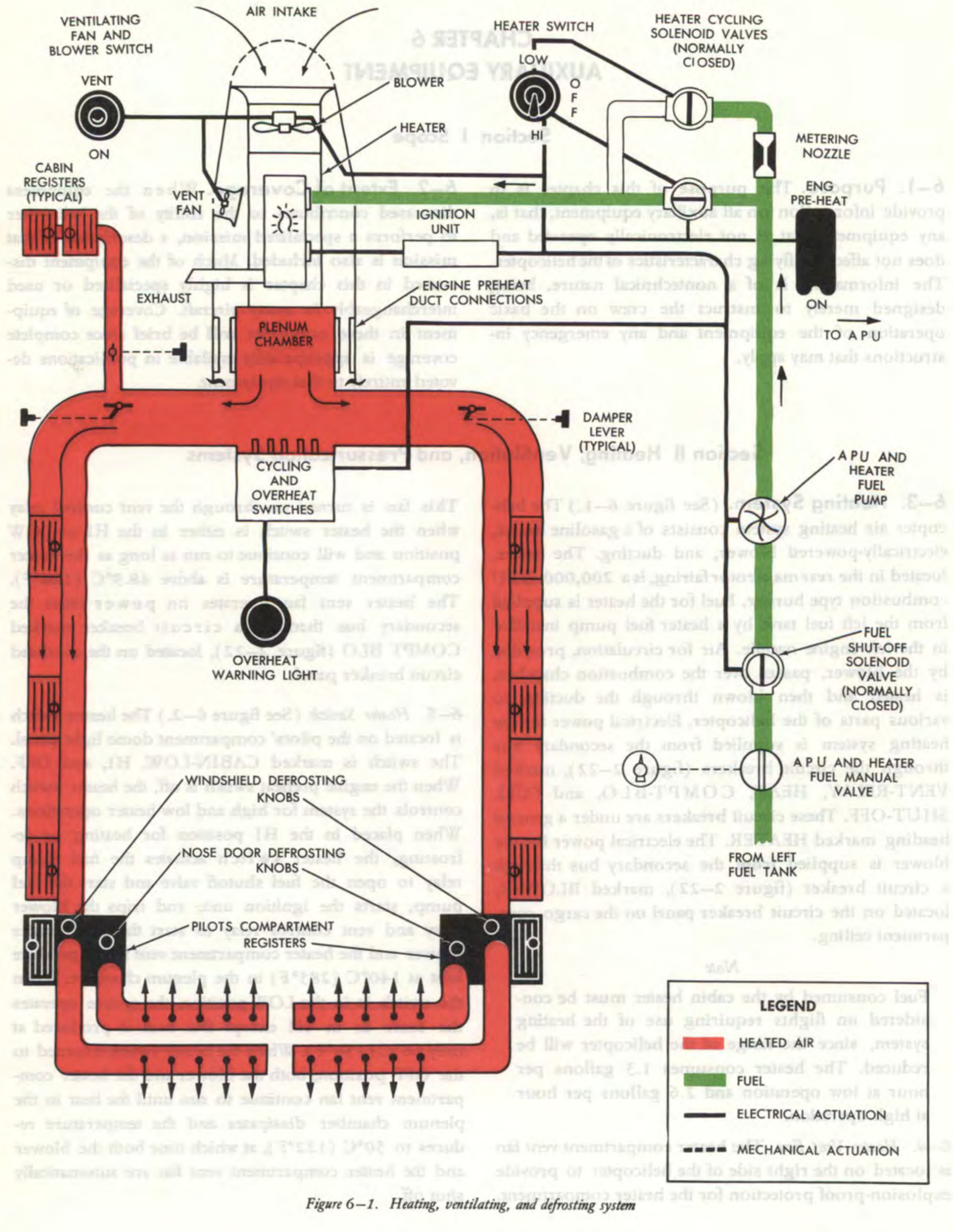


Figure 6–1. Heating, ventilating, and defrosting system

6–6. *Overheat Warning Light.* (See figure 6–2.) A red overheat warning light, marked OVERHEAT, is located on the pilots' compartment dome light panel. If the heater is operating and all distribution ducts and registers are closed so that the heat builds up to 177°C (350°F) in the plenum chamber (or if the temperature rises to this degree for any other reason) an overheat thermal switch on the plenum chamber automatically cuts off the heater ignition, fuel shutoff valve, and the heater fuel pump and causes the overheat warning light to come on. If a winterization kit consisting of a 600,000 BTU heater is installed, a 230°C (450°F) overheat thermal switch is used. When the warning light comes on, the heater switch or the engine preheat switch should be turned off and enough registers opened to allow the blower to disperse the heat. The system should be allowed to cool before using the heater again. In the case of an overheat condition other than a fire, the heater reset switch, located on the heater fire detector panel, must be actuated to energize the heater system.

6–7. *Heater Compartment Fire Detector System.* (See figure 6–3.) A fire detector element is located along the floor of the heater compartment. If a fire should occur in the heater compartment, the fire detector system will automatically shut off the fuel supply, blowers, and ignition of the heater system and will light a warning light, marked WARN, located on the inboard face of the heater fire detector panel on the right side of the cabin ceiling forward of the cargo door. Two switches, marked TEST and RESET, are also located on the heater relay panel. To test the heater fire detector system, hold the test switch on for a few seconds. The warning light should come on, then go out when the test switch is released. When the warning light comes on due to a fire in the heater compartment, the heater is shut off and cannot be operated until the reset switch is actuated.

Caution

Do not actuate heater reset switch during flight. There is no way to inspect heating system to ascertain that fire will not be restarted as soon as heater is turned on. After landing, make sure that cause of heater malfunction has been found and corrected before actuating heater reset switch.

6–8. *Cabin and Pilots' Compartment Registers.* Eight registers are installed in the two cabin ducts which extend along the cabin walls near the ceiling; three in the right duct, three in the left duct, and two in the aft cabin ceiling above the cargo door. Two additional registers are located on the outer walls of the pilots' compartment just above the floor. Ventilation may be controlled by rotating the knob on each register. The knobs are marked OPEN with an arrow pointing clockwise.

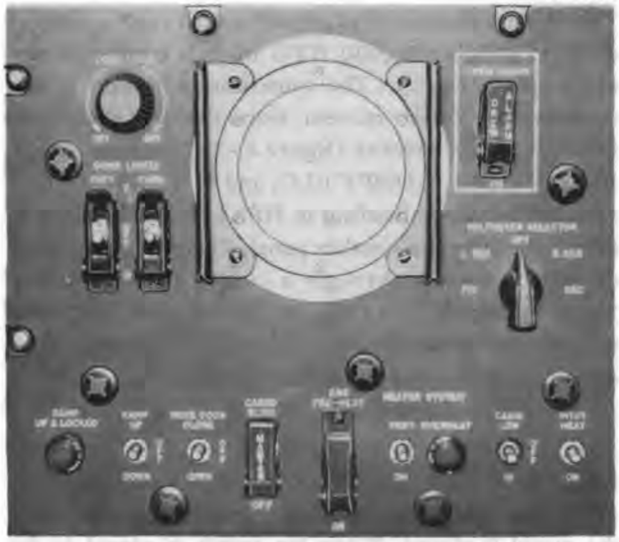


Figure 6–2. Pilot's compartment dome light panel

6–9. *Normal Operation.* Normal operation of the heating system is as follows:

a. Heater switch – HI OR LOW AS DESIRED.

b. Register and defrosting knobs – REGULATE AS NECESSARY.

6–10. *Emergency Operation.* There is no emergency operation of the heating system. The system operates on direct current from the secondary bus and therefore will become inoperative in event of failure of an engine or a generator. Should this occur and operation of the heater becomes necessary, place the bus control switch in the SEC BUS OVERRIDE position.

6–11. Winterization Heating System. A winterization kit may be installed utilizing a 600,000 BTU heater in lieu of the 200,000 BTU heater. When the 600,000 BTU heater system is installed a larger blower is provided, and the 205°C (400°F) overheat thermal switch is replaced by a 230°C (450°F) thermal switch to provide an overheat shutoff for the system.

Note

Fuel consumed by the cabin heater must be considered on flights requiring use of the heating system, since the range of the helicopter will be reduced. The cabin heater consumes 3.5 gallons per hour at low operation and 7 gallons per hour at high operation.

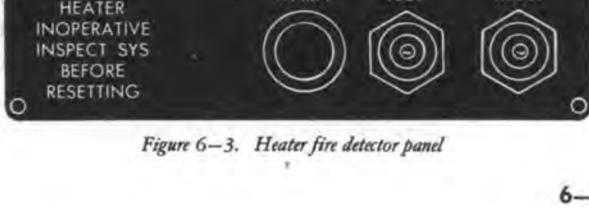


Figure 6–3. Heater fire detector panel

The plenum chamber has provisions for engine preheat ducts to supply 300,000 BTU to each engine. (Refer to paragraph 10–25.) The winterization heating system operates on direct current from the secondary bus through circuit breaker (figure 2–22), marked VENT RELAY, HEAT, COMPT BLO, and FUEL SHUT-OFF, all under a general heading of HEATER and located on the overhead circuit breaker panel. The blower operates on direct current through a circuit breaker (figure 2–22), marked BLOWER, on the high-amperage circuit breaker panel, located forward of the battery bus circuit breaker panel on the cabin ceiling.

6–12. *Engine Preheat Switch.* (See figure 6–2.) The engine preheat switch is located on the pilots' compartment dome light panel. The guarded switch, marked ENG PRE-HEAT and ON, is in the OFF position when the guard is closed. When the switch is placed in the ON position, the heater is turned on to produce heat at 177°C (350°F). Manual dampers in the plenum chamber must be closed to direct heat to the engine preheat ducts.

6–13. *Emergency Operation.* There is no emergency operation of the engine preheat system. The system operates on direct current from the secondary bus and therefore will become inoperative in event of failure of an engine or a generator. Should this occur and operation of the heater is necessary, place the bus control switch in the SEC BUS OVERRIDE position.

6–14. Ventilating System. The blower may be used for circulation of air throughout the pilots' compartment and cargo compartment when outside air temperatures are high. Air from outside is forced through the ducting and out the registers to provide the desired circulation. There is no cooling of air during this process.

6–15. *Ventilating Blower Switch.* (See figure 6–2.) The ventilating blower switch is located on the pilots' compartment dome light panel. The switch is marked VENT under the general heading HEATER SYSTEM. The system is energized when the switch is placed in the ON position. When centered, the switch is in the OFF position.

6–16. *Normal Operation.* Normal operation of the ventilating system is as follows:

a. Ventilating blower switch – ON.

b. Register and defrosting knobs – REGULATE AS NECESSARY.

Section III Anti-icing, Deicing, and Defrosting Systems

6–17. Anti-Icing and Deicing Systems. The only anti-icing and deicing system installed is that for the pitot tubes.

6–18. Pitot Heaters. An electric pitot heater is built into each of the two pitot tubes to prevent the formation of ice. The pitot heaters operate on direct current from the primary bus through a circuit breaker (figure 2–22), marked PITOT HEAT, located on the overhead circuit breaker panel.

6–19. *Pitot Heater Switch.* (See figure 6–2.) A pitot heater switch is located to the right of the heater control group on the pilots' compartment dome light panel. The switch is marked PITOT HEAT-ON. When the switch is in the ON position the pitot heaters are on. When this switch is placed in the center position, the pitot heaters are off.

6–20. Defrosting System. The defrosting system is a part of the heating and ventilating system. Heated air from the heater is carried through the ducting to the windshield and nose door defrosting ducts. The heater and blower must be in operation for defrosting.

6–21. *Windshield and Nose Door Window Defrosting Knobs.* Ventilating air going to the four defrosting ducts may be regulated or cut off completely by adjusting four defrosting knobs in the pilots' compartment. The upper windshield defrosting knobs, located below the pilot's and copilot's ventilating registers, control the defrosting of the right and left sides of the windshield, and the lower nose door window knobs control the defrosting of the right and left nose door windows. The knobs are spring-loaded and connected to the dampers. When the dampers are pushed in and rotated clockwise, they close off the defrosting air. When they are pushed in and rotated counterclockwise, they increase the flow of air.

6–22. *Normal Operation.* Normal operation of the defrosting system is as follows:

a. Heater switch – HI OR LOW AS DESIRED.

b. Register and defrosting knobs – REGULATE AS NECESSARY.

Section IV Lighting Equipment

6–23. Navigation Lights. (See figure 6–4.) The navigation lights consist of three position lights and three fuselage lights. The position lights are located as follows: A red light (12) on the outside of the left nacelle, a green light (12) on the outside of the right nacelle, and a yellow light (16) on top of the pylon. The fuselage lights are white, one located on the bottom of the fuselage (13) just aft of amidships; and two located on top of the fuselage, one just forward of the main rotor fairing (8) and one just aft of the main rotor fairing (4).

6–24. Navigation Light Switches. (See figure 2–12.) The FLASH-OFF-STEADY switch is the master control switch and when placed in the FLASH position connects the lights to the light flasher. The DIM-BRT switch is operative for either operating position of the FLASH-OFF-STEADY switch. In DIM position, the switch connects two resistors, one for the position lights and one for the fuselage lights, into the circuits. In BRT position the switch bypasses the resistors. Operating power is supplied from the primary bus through the circuit breaker, marked POS LTS, on the overhead control panel.

6–25. Top Forward Position Light Switch. (See figure 2–12.) A top forward position light switch is located on the overhead switch panel. The switch is marked TOP FWD POS LT and has positions OFF and ON. The switch may be used to turn off the top forward position light to prevent cockpit glare. The circuit operates on direct current from the secondary bus and is protected by a circuit breaker marked POS LTS, located on the overhead circuit breaker panel.

6–26. Landing Lights. (See figure 6–4.) A full 360 degree swivel, 90 degree tilt, retractable landing light (11) is located on the understructure of the right and the left nose doors. Both the pilot's and copilot's landing lights may be extended, rotated, or tilted downward in any direction and retracted by electric motors controlled by switches. The landing lights operate on direct current from the primary bus, through circuit breakers marked LAMP and MOTOR under the general heading LANDING LTS, located on the overhead circuit breaker panel.

6–27. Landing Light Master Switches. (See figure 6–5.) The landing light master switches are located on the landing light switch boxes, marked LDG LT, at the end of each collective pitch lever. The switch has positions MASTER, OFF, and RETRACT. Placing the switch in the MASTER position turns on the lamp and energizes an extend-retract-right-left switch to the right of the master switch on the landing light switch box at the end of the pilot's collective pitch lever. When the master switch is placed in the RETRACT position, the light will retract and go out. In the OFF position, the light will go out but will not retract.

6–28. Landing Light Control Switches. (See figure 6–5.) The landing light control switches are located to the right of the landing light master switch at the end of each collective pitch lever. The landing light control switch is a spring-loaded, four-position thumb switch marked EXTEND, RETRACT, L-R. This switch may be used to extend or retract the landing light and to rotate the landing light to the left or right. If the switch is placed in the RETRACT position while the landing light is extended, the light will go out and automatically retract to the stowed position. When the switch is released, it will return to the off position.

6–29. Anticollision Light. (See figure 6–4.) The anticollision light (1), located on top of the pylon, is provided to create a flashing action which is visible for a considerable distance under conditions of restricted visibility. The rotating red light is used continuously during flight to preclude a collision. This light operates on power supplied from the primary bus through a circuit breaker marked ROT. LT. (See figure 2–22.)

Note

Use of anticollision light on ground should be kept to an absolute minumum to avoid excessive heat created on ground, which is detrimental to bulb life and increases maintenance problems; and to prevent possible confusion of rescue operations since emergency ground vehicles use a similar light.

6–30. Anticollision Light Switch. The anticollision light switch (figure 2–12) is located on the overhead switch panel and is marked ROTATING-ON. To energize the anticollision light, this switch must be in the ON position.

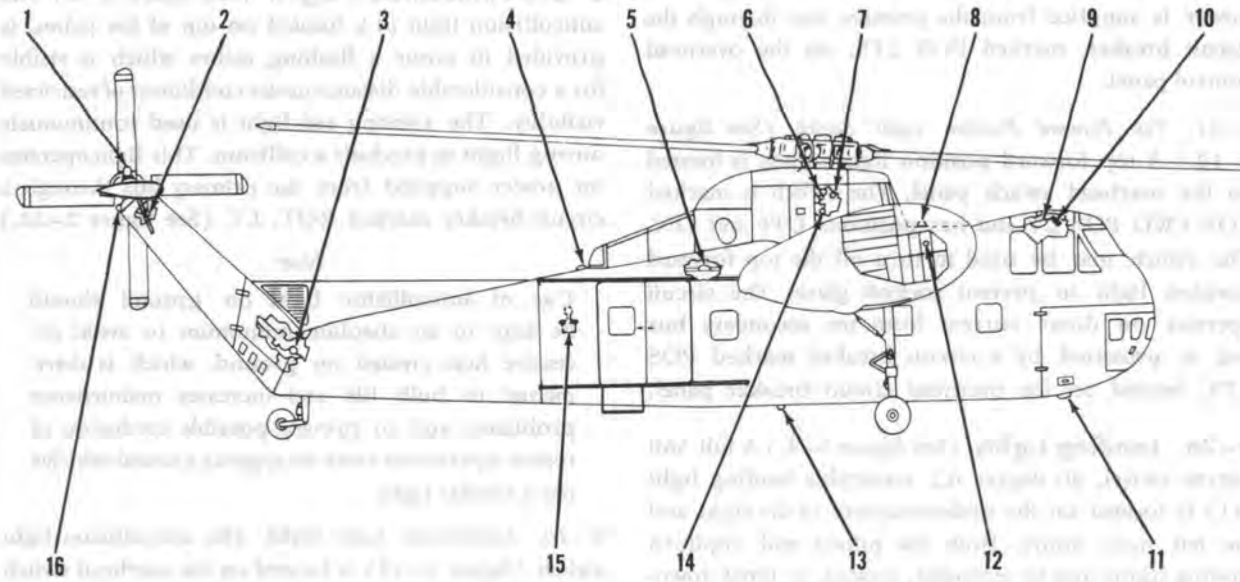
Note

The rotating anticollision light should be turned off during flight through conditions of reduced visibility where pilot could experience vertigo as a result of rotating reflections of light against clouds. In addition, light would be ineffective as an anticollision light during these conditions since it could not be observed by pilots of other aircraft.

6–31. Dome Lights. (See figure 6–4.) Eight overhead dome lights for general illumination are installed. One in the pilots' compartment (9), four in the forward cabin, and three in the aft cabin (5). The lights, containing both a red and white lamp, are controlled by the two dome lights switches, marked CKPT and CABIN. Operating power for pilots' compartment dome light is supplied by the battery bus through the circuit breaker, marked CKPT DOME LT, on the battery bus circuit breaker box. Operating power for the cabin dome lights is supplied by the primary bus through the circuit breaker, marked CABIN DOME LTS, on the overhead control panel.

6–32. Dome Lights Switches and Rheostat. (See figure 6–2.) Two dome light switches, marked CKPT and CABIN, with the positions R, OFF, and W, and a dome light rheostat with OFF and BRT positions are installed on the overhead control panel. The dome light rheostat dims the red lamp of the pilots' compartment dome light only. Both switches are equipped with guards so that the white lights cannot be turned on accidentally.

6–33. Instrument Lights and Rheostats. (See figure 2–12.) The individual instrument lights are connected in two circuits. One circuit lights the flight instruments in front of the pilot and copilot and the standby magnetic compass; it is controlled by rheostats located on the overhead switch panel. The rheostats are marked FLIGHT INST LIGHTS, PILOT and FLIGHT INST LIGHTS, COPILOT with positions OFF and BRT. The standby magnetic compass light switch (7, figure 2–9) is located on the right side of the compass mounting bracket, so that the compass light may be turned off when the other flight instrument lights are on. The switch has marked positions, ON and OFF. After the flight instrument lights are turned on most of the warning lights may be automatically dimmed by actuating the warning light dimming switch. The second circuit lights the engine instruments in the center of the instrument panel and is controlled by a nonflight instrument light rheostat, located to the right of the copilot's flight instrument light rheostat. The rheostat is marked NON-FLIGHT INST LIGHTS, with positions OFF and BRT. The intensity of the



1. Anticollision light (red)
2. Tail gear box oil level inspection light
3. Intermediate gear box oil level inspection light
4. Fuselage light (white)
5. Cabin dome lights (7, red or white)
6. Main gear box oil level inspection light
7. Utility hydraulic reservoir oil level inspection light
8. Fuselage light (white)
9. Pilot's compartment dome light (red or white)
10. Map lights (red or white)
11. Landing lights (left and right)
12. Position lights (left side red, right side green)
13. Fuselage light (white)
14. First and second stage servo hydraulic reservoir oil level inspection light
15. Signal light (right side)
16. Position light (yellow)

Figure 6–4. Lighting equipment

lights is controlled by rotating the rheostats. Spare instrument light bulbs are stowed at the forward end of each outboard face of the overhead switch panel box. The flight and engine instrument lights operate on direct current from the primary bus through circuit breakers, marked NON-FLT INST, PILOT FLT INST, and COPILOT FLT INST, located on the overhead circuit breaker panel.

6–34. Warning Light Dimming Switch. (See figure 2–12.) A warning light dimming switch is located on the overhead switch panel. The momentary-type switch, marked WARN LIGHT, has positions DIM and BRT. This switch controls the intensity of the various warning lights and is operative only when the flight instrument light rheostat is turned on. The switch is normally in the off position and is placed in either extreme momentary position to dim or brighten the warning lights. The lights will remain dim or bright after finger pressure is removed from the switch. When the flight instrument light rheostat is not turned on, and until the warning light dimming switch is pushed to the DIM position after the flight instrument lights are turned on, the warning lights will illuminate brightly. The only purpose of the BRT position of the warning light dimming switch is to restore the warning light to the bright condition (with flight instrument lights on) after they have once been dimmed.

6–35. Console and Panel Lights Rotary Switch. (See figure 2–12.) The console and panel lights rotary switch is located on the overhead switch panel. The rotary switch is marked CONSOLE and PANEL LIGHTS, with positions OFF and BRT. The switch controls lights on the engine control quadrant, the radio control panels, the landing gear control panel, the checklist, the copilot's panel, and the cabin interphone panel. It also controls the intensity of the lights by rotating the rotary switch from left to right and right to left. The lights operate on direct current from the primary bus through a circuit breaker, marked PANEL CKPT SPOT, located on the overhead circuit breaker panel.

6–36. Map Lights. (See figure 2–9.) The pilot's and copilot's detachable map lights (3 and 13) are mounted in adjustable brackets, one on each side of the overhead switch panel. The map lights are controlled by rheostats with positions ON and OFF. The intensity of the lights may be varied in the ON position. The lights are equipped with removable red filters and operate on direct current from the primary bus through a circuit breaker, marked PANEL CKPT SPOT, located on the overhead circuit breaker panel.

Figure 6–5. Landing light switch box

6–37. Signal Light. A portable signal light (15, figure 6–4) is installed on a bracket located on the right side of the cabin aft of the cargo door. The light, controlled by an on-off switch on the handle, operates on direct current from the secondary bus when plugged into a utility receptacle. The light is protected by a circuit breaker, marked CABIN under the general heading UT RECP, located on the overhead circuit breaker panel.

6–38. Nose Door and Ramp Manual Override Controls Light Switch. The nose door and ramp manual override controls light switch (figure 6–6) is located forward of the ramp hydraulic valve. The switch is marked NOSE DOOR & RAMP VALVE LTS. This switch controls the lights over the nose door hydraulic valve and the ramp hydraulic valve to illuminate the nose door and ramp manual override knobs. The manual override controls light circuit operates on power from the battery bus and is protected by a circuit breaker marked CKPT DOME LT (figure 2–22), located on the battery bus circuit breaker panel.

Figure 6–6. Nose door and ramp manual override control light switch

Figure 6–7. Oil level inspection light switch

6–39. Oil Level Inspection Light Switch. (See figure 6–7.) An oil level inspection light switch is located in a box forward of the cabin door on the right side of the cabin. The switch is marked OIL LEVEL INSP LTS and OFF. When the switch is turned on, it illuminates inspection lights at the oil level inspection windows of the main, intermediate, and tail gear boxes and of the first and second stage servo and utility hydraulic reservoirs, and at the same time illuminates a red pilot light on the side of the switch box. The oil level inspection lights operate on direct current from the battery bus through a circuit breaker (figure 2–22), marked CKPT DOME LT, located on the battery bus circuit breaker panel. When the switch is placed in the OFF position, all lights turn off. The switch operates from the battery bus so that these lights may be illuminated regardless of the position of the battery switch.

Section V Oxygen System

Not Applicable

Section VI Auxiliary Power Unit

6–40. Auxiliary Power Unit (APU). (See figure 6–8.) The auxiliary power unit is installed in the aft left corner of the cabin and is fastened to cargo tie-down fittings in the floor by four wing nuts. The portable APU consists of a generator and a two-cylinder, four-cycle, gasoline engine that drives the generator. The engine receives fuel from the left fuel tank through a pump and line that also supplies the fuel for the cabin heater. Fuel shutoff solenoid valves are located on the cabin side panel behind the power unit. The power unit engine exhaust and cooling air intake are connected by ducts through the left side of the cabin. A starter cord stowed in a service kit, located at the rear of the power unit, is used for emergency starting. The auxiliary power unit, control panel, and power cable may be removed from the helicopter to reduce the weight or to make room for cargo.

Note

APU may be used to charge battery when helicopter is on ground and all unnecessary electrical equipment is turned off.

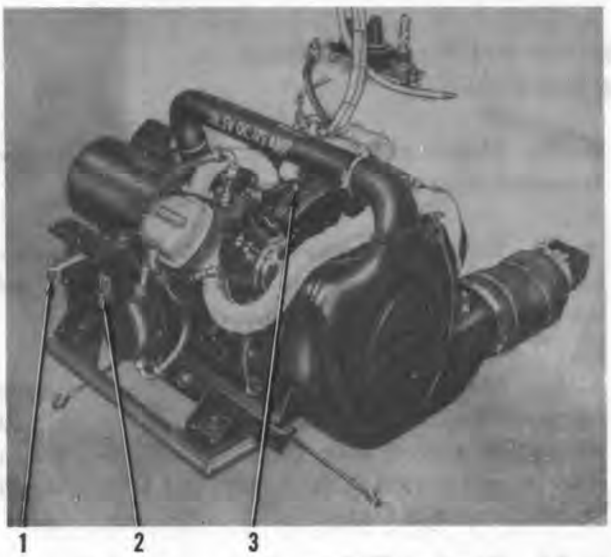
6–41. APU Ignition Switch. (See figure 6–8.) The APU ignition switch (2) is located on the left-inboard side of the auxiliary power unit. The switch is marked IGNITION and has positions ON and OFF. The function of the ignition switch is to close the circuit between the magneto and spark plugs of the APU.

6–42. APU Altitude Valve. (See figure 6–8.) The APU altitude valve (3) is located on the APU carburetor between the cylinders. When operating at altitudes above sea level, the valve must be adjusted with a thumb screw so that the pointer is set opposite the figure nearest the altitude at which the engine will be operating.

6–43. APU Governor Control and Choke Lever. (See figure 6–8.) The APU governor control and choke lever (1) is located on a horizontal quadrant installed on the left-inboard side of the APU. The lever has the marked positions CHOKE, IDLE, and RUN. To aid starting the APU at low temperatures, place the lever in the CHOKE position. Use the IDLE position during warmup. Just before turning on the APU generator, move the lever to the RUN position.

6–44. APU Control Panel. (See figure 6–9.) The auxiliary power unit control panel is located above the auxiliary power unit on the cabin side panel and contains the switches, circuit breakers, and relays that connect the auxiliary power unit generator voltage to the primary bus.

6–45. APU Fuel Pump Switch. (See figure 6–9.) The circuit breaker switch is located on the auxiliary power unit control panel. The switch has two positions, marked FUEL PUMP and OFF. The switch controls the fuel pump in the left engine nacelle and the fuel solenoid valves behind the APU. Placing the switch in the FUEL PUMP position turns on the fuel pump and opens the electrically actuated solenoid valve, permitting fuel under pressure to flow to the carburetor of the APU.



1. Governor control and choke lever
2. Ignition switch
3. Altitude valve

Figure 6–8. Auxiliary power unit

Placing the switch in the OFF position turns off the pump and closes the solenoid valve.

6–46. APU Starter Switch. (See figure 6–9.) The APU starter switch is located on the control panel of the auxiliary power unit. The starter switch has two positions, marked START and NORMAL. When the switch is held in the START position, direct current from the primary bus will motorize the APU generator and start the power unit engine. The switch is spring-loaded and will return to the NORMAL position when finger pressure is released.

6–47. APU Generator Switch. (See figure 6–9.) The APU generator switch is located on the left side of the control box of the auxiliary power unit. The switch is marked GENERATOR with two positions ON and OFF. After the power unit engine is running, the APU generator switch is turned to the ON position to connect the generator output to the helicopter primary bus. A reduction in engine speed may be anticipated when electrical loads are applied.

6–48. APU Generator Failure Warning Light. (See figure 6–9.) A red, press-to-test APU generator failure warning light is located to the left of the generator switch on the control box of the APU. The warning light is marked WARNING, LIGHT ON NO OUTPUT and will come on if there is no APU generator output.

6–49. APU Ammeter. (See figure 6–9.) The APU ammeter is located below the switches on the control box of the auxiliary power unit and indicates the amount of current being drawn from the APU. The ammeter should not indicate a continuous load of more than 175 amperes; however, for periods no longer than 5 minutes, the load may be as high as 263 amperes.

6–50. Normal Operation. Normal operation of the APU is as follows:

a. To start APU.

(1) Battery switch – ON.

Figure 6–9. APU control panel

(2) APU fuel pump switch (on APU control panel) – ON.

(3) APU ignition switch (on APU) – ON.

(4) APU governor and choke lever (on APU) – IDLE.

(5) APU starter switch (on APU control panel) – START.

(6) APU governor and choke lever – CHOKE, IDLE, then RUN. CHOKE (if necessary) for starting. Move to the IDLE position until engine warms up and then to the RUN position for 2 minutes without load.

(7) APU generator switch – ON. After 2 minutes of engine operation at RUN position.

b. To stop APU:

(1) APU generator switch – OFF.

(2) APU governor and choke lever – IDLE. For 5 minutes.

(3) APU fuel pump switch – OFF.

(4) APU ignition switch – OFF. After the engine consumes all the fuel and then stops.

6–51. Emergency Operation. The APU may be started manually by winding the starter cord around the grooved pulley located on the flywheel and pulling from any convenient angle. More choking will be required.

Section VII Armament System

Not Applicable.

Section VIII Photographic Equipment

Not Applicable.

Section IX Aerial Delivery Equipment

Not Applicable.

Section X Miscellaneous Equipment and Main Rotor Blade and Pylon Folding and Unfolding

6–52. Windshield Wiper Switch. The windshield wiper switch is located on the right side of the overhead switch panel. (See figure 2–12.) The switch is marked WINDSHIELD WIPER and has positions PARK, OFF, FAST, MED, and SLOW. The switch controls an electric motor located below the center of the windshield. The motor operates on the direct current and is protected by a circuit breaker, marked WIND. WIPER, located on the overhead circuit breaker panel. The motor operates on direct current from the primary bus. Flexible shafting extends from the motor to two units which operate windshield wiper blades in front of the pilot and copilot. Turning the switch to the PARK position before finally turning the windshield wiper off assures that the wiper blades will come to rest at an extreme position.

6–53. Map and Data Case. A map and data case is located above and aft of the pilot's seat.

6–54. Balance Computer. A slide-rule type, cabin-loading balance computer is stowed in a case mounted on the copilot's inboard seat support.

6–55. Nose Door Gun Ports. Each nose door is equipped with a gun port that is facing forward and covered by a small door. (See 17, figure 2–2.) Each door hinges inward at the bottom and is held closed by two fasteners at the top.

6–56. Mooring Fittings. Five mooring fittings are provided on the helicopter. Each main landing gear strut has a fitting on the inboard and outboard side.

(See 24, figure 2–2.) A fitting is also located at the rear of the aft fuselage section aft of the tail wheel.

6–57. Electrical Utility Receptacles. Four capped electrical utility receptacles are connected to the secondary bus through two circuit breakers, marked CKPT and CABIN, located under a general heading of UT RECP on the overhead circuit breaker panel. Two receptacles are located in the pilots' compartment, one on each side panel below the sliding windows. Two receptacles are located on the right cabin side panel near the interphone stations, one forward beneath the radio deck and one aft near the cargo door.

6–58. Safety Harness. An air safety harness that may be clipped to a cargo tie-down fitting is furnished to be used when the cargo hatch is open during flight.

6–59. Relief Tube. The relief tube is located by the escape hatch opposite the cargo door. The relief tube installation consists of a horn, tube, and venturi. The horn is held in a bracket secured to the side of the fuselage. The tube extends from the horn through the fuselage terminating at the venturi. If used, the tube should be cleaned with a disinfectant-deodorant solution after flight.

6–60. Cargo Hoist Winch. A cargo hoist winch capable of lifting 2000 pounds travels on a hoist monorail suspended from the cabin ceiling. The cargo hoist winch components are a motor-driven winch containing 50 feet of cable, and four trolley wheels which travel on the monorail. An automatic clutch is built into the winch to prevent overloading. The clutch is designed to slip when the cable tension exceeds 2000 pounds. If the clutch slips during loading, operation of the clutch should be discontinued immediately to avoid damage to the winch, and the load should be reduced. The cargo hoist winch is also equipped with three locks to secure it to the rail at various points. Two of the locks consist of removable pins located below each set of trolley wheels. These lockpins are used to secure the hoist to the rail for performing rescue operations through the hatchway in the cabin floor. A rescue sling may be attached to the cable hook for this purpose. Maximum capacity for in-flight rescue operations is 600 pounds, due to G load. The lockpins are also used to secure the hoist to the specially braced portion of the rail, just forward of the curved portion, for towing wheeled equipment up the nose ramp and securing the hoist during flight. The third lock consists of a spring-loaded pin which operates through the hub of one set of trolley wheels. This pin extends through holes in the web of the rail to anchor the hoist at various points to deposit cargo picked up from the rear cargo door. The auxiliary power unit is the normal source of electric power for the operation of the hoist so that cargo may be handled without engine operation. The hoist electric power cable is connected to a receptacle on the right cabin wall and operates on direct current through a circuit breaker marked HOIST located on the high-amperage circuit breaker panel. (See figure 2–22.) Power to operate the hoist is derived from the primary bus. The monorail extends from the front of the cabin to a point opposite the aft cargo door where it curves 90 degrees and extends out the door. The monorail is braced at its outer end by two boom supports which are attached to the fuselage bottom structure with quick-disconnect pins. A plug in the aft section of the cargo and passenger door may be removed to allow the door to be opened or closed when the monorail is rigged through the doorway. A short portion of the monorail track just forward of the curve is well braced to the cabin ceiling and is the only part from which towing may be accomplished. When used in this manner, the winch can be used to tow wheeled and skidded loads weighing up to 10,000 pounds, provided the force required to drag the cargo does not exceed 2000 pounds. The monorail track may be folded up to the right and locked against the ceiling to increase the head room in the cabin; or it may be completely removed from the helicopter.

Caution

Winch should be parked and locked on tow section of rail or removed from monorail and secured to floor before takeoff.

Cargo hoist system is specifically designed for towing from forward to aft. Towing operations which impose loads on hoist winch from any other direction are prohibited.

When towing loads, mount hoist winch with arrow on side of winch pointing toward load.

6–61. Cargo Hoist Switch. The cargo hoist switch, located on the end of a four-foot cable attached to the cargo hoist, controls the hoist winch. The thumb switch has two marked positions, UP and DOWN. When the switch is not actuated, an automatic brake will hold the load. To actuate the winch, push the thumb switch to either extreme position.

6–62. Cargo Hoist Shear Switch. Two cargo hoist shear switches (figure 6–10) are provided for releasing the cargo in the event of an emergency. One switch, marked SHEAR, is located on the instrument panel and the other, marked HOIST CABLE SHEAR, is located in

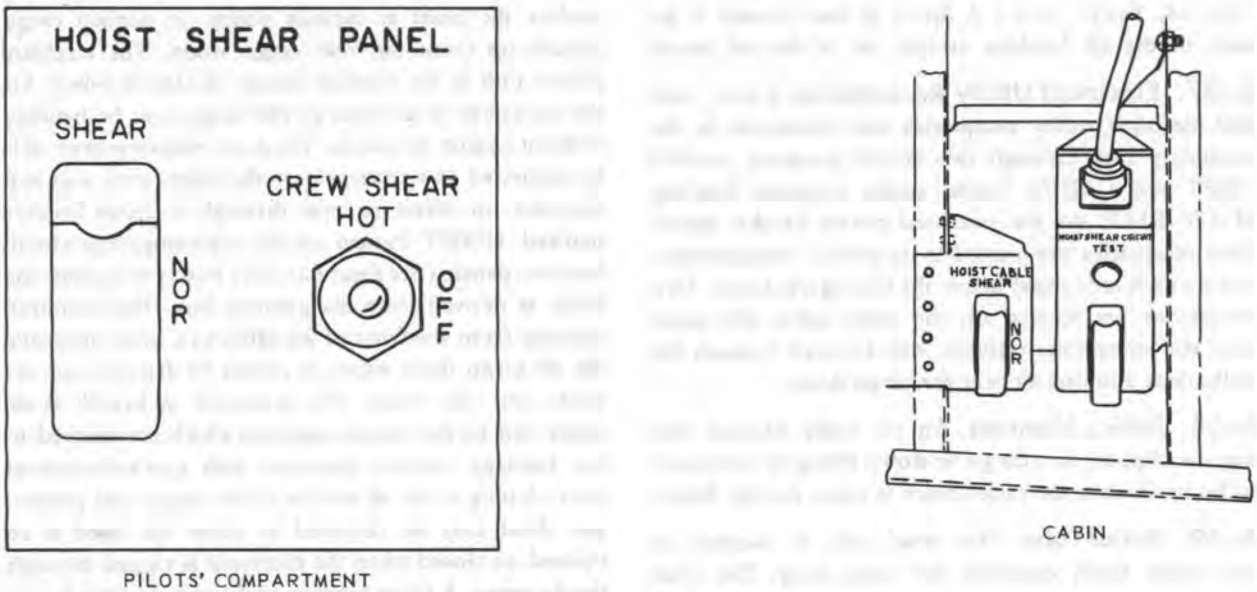


Figure 6–10. Hoist shear switches

the cabin. The cargo hoist shear switch in the cabin is operative only when the crew shear selector switch, marked CREW SHEAR-HOT-OFF, is in the HOT position. The crew shear selector switch is located on the instrument panel next to the pilot's hoist shear switch. The cargo hoist shear circuit operates on power from the primary bus through a circuit breaker marked HOIST SHEAR.

6–63. External Cargo Sling. (See figure 6–11.) An external cargo sling capable of carrying 10,000 pounds is attached to the four corners of the floor hatchway. The four cables extend from the bottom of the fuselage to a hook assembly. The cargo hook may be opened electrically to release an external load by depressing thumb switches on the pilot's or copilot's cyclic stick grips.

Warning

Due to high amount of static electricity generated by helicopter, the charge should be dissipated prior to hook-up or manual release.

The release circuit operates on direct current from the primary bus. The cargo release circuit is protected by a circuit breaker marked CARGO SLING located on the overhead circuit breaker panel. The hook may also be opened manually from the cabin by pulling a cargo release handle, located in the cargo hatchway, or by actuating a lever located on the hook itself. Cargo is attached to the hook manually by ground personnel. In order to install the external cargo sling, it is necessary to remove the two bottom fairings that cover the hatchway. The hatch floor panel may be left in place and operations observed from the cabin or window at the end of the hatch. When the cargo sling is attached but is not in use, it is drawn up against the right side of the fuselage into the stowed position by a cargo sling stowage line.

6–64. Cargo Sling Master Switch. (See figure 6–11.) A guarded, cargo sling master switch is located on the pilots' compartment dome light panel. It controls the operation of the cargo sling hook. The switch, marked MASTER, has two marked positions, CARGO SLING, and OFF. It should be kept in the OFF position during loading and flight. The hook may be manually closed or opened by ground personnel or opened by pulling the cargo manual release handle in the hatchway. When preparing to release cargo electrically, the switch is placed in the CARGO SLING position. With the switch in the CARGO SLING position, the cargo is dropped by actuating either cyclic stick thumb switch. The switch should be returned to the OFF position and the sling stowed after the cargo has been dropped.

6–65. Cargo Release Switches. (See figure 6–11.) A cargo release switch is located on both the pilot's and copilot's cyclic stick grip. The cargo release switch is marked CARGO. Either push-button type switch may be depressed to open the cargo sling hook when the cargo sling master switch is in the CARGO SLING position.

6–66. Cargo Manual Release Handle. (See figure 6–11.) A cargo manual release handle, located under an access door at the aft end of the floor hatch is connected

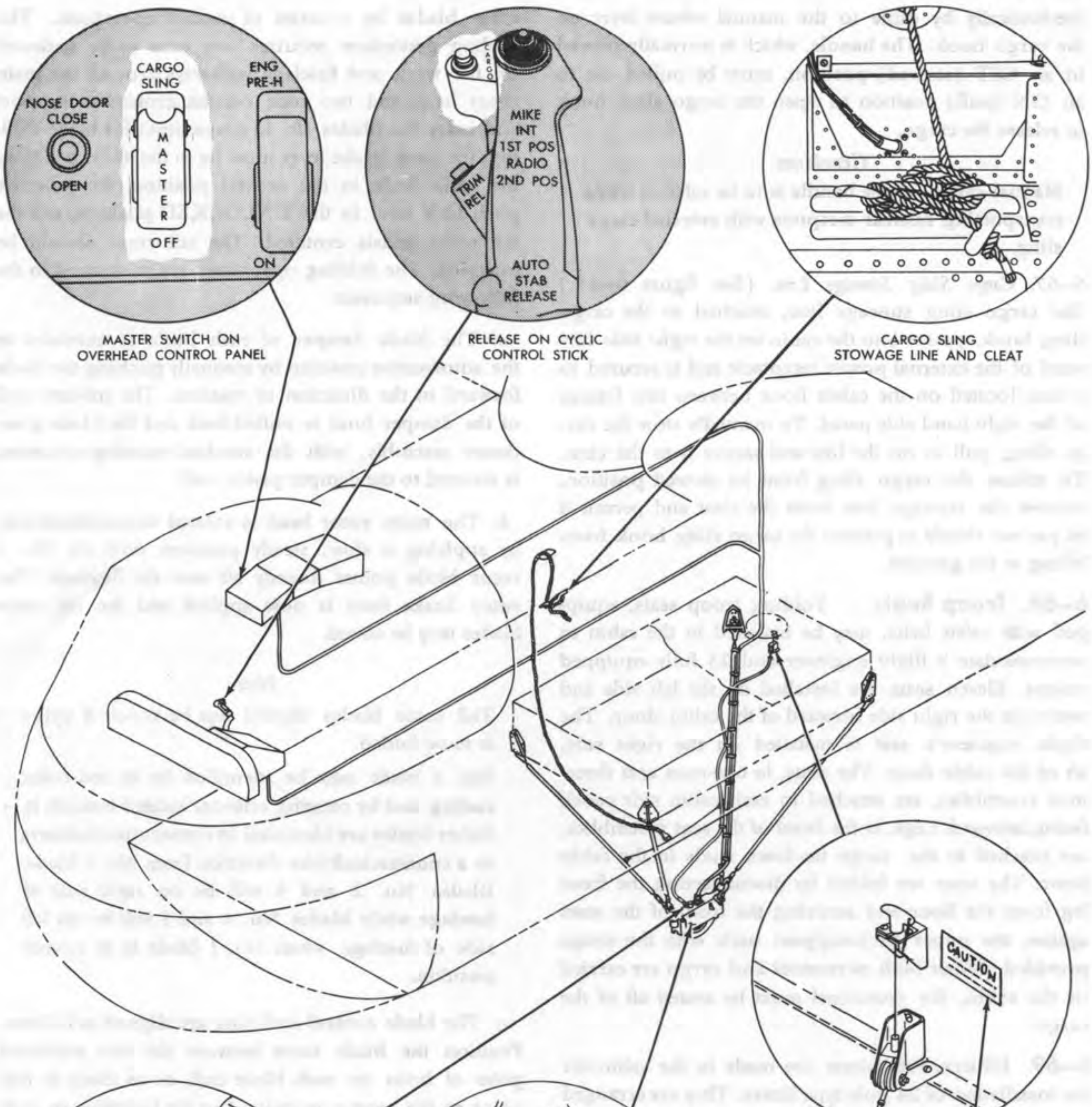


Figure 6–11. External cargo sling and controls

mechanically by cable to the manual release lever on the cargo hook. The handle, which is normally stowed in an OFF (stowed) position, must be pulled out to an ON (pull) position to open the cargo sling hook to release the cargo.

Caution

Manual cargo release handle is to be safetied while transporting nuclear weapons with external cargo sling.

6–67. Cargo Sling Stowage Line. (See figure 6–11.) The cargo sling stowage line, attached to the cargo sling hook, passes into the cabin on the right side forward of the external power receptacle and is secured to a cleat located on the cabin floor between two frames of the right-hand side panel. To manually stow the cargo sling, pull in on the line and secure it to the cleat. To release the cargo sling from its stowed position, remove the stowage line from the cleat and permit it to pay out slowly to prevent the cargo sling hook from falling to the ground.

6–68. Troop Seats. Folding troop seats, equipped with safety belts, may be installed in the cabin to accommodate a flight engineer and 23 fully equipped troops. Eleven seats are installed on the left side and twelve on the right side forward of the cabin door. The flight engineer's seat is installed on the right side, aft of the cabin door. The seats, in one-man and three-man assemblies, are attached to each cabin side panel, facing inboard. Legs, at the front of the seat assemblies, are attached to the cargo tie-down studs in the cabin floor. The seats are folded by disconnecting the front leg from the floor and securing the front of the seats against the upper back-support back with the straps provided. When both personnel and cargo are carried in the cabin, the personnel must be seated aft of the cargo.

6–69. Litters. Provisions are made in the cabin for the installation of 24 pole-type litters. They are arranged in three tiers, of four litters each, on either side of the cabin, extending from the cockpit ladder aft to the escape hatch and cargo door. The bottom litter on each tier rests on the cabin floor and the three litters above it are clamped by their outboard poles to the cabin side panels. The inboard poles of the litters are supported by straps running from fittings in the ceiling to the cargo tie-down fittings in the floor. When all litters are installed, the forward half of the cargo door is blocked.

6–70. Main Rotor Blade Folding. The main rotor blades may be folded back over the fuselage to conserve space. At least four men are required to fold the main rotor blades by a series of manual operations. The folding procedure requires two men to be stationed on the wing and fuselage walkways around the main rotor head and two men on the ground to support and carry the blades aft. In preparation for blade folding, the rotor brake lever must be in the OFF position, the cyclic stick in the neutral position, the collective pitch lock lever in the UNLOCKED position, and the tail rotor pedals centered. The tail rotor should be unconed. The folding operations are performed in the following sequence:

a. The blade damper of each blade is extended to the autorotative position by manually pushing the blade forward in the direction of rotation. The inboard end of the damper boot is pulled back and the blade positioner assembly, with the attached warning streamer, is secured to the damper piston rod.

b. The main rotor head is rotated counterclockwise by applying a slow, steady pressure until the No. 1 rotor blade points directly aft over the fuselage. The rotor brake lever is now applied and the tail rotor blades may be coned.

Note

Tail rotor blades should not be coned if pylon is to be folded.

No. 1 blade may be identified by its red color coding and by rotating scissors located beneath it. Other blades are identified by consecutive numbers in a counterclockwise direction from No. 1 blade. Blades No. 2 and 3 will be on right side of fuselage while blades No. 4 and 5 will be on left side of fuselage when No. 1 blade is in stowed position.

c. The blade control lockpins are aligned as follows: Position the blade rotor between the two outboard pairs of bolts on each blade cuff, or as close to this point as the rotator permits. Cut the lockwire on each control lock, except that of the No. 1 blade, and rotate each blade until the blade control lockpin is aligned with its hole and seated. Engage the blade control lock on each sleeve-spindle horn by rotating the hex-head bolt inboard of the trailing edge of the blade until the lockpin is seated. When the blade control lockpin has been engaged, the end of the rack gear on it will be flush with the housing. If the rack gear protrudes, the lockpin is not engaged. Align the blade control lockpins of blades No. 5, 3, 4, and 2, in that order. The final lockpin, blade No. 2, should seat without rotating the blade. If it is not aligned, it will be necessary to adjust the blade lock guide in the No. 2 sleeve-spindle assembly, using the bolts and checknuts.

Note

To aid in stowing blades after aligning control lockpins of No. 4 and 5 blades, loosen blade position locks of No. 4 and 5 blades and rotate blades clockwise, using blade rotator, so that leading edge is down and aft 24 degrees from normal flight angle. Seat blade position locks. A red painted area of the horn is exposed when blades are rotated, serving as a warning that blades No. 4 and 5 must be relocated to normal flight angle before next flight.

Caution

If pylon is to be folded, it must be folded after No. 1 blade has been positioned and before installing blade stowage rack assembly to prevent damage to pylon, tail rotor blades, or stowage rack. Care must be taken to clear stabilizer when folding pylon.

Note

Tail rotor blades should be coned after pylon has been folded.

d. The crutch assembly, consisting of a blade clamp and attached pole, is positioned and locked with an assist pole on blade No. 2 between the first and second blade pockets. The blade is raised from the droop position by fully extending the pole and supported by resting the end of the pole in the ground to permit removal of the taper pin.

e. The forward attaching taper pin is removed from the cuff of the blade. The blade is carried aft, with the crutch and assist pole, by two men stationed on the ground.

f. Blades No. 3, 5, and 4, in that order, are folded in the same manner.

Warning

Before and while each blade is being walked aft, insure that antiflapping restrainer remains in place behind stop located on top of sleeve-spindle assembly. Be sure to keep fingers clear of restrainer arm end.

Note

When blades are to be folded, blade stowage racks and blade restrainers must be used. After each blade is folded, appropriate blade restrainer is installed and secured at sleeve and blade cuff to hold root end of blade.

On helicopters equipped with wide chord blade, appropriate pole and clamp assembly should be positioned on centerline of fourth pocket.

g. Open the blade stowage rack clamp with the assist pole and lift the blade onto it. Close the clamp with the assist pole and release the pole and clamp assembly.

Caution

Before closing clamp on No. 2 and 3 wide chord blades, make certain trailing edge of blade is in firm contact with sponge bumper at clamp hinge point.

Note

Clamp latching mechanism is adjustable to assure proper blade fit and lock in wide chord stowage blade clamp.

h. The crutch is positioned on blade No. 1 so that its poles will be vertical when secured in place. The clamping assist pole is installed on the right-hand side of the crutch. The length of the crutch assembly is adjusted and each of the assist poles is positioned to the studs located on the aft end of the crossarms of the left- and right-hand blade stowage rack assemblies.

Note

On wide chord blades, position pole and clamp assembly on No. 1 blade so that its assist poles will be vertical when secured in place. Clamp pole and clamp assembly to blade. Adjust length of pole and clamp assembly to the white stripe or expose twenty (20) adjustment holes. Position ball ends of two assist poles into sockets located on forward end of crossarms of left- and right-hand blade stowage rack assemblies and slide ball-lockpins into holes provided.

Caution

To prevent damage to rotor system, do not actuate flight controls to helicopter while blades are folded.

6–71. Main Rotor Blade Unfolding. The main rotor blades are unfolded by reversing the folding procedure.

6–72. Pylon Folding. The tail rotor pylon may be hydraulically folded around to lie along the right side of the aft fuselage section by extracting the pylon lockpins on the left side, turning a valve selector, and actuating a hydraulic wobble pump to provide folding power. If both blades and pylon are to be folded, the No. 1 blade must first be positioned aft over the top of the fuselage. The pylon must then be folded before the remaining blades are folded. If both blades and pylon are to be unfolded, the pylon must be unfolded first. When blade stowage racks are to be installed, they must be installed after pylon folding. The tail rotor blades must be coned after folding the pylon. (Refer to paragraph 2–22.) All pylon operations are performed by ground personnel at the pylon hinge point. An electrical interlock is provided to assure that neither rotor clutch can be engaged unless the pylon lockpins are seated. (See figures 6–12 and 6–13.)

6–73. Pylon Lockpin Ratchet Handle and Position Indicator. (See figure 6–12.) The pylon lockpins, on the left side of the fuselage at the base of the pylon, are pulled by actuating a pylon lockpin ratchet handle fore-and-aft. The lower pin is extracted upward and the upper pin downward. The ratchet action of the handle is reversed for seating the lockpins, after the pylon is unfolded, by twisting the end of the handle 180 degrees. When not in use, the ratchet handle is pushed forward where it is retained by a spring-loaded latch. As the pylon lockpins retract, a red metal pylon lockpin indicator flag, marked PIN OUT, appears from a slot in the fuselage skin above the lockpins.

6–74. Pylon Fold Valve Selector and Pump Lever. (See figure 6–13.) A pylon fold valve selector and a detachable pump lever, used to manually operate the pylon fold hydraulic pump, are installed on the aft end of the fuselage behind the trailing edge fairing below the pylon. The valve selector has positions FOLD, OFF, and UNFOLD. Before folding the pylon, it is necessary to remove the fairing to gain access to the valve selector and pump lever. The valve selector is normally kept in the UNFOLD position. To fold the pylon, place the valve selector in the FOLD position. Insert the pump lever, which is normally stowed in clips, into a socket on the pump and actuate fore-and-aft. After folding the pylon, place and leave the valve selector in the UNFOLD position.

Caution

To prevent damage to the fold valve, lockpins, or pylon hinge, do not fold pylon unless pylon lockpins are fully retracted and red pylon lockpin indicator flag, marked PIN OUT, is fully extended.

Warning

When folding or unfolding pylon, keep clear of pylon and tail rotor blades.

Caution

When pylon has reached over-center position, it has a tendency to accelerate because of inclined hinge. Rate of its movement may be reduced by moving valve selector toward OFF (center) position until desired rate is obtained.

6–75. Pylon Unfolding. To unfold the pylon, check that the valve selector is in the UNFOLD position and proceed to unfold the pylon in the same manner as in folding. Leave the valve selector in the UNFOLD position.

Warning

Before unfolding pylon, be sure to disconnect jury strut.

Figure 6–12. Pylon lockpin ratchet handle and position indicator

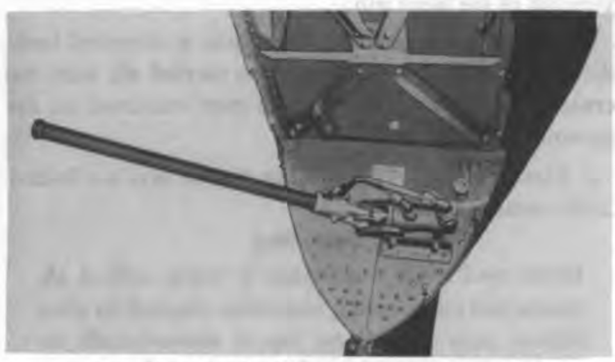


Figure 6–13. Pylon fold valve selector and pump lever

CHAPTER 7
OPERATING LIMITATIONS

Section I Scope

7—1. Purpose. The purpose of this chapter is to provide the pilot with coverage of all important limitations that must be observed during normal flight operations.

7—2. Extent of Coverage. Limitations that are characteristic of specialized phases of operation are not covered in this chapter, but may be found in Chapter 4, Emergency Procedures or Chapter 10, Weather Operations.

Section II Limitations

7—3. Introduction. Operating limitations are established to insure safety of flight and to assist the pilot in obtaining maximum utility from the helicopter. These limitations are derived from flight test and engineering data; however, they are subject to changes as additional operation experience is obtained. Instrument range markings (figure 7—1) should be referred to as all of the range markings do not necessarily appear in the text. The range markings requiring additional coverage and additional limitations on operating procedures, maneuvers, and weight are covered in the following paragraphs.

7—4. Minimum Crew Requirements. The minimum crew required to operate the helicopter under normal nontactical conditions is a pilot, a copilot, and a flight engineer. Additional crewmembers, as required, will be added at the discretion of the commander, in accordance with appropriate Department of the Army Regulations.

7—5. Engine Limitations. Engine limitations are as follows:

7—6. *Power Limitations.* (Refer to table 7—1.) Maximum power, 2100 BHP per engine, is limited to a 5 minute operation. Power settings for maximum power at sea level are 2700 rpm and 57.5 inches Hg with RICH mixture. Critical altitude for maximum power is 5400 feet. Power settings for METO power at sea level are 2600 engine rpm and 50.5 inches Hg with NORMAL mixture. Critical altitude for METO power is 7800 feet. Power settings for recommended METO at sea level are 2600 engine rpm and 45.8 inches Hg with NORMAL mixture. Critical altitude for recommended METO is 10,200 feet. Recommended cruise is 1380 BHP per engine. Power settings for recommended cruise at sea level are 2600 engine rpm and 37.6 inches Hg with NORMAL mixture.

7—7. *Power Limitations, Alternate Fuel.* Fuel grade 115/145 fuel is recommended; however, when it is not available, 100/130 fuel may be used as an alternate for power settings at less than maximum power. When using the alternate fuel grade, power settings at sea level are as follows: Maximum power, 1950 BHP per engine, is limited to a 5 minute operation. Power settings for maximum power at sea level are 2600 rpm and 54.0 inches Hg with RICH mixture. Critical altitude for maximum power is 5700 feet; Power settings for METO power at sea level are 2600 rpm and 47.5 inches Hg with NORMAL mixture. Critical altitude for METO power is 9900 feet.

7—8. *Engine Speed {RPM}.* (See figure 7—1.) Engine operation between 2600 and 2700 engine rpm is limited to 5 minutes (RICH mixture). The normal operating range is between 2500 and 2600 engine rpm. Because of the main rotor blade allowable stresses, operation between 2400 and 2500 engine rpm is restricted to lower gross weights. Avoid operation between 2300 and 2400 engine rpm, except at low gross weights and airspeeds. For permissible gross weight versus rpm, see chart 8—1.

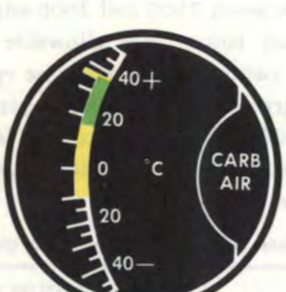
Table 7—1. Maximum manifold pressure for specified rpm

RPM	MANIFOLD PRESSURE IN. HG
2700	57.5 (Limited to 5 min.)
2600	50.5
2500	49.0
2400	47.0
2300	45.4
2200	44.0

MANIFOLD PRESSURE
- 23 TO 37.6 IN. HG — NORMAL (green)
- 57.5 IN. HG — MAXIMUM (TAKE OFF 5 MINUTES) (red)

AIRSPEED INDICATOR
- 0 TO 40 KNOTS IAS — CAUTION LOW ALTITUDE (yellow)
- 40 TO 100 KNOTS IAS — NORMAL (green)
- 100 TO 120 KNOTS IAS — POSSIBLE BLADE STALL (yellow)
- 120 KNOTS IAS — MAXIMUM (red)

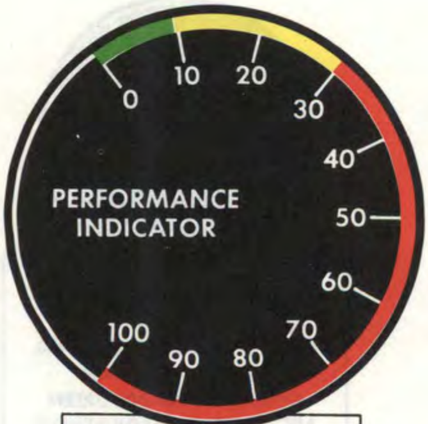
FUEL PRESSURE
- 21 PSI — MINIMUM (red)
- 21 TO 23 PSI — NORMAL (green)
- 25 PSI — MAXIMUM (red)
- 23 TO 25 PSI — WITH FUEL BOOST



CARBURETOR AIR TEMPERATURE
- −10 TO +15°C — CAUTION ICING (yellow)
- 15 TO 38°C — NORMAL (green)
- 38°C — MAXIMUM WITH HEATED AIR (yellow)

CYLINDER HEAD TEMPERATURE
- 100°C — MINIMUM (red)
- 150 TO 232°C — NORMAL (green)
- 260°C — MAXIMUM (red)
- 232 TO 260°C — 30 MINUTE LIMIT
- 100 TO 150°C — AT OIL TEMPERATURE ABOVE 40°C

Figure 7–1. Instrument range markings (Sheet 1 of 3)



PERFORMANCE INDICATOR
- 0 TO 10 — NORMAL
- 10 TO 30 — CAUTION
- 30 TO 100 — AVOID

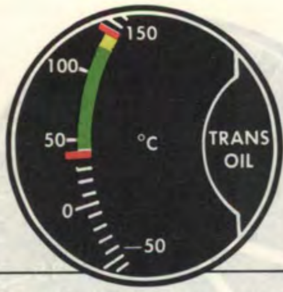
ENGINE TACHOMETER
- 2300 RPM — MINIMUM FLIGHT
- 2400 TO 2500 RPM — LIMITED
- 2500 TO 2600 RPM — NORMAL OPERATING RANGE
- 2700 RPM — MAXIMUM

ROTOR TACHOMETER
- 164 RPM — MINIMUM FLIGHT
- 178 TO 200 RPM — NORMAL
- 215 RPM — MAXIMUM

ENGINE OIL TEMPERATURE
- 40°C — MINIMUM
- 40 TO 85°C — NORMAL
- 100°C — MAXIMUM
- 85 TO 100°C — 30 MINUTE LIMIT

ENGINE OIL PRESSURE
- 60 PSI — MINIMUM
- 75 TO 100 PSI — NORMAL
- 100 PSI — MAXIMUM
- 60 TO 75 PSI — 30-MINUTE LIMIT

Figure 7–1. Instrument range markings (Sheet 2 of 3)



TRANSMISSION OIL TEMPERATURE

(Gear Box Outlet Temperature)

40°C — MINIMUM
40 TO 120°C — NORMAL
120 TO 140°C — CAUTION
140°C — MAXIMUM

TRANSMISSION OIL PRESSURE

25 PSI — MINIMUM
25 TO 60 PSI — NORMAL
120 PSI — MAXIMUM

OPERATION ABOVE GREEN ARC REQUIRES READJUSTMENT TO SYSTEM

FIRST STAGE SERVO HYDRAULIC PRESSURE

2600 PSI — MINIMUM
2600 TO 3150 PSI — NORMAL
3150 PSI — MAXIMUM

SECOND STAGE SERVO HYDRAULIC PRESSURE

1750 PSI — MINIMUM
1750 TO 2150 PSI — NORMAL
2150 PSI — MAXIMUM

UTILITY SYSTEM HYDRAULIC PRESSURE

2600 PSI — MINIMUM
2600 TO 3150 PSI — NORMAL
3150 PSI — MAXIMUM

EMERGENCY SYSTEM HYDRAULIC PRESSURE

3000 PSI — MAXIMUM

Figure 7–1. Instrument range markings (Sheet 3 of 3)

7–9. *Engine Overspeed.* When engine speed exceeds 2700 rpm, the pilot should note in Form 2408 the maximum engine rpm attained and the duration of the overspeed condition. The overspeed limits are as follows:

a. 2800 to 3100 engine rpm—No inspection required.

b. 3100 to 3350 engine rpm—Inspection required.

c. Above 3350 engine rpm—Removal of engine required.

7–10. *Manifold Pressure.* The manifold pressure gage markings (figure 7–1) are for sea level conditions. As altitude is increased, up to the critical altitude, manifold pressure must be reduced in accordance with table 14–4 to avoid exceeding the power limitations. Above critical altitude, full throttle may be used.

7–11. *Engine Overboost.* When engine overboost occurs which is less than 5 inches Hg and less than 15 seconds in duration, an inspection is not mandatory; however, a log book entry must be made. When overboost occurs, an engine inspection in accordance with TM 55-1520-203-35 will be required under the following conditions:

a. When overboost exceeds 5 inches Hg at power settings above 2200 rpm for any period of time.

b. When overboost is less than 5 inches Hg for more than 15 seconds at power settings above 2200 rpm.

7–12. *Carburetor Air Temperature.* (See figure 7–1.) The range markings on the carburetor air temperature gage are intended to assist the pilot in the use of the carburetor air lever to prevent carburetor icing. Carburetor heat should be applied when the gage indicates temperatures within the −10° to +15° C yellow cautionary range. When normal operation is restored, adjust the carburetor air lever to maintain carburetor air temperature in the range between 20° and 30°C. No maximum carburetor air temperature limit is imposed for safe engine operation. As long as the maximum allowable limits for engine rpm, cylinder head temperature, and manifold pressures are not exceeded, engine deterioration shall not occur because of the carburetor air temperature; however, excessive carburetor air temperature will reduce the available engine power. A 1 percent power loss will be experienced for each 6 degrees above 38°C; therefore, to insure maximum available engine power output, do not apply carburetor heat when the carburetor air temperature is above 38°C.

7–13. Transmission System Limitations. (See figure 7–1.) Operating limitations of the transmission system are governed by the transmission (main gear box) oil pressure and temperature. Operation above the green arc of the transmission (main gear box) oil pressure gage requires adjustment of the oil pressure system. Operation in the yellow arc of the transmission (main gear box) oil temperature gage indicates possible transmission or oil cooler malfunction, and the transmission oil pressure gage should be closely monitored.

7–14. Rotor System Limitations. (See figure 7–1.) Rotor speed should not be allowed to remain below 164 rotor rpm (yellow radial line) during autorotation as the inertia of the rotating blades below this speed is not sufficient to accomplish a safe power-off landing. During clutch engagement or disengagement, with the helicopter headed into the wind, the steady component of the wind plus the gust velocity should not exceed 60 knots. Excessive blade flapping at low rotor rpm will be encountered at higher wind velocities. The recommended range for autorotation is 178 to 200 rotor rpm.

7–15. *Ground Operation, Clutches Disengaged.* (See table 7–2.) Prolonged ground operation with the clutches disengaged is not recommended; however, when necessary, ground operation should be accomplished at between 1500 and 1600 engine rpm to minimize the possibility of the clutch overheating. Overheating of the clutches can damage the oil seals, causing leakage of oil and hydraulic fluid and also failure of the clutches. When ground operation with the clutches disengaged is necessary, the duration of ground operation should be varied in accordance with ambient air temperature, and engine speed should be between 1500 to 1600 rpm.

7–16. *Collective Pitch Limitations.* Rapid increase in collective pitch of the main rotor blades may result in excessive torque in the main rotor drive. Failure of the hydromechanical clutch and engine overspeed could occur as a result of this. During takeoff, allow a minimum of 2 seconds to move the collective pitch lever from low to high pitch.

7–17. Transmission and Rotor Overspeed. Overspeeding of the rotor system imposes a severe overload on the rotor and transmission system. When an overspeed condition occurs, the pilot should note in Form 2408 the maximum rotor rpm attained and the duration of the overspeed condition. For conversion of engine rpm to rotor rpm, refer to table 14–2.

Table 7–2. Maximum duration – ground run, clutches disengaged

AMBIENT AIR TEMPERATURE		DURATION
°C	°F	MINUTES
−18	0	35
− 4	25	25
10	50	15
24	75	10
38	100	5

7-18. Airspeed Limitations
(fig. 7-1)

The airspeed limitations for forward, sideward, and rearward flights are as follows:

Caution: **Close pilot's window when approaching maximum airspeeds or when operating in a critical speed regime. Flight with the pilot's compartment window open may cause turbulence or low pressure at the entrance of the pitot tubes, and result in erroneous readings of the airspeed indicators. The airspeed error at 80 knots, with the window open, is approximately 5 knots. When parachutists are to jump from the aircraft, the indicated airspeed during the actual jumps should not be less than 50 knots or more than 70 knots.**

7-19. Forward Speed Limitation

The yellow arc covering the cautionary low speed range of the airspeed indicator is a warning that in the event of failure of both engines at low altitude with 0 to 40 knots airspeed, the possibility of accomplishing a satisfactory autorotative landing is reduced. The yellow arc covering the cautionary high speed range indicates where possible roughness, due to blade stall, would most likely occur. For maximum level flight airspeeds limited by recommended METO power or blade stall, refer to tables 8-1 and 8-2.

7-20. Sideward Speed Limitation

Sideward speed of the helicopter is limited to 35 knots.

7-21. Rearward Speed Limitation

Rearward speed of the helicopter is limited to 20 knots. Further increase in speed requires full limit of the cyclic stick and, consequently, no margin of control will remain for maneuvering in rearward flight.

7-22. Performance Indicator

The performance indicator indicates the maximum safe steady state condition for all flight regimes, including maneuvers, that the pilot should not exceed from a controllability standpoint as affected by blade stall. The range markings indicate the degree of blade stall encountered during flight. Operation within the green area is desirable for maximum performance. Normally, the helicopter should be flown at airspeeds or rotor speeds that prevent any fluctuating indications of the gage. Fluctuations within the green area indicate that a slight amount of blade stall is present, and the pilot should not plan on any further increase in speed, load factor, or reduction in rotor speed. Steady or fluctuating readings within the yellow area indicate that an increased amount of blade stall is being encountered and some loss of control may be experienced; therefore, the pilot should take some corrective action to reduce the amount of stall. Steady or fluctuating readings in the red area should be avoided due to excessive blade stall which can lead to complete loss of control. Indications within this area are not cause for an inspection of the control system. The performance indicator does not necessarily show when limit airspeed is achieved. In general, at low density altitudes (below 3,000 ft), the speed limits of tables 8-1 and 8-2 will apply, with the performance indicator becoming a forward speed and rotor speed limiting device at higher density altitudes. In the event of failure of the indicator, the limit speeds of tables 8-1 and 8-2 apply. This indicator is not installed for the purpose of indicating best range or maximum endurance. Flight planning charts of chapter 14 should be used for this purpose.

7-23. Maneuvers

Maneuvering limitations are as follows:

7-24. Angle of Bank

The angle of bank may be restricted to less than 45 degrees by the performance indicator. For permissible combinations of angle of bank, gross weight, and engine rpm, see chart 8-1.

7-25. Abrupt Maneuvers

The flight controls will not be moved abruptly. Abrupt movements may induce or aggravate blade stall.

7-26. Acrobatic Maneuvers

Acrobatic maneuvers are not recommended in this helicopter.

7-27. Hovering Limitations

Hovering turns will not be executed at a rate greater than 12 degrees per second (360 degrees in 30 seconds), due to stresses imposed on the tail rotor drive shaft. The helicopter will not be hovered in crosswinds of velocity greater than 35 knots, due to a decrease in the margin of tail rotor control available for safe operation.

7-28. Minimum Height for Safe Landing After Engine Failure

(chart 7-1).

Chart 7-1 plots minimum heights required for safe autorotative landing after engine failure versus airspeed. Regions of caution are indicated in yellow, avoidance in red, and safe operation in green. Separate charts are furnished for single-engine failure and dual-engine failure. The data is based on a minimum time delay between power loss and application of full down collective pitch of 2 seconds.

7-29. Center of Gravity Limitations

It is possible to exceed the fore-and-aft center of gravity limits if the helicopter is not properly loaded. Use actual

SINGLE ENGINE FAILURE

MODELS: CH-37B
DATE 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

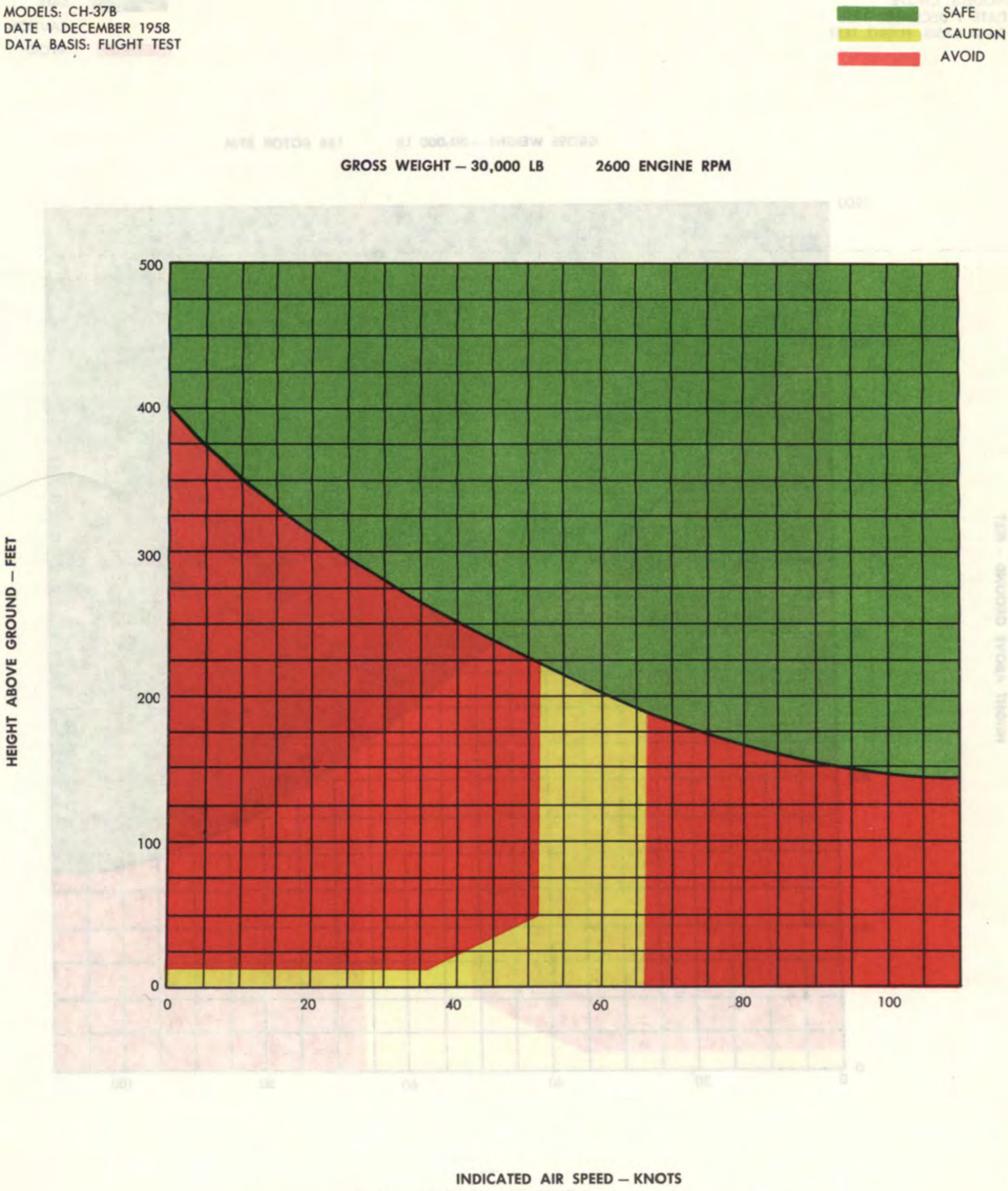


Chart 7–1. Minimum height for safe landing after engine failure {Sheet 1 of 2}

DUAL ENGINE FAILURE

MODELS: CH-37B
DATE 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

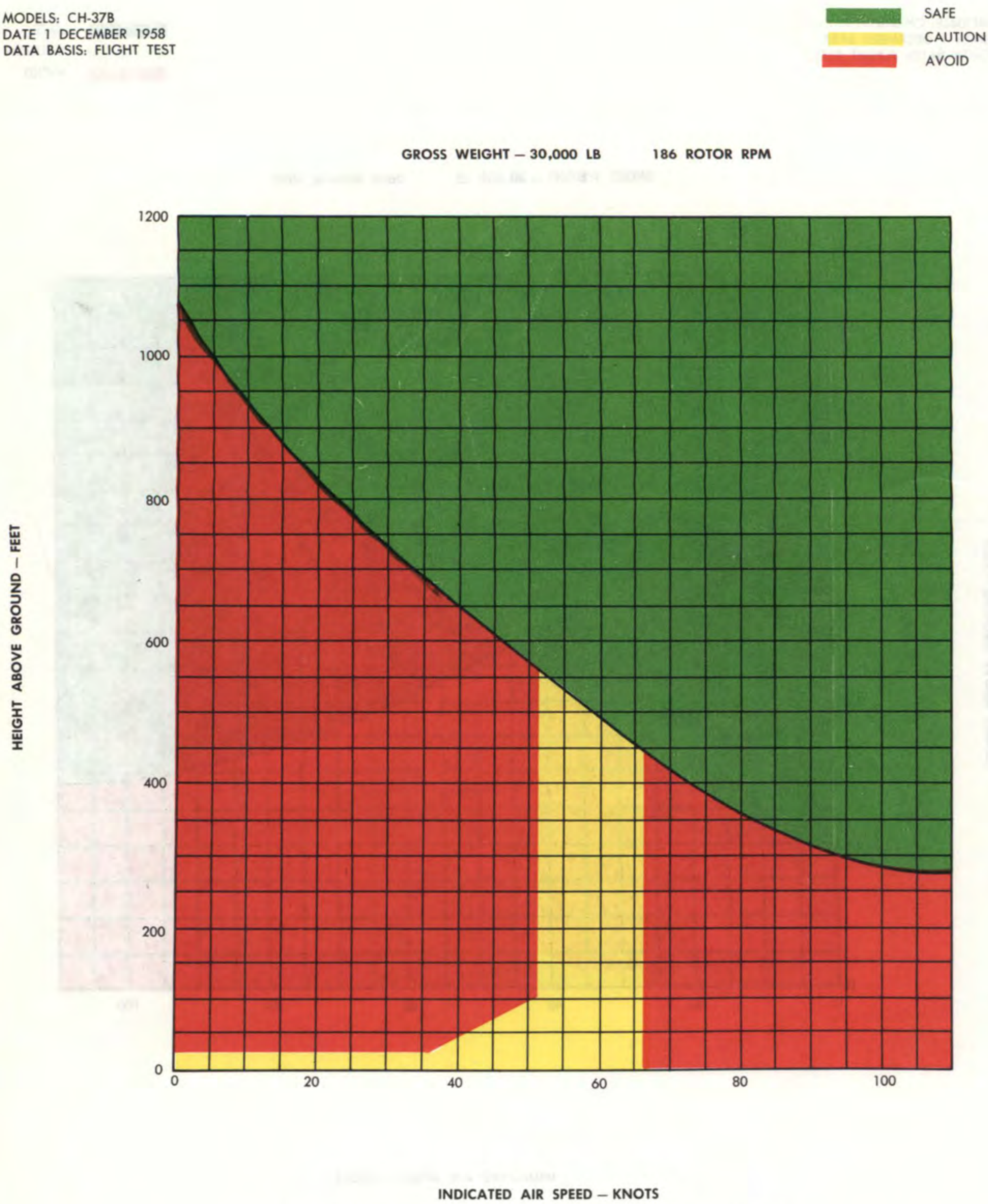


Chart 7–1. Minimum height for safe landing after engine failure {Sheet 2 of 2}

weight of crew, if available. For center of gravity limits, see figure 7–2.

Caution

Personnel are prohibited from proceeding beyond cabin aft bulkhead during flight in order not to exceed center of gravity limitations.
When operating weight of helicopter without cargo includes pilot, copilot, and flight engineer, cargo hoist winch should be in forward position to maintain center of gravity limit.

7–30. Weight Limitations. The design gross weight of the helicopter for structural analysis is 30,342 pounds at a limit load factor of 2.50. The maximum alternate gross weight and the maximum recommended takeoff weight is 31,000 pounds at a limit load factor of 2.45. In addition to the gross weights, other criteria covered in the following paragraphs will also limit maximum weights.

7–31. *Internal Cargo.* The cabin floor is stressed for 300 pounds per square foot static loading.

7–32. *External Cargo.* The maximum load for the external cargo sling is 10,000 pounds.

7–33. *Margin of Safety and Limit Load Factor.* The helicopter is designed to withstand a load of 2-1/2 times its own weight at 30,342 pounds. This means that the limit load factor is equal to 2.5 G. The difference between the limit load factor and the flight load factor (G) is the margin of safety. It is of prime importance to anticipate the maximum flight load factor that will be encountered or induced during a mission. The recommended margin of safety is 1.0 G. The performance indicator can be used as an indication of excessive G loading in flight.

7–34. *Weight Limitation Chart.* (See chart 7–2.) The function of the weight limitations chart is to provide the flight crew with a rapid means of determining the load carrying capabilities of the helicopter while remaining within the safe operating limits. Performance, due to the requirements of a particular mission as well as structural limitations, may restrict the maximum weight at which the helicopter can be flown. The following paragraphs will explain the construction and use of the weight limitations chart:

a. Operating weight. The operating weight on which the chart is based is 22,723 pounds. The operating weight is the weight of the helicopter ready to fly except for the two variables, alternate load (cargo or passengers), and fuel, and is the approximate basic weight, plus the weight of the pilot, copilot, flight engineer, and the full oil capacity of 60 gallons. The intersection of the alternate load and the fuel load axis at zero represents this operating weight. The chart indicates the various combinations of fuel and alternate loads that can be added to the operating weight to remain within the safe operating range. Since the operating weight of individual helicopters vary, it will be necessary to adjust the operating weight as shown on the chart to the actual operating weight of the particular helicopter. To adjust the chart, determine the basic weight of the helicopter, add 600 pounds for the pilot, copilot, and flight engineer, and 450 pounds for the engine system oil capacity. If the actual operating weight exceeds 22,723 pounds, subtract the difference between the actual operating weight and 22,723 pounds from the alternate load as shown on the chart. If the actual operating weight is less than 22,723 pounds, add the difference between the actual operating weight and 22,723 pounds to the alternate load as shown on the chart.

b. External fuel tanks. External fuel may be carried in two jettisonable 150-gallon fuel tanks or two 300-gallon fuel tanks. The weight of the fuel contained in either type of tank is included on the weight limitations chart; however, the weight of the supporting structure for the tanks and the weight of the tanks is not included in the operating weight. When either type tank is installed, the alternate load must be reduced by the weight of the tanks and supporting structure. This may be accomplished most easily by ignoring the fact that the tanks are installed and determining the alternate load that can be carried with any given quantity of fuel. After determining the alternate load, reduce this value by 332 pounds when the 150-gallon tanks are installed or 524 pounds when the 300-gallon tanks are installed. The total weight of the supporting structure and bomb racks or nonjettisonable weight, included in the above values for either type tank, is 164 pounds.

c. Gross weight. Two gross weights of the loaded helicopter are shown as diagonal lines on the chart, 30,315 pounds and 31,000 pounds. Limit load factors are shown at each of these weights.

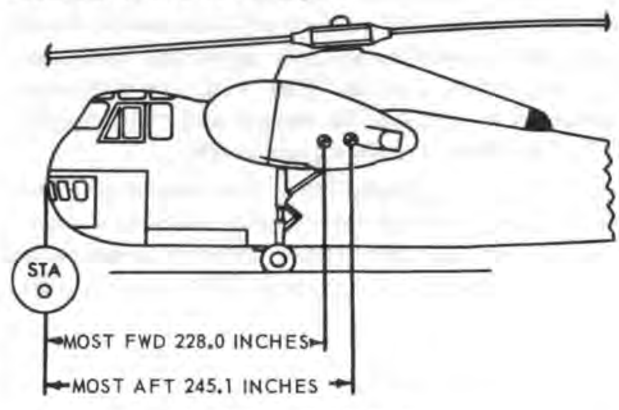


Figure 7–2. CG limits

d. Landing gear limitations. The landing gear is designed for landing at the design gross weight of 30,342 pounds with ground contact at a sinking speed of 8 feet per second.

e. Green area. The green area (recommended loading) represents loading conditions that present no particular problems in regard to strength or performance of the helicopter. The gross weight of the upper limit of the green area should not be exceeded. The green area is bounded by the maximum recommended gross weight line at 31,000 pounds.

f. Red area. The red area (not recommended loading) represents loadings that should not be used except under conditions of extreme emergency when safety of flight is of secondary importance. The commander will decide whether the degree of risk warrants the use of the helicopter within the red area.

Note

Gross weight should never exceed that required for mission since unnecessary risk and equipment wear will result. Data shown on chart is for information and guidance; however, takeoff gross weight must be considered, especially at high altitudes. Availability of cleared area for level flight air accelerations, atmospheric temperatures, mission requirements, and urgency of mission should also be taken into consideration, especially when operating within red area.

When a helicopter has been operated at weights within red area, a suitable entry should be made in Form 2408.

7–35. Sample Problems. Two problems are provided for an explanation of the use of the weight limitation chart.

a. Problem 1. To accomplish a particular mission, if it is determined that it is necessary to carry 2000 pounds of fuel. Determine the alternate load that can be carried.

(1) Enter chart (chart 7–2) at a fuel weight of 2000 pounds and project vertically until first diagonal line (30,315 pounds) on the chart is intersected. From this point, proceed horizontally to alternate load scale and read 5592 pounds. This weight is maximum alternate load that can be carried with 2000 pounds of fuel to remain at normal gross weight.

(2) Proceed vertically from 2000 pound fuel line until second diagonal line (31,000 pounds) is intersected. From this intersection, proceed horizontally to alternate load scale and read 6277 pounds. This weight is maximum alternate load that can be carried with 2000 pounds of fuel to remain at maximum recommended gross weight.

(3) After determining alternate load, adjustments must be made for actual operating weight of helicopter. Actual operating weight may be determined by adding weight of pilot (200 pounds), copilot (200 pounds), flight engineer (200 pounds), and full engine oil capacity (450 pounds) to helicopter basic weight. For example, if actual operating weight should be 22,900 pounds, proceed as follows: subtract operating weight on chart (22,723 pounds) from actual operating weight and deduct difference from alternate load 22,900 –22,723=177 pounds. Alternate load at a gross weight of 30,315 pounds would then be 5592 – 177 = 5415 pounds. Alternate load at maximum recommended gross weight would then be 6277 – 177 = 6100 pounds.

b. Problem 2. With 300-gallon auxiliary tanks installed and at total fuel capacity of 5952 pounds, determine alternate load at a gross weight of 30,315 pounds.

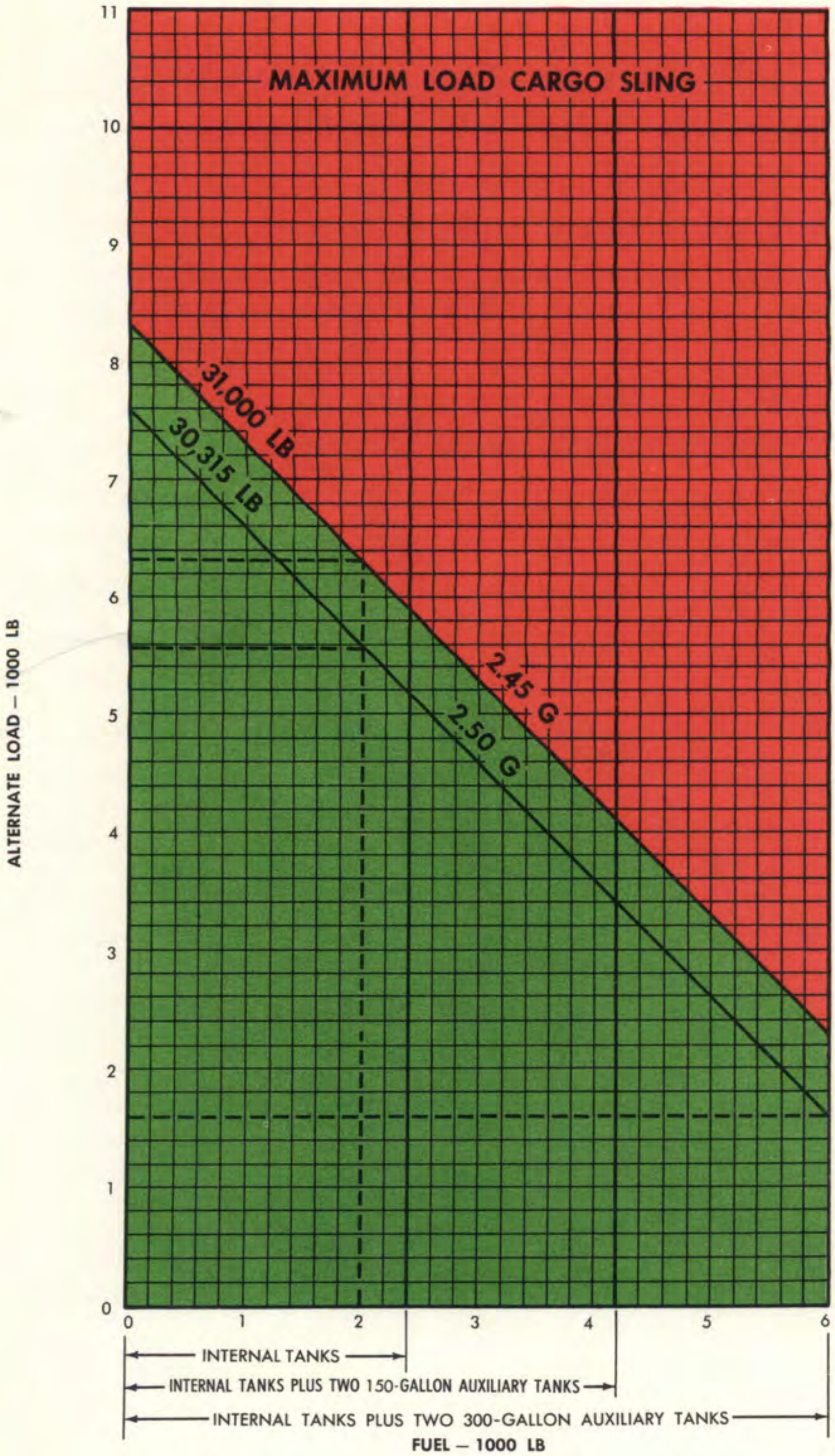
(1) Enter chart at a fuel weight of 5952 pounds and proceed vertically to intersect 30,315 pound gross weight line. From this point, proceed horizontally to alternate load scale and read 1600 pounds which is alternate load at a gross weight of 30,315 pounds.

(2) After determining alternate load, adjustments must be made for actual operating weight of helicopter. Actual operating weight may be determined by adding weight of pilot (200 pounds), copilot (200 pounds), flight engineer (200 pounds), full engine oil capacity (450 pounds), and weight of two auxiliary fuel tanks plus supporting structure (524 pounds) to helicopter basic weight. For example, if actual operating weight is 23,000 pounds, subtract operating weight as shown on chart 7–2 from actual operating weight, 23,000 – 22,723=277 pounds. Alternate load at normal gross weight of 30,315 pounds would then be 1600–277= 1323 pounds.

7–36. Gust Limitations. The maximum recommended limit for horizontal gust spread is 30 knots. The performance indicator should be closely monitored during gusty conditions and the pilot should be prepared to initiate blade stall recovery procedure.

7–37. Nose Door and Ramp Limitations. The nose door and ramp should not be opened in flight.

OPERATING WEIGHT —22,723 LB



31,000 LB

Maximum Recommended Gross Weight.

Limit Load Factor 2.45G.

Maximum Vertical Rate-of-Climb at sea level with maximum power zero fpm out of ground effect.

Rate-of-climb at best rate-of-climb air speed at METO power 865 fpm.

Service Ceiling 9200 feet.

30,315 LB

Limit Load Factor 2.50G.

Vertical Rate-of-climb at maximum power 100 fpm.

Rate-of-climb at best rate-of-climb air speed at METO power 930 fpm.

Hovering Ceiling 800 feet.

Service Ceiling 9800 feet.

RECOMMENDED LOADING

NOT RECOMMENDED LOADING

NOTE

THIS CHART, BASED ON STANDARD ATMOSPHERIC CONDITIONS AND 115/145 FUEL GRADE, IS TO BE USED AS A GUIDE ONLY.

FOR SPECIFIC PERFORMANCE DATA REFER TO CHAPTER 14.

WHEN TWO 300-GALLON AUXILIARY FUEL TANKS ARE INSTALLED DEDUCT 524 LB (WEIGHT OF EMPTY TANKS PLUS SUPPORTING STRUCTURE) FROM ALTERNATE LOAD.

WHEN TWO 150-GALLON AUXILIARY FUEL TANKS ARE INSTALLED DEDUCT 332 LB FROM ALTERNATE LOAD.

Chart 7–2. Weight Limitations

CHAPTER 8
FLIGHT CHARACTERISTICS

Section I Scope

8—1. Purpose. This chapter provides the operator with the unique flight characteristics as well as any dangerous tendencies of the helicopter.

8—2. Extent of Coverage. This chapter contains unique flight characteristics of the helicopter which are based on flight operations at maximum gross weight. This chapter also discusses the effectiveness and unusual reactions that may be encountered in the operation and use of flight controls during normal flight and under various speed conditions.

Section II General Flight Characteristics

8—3. Flight Characteristics. Unlike a conventional fixed-wing aircraft, this helicopter, as is common to most helicopters, has no absolute minimum speed limited by such a definite characteristic as a stall. The safe operating airspeed range extends from a rearward speed of approximately 20 knots to a forward speed of approximately 120 knots IAS and also includes lateral speeds either to the left or the right of 35 knots. These speeds are not definite as they are limited by the amount of control available with various center of gravity loadings and power settings. The forward safe operating speeds are shown in chart 8—1 and tables 8—1 and 8—2. While there may be no need for flight other than in the forward direction, it is frequently necessary to hover in cross winds and tail winds of the same velocities as those mentioned above for sideward and rearward flight. The helicopter is directionally stable in forward flight, but in sideward and rearward flight, directional control is more difficult to maintain as the nose of the helicopter has a tendency to swing in the direction of flight. This is due to location of the center of fin area which is aft of the center of gravity.

Warning

Concentration of carbon monoxide may increase rapidly in the flight compartment when hovering with engine exhaust to windward.

8—4. Blade Stall. Blade stall will be experienced, when the airspeed of the tip of the retracting blade falls below a predetermined value or when the relative blade angle exceeds a predetermined value.

8—5. Blade Stall in Level Flight. Chart 8—1 and tables 8—1 and 8—2 indicate the relationship of altitude and rpm to the airspeed at which blade stall will occur under smooth air conditions in straight and level flight with a load factor of 1 G. Turbulent air or maneuvers which increase the load factor of 1 G reduce maximum airspeed at which blade stall will occur. At the threshold of blade stall, the pilot may feel an increase in the general vibration level of the helicopter, or the performance indicator will indicate the degree of blade stall. A further increase in forward speed, a reduction in rpm, or performing maneuvers can aggravate the stall so that the controllability of the helicopter will deteriorate. If such vibrations should be noticed, the stall may be easily eliminated by accomplishing any one or a combination of the following:

a. Reduce collective pitch.

b. Increase rotor rpm.

c. Decrease severity of the maneuver.

d. Gradually decrease airspeed.

8—6. Severe Blade Stall—Pitch-up. During maneuvers that increase the G load, such as sharp turns or high speed flares from diving descents where rapid application of collective pitch is involved, and especially when using aft cyclic stick, severe blade stall may be encountered. Severe blade stall may also be encountered in turbulent air when the pilot attempts to counteract induced porpoising with rapid or sharp forward applications of the cyclic stick and during normal turn recoveries at high altitude when forward cyclic stick is applied to lower the nose of the helicopter. Severe blade stall can be recognized by an abrupt pitch-up of the nose of the helicopter. The pitch-up is caused by the retreating blade having a greater stalled area than the stalled area encountered during the fringe of blade stall and is due to excessive angle of attack. This greater area of blade stall results in a loss of lift of the retreating blade which causes the blade to drop downward instead of climbing

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

BLADE STALL FOR VARIOUS GROSS WEIGHTS, RPM, AND LOAD FACTORS

CONFIGURATION: CLEAN LANDING GEAR UP

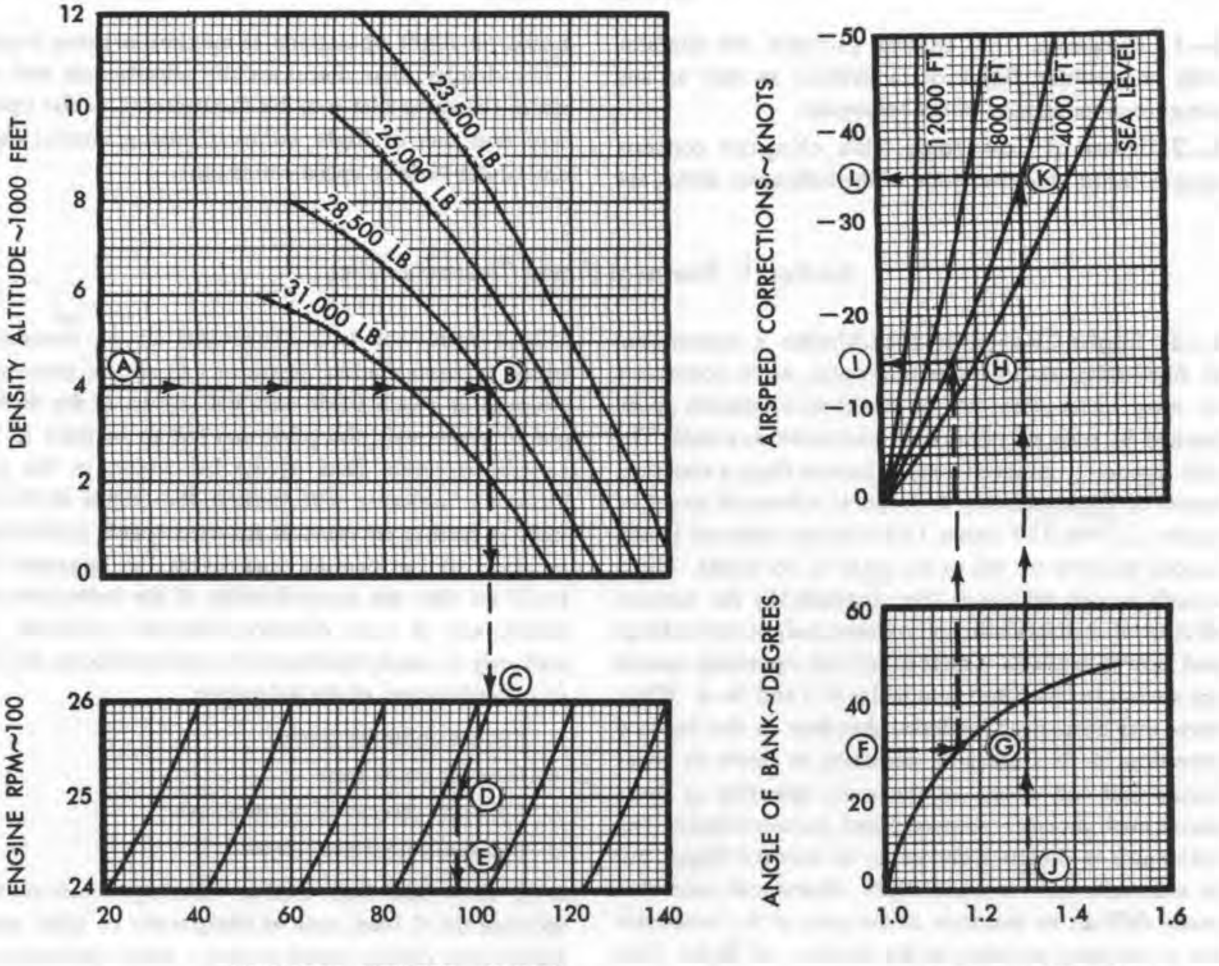


Chart 8–1. Blade stall data (Sheet 1 of 2)

upward as it approaches the tail cone of the helicopter. The retreating blade will reach its lowest point 90 degrees from the point at which lift decreases, thereby causing the tip-path plane of rotation of the main rotor blades to tilt downward toward the rear and causing the nose of the helicopter to pitch upward. This change in attitude results in an extremely high G loading and an increase of the inflow of air to the rotor which greatly increases the angle of attack and accentuates blade stall. The normal control response to overcome pitching (forward application of the cyclic stick without decreasing the collective pitch lever) may be ineffective. The uncontrolled pitch-up will last only for a very short period as full control is restored automatically as airspeed decreases in the nose high attitude and the excessively high angle of attack no longer exists. To stop the nose pitch-up, especially during turns at critical airspeeds and attitudes, gradually reduce collective pitch and/or rapidly increase rotor rpm and gently ease the nose of the helicopter down with smooth forward application of the cyclic stick. Level off by use of the tail rotor pedals and lateral movement of the cyclic stick. Avoid operation in thunderstorms and associated turbulent areas, and when in turbulent air reduce airspeed to minimize the porpoising as these conditions may cause severe blade stall.

8–7. *Blade Stall Charts.* (See chart 8–1.) The blade stall charts may be used to determine the airspeed at which blade stall will occur under various altitude, rpm, and gross weight conditions in level flight coordinated turns or during maneuvers which increase the G load.

8–8. *Use of Blade Stall Chart.* An explanation of the use of chart 8–1 is as follows:

a. Example 1. Determine the maximum recommended airspeed as limited by blade stall in level flight with a gross weight of 28,500 pounds at a density altitude of 4000 feet, using 2500 rpm.

(1) Enter chart (chart 8–1, sheet 1) for clean configuration at a density altitude of 4000 feet (point A).

(2) From point A, move horizontally to the 28,500-pound gross weight curve (point B).

(3) From point B, proceed vertically to the 2600 rpm baseline (point C).

(4) From point C, move parallel to rpm influence lines to 2500 rpm (point D).

(5) From point D, move vertically to stalling speed point E. Maximum recommended airspeed as limited by blade stall with above conditions is 95 knots.

b. Example 2. Determine the maximum recommended airspeed due to blade stall in a coordinated turn requiring an angle of bank of 30 degrees with the same

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

BLADE STALL FOR VARIOUS GROSS WEIGHTS, RPM, AND LOAD FACTORS
CONFIGURATION: TWO 150-OR 300-GALLON AUXILIARY TANKS, LANDING GEAR DOWN

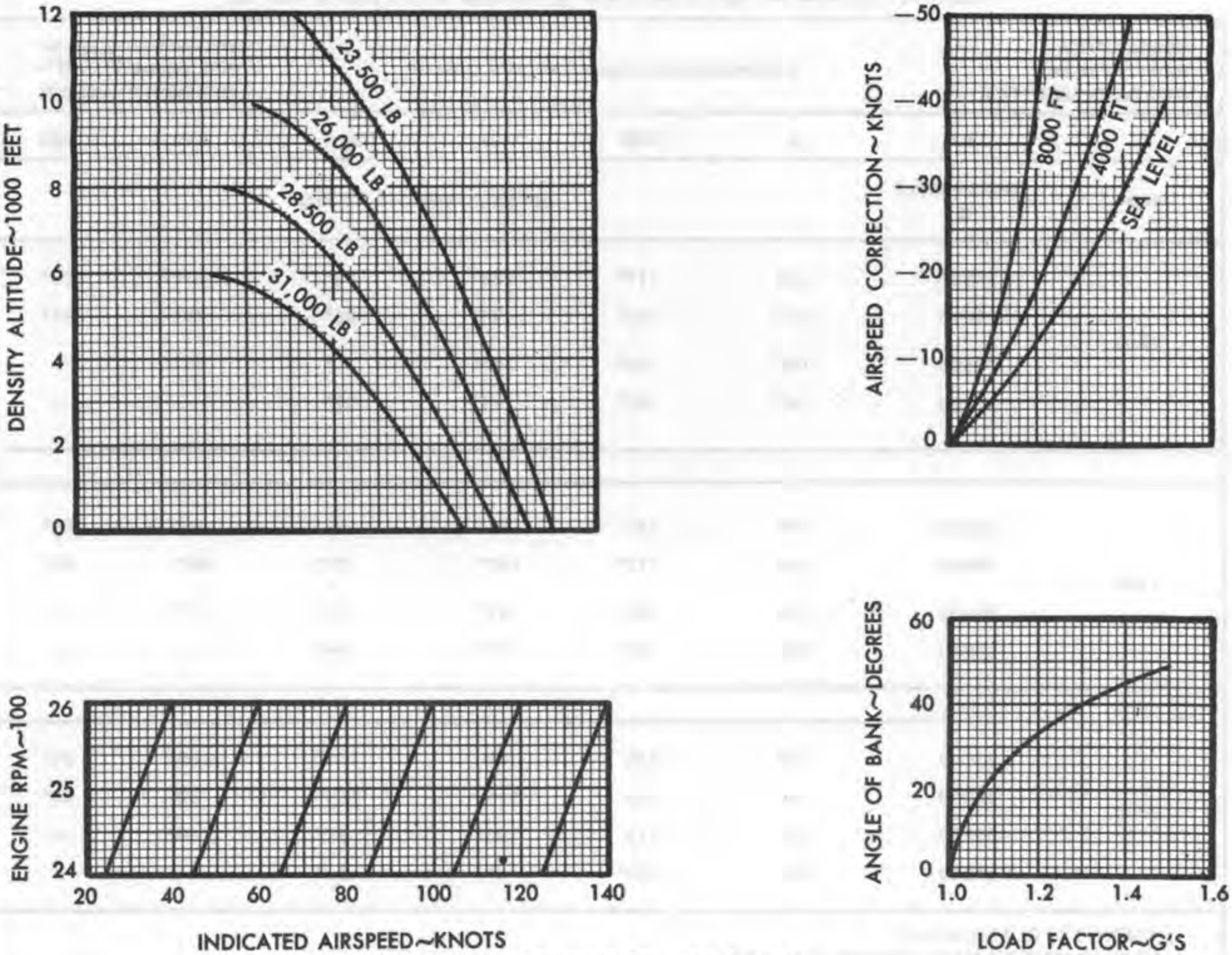


Chart 8–1. Blade stall data (Sheet 2 of 2)

gross weight, altitude, and rpm conditions as in paragraph 8–8*a*.

(1) Enter chart at an angle of bank of 30 degrees (point F).

(2) From point F, move horizontally to load factor curve (point G).

(3) From point G, move vertically to airspeed correction line at 4000 feet (point H).

(4) From point H, move horizontally to airspeed correction (point I). For a 30 degree bank angle, airspeed correction is -15 knots.

(5) To determine maximum recommended airspeed, as limited by blade stall during the 30 degree bank, add airspeed correction of -15 knots to maximum recommended airspeed in level flight of 95 knots. Corrected airspeed in a coordinated turn requiring a 30 degree bank with above condition is 95-15 = 80 knots.

c. Example 3. Determine the maximum recommended airspeed due to blade stall during maneuver in which 1.3 G's are pulled with the same gross weight, altitude, and rpm conditions as in paragraph 8–8a.

(1) Enter chart at a load factor of 1.3 G's (point J).

(2) From point J, move vertically to airspeed correction curve at 4000 feet (point K).

(3) From point K, move horizontally to airspeed correction (point L). With a load factor of 1.3 G's, airspeed correction is -35 knots.

(4) To obtain maximum recommended airspeed, as limited by blade stall during a 1.3 G maneuver, add airspeed correction of -35 knots to maximum recommended airspeed in level flight of 95 knots. Corrected airspeed during a 1.3 G maneuver with the above conditions is 95-35 = 60 knots.

8–9. Power Settling. At high altitudes, high gross weights, or when operating with reduced power, it may not be possible to maintain level flight due to the lack of power. When certain rates of descent and speed combination occur, roughness and a partial loss

Table 8–1. Maximum level flight airspeeds limited by recommended METO power or blade stall

MODEL CH-37B
DATE: 7 APRIL 1960
DATA BASIS: FLIGHT TEST

CONFIGURATION: CLEAN, LANDING GEAR UP

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

RPM	GROSS WEIGHT LB	SL	2000	4000	6000	8000	10000
	ALT →	INDICATED AIRSPEED – KNOTS					
2400	23500	120	117*	108*	98*	87*	74*
	26000	117*	108*	98*	86*	71*	51*
	28500	109*	99*	86*	70*	43*	–
	31000	99*	85*	68*	35*	–	–
2500	23500	120	120	117*	107	96*	83*
	26000	120	117*	107*	95*	80*	60*
	28500	118	108*	95*	79*	52*	–
	31000	108*	94*	77*	44*	–	–
2600	23500	120	120	120	115*	104*	91*
	26000	120	120	115	103*	88*	68*
	28500	120	115	103*	87*	60*	–
	31000	114	102*	85*	52*	–	–

*DENOTES BLADE STALL
RECOMMENDED METO POWER 3450 BHP

Table 8–2. Maximum level flight airspeeds limited by recommended METO power or blade stall

MODEL: CH-37B DATE: 7 APRIL 1960 DATA BASIS: FLIGHT TEST	CONFIGURATION: TWO 150-OR TWO 300-GALLON AUXILIARY TANKS, LANDING GEAR DOWN					ENGINES: (2) R-2800-54 FUEL GRADE: 115/145 FUEL DENSITY: 6 LB/GAL	
	ALT	SL	2000	4000	6000	8000	10000
RPM	GROSS WEIGHT LB	INDICATED AIRSPEED – KNOTS					
2400	23500	111	107	101*	92*	83*	71*
	26000	106	101*	92*	82*	69*	45*
	28500	102	93*	81*	68*	37*	–
	31000	94*	82*	67*	31*	–	–
2500	23500	110	109	105	99*	90*	78*
	26000	109	105	99*	89*	76*	52*
	28500	104	100*	88*	75*	44*	–
	31000	99	89*	74*	38*	–	–
2600	23500	109	106	105	103	98*	86*
	26000	107	103	102	97*	84*	60*
	28500	105	101	96*	83*	52*	–
	31000	102	97	82*	45*	–	–

*DENOTES BLADE STALL
RECOMMENDED METO POWER 3450 BHP

of control may be indicated by ineffectiveness of the controls. The velocity of the downward airflow through the main rotor is extremely high while at, or near, hovering attitude. Under certain power and rate of descent combinations, the downwash from the rotor begins to recirculate up, around, and back down through the effective outer rim of the rotor disc. The velocity of this recirculating mass of air may become so high that full collective pitch will not produce sufficient lift to retard or control rate of descent. A considerable loss of altitude may occur before the condition is recognized and recovery is completed. During approach for landings, the conditions causing power settling should be avoided. During descent or takeoff above congested areas or mountainous terrain, anticipate changes in wind velocity and direction. Fly airspeed and not groundspeed. Recovery may be accomplished easily, however, in the following manner:

a. Lower nose to increase forward speed.

b. Decrease collective pitch.

Flight conditions causing power settling should be avoided because of the attendant loss of altitude necessary for recovery.

8–10. Maneuvering Flight. No acrobatic maneuvers are recommended with this helicopter.

Section III Control Characteristics

8—11. Flight Controls. Pilot fatigue is reduced considerably by the installation of two flight control servo systems. The first stage and second stage servos are both in operation at all times. Because of the servo units, the control forces are virtually eliminated and are constant throughout their full range. This may cause a tendency to overcontrol because there is very little feel in operating the cyclic stick unless the stick trim system is in operation. If either servo system should fail or malfunction, it may be turned off provided there is hydraulic pressure in the other system. Very little difference will be noticed by the pilot in the operation of the controls when flying with one servo system inoperative.

8—12. Coordination of Flight Controls. The climb and descent of this helicopter is controlled primarily by raising or lowering the collective pitch lever; however, coordinated movements of the tail rotor pedals and cyclic stick are necessary to maintain a constant heading. When collective pitch is increased to ascend, additional torque is developed by the main rotor. This torque must be compensated for by depressing the left tail rotor pedal to increase the pitch and thrust of the tail rotor to the right. Sideways flight from hovering is accomplished primarily by lateral displacement of the cyclic stick; however, it is necessary to use tail rotor control to prevent the nose from swinging toward the direction of flight. When flying sideways to the right, the cyclic stick is displaced to the right, and the left tail rotor pedal is used to keep the nose of the helicopter in the original direction. For sideways flight to the left, the cyclic stick is displaced to the left, and the right tail rotor pedal is used. In hovering with no wind, no appreciable movement of the cyclic stick is necessary; however, with a wind condition, the cyclic stick should be held into the direction of the wind to maintain the same relative position above the ground. Turns while hovering are accomplished primarily by depressing the right tail rotor pedal for a right turn, and the left tail rotor pedal for a left turn. During forward flight at low speeds, coordinated movements of the cyclic stick and tail rotor pedals are necessary to accomplish turns. In high speed flight, less tail rotor pedal displacement is necessary; in fact, turns can be accomplished by lateral movements of the cyclic stick only.

8—13. Level Flight Characteristics Under Various Speed Conditions. For hovering or low speed flight, high rotor rpm is required because of the high power and control necessary. When, from hovering or low speed flight, increased forward speed is desired, the cyclic stick is moved forward. A momentary settling may occur with rapid acceleration, and then the helicopter will begin to climb because the main rotor blades encounter an increased flow of air due to the forward movement of the helicopter. As the helicopter accelerates to approximately 60 knots, collective pitch and manifold pressure should be steadily decreased to maintain a constant altitude. To maintain the same altitude above this airspeed, an increase in collective pitch and manifold pressure is necessary until maximum speed is reached. (For maximum level flight speeds, refer to tables 8—1 and 8—2.) As forward speed is increased, the helicopter will assume an increasing nose-down attitude. This is caused by the fact that the main rotor blade flapping hinges are located at a distance from the center of the main rotor hub. When the rotor blade tip-path plane is tilted forward to increase forward speed, the centrifugal force of the blades will tend to align the plane of the rotor hub, and consequently the fuselage, with the forward tilted tip-path plane. Thus, for high speed flight, a slightly aft cg location will produce a more level fuselage attitude. An aft cg location imposes no limitation on forward cyclic control, though normal cyclic stick operation will be centered at a point further forward.

Caution

Flight with the pilots' compartment window open may cause turbulence or low pressure at the entrance of the pitot tubes and result in erroneous readings of the airspeed indicators. The airspeed error at 80 knots, with the window open, is approximately 5 knots.

8—14. Ground Resonance. With proper operation and maintenance, ground resonance should not occur with this helicopter because of the design of the rotor head and landing gear; however, any helicopter equipped with hinged blades and a flexible landing gear is susceptible to some degree of ground resonance under certain operating conditions. Ground resonance may occur at rotor speeds that produce a vibration having the same frequency as the natural frequency of the landing gear. Ground resonance may be aggravated by hard one-wheel landings, by blades that are out of track or are unevenly displaced from their 72 degree relationship, by improper operation of the blade dampers, or by improper operation of the landing gear oleo struts. If ground resonance should occur, corrective action must be taken immediately or severe oscillations will build up so rapidly that damage to the helicopter will result.

Caution

If ground resonance should occur with high rpm, immediately increase power and take off. Resonance will stop when the helicopter becomes airborne. If ground resonance should occur with low rpm, immediately decrease rotor rpm further by decreasing throttle and apply both rotor brake and wheel brakes.

To prevent the possibility of ground resonance occurring during takeoff, steadily increase collective pitch until the wheels are clear of the ground; during landings, steadily decrease collective pitch as the wheels contact the ground.

8–15. Flight with External Loads. The external loads for this helicopter are normally of two configurations. One or both external auxiliary fuel tanks, or a load carried on the cargo sling. Both types of external load may be carried at once, provided the maximum gross weight is not exceeded.

Note

With external loads, airspeed is reduced and range is decreased for any given power setting.

The added drag produced by external loads has the effect of pulling the nose of the helicopter down in forward flight. This effect is negligible when the auxiliary fuel tanks are carried (or even when the landing gear is lowered) but may be considerable when a bulky load is carried on the cargo sling because of its lower location. When using the external cargo sling, the load should be coupled as closely as possible to the sling hook. Flight should be performed as smoothly and as level as possible so that the weight of the external load will be distributed evenly between all four sling cables. If the helicopter is put into a nonlevel attitude the load will be supported by only two cables from the high side of the helicopter. The other two sling cables will be slack, but will take up the load suddenly as the helicopter overshoots in correcting its attitude. Note that the external load itself acts to correct for a nonlevel position. However, sensitive control movements can aid in maintaining smooth flight and dampening out oscillations. This is especially true if the external load is attached to the sling hook with long cables and tends to swing.

CHAPTER 9
SYSTEMS OPERATION

Section I Scope

9—1. Purpose. This chapter provides additional information to that already covered in the other chapters regarding the operation of the various helicopter systems. For example, theory of operation of a new or complex system is covered in this chapter so as to avoid overcrowding the other chapters and destroying continuity of thought. The same is true for lengthy or involved procedures such as fuel system management, automatic stabilization equipment, etc , which could not be appropriately located in any other single place in the manual.

9—2. Extent of Coverage. Special problems involved in the operation of various helicopter systems are covered in this chapter.

Section II Systems

9—3. Engine. During engine operation various conditions may be encountered, which if not corrected, may result in engine malfunction. Paragraphs 9—4 through 9—12 provide a description of these various conditions, their cause, a means of preventing them, and the action required to correct them.

9—4. *Hydraulic Lock.* If the starter should suddenly slow down or hesitate when turning the engine, or if the engine should stop and the starter speed up because of a slipping starter clutch, the pistons are being forced against unusually high pressures. This is an indication of hydraulic lock. If turning of the engine is continued, damage to the engine may result. When a hydraulic lock is indicated, the spark plugs of the lower cylinders should be removed and the fluid allowed to drain from the cylinders before attempting to start the engine. A ground crewmember should stand by each engine throughout the starting operation to assure that the starter turns the engine, to check for leaks or erratic operation, and to act as fire guard.

Caution

If the pistons squeak when the engine is being turned, it is an indication that oil film has drained from cylinder walls. Dry cylinder walls may cause scoring of walls and piston seizure. When this squeaking is heard, do not attempt to start engine.

9—5. *Mixture Lever.* Manual leaning beyond the NORMAL detent position should not be attempted with this type of carburetor. The RICH position of the mixture levers should be used for takeoff, landing, and when high power is required. The NORMAL position of the mixture levers should be used at all other times as long as cylinder head temperature remains within limits and engine operation is normal.

9—6. *Carburetor Ice.* Carburetor ice is of three different types: impact ice formed by snow, sleet, or sub-cooled water in the atmosphere; throttle ice formed on or near the throttle because of the cooling effect caused by restrictions in the carburetor throat or air passages; and ice formed by the cooling effect due to evaporation of fuel as it is sprayed into the blower throat. Indications of carburetor icing are: a decrease in manifold pressure, resulting in loss of power; changes in fuel-air ratio, either richer or leaner as indicated by rough engine operation; and icing on other components of the helicopter. To prevent the formation of carburetor ice, maintain sufficient carburetor heat to keep the carburetor air temperature within the normal operating range. Removal of ice already formed is best accomplished by use of full carburetor heat. Other methods of eliminating ice are to increase throttle or to change altitude to ice-free atmospheric conditions.

9—7. *Carburetor Air Filter.* Since an engine is an air-breathing device, it is necessary to provide dust-free air. Dust consists of small particles of hard abrasive material. Drawn in by the air, dust asserts itself in the cylinder walls by grinding down these surfaces and the piston rings. Then dust contaminates the oil and is carried through the engine, causing the bearings and gears to experience premature wear. In extreme cases, an accumulation may clog an oil passage and cause oil starvation. Dust may also collect on the metering elements of the carburetor, upsetting the proper relation of fuel to power. Dust and grit are most evident close to the ground, but in some regions they may be carried to altitudes as high as 15,000 feet. Continued operation under such conditions without engine protection will result in engine wear as indicated by increased oil consumption. Engines, which normally perform satisfactorily for 600 to 700 hours between overhauls under dust-free conditions, may become so worn after 35 to 50 hours of operation under dusty conditions as to be worthless. Usually it is not necessary to use the carburetor air filter when the helicopter is operated from hard-surfaced runways. However, when dust conditions exist, the filter should be used. The carburetor air filter should be used as soon as the engine has been started. The air should be drawn in from this source until after takeoff has been performed and an altitude reached where dust-free air is present. When the carburetor air lever is moved to the FILTER position, a slight drop in manifold pressure will be experienced with a clean filter. At part throttle operation, advancing throttle will compensate for this loss. An excessive drop, however, may indicate the need for cleaning or replacing the filter element.

9–8. *Backfiring.* After a cold engine is started, the throttle, while in the CLOSED and LOCKED position, should be increased slightly to produce an adequate rpm. If the throttle is opened too wide, it should be closed again quickly, as the excessive amount of air admitted to the cold engine rapidly reduces the fuel-air mixture and may cause backfiring. Backfiring may also be caused by underpriming.

Caution

Do not pump throttle after starting while engine is still cold as it frequently causes backfiring. Backfiring may cause damage to induction system and it also presents a fire hazard.

9–9. *Spark Plug Fouling.* Spark plug fouling is a principal cause of ignition trouble, which in turn is one of the most common engine maintenance and operating problems with aircraft engines using 115/145 or 100/130 grade fuel. These grades of fuel may contain a relatively high lead content, up to 4.6 cc. Such fouling might be defined as an accumulation of deposits which causes misfiring or prevents firing across the spark plug electrodes. The most common types of fouling are lead fouling (the main troublemaker) and carbon fouling. Cause, prevention, and cure of spark plug fouling are all linked to the chemistry and physics of the combustion cycle, which in turn are subject to wide variation under different ground and flight engine operating conditions. A logical treatment of the problem involves separate discussion of each aspect of typical engine operation, including ground running, takeoff, climb, cruise, and descent, following the typical sequence of operation. Prevention appears to be the most profitable line of attack on the problem.

Tetraethyl lead is the most important basic cause of lead fouling. Scavenger agents such as bromine in the tetraethyl lead are provided to combine with the lead during combustion, removing it with the exhaust gases. However, under certain conditions of temperature and pressure, the lead will condense out on the spark plug insulator as lead oxide or lead bromide compounds. In the presence of excess carbon as a reducing agent, these may form metallic lead particles. All such deposits can prevent ignition or firing. Obviously, the best solution is to remove or reduce the lead compounds presently contaminating the fuels. Other pertinent factors which influence plug misfiring include the type of ignition system, spark plug characteristics, and general engine conditioning, including the care and handling of spark plugs, the operating requirements and characteristics of the particular engine installation, and the specific engine operating conditions.

In general, spark plug fouling involves a buildup of deposits through prolonged operation under a fixed set of conditions. Prevention and remedy for plug fouling, therefore, depend on taking action to vary these conditions, upset the chemistry of the fouling cycle, and restore good ignition.

a. Ground running. The type, cause, prevention, and cure of spark plug fouling during ground running are as follows:

(1) Type and Cause: Lead fouling may be residual from a previous flight. Carbon fouling is usually due to prolonged ground running at idle, particularly when the idle mixture is richer than best power; excess carbon from the rich mixture plus engine oil in combustion tend to build up as fouling deposits. The symptoms of such fouling usually include excessive magneto drop at the ignition system check at field barometric manifold pressure.

(2) Prevention: The importance of preventing plug fouling during ground running is obvious since this type of fouling is apt to cause flight delays (either as a result of excessive magneto drops during the ignition system check, or due to engine malfunction during takeoff) in frequent cases where the plug fouling has occurred but is not apparent at any stage of the engine check-out procedure. Where possible, avoid prolonged

or unnecessary ground running. The idle mixture should be adjusted to best power mixture at the idle speed commonly used for ground running, rather than at the minimum idle speed, since there is a tendency for the mixture to enrich with any increase in rpm and excessively rich idling mixtures are the most common cause of carbon fouling. Emphasis must be placed on the importance of properly adjusting idle mixture and of frequent checks to insure the setting is correct. After each 10 minutes of ground running with the rotor engaged, the engine should be run up to field barometric manifold pressure for 1 minute.

(3) Cure: A cure for fouling is less dependable than adequate preventive procedures, and the only practical cure may be a spark plug change. Generally preventive action is the best cure; however, the 1 minute run at barometric manifold pressure with the rotor engaged may have a curative effect. Additional running for short periods of time with manifold pressure changes of about 2 inches is sometimes effective. Due to generally poor engine cooling under such conditions, caution must be exercised to avoid any prolonged operation at or above field barometric manifold pressure.

b. Takeoff. The type, cause, prevention, and cure of spark plug fouling during takeoff are as follows:

(1) Type and Cause: Lead and/or carbon fouling. The rapid change in combustion temperature pressures and the high levels achieved under takeoff conditions are favorable to spark plug misfiring if there is any fouling from previous flight or ground running. The electrical resistance of residual deposits decreases rapidly as limited temperatures are approached, so that the spark may short circuit along the insulator rather than firing the gap. If excess carbon is present, metallic lead may be formed by the reducing action of free carbon on lead oxides and lead bromides. The most common symptoms include power loss and erratic power fluctuations with associated backfiring and rough running; all of these are evidences of advanced stages of misfiring. Misfiring of a few plugs will normally go undetected.

(2) Prevention: Same as for ground running. In addition, it is important to reduce cylinder head temperature to the recommended cylinder head temperature level prior to takeoff to take advantage of the increased BHP and decreased tendency for misfiring with relatively cool cylinder head temperature during takeoff. Smooth and steady application of throttle is preferable to rapid or jam acceleration to takeoff power.

(3) Cure: Reduce manifold pressure 2 to 5 inches, or as required to restore smooth operation.

c. Climb. Fouling is rarely a problem during climb. It might persist as a continuation of takeoff fouling. A reduction in manifold pressure will tend to restore normal ignition.

d. Cruise. The type, cause, prevention, and cure of spark plug fouling during cruise conditions are as follows:

(1) Type and Cause: Cruise conditions usually generate lead fouling rather than carbon fouling. Conditions favorable to lead fouling include long continued application of a given set of engine conditions typical of cruise flight, particularly those involving lean mixtures at or leaner than NORMAL position. Associated contributing factors include abnormally cool cylinder head temperature and low BMEP. High tension ignition appears more susceptible to fouling than low tension. Common symptoms include backfiring or afterfiring.

(2) Prevention: Although a periodic change in engine conditions will usually forestall lead fouling, the nature of the helicopter cruise operation minimizes this type fouling. Hourly intervals are frequently used and may accomplish results either by use of RICH for 5 minutes, use of primer for 1 minute, a change of 3 to 5 inches of manifold pressure, or a change of 100 to 130 rpm. A reduction in power level followed by an increase appears to be the preferable approach to prevention. One or more of these procedures should prove effective, and the procedure which least affects the flight condition is naturally preferable.

(3) Cure: Cure is less certain and includes a wider variety of procedures than prevention. One technique involves a complete change in the power cycle, including use of RICH, a reduction of 8 to 10 inches manifold pressure, and a period of engine cooling under low output conditions, followed by gradual restoration of cruise power in increments of 2 to 3 inches manifold pressure with several minutes of operation at each level. Generally, plugs which are misfiring or completely fouled are apt to resume firing at lower power settings; therefore, it is preferable to reduce power and then restore it, rather than attempt to reach a high power level with malfunctioning plugs. High power burn-out procedures may change the chemistry of the fouling deposits to the extent that a change of spark plugs is the only cure. They also introduce the possibility of destructive backfiring during application of increased power.

e. Descent. Plug fouling in descent may be carbon or lead fouling, favored by low power output conditions such as cool cylinder head temperature, low BMEP, and cold carburetor air temperature often associated with descent. This type of plug fouling is minimized by the relatively short duration of helicopter descents.

9–10. Cylinder Head Temperature. To keep cylinder head materials at high operating strength, it is recommended that the cylinder head temperature be held within the green arc as shown in figure 7–1. Cylinder head temperature may be controlled by regulating the carburetor air lever. Other means of controlling cylinder head temperature are by use of the mixture lever and the throttle. A rich mixture will produce cooler operating temperatures than a lean mixture; a decrease in manifold pressure will also produce lower operating temperatures.

9–11. Detonation. Normal combustion produces a rapid but even burning of the fuel-air mixtures in the combustion chamber. Detonation, on the other hand, is a sudden, violent explosion which transmits extremely high pressures and impact loads to the pistons, cylinders, and other components of the engine. Detonation produces a loss in power and causes a rapid increase in cylinder head temperature which may result in damage or failure of the engine. The increase in cylinder head temperature may cause a hot spot in the combustion chamber which will ignite the fuel-air charge far in advance of the spark timing. This condition is known as preignition and will further increase engine temperature. Conditions causing detonation are excessive manifold pressure, excessive cylinder head temperature, excessive carburetor air temperature, advanced spark timing, lean mixture, or grades of fuel with a lower antiknock rating than is required by the engine. Detonation may be eliminated by decreasing manifold pressure and rpm and by enriching mixture and decreasing carburetor air temperature.

9–12. Priming. Starting should be accomplished by priming. The fuel booster pump must be used to supply the fuel pressure necessary for priming. The priming fuel is sprayed into the induction system, below the carburetor, where it is mixed with air from the carburetor and carried into the intake ports of the cylinders. The amount of priming necessary for starting depends upon air and engine temperatures. Under exceedingly cold atmospheric and engine conditions, it may be necessary to actuate the primer continuously to effect an engine start. Conversely, under temperate or tropical conditions, intermittent prime should be used and caution exercised to avoid overpriming.

a. Overpriming. Overpriming will load the cylinders with fuel and make the engine difficult to start. An indication of overpriming is weak firing followed by dense black smoke. In extreme cases of overpriming, the fuel will wash the oil film from the cylinder walls, pistons, and piston rings. Without this lubricating oil film, there is danger of scoring the cylinder walls and of piston seizure. This condition will be indicated by squeaking of the piston when the engine is being turned by the starter. When this squeaking is heard, do not attempt to start the engine until the spark plugs have been removed and the cylinder walls have been sprayed with fresh oil. When the engine has been slightly overprimed and will not start, but neither squeaking is heard nor hydraulic lock is indicated, the engine may be turned by the starter for several revolutions with the ignition switch OFF and the mixture lever in IDLE CUTOFF. Repeat the starting procedure with little or no priming.

b. Underpriming. Indications of underpriming are failure of the engine to start, erratic running, weak firing with insufficient energy to turn the engine, puffs of white smoke, and backfiring. When any of the above conditions occur, check that the fuel shutoff switch is properly set and that there is sufficient fuel pressure for priming. Additional priming should be done cautiously.

9–13. Rotor Clutches. Each of the hydromechanical rotor clutches, which provide engagement between the engines and the transmission system, is composed of a fluid coupling and a mechanical coupling incorporating a freewheeling unit. (Refer to Chapter 2.) The fluid coupling consists of two sets of vanes enclosed in a housing. The vanes face each other and rotate about the same axis but are not connected to each other. One set of vanes, the driving vanes, is attached to the engine shaft and rotates at engine speed. The second set, the driven vanes, is attached to the main transmission drive shaft. The mechanical coupling consists of a freewheeling unit, a flyweight assembly, and a blocker plate. To engage the transmission and rotor systems, the rotor clutch switches are turned on when the engines are operating at 1500 rpm. Oil will be pumped into the fluid coupling housings where it is impelled by the driving vanes. This motion is transmitted to the driven vanes which begin to drive the rotor system. Engine speed is increased slowly to 1800 to 2100 rpm with the collective pitch lever in the low pitch position. As the transmission system accelerates, indicated by movement of the rotor pointer of the dual tachometer, an increase in throttle will be necessary to maintain 100 rotor rpm. During this procedure, and as long as engine rpm remains greater than the equivalent main rotor rpm, the blocker plates in the mechanical couplings prevent direct mechanical engagement. When main rotor speed has increased to approximately 100 rpm, the quadrant throttle of one engine is decreased to drop engine rpm below the corresponding main rotor rpm. The decrease in engine rpm allows the blocker plate to slide out of position, releasing the flyweights. The centrifugal force of the flyweights places the free-wheeling unit in operation. To complete the direct mechanical drive, engine rpm is increased until the engine pointer and the main rotor pointer of the dual tachometers are in line. As the throttle is increased to complete the mechanical drive of one engine, the throttle of the second engine is backed off to prevent overspeeding as the direct drive of one engine will be carrying the entire transmission driving load. Throttle should be decreased on the second engine a sufficient amount to allow the engine tachometer pointer to drop below the rotor tachometer pointer. After the pointer of the second engine tachometer has fallen below the rotor pointer, the quadrant throttle of the second engine is advanced to increase rpm and complete its direct mechanical drive. After mechanical engagement of one clutch is completed, the clutch switches are turned off and oil in the housing of the fluid couplings will drain back into the clutch oil tanks. As long as rotor speed is held above approximately 80 rpm, the mechanical couplings will remain engaged although they may be either in the free-wheeling position or in the driving position. The clutches are disengaged by closing the throttles and permitting main rotor speed to drop below 80 rpm. A spring in the mechanical couplings will override the centrifugal force created by the flyweights at this rpm and push the mechanical couplings to the disengaged position.

9–14. Overspeed of Rotor and Transmission System. Overspeeding the rotor system imposes severe loads on the rotor head and the transmission system. When the rotor rpm exceeds the red radial line on the rotor scale of the tachometer, the maximum overspeed and the duration of the overspeed condition should be noted on DA Form 2408.

9–15. Fuel System Management. For normal operation, the left fuel tank supplies fuel to the left engine, and the right tank supplies fuel to the right engine. For operation under unusual conditions, the fuel system controls, together with the fuel crossfeed system, provide such flexibility of operation that table 9–1 is included as a guide. During single engine operation, fuel may be used from both tanks at the same time or from one tank at a time. When using fuel from both tanks, it is possible that fuel will actually be supplied from one tank only. This can occur if the difference in the normal operating pressure of the fuel booster pumps is sufficient to close the check valve downstream of the weaker pump. When using fuel from both tanks, check the fuel quantity gages periodically. If fuel is being consumed at an unequal rate from tanks, it may be more satisfactory to operate from one tank at a time to equalize the fuel quantity in each tank.

9–16. Fuel Booster Pump Operation. Fuel booster pumps are located in the sumps of the right and left wing tanks and supply fuel under pressure to the two independent fuel systems. Normally, fuel flows from the wing tanks through fuel strainers and shutoff

Table 9–1. Fuel system management

	CONDITION	CROSS FEED SWITCH	FUEL SHUTOFF SWITCHES	BOOSTER PUMP SWITCHES
BOTH ENGINES OPERATING	Normal Operation – Left tank to left engine and right tank to right engine.	CLOSED	Both – ON	Both – NORM
	Both tanks to both engines.	OPEN	Both – ON	Both – NORM
	Either tank to both engines.	OPEN	Both – ON	Tank in use – EMER Tank not in use – NORM
ONE ENGINE OPERATING	Left tank to left engine or right tank to right engine.	CLOSED	Good engine – ON Failed engine – OFF	Good engine – EMER Failed engine – OFF
	Both tanks to either engine.	OPEN	Good engine – ON Failed engine – OFF	Both – EMER
	Either tank to opposite engine.	OPEN	Good engine – ON Failed engine – OFF	Tank not in use – EMER Tank in use – EMER

valves to engine-driven fuel pumps and then to the carburetors. Should an engine-driven fuel pump fail, the booster pump will deliver sufficient fuel pressure to the carburetor for proper operation. The NORM position of the switch is used during engine start, warmup, and flight, while the EMER position is used for takeoff, approach, landing, and in event of failure of the engine-driven fuel pumps. If, when flying at altitude, it is noted that the fuel pressure fluctuates while in the NORM position, the switch should be placed in the EMER position. Also, during crossfeed operations when one fuel tank is being used to supply fuel to both engines, the EMER position should be used.

Caution

When using auxiliary fuel tanks, check the NO TRANSFER lights frequently. Shut off the auxiliary fuel pump when the NO TRANSFER light indicates an empty auxiliary fuel tank. Dry operation of the pumps will damage carbon bearings of the pumps.

9–17. Quadrant Throttles and Twist-Grip Throttle Operation. The following information is supplemental to the description of the two throttles in Chapter 2 and of their operation in Chapter 3. The quadrant throttles are connected directly to the carburetors, and the position of the quadrant levers is a constant indication of actual carburetor throttle position. The twist-grip throttles on the collective pitch levers will operate the throttles at the carburetors only when not restricted by the quadrant throttles. When the twist-grip throttles are moved to control the engines, the quadrant throttle levers will move accordingly, however, when the quadrant throttles are moved, the motion is not transmitted to the twist-grips. When starting the engines, the twist-grip throttles are preset to 40 degrees, as indicated on the twist-grip throttle indicator, with the quadrant throttle levers locked closed. The preset twist-grip throttle position does not preset the carburetor throttles because the quadrant throttle levers are locked closed. When starting an engine, the quadrant throttle should be fully closed and locked. A slotted bar will allow enough closed and locked throttle movement for engine starting and permit up to 1600 to 1700 rpm for engine warmup. If the quadrant throttles are not fully closed and locked, microswitches will open and cut off dc power from the engine starting systems.

During warmup, each engine is controlled by its own quadrant throttle. The levers operate smoothly with no detents or ratchets. The clutches are engaged with the quadrant throttles set at approximately 10 to 12 degrees, which correspond to a 40 degree setting of the twist-grip throttles; the manifold pressure of the engines is then equalized at 2500 rpm. Fine synchronizing adjustments can be made by adjusting the levers up or down while watching the tachometers. When making larger synchronizing adjustments, it is advisable to move one throttle lever up and the other down to synchronize at a point between the original positions in order not to disturb the relation between the twist-grip throttles and the quadrant throttles. The engines may be synchronized before clutch engagement if extensive ground operation with both engines running is desired; if this is done, the engines will have to be synchronized again after the clutches are engaged. After clutch engagement and sychronization, the quadrant throttles are left alone and control of both engines simultaneously is accomplished by means of either twist-grip throttle.

The twist-grip throttle is synchronized with movements of the collective pitch lever to remain approximately at constant rpm as collective pitch is increased or decreased. The synchronizer will operate when the throttle grip is prevented from rotating as the collective pitch control is raised or lowered. The pilot may hold the grip or apply a sufficient amount of friction by means of the friction knob, to prevent the grip from rotating. If the throttle grip is permitted to rotate when changing pitch, the synchronizer will not operate correctly, resulting in insufficient increases in throttle setting when collective pitch is increased and insufficient decreases in throttle setting when collective pitch is decreased. Under certain loading and atmospheric conditions, proper synchronization may not be obtained. Then the throttle may be used independently by rotating the grip. Although the synchronizer will increase engine power as collective pitch is increased, it is advisable to be prepared to further increase engine power by rotating the throttle grip to the left while increasing pitch to prevent a possible loss of rpm. During takeoff under certain conditions, it may be necessary to use almost full throttle before maximum power is obtained. Full open throttle may be obtained with a small increase in collective pitch at maximum rpm. If collective pitch is increased beyond the point where the throttle is full open, an override spring in the throttle linkage will extend and prevent damage to the system. The quadrant throttles should not be used while the helicopter is being flown with the twist-grip throttles, except for fine engine synchronization adjustment while the twist-grip and collective pitch lever are held steady. To move both quadrant throttles while in flight, or to equalize engine manifold pressure by always moving the quadrant throttles in only one direction, would throw the synchronization between the twist-grip and throttles and the collective pitch lever out of adjustment, resulting in the necessity of rotating the twist-grip excessively as the collective pitch lever is moved. This could also result in lack of authority of the twist-grip throttle to command full power for landing or minimum power for engine shutdown, as it would be rotated against either of its stops with the quadrant throttles still far from their stops. At normal landing approach powers, the twist-grip throttle indicator should read within the range of 10 to 70 degrees. If the indicator reads above 70 degrees with low engine power, the pilot should back off the twist-grip throttle and the copilot should advance both quadrant throttles, maintaining constant engine power, until the indicator reads below 40 degrees. If the indicator reads below 10 degrees with high engine power, the pilot should advance the twist-grip throttle and the copilot should back off both quadrant throttles until the indicator reads above 40 degrees. Maintain steady engine rpm during these adjustments. The final position of the twist-grip indicator should bear approximately the same relationship to its total range of travel as the position of the quadrant throttles do to their total range of travel. This relationship will not be exact (the twist-grip indicator position should lag somewhat behind the quadrant throttle position) because of the amount of throttle increase that has been added by the collective pitch synchronization at level flight cruising speed.

9–18. Automatic Stabilization Equipment (ASE). A description of the automatic stabilization equipment is given in Chapter 5, and normal operation is covered in Chapter 3. In addition to the ASE control panel and the pushbuttons on the cyclic stick grips, the major components of the equipment include a control gyro and amplifier assembly located in the transmission compartment and a barometric altitude control and directional gyro compass located in the electronics compartment. Four servo motors that control altitude, roll, pitch, and yaw are part of the ASE servo unit located in the ceiling of the cabin fuselage forward of the mixing unit. The sensing signals for the equipment furnished by the elements listed below are fed directly into the amplifier except the yaw and altitude signals. The yaw signals, furnished by the directional gyro compass system, are modified by adjustment of the yaw knob on the ASE control panel and are then fed into the amplifier. The pitch and roll signals are provided by a vertical gyro inside the amplifier. The barometric altitude signals are provided by the barometric altitude control which is connected to a static port located in the aft fuselage section.

In the amplifier, rate signals associated with all sensing signals are electronically derived, mixed with the sensing signals, and amplified. These signals are then fed to the motor box where they are further amplified and fed as input signals to drive the servo motors. The servo motors actuate the pilot valves which, in turn, control the power pistons of the ASE servo system which actuate the flight controls. Attached to each servo motor are a displacement transducer and a tachometer-generator which provide voltages proportional to servo motor output. These voltages are fed back into the amplifier and reintroduced to the servo motor to smooth out the automatic stabilization equipment corrective action and prevent excessive overshooting.

With the equipment engaged, the stabilized behavior of the helicopter is controlled by conventional use of the flight controls. Pitch and roll stick cancellers, located in the linkage under the pilots' compartment floor, sense the motions of the cyclic stick and feed proportional voltage signals into the amplifier when the stick is moved. The vertical gyro senses the pilot induced attitude change and also sends a signal to the amplifier. The stick canceller signals, in effect, nullify this signal from the vertical gyro and retain the helicopter in the new attitude corresponding to the new stick position. When one or both tail rotor pedals are depressed (opening the microswitches and cancelling the directional signals to the automatic stabilization equipment), the pilot or copilot has full command of the rate of turn except as limited by the tail rotor pedal damper. When the feet are on the pedals, this switch circuit is opened and no directional sensing signal is fed into the amplifier. Simultaneously, a circuit in the yaw channel of the amplifier is closed which nullifies the yaw signal. After the desired heading has been assumed, and as soon as the feet are removed from the pedals, the directional sensing signal is again fed into the amplifier and the nullifying circuit is opened. The helicopter will then stabilize on the new heading and will not return to the original heading. Heading changes may also be made by slowly turning the yaw trim knob on the ASE control panel.

With the barometric altitude mode in operation, the collective pitch lever may be used to override the automatic stabilization equipment; however, no cancelling and nulling device is incorporated in the altitude channel. When the altitude change is desired, the BAR ALT OFF button must be depressed and the helicopter brought to the new altitude and trimmed approximately to a zero rate of climb. After speed, power, and altitude have stabilized, apply sufficient friction to the collective pitch lever to prevent creeping, then reengage the BAR ALT button on the ASE control panel. If the BAR ALT button is not disengaged when changing altitude, the helicopter will attempt to remain at the altitude at which the BAR ALT button was depressed. In addition to the OVERRIDE CHECK switch, the motor box is fitted with a guarded rotary switch, marked CHANNEL SELECTOR, which permits use of the null indicator on the ASE control panel to monitor the motion of all servo motors. Normally, the CHANNEL SELECTOR switch is kept in the PITCH position so that the indicator can be used with the cg trim knob to adjust for shifting cg. A third switch on the motor box, when actuated to the MOTOR INPUT position, transforms the null indicator into a voltmeter in order to check the input error voltages to the servo motors. There are four CHANNEL DISENGAGE switches which will disengage any one of the ASE channels when placed in the OFF position. This arrangement is to prevent complete shutdown of the ASE in the event of one channel malfunctioning. Also accessible on the outside of the motor box are the TACH GEN. and F. U. NULL adjustment potentiometers. These are set when leaving the factory and, except for system alignment at overhaul, should not be disturbed.

Since the authority of the automatic stabilization equipment on all channels is limited to a fraction of total control travel, any emergency override in case of malfunction may normally be achieved by introducing a manual control correction. Under these circumstances, however, a jumpy control movement caused by servo motor action may be disconcerting. This can be eliminated by pressing the AUTO STAB RELEASE button on the cyclic stick. A second step is to turn off the ASE servo to eliminate the action of the servo motors from the flight control system. This action, however, also cuts out the throttle servo and the pedal damper.

9–19. *Automatic Stabilization Equipment Malfunctions.* Malfunctions that may occur during operation of the automatic stabilization equipment are as follows:

a. Hardover in ASE servo. A hardover control can be caused by a broken pilot valve or feedback link, a pilot valve or connecting linkage that has gone badly out of adjustment, or improper action of the feedback linkage preventing proper servo followup. Should the first or second of these possibilities occur in the ASE servo, the power piston of the affected channel will drive to its extreme position. Depending on the initial position of the affected flight control, it may or may not be driven through part of its travel. Due to the amount of additional motion required in the sloppy link for the ASE function, the pilot apparently will be able to retain about one-fourth of the total control motion before encountering a mechanical stop. Actually, none of this motion is effective since the ASE power piston cannot be moved from its initial extreme position. Should the third of these possibilities occur, the result would be constant force driving the cyclic stick to its extreme position. Depending upon the severity of the malfunction in the sloppy link, the pilot may be able to override the force and thereby retain cyclic control over the power piston position. In extreme cases, the cyclic stick can be driven to its stop and then be rigidly fixed in this position. A lack of control is evidenced in one channel only.

b. Maladjustment of servo valve. ASE signals are introduced into the control system at the ASE servo and, therefore, into the unmixed portion of the controls. This is accomplished through electric motors driving jackscrews. Mechanical stops serve to limit the total jackscrew travel consistent with the limited authority concept. This means that with properly adjusted servo valve, there is sufficient travel within the sloppy link cam for the pilot to override a full displacement ASE input. Normally, in a condition of equilibrium, the feedback linkage is neutrally positioned relative to the sloppy link cam, and in addition, the electronic error signal is zero so that the jackscrews are neutrally located relative to their stops. If a servo valve becomes slightly maladjusted, this equilibrium condition becomes upset. To resume the helicopter's equilibrium, ASE will impose a steady state error reflected as a null shift of a jackscrew from its geometrical neutral position. The bearing and slop eliminator cam relationship remains essentially unchanged. In the resulting system, a jackscrew can traverse less than its normal range from the new null position in one direction and more than the normal travel in the opposite. It is this extra amount of travel in one direction which can provide a recognizable sympton, because if a jackscrew travels to its distant stop in response to an ASE signal, the free motion allowed in the sloppy link cam may be insufficient to permit proper feedback. The result is a force driving the cyclic stick in one direction in the affected channel as long as the ASE servo motor position is biased sufficiently to make the maladjustment critical.

The frequency and extent of these unidirectional single channel cyclic stick forces will, therefore, vary depending upon the instantaneous ASE motor position and, hence, the helicopter flight condition and the degree of pilot valve maladjustment. For example, an ASE servo with a maladjusted valve might behave normally until the ASE called for a large correction, at which time the maladjusted valve would suddenly be manifested for the first time as a force on the pilot's control.

c. Jam in ASE servo. A jam in the ASE servo may be created by a physical binding of the servo valve in the neutral position, or the blocking of the return metering ports in the servo valve sleeve. In the first instance, the result is an immovable stick. In the second case, motion of the controls is normal in one direction. However, motion in the opposite direction is possible only within the limit of the sloppy link and this motion is not effective in positioning the power piston. The resulting system, therefore, is in effect a ratchet, any input motion in the normally functioning direction being irrecoverable. A ramification of this second case might be considered in the case of a pressure metering port on the sleeve being blocked. Again, the control would function normally in one direction. Motion in the opposite direction, however, would be effective only after the cyclic stick had moved through the limit of the sloppy link. Further cyclic stick motion would effectively position the power piston but would require a cyclic stick force sufficient to overcome the spring effect of a cavitating hydraulic cylinder (the power piston). The malfunction is evidenced in one channel only.

CHAPTER 10
WEATHER OPERATION

Section I Scope

10–1. General. The purpose of this chapter is to inform the crew of the special precautions and procedures to be followed during the various weather and climatic conditions that may be encountered in flight.

10–2. Extent of Coverage. With the exception of some possible repetition of text necessary for emphasis, clarity, or continuity of thought, this chapter contains only those procedures that differ from, or are in addition to, the normal operating instructions found in Chapter 3. Any discussions relative to systems operation are covered in Chapter 9.

Section II Instrument Flight Procedures

10–3. Operation Under Instrument Flight Conditions. It is possible to fly the helicopter during instrument conditions; however, instrument flight is more fatiguing to the pilot than in conventional fixed-wing aircraft. This is caused by the lack of flight control "feel" and by inherent instability. The pilot must diligently scan the flight instruments and continuously adjust the flight controls to maintain proper flight attitude. Instrument flight should be conscientiously planned, keeping in mind that high winds, icing conditions, and turbulence will greatly affect flight because of the helicopter's relatively low speed, lack of anti-icing and deicing equipment, and the additional work load imposed on the pilot by turbulence. Pilot fatigue can be greatly reduced if the copilot navigates, makes position reports, operates communication equipment, and relieves the pilot for short periods. Except for some repetition necessary for emphasis or continuity of thought, the following information contains only those maneuvers and techniques that differ from, or are in addition to, the normal operating procedures covered in other chapters. For the airspeeds and power settings used during instrument and/or night flight conditions, refer to the charts in Chapter 14.

Note

Rotating anticollision light should be turned off during flight through conditions of reduced visibility where pilot could experience vertigo as a result of rotating reflections of light against clouds. In addition, light would be ineffective as an anticollision light during instrument conditions since it could not be observed by pilots of other aircraft.

10–4. Instrument Takeoff and Initial Climb. After the helicopter is headed into the wind, apply brakes or set the parking brake to prevent forward movement. If the parking brake is used, it must be released after the takeoff has been completed. Set the runway heading under the index of the compass indicator. In this position (12 o'clock), the needle indicates the correct magnetic heading and aids in observing any deviation from the desired heading. Sufficient friction should be applied to the collective pitch lever to minimize overcontrolling. However, the application of excessive friction should be avoided, due to limiting collective pitch lever movement. Enough twist-grip throttle friction should be applied to prevent loss of engine rpm but still permit throttle adjustment. Adjust the attitude indicator by setting the miniature aircraft one bar width above the horizon bar.

10–5. Takeoff and Initial Climb Procedure. After a recheck to determine that all instruments are operating properly, start the takeoff by applying maximum power. Maximum power is used to gain airspeed and altitude simultaneously and to prevent settling to the ground. As power is applied and the helicopter becomes airborne, use the tail rotor pedals to maintain the desired heading by correcting for the increase in torque. At the same time, move the cyclic stick forward to start the acceleration to climbing airspeed. As airspeed increases, gradually lower the nose of the helicopter to the climbing flight attitude; and as climbing airspeed is reached, reduce power to the climbing power setting. While maintaining climbing airspeed, adjust power to maintain desired rate of climb. During the initial climb-out, minor heading corrections should be made with the tail rotor pedals only. If the cyclic stick is used to correct for heading, overcontrolling will result. Begin a rapid cross-check of all flight instruments at the time the helicopter leaves the ground.

10–6. Straight and Level Flight. To level off, apply forward pressure on the cyclic stick approximately 40 feet prior to reaching the desired altitude. Maintain climbing power until cruising airspeed is established, then reduce power to normal cruise settings. After the airspeed and altitude stabilize and level flight is attained, adjust the miniature aircraft and attitude indicator, if necessary, to reflect level flight attitude. Thereafter, any deviation in attitude can be read directly from the attitude indicator. Since the miniature aircraft is set for level flight at normal cruise (80 knots IAS), it will appear as a one bar above-the-horizon indication when the helicopter is in level flight at slow cruise (70 knots IAS). This indication, then, is the neutral position for slow cruise, and corrections for attitude should be made when any deviation is observed. When a deviation from the established heading is observed, make immediate and smooth corrections with the flight controls to return the helicopter to the desired heading. The sooner a deviation from the desired heading is observed, the smaller the amount of correction required. During straight and level flight, maintain heading, airspeed, and altitude with the cyclic stick, and trim (ball of turn-and-bank indicator centered) with the tail rotor pedals. Power is used to adjust altitude only if the desired airspeed varies by plus or minus 10 knots.

10–7. Straight Climb. The straight climb can be entered from either slow (70 knots IAS) or normal (80 knots IAS) cruise. To enter a climb from slow cruise, increase power to produce a 500 fpm rate of climb. As power is applied, correct for trim with the tail rotor pedals and check the tachometer to determine if rpm is being maintained. Since slow cruise and climb airspeeds are the same, there will be no apparent change of attitude as read from the attitude indicator. Several seconds are required for the vertical velocity indicator to indicate the correct rate of climb. If the amount of power applied does not produce the desired rate of climb, make minor adjustments. As a rule of thumb, a change of 1 inch of manifold pressure will change the rate of climb 100 fpm. To enter a climb from normal cruise, the attitude of the helicopter is changed with cyclic control to reflect a one bar above-the-horizon indication as read from the attitude indicator. As airspeed dissipates, apply power to maintain climbing airspeed. During the climb, heading, attitude, airspeed, and rate of climb are maintained with the cyclic stick, and trim with the tail rotor pedals. Since a 5-knot change in airspeed will change rate of climb 200 fpm, power is used to adjust the rate of climb only if the desired airspeed varies by plus or minus 5 knots. Although the amount of lead varies with the helicopter and individual technique, use a lead of approximately 40 feet to level off at a desired altitude. To level off at slow cruise, adjust power to the slow cruise setting. To level off at normal cruise, apply forward pressure on the cyclic stick to establish the desired attitude with reference to the attitude indicator. Reduce power as normal cruise airspeed is reached.

10–8. Straight Descent. Straight descent can be entered from either normal or slow cruise. To enter a descent from slow cruise, reduce power to the setting that will result in the desired rate of descent. To maintain trim as power is reduced, correct for torque with the tail rotor pedals. The attitude of the helicopter in descent will be the same as the climb or slow cruise attitude. If the initial power reduction does not produce the desired rate of descent, make additional adjustments using the rule of thumb (a change of 1 inch manifold pressure will change the rate of descent 100 fpm). To enter the descent from normal cruise, reduce power to the predetermined setting. Aft pressure on the cyclic stick is used to maintain altitude and to change to the slow cruise attitude. The descent will begin as soon as descending airspeed is reached. During the descent, maintain heading, attitude, airspeed, and rate of descent with the cyclic stick, and trim with the tail rotor pedals. Use power to adjust rate of descent only if desired airspeed varies by plus or minus 5 knots. To level off from the descent, apply power prior to reaching the desired altitude. This will check the downward movement in sufficient time to prevent going below the desired altitude. The amount of lead depends upon the gross weight of the helicopter and the rate of descent. For a 500 fpm rate of descent, the lead is normally 40 feet. When the proper altitude for starting the level-off is reached, apply power to the predetermined manifold pressure and check the vertical velocity indicator to determine if level flight has been established. To level off at the desired altitude with a normal cruise airspeed, apply power and establish the normal cruise attitude with the cyclic stick as the helicopter accelerates to the desired airspeed.

10–9. Turns. The angle of bank necessary to produce a standard rate of turn is determined by the true airspeed of the helicopter. At an airspeed of 70 to 80 knots IAS, the angle of bank of the standard rate of turn is approximately 12 to 13 degrees, as read from the attitude indicator. The number of degrees to be turned governs the amount of bank that is used. A change in heading of 10 degrees or more requires a standard rate of turn (3 degrees per second) and is shown as a 2-needle deflection on the 4-minute turn-and-bank indicator. A change of less than 10 degrees requires a one-half standard rate of turn and is shown as a 1-needle deflection.

10–10. Level Turns. The level turn is performed at normal or slow cruise. To enter a turn, use coordinated movements of the cyclic stick and tail rotor pedals in the direction of the desired turn. The roll-in should be smooth and steady and should take approximately 4 to 6 seconds. When the desired rate of turn as read from the turn-and-bank indicator has been attained, relax control pressure to prevent overbanking. As the angle of bank is increased, apply additional power to compensate for the loss of vertical lift caused by banking the helicopter, and coordinate with tail rotor pedals to maintain trim. During the turn, maintain rate of turn and altitude with the cyclic stick, airspeed with the collective pitch lever (power), and trim with the tail rotor pedals. To recover straight and level flight, apply coordinated movement of the cyclic stick and tail rotor pedals in a direction opposite to the established turn. As the angle of bank decreases, the vertical lift increases, requiring a reduction in power to the original setting to prevent a gain in altitude and coordination of the tail rotor pedals to maintain trim. The rate of roll-out (4 to 6 seconds) should be the same as the roll-in. Establish straight and level flight with reference to all available instruments.

10–11. Turn to a Gyro Heading. A turn to a gyro heading consists of a level turn to a specified heading, as read from the compass indicator, and is performed at normal cruise. Turns to specified headings should be made in the shortest direction. The turn is entered and maintained as described in paragraph 10–10. Since the helicopter will continue to turn as long as the bank is held, the roll-out must be started before reaching the desired heading. The amount of lead necessary varies with the rate of roll of the helicopter and individual technique. As a rule of thumb, the amount of lead to use to roll out on a desired heading should be equal to one-half the angle of bank. The roll-out to a gyro heading is performed in the same manner as the roll-out of the level turn. When the heading for starting the roll out is reached, apply cyclic stick and tail rotor pedals in the direction opposite the turn.

10–12. Compass Turn. A compass turn is a level turn to a specific heading, as read from the magnetic compass, and is performed at normal cruise airspeed. In the maneuver, the compass indicator and clock are monitored. To properly perform the compass turn, errors of the magnetic compass should be thoroughly understood. It should be remembered that the compass lags to the north and leads to the south. The amount of lead or lag used when turning to headings of north or south is approximately equal to the latitude of the area over which the turn is made. The compass should be read only when the helicopter is flying straight and level at constant airspeed. During a compass turn, maintain rate of turn and altitude with the cyclic stick, airspeed with the collective pitch lever (power), and trim with the tail rotor pedals.

10–13. Steep Turns. Steep turns are to be avoided in this helicopter because of high load factors and associated damaging stresses upon the dynamic components such as rotor blades and drive shafts.

10–14. Timed Turns. In a timed turn, the heading of the helicopter is changed a definite number of degrees with reference to the turn-and-bank indicator and the clock.

10–15. Turn-and-Bank Indicator Calibration. To perform accurate timed turns, the needle of the turn-and-bank indicator must be calibrated. To calibrate the turn needle, establish the approximate angle of bank for a standard rate of turn with reference to the attitude indicator. Make necessary changes to produce an indication of a standard rate of turn with reference to the turn needle. Unless oscillations of the turn needle are of equal distance on either side of the standard rate position (averaged out), the rate of turn will not be standard. After establishing the rate of turn, note the position of the second hand and the gyro heading. Maintain the rate of turn until a predetermined time has elapsed and the compass heading is noted again. Exact timing is very important. If the turn needle is in calibration, a standard rate of turn for 10 seconds will produce a change of heading of 30 degrees. Correct any deviation by changing the position of the turn needle so that a turn of 3 degrees-per-second results. When the needle is properly calibrated, carefully note and use this position during all standard rate of turns.

10–16. Timed Turn Procedures. Prior to starting the turn, compute time necessary to turn to the new magnetic heading. To compute the time in seconds, the angular difference (shortest direction) between the present heading and the new heading is divided by 3. The techniques of entry and control of the timed turn are the same as for the level turn. Note the position of the second hand of the clock the instant the turn is started. For ease in timing, it is best to start the time when the second hand passes the 12, 3, 6, or 9 o'clock position. Maintain the standard rate of turn until the predetermined time has elapsed, then start the roll-out. The rate of roll-out is the same as the rate of roll-in. After straight and level flight is established, the compass should reflect the desired heading.

10-17. Climbing Turn. The climbing turn is a combination of the straight climb and level standard rate of turn. Normally this is a standard rate of turn with a rate of climb of 500 feet-per-minute. During a climbing turn, the rate of climb and the rate of turn are both checked against time. The climbing turn is performed at slow cruise and requires a very rapid cross-check for precise execution. The climbing turn is started as the second hand of the clock passes the 12 o'clock position. As power is applied to the predetermined setting, make torque correction with tail rotor pedals to maintain trim. Establish the initial bank with reference to the attitude indicator. To maintain the rate of turn, make minor corrections with reference to the turn-and-bank indicator. During the climbing turn, maintain the rate of climb and airspeed with the cyclic stick, and trim with tail rotor pedals. Use power to adjust the rate of climb only if airspeed is exceeded by plus or minus 5 knots. After 30 seconds, the helicopter will have turned approximately 90 degrees and climbed approximately 250 feet. If the instruments indicate other than the desired readings, the rate of climb and/or turn should be adjusted accordingly. A further check can be made at the expiration of 45 seconds. Adjustment in the rate of climb and/or turn should be made again, if necessary. A recovery should be made when the desired heading and altitude have been reached.

10-18. Descending Turn. The descending turn, consisting of a standard rate of turn and a descent of 500 feet-per-minute, is performed at slow cruise airspeed. Start the turn as the second hand of the clock passes the 12 o'clock position. As power is reduced to a predetermined setting, make a torque correction with the tail rotor pedals to maintain trim. The initial bank is established with reference to the attitude indicator. Make adjustments in the rate of turn, if necessary, with reference to the turn-and-bank indicator. During the descending turn, maintain the rate of turn, rate of descent, and airspeed with the cyclic stick, and trim with the tail rotor pedals. Use power to adjust the rate of descent only if the airspeed is exceeded by plus or minus 5 knots. Check the rates of turn and descent against time at the expiration of 30 to 45 seconds, as described in paragraph 10-17. If necessary, make adjustment. Make a recovery when the desired heading and altitude have been reached.

10-19. Unusual Attitudes. Any attitude not required for normal instrument flight is an unusual attitude and may be caused by turbulence, vertigo, instrument failure, or carelessness in cross-checking instruments. Due to the inherent instability of the helicopter, unusual attitudes can be extremely critical. As soon as an unusual attitude is detected, a recovery to flight must be made as quickly as possible with a minimum loss of altitude.

10-20. Recovery From an Unusual Attitude. To recover from an unusual attitude, correct the bank attitude, adjust power, and correct pitch attitude. All components of control are changed almost simultaneously with little lead of one over the other. For example, if the helicopter is in a steep descending turn, start the recovery by correcting the bank attitude with reference to the turn-and-bank indicator and attitude indicator. As the bank is being corrected, reduce power with reference to the airspeed indicator and tachometer to prevent excessive airspeed and rpm. Then correct the pitch attitude with reference to the vertical velocity indicator and altimeter. Care must be taken to prevent overcontrolling. Since the helicopter is passing through level flight attitude when the altimeter and airspeed indicator stop and reverse their direction of movement, the controls should be neutralized to prevent overcontrol.

10-21. Night Flying. Night flying presents the same problem as instrument flying, plus additional problems induced by illumination of the pilots' compartment and instruments, and by reflections from exterior lights. Interior lights should be adjusted, as required, to provide adequate or proper illumination.

Note

Top forward cockpit lights may be turned off to reduce pilots' compartment glare.

Rotating anticollision light should be used on ground, whenever necessary, to preclude a collision.

Use of the anticollision light on ground should be kept to an absolute minimum to avoid excessive heat created on ground which is detrimental to bulb life and increases maintenance problems, and to prevent possible confusion of rescue operations, since emergency ground vehicles use a similar light.

10-22. Night Takeoff. There is basically little difference in the technique used on night takeoff from that used in day operations. Care should be used to make a clean decisive break from the ground to a safe hovering altitude. The landing light should be used to illuminate the ground. Position the beam of the light to provide a good forward reference.

Caution

Landing light should be extended and positioned for immediate use in event of an emergency.

Note

Rotating anticollision light is used continuously during flight to preclude a collision. Rotating anticollision light should be turned off during flight through actual instrument conditions where pilot could experience vertigo as a result of the rotating reflections of light against clouds. In addition, light would be ineffective as an anticollision light during instrument conditions since it could not be observed by pilots of other aircraft.

10–23. Approach and Landing. The landing light should be used for all landings. In poorly lighted or unlighted areas, the landing light can be used to clear the landing area prior to landing. The light can be preset for landing or adjusted during the final approach.

Warning

During an instrument approach, "break-out" would not be detected as soon with pilots' compartment lights at high intensity.

Section III Cold Weather Operation

10–24. Cold Weather Procedures. The following operating instructions are presented in addition to instructions in Chapter 3 and should be complied with when cold weather conditions are encountered. The major problem in cold weather operation is engine starting. When cold weather engine starts are anticipated, oil dilution must be accomplished during the engine shutdown procedure.

Caution

When operating in cold weather conditions, ascertain that helicopter has been serviced with proper lubricants. (Refer to table 2–2.)

10–25. Preparation for Flight. During cold weather operations, engine preheating is recommended to assist in engine starts. With the combined use of the winterization kit and the auxiliary power unit, the engine starting problem is greatly simplified. The 600,000 BTU heater should be used to preheat the engines until the cylinder head temperature gages indicate approximately 0°C. It is recommended that the winterization kit be used when the ambient temperature is below –32°C (–25°F). Approximate times for engine preheat at various temperatures are as follows:

0°F (–18°C) – 10 minutes
–20°F (–29°C) – 20 minutes
–40°F (–40°C) – 30 minutes
–65°F (–54°C) – 40 minutes

Note

If a winterization kit is not installed and auxiliary ground equipment is used for preheating, engine preheat times listed above are not applicable. Under these conditions, continue to use preheat until cylinder head temperature gages register approximately 0°C.

The following procedure may be used to preheat the engines: Cap off the left-hand side of the heating system plenum chamber and close the plenum chamber damper levers. Operate the heater on helicopter battery power, and by use of the right engine main preheating duct, preheat the APU for a maximum of 3 minutes. When cold weather engine starts are anticipated, consideration must also be given to starting the APU under low temperature conditions, as the battery is unable to sustain the cabin heater for a long period of time to properly preheat the APU. To facilitate starting APU, oil may be diluted. The oil capacity of the APU is 3 quarts. If lubricating oil, Military Specification MIL-L-8383, is used, dilute 10 percent below –20°F (–29°C); if MIL-L-6082, grade 1100, is used, dilute 10 percent below +30°F (–1°C). For temperatures down to +5°F, dilute 10 percent; between +5°F and –25°F, dilute 20 percent; and between –25°F and –65°F, dilute 30 percent. The APU may then be started by hand or by the helicopter battery to supply power for the operation of the heater to preheat the engines. When preheating the engine, use the engine preheat switch, located on the overhead switch panel in the pilots' compartment, to allow the heater to cycle at a higher temperature. For operation of the APU and of the heater, refer to Chapter 6. With the installation of protective covers to shroud each engine nacelle nose section and by use of the two large flexible ducts (part of the winterization kit), the helicopter may be preheated in extremely low temperature regions without recourse to auxiliary ground equipment. The engines are preheated by fastening the covers over the nacelles and sealing off the engine cooling air entrances and exits and the oil cooler intake duct. The two large flexible hoses are attached to engine preheat duct connections (7, figure 2–2), at each end of the plenum chamber. Access to the connections is gained by removing a panel on each side of the main gear box fairing. The hoses lead over the wings and are connected at the other end to ports cut into the outboard side of the nacelle covers. Both hoses may be connected to one engine cover for quicker preheating of one engine, if desired.

Note

Commence engine preheating prior to preflight check so that engines will be warmed up sufficiently for engine starting at completion of preflight check.

In addition to accomplishing the normal exterior inspection, be sure that the fuel and oil tank sumps are drained of water. If there is no flow, preheat to insure some flow. Check the tires, rotor brake accumulator, and the main landing gear shock struts for proper pressure at low temperatures. Also, check that the engine oil pressure transmitter line has been purged for low temperature operation.

10–26. Starting Engines. Since engine preheat has been applied, the normal starting procedure should be used. If oil pressure does not register almost immediately, shut down the engine to prevent damage due to a lack of lubrication.

10–27. Warmup and Ground Test. On cold days it may require too long a time to warm up the engine until the oil temperature reaches 40°C by following the regular procedure. Under these conditions, engine rpm may be increased above 1500 rpm until the oil temperature stabilizes and the engine operates satisfactorily. In no case should the throttle be advanced to the point where maximum oil pressure is exceeded.

Caution

Engine oil pressure gages should be monitored frequently to assure proper engine lubrication.

Check that engine overboard breathers are free of icing during prolonged engine idle periods.

It is recommended that the rotor be engaged soon after starting, as the load on the engines will be instrumental in avoiding icing of the engine and oil tank breather lines. After rotor clutch engagement, monitor the transmission oil pressure gage to assure proper lubrication of the main gear box.

10–28. Taxiing. Taxiing procedure in cold weather is no different than under normal conditions.

Warning

In cold weather, make sure that all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

10–29. Cruise Checks. Extreme caution should be exercised during hoisting operations or cargo sling operations, during extremely low temperature periods, because of the possibility of freezing personnel with the rotor blast.

Warning

Static electricity resulting from atmospheric conditions should be dissipated by allowing hoist to touch ground prior to being handled by personnel. Otherwise, anyone standing on the ground and touching the hoist will be shocked by electrical charge. A short length of weighted ground wire should be provided for attachment to hoist slings to establish a ground for dissipation of static electricity during hoisting operations.

During flight, insure continued availability of cyclic and collective servo control and cabin heat. Continued flight with loss of either cabin heat or flight control servos should be made with extreme caution.

10–30. Stopping of Engines. Prior to stopping engines, the engine oil system should be diluted with fuel to retain oil fluidity at low temperatures.

a. Oil dilution. Before diluting oil, check the oil level and drain or fill as needed.

b. Oil dilution procedures. (Refer to table 10–1.) Oil dilution procedures are as follows:

Table 10–1. Oil dilution time

AIR TEMPERATURE		TIME	DILUTION
°C	°F	MINUTES	PERCENT
−6.7	20	1.3	7
−12	10	1.7	10
−18	0	3.2	13
−29	−20	6	20
−46	−50	10.5	30

(1) Idle engine at 1000 rpm until oil temperature falls to 40°C (104°F).

Note

Check that engine overboard breathers are free of icing during prolonged engine idle periods.

Dilution of engine oil should not be accomplished with oil temperature above 40°C (104°F), since heat of the oil will evaporate some fuel, resulting in improper dilution.

(2) Oil dilution manual shutoff valve handle—OPEN (VERTICAL).

(3) Fuel booster pump switch—NORM.

(4) Oil dilution switch—HOLD IN ON POSITION.

Note

A considerable drop in fuel pressure is an indication that oil dilution system is functioning properly.

(5) At end of dilution period, accomplish a normal engine shutdown, but hold oil dilution switch in the ON position until engine stops.

Note

Check oil supply, after a thorough warmup, at next starting of an engine in which oil has been diluted.

10–31. Before Leaving the Helicopter. After the engines have stopped, protective covers should be installed. The fuel and the oil sumps should be drained of water. If the helicopter is to remain unsheltered at temperatures below −29°C (−20°F), the battery should be removed to a heated area. Check that the battery is reinstalled before the next engine start.

10–32. Ice, Snow, and Rain. The problem of major concern in the ice, snow, and rain operation of helicopters is the restriction of visibility as a result of blowing snow (from the main rotor wash) or a heavy downpour of rain, especially during landings and takeoffs. The problem is of paramount importance when operating from other than an operational air base. The danger of breaking through ice or hidden snow-crust is minimized by maintaining maximum rpm when resting on an unknown surface.

Warning

Flights during icing conditions should not be made. These helicopters are not equipped with anti-icing and deicing equipment.

10–33. Exterior Inspection. In accomplishing the exterior inspection, the main rotor system, particularly the main blade dampers, should be checked for freedom of movement. The dampers may be checked from the main gear box platform by rocking the main rotor blades fore-and-aft. Check engine induction cold air intake screens and pitot tubes to determine that they are free from ice.

Caution

Remove all ice accumulations prior to flight.

10–34. Taxiing. Little difference will be noted between normal taxiing and taxiing on ice. Helicopters should not be taxied on an ice-covered surface other than on hard surfaced areas of an air base.

Caution

Use caution when taxiing on iced surfaces because of minimum braking action available. Little difference will be noted between normal taxiing and taxiing on snow. Helicopters should not be taxied on a snow-covered surface other than on hard surfaced areas of an air base. If visibility is restricted by blowing snow, or if power required to taxi is excessive, helicopter should be towed to takeoff position.

Use caution when taxiing on surfaces with snow because of minimum braking available.

Retract landing light when taxiing in loose snow to preclude damage to retraction mechanism.

When taxiing through drifted snow, the helicopter has a tendency to tip forward on its nose. The pilot should anticipate this and counteract with careful application of the pitch and cyclic controls.

10–35. Takeoff. Takeoff from ice-covered runways or other prepared takeoff areas may be considered normal, except for the following precaution that should be observed: The pilot must ascertain that the helicopter is broken completely free of ice. A slight yawing movement, induced by light tail rotor pedal motion with throttle near maximum rpm, should be made to break the wheels free from any possible seizing.

Caution

Takeoff is prohibited with snow or ice on helicopter. Failure to remove all snow and ice accumulated on helicopter, including all rotor blades, while on the ground can result in serious aerodynamic and structural effects when flight is attempted. Depending on weight and distribution of snow and ice, takeoff, hovering, and climb-out performances can be adversely affected. This roughness pattern and location of snow and ice can affect stall speeds and handling characteristics to a dangerous degree. Inflight structural damage can also result due to vibrations induced in flight by unbalanced loads of unremoved accumulations. The hazards can be eliminated by removing all snow and ice accumulations prior to flight.

Snow takeoffs may be considered normal except for the following precautions that should be observed: Select an area devoid of loose or powdery snow to minimize the restriction to visibility from blowing snow. Before attempting to take off, roll the helicopter forward to insure that all tires are free and not frozen to the surface.

10–36. Cruise Check. The radio compass is susceptible to static caused by precipitation. Therefore, when flights are made during these conditions, the pilot should expect poor radio range reception.

Caution

During icing conditions, main rotor assembly and blades will collect ice. After a sufficient amount has accumulated, vibration or feedback will be felt in the cyclic stick. An unbalanced blade condition, with probable loss of control, will result when portions of ice are thrown from the rotor blade. A landing should be made as soon as ice is detected.

Note

Windshield wipers may not operate properly and forward visibility may become distorted or obscured by precipitation. However, limited visibility is possible through side windows.

10–37. Before Landing. A normal descent should be made; however, select a landing area, if possible, devoid of loose powdery snow so that visibility will not be restricted by blowing snow.

10–38. Landing. Landings on ice-covered runways or other prepared landing areas may be considered normal, except for the following precaution that should be observed: Accomplish a normal landing with a minimum hover before touchdown.

Caution

Droop stops may not function properly during shutdown if helicopter has been flown during icing conditions. In event of droop stop malfunction, cyclic stick should be held well forward of neutral position to insure maximum tail cone clearance.

Loose powdery snow and crusts (surface and hidden) should be anticipated on all landings on snow. Accomplish an approach with minimum hover before touchdown to minimize the rotor wash on loose powdery snow. Limited visibility will result if hovering is attempted before touchdown. If possible, landing should always be made where visual ground reference can be maintained. The reference point should be kept immediately forward and to the right so that it will be visible to the pilot at all times.

10–39. Engine Shutdown. For engine shutdown procedures, refer to Normal Procedures, Chapter 3.

Section IV Desert and Hot Weather Operation

10–40. Hot Weather Operation. More power will be required to hover during hot weather than on a standard day. Hovering ceilings will be lower for the same gross weight and power settings on a hot day. High rpm should be maintained at all times to insure sufficient power and control, especially during takeoffs and hovering. Chart 14–6 shows maximum gross weights at which the helicopter can be hovered out of ground effect with various combinations of altitude, temperature, dew point, and head wind.

10–41. Carburetor Air Temperature. When operating in hot weather, it may not be possible to hold carburetor air temperature below 38°C. When carburetor heat is not being utilized and a check of all other engine operating instruments indicates normal operation, no maximum carburetor air temperature will apply.

Note

For each 6°C rise in carburetor air temperature above 38°C, available engine horsepower is reduced 1 percent. Check the security of the insulation blanket at frequent intervals.

10–42. Desert Operation. The major problem in desert operation is the restriction of visibility as a result of the dust cloud created by the rotor downwash. Consequently, takeoffs, cargo sling load operations, and landings in sandy or dusty areas must at times be made without reference to the horizon and surrounding objects. This restriction of visibility can be partially overcome by proper use of the pilot's landing light. Operation in dusty or sandy areas can also be harmful to the engines. Use of the carburetor air filter will help to minimize damage to the engine. (Refer to Chapter 9.)

10–43. Before Entering the Helicopter. The helicopter should be towed into takeoff position, which, if at all possible, should be on a hard clean surface, free from sand. After the helicopter is towed into position, accomplish the normal exterior inspection. (Refer to Chapter 3.) Perform the following in addition to the requirements of figure 3–2.

a. Oleo struts – CHECK FOR PRESENCE OF SAND AND GRIT. Have personnel clean in accordance with approved methods, if necessary.

b. Rotor blades – CHECK FOR EVIDENCE OF SAND ABRASION.

c. Protective covers – REMOVED.

d. Fuselage and engine nacelles – CHECK FOR SAND THAT HAS FILTERED THROUGH OPENINGS.

e. Carburetor air filter – CHECK FOR SAND CLOGGING.

f. Engine and main gear box oil coolers – CHECK FOR SAND CLOGGING AND CONTAMINATION.

10–44. On Entering the Helicopter. Open all vents, windows, and doors to increase ventilation. Turn on ventilation system as soon as an external power supply is available. Perform the normal interior inspection. (Refer to Chapter 3.)

10–45. Engine Starting and Ground Operation. If possible, engine starting and ground operation should be accomplished from a hard clean surface. This is extremely important after rotor clutch engagement, as the downwash from the main rotor will stir up clouds of sand.

Caution

Do not start engine during a dust or sand storm, unless absolutely necessary, to avoid danger of drawing sand into carburetor induction air intakes resulting in premature engine wear.

Accomplish the normal engine start as presented in Chapter 3. Limit ground operation of the engines to a minimum. Every effort should be made to minimize blowing the sand up around the main rotor assembly and the engine nacelles by utilizing minimum pitch and engine rpm.

Note

Use filtered air to minimize engine contamination.

10–46. Takeoff. Increase engine to maximum rpm. If the rotor should stir up dust and sand, it would be best to increase collective pitch and take off; do not hover in ground effect but continue to climb rapidly. (Refer to Chapter 3.) Takeoffs, unless necessary, should be avoided during a dust or sand storm.

10–47. Cruise Checks. When sand storm conditions are encountered, evasive action should be taken to prevent extensive damage to the helicopter, particularly to the rotor blades and engines. If the storm area is not too extensive, it may be possible to fly over or around it, but never through it. If practicable, return to the base so that the helicopter may be tied down and all protective covers installed. If this is not possible, land and shut down. Head the helicopter into the wind, and if possible, tie down the blades. Close all doors, windows, and vents and remain in the helicopter. When the storm is over, perform an exterior inspection before resuming flight. (See figure 3–1.) Clean out as much of the sand as possible that has sifted into the fuselage and the engine nacelles, particularly the induction air and oil cooling systems. Check the rotor blades for damage and the flight control system for excessive friction.

10–48. Cargo Sling Load Operation. When a cargo sling load hookup is to be made in a dusty or sandy area, make an approach at a slightly steeper angle than in the normal approach; terminating the approach slightly higher than the upper limit of ground cushion. This enables the pilot to orient over the load, and start a vertical descent through the dust cloud created by the rotor downwash as the helicopter descends into ground effect. The dust cloud is initially blown out and away from the helicopter and ground visibility can be maintained by looking straight down until hovering height is reached. As the dust cloud builds, obstructing visibility, adjust the landing light down and to the right. This creates a "ball of light" on the ground from which the height and position of the helicopter can be determined. Determine the approximate altitude desired for hookup operations and adjust the landing light at a hover prior to entering the hookup area. While the pilot's attention is centered on the "ball of light," the copilot will monitor all instruments and override the pilot on the twist-grip throttle to maintain the proper engine rpm. As the load is brought to a hover a, light place on the ground, out in front of the helicopter, can be seen through the thin upper portion of the dust cloud and establishes a point of reference for the takeoff out of the dust cloud.

10–49. Approach and Landing. The landing approach should be relatively steep at low airspeed, with little forward speed just above the surface and landing without hovering. Try to land on a hard surface or in an area where sand will not be blown on other helicopters. Restrict taxiing to a minimum.

10–50. Postflight Check and Engine Shutdown. Accomplish postflight check and engine shutdown as soon as possible. (Refer to Chapter 3.)

10–51. Before Leaving the Helicopter. Close all doors, windows, and vents. Be sure that all protective covers are installed and check the carburetor air filters for cleanliness, as they must not be left in a clogged condition.

Section V Turbulence and Thunderstorm Operation

10-52. Turbulent Air. Turbulent areas should be avoided, if possible. However, if inadvertently turbulence is encountered, the helicopter should be flown at the recommended instrument airspeeds to improve its flying qualities and decrease the chance of blade stall. If severe turbulence is encountered, reduce airspeed to 70 knots and land, if possible. In moderate turbulence, the work load of the pilot increases to the extent that he must concentrate solely on flying the helicopter. As a result, the pilot must disregard navigation, position reports, etc.

10-53. Thunderstorms. Because of the helicopter's relatively slow speed and the difficulty of handling the helicopter in turbulence, thunderstorm flying is not recommended.

Note

If thunderstorms are encountered during flight, land and wait for storm to pass. Moderate turbulence and restricted visibility may be expected.

CHAPTER 11
CREW DUTIES

Section I Scope

11—1. General. This chapter covers the responsibilities of each crewmember and includes a discussion of the primary and alternate functions.

11—2. Purpose. The purpose of this chapter is to provide a compact collection of material wherein each crewmember can readily determine his complete responsibilities when accomplishing a mission.

Section II Responsibilities

11—3. Crew Responsibilities. The minimum crew required to fly the helicopter is one pilot, one copilot, and a third crewmember who will be stationed in the cabin and designated as flight engineer. Duties of each crewmember are discussed, although normal procedures as given in Chapter 3 are not repeated.

11—4. Pilot. The pilot has overall responsibility for the helicopter and the efficient completion of the mission. He should arrange to have all persons briefed on normal and emergency procedures and correct use of equipment. The pilot cannot operate the main landing gear emergency valve switch, the emergency hydraulic valve handle, and the pump lever located on the left of the copilot. All circuit breakers, switches, and controls on the overhead panels, the control console, and the engine control quadrant are accessible to the pilot and the copilot. Copilot assistance will be necessary to adjust the quadrant throttles to equalize the manifold pressure of the engines, while the pilot operates the twist-grip throttle. The radio controls are equally accessible to pilot or copilot, except the marker beacon switch which is on the pilot's side of the instrument panel.

11—5. Copilot. The copilot must be able to substitute for the pilot in any of his duties and must be as familiar with them as with his own. The helicopter may be flown from the copilot's position alone. The copilot can assist the pilot in making all inspections and checks and can operate auxiliary equipment such as lights, windshield wiper, radios, etc , as the pilot flies the helicopter. It will be convenient for the copilot to turn the rotor clutch switches on and off and to equalize the manifold pressures of the engines by means of the quadrant throttles while the pilot operates the twist-grip throttle after the clutches have been engaged.

11—6. Flight Engineer. The flight engineer's station is at one of the single troop seats, either just forward or aft of the cargo door on the right side of the cabin. The flight engineer is normally in charge of the cabin. In addition to assisting the pilot and copilot in accomplishing the cabin interior check, the arrangement of controls in the helicopter is such that the flight engineer may have to operate the following equipment:

a. Forward or aft cabin interphone.

b. Cargo manual release lever.

c. Cargo sling stowage line.

d. Pilot's compartment ladder.

e. Heater compartment fire warning light.

f. Auxiliary power unit.

g. Cargo hoist winch.

h. Landing gear emergency release handle.

Note

In the event of electrical failure the following equipment and controls must also be operated by the flight engineer.

i. Auxiliary fuel tank manual release and safety pin release handles.

j. Nose door and ramp hydraulic valves manual override knobs.

k. Battery bus and high amperage circuit breaker panels.

Cabin personnel should check with the pilot before operating any equipment during flight. When the auxiliary power plant is used for engine starting, it should not be turned off until the pilot signals that the generator switches are on and that the generators are operating.

Warning

The flight engineer should always wear the safety harness, clipped to a cargo tie-down ring when the cargo hatch in the center of the cabin floor is open in flight.

CHAPTER 12
WEIGHT AND BALANCE COMPUTATION

Section I Scope

12–1. Purpose. This chapter provides appropriate information required for the computation of weight and balance for loading the CH-37B helicopter.

12–2. Extent of Coverage. Sufficient data has been provided so that, knowing the basic weight and moment of the helicopter, any combination of weight and balance can be computed.

Section II Introduction

12–3. General. The data to be inserted on weight and balance charts and forms are applicable only to the individual helicopter, the serial number of which appears on the title page of the booklet entitled WEIGHT AND BALANCE DATA supplied by the helicopter manufacturer and on the various forms and charts which remain with the helicopter in accordance with existing directives. The charts and forms referred to in this chapter may differ in nomenclature and arrangement from time to time, but the principle on which they are based will not change.

12–4. Charts and Forms. The standard system of weight and balance control requires the use of several different charts and forms. They are identified as follows:

a. Chart C – Basic Weight and Balance Record, DD Form 365C.

b. Chart E – Loading Data, Charts and Graphs.

c. Form F – Weight and Balance Clearance Form F, DD Form 365F.

12–5. Responsibility. The helicopter manufacturer inserts all helicopter identifying data on the title page of the booklet entitled WEIGHT AND BALANCE DATA and on the various charts and forms. All charts, including one sample Weight and Balance Clearance Form F if applicable, are completed at time of delivery. This record is the basic weight and balance data of the helicopter at delivery. All subsequent changes in weight and balance are compiled by the weight and balance technician.

12–6. Helicopter Weighing. The helicopter basic weight and cg location can only be as accurate as the scale equipment employed. The crewmember has available the current basic weight, moment/1000, and index in the WEIGHT AND BALANCE DATA booklet. The helicopter must be weighed periodically as required by pertinent directives or when:

a. The pilot reports unsatisfactory flight characteristics (nose or tail heaviness).

b. Major modifications or repairs are made.

c. The basic weight data contained in the records are suspected to be in error.

Section III Definitions

12–7. Weight Definitions. Weight definitions are as follows:

12–8. Basic Weight. The basic weight of a helicopter is that weight which includes all fixed operating equipment and trapped fuel and oil to which it is only necessary to add the variable or expendable load items for the various missions.

Note

The basic weight of a helicopter varies with the structural modifications and changes in the fixed operating equipment. The term, basic weight, when qualified with a word indicating the type of mission such as Basic Weight for Combat, Basic Weight for Ferry, etc , may be used in conjunction with directives stating what the equipment shall be for these missions. For example, extra fuel tanks and various items of equipment installed for long range ferry flights which are not normally carried on combat missions will be included in Basic Weight for Ferry, but not in Basic Weight for Combat.

12–9. Operating Weight. The operating weight is the weight of the helicopter, including the crew and all equipment required for the mission, but not including fuel or payload.

12–10. Gross Weight. The gross weight is the total weight of a helicopter and its contents.

a. The takeoff gross weight is the operating weight plus the variable and expendable load items which vary with the mission. These items include fuel, external fuel tanks (if to be disposed of during flight), etc.

b. The landing gross weight is the takeoff gross weight minus the expended load items.

12–11. Balance Definitions. Balance definitions are as follows:

12–12. Reference Datum. (See figure 12–1.) The reference datum line is an imaginary vertical plane at or forward of the nose of the helicopter from which all horizontal distances are measured for balance purposes. Diagrams of each helicopter show this reference datum line as balance station zero.

12–13. Arm. (See figure 12–1.) Arm, for balance purposes, is the horizontal distance in inches from the reference datum line to the cg of the item. Arms may be determined from the helicopter diagram in figure 12–3, chart E.

12–14. Moment. Moment is the weight of an item multiplied by its arm. Moment divided by a constant is generally used to simplify balance calculations by reducing the number of digits. For this helicopter, inches and moment/1000 have been used.

12–15. Average Arm. (See figure 12–1.) Average arm is the arm obtained by adding the weights and adding the moments of a number of items and dividing the total moment by the total weight.

12–16. Basic Moment. Basic moment is the sum of the moments of all items making up the basic weight. When using data from an actual weighing of a helicopter, the basic moment is the total moment of the basic helicopter with respect to the reference datum.

12–17. Center of Gravity. (CG). (See figure 12–1.) Center of gravity is the point about which a helicopter would balance if suspended. Its distance from the reference datum line is found by dividing the total moment by the gross weight of the helicopter.

12–18. CG Limits. Cg limits are the extremes of movement which the cg can have without making the helicopter unsafe to fly. The cg of the loaded helicopter must be within these limits at takeoff, in the air, and on landing. In some cases, separate takeoff and landing limits may be specified.

12–19. Balance Computer Index. Balance computer index is a number representing the moment, which when considered in conjunction with the weight, gives the cg position.

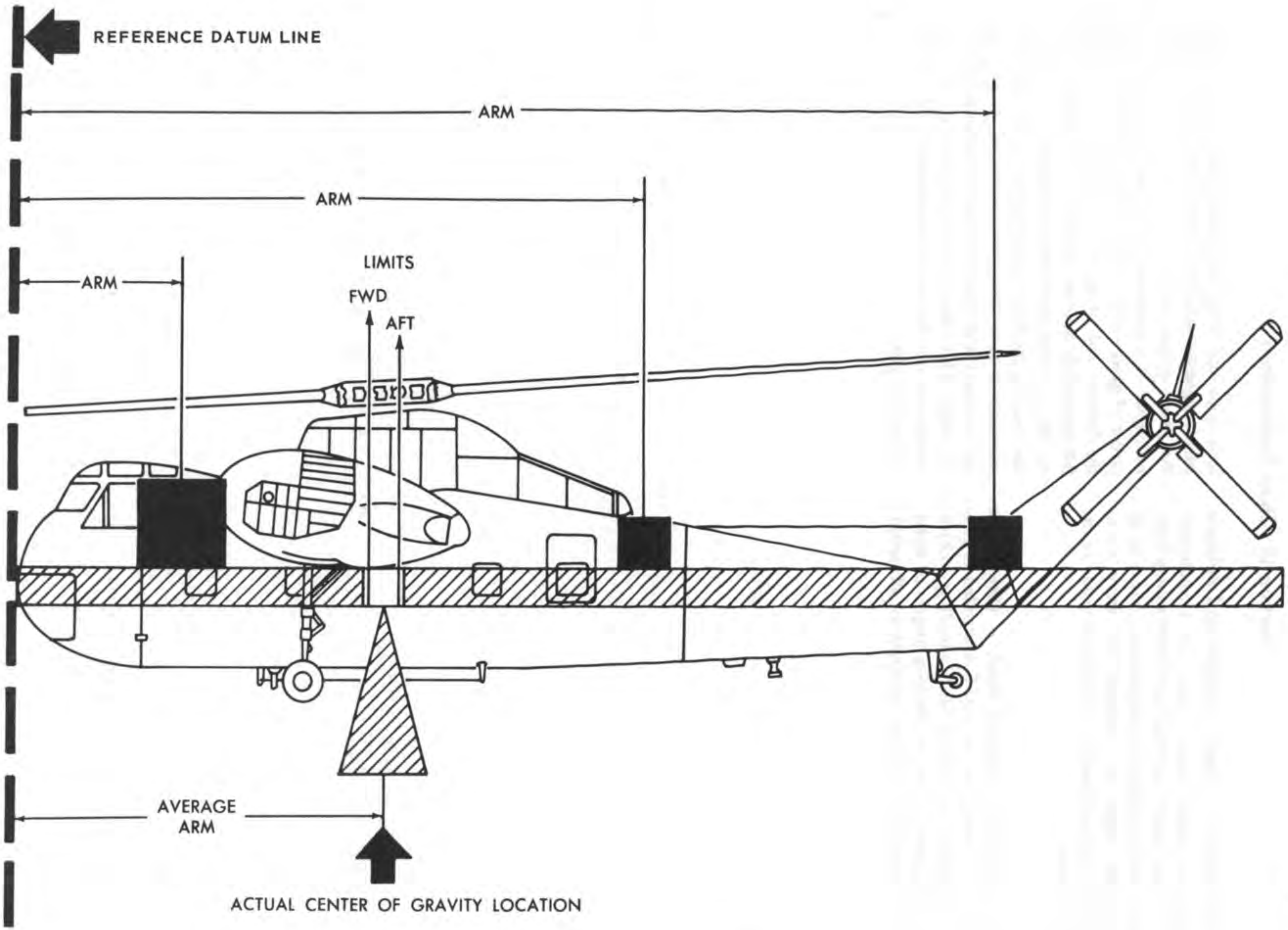


Figure 12–1. Reference datum

Section IV Chart Explanations

12–20. Chart C – Basic Weight and Balance Record. (See figure 12–2.) Chart C is a continuous history of the basic weight and moment resulting from structural and equipment changes in service. At all times, the last weight and moment/1000 entry is considered the current weight and balance status of the basic helicopter.

12–21. Chart E – Loading Data. (See figure 12–3.) The loading data in chart E is intended to provide information necessary to work a loading problem for the helicopter. From the loading graphs or tables, weight and moment/1000 are obtained for all variable load items and are added arithmetically to the current basic weight and moment/1000 (from chart C) to obtain the gross weight and moment. The cg of the loaded helicopter is represented by a moment figure in the center of gravity table. If the helicopter is loaded within the forward and aft cg limits, the moment figure will fall numerically between the limiting moments. The effect on the cg of the expenditure in flight of such items as fuel may be checked by subtracting the weights and moments of such items from the takeoff gross weight and moment and checking the new moment with the cg table. This check should be made to determine whether or not the cg will remain within limits during the entire flight.

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-37 | SERIAL NO. 54-321 | 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]	WEIGHT	ARM	MOMENT[1]	WEIGHT	MOMENT[1]	INDEX[2]
2-10-55			Delivery Basic Weight							21500	5285.8	80.8
3-20-56			Overhaul and Reweighed							21595	5305.9	80.7
			Inventory as checked in Chart A 6-7-56									
6-7-56	J-6		27C56 Heater	30	343	10.3						
	J-9		X702-181A Blower	34	374	12.7						
		K-4	Fire Extinguisher Type A-20 Removed									
			Permanently (T.O. No. 01-11BC-87)				8	442	3.5			
	K-6		Fire Extinguisher Type A-25(1)6-7-56	9	442	3.9						
	K-2		1 Man Troop Seat ACA-1142-21 (1)	3	431	1.3						
			TOTALS	76		28.2	8	442	3.5	21663	5330.1	81.1
6-6-62			Retrofit to B configuration and Reweighed.							22197	5431.5	79.7

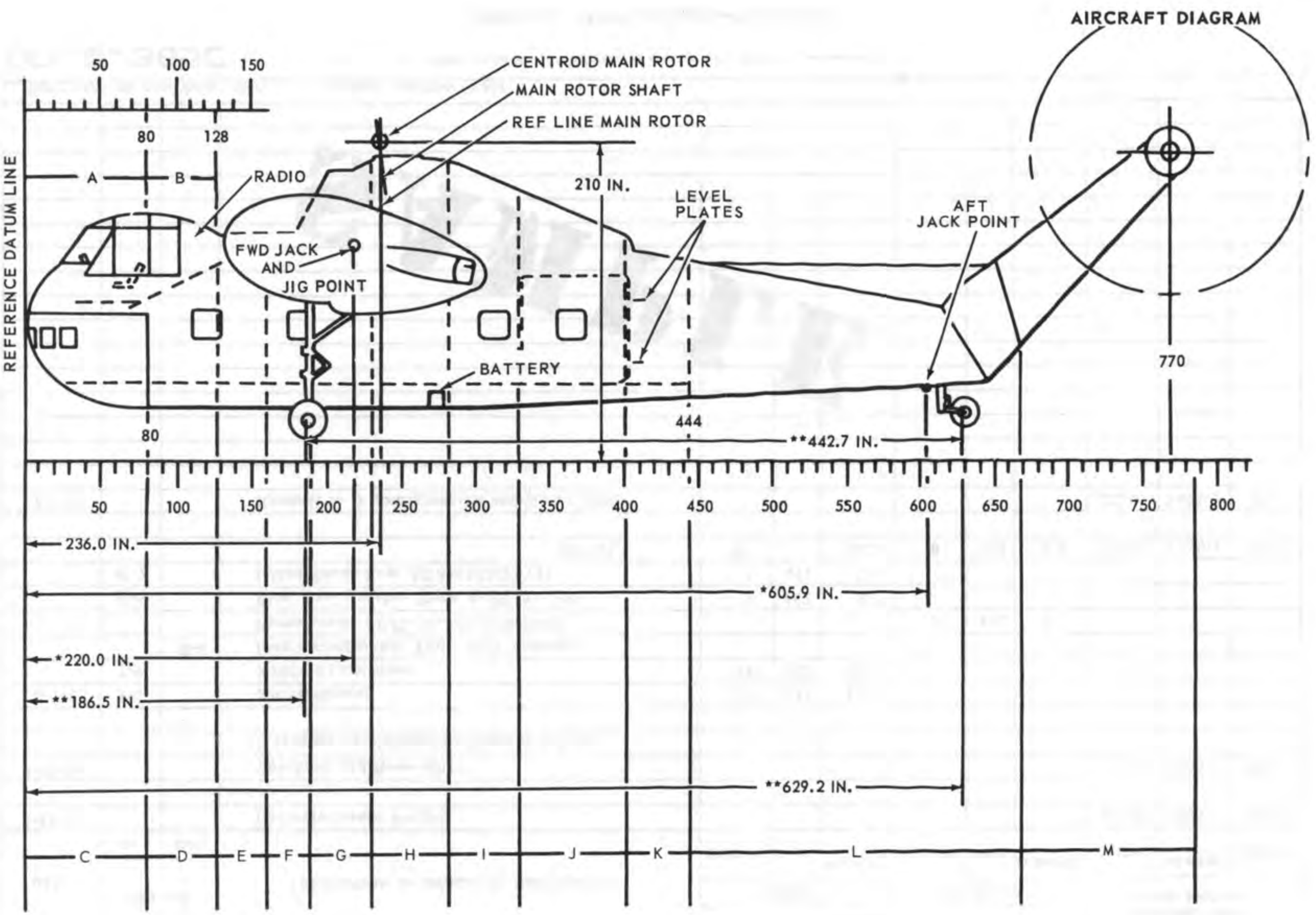
SAMPLE

[1] *Enter constant used below line.* [2] *Balance computer index.*

DD FORM 1 SEPT 54 365C

Previous editions of this form may be used until stocks are exhausted.

Figure 12—2. Chart C, basic weight and balance record



*DIMENSIONS JACK POINTS

**DIMENSIONS WEIGHING ON WHEELS (APPROXIMATELY)

Figure 12–3. Chart E, loading data (Sheet 1 of 20)

AIRCRAFT DIAGRAM

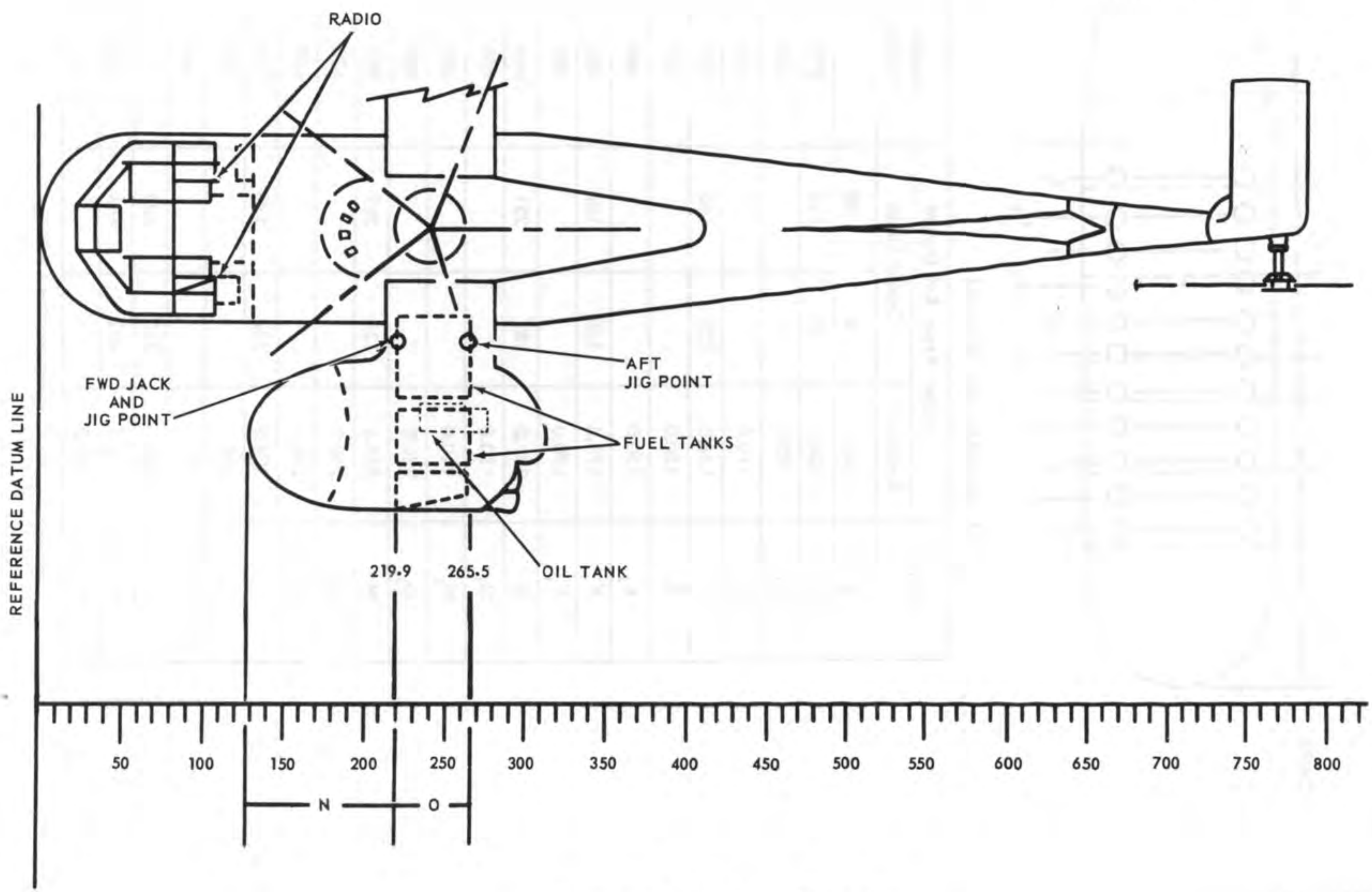
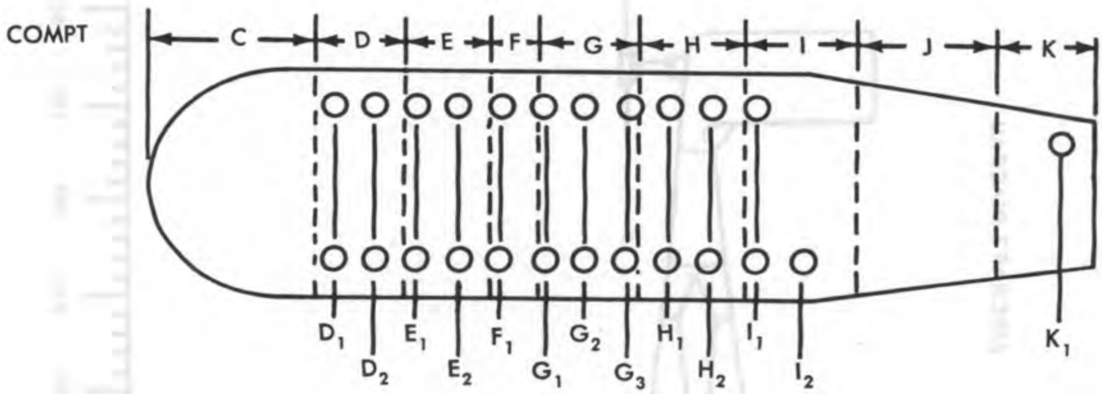


Figure 12–3. Chart E, loading data (Sheet 2 of 20)

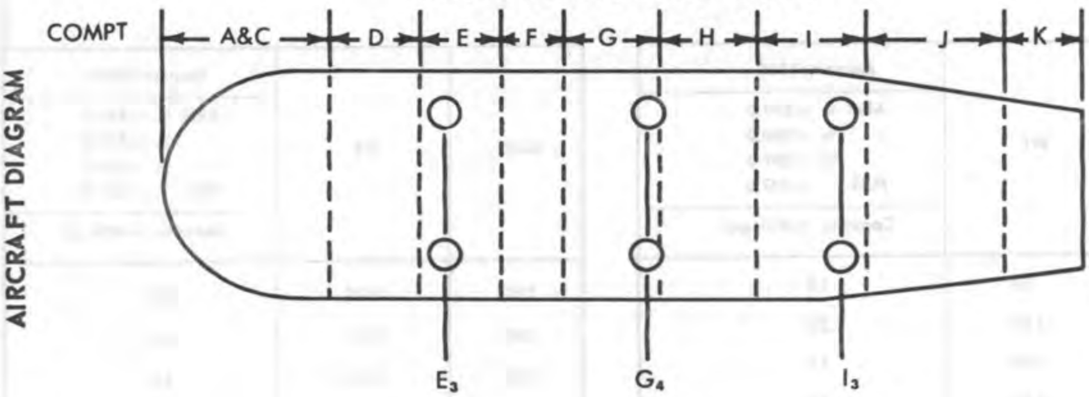
TROOPS



Compt	Inches From Ref Datum			Weight (Pounds)
	Centroid	Compt Limits		
C	45.6	0	80	
D	104.0	80	128	960
D_1	90.0			480
D_2	110.0			480
E	144.0	128	160	960
E_1	130.0			480
E_2	150.0			480
F	173.5	160	187	480
F_1	170.0			480
G	209.0	187	231	1440
G_1	190.0			480
G_2	210.0			480
G_3	230.0			480
H	256.5	231	282	960
H_1	250.0			480
H_2	270.0			480
I	306.0	282	330	720
I_1	290			480
I_2	311			240
J	365	330	402	
K	422.5	402	444	240
K_1	431.5			240

Figure 12–3. Chart E, loading data (Sheet 3 of 20)

LITTER PATIENTS AND CARGO



COMPARTMENT DESIGN DATA

1. Compartment Designation	2. Inches From Ref Datum			3. Max Cap. Pounds	4. Area Sq Ft	5. Volume Cu Ft	6. Max Evenly Distributed Load Over Entire Compt
	Centroid	Compt Limits					
A Pilot & Copilot	66.0	0	80	500	——	——	——
C Nose Doors	45.6	0	80	——	27.5	103.5	——
D Cargo	104.0	80	128	1500*	29.1	169.7	300 lb/sq ft
E Cargo	144.0	128	128	5800	19.4	121.2	300 lb/sq ft
E_3 Litters	131.0	——	——	2000	——	——	——
F Cargo	173.5	160	187	4900	16.4	102.5	300 lb/sq ft
G Cargo	209.0	187	231	7700	26.6	166.3	300 lb/sq ft
G_4 Litters	227.0	——	——	2000	——	——	——
H Cargo	256.5	231	282	7700	30.9	193.1	300 lb/sq ft
I Cargo	306.0	282	330	5900	28.1	175.6	300 lb/sq ft
I_3 Litters	323.0	——	——	2000	——	——	——
J Cargo	365.0	330	330	4500	35.7	223.1	300 lb/sq ft
K Cargo	422.5	402	444	——	16.2	101.2	300 lb/sq ft

Includes 20 lb for each litter

*Note: Do not use Compartment D when Compartment E is used.

Figure 12–3. Chart E, loading data (Sheet 4 of 20)

FUEL

GAL	WT	Moment/1000 ARM ¼ =241.0, ½ =240.0, ¾ =239.0, FULL =237.0; Capacity =410 gal
10	60	14
20	120	29
30	180	43
40	240	58
50	300	72
60	360	87
70	420	101
80	480	116
90	540	130
100	600	145
110	660	158
120	720	173
130	780	187
140	840	202
150	900	216
160	960	230
170	1020	245
180	1080	259
190	1140	274
200	1200	288
210	1260	301

GAL	WT	Moment/1000 ARM ¼ =241.0, ½ =240.0, ¾ =239.0, FULL =237.0; Capacity =410 gal
220	1320	315
230	1380	330
240	1440	344
250	1500	358
260	1560	373
270	1620	387
280	1680	402
290	1740	416
300	1800	430
310	1860	441
320	1920	455
330	1980	469
340	2040	483
350	2100	498
360	2160	512
370	2220	526
380	2280	540
390	2340	555
400	2400	569
410	2460	583

NOTE: Wing fuel tanks are self-sealing and nacelle fuel tanks are crash resistant. Approximate weights and moments for full fuel tanks under standard conditions (60°F) based on 6.0 pounds per gal.

CAUTION

This helicopter is equipped with capacitor-type fuel quantity gages which are calibrated in pounds. Aircraft fuel varies in weight per gallon dependent upon specific gravity and temperature of fuel; therefore, notation FULL does not appear on instrument dial and pilot should anticipate variations in instrument readings when tanks are full.

Figure 12–3. Chart E, loading data (Sheet 5 of 20)

FUEL — JETTISONABLE FUEL TANKS

GAL	WT	Moment/1000 Cap. 600 Gal ARM =219.9	Moment/1000 Cap. 300 Gal ARM =219.9
10	60	13	13
20	120	26	26
30	180	40	40
40	240	53	53
50	300	66	66
60	360	79	79
70	420	92	92
80	480	106	106
90	540	119	119
100	600	132	132
110	660	145	145
120	720	158	158
130	780	172	172
140	840	185	185
150	900	198	198
160	960	211	211
170	1020	224	224
180	1080	237	237
190	1140	251	251
200	1200	264	264
210	1260	277	277
220	1320	290	290
230	1380	303	303
240	1440	317	317
250	1500	330	330
260	1560	343	343
270	1620	356	356
280	1680	369	369
290	1740	383	383
300	1800	396	396

GAL	WT	Moment/1000 Cap. 600 Gal ARM =219.9
310	1860	409
320	1920	422
330	1980	435
340	2040	449
350	2100	462
360	2160	475
370	2220	488
380	2280	501
390	2340	515
400	2400	528
410	2460	541
420	2520	554
430	2580	567
440	2640	581
450	2700	594
460	2760	607
470	2820	620
480	2880	633
490	2940	647
500	3000	660
510	3060	673
520	3120	686
530	3180	699
540	3240	712
550	3300	726
560	3360	739
570	3420	752
580	3480	765
590	3540	778
600	3600	792

NOTE: Approximate weight and moments for tank under standard conditions (60°F) based on 6.0 pounds per gal. Fuel from this system is pumped directly to nacelle tank.

Figure 12–3. Chart E, loading data (Sheet 6 of 20)

AVERAGE VARIATION IN FUEL WEIGHT
WITH TEMPERATURE

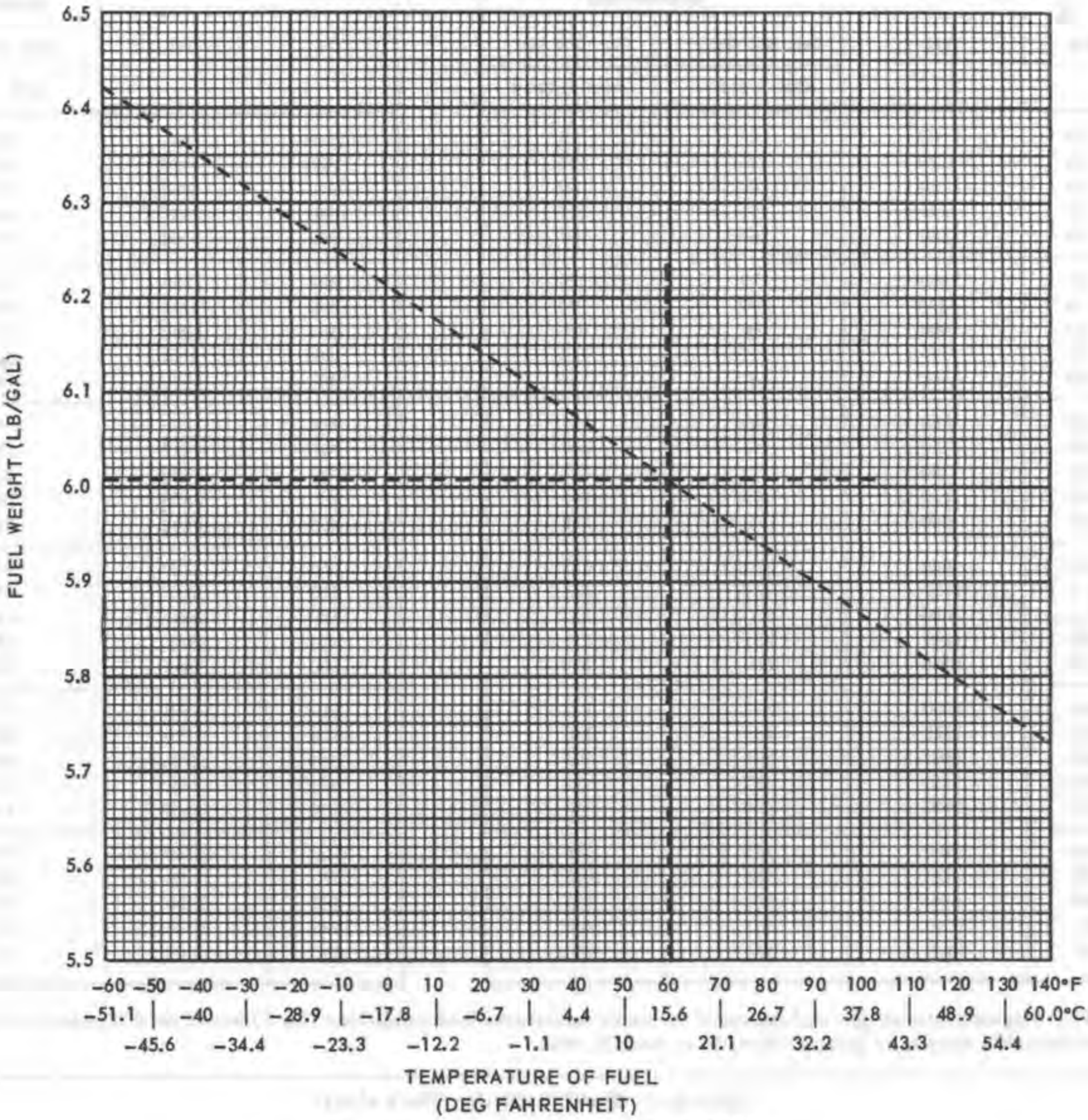


Figure 12-3. Chart E, loading data (Sheet 7 of 20)

OIL					
CAPACITY = 60.0 GAL			CAPACITY = 60.0 GAL		
ARM = 255.7			ARM = 255.7		
U.S. GAL	WEIGHT (POUNDS)	MOMENT 1000	U.S. GAL	WEIGHT (POUNDS)	MOMENT 1000
2	15.0	4	32	240.0	61
4	30.0	8	34	255.0	65
6	45.0	12	36	270.0	69
8	60.0	15	38	285.0	73
10	75.0	19	40	300.0	77
12	90.0	23	42	315.0	81
14	105.0	27	44	330.0	84
16	120.0	31	46	345.0	88
18	135.0	35	48	360.0	92
20	150.0	38	50	375.0	96
22	165.0	42	52	390.0	100
24	180.0	46	54	405.0	104
26	195.0	50	56	420.0	107
28	210.0	54	58	435.0	111
30	225.0	58	60	450.0	115

Figure 12–3. Chart E, loading data (Sheet 8 of 20)

CARGO COMPARTMENT

	D	E	F	G	H	I	J
ARM	*104.0	144.0	173.5	209.0	256.5	306.0	365.0
WEIGHT (POUNDS)	MOMENT/1000 FOR COMPARTMENTS AT CENTROIDS NOTED						
20	2	3	3	4	5	6	7
40	4	6	7	8	10	12	15
60	6	9	10	13	15	18	22
80	8	12	14	17	21	24	29
100	10	14	17	21	26	31	36
200	21	29	35	42	51	61	73
300	31	43	52	63	77	92	110
400	42	58	69	84	103	122	146
500	52	72	87	104	128	153	182
600	62	86	104	125	154	184	219
700	73	101	121	146	180	214	256
800	83	115	139	167	205	245	292
900	94	130	156	188	231	275	328
1000	104	144	174	209	257	306	365
1100	114	158	191	230	282	337	402
1200	125	173	208	251	308	367	438
1300	135	187	226	272	333	398	474
1400	146	202	243	293	359	428	511
1500	156	216	260	314	385	459	548
1600		230	278	334	410	490	584
1700		245	295	355	436	520	620
1800		259	312	376	462	551	657
1900		274	330	397	487	581	694
2000		288	347	418	513	612	730
2100		302	364	439	539	643	766
2200		317	382	460	564	673	803
2300		331	399	481	590	704	840
2400		346	416	502	616	734	876
2500		360	434	522	641	765	912
2600		374	451	543	667	796	949
2700		389	468	564	693	826	986

*NOTE: Do not use compartment D when compartment E is used.

Figure 12-3. Chart E, loading data (Sheet 9 of 20)

CARGO COMPARTMENT

	D	E	F	G	H	I	J
ARM	*104.0	144.0	173.5	209.0	256.5	306.0	365.0
WEIGHT (POUNDS)	MOMENT/1000 FOR COMPARTMENTS AT CENTROIDS NOTED						
2800		403	486	585	718	857	1022
2900		418	503	606	744	887	1058
3000		432	521	627	770	918	1095
3100		446	538	648	795	949	1132
3200		461	555	669	821	979	1168
3300		475	573	690	846	1010	1204
3400		490	590	711	872	1040	1241
3500		504	607	732	898	1071	1278
3600		518	625	752	923	1102	1314
3700		533	642	733	949	1132	1351
3800		547	659	794	975	1163	1387
3900		562	677	815	1000	1193	1424
4000		576	694	836	1026	1224	1460
4100		590	711	857	1052	1255	1497
4200		605	729	878	1077	1285	1533
4300		619	746	899	1103	1316	1570
4400		634	763	920	1129	1346	1606
4500		648	781	941	1154	1377	1642
4600		662	798	961	1180	1408	
4700		677	815	982	1206	1438	
4800		691	833	1003	1231	1469	
4900		706	850	1024	1257	1499	
5000		720		1045	1283	1530	
5100		734		1066	1308	1561	
5200		749		1087	1334	1591	
5300		763		1108	1359	1622	
5400		778		1129	1385	1652	
5500		792		1150	1411	1683	
5600		806		1170	1436	1714	
5700		821		1191	1462	1744	

*NOTE: Do not use compartment D when compartment E is used.

Figure 12–3. Chart E, loading data (Sheet 10 of 20)

CARGO COMPARTMENT							
	D	E	F	G	H	I	J
ARM	*104.0	144.0	173.5	209.0	256.5	306.0	365.0
WEIGHT (POUNDS)	MOMENT/1000 FOR COMPARTMENTS AT CENTROIDS NOTED						
5800		835		1212	1488	1775	
5900				1233	1513	1805	
6000				1254	1539		
6100				1275	1565		
6200				1296	1590		
6300				1317	1616		
6400				1338	1642		
6500				1359	1667		
6600				1379	1693		
6700				1400	1719		
6800				1421	1744		
6900				1442	1770		
7000				1463	1796		
7100				1484	1821		
7200				1505	1847		
7300				1526	1872		
7400				1547	1898		
7500				1568	1924		
7600				1588	1949		
7700				1609	1975		

*NOTE: Do not use compartment D when compartment E is used.

Figure 12–3. Chart E, loading data (Sheet 11 of 20)

TROOP COMPARTMENT													
COMPT	D		E		F	G			H		I		K
	D_1	D_2	E_1	E_2	F_1	G_1	G_2	G_3	H_1	H_2	I_1	I_2	K_1
ARM	90.0	110.0	130.0	150.0	170.0	190.0	210.0	230.0	250.0	270.0	290.0	311.0	431.5
WEIGHT POUNDS	MOMENT/1000 FOR ARM AS NOTED												
20	2	2	3	3	3	4	4	5	5	5	6	6	9
40	4	4	5	6	7	8	8	9	10	11	12	12	17
60	5	7	8	9	10	11	13	14	15	16	17	19	26
80	7	9	10	12	14	15	17	18	20	22	23	25	35
100	9	11	13	15	17	19	21	23	25	27	29	31	43
120	11	13	16	18	20	23	25	28	30	32	35	37	52
140	13	15	18	21	24	27	29	32	35	38	41	44	60
160	14	18	21	24	27	30	34	37	40	43	46	50	69
180	16	20	23	27	31	34	38	41	45	49	52	56	78
200	18	22	26	30	34	38	42	46	50	54	58	62	86
220	20	24	29	33	37	42	46	51	55	59	64	68	95
240	22	26	31	36	41	46	50	55	60	65	70	75	104
260	23	29	34	39	44	49	55	60	65	70	75		
280	25	31	36	42	48	53	59	64	70	76	81		
300	27	33	39	45	51	57	63	69	75	81	87		
320	29	35	42	48	54	61	67	74	80	86	93		
340	31	37	44	51	58	65	71	78	85	92	99		
360	32	40	47	54	61	68	76	83	90	97	104		
380	34	42	49	57	65	72	80	87	95	103	110		
400	36	44	52	60	68	76	84	92	100	108	116		
420	38	46	55	63	71	80	88	97	105	113	122		
440	40	48	57	66	75	84	92	101	110	119	128		
460	41	51	60	69	78	87	97	106	115	124	133		
480	43	53	62	72	82	91	101	110	120	130	139		

Figure 12–3. Chart E, loading data (Sheet 12 of 20)

EXTERNAL CARGO

WEIGHT (POUNDS)	Moment/1000 ARM = 225.1	WEIGHT (POUNDS)	Moment/1000 ARM = 225.1	WEIGHT (POUNDS)	Moment/1000 ARM = 225.1
100	23	500	788	900	1553
200	45	600	810	7000	1576
300	68	700	833	100	1598
400	90	800	855	200	1621
500	113	900	878	300	1643
600	135	4000	900	400	1666
700	158	100	923	500	1688
800	180	200	945	600	1711
900	203	300	968	700	1733
1000	225	400	990	800	1756
100	248	500	1013	900	1778
200	270	600	1035	8000	1801
300	293	700	1058	100	1823
400	315	800	1080	200	1846
500	338	900	1103	300	1868
600	360	5000	1126	400	1891
700	383	100	1148	500	1913
800	405	200	1171	600	1936
900	428	300	1193	700	1958
2000	450	400	1216	800	1981
100	473	500	1238	900	2003
200	495	600	1261	9000	2026
300	518	700	1283	100	2048
400	540	800	1306	200	2071
500	563	900	1328	300	2093
600	585	6000	1351	400	2116
700	608	100	1373	500	2138
800	630	200	1396	600	2161
900	653	300	1418	700	2183
3000	675	400	1441	800	2206
100	698	500	1463	900	2228
200	720	600	1486	*10,000	2251
300	743	700	1508		
400	765	800	1531		

* Maximum capacity.

Figure 12–3. Chart E, loading data (Sheet 13 of 20)

WARNING

When helicopters are operated at gross weights approaching the critical area, 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 will be computed as follows: Combat equipped soldiers: 240 lb per individual. Combat equipped paratroopers: 260 lb per individual. Crew and passengers with no equipment: Use actual crew weights. Add 20 lb for each parachute carried. Maximum allowable in pilot and copilot position 250 lb each.

LITTER PATIENT			
	E	G	I
COMPT	E_3	G_4	I_3
ARM	131	227	323
WEIGHT (POUNDS)	MOMENT/1000		
250	33	57	81
500	66	114	162
750	98	170	242
1000	131	227	323
1250	164	284	404
1500	196	340	484
1750	229	397	565
2000	262	454	646
NOTE: Includes 20 pounds for litters.			

Figure 12–3. Chart E, loading data (Sheet 14 of 20)

CREW	
	PILOT & COPILOT
WEIGHT	ARM = 66.0
(POUNDS)	MOMENT/1000
140	9
160	11
180	12
200	13
220	15
240	16
260	17
280	18
300	20
320	21
340	22
360	24
380	25
400	26
420	28
440	29
460	30
480	32
500	33

NOTES: Use actual crew weights and allow 20 lb each for parachutes if carried.

Maximum allowable in pilot and copilot position 250 lb each.

Figure 12–3. Chart E, loading data (Sheet 15 of 20)

TABLE OF MOMENTS FOR CREW AND CREW MOVEMENTS

COMPARTMENT	A	C	D	E	F	G	H	I	J	K
ARM (INCHES)	45.6	66.0	104.0	144.0	173.5	209.0	256.5	306.0	365.0	422.5
TOTAL MOMENT/ 1000 CREW ADDED	9	13	21	29	35	42	51	61	73	84

CREW MOVEMENTS

K	CARGO COMPT	75	71	63	55	49	42	33	23	11
J	CARGO COMPT	64	60	52	44	38	31	22	12	
I	CARGO COMPT	52	48	40	32	26	19	10		
H	CARGO COMPT	42	38	30	22	16	9			
G	CARGO COMPT	33	29	21	13	7				
F	CARGO COMPT	26	22	14	6					
E	CARGO COMPT	20	16	8						
D	CARGO COMPT	12	8							
C	NOSE DOORS	4								

NOTE: Add moment/1000 for crew movement aft [plus (+) sign]. Subtract moment/1000 for crew movement fwd [minus (—) sign]. Based on 200 pounds per man.

Example: Move one man from C Compartment to F Compartment. Add 26 to total moment/1000.
Move one man from J Compartment to D Compartment. Subtract 52 from total moment/1000.

Figure 12–3. Chart E, loading data {Sheet 16 of 20}

CENTER OF GRAVITY TABLE

GROSS WEIGHT (POUNDS)	MOMENT/1000 STA 228*	STA 230	STA 233	STA 236	STA 239	STA 242	STA 245.1**
21000	4788	4830	4893	4956	5019	5082	5111
100	4811	4853	4916	4980	5043	5106	5136
200	4834	4876	4940	5003	5067	5130	5160
300	4856	4899	4963	5027	5091	5155	5185
400	4879	4922	4986	5050	5115	5179	5209
500	4902	4945	5010	5074	5138	5203	5234
600	4925	4968	5033	5098	5162	5227	5258
700	4948	4991	5056	5121	5186	5251	5283
800	4970	5014	5079	5145	5210	5276	5306
900	4993	5037	5103	5168	5234	5300	5332
22000	5016	5060	5126	5192	5258	5324	5356
100	5039	5083	5149	5216	5282	5348	5381
200	5062	5106	5173	5239	5306	5372	5405
300	5084	5129	5196	5263	5330	5397	5430
400	5107	5152	5219	5286	5354	5421	5454
500	5130	5175	5242	5310	5378	5445	5479
600	5153	5198	5266	5334	5401	5469	5503
700	5176	5221	5289	5357	5425	5493	5528
800	5198	5244	5312	5381	5449	5518	5552
900	5221	5267	5336	5404	5473	5542	5577
23000	5244	5290	5359	5428	5497	5566	5601
100	5267	5313	5382	5452	5521	5590	5626
200	5290	5336	5406	5475	5545	5614	5650
300	5312	5359	5429	5499	5569	5639	5675
400	5335	5382	5452	5522	5593	5663	5699
500	5358	5405	5476	5546	5616	5687	5724
600	5381	5428	5499	5570	5640	5711	5748
700	5404	5451	5522	5593	5664	5735	5773
800	5426	5474	5545	5617	5688	5760	5797
900	5449	5497	5569	5640	5712	5784	5822
24000	5472	5520	5592	5664	5736	5808	5846
100	5495	5543	5615	5688	5760	5832	5871
200	5518	5566	5639	5711	5784	5856	5895
300	5540	5589	5662	5735	5808	5881	5920
400	5563	5612	5685	5758	5832	5905	5944
500	5586	5635	5708	5782	5856	5929	5969
600	5609	5658	5732	5806	5879	5953	5993
700	5632	5681	5755	5829	5903	5977	6018
800	5654	5704	5778	5853	5927	6002	6042
900	5677	5727	5802	5876	5951	6026	6067
25000	5700	5750	5825	5900	5975	6050	6092
100	5723	5773	5848	5924	5999	6074	6116
200	5746	5796	5872	5947	6023	6098	6140
300	5768	5819	5895	5971	6047	6123	6165
400	5791	5842	5918	5994	6071	6147	6181
500	5814	5865	5942	6018	6094	6171	6214

*Forward Limit-Wheels Down — Sta 228

**Aft Limit-Wheels Up — Sta 245.1 Moment/1000 due to retraction of landing gear is +36. Moment/1000 values listed in this column are moment corresponding to sta 245.1 reduced by moment for retraction of the landing gear and are equivalent to approximately sta 243.4 at 21,000 pounds to sta 243.9 at 31,000 pounds. Loadings, based on wheels down condition, which fall within limiting moment in table, will be satisfactory when landing gear is retracted.
Recommended Maximum Take Off Gross Weight 31,000 Pounds.
Recommended Maximum Landing Gross Weight 31,000 Pounds.

Figure 12–3. Chart E, loading data (Sheet 17 of 20)

CENTER OF GRAVITY TABLE

GROSS WEIGHT (POUNDS)	STA 228*	STA 230	STA 233	STA 236	STA 239	STA 242	STA 245.1**
600	5837	5888	5965	6042	6118	6195	6238
700	5860	5911	5988	6065	6142	6219	6263
800	5882	5934	6011	6089	6166	6244	6288
900	5905	5957	6035	6112	6190	6268	6312
26000	5928	5980	6058	6136	6214	6292	6337
100	5951	6003	6081	6160	6238	6316	6361
200	5974	6026	6105	6183	6262	6340	6386
300	5996	6049	6128	6207	6286	6365	6410
400	6019	6072	6151	6230	6310	6389	6435
500	6042	6095	6174	6254	6334	6413	6459
600	6065	6118	6198	6278	6357	6437	6484
700	6088	6141	6221	6301	6381	6461	6508
800	6110	6164	6244	6325	6405	6486	6533
900	6133	6187	6268	6348	6429	6510	6557
27000	6156	6210	6291	6372	6453	6534	6582
100	6179	6233	6314	6396	6477	6558	6606
200	6202	6256	6338	6419	6501	6582	6631
300	6224	6279	6361	6443	6525	6607	6655
400	6247	6302	6384	6466	6549	6631	6680
500	6270	6325	6408	6490	6572	6655	6704
600	6293	6348	6431	6514	6596	6679	6729
700	6316	6371	6454	6537	6620	6703	6753
800	6338	6394	6477	6561	6644	6728	6778
900	6361	6417	6501	6584	6668	6752	6802
28000	6384	6440	6524	6608	6692	6776	6827
100	6407	6463	6547	6632	6716	6800	6851
200	6430	6486	6571	6655	6740	6824	6876
300	6452	6509	6594	6679	6764	6849	6900
400	6475	6532	6617	6702	6788	6873	6925
500	6498	6555	6640	6726	6812	6897	6949
600	6521	6578	6664	6750	6835	6921	6974
700	6544	6601	6687	6773	6859	6945	6998
800	6566	6624	6710	6797	6883	6970	7023
900	6589	6647	6734	6820	6907	6994	7048
29000	6612	6670	6757	6844	6931	7018	7072
100	6635	6693	6780	6868	6955	7042	7096
200	6658	6716	6804	6891	6979	7066	7121
300	6680	6739	6827	6915	7003	7091	7145
400	6703	6762	6850	6938	7027	7115	7170
500	6726	6785	6874	6962	7050	7139	7194
600	6749	6808	6897	6986	7074	7163	7219
700	6772	6831	6920	7009	7098	7187	7243
800	6795	6854	6943	7033	7122	7212	7268
900	6817	6877	6967	7056	7146	7236	7292
30000	6840	6900	6990	7080	7170	7260	7317

*Forward Limit-Wheels Down – Sta 228

**Aft Limit-Wheels Up – Sta 245.1 Moment/1000 due to retraction of landing gear is +36. Moment/1000 values listed in this column are moment corresponding to sta 245.1 reduced by moment for retraction of the landing gear and are equivalent to approximately sta 243.4 at 21,000 pounds to sta 243.9 at 31,000 pounds. Loadings, based on wheels down condition, which fall within limiting moment in table, will be satisfactory when landing gear is retracted.
Recommended Maximum Take Off Gross Weight 31,000 Pounds.
Recommended Maximum Landing Gross Weight 31,000 Pounds.

Figure 12–3. Chart E, loading data (Sheet 18 of 20)

CENTER OF GRAVITY TABLE

GROSS WEIGHT (POUNDS)	STA 228*	STA 230	STA 233	STA 236	STA 239	STA 242	STA 245.1**
100	6863	6923	7013	7104	7194	7284	7341
200	6886	6946	7037	7127	7218	7308	7366
300	6908	6969	7060	7151	7242	7333	7391
400	6931	6992	7083	7174	7266	7357	7415
500	6954	7015	7106	7198	7290	7381	7439
600	6977	7038	7130	7222	7313	7405	7464
700	7000	7061	7153	7245	7337	7429	7489
800	7022	7084	7176	7269	7361	7454	7513
900	7045	7107	7200	7292	7385	7478	7537
31000	7068	7130	7223	7316	7409	7502	7562

***Forward Limit-Wheels Down – Sta 228**
****Aft Limit-Wheels Up – Sta 245.1 Moment/1000 due to retraction of landing gear is+36. Moment/1000 values listed in this column are moment corresponding to sta 245.1 reduced by moment for retraction of the landing gear and are equivalent to approximately sta 243.4 at 21,000 pounds to sta 243.9 at 31,000 pounds. Loadings, based on wheels down condition, which fall within limiting moment in table, will be satisfactory when landing gear is retracted.**

Recommended Maximum Take Off Gross Weight 31,000 Pounds.
Recommended Maximum Landing Gross Weight 31,000 Pounds.

Figure 12–3. Chart E, loading data (Sheet 19 of 20)

Side Cargo Door — Maximum Heights

LENGTH IN INCHES	WIDTH IN INCHES 10	15	20	25	30	35	40	45	50	55	60	65
60	70	70	70	70	70	70	70	70	70	70	67	67
70	70	70	70	70	70	70	70	70	70	70	65	63
80	70	70	70	70	70	70	70	70	70	60	55	
90	70	70	70	70	70	70	70	70	70	55		
100	70	70	70	70	70	70	70	68	67			
110	70	70	70	70	70	70	70	68	60			
120	70	70	70	70	70	70	70	68				
130	70	70	70	70	70	70	68					
140	70	70	70	70	70	70	68					
150	70	70	70	70	70	51						
160	70	70	70	70	70	51						
170	70	70	70	70	51							
180	70	70	70	70	51							
190	70	70	70	51								
200	70	70	70	51								
210	70	70	55	51								
220	70	70	55									
230	70	70	51									
240	70	70	51									
250	51	51	51									
260	51	51	51									
270	51	51										
280	51	51										
290	51	51										
300	51	51										
310	51	51										
320	51	51										

Figure 12–3. Chart E, loading data (Sheet 20 of 20)

Section V Weight and Balance Clearance Form F, DD Form 365F

12–22. Description. Form F is the summary of the actual disposition of load. Form F records the balance status step by step and serves as a work sheet on which the weight and balance technician records the calculations. He also records any corrections that must be made to insure that the helicopter will be within weight and cg limits. It is necessary to accomplish Form F prior to flight when a helicopter is loaded in a manner for which no previous valid Form F is available. Form F is furnished in expendable pads, or as separate sheets, which can be replaced when exhausted. An original and carbon 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 were designed to provide for the respective loading arrangements of these two types of aircraft. The general use and fulfillment of either version is the same, although specific instructions for filling out only one version are given herein.

12–23. Transport Aircraft. (See figure 12–4.) *a.* Insert the necessary identifying information at the top of the form. In the blank spaces of the LIMITATIONS table, enter the gross weight and cg restrictions obtained from the latest applicable Technical Manuals.

b. Ref 1. Enter the helicopter basic weight and index or moment/1000. Obtain these figures from the last entry on chart C – Basic Weight and Balance Record.

Note

> If a balance computer is used in loading the helicopter, enter opposite Ref 1 index figure obtained from chart C and use index figures throughout form. Enter plate number of computer (located on left end of base) under REMARKS. If chart E is used instead of a balance computer, enter moment/1000 values throughout form.

c. Ref 2. Enter amount and weight of oil.

d. Ref 3. Enter number and weight of crew. Use actual crew weights if available.

e. Ref 4. Enter weight of crew's baggage.

f. Ref 5. Enter weight of steward's equipment.

g. Ref 6. Enter weight of emergency equipment.

h. Ref 7. Enter weight of any extra equipment.

i. Ref 8. Enter sum of the weights for Ref 1 through Ref 7 inclusive to obtain OPERATING WEIGHT.

j. Ref 9. Enter number of gallons and weight of takeoff fuel. Weight of fuel used in warmup and taxi should not be included.

Note

> List under REMARKS fuel tanks concerned and amount of fuel in each tank. If external or bomb-bay fuel is carried, make appropriate entries to that effect in space provided.

k. Ref 10. Not applicable.

l. Ref 11. Enter sum of weights for Ref 8 through Ref 10 inclusive to obtain TOTAL AIRPLANE WEIGHT.

m. Determine ALLOWABLE LOAD based on takeoff, landing, or limiting wing fuel restrictions by use of LIMITATIONS table in upper left-hand corner of form as follows:

(1) Enter ALLOWABLE GROSS WEIGHT for TAKEOFF and LANDING. For aircraft which have a gross weight restriction above which all weight must be fuel in wings (e g , a zero wing fuel gross weight), enter ALLOWABLE GROSS WEIGHT for LIMITING WING FUEL in last column of LIMITATIONS table.

(2) Enter TOTAL AIRPLANE WEIGHT (from Ref 11). Estimate fuel to be aboard at time of landing and the OPERATING WEIGHT (from Ref 8). Enter the total in the OPERATING WEIGHT PLUS ESTIMATED LANDING FUEL WEIGHT blank.

(3) Subtract above weights from respective ALLOWABLE GROSS WEIGHTS to obtain respective ALLOWABLE LOADS. Smallest of these ALLOWABLE LOADS is ALLOWABLE LOAD and represents maximum amount of weight which may be distributed throughout helicopter in various compartments without exceeding limiting gross weights of helicopter.

n. Ref 12. Using same compartment letter designation as shown on back of balance computer or in figure 12–4, enter number and weight of passengers and weight of cargo (baggage, mail, etc). Enter total for each compartment in WEIGHT column. If desired for statistical pusposes, TOTAL FREIGHT and TOTAL

WEIGHT AND BALANCE CLEARANCE FORM F

TRANSPORT

(USE REVERSE TACTICAL MISSIONS)

Cross Reference RAF Form 2870 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
15 AUG 62	H-37 B	R L I	LSF
MISSION/TRIP/FLIGHT/NO.	**SERIAL NO.**	**TO**	**PILOT**
FERRY	54-321	LSF	DOE

LIMITATIONS

CONDITION	TAKEOFF	LANDING	LIMITING WING FUEL
²ALLOWABLE GROSS WEIGHT	31,000	31,000	—
TOTAL AIRPLANE WEIGHT (Ref. 11)	27,307	X	X
OPERATING WEIGHT PLUS ESTIMATED LANDING FUEL WEIGHT	X	24,307	X
OPERATING WEIGHT (Ref. 8)	X	X	—
ALLOWABLE LOAD (Ref. 12) (use SMALLEST figure)	3,693	6,693	—
³PERMISSIBLE C. G. TAKEOFF	FROM 228.0	TO (% or IN.) 243.9	
⁴PERMISSIBLE C. G. LANDING	FROM 228.0	TO (% or IN.) 243.9	
⁵LANDING FUEL WEIGHT	1260		

REF	ITEM	WEIGHT	¹INDEX OR MOM/1000
1	BASIC AIRPLANE (From Chart C)	22197	54315
2	OIL (60 Gal.)	450	1150
3	CREW (No.) 2	400	260
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8	OPERATING WEIGHT	23047	55725
9	TAKEOFF FUEL (710 Gal.)	4260	9790
10	(Gal.)		
11	TOTAL AIRPLANE WEIGHT	27307	65515

REMARKS

300 GAL AUX FUEL

USE ALL AUX FUEL + 1200# MAIN FUEL

12 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

COMPT	UPPER: PASSENGERS NO.	UPPER: PASSENGERS WEIGHT	UPPER: CARGO	COMPT	LOWER: PASSENGERS NO.	LOWER: PASSENGERS WEIGHT	LOWER: CARGO	WEIGHT	MOM/1000
A									
B									
C									
D-1					2	400		400	360
E-1					2	400		400	520
F									
G							500	500	1040
H-1					1	200	300	500	1270
I									
J									
K-1					1	200		200	860
L									
M									
N									
O									
P									
FWD BELLY									
AFT BELLY									

TOTAL FREIGHT	800
TOTAL MAIL	
COMPUTER PLATE NUMBER (If used)	

¹Enter constant used.
²Enter values from current applicable T.O.
³Applicable to gross weight (Ref. 15).
⁴Applicable to gross weight (Ref. 18).
⁵Ref. 9 minus Ref. 17.

SAMPLE

CORRECTIONS (Ref. 14)

COMPT	ITEM	CHANGES (+ or −) WEIGHT	¹INDEX OR MOM/
K-1	TROOP	−200	−86.0
F-1	TROOP	+200	+34.0
TOTAL WEIGHT REMOVED		−200	−
TOTAL WEIGHT ADDED		+200	+
NET DIFERENCE (Ref. 14)		0	−52.0

REF	ITEM	WEIGHT	MOM/1000
13	TAKEOFF CONDITION (Uncorrected)	29307	69565
14	CORRECTIONS (If required) (−)	—	520
15	TAKEOFF CONDITION (Corrected)	29307	69045
16	TAKEOFF C. G. IN IN.	235.7	
17	LESS FUEL	3000	6840
18	LESS AIR SUPPLY LOAD DROPPED		
19	MISC. VARIABLES (+FUEL @ NEW ARM)		
20	ESTIMATED LANDING CONDITION	26307	62205
21	ESTIMATED LANDING C. G. IN IN.	236.4	

COMPUTED BY: John Doe SIGNATURE CWO US ARMY

WEIGHT AND BALANCE AUTHORITY: Charles Smith SIGNATURE 1ST LT US ARMY

PILOT: John Doe SIGNATURE CWO US ARMY

DD FORM 1 SEP 54 365F

16—67910-3 U.S. GOVERNMENT PRINTING OFFICE

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 12-4. Weight and balance clearance form F (Sheet 1 of 2)

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

WEIGHT AND BALANCE CLEARANCE FORM F

TRANSPORT

(USE REVERSE TACTICAL MISSIONS)

Cross Reference RAF Form 2870 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
15 AUG 62	H-37B	RLI	LSF
MISSION/TRIP/FLIGHT/NO.	**SERIAL NO.**	**TO**	**PILOT**
FERRY	54-321	LSF	DOE

CONDITION	LIMITATIONS TAKEOFF	LANDING	LIMITING WING FUEL
[2]ALLOWABLE GROSS WEIGHT	31,000	31,000	—
TOTAL AIRPLANE WEIGHT *(Ref. 11)*	27,307		
OPERATING WEIGHT PLUS ESTIMATED LANDING FUEL WEIGHT		24,307	
OPERATING WEIGHT *(Ref. 8)*			—
ALLOWABLE LOAD *(Ref. 12) (use SMALLEST figure)*	3,693	6,693	—
[3]PERMISSIBLE C. G. TAKEOFF	FROM 228.0	TO (% or IN.) 243.9	
[4]PERMISSIBLE C. G. LANDING	FROM 228.0	TO (% or IN.) 243.9	
[5]LANDING FUEL WEIGHT	1,260		

REF	ITEM	WEIGHT	[1]INDEX OR ~~MOM/~~
1	BASIC AIRPLANE *(From Chart C)*	22197	797
2	OIL (*Gal.)*	450	800
3	CREW *(No.)*	400	765
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8	OPERATING WEIGHT	23047	765
9	TAKEOFF FUEL (710 *Gal.)*	4260	731
10	(*Gal.)*		
11	TOTAL AIRPLANE WEIGHT	27307	731

REMARKS

300 GAL. AUX. FUEL

USE ALL AUX FUEL + 1200# MAIN FUEL.

12 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

COMPT	UPPER PASSENGERS NO.	UPPER PASSENGERS WEIGHT	UPPER CARGO	COMPT	LOWER PASSENGERS NO.	LOWER PASSENGERS WEIGHT	LOWER CARGO	WEIGHT	INDEX
A									
B									
C									
D-1					2	400		400	701
E-1					2	400		400	679
F									
G							500	500	660
H-1					1	200	300	500	664
I									
J									
K					1	200		200	683
L									
M									
N									
O									
P									
FWD	BELLY								
AFT	BELLY								

SAMPLE

TOTAL FREIGHT	800
TOTAL MAIL	—

COMPUTER PLATE NUMBER *(If used)* E1082-6

[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.

CORRECTIONS *(Ref. 14)*

COMPT	ITEM	CHANGES (+ or −) WEIGHT	[1]INDEX OR MOM/
K-1	TROOP	−200	68.3
F-1	TROOP	+200	66.3
TOTAL WEIGHT REMOVED		−200	−
TOTAL WEIGHT ADDED		+200	+
NET DIFERENCE *(Ref. 14)*		0	66.3

REF	ITEM	WEIGHT	INDEX
13	TAKEOFF CONDITION *(Uncorrected)*	29307	683
14	CORRECTIONS *(If required)*	—	663
15	TAKEOFF CONDITION *(Corrected)*	29307	663
16	TAKEOFF C. G. IN IN.	235.7	
17	LESS FUEL	3000	694
18	LESS AIR SUPPLY LOAD DROPPED		
19	MISC. VARIABLES		
20	ESTIMATED LANDING CONDITION	26307	694
21	ESTIMATED LANDING C. G. IN IN.	236.8	

COMPUTED BY John Doe SIGNATURE CWO US ARMY

WEIGHT AND BALANCE AUTHORITY Charles Smith SIGNATURE 1ST LT US ARMY

PILOT John Doe SIGNATURE CWO US ARMY

DD FORM 1 SEP 54 365F

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Figure 12—4. Weight and balance clearance form F (Sheet 2 of 2)

MAIL weights may also be listed in space provided under REMARKS.

Warning

When helicopters are operated at gross weights approaching the critical area, 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 will be computed as follows: Combat equipped soldiers: 240 lb per individual. Combat equipped paratroopers: 260 lb per individual. Crew and passengers with no equipment: Use actual crew weights. Add 20 lb for each parachute carried. Maximum allowable in pilot and copilot position 250 lb each.

Note

Sum of the compartment totals must not exceed ALLOWABLE LOAD determined in LIMITATIONS table.

o. Ref 13. Enter sum of Ref 11 and compartment totals under Ref 12 opposite TAKEOFF CONDITION (uncorrected). Calculate and enter index or moment/1000 for Ref 1 through Ref 13 inclusive.

p. Check weight figure, Ref 13, against GROSS WEIGHT TAKEOFF in LIMITATIONS table. Check index or moment/1000 figure opposite Ref 13 by means of balance computer or chart E, respectively, to ascertain that indicated cg is within allowable limits.

q. If changes in amount of distribution of load are required, indicate necessary adjustments by proper entries in CORRECTIONS table in lower left-hand corner of form. Enter a brief description of adjustment made in column marked ITEM. Add all weight and moment decreases and insert totals in space opposite TOTAL WEIGHT REMOVED. Add all weight and moment increases and insert the totals in space opposite TOTAL WEIGHT ADDED. Subtract smaller from larger of two totals and enter difference (with applicable + or − sign) opposite NET DIFFERENCE. If a balance computer is used, revised index for each correction item rather than plus or minus index changes is entered. Transfer these NET DIFFERENCE figures to spaces opposite Ref 14.

r. Ref 15. Enter sum of and/or difference between Ref 13 and Ref 14. Recheck to assure that these figures do not exceed allowable limits.

s. Ref 16. By referring to cg table in chart E or to cg grid on balance computer, determine takeoff position. Enter this figure in space provided opposite TAKEOFF CG.

t. Ref 17. Estimate weight of fuel which may be expended before landing. Enter figures together with index or moment/1000 in the spaces provided.

Note

Do not consider reserve fuel as expended when determining ESTIMATED LANDING CONDITION.

u. Ref 18. Enter weight of AIR SUPPLY LOAD to be dropped before landing, with index or moment/1000.

v. Ref 19. Enter weight of MISCELLANEOUS VARIABLES to be expended before landing, with index or moment/1000; and enter shift of crew to landing positions, with index or moment/1000 change due to crew movement. Explain under REMARKS, if necessary.

w. Ref 20. Enter differences in weights and index or moment/1000 between Ref 15 and total of Ref 17, 18, and 19.

x. Ref 21. By again referring to cg table on chart E or to cg grid on balance computer, determine estimated landing cg position. Enter this figure opposite ESTIMATED LANDING CG.

y. Necessary signatures must appear at bottom of form.

12–24. Computation Without Computer. For sample problem and solution, calculate the weight and balance conditions for landing and takeoff of the model CH-37B helicopter which is to be loaded as listed in the following steps. (See figure 12–4.)

12–25. Problem. a. Basic Weight 22,197.

b. Basic Moment 543,150 in./lb.

c. Nonbasic Items to be loaded:

Item	Arm (in.)	Weight (lb)
Oil	255.7	450
Crew		
Pilot	66.0	200
Copilot	66.0	200
Fuel		
Internal (410 gal)	237.0	2460
External (Two 150-gal tanks)	219.9	1800

Cargo		
Compartment G	209.0	500
Compartment H	256.5	300
Passengers		
2, Compartment D	104.0	400
2, Compartment E	144.0	400
1, Compartment H	256.5	200
1, Compartment K	422.5	200

d. Assume that the only chart E information available is as follows:

(1) Compartment Loading Data (Troops) (figure 12–3, sheet 3).

(2) Compartment Loading Data (Litter Patients and Cargo) (figure 12–3, sheet 4).

(3) Fuel Tables (figure 12–3, sheets 5 and 6).

(4) Dimensional Data (figure 12–3, sheets 1 and 2).

(5) Center of Gravity Table (figure 12–3, sheets 17, 18, and 19).

e. All external fuel will be expended in flight. Landing will be with 210 gallons internal fuel on board. Fuel density is 6.0 lb/gal.

12–26. Solution. (See DD Form 365F, figure 12–4, sheet 1.) *a.* Takeoff weight, arm, moment and cg:

	Weight	Arm	Moment/1000
Basic Airplane	22197	–	5431.5
Oil	450	255.7	115.0
Pilot	200	66.0	13.0
Copilot	200	66.0	13.0
Fuel, Internal	2460	237.0	583.0
Fuel, External	1800	219.9	396.0
Cargo, Compt G	500	209.0	104.0
Cargo, Compt H	300	256.5	77.0
2 Passenger, Compt D	400	104.0	36.0
2 Passenger, Compt E	400	144.0	52.0
1 Passenger, Compt H	200	256.5	50.0
1 Passenger, Compt K	200	422.5	86.0
Totals	29307		6956.5

b. Takeoff cg:

$$cg = \frac{6956.5 \times 1000}{29307} = 237.3$$

c. Referring to the center of gravity table (figure 12–3, sheets 17, 18, and 19), it is seen that the cg should be between 228.00 and 243.9 for a load of 29,300 pounds (nearest to 29,307 pounds). If the cg had fallen out of the allowable limits or, in this case, if it is desired to shift the cg forward, it may be possible to shift part of the load forward. In this case the passenger is shifted from compartment K to compartment F. Computations for this shift are as follows:

	Weight	Moment/1000
Takeoff Condition	29307	6956.5
Remove Passenger from Compt K	– 200	– 86.0
	29107	6870.5
Add Passenger to Compt F	200	34.0
	29307	6904.5

Moment/1000 for 1 passenger in Compt F

$$\frac{200 \times 170.0}{1000} = 34.0 \text{ in/lb}$$

Corrected takeoff cg:

$$cg = \frac{6904.5 \times 1000}{29307} = 235.7$$

Referring to the center of gravity tables (figure 12–3, sheets 17, 18, and 19), it is seen that the corrected takeoff cg falls within the allowable limits.

12–27. Fuel Adjustment for Landing. Refigure the moment/ 1000 of fuel expended on landing, and enter in Ref 17 DD Form 365F. (See figure 12–4.)

Item	Weight	Arm	Moment/1000
Fuel Internal	2460	237.0	583.0
Fuel External	1800	219.9	396.0
Total Fuel	4260		979.0
Fuel Remaining	1260	240.0	295.0
Fuel Expended	3000		684.0

a. Landing weight and moment:

	Weight	Moment/1000
Corrected Takeoff Condition	29307	6904.5
Fuel Expended	–3000	–684.0
Landing Condition	26307	6220.5

b. Landing cg:

$$cg = \frac{6220.5 \times 1000}{26307} = 236.4$$

Caution

Although not included as part of the illustrative problem, control of the cg location while the helicopter is in flight (other than takeoff and landing) is also of importance. Balance limits may be exceeded in flight due to shifting loads or improper management of expendable loads. For example, passengers and unsecured (or improperly secured) loads may move and cause the cg to shift beyond the allowable limits. Care must be taken in planning for drop loads since release of these items will effect a sudden change of the helicopter weight and balance condition. Proper securing of loads, planning for drop loads, and briefing of passengers will aid in preventing unbalanced conditions in flight.

12–28. Weight and Balance Computation Using a Balance Computer. (See figures 12–5 and 12–6.) The H-37A balance computer is used to compute weight and balance for the CH-37B helicopter. When using the H-37A computer to compute weight and balance for the CH-37B helicopter, the oil should be considered as cargo in compartment H. Using the information and requirements of the preceding problem, calculate the weight and balance conditions for landing and takeoff of the CH-37B helicopter utilizing the H-37A balance computer. From chart C the basic weight is determined to be 22,197 pounds and the moment /1000 is 5431.5.

12–29. Use of Balance Computer. Figure 12–7 gives a step by step illustration of a computation using a balance computer. (See DD Form 365F, figure 12–4, sheet 2 for record of balance computer computation.)

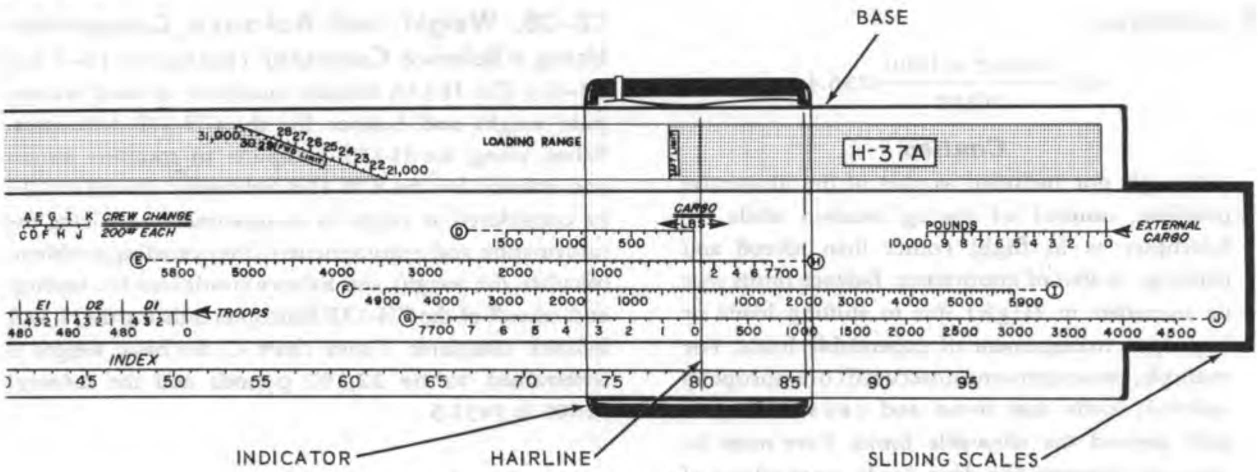


Figure 12–5. Balance computer components

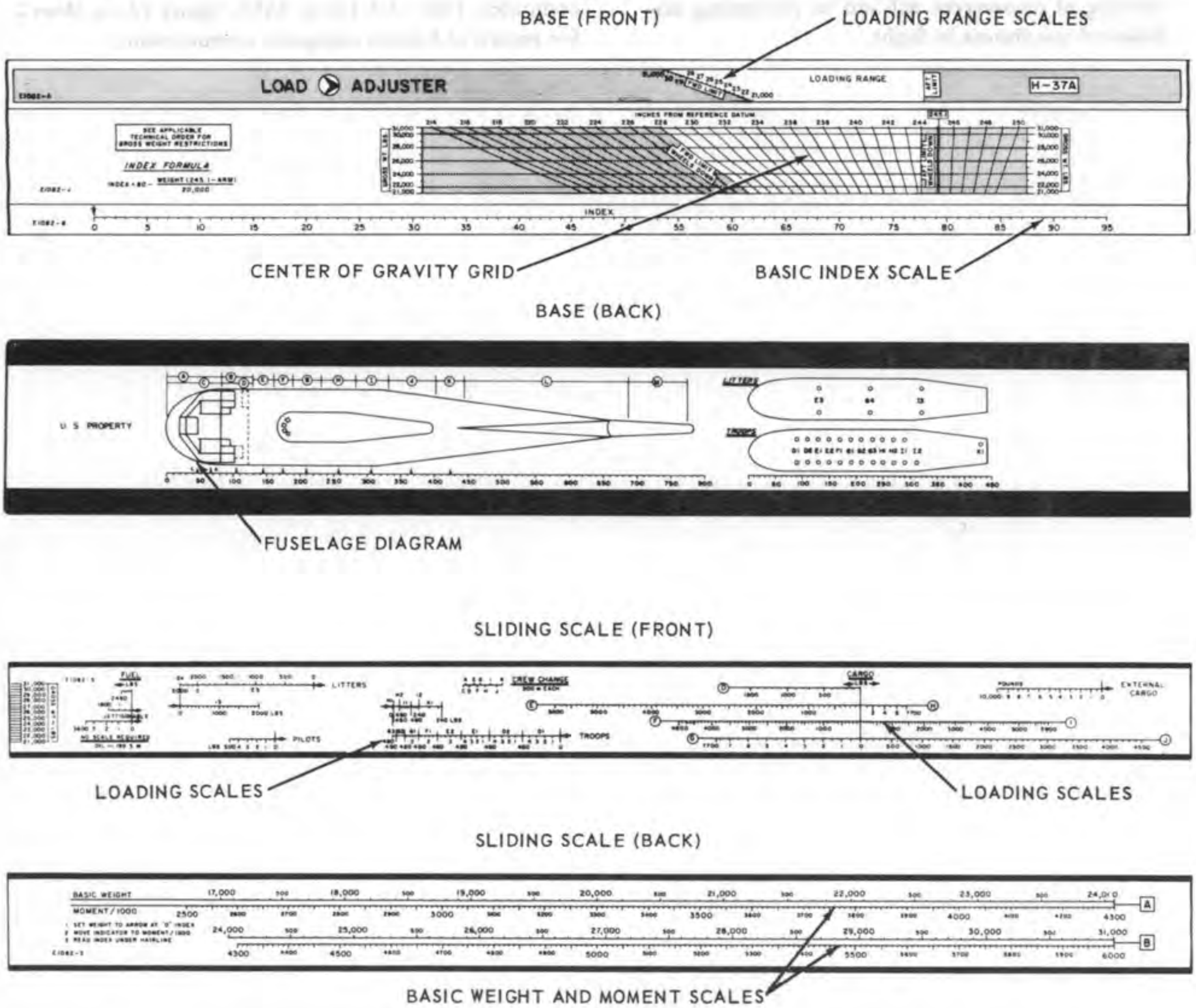
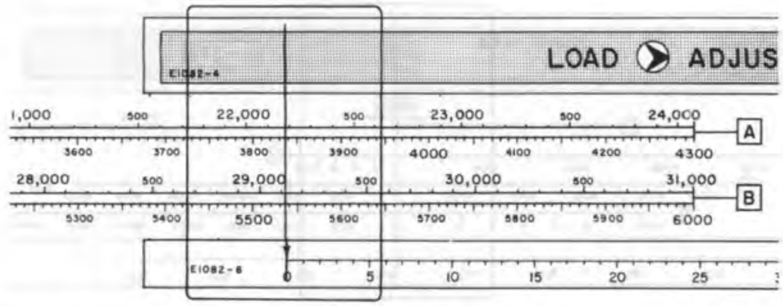
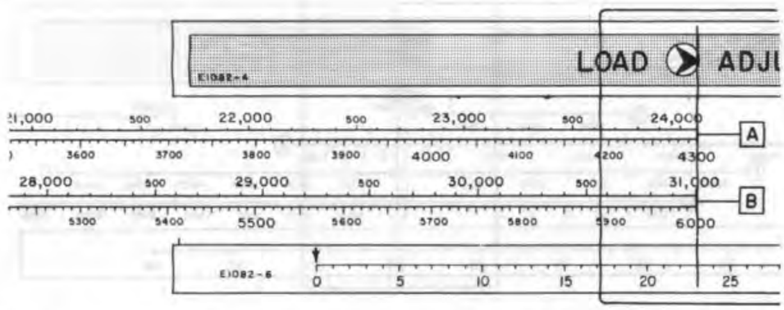


Figure 12–6. Balance computer scales

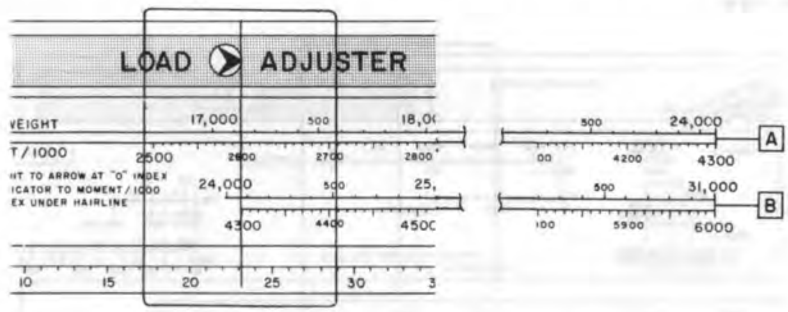
Step 1. Compute the basic index using the reverse side of the balance computer slide.



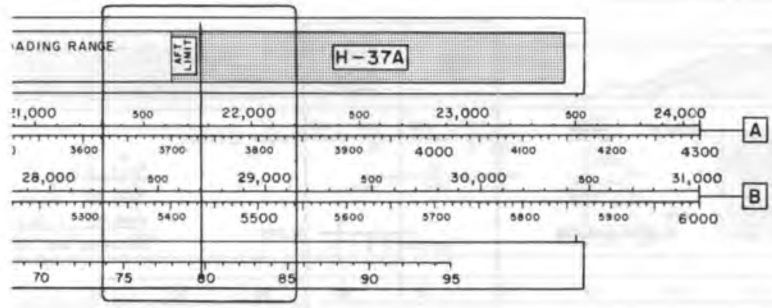
a. Set the hairline indicator to 0 on the index scale and move the slide so that the basic weight, 22,197 pounds, is under the hairline.



b. Move the indicator so that the hairline is over the moment/1000 of 4300 on scale A.



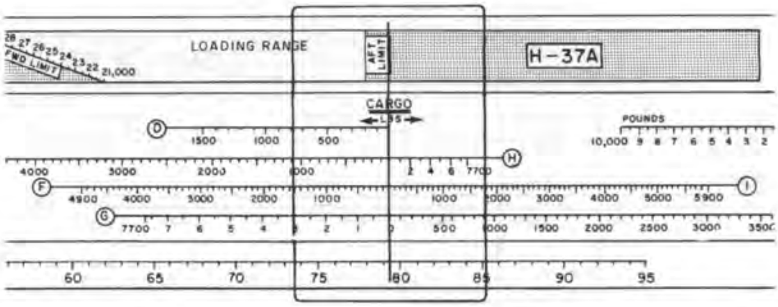
c. Move the slide so that the moment/1000 of 4300 is under the hairline on scale B.



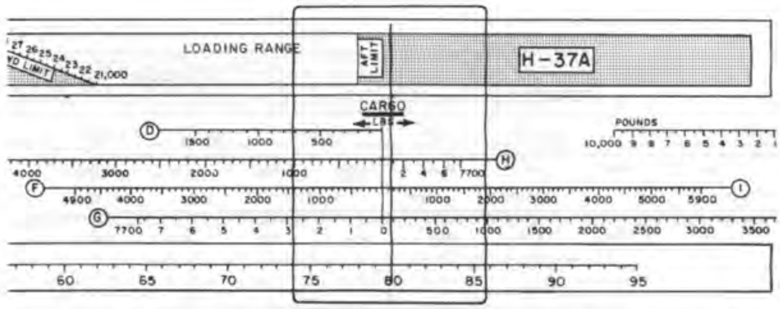
d. Move the indicator line so that the hairline is over the moment/1000 of 5431.5 on scale B. Read the basic index as 79.7 under the hairline on the index scale. Record on Form F, Ref 1.

Figure 12-7. Use of balance computer (Sheet 1 of 9)

Step 2. Load in the oil. Rotate the balance computer slide so that the loading scales face outward.

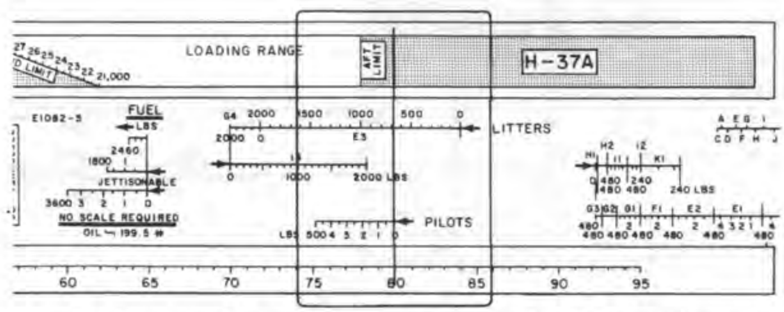


a. Set the indicator hairline over the basic index of 79.7, and move the slide to the 0 mark for cargo.

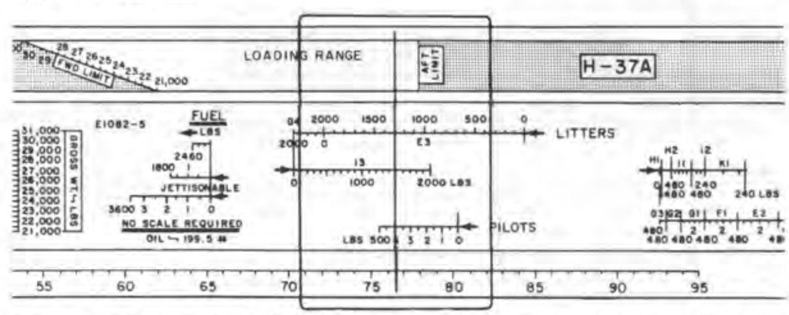


b. Move the indicator until the hairline is over 450 lb on the scale for compartment H. Read 80.0 on the index scale under the hairline and record on Form F, Ref. 2.

Step 3. Add the crew.



a. With the indicator hairline over the new index of 80.0, move the sliding scale so that the 0 of the pilots scale is under the hairline.

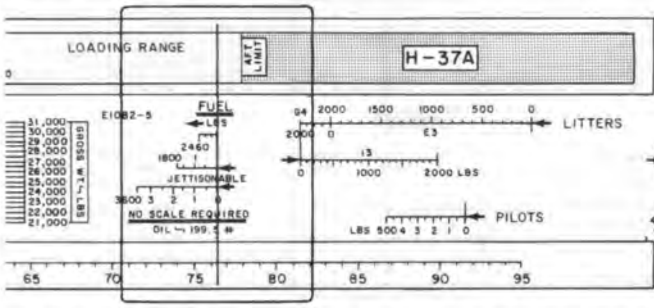


b. Move the indicator hairline to the 400 lb mark on the pilots scale. Read 76.5 on the index scale under the hairline and record on Form F, Ref 3.

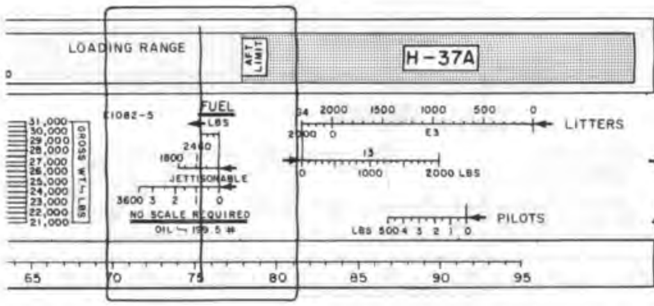
Figure 12-7. Use of balance computer (Sheet 2 of 9)

Step 4. Enter the operating weight (Total Ref 1 through 7) and index (last reading, in this case 76.5) on Form F, Ref 8. This index is representative of the helicopter cg for the operating weight.

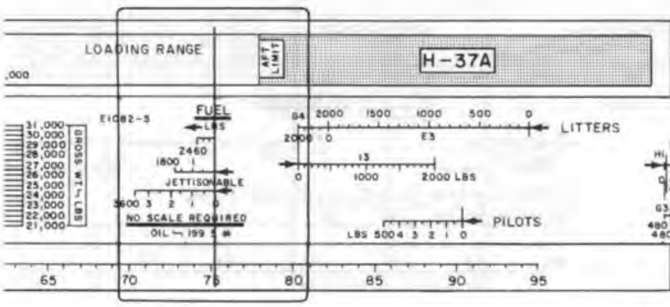
Step 5. Load In the fuel. Show the fuel breakdown in the remarks section of the Form F.



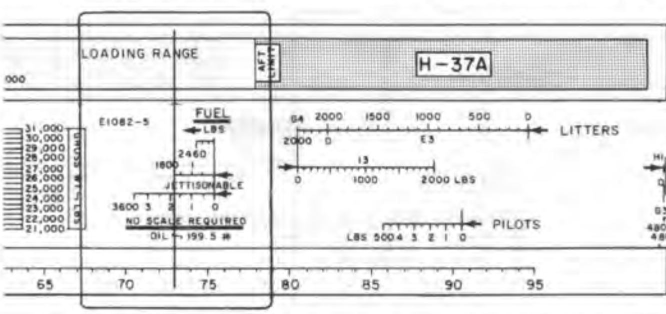
a. With the indicator hairline over 76.5 move the sliding scale so that the 0 of the fuel scale is under the hairline.



b. Move the indicator hairline to the 2460 lb mark on the top fuel scale.



c. Reset the sliding scales so that the 0 of the fuel scales is under the hairline.

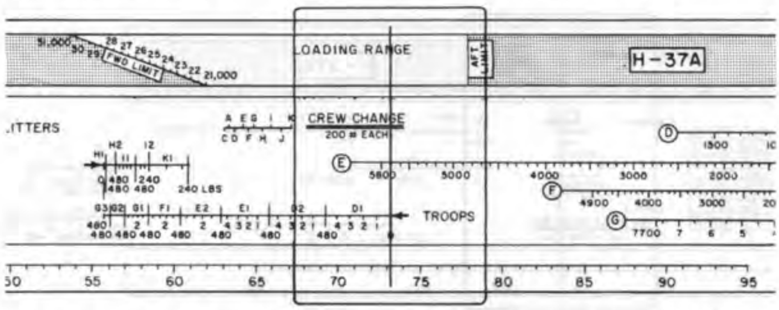


d. Move the indicator hairline to the 1800 lb mark on the jettisonable fuel scale. Read 73.1 on the index scale under the hairline and record on Form F, Ref 9.

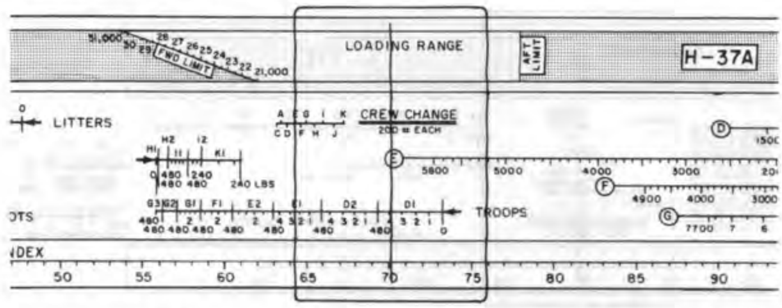
Figure 12–7. Use of balance computer (Sheet 3 of 9)

Step 6. Enter the total helicopter weight (total of Ref 8 through 10) and index (last entry, in this case 73.1) on Form F, Ref 11.

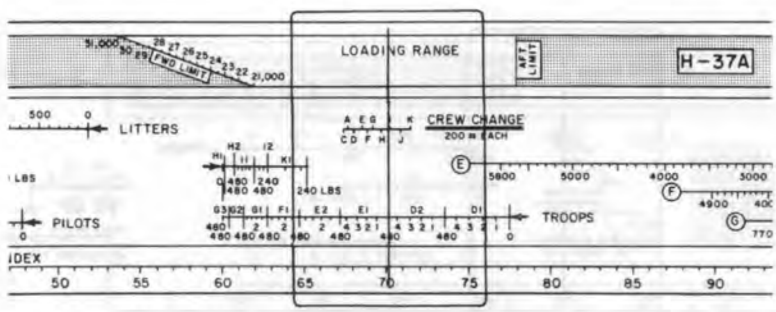
Step 7. Load In cargo and passengers. Record results in approximate spaces of Ref 12, Form F.



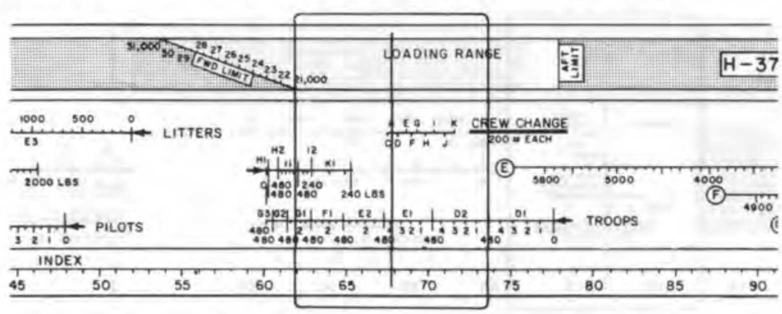
a. With the hairline over the index 73.1 move the sliding scale so that the 0 mark of the troops scale at compartment D1 is under the hairline.



b. Move the indicator until the hairline is over 400 lb (4 on TROOPS scale D1). Read 70.1 on the index scale under the hairline and record on Form F.

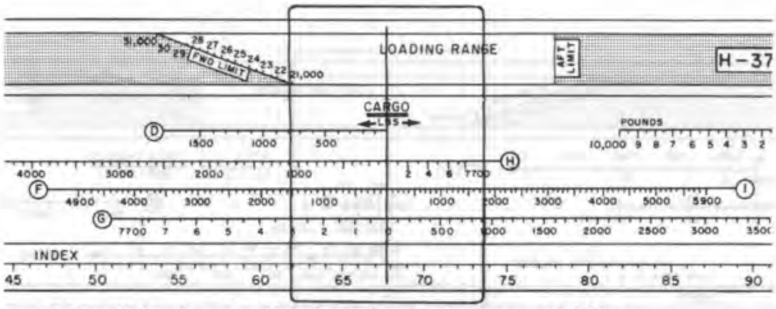


c. Move the sliding scale until the 0 mark of the compartment E1 troops scale is under the hairline.

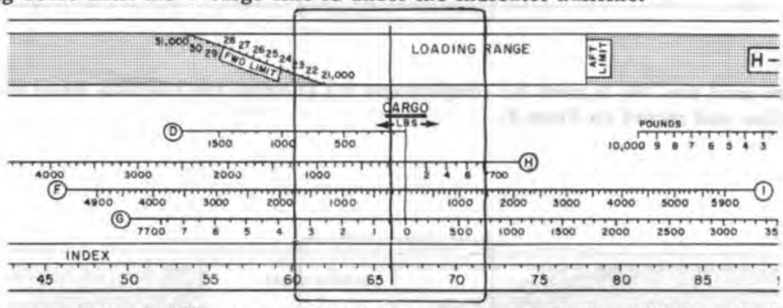


d. Move the indicator until the hairline is over the 400 lb mark for compartment E1 troops. Read 67.9 on the index scale under the hairline and record on Form F.

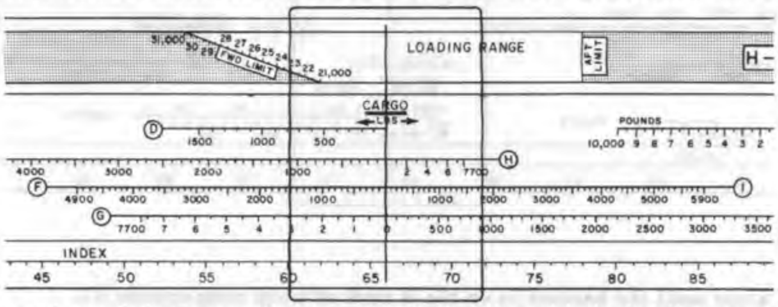
Figure 12–7. Use of balance computer (Sheet 4 of 9)



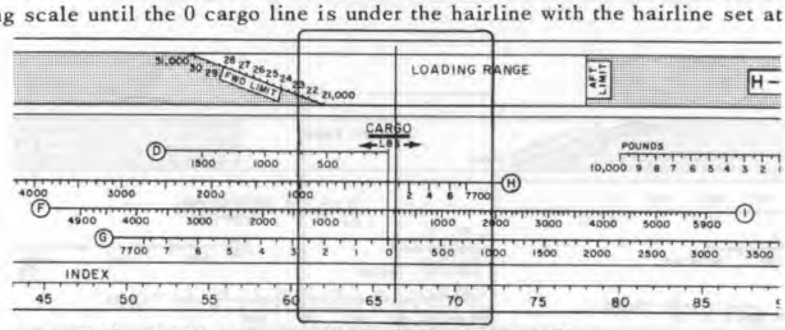
e. Move the sliding scale until the 0 cargo line is under the indicator hairline.



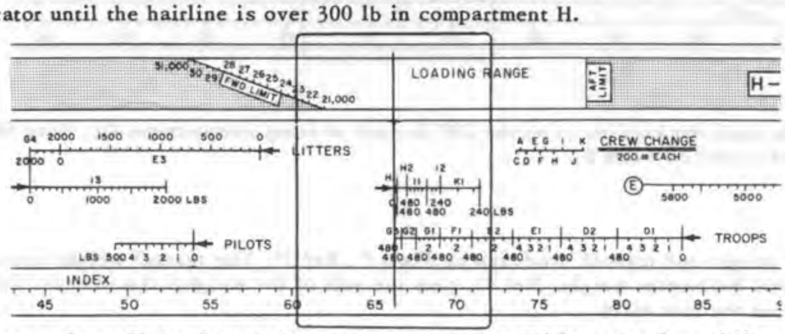
f. Move the indicator until the hairline is over 500 lb in compartment G. Read 66.0 on the index scale and record on Form F.



g. Move the sliding scale until the 0 cargo line is under the hairline with the hairline set at 66.0 on the index scale.

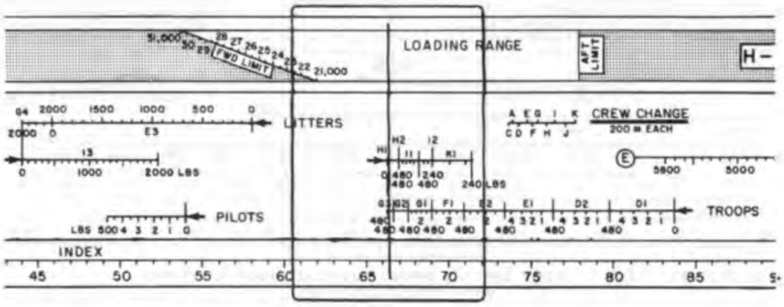


h. Move the indicator until the hairline is over 300 lb in compartment H.

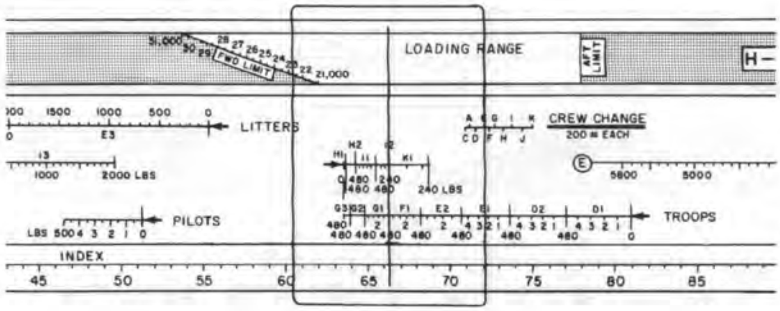


i. Move the sliding scale until the 0 mark for troops compartment H1 is under the hairline.

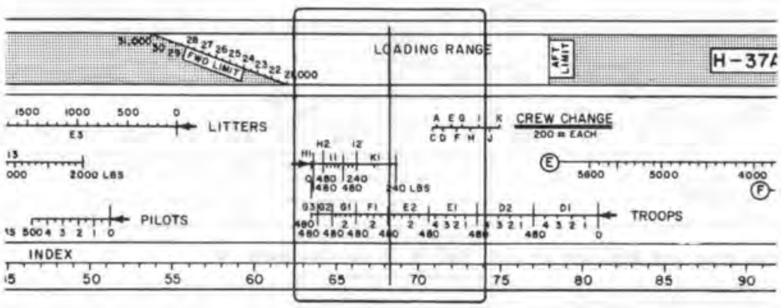
Figure 12–7. Use of balance computer (Sheet 5 of 9)



j. Move the indicator until the 200 lb mark for compartment H1 is under the hairline. Read 66.4 on the index scale under the hairline and record on Form F.



k. Move the sliding scale until the hairline is on the 0 mark of troop compartment K1.

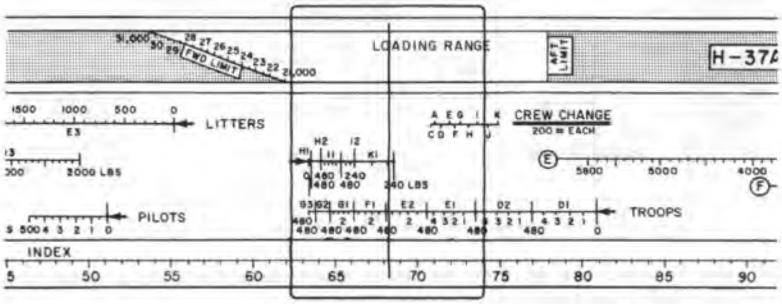


l. Move the indicator until the hairline is on the 200 lb mark of troop compartment K1. Read 68.3 on index scale under the hairline and record on Form F.

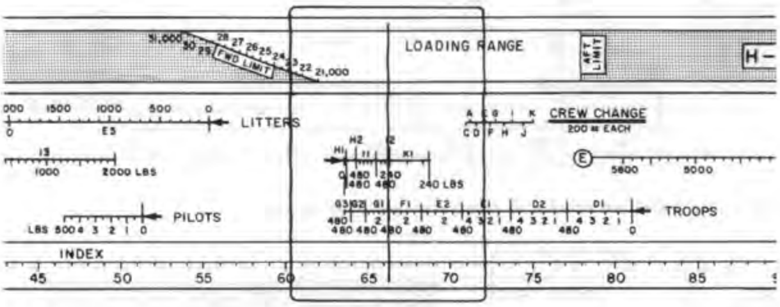
Step 8. Enter the weight and takeoff condition on Form F, Ref 13. The takeoff weight uncorrected is 29,307 lb, which is the total helicopter weight, Ref 11, plus the sum of the weights listed under Ref 12. Carry the index 68.3 down from the last entry.

Figure 12–7. Use of balance computer (Sheet 6 of 9)

Step 9. If a change in the cg location is desired as stated in the preceding problem, the method below is used. To move cg forward move passenger from troop compartment K1 to troop compartment F1.

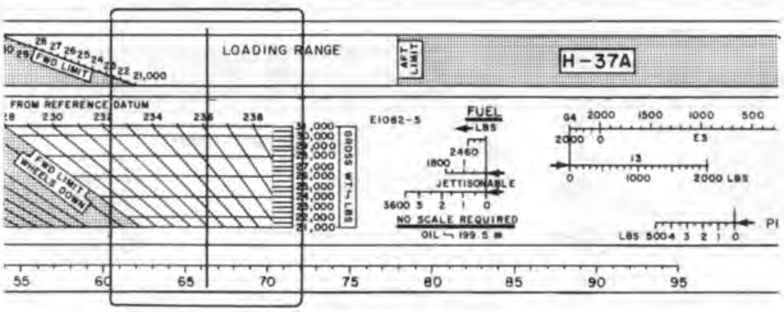


a. Set hairline of indicator over 68.3 on index scale and 200 lb mark of troop compartment K1 under hairline.



b. Move indicator until hairline is over the 0 mark for troop compartment K1. Read 66.3 on index scale under hairline and record in corrections section of Form F, Ref 14 and 15.

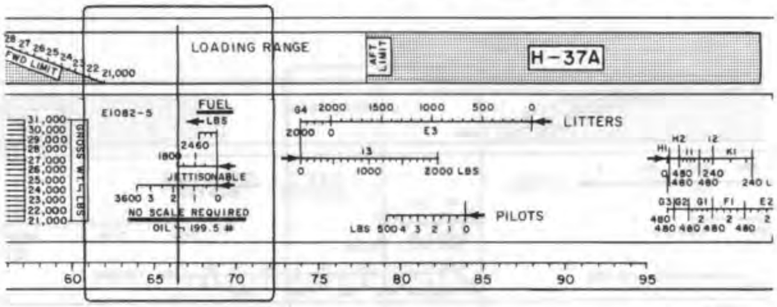
Step 10. Determine the take off cg in inches from the reference datum line.



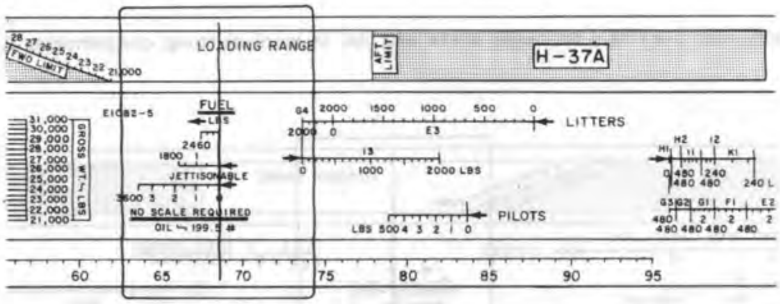
a. With the indicator hairline at the takeoff index 66.3, move the sliding scale to the right so that the vertical gross weight scale at the extreme left end of the sliding scale is near and to the right of the hairline. Find the intersection of the takeoff weight (29,307 lb) and the indicator hairline on the cg grid. Extend the intersection upward and parallel to the diagonal lines of the cg grid. Read 235.7 inches and record on Form F, Ref 16.

Figure 12–7. Use of balance computer (Sheet 7 of 9)

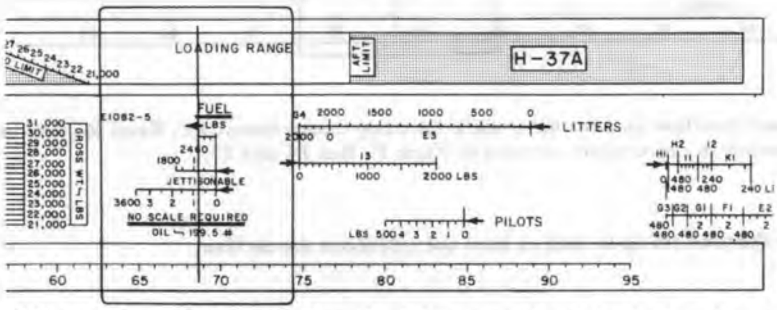
Step 11. Determine the estimated cg in inches from the reference datum line at landing.



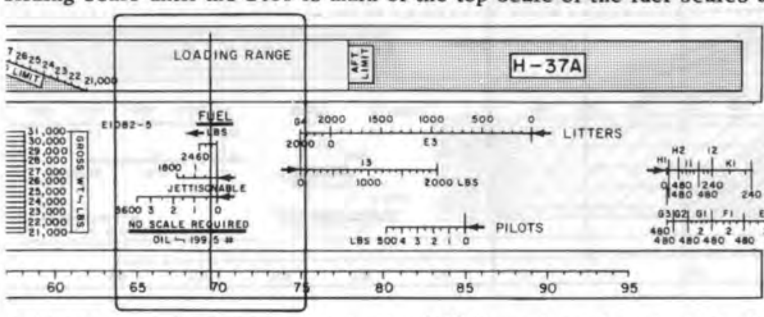
a. With the indicator hairline over 66.3 on the index scale move the sliding scale to place 1800 lb jettisonable fuel line under the hairline.



b. Move the indicator hairline to the 0 mark on the fuel scales.



c. Move the sliding scale until the 2460 lb mark of the top scale of the fuel scales appears under the hairline.

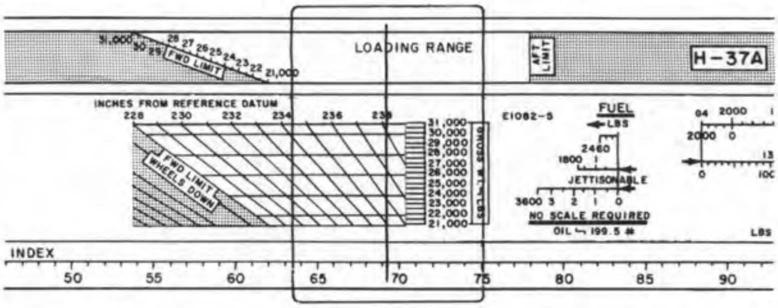


d. Move the indicator until the hairline is over the 1260 lb mark on the top scale of the fuel scales. Read 69.4 on the index scales and record on Form F, Ref 17 and 20.

Note

The computer allows for the shifting arm of the fuel as it is used; therefore, the adjustment step used in the computation without the computer is not necessary.

Figure 12-7. Use of balance computer (Sheet 8 of 9)



e. With the indicator hairline at the landing index of 69.4, move the sliding scale to the right so that the vertical gross weight scale is near and to the right of the hairline. Find the intersection of the landing weight (26,307 lb) and the indicator hairline on the cg grid. Extend the intersection upward and parallel to the diagonal lines of the cg grid. Read 236.8 inches and record on Form F, Ref 21.

Step 12. Complete Form F by filling in the information required in the Limitations block of the form.

Figure 12–7. Use of balance computer (Sheet 9 of 9)

CHAPTER 13
AIRCRAFT LOADING

Section I Scope

13—1. General. This chapter provides operating personnel with all loading instructions necessary to insure maximum safety of flight conditions, safety and comfort of passengers, protection of cargo, minimum abuse to the helicopter, and delivery of load at destination in the best condition possible.

13—2. Introduction. The purpose of this chapter is to provide information on the helicopter's loading equipment, cargo compartments, limitations of cargo floor, troop seats, litters, emergency equipment, comfort provisions, and external cargo sling. Section II of this chapter describes the equipment. Section III contains instructions on how to prepare and load the helicopter when carrying troops, litters, or cargo. Instructions are given on how to use each item of equipment installed on the helicopter to facilitate loading and unloading. Also, information is provided on the external cargo sling. Section IV includes general instructions for loading, securing, and unloading the helicopter. This information is intended primarily for use by personnel who will accomplish this mission. Section IV also contains some special cargo and vehicle loads which the helicopter may be called upon to carry. Specific instructions are given on how to load and secure a few types of vehicles. Section V contains no listing of specific load items at this time; however, as information is received for different type loads, it shall be incorporated into revisions to this manual.

Caution

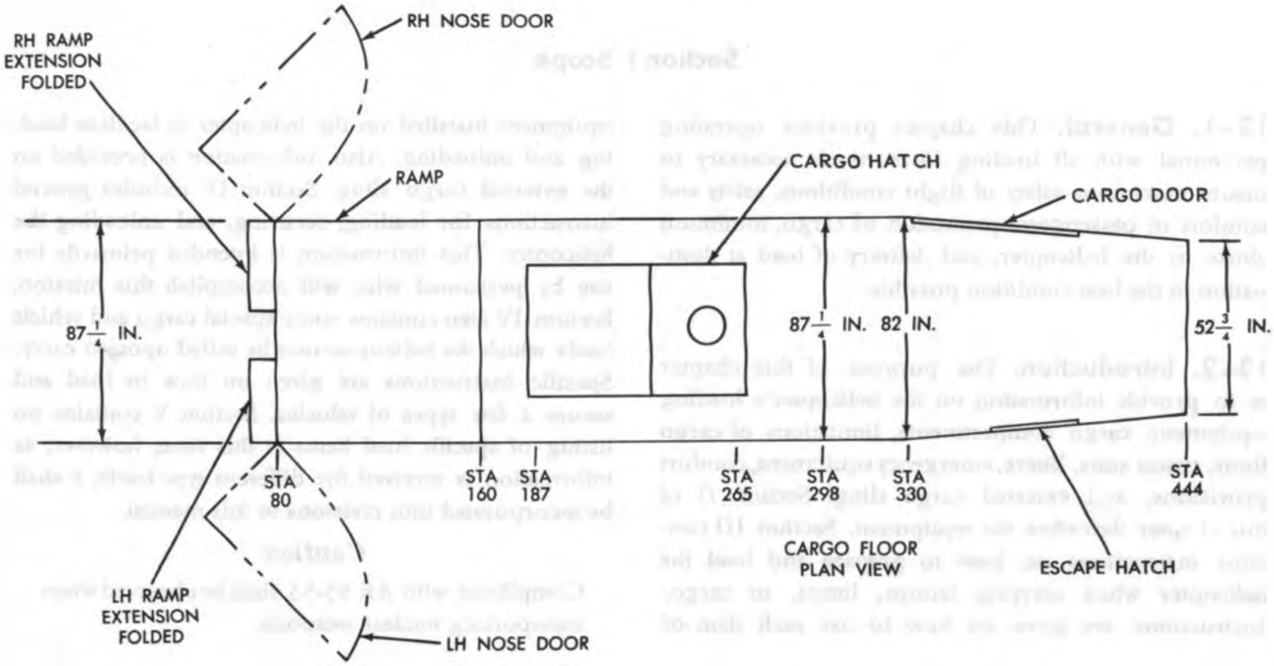
Compliance with AR 95-55 shall be observed when transporting nuclear weapons.

Section II Aircraft Cargo Features

13—3. Cargo Compartment. The fuselage of this helicopter contains a cargo compartment approximately 30 feet 4 inches long, 7 feet 8 inches wide, and 6 feet 8 inches high. (See figure 13—1.) At the forward end of the cargo compartment, below the pilots' compartment, vertical clearance tapers down to approximately 5 feet with the ramp in the raised position. The forward 80 inches of the cargo compartment contains the ramp (7, figure 13—2) which can be lowered and raised to facilitate cargo loading and unloading. The only obstructions in the cargo compartment are the removable auxiliary power unit which is located on the aft left corner of the floor, the pilot's compartment ladder in the center forward section, the cargo monorail, and the heater duct along the ceiling. If necessary, the pilots' compartment ladder may be folded upward anu the pilot and copilot can enter or leave the helicopter through the pilots' compartment right sliding window. The cargo compartment is entered either through the nose doors or the cargo passenger door on the right side of the fuselage. For loading purposes, the cargo compartment is divided into eight compartments. (See figure 13—3.) There are 112 tie-down fittings (figure 13—4) in the cargo compartment floor. Eighteen of the fittings, nine in each outboard row of the tie-downs, are rated at 5000 pounds. The rest of the fittings are rated at 2200 pounds. Thirty 5000-pound MC-1 cargo tie-down devices are stowed in pockets along the cargo compartment side panels.

13—4. Compartment Identification. (See figure 13—3.) The helicopter is divided into compartments. Each compartment is outlined by white lines on the cargo floor and black lines on the cargo compartment side panels. Decals on the cargo compartment side panels state the compartment, the maximum load, and the center of gravity for each compartment.

13—5. Cargo Compartment Critical Dimensions. The contour of the fuselage, the slope of the ramp when loading, and the arrangement of equipment within the cargo compartment place certain limitations on the application of the dimensions shown on figure 13—1 to cargo loading. Careful consideration of these limitations will avoid unnecessary delays and changes in cargo loading. The height of the cargo compartment is reduced 18-1/4 inches when the traverse hoist monorail is installed and extended. The height of the cargo



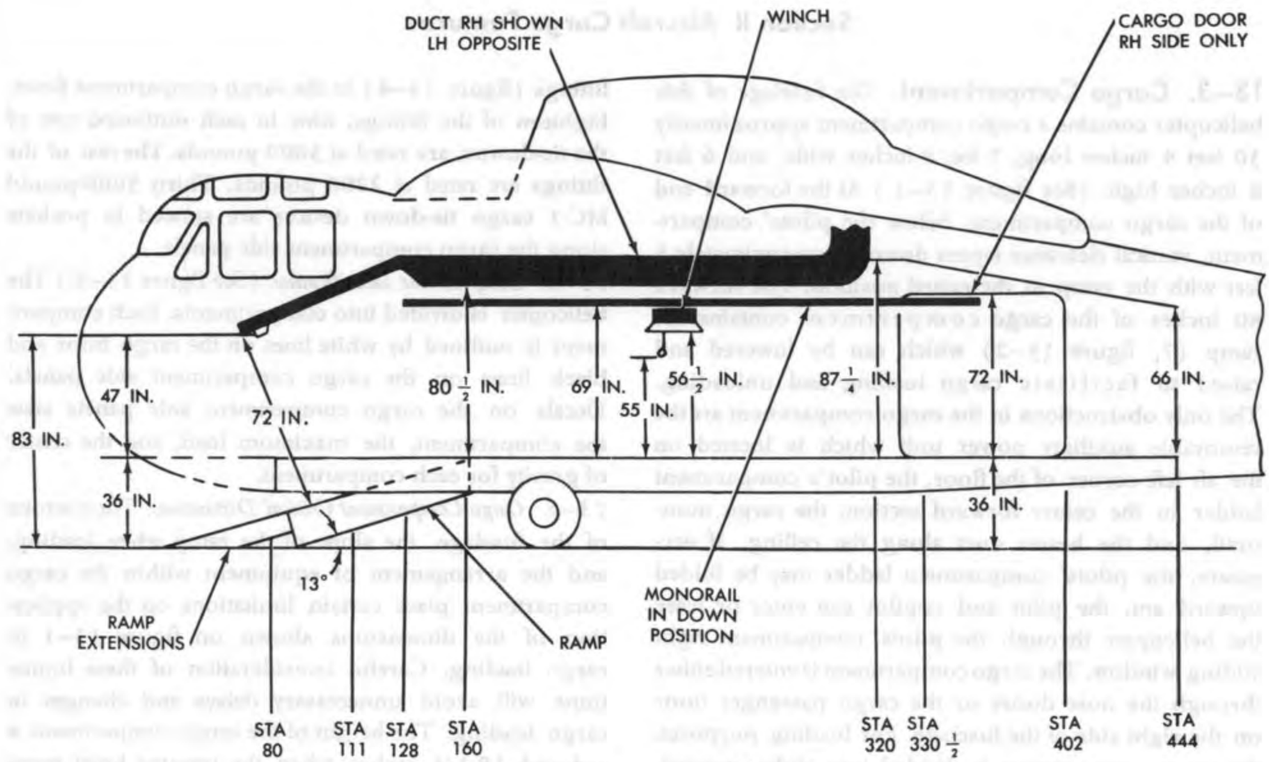


Figure 13–1. Cargo compartment (Sheet 1 of 2)

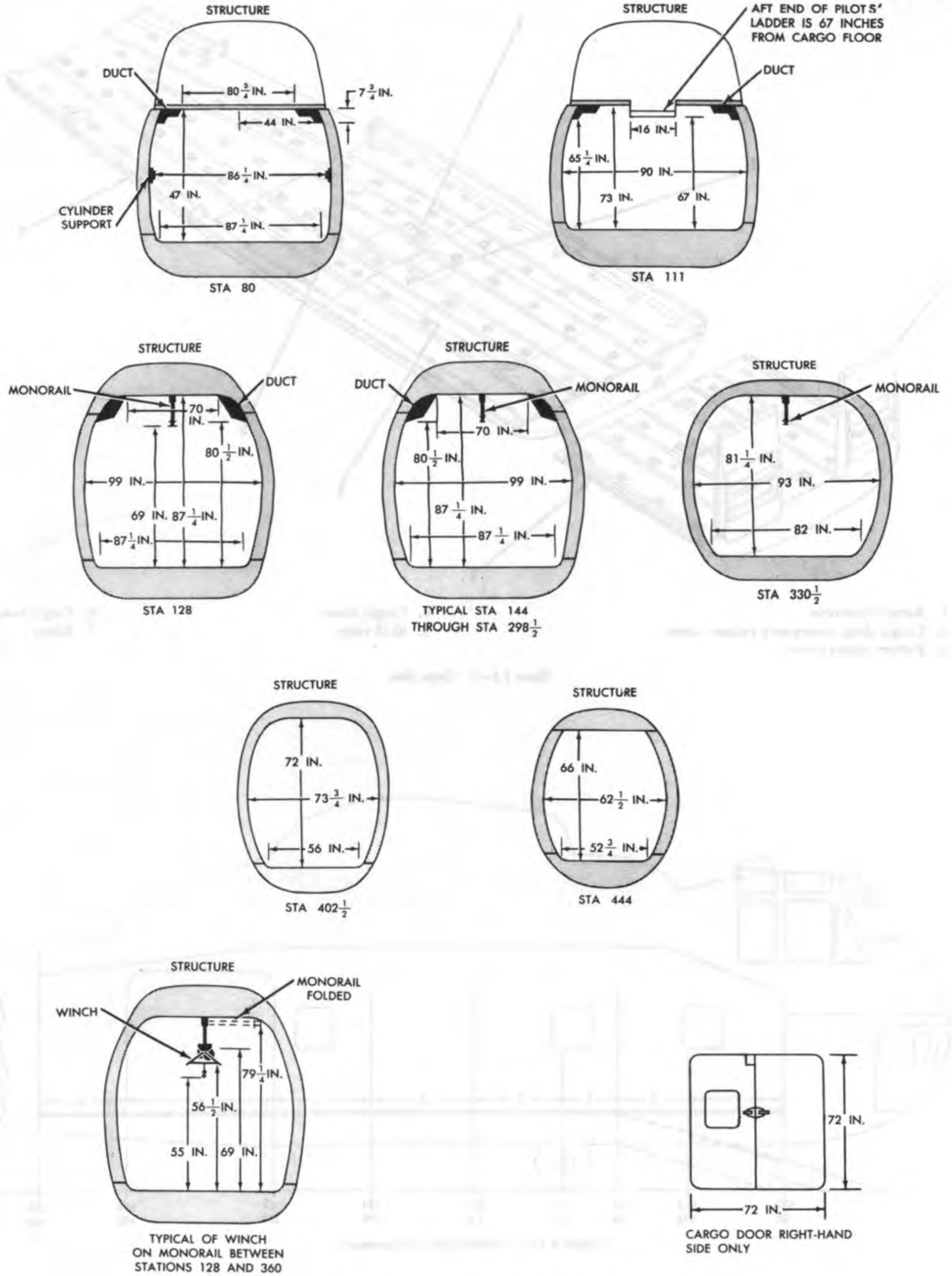
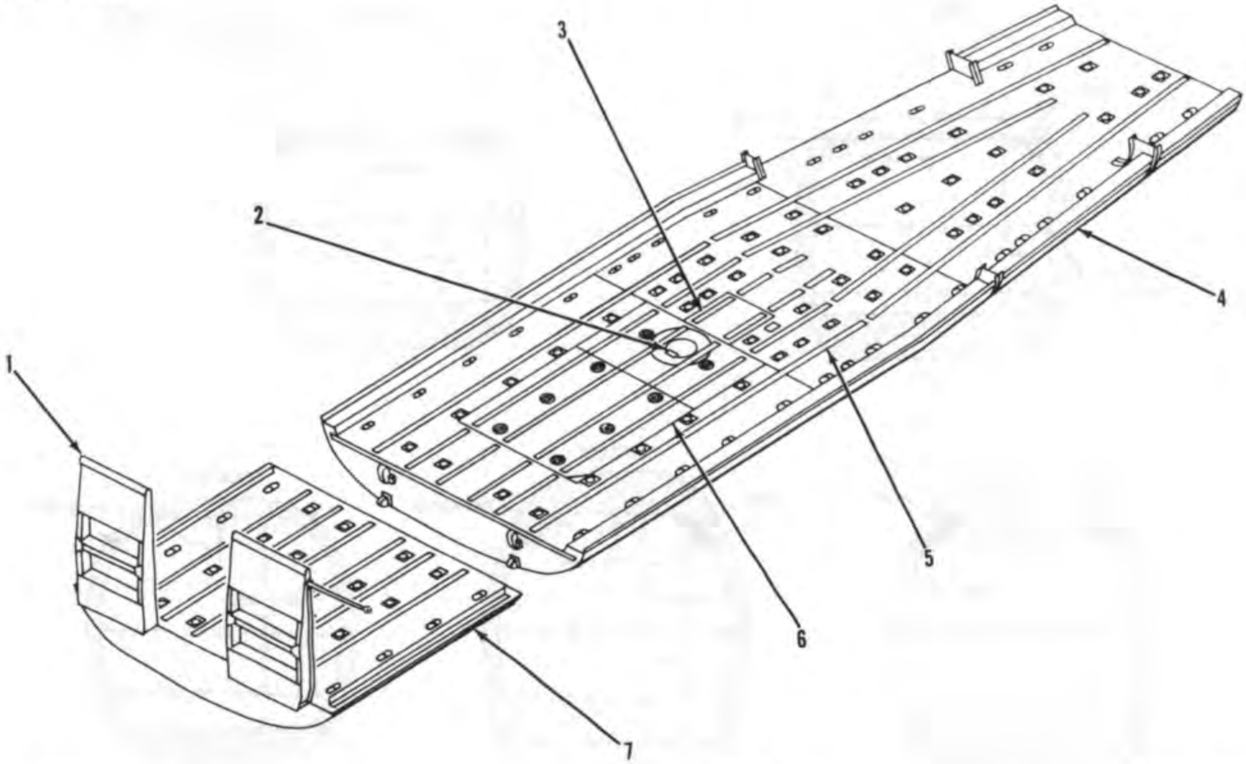


Figure 13–1. Cargo compartment (Sheet 2 of 2)



1. Ramp extension
2. Cargo sling emergency release access
3. Battery access cover
4. Cargo floor
5. Skid strip
6. Cargo hatch
7. Ramp

Figure 13–2. Cargo floor

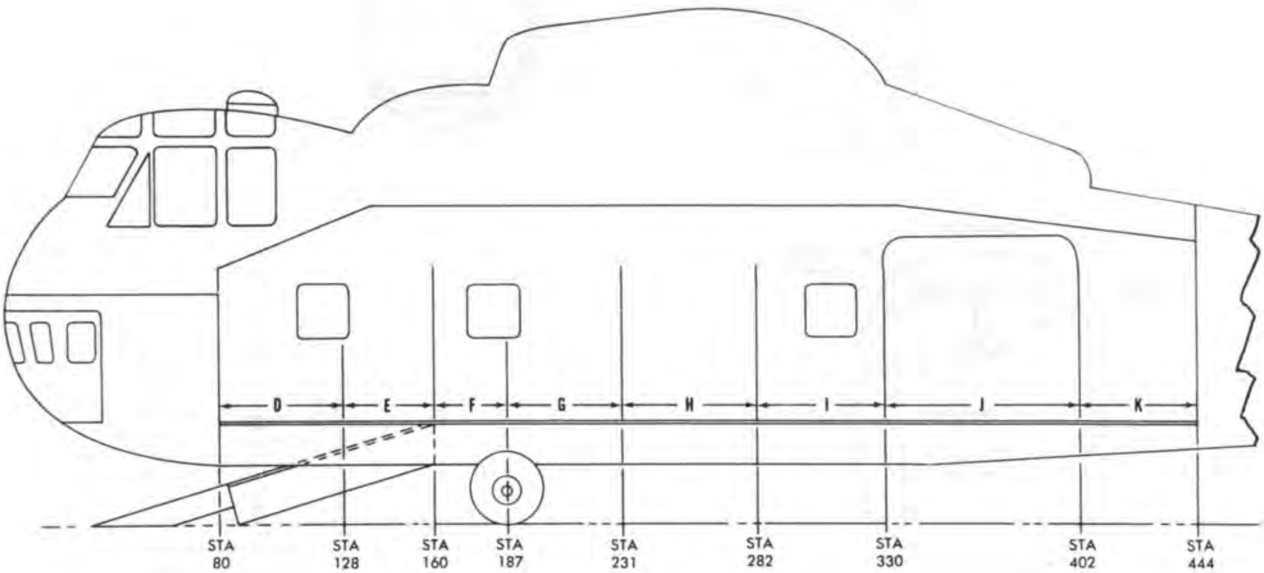
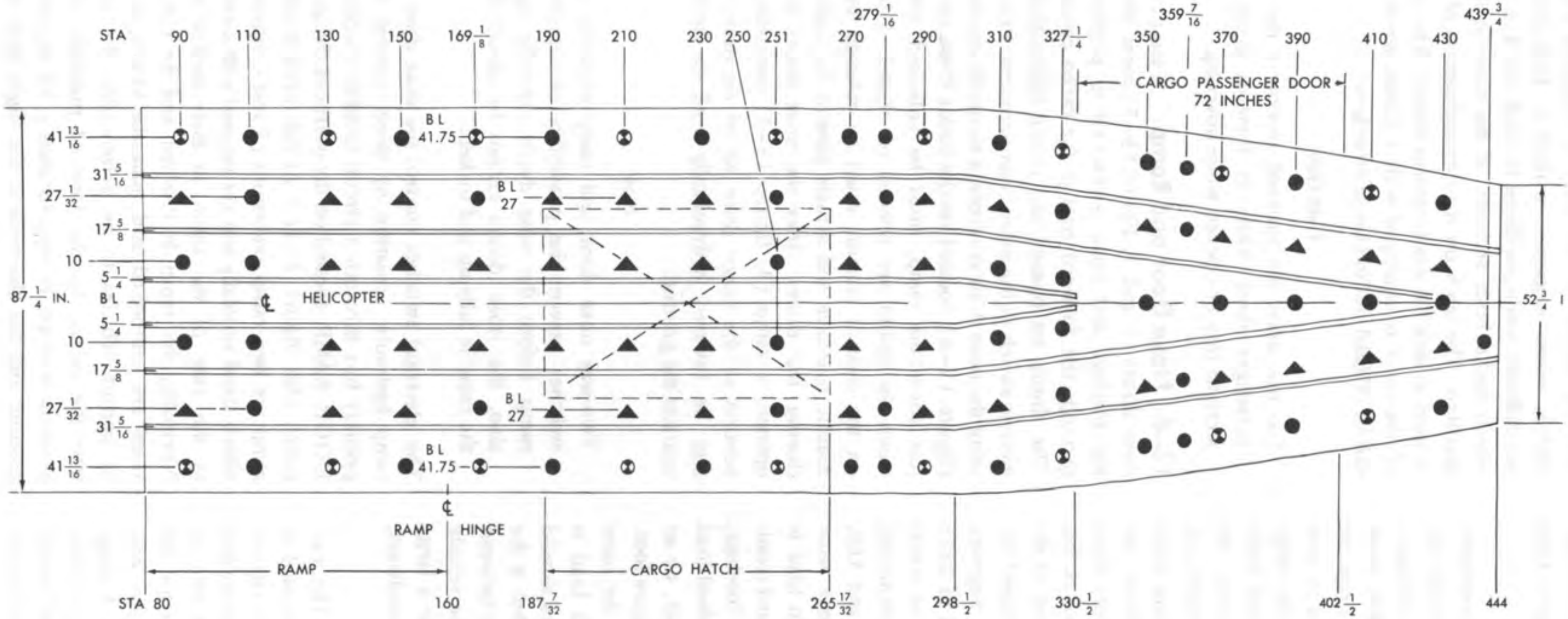


Figure 13–3. General cargo compartment



LEGEND

50	●	CARGO TIE-DOWN FITTING (2200 POUNDS).
44	▲	SEAT & CARGO TIE-DOWN FITTING (2200 POUNDS).
18	⦿	CARGO TIE-DOWN FITTING (5000 POUNDS).
	▭	CARGO SKID STRIP.
		TOTAL TIE-DOWNS 112

Figure 13–4. Location of tie-down fittings

compartment at the sides is reduced by 6-3/4 inches. From station 298, the cargo compartment tapers from 87-1/4 inches to 52-3/4 inches at station 444.

13–6. Cargo Floor. The floor of the cargo compartment (figures 13–2 and 13–5) is made of riveted aluminum alloy panels which are reinforced with stringers. The floor is completely covered with nonskid material for personnel footing. Magnesium skid strips are installed to facilitate movement of cargo and to protect the floor. Two sets of treadways on the cargo floor are designed to carry more concentrated loads than the remainder of the floor. The treadways are outlined with white lines. Except for the treadways, the cargo floor is designed to support, during flight and/or loading, a maximum load of 300 pounds per square foot. This does not mean that the entire floor can be loaded to 300 pounds per square foot as this would exceed the weight carrying capabilities of the helicopter. The outboard treadways, which extend between stations 80 and 187, are designed to support, between stations 160 and 187, a wheel load of 2575 pounds, an axle load of 5100 pounds, or an evenly distributed load of 1600 pounds per square foot during flight and/or loading. Between stations 80 and 160, these treadways are designed to support these same loads, except that the evenly distributed flight load is only 700 pounds per square foot. The inboard treadways, which extend the entire length of the fuselage, are designed to support, during loading, a wheel load of 930 pounds, an axle load of 1860 pounds, or an evenly distributed load of 950 pounds per square foot. During flight, these treadways will support the same wheel loads; however, the evenly distributed load is limited to 700 pounds per square foot. Vehicles should be loaded on the treadways when possible, but if the tread of the vehicle does not match the width between treadways, it may still be possible to carry the vehicle if shoring is used to distribute the load over a large area, or bridge shoring is used to span the treadways. The use of shoring is explained in Section IV.

13–7. Cargo-Passenger Sliding Door. The cargo-passenger sliding door (figure 13–6) is located in the aft section of the cabin on the right-hand side of the fuselage. It is approximately 72 inches square and is made up of a forward and aft section, which ride on tracks secured to the fuselage above and below the door. A passenger step is attached to the helicopter tub, below the aft half of the cargo-passenger door. A plug, located in the aft section of the cargo-passenger door, may be removed to permit the boom and rail installation to remain installed while the doors are closed. The aft section of the door is equipped with a latch which, when engaged, is used to lock the door in six different positions along its track and a second latch which locks both sections of the door in the closed position. The latch on the forward section of the door is used to lock the door open or closed. The aft section of the door is equipped with a plastic window which can be pushed out in case of emergency.

Caution

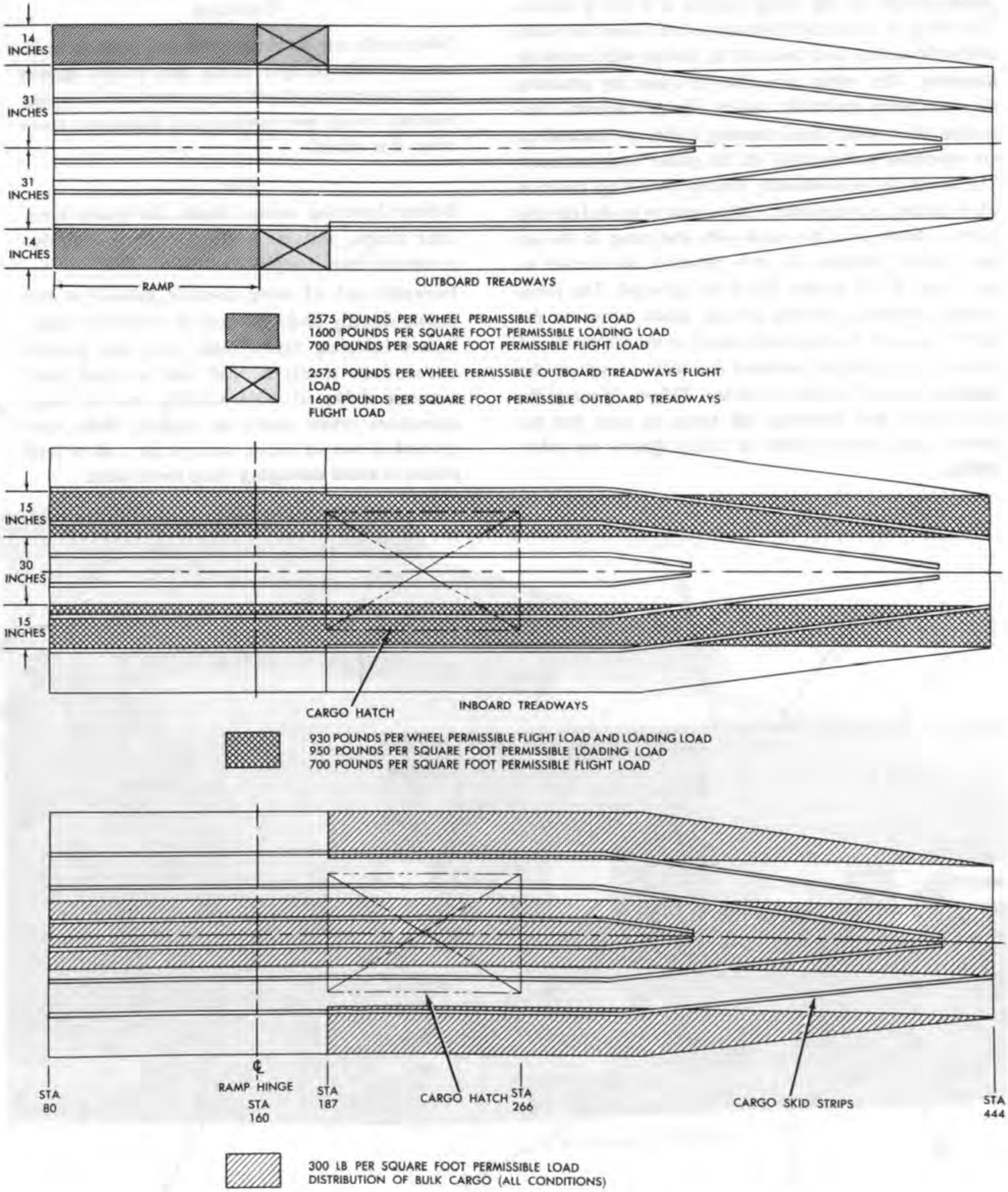
Do not open the forward section of the cargo-passenger door while in forward flight. Both sections may be opened while hovering.

13–8. Nose Door and Ramp. Two clamshell nose doors (1 and 7, figure 13–7) form the nose of the fuselage and open outward to permit loading through the forward part of the cargo compartment. The doors are opened and closed hydraulically by an electric switch in the pilots' compartment. Prior to actuating the nose door controls, a manually operated catch (figure 13–8), located on the inside of the nose doors just above the ramp, must be unlocked and locked when the doors are opened or closed. A lock lever on the control console must be released before hydraulic pressure will actuate pistons for opening and closing the doors. After the nose doors have been opened, a ramp (3, figure 13–7) consisting of the portion of the cargo floor aft of the door opening, may be lowered hydraulically until its forward end contacts the ground.

Note

Two-way nose door and ramp sequence microswitches prevent the possibility of lowering the ramp before the nose doors are fully opened; also, the nose doors cannot be closed before the ramp is fully up and locked.

The electrical switches control the nose door and the ramp hydraulic actuation by direct current from the primary bus through a circuit breaker marked NOSE DOOR RAMP, located on the overhead circuit breaker panel. (See figure 2–22.) At the forward end of the ramp are two ramp extensions (2 and 4, figure 13–7) which stand vertically and are secured with swivel hooks to the side of the cabin in their stowed position. Normally, the ramp is lowered and the ramp extensions are unhooked and manually swung downward to permit vehicles to be driven onto the ramp and into the cabin. In the lowered position, the ramp presents a slope of approximately 13 degrees to the ground, and the clearance to the flight deck structure



NOTE

REFER TO SECTION V FOR INFORMATION ON LOADS THAT MAY BE ROLLED AND LOADED ON THE CARGO FLOOR

Figure 13–5. Cargo floor and ramp strength area perpendicular to the ramp surface is 6 feet 8 inches. The ramp is raised by hydraulic power from the utility hydraulic system and lowered by gravity with hydraulic damping. The ramp may also be raised by actuating the emergency hydraulic system. Ramp controls, consisting of a switch and warning light, are located on the overhead switch panel in the pilots' compartment. The ramp is automatically locked in the up position when raising is completed. Cargo may be loaded directly from a truck into the cabin with the ramp in the up and locked position. In this position, the surface of the ramp is 36 inches above the ground. The ramp uplock cylinders, located behind small doors on the inside of each fuselage side panel at the forward end of the ramp, may be operated manually to unlock the ramp in case of hydraulic failure. Before opening the nose doors and lowering the ramp, be sure that the pilots' compartment ladder is raised against the cabin ceiling.

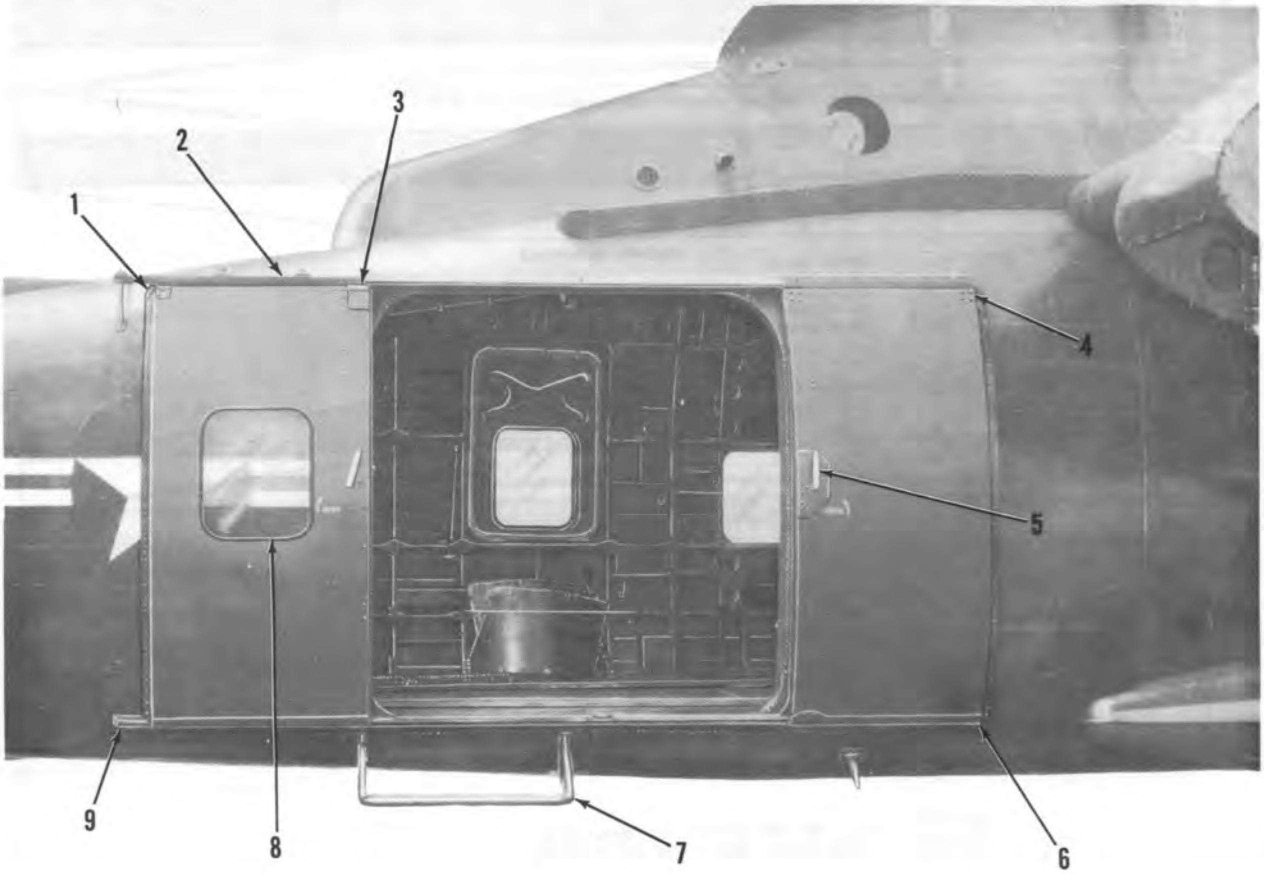
Caution

Safety belts on forward troop seat ends must be stowed with bungee cords and hooks against cargo compartment wall to prevent their dropping between ramp and fuselage and damaging ramp when it is raised.

Note

Before lowering ramp, check that troop seats, litter straps, and cargo tie-down straps are disconnected from ramp floor.

Forward end of ramp contacts ground at two points directly under reinforced "roadway" strips. Before lowering ramp, make sure that ground under these points is level and of equal load-carrying ability to avoid twisting ramp or ramp extensions when loads are applied. Make sure ground is free of rocks, stumps, etc , aft of load points to avoid damaging ramp lower skin.



1. Aft door
2. Upper track
3. Plug
4. Roller fitting
5. Latch
6. Forward door
7. Step
8. Window
9. Lower track

Figure 13–6. Cargo-passenger sliding door

1. Right nose door
2. Right ramp extension
3. Ramp
4. Left ramp extension
5. Nose door floor
6. Nose door manual latch
7. Left nose door

Figure 13–7. Nose doors and ramp

13–9. Nose Door Manual Catch. (See figure 13–8.) A nose door manual catch is located on the inside of the nose doors above the ramp. The manual catch has two positions, LOCKED and UNLOCKED. Prior to activating the nose door controls, the manual catch must be unlocked. After closing the nose doors, the manual catch must be locked.

13–10. Nose Door Lock Lever. (See figure 2–14.) The nose door lock lever is located on the left side of the control console in the pilots' compartment. The lever, with marked positions UNLOCKED and LOCKED, moves fore-and-aft in a quadrant marked NOSE DOOR. Mechanical linkage leads from the lever down to the lock, located above the doors on the center line of the fuselage. The nose door lock lever must be placed forward in the UNLOCKED position before nose door opening or closing and ramp actuation can be accomplished. A latch, to retain the nose door lock lever in the LOCKED position, must be pushed inboard before the lever can be moved.

13–11. Nose Door Switch. (See figure 13–9.) A nose door switch is located on the left side of the pilots' compartment dome light panel. The switch is marked NOSE DOOR and has positions CLOSE, OFF, and OPEN. The switch electrically controls the hydraulic actuation of the nose doors and is inoperative until the nose door lock lever has been manually released. When the switch is placed in the CLOSE or OPEN position, the doors are actuated. The switch must be returned to the OFF position at the completion of either operation. This switch is inoperative until the ramp is fully up and locked.

13–12. Ramp Switch and Indicator Light. (See figure 13–9.) The ramp switch is located to the left of the nose door switch on the pilots' compartment dome light panel. The switch is marked RAMP and has positions UP, OFF, and DOWN. The switch electrically controls the hydraulic actuation of the ramp. The switch is inoperative until the nose doors have been opened. When the switch is placed in the UP or DOWN position, the ramp is actuated. The switch must be returned to the OFF position at the completion of either operation to avoid damage to the ramp hydraulic control valve. A green indicator light marked RAMP UP & LOCKED, located to the left of the ramp switch, operates on direct current from the primary bus through two circuit breakers marked WARN LTS, PWR, and TEST, located on the overhead circuit breaker panel. The light will come on when the ramp is locked in the up position. The ramp switch is then turned OFF and the light will go out.

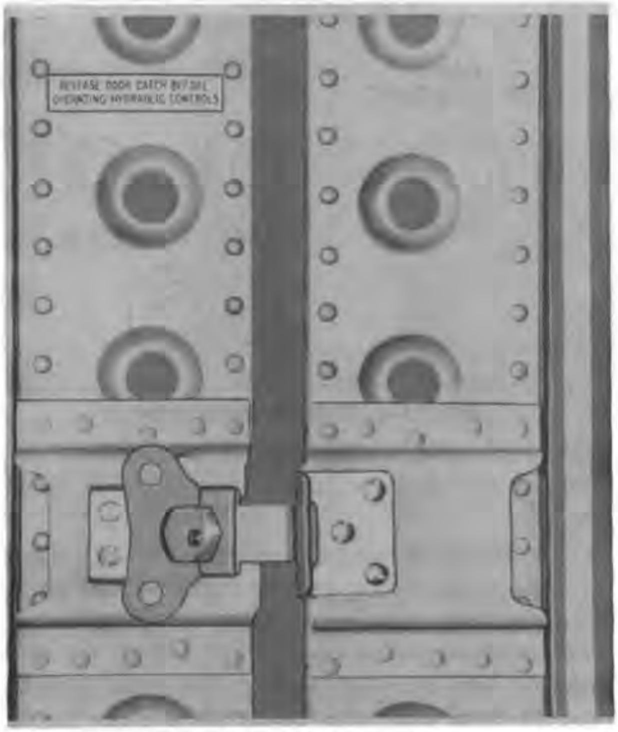


Figure 13–8. Nose door manual catch

13–13. Nose Door and Ramp Hydraulic Valves. The electrically actuated hydraulic valves that control the operation of the nose door and ramp are located on the left-hand cabin side panel approximately under the main gear box. The forward valve controls the ramp, and the aft valve, equipped with a hinged cover to protect it against heat from the register located directly above, controls the nose doors. In case of electrical failure, these valves must be positioned with manual override knobs. The valve should never be actuated while the helicopter is airborne. Each valve is equipped with a safety collar

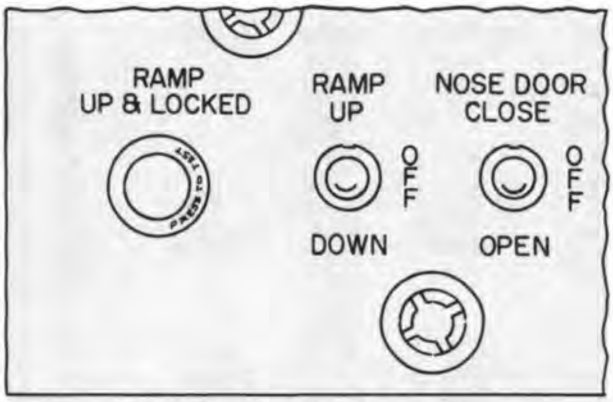


Figure 13–9. Nose door and ramp switches

that prevents accidental actuation. If the valves have been used, be sure that the collars are replaced before takeoff.

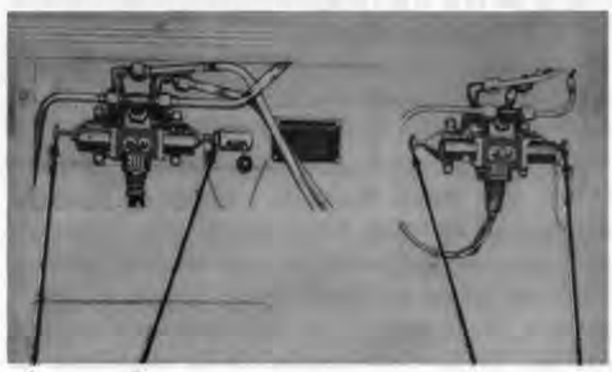
13–14. Manual Override Knobs. (See figure 13–10.) Four manual override knobs, used to actuate the nose doors and ramp if electrical failure occurs, are spring-loaded. Two knobs are located on each end of both the nose door and ramp hydraulic valves. A safety collar must be removed from each valve before the override knobs can be actuated. Both valves are placarded to indicate which knob must be held in to accomplish the actuation required. The nose door valve is equipped with a slide bolt which will permit the override knob to be held in the OPEN position to prevent the doors from closing during cargo loading operations. The slide bolt must be released before attempting to close the doors.

13–15. Emergency Ramp Lock Levers. In case of utility hydraulic system failure, the ramp may be manually unlocked by pulling aft on two emergency ramp levers, located one on each side behind the small doors in the lower forward corners of the fuselage side panels. The doors are hinged at the bottom and are held closed by two fasteners at the top. Both levers must be actuated before the ramp will be released to lower under its own weight.

13–16. Cargo Hatch. The cargo hatch (6, figure 13–2), located in the center of the cabin floor, is used for cargo or rescue operations. During cargo operations, using the cargo sling, the hinged portion of the cargo hatch may be opened and personnel inside the helicopter may view cargo hook operations. During rescue or cargo loading operations, the door and window assembly of the cargo hatch may be hinged open and personnel and cargo can be loaded into the helicopter. When the cargo hatch is to be used, the bolted portion of the cargo hatch and the outer skin panels on the under side of the fuselage must be removed before takeoff. When access to the cargo sling emergency release is required, the small circular door in the cargo hatch, located at station 265.5, must be unfastened and hinged open. During cargo or rescue operations while the cargo hatch is open, personnel near the hatch must wear air safety harnesses which are secured to cargo tie-down fittings. The section of the cargo hatch which overlaps the inboard treadway is capable of withstanding the same loads as the treadway. Loads on the remainder of the cargo hatch are limited to 300 pounds per square foot.

13–17. Troop Seats. (See figure 13–11.) Nylon wall-type troop seats, to accommodate 23 passengers and one equipment operator, are installed inside the helicopter against the cargo compartment walls. On the left-hand side, three three-man and two one-man seats are installed between the nose door and station 298-1/2. On the right-hand side, three three-man seats and three one-man seats are installed between the nose door and the cargo door, with an additional one-man seat aft of the passenger door. When not in use, the seats may be folded up against the cargo compartment wall, rolled and stowed, or removed from the helicopter. Stowage straps, secured to the seat back tubes and to the underside of the seats, secure the seats in both the folded and the stowed position. Safety belts for each passenger are attached to anchor rings in the eyebolts attached to the seat rear tubes. Safety belts on the forward troop seat ends must be stowed with the bungee cords and hooks against the cargo compartment wall to prevent their dropping between the cargo ramp and fuselage and damaging the cargo ramp when raised. For removal and installation of the troop seats, refer to Section III.

13–18. Litters. (See figure 13–12.) Twenty-four litters may be installed in the fuselage. They are arranged in three tiers of four litters each on either side of the



1 2 3 4

1. Nose door manual override knob (press to close doors)
2. Nose door manual override knob (press to open doors)
3. Ramp manual override knob (press to raise ramp)
4. Ramp manual override knob (press to lower ramp)

Figure 13–10. Nose doors and ramp hydraulic valves manual override knobs

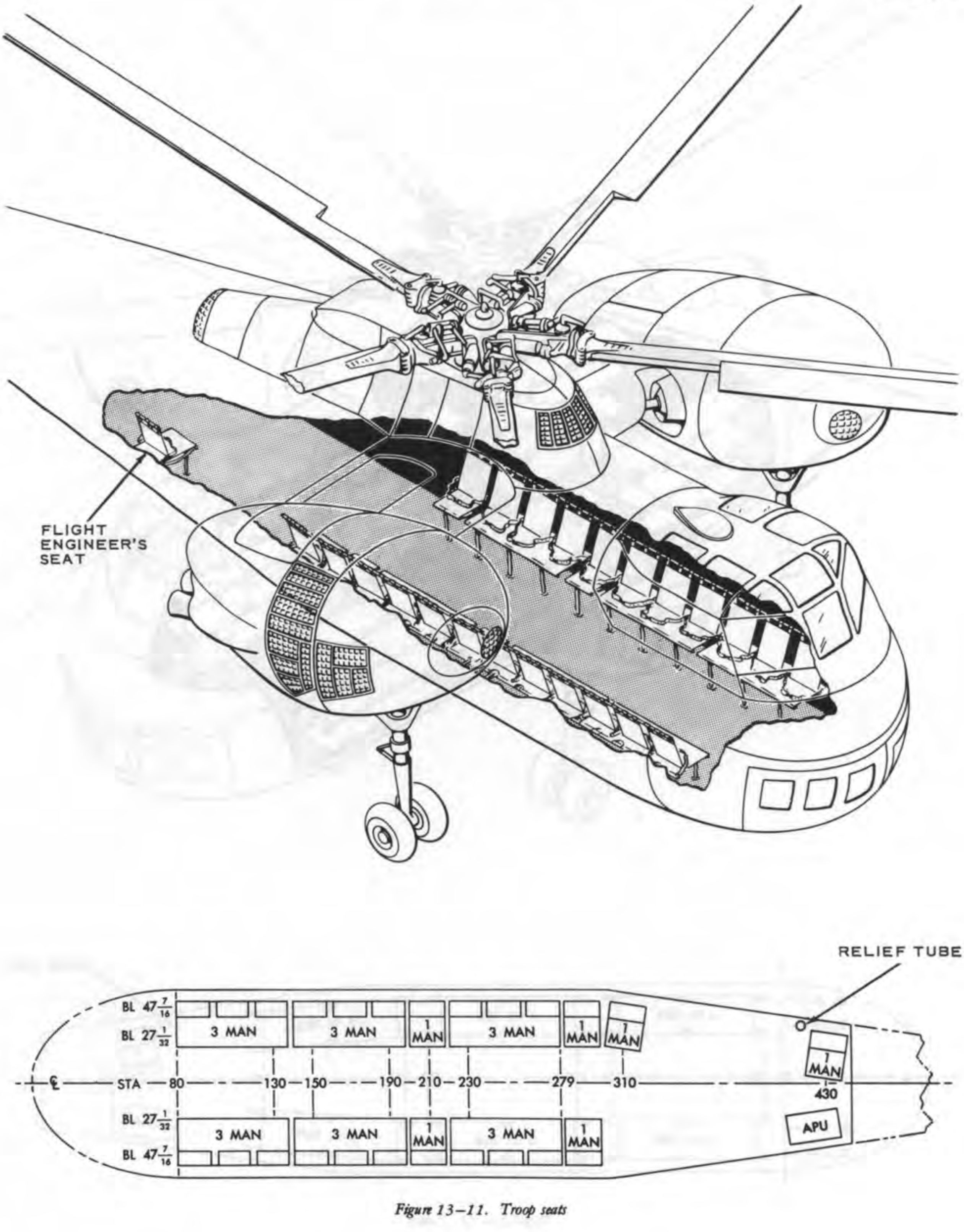


Figure 13–11. Troop seats

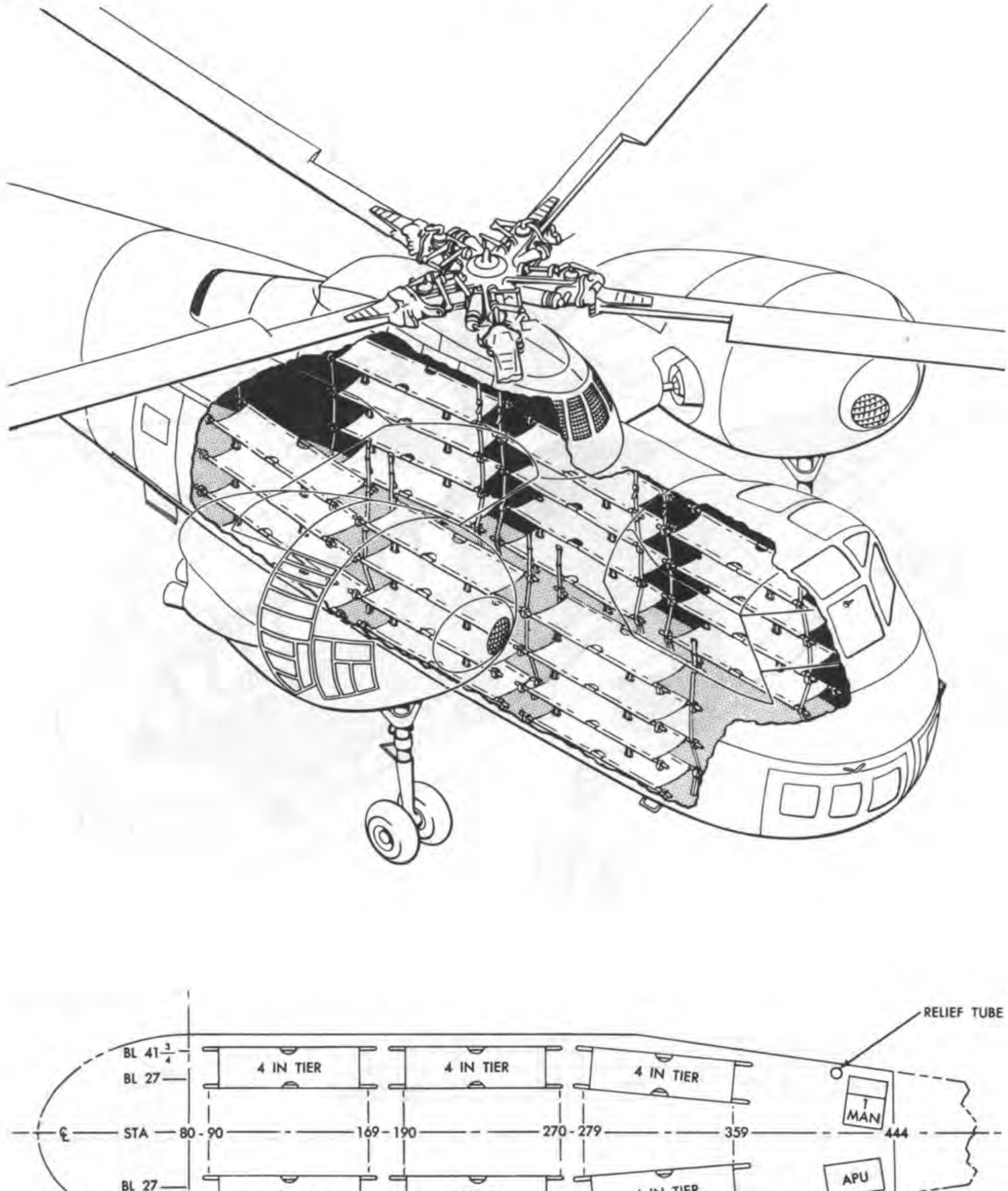


Figure 13—12. Litters

cargo compartment, extending from the cockpit ladder aft to the escape hatch and cargo door. The litters are supported in brackets secured to the fuselage sides and by straps with brackets suspended from the ceiling tie-down fittings. The straps are secured to the cargo floor tie-down fittings on the floor. The forward litter straps are fastened to tie-down fittings on the ramp and must be unfastened before the ramp is lowered. The brackets in which the litters are secured enable quick removal and installation of litters. (Refer to Section III.)

13–19. Cargo and Troop Seats Combination. Cargo and troops may be loaded in the cargo compartment when space and weight are available. When cargo and troops are loaded, the troops must be loaded aft of the cargo load.

13–20. Litters and Troop Seats Combination. For combinations of litters that may be installed with a minimum loss of troop seats, see figure 13–13. The alternate litter and troop seat combinations shown in figure 13–13 include six top litters with all troop seats installed and, with troop seats folded and rolled, 18 litters installed by loading a bottom litter and two top litters in each tier.

13–21. Relief Tube. A relief tube is located in the right-hand corner of the cargo compartment, aft of the cargo door.

13–22. Aerial Delivery. There are two types of aerial delivery with this helicopter, aerial delivery of external cargo and aerial delivery of internal cargo. Aerial delivery of external cargo is the releasing of cargo from the cargo sling hook while hovering. Aerial delivery of internal cargo is the pushing of internal cargo out of the side cargo door and may be used only when the helicopter is unable to land because of trees, buildings, or other obstructions.

13–23. Aerial Delivery Using External Cargo Sling. Helicopter operations with external loads will normally be employed to expedite loading and off-loading of prepackaged loads. This will also afford a means of delivery during operations in rugged areas where the motor vehicles cannot function and transport aircraft cannot land but are capable of hovering. The following information is limited and contains only a description of the cargo sling and approved helicopter hand signals. Detailed information on cargo sling operations will be added to this manual when it becomes available.

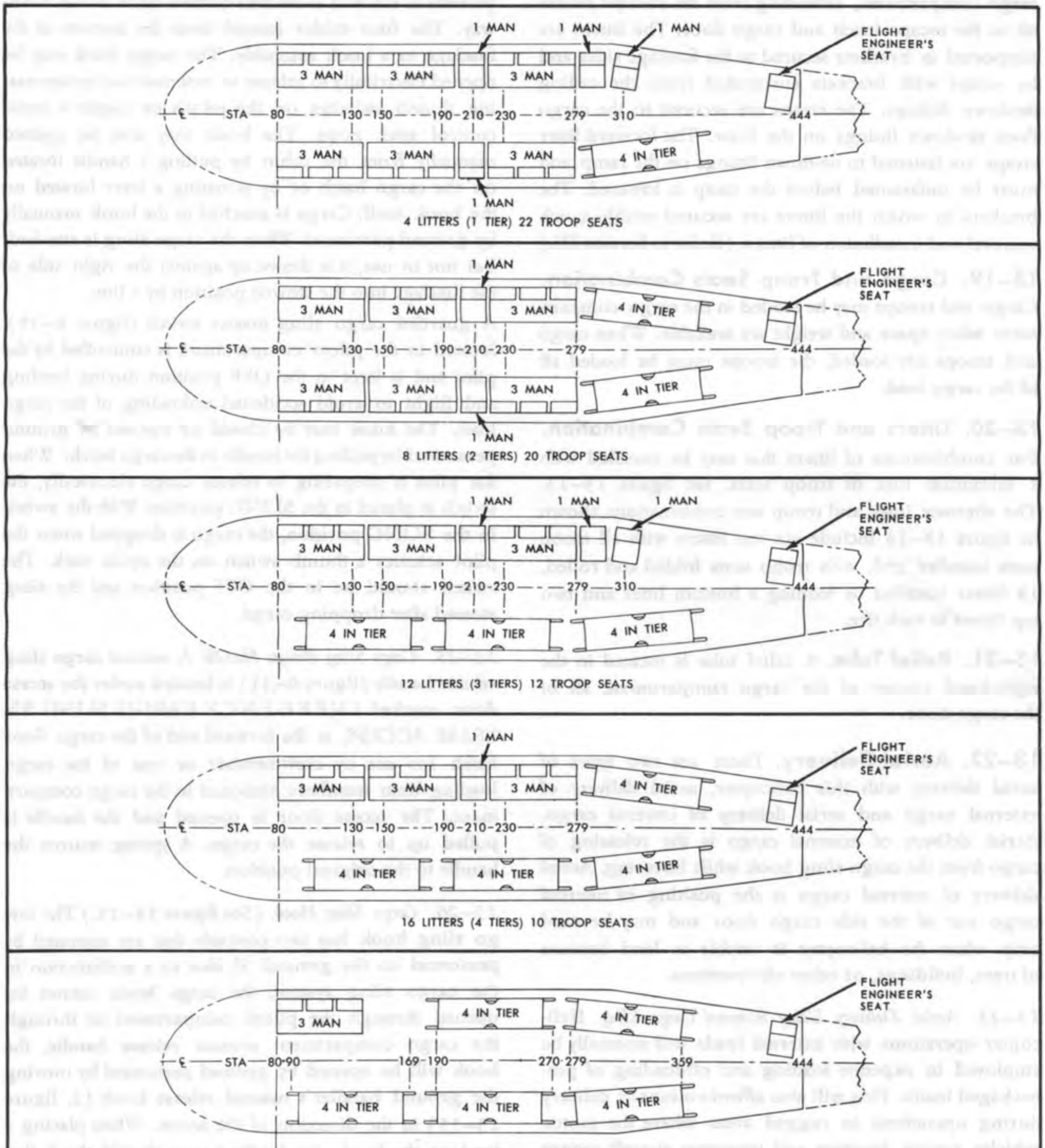
13–24. External Cargo Sling. (See figure 13–14.) An external cargo sling capable of carrying 10,000 pounds is attached to the four corners of the floor hatchway. The four cables extend from the bottom of the fuselage to a hook assembly. The cargo hook may be opened electrically to release an external load by depressing thumb switches on the pilot's or copilot's cyclic control stick grips. The hook may also be opened manually from the cabin by pulling a handle located on the cargo hatch or by actuating a lever located on the hook itself. Cargo is attached to the hook manually by ground personnel. When the cargo sling is attached, but not in use, it is drawn up against the right side of the fuselage into the stowed position by a line.

A guarded cargo sling master switch (figure 6–11), located in the pilots' compartment, is controlled by the pilot and is kept in the OFF position during loading and flight to avoid accidental unloading of the cargo load. The hook may be closed or opened by ground personnel by pulling the handle in the cargo hatch. When the pilot is preparing to release cargo electrically, the switch is placed in the SLING position. With the switch in the SLING position, the cargo is dropped when the pilot actuates a thumb switch on the cyclic stick. The switch should be in the OFF position and the sling stowed after dropping cargo.

13–25. Cargo Sling Release Handle. A manual cargo sling release handle (figure 6–11) is located under the access door, marked EMERGENCY CARGO SLING RELEASE ACCESS, at the forward end of the cargo floor hatch for use by crewmember or one of the cargo loading team members stationed in the cargo compartment. The access door is opened and the handle is pulled up to release the cargo. A spring returns the handle to the original position.

13–26. Cargo Sling Hook. (See figure 13–15.) The cargo sling hook has two controls that are operated by personnel on the ground. If, due to a malfunction in the cargo sling system, the cargo hook cannot be opened through the pilots' compartment or through the cargo compartment manual release handle, the hook will be opened by ground personnel by moving the ground handler's manual release knob (2, figure 13–15) in the direction of the arrow. When placing a load on the hook, the loading crew should check that the cargo hook positive lock lever (3) is in the POSITIVE LOCK HERE position.

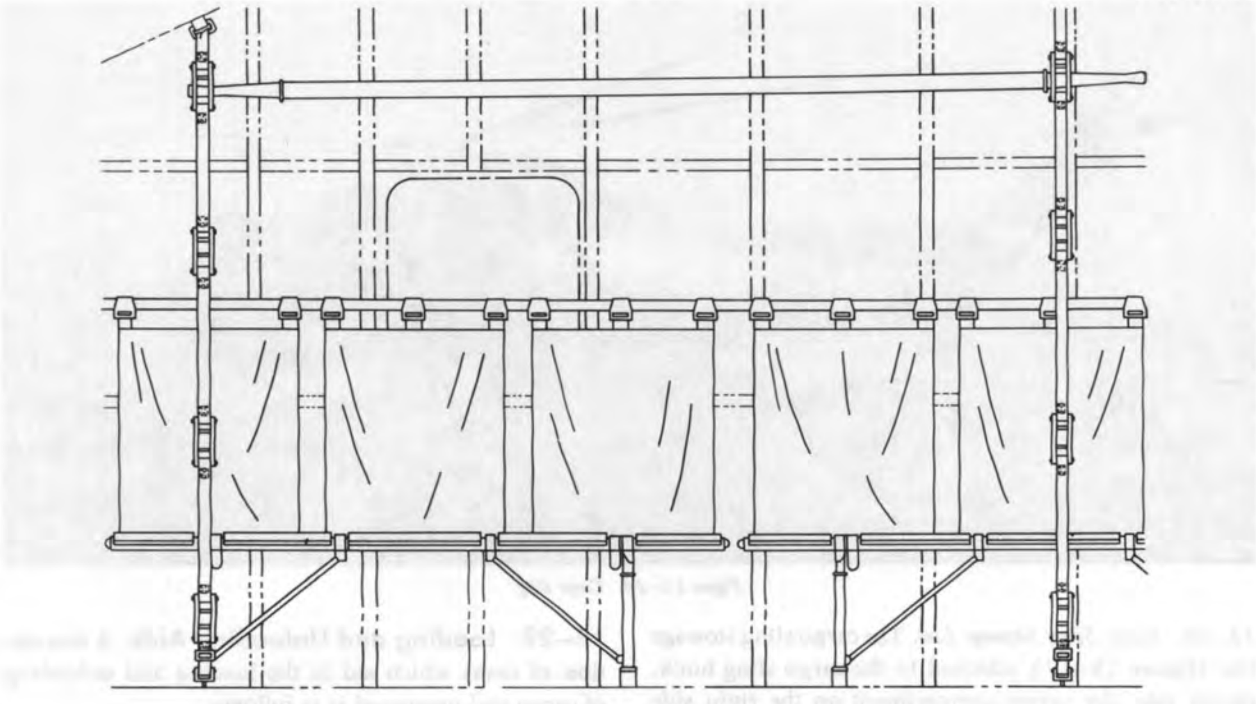
13–27. Cargo Sling Hook Protective Cover. (See figure 13–16.) The cargo sling hook protective cover is used when the cargo sling hook is not in use. Remove the cover by unsnapping the five buttons on top and the two on each side of the side plate and pull down.



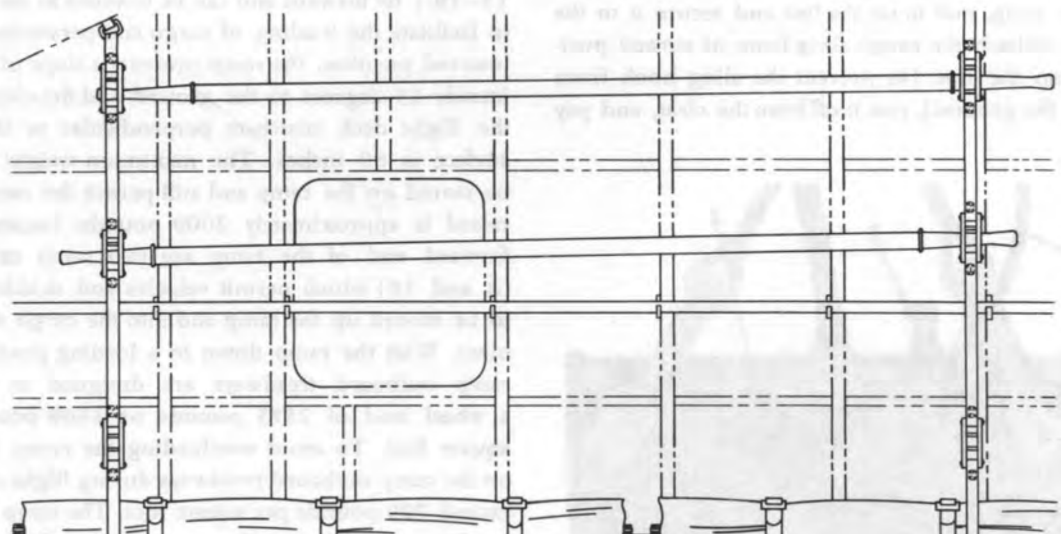
NOTE

THE LITTER AND TROOP SEAT COMBINATIONS SHOWN ABOVE ARE FOR MINIMUM LOSS OF TROOP SEATS; HOWEVER, IF THERE IS NO CONCERN FOR TROOP SEATS, IT IS ADVISABLE TO LOAD LITTERS FORWARD TO AFT FOR A BETTER CG CONDITION.

Figure 13–13. Combination of troop seats and litters (Sheet 1 of 2)



SEATS UNFOLDED, 1 LITTER INSTALLED



SEATS ROLLED, 3 LITTERS INSTALLED

Figure 13–13. Combination of troop seats and litters (Sheet 2 of 2)

Figure 13–14. Cargo sling

13–28. Cargo Sling Stowage Line. The cargo sling stowage line (figure 13–17), attached to the cargo sling hook, passes into the cargo compartment on the right side forward of the external power receptacle and is secured to a cleat located on the cargo compartment floor between two frames of the right-hand side panel. To stow the cargo sling, pull in on the line and secure it to the cleat. To unlatch the cargo sling from its stowed position, grasp the line (to prevent the sling hook from falling to the ground), cast it off from the cleat, and pay out.

1. **Cabin manual release handle cable**
2. Ground handler's manual release knob
3. Positive lock lever

Figure 13–15. Cargo sling hook

13–29. Loading and Unloading Aids.

A description of items which aid in the loading and unloading of cargo and personnel is as follows:

13–30. Cargo Ramp. The cargo ramp is the forward 80 inches of the cargo compartment floor. (See figure 13–18.) Its forward end can be lowered to the ground to facilitate the loading of cargo and personnel. In the lowered position, the ramp presents a slope of approximately 13 degrees to the ground and the clearance to the flight deck structure perpendicular to the ramp surface is 80 inches. The maximum weight that can be stored on the ramp and still permit the ramp to be raised is approximately 2000 pounds. Located at the forward end of the ramp are two ramp extensions (8 and 10) which permit vehicles and skidded cargo to be moved up the ramp and into the cargo compartment. With the ramp down in a loading position, the ramp outboard treadways are designed to support a wheel load of 2575 pounds or 1600 pounds per square foot. To avoid overloading the ramp, the load on the ramp outboard treadways during flight must not exceed 700 pounds per square foot. The ramp inboard treadways are designed to support a wheel load of 930 pounds or 950 pounds per square foot with the ramp down in a loaded position. A maximum load of 700 pounds per square foot is allowed on the ramp inboard treadways during flight. The remainder of the cargo ramp will support a maximum load distribution of 300 pounds per square foot of bulk cargo. Cargo may also be loaded directly from a truck into the cargo compartment with the ramp locked in the up position. In this position, the surface of the ramp is 36 inches from the ground.

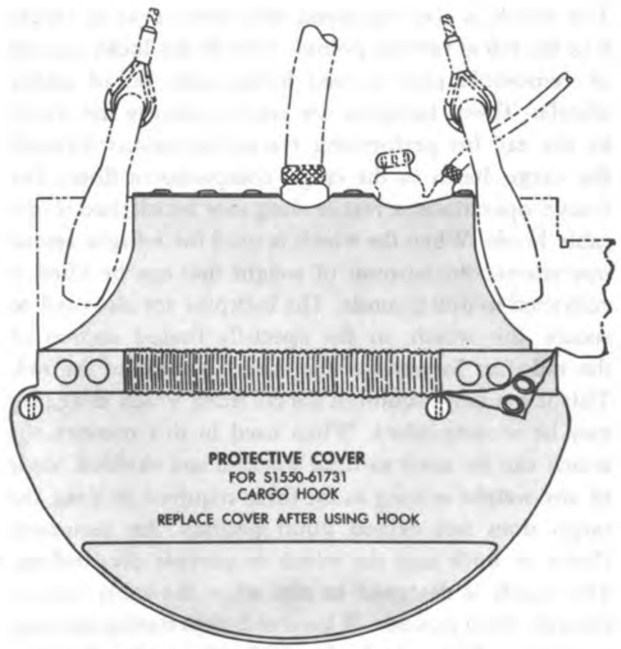


Figure 13–16. Cargo sling hook protective cover

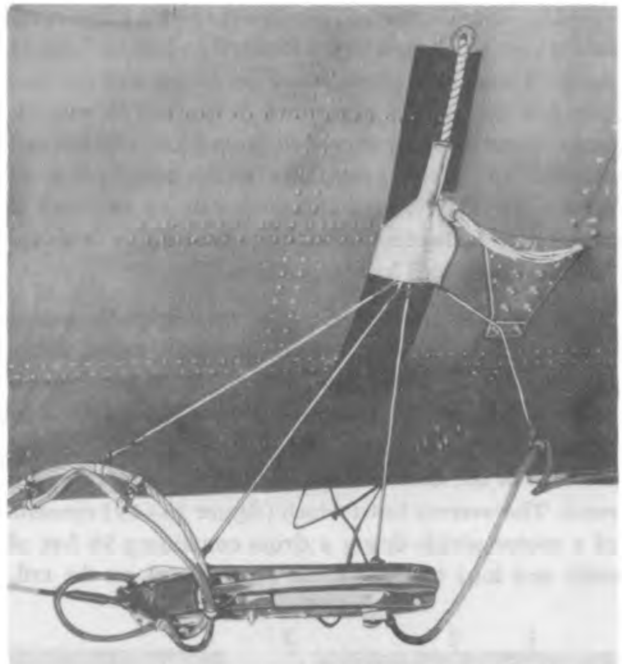
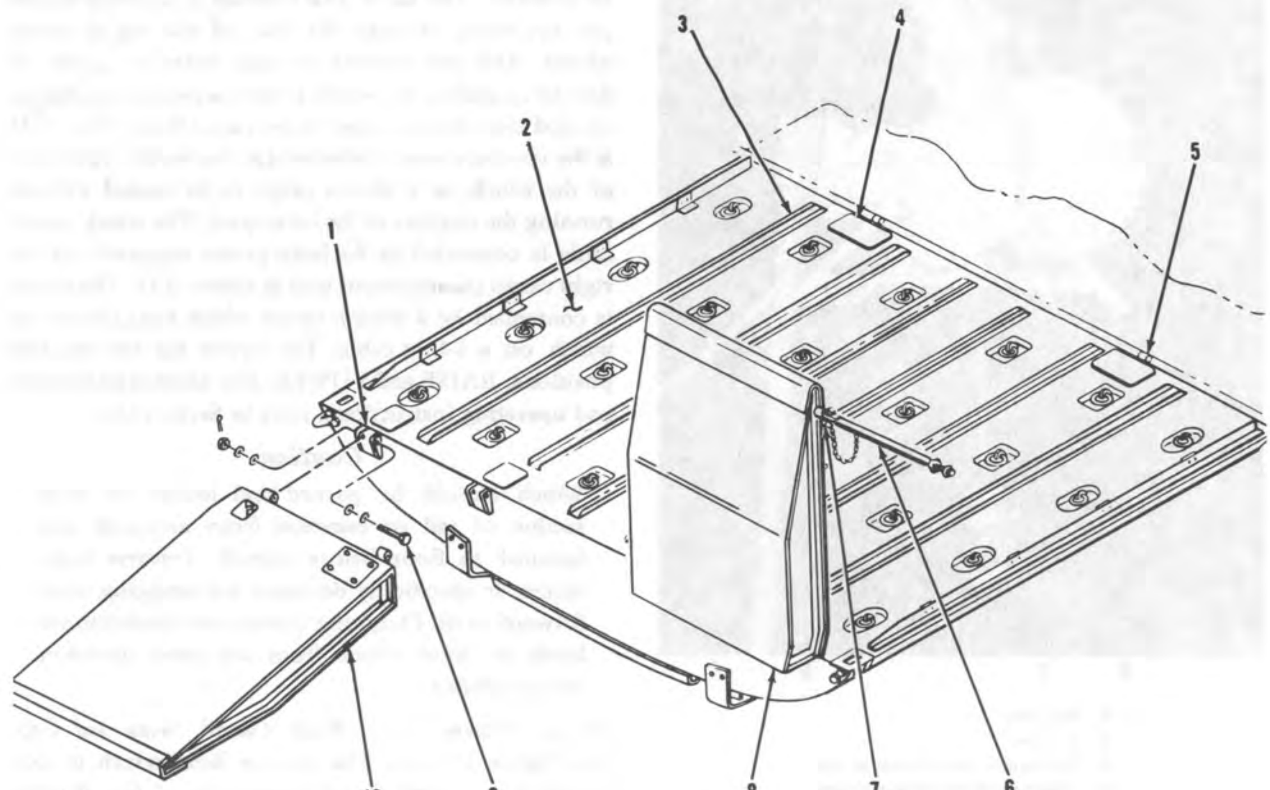


Figure 13–17. Cargo sling hook stowed

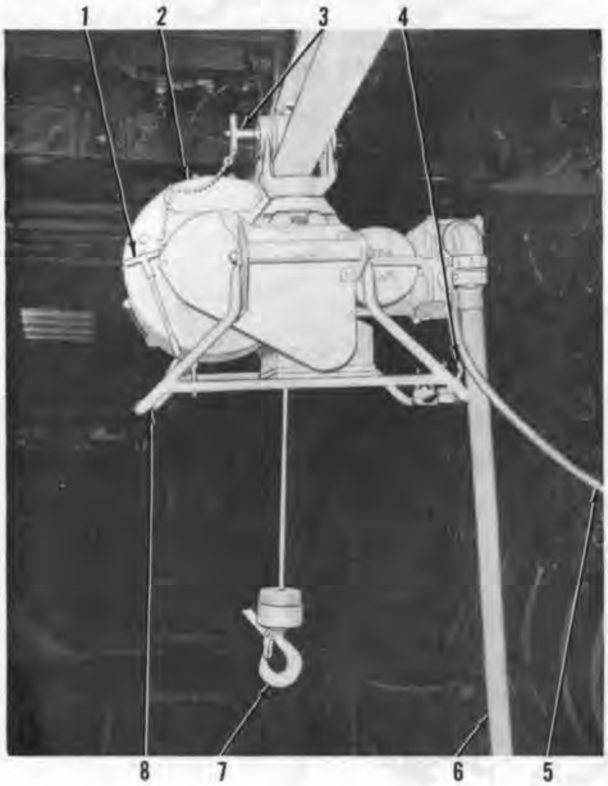


1. Hinge
2. Ramp
3. Skid strip
4. Ramp hinge cover
5. Hinge
6. Hook
7. Lockpin
8. Ramp extension, left-hand side fold up position
9. Bolt, washers, nut
10. Ramp extension, right-hand side extended position

Figure 13–18. Ramp and ramp extension

13–31. Ramp Extensions. (See figure 13–18.) Two ramp extensions are hinged to the forward end of the loading ramp. These extensions must be raised and lowered manually by loading personnel. When not in use, the ramp extensions are stowed in the vertical position and secured with hook assemblies to the cargo compartment wall. The ramp extensions can be removed if cargo is to be loaded through the nose doors with the ramp in the up and locked position.

13-32. Traverse Hoist System. The traverse hoist system consists of a monorail and an electrically driven 2000-pound capacity winch and is capable of picking up cargo, armament, or personnel at the side cargo door or through the cargo hatch and carrying and depositing the load at the desired location in the cargo compartment. The traverse hoist winch (figure 13–19) consists of a motor which drives a drum containing 50 feet of cable and four trolley wheels which travel on the rail.



1. Pip pins
2. Winch
3. Pip pins – lock winch to rail
4. Control switch stowage clips
5. Control switch cable
6. Electrical source cable
7. Winch hook
8. Man handling grips

Figure 13–19. Traverse hoist winch

The winch is also equipped with three locks to secure it to the rail at various points. Two of the locks consist of removable pins located below each set of trolley wheels. These lockpins are used to secure the winch to the rail for performing rescue operations through the cargo hatch in the cargo compartment floor. For rescue operations, a rescue sling may be attached to the cable hook. When the winch is used for inflight rescue operations, the amount of weight that can be lifted is restricted to 600 pounds. The lockpins are also used to secure the winch to the specially braced section of the rail, just forward of the curved section of the rail. This is the only section of the rail from which dragging may be accomplished. When used in this manner, the winch can be used to drag wheeled and skidded loads of any weight as long as the force required to drag the cargo does not exceed 2000 pounds. An automatic clutch is built into the winch to prevent overloading. The clutch is designed to slip when the cable tension exceeds 2000 pounds. If the clutch slips during loading, operation of the winch should be discontinued immediately to avoid damage to the winch and the load should be reduced. The third lock consists of a spring-loaded pin operating through the hub of one set of trolley wheels. This pin extends through holes in the web of the rail to anchor the winch at various points of picking up and depositing cargo on the cargo floor. The APU is the normal source of electrical power for the operation of the winch, as it allows cargo to be loaded without running the engines of the helicopter. The winch power cable is connected to the hoist power receptacle on the right cargo compartment wall at station 231. The winch is controlled by a thumb switch which hangs from the winch on a 4-foot cable. The switch has two marked positions, RAISE and LOWER. For detailed installation and operating instructions, refer to Section III.

Caution

Winch should be parked and locked on drag section of rail or removed from monorail and fastened to floor before takeoff. Traverse hoist system is specifically designed for dragging from forward to aft. Dragging operations which impose loads on hoist winch from any other direction are prohibited.

13–33. Traverse Hoist Winch Control Switch and Grip. (See figure 13–20.) The traverse hoist winch is controlled by a thumb switch hanging on 4 feet of cable from the hoist. The switch has two marked positions, RAISE and LOWER. When the switch is off, an automatic brake will hold the load. To actuate the winch, push the thumb switch to either extreme position.

Figure 13–20. Traverse hoist winch control switch and grip

13–34. Tie-Down Fittings. (See figure 13–21.) A total of 112 tie-down fittings are installed on the cargo floor and ramp; 18 are rated at 5000 pounds and are capable of resisting a 5000-pound load exerted along any radius of a hemisphere, the flat side of which is the surface of the cargo floor; 94 are rated at 2200 pounds and are capable of resisting a 2200-pound load exerted along any surface of a hemisphere, the flat side of which is the surface of the cargo floor; and 44 of the 2200-pound fittings incorporate studs which are used to install the troop seats.

13–35. Air Safety Harness. (See figure 13–22.) Two air safety harnesses, each consisting of webbed shoulder straps, waist belt, and connecting lines with snap hooks, are provided to prevent the person operating the cargo hoist from falling through the open hatch during rescue missions or when loading cargo through the hatch. When observing through the cargo door, with the aft section of cargo-passenger sliding door open and helicopter in flight, the air safety harness should be worn to prevent the observer from accidently falling from the helicopter. The hook on the connecting line can be attached to any of the cargo floor tie-down fittings. When not in use, the air safety harnesses are stored in any of the cargo or litter strap storage shelves.

13–36. Communication Stations. The two communication stations in the cargo compartment are both on the right side of the helicopter, one located just forward of the cargo door for the equipment operator and the other at the forward end of the compartment. These stations are provided with headsets and microphones, a hook for supporting the headsets, and a portable microphone switch. The forward cargo compartment communication station includes a signal distribution panel identical to the pilot's and copilot's panels except that the transmitter selector switch is operable only for transmitting over interphone. The switch should be left in the INT position. The forward cargo compartment communication station is also equipped with a hot mike switch mounted on a bracket above the signal distribution panel. The switch has both a momentary and a fixed position and is connected in parallel with the forward portable microphone push-to-talk switch. When the switch is held in the momentary position, it functions the same as the portable microphone switch. When it is placed in the fixed position, the microphone is always operating, relieving the operator of having to hold his thumb on the portable switch.

NOTE

Counting from fore to aft, the outboard tie-down rings, 1, 3, 5, 7, 9, 12, 14, 17, and 19 are 5000-pound tie-down fittings; the balance are 2200-pound tie-down fittings.

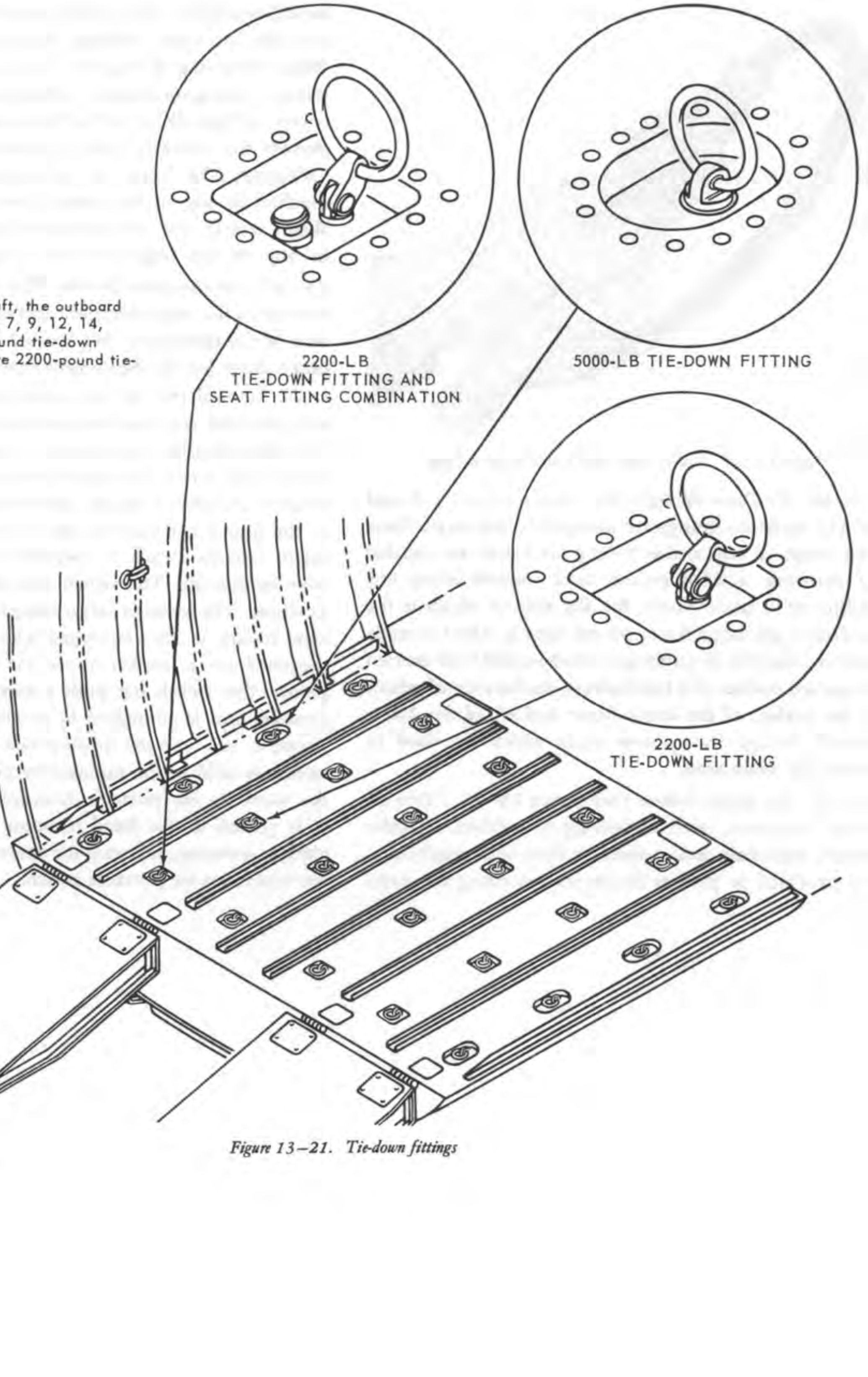


Figure 13–21. Tie-down fittings

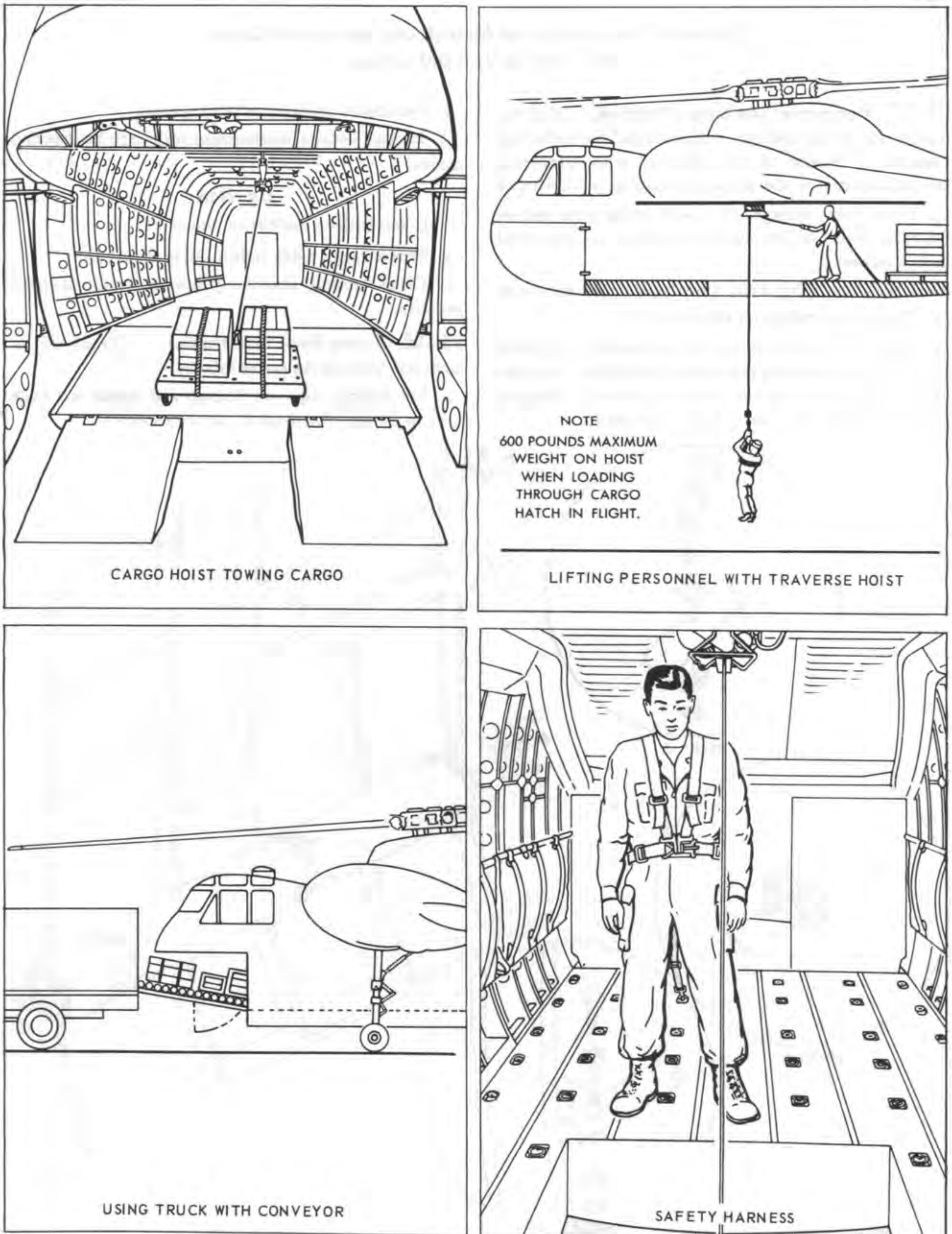


Figure 13–22. Loading aids

Section III Preparation of Aircraft and Personnel Cargo for Loading and Unloading

13–37. Personnel Loading Checklist. In addition to the usual preflight preparations, the following procedures should be accomplished when preparing the helicopter for the transportation of personnel:

a. Fold, stow, remove, or install troop seats and/or litters as required. Detailed instructions are described in this section.

b. Check that safety belts are provided for each seat.

c. Check that emergency exits are clear.

d. Make sure that emergency equipment is installed and in proper working condition; flashlights – batteries usable and spares available; fire extinguishers – charged; canteen – filled; crew alarm bell – operative.

e. Parachutes available, when required.

f. Inspect jettison mechanisms on escape hatches and doors.

Caution

Do not jettison hatches on doors.

g. Secure cargo hatch (when not to be used).

h. Check landing gear for proper extension as stated on strut.

13–38. Troop Seat Installation. Troop seat installation procedures are as follows:

a. Lift spring clips on fittings and install seat back tube in fitting. (See detail B, figure 13–23.)

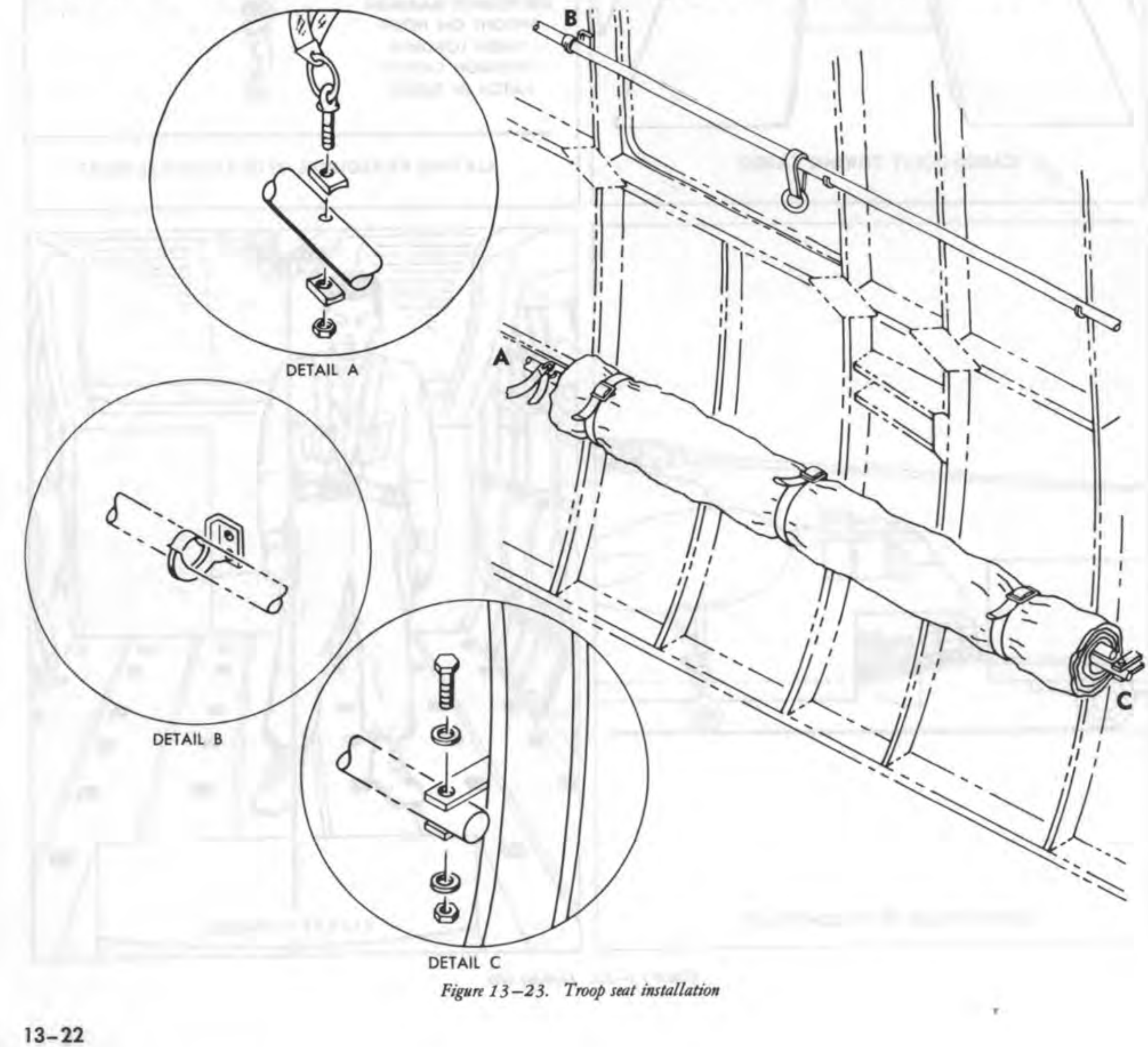


Figure 13–23. Troop seat installation

b. Hold rolled seat in position on cargo compartment wall and connect seat rear tube in its support fittings. Install eyebolts, washers, bolts, nuts, rings and spacers. (See details A and C, figure 13–23.)

c. Open seat stowage straps and unroll seat (figure 13–24).

d. Unfold seat spreaders and connect inboard end (figure 13–25).

e. Unfold extended seat legs (figure 13–26) and connect seat leg brace by pulling outward on pip pin and allowing pin to return when holes are aligned (figure 13–27).

f. Adjust tension on thumb screw (figure 13–28) and turn seat leg downward until it rests on floor and apply tension on thumb screw again to hold seat leg stationary.

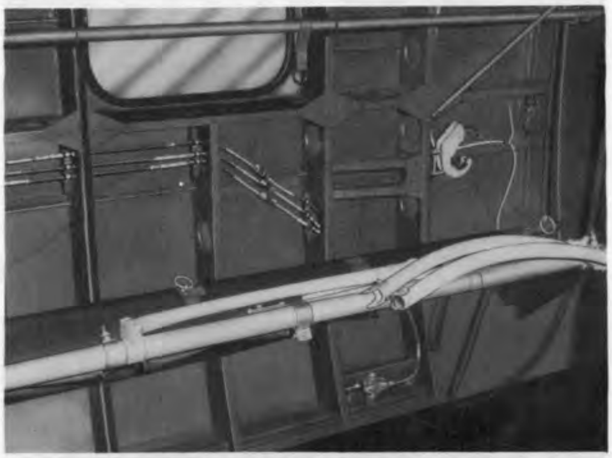


Figure 13–24. Troop seat unrolled

g. Secure seat legs to cargo floor stud fitting by placing leg over stud and applying downward pressure until leg and stud are engaged.

Note

Ramp cannot be lowered when forward troop seats are installed. First troop seat legs of two forward three-man seats on both sides of cargo compartment must be disengaged from cargo floor tie-down fittings before ramp can be lowered.

h. To remove troop seats, follow steps *a* through *g* in reverse order.

13–39. Troop Seat Folding. Troop seat folding procedures are as follows:

Note

When troop seats are not in use, they may be folded up against the cargo compartment wall, rolled, and stowed against cargo compartment wall or removed from helicopter.

Figure 13–25. Inboard end of seat spreader

a. Single or three-man seats are folded in same manner. Press in ears on lower ends of legs (figure 13–29), pull up sliding sleeve, and release legs from tie-down fittings.

b. Adjust thumb screw (figure 13–28) on back of each leg to allow leg to rotate independently of seat front tube.

c. Turn legs over onto seats (figure 13–30) and apply tension on thumb screw (figure 13–28).

d. Fold seats against seat backs (figure 13–31) and secure with stowage straps (figure 13–32) attached to seats and to seat back tubes (figures 13–33 and 13–34).

e. To unfold troop seats, follow steps *a* through *d* in reverse order.

Figure 13–26. Seat legs extended

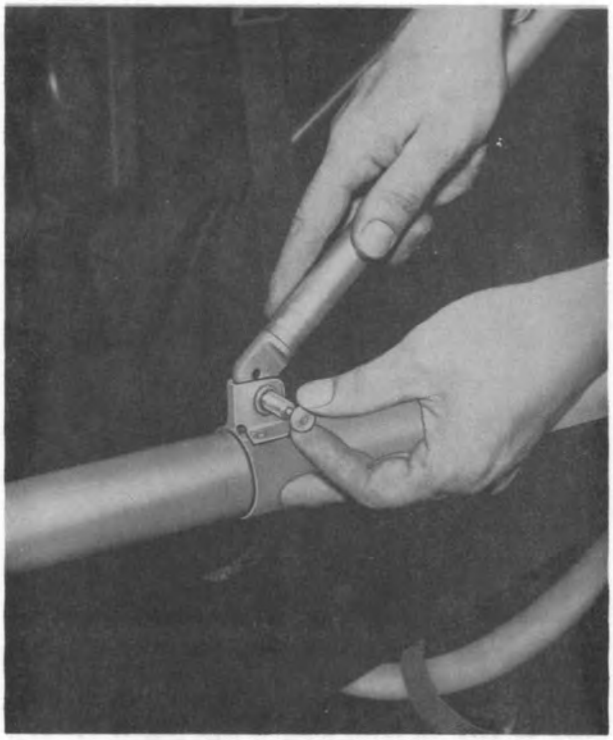


Figure 13-27. Pulling pip pin for seat leg brace

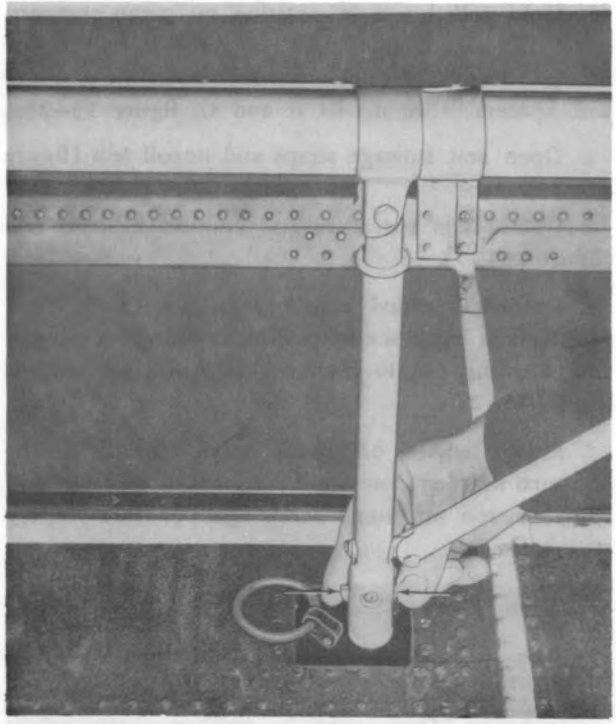


Figure 13-29. Releasing seat leg from cargo floor stud fitting

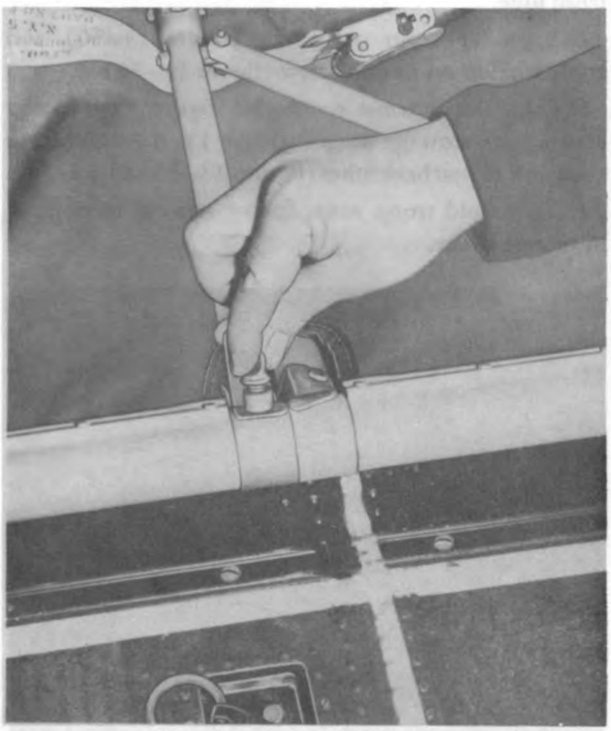


Figure 13-28. Adjusting tension on thumb screw

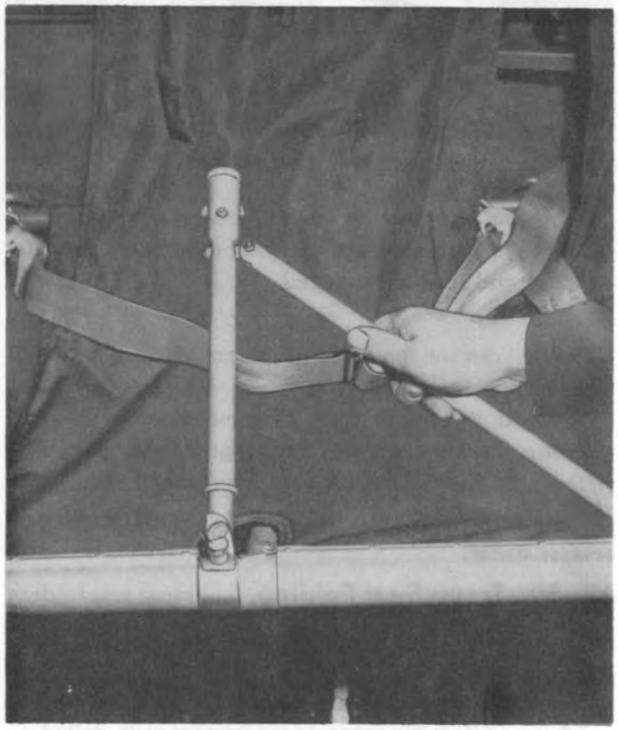


Figure 13-30. Turning troop seat leg

Figure 13–31. Folding seat against cargo compartment wall

Figure 13–32. Securing folded seat with stowage strap

Figure 13–33. Three-man seat folded and secured in place

13–40. Troop Seats Rolling and Unrolling.

The three-man seats can be rolled and stowed against the cargo compartment wall. The one-man seats cannot be rolled. They must be folded in place for stowage.

a. Unhook seat backs and fold properly on seat (figure 13–35).

b. Release legs from floor, rotate as in paragraph 13–39, steps *a* and *b* , and proceed as follows:

c. Disconnect leg brace by pulling outward on pip pin and removing brace (figure 13–27).

d. Extend leg and brace on forward seat tube (figure 13–26).

e. Disconnect and fold inboard end of seat spreader (figure 13–25).

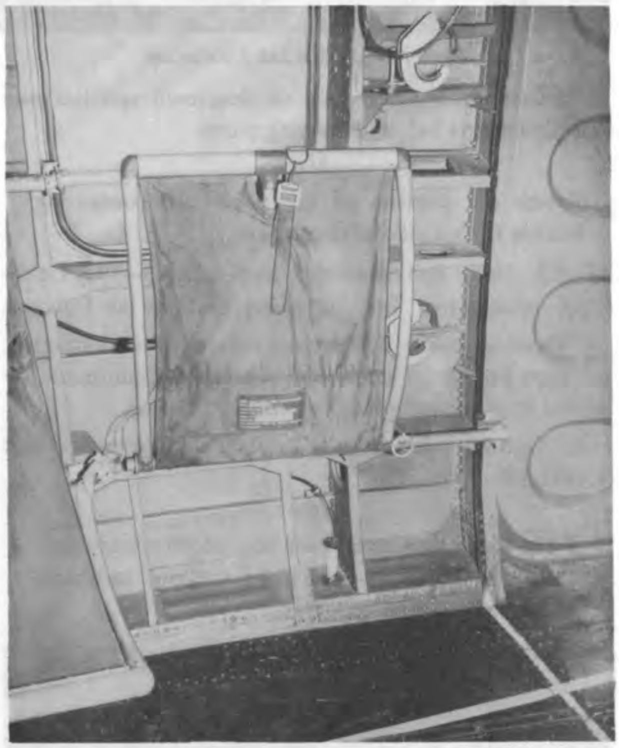


Figure 13–34. Single seat folded and secured in place

f. With legs and spreaders folded, roll seat to cargo compartment wall.

g. Roll three-man seats compactly and secure to seat rear tubes with stowage straps (figure 13–36).

h. To unroll three-man troop seats, follow steps *a* through *g* in reverse order.

13–41. Safety Belts.

(See figure 13–37.) Each seat is equipped with a webbed, lap-type safety belt. These belts are attached to anchor rings mounted on the lower support tube behind the seats. To install safety belts, proceed as follows:

a. Clip safety belt to anchor ring. (See figure 13–38.)

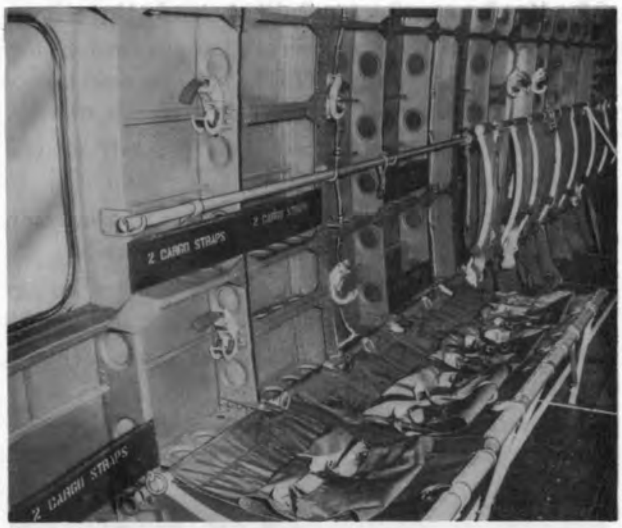


Figure 13–35. Seat back folded on seat

b. Install each safety belt so that each seat has one complete safety belt with mating parts.

Note

Attach the portion of the safety belt containing buckle on left side of troop seat.

13–42. Safety Belt Operation. (See figure 13–39.) Operating procedures for the safety belt are as follows:

a. Position safety belt across lap and slide engaging bar into buckle of safety belt where it is automatically locked in a secured position (figure 13–40).

b. Tighten safety belt by pulling on free end of belt (figure 13–41).

Note

To loosen safety belt, push belt length adjustment knob (3, figure 13–39) to left and pull webbing through buckle as required.

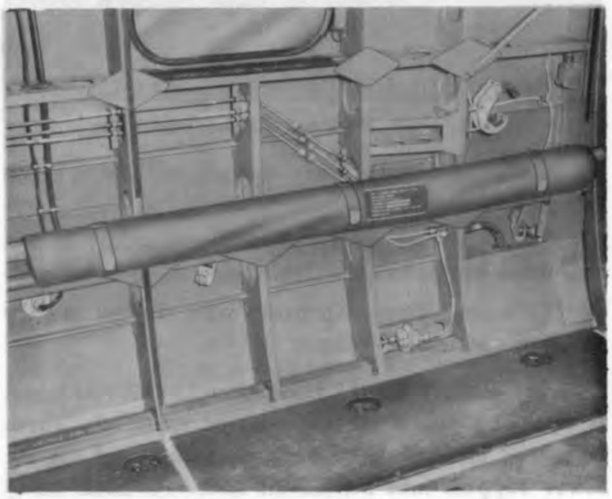
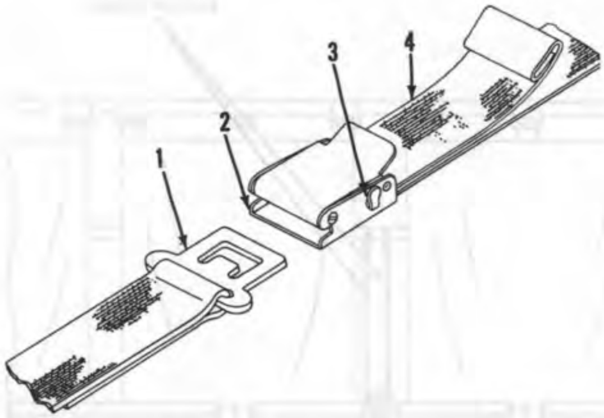


Figure 13–36. Troop seat rolled and stowed

Figure 13–37. Troop seat safety belt

Figure 13–38. Attaching safety belt to anchor ring



1. Engaging bar and belt
2. Buckle
3. Belt length adjustment knob
4. Adjusting belt

Figure 13–39. Safety belt buckle

Figure 13–40. Inserting engaging bar into safety belt buckle

c. To release safety belt, lift buckle lever (see figure 13–42).

Note

Safety belt should not release unless lock buckle is pressed forward.

Note

Before folding troop seats, check that safety belts on free end of forward three-man troop seats are suspended with the bungee cords installed. (See figure 13–43.) This is to prevent ends of safety belts from dropping between fuselage and cargo ramp and causing damage when ramp is raised.

13–43. Emergency Equipment Checklist. The emergency equipment checklist is as follows:

a. Fire extinguishers installed and with proper amount of pressure.

b. First aid kits in position and complete.

c. Crew alarm bell operating.

d. Flashlights in position and operating.

e. Relief tube accessible and in working condition.

13–44. Litter Support Installation. (See figure 13–44.) The litter support installation procedures are as follows:

Note

For combinations of troop seats and litters which may be installed, refer to Section II.

a. Remove all litter support straps from stowage shelves located on cargo compartment walls.

b. Attach upper end of litter strap to ceiling by inserting strap through ceiling tie-down fitting (figure 13–45) and follow through by inserting strap into strap buckle. (See figure 13–46.)

c. Connect clamp at lower end of litter strap to floor tie-down ring as follows:

(1) Press clip release to open clamp jaws (figure 13–47).

(2) Insert tie-down fitting into clamp jaws (figure 13–48).

(3) Press clamp shut on tie-down fitting. Pull strap to lock and test.

d. Take up all slack in litter strap and adjust litter support strap so that litter brackets are slightly higher than cargo compartment wall litter support brackets.

e. Pull all wall brackets to inboard position.

f. Open all brackets to prevent delays during litter loading by pressing down on release cam (figure 13–49).

g. Disconnect litter support strap from floor tie-down ring after it has been adjusted for length.

Figure 13–41. Tighten safety belt

Figure 13–42. Releasing safety belt by lifting on buckle lever on left side of buckle

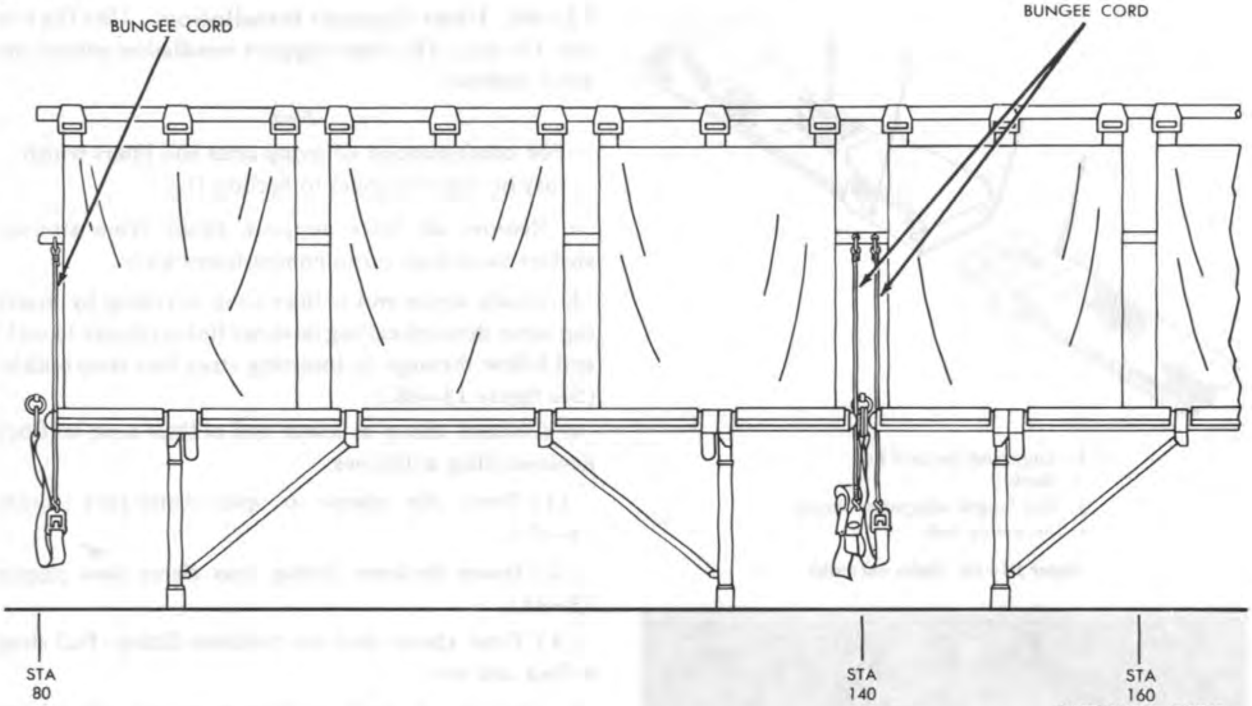


Figure 13-43. Troop seat safety belt bungee cord installation

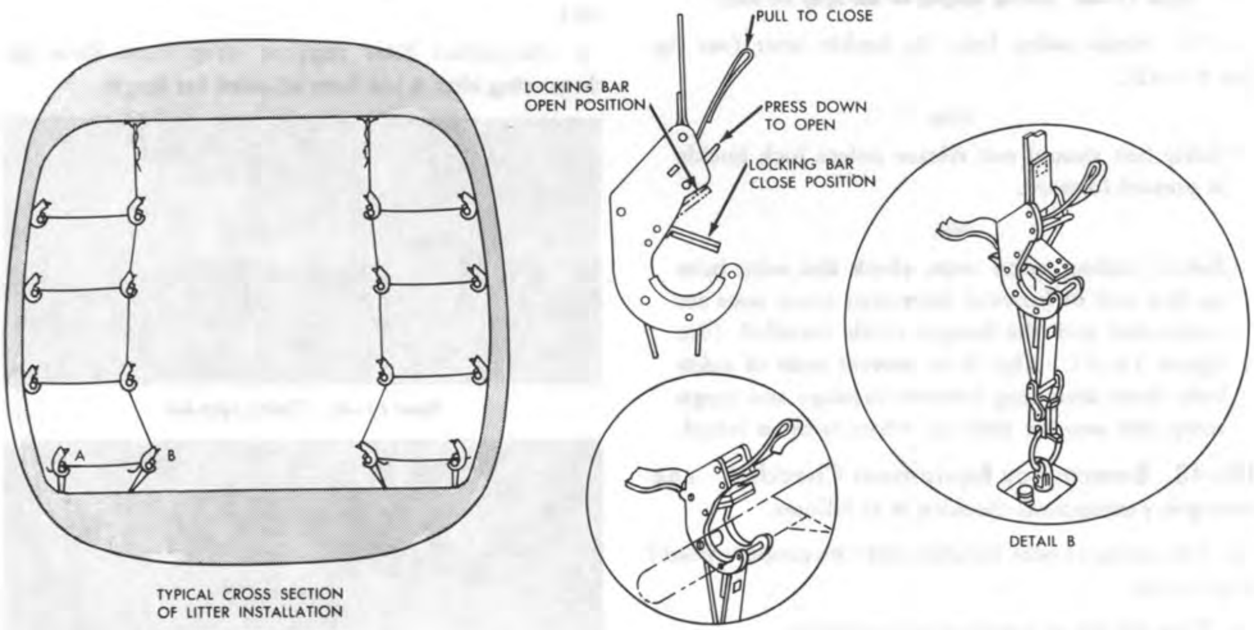


Figure 13-44. Litter support installation

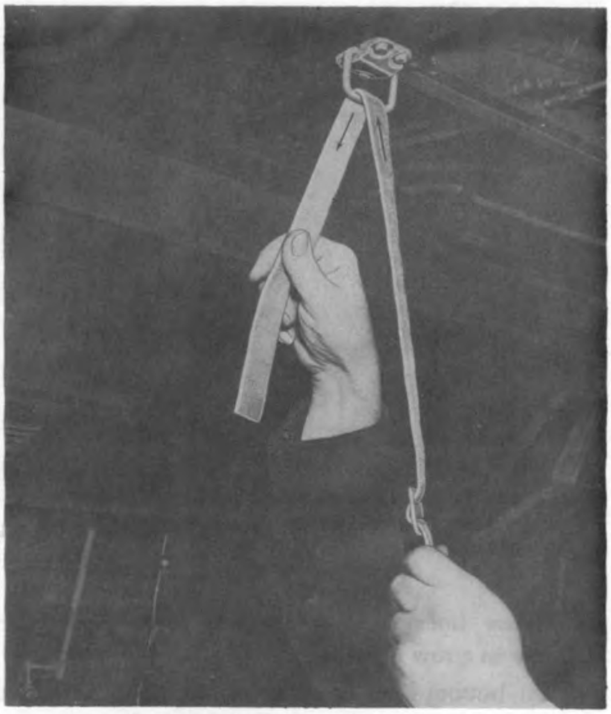


Figure 13—45. Insert litter strap through ceiling tie-down ring

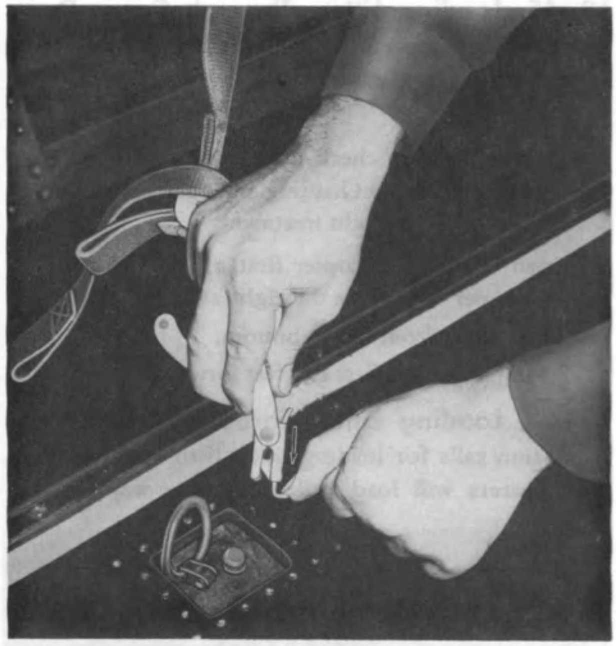


Figure 13—47. Press clip release to open clamp jaws

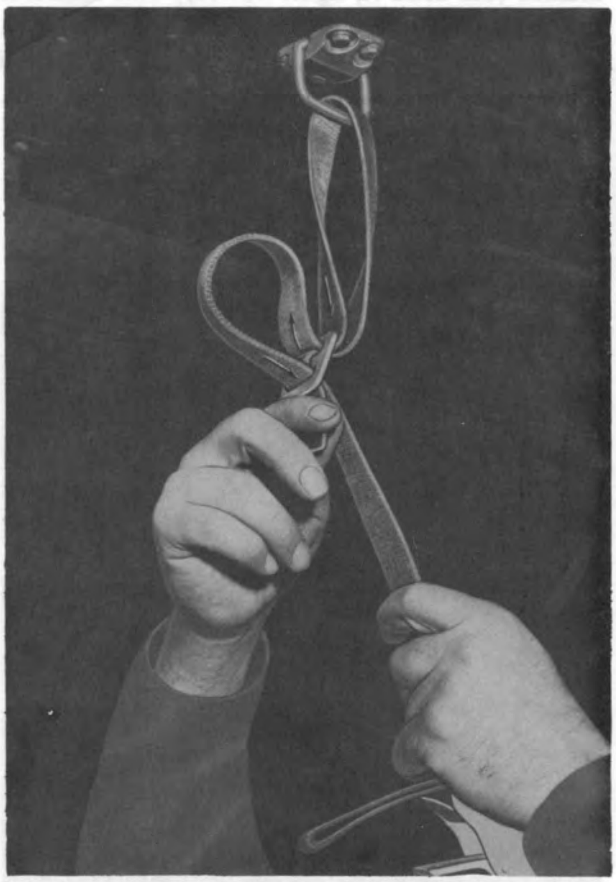


Figure 13—46. Insert strap end through strap buckle

Figure 13—48. Insert tie-down ring into clamp jaws

13–45. Loading Litters Through Cargo Door.

The following procedures are to be used when loading litters through cargo door:

Note

Prior to loading, check litter patient's wound to better determine best loading arrangement to facilitate emergency inflight treatment.

a. Load front of helicopter first, a tier of four on left side then a tier of four on the right side.

b. Load litters from top to bottom.

c. Load patient feet first and feet forward.

13–46. Loading Litters Through Nose Doors.

If mission calls for loading litters through nose door, litter bearers will load helicopter same way as cargo

Figure 13–49. Press cam down opening bracket

door loading, except they will begin to load from rear of helicopter and work forward.

Caution

When ramp is lowered, forward litter straps must be disconnected from floor and cannot be connected again until ramp is up and locked.

13–47. Loading Litters on Litter Brackets. The procedures for loading litters on litter brackets are as follows:

a. Place one end of litter on wall brackets. (See figure 13–50.)

b. Place other set of litter handles on corresponding brackets on litter support straps.

13–48. Securing Litters. The procedures for securing litters are as follows:

a. Pull web tongue on brackets to lock the lock bar down on litter handle. (See figure 13–51.)

Figure 13–50. Place litters on wall bracket first

b. Secure litter support strap to cargo floor after last litter in a row is loaded.

c. On bottom litter in each tier, secure litter handle next to cargo compartment wall with extra litter support bracket. (See detail A, figure 13–44.) This bracket is attached to tie-down fitting with strap (figure 13–52).

d. On front tier of litters on right and left sides of helicopter, secure top two litters in each tier with litter retaining cap assemblies to prevent extreme forward movement of litters and further injury of patient (figure 13–52).

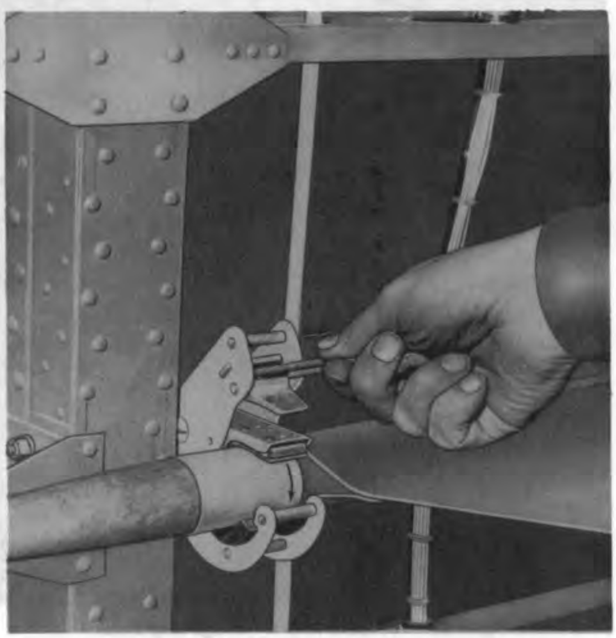


Figure 13–51. Pull web tongue to lock locking bar on litter handle

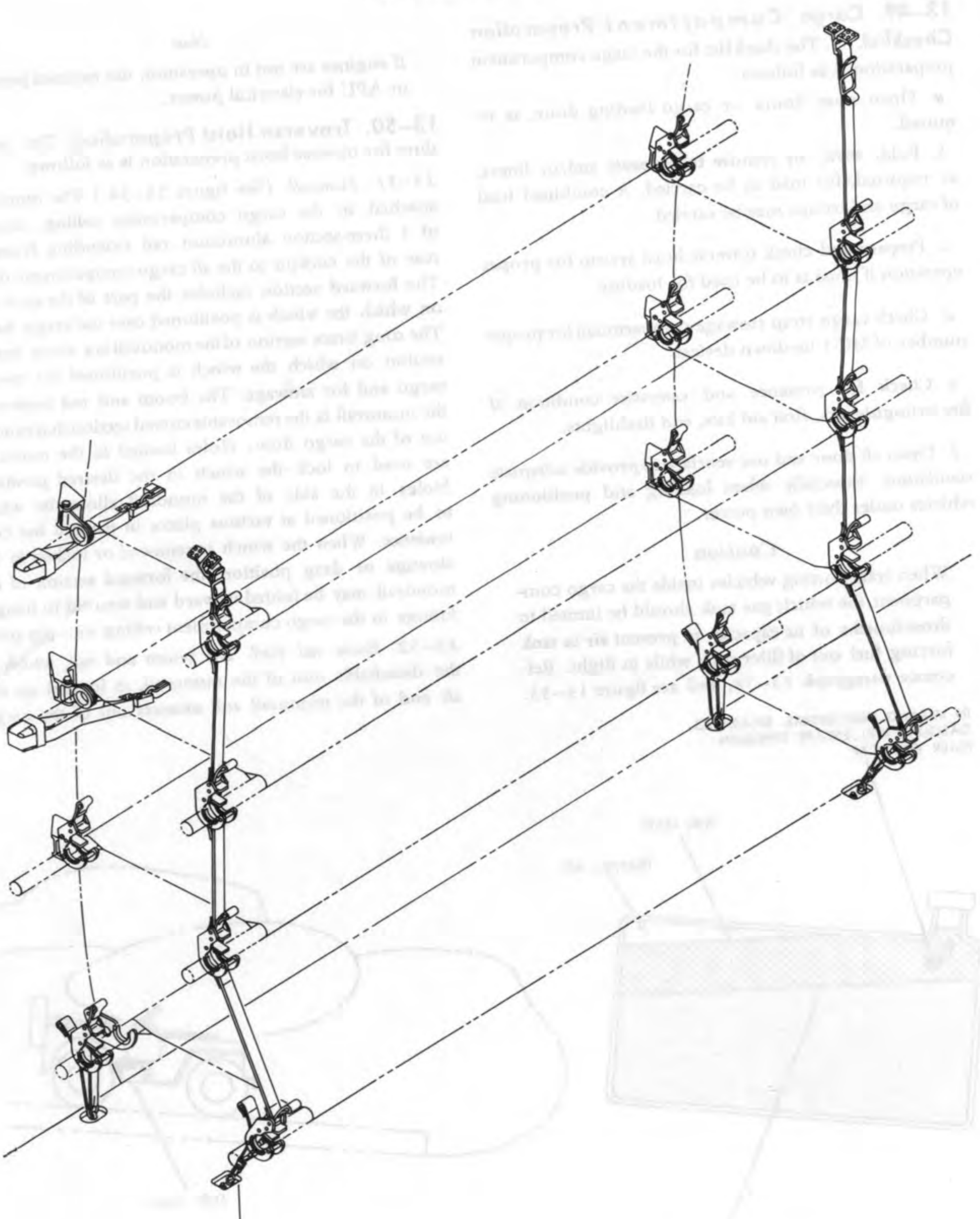


Figure 13–52. Litters installed

13–49. Cargo Compartment Preparation Checklist. The checklist for the cargo compartment preparation is as follows:

a. Open nose doors or cargo loading door, as required.

b. Fold, stow, or remove troop seats and/or litters, as required, for load to be carried. A combined load of cargo and troops may be carried.

c. Prepare and check traverse hoist system for proper operation if hoist is to be used for loading.

d. Check cargo strap stowage compartment for proper number of MC-1 tie-down devices.

e. Check for presence and operative condition of fire extinguishers, first aid kits, and flashlights.

f. Open aft door and use vent fans to provide adequate ventilation, especially when loading and positioning vehicles under their own power.

Caution

When transporting vehicles inside the cargo compartment, the vehicle gas tank should be limited to three-fourths of its capacity, to prevent air in tank forcing fuel out of filler neck while in flight. Reference paragraph 13–78, and see figure 13–53.

Note

If engines are not in operation, use external power or APU for electrical power.

13–50. Traverse Hoist Preparation. The procedure for traverse hoist preparation is as follows:

13–51. Monorail. (See figure 13–54.) The monorail, attached to the cargo compartment ceiling, consists of a three-section aluminum rail extending from the rear of the cockpit to the aft cargo compartment door. The forward section includes the part of the monorail on which the winch is positioned over the cargo hatch. The drag brace section of the monorail is a short braced section on which the winch is positioned for towing cargo and for stowage. The boom and rail section of the monorail is the removable curved section that extends out of the cargo door. Holes located in the monorail are used to lock the winch in the desired position. Holes in the side of the monorail allow the winch to be positioned at various places in the rail for convenience. When the winch is removed or locked in the stowage or drag position, the forward section of the monorail may be folded upward and secured to hanger fittings in the cargo compartment ceiling with pip pins.

13–52. Boom and Rail. The boom and rail, which is the detachable unit of the monorail, is located on the aft end of the monorail and extends out of the cargo

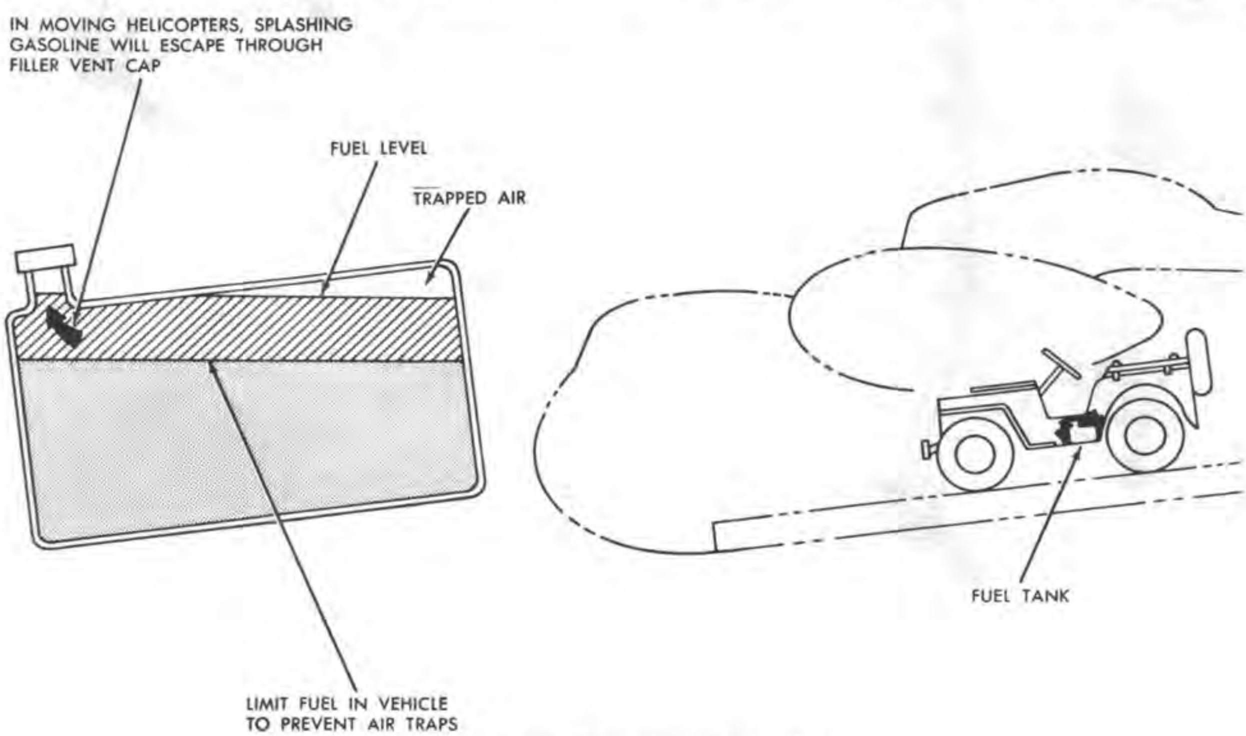


Figure 13–53. Fuel limitation for vehicle loading

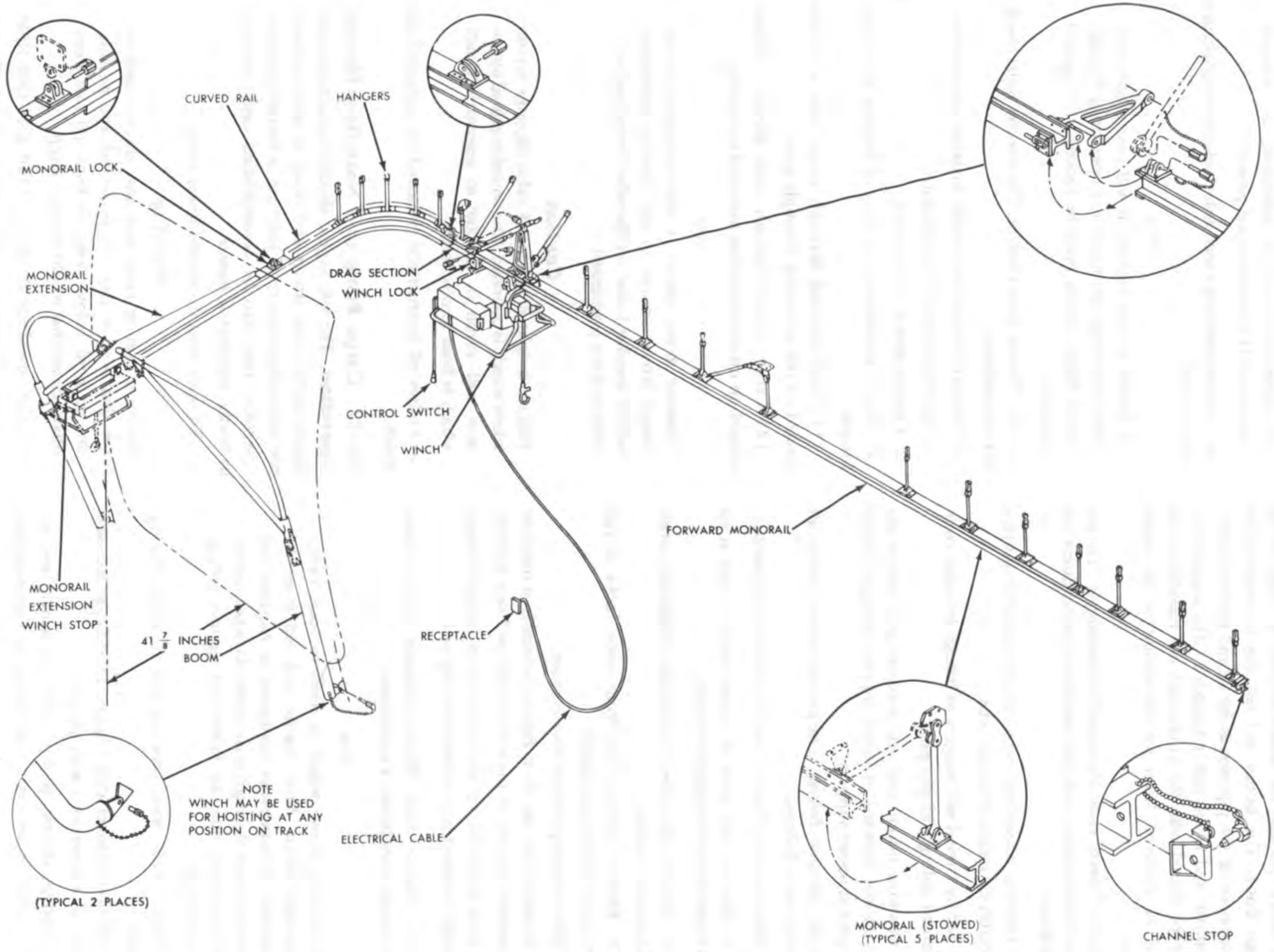


Figure 13–54. Traverse hoist system

door. The boom supports the extension of the curved rail which permits the winch to pick up cargo at the cargo door. The boom and rail may be removed by disconnecting the pip pins at the aft and forward lower supports and at the upper supports. The cargo door may be closed with the boom and rail installed if the plug is removed from the aft section of the cargo door.

13–53. *Traverse Hoist Boom and Rail Installation.* The traverse hoist boom and rail installation procedures are as follows:

a. Position curved rail onto rail portion of drag brace assembly by means of track locks.

b. Secure curved rail hangers to fittings in cargo compartment ceiling with pip pins.

c. Position boom and rail support and secure pip pins aft and forward of lower support fittings. Fasten pip pins at upper support.

13–54. *Monorail Folding.* The procedures for monorail folding are as follows:

a. Remove hoist boom and rail in following manner:

(1) Remove pip pins at upper support and at aft and forward lower support fittings.

(2) Remove pip pins from hanger fittings on cargo compartment ceiling.

(3) Remove curved rail from track locks at rail portion of tow brace assembly.

b. Remove pip pin from rod support.

c. Remove pip pin from hanger assembly at junction of forward section of monorail and tow brace section.

d. Fold monorail up and secure it to hanger fittings in cargo compartment ceiling with pip pins.

13–55. *Traverse Hoist Winch Installation.* The traverse hoist winch installation is as follows:

Note

If traverse hoist winch is used to load cargo through cargo door, boom and rail must be installed. If maximum headroom is required for towing cargo through nose doors, forward section of monorail may be folded up against ceiling and stowed.

a. Place winch with forward end of arrow facing forward.

b. Position channel stop (figure 13–54) on forward end of rail and secure it with pip pin.

c. Connect electric power cable to winch and to hoist receptacle on right side of cargo compartment wall.

Note

If engines are not in operation, use external power or APU for electrical power.

d. Position and lock winch at desired operating location on monorail.

Note

If winch is not locked, it will center itself over load. For drag operations and operations through cargo hatch, winch must be locked at designated location.

13–56. *Traverse Hoist Checklist.* The traverse hoist checklist is as follows:

a. Monorail down and winch installed on monorail.

b. Electrical power – Connected.

c. Control switch – Operating.

d. Winch positioned for type of loading to be performed:

(1) Cargo loading through cargo door – Winch located on rail extending through door.

(2) Cargo towed through nose doors – Winch located on monorail section indicated for towing.

Note

Traverse hoist system is only designed to tow cargo from forward to aft. Towing operations which impose loads on the winch from any other direction are prohibited.

Caution

Reduce weight if continued cable slippage occurs when winch is operated. Continued overload operation will result in damage to automatic clutch which is built into winch.

e. Follow all instructions indicated on monorail and winch.

13–57. Cargo Ramp and Nose Door Normal Operation. The left engine should be running while operating the nose doors and ramp in order to maintain hydraulic pressure of 3000 psi in the utility system. Operation may also be accomplished using external hydraulic and electric power.

a. To open nose doors and lower ramp:

Warning

Before operating ramp and nose doors, check to see that area is clear of personnel and be sure that ground below ramp is level and free from obstructions that would damage ramp.

(1) Left quadrant throttle – 1500 ENGINE RPM.

(2) Pilots' compartment ladder – FOLDED UP.

(3) Nose door manual catch – UNLOCKED.

(4) Nose door lock lever – UNLOCKED.

(5) Nose door switch – OPEN.

(6) Ramp switch – DOWN.

Note

Steps (5) and (6) can be accomplished simultaneously due to the sequence switches in the system.

(7) Ramp extensions – MANUALLY UNHOOK AND FOLD DOWN.

(8) Nose door valve slide bolt – LOCK, TO PREVENT DOORS FROM CLOSING.

b. To raise ramp and close nose doors:

(1) Left quadrant throttle – 1500 ENGINE RPM.

(2) Ramp extensions – MANUALLY FOLD UP AND SECURE WITH HOOKS.

(3) Ramp switch – UP, then OFF (after ramp up and locked indicator light comes on). Ramp locks checked for locked position.

(4) Nose door valve slide bolt – RELEASE.

(5) Nose door lock lever – UNLOCKED.

(6) Nose door switch – CLOSE.

Note

Steps (3) and (6) can be accomplished simultaneously due to sequence switches in system.

(7) Nose door lock lever – LOCKED.

(8) Nose door manual catch – LOCKED.

(9) Nose door switch – OFF.

13–58. *Operation Without Electrical Power.* The nose door and ramp hydraulic valves, located on left cabin side panel forward, are positioned with manual override knobs. Since interlock circuits in ramp-up indicator light will be inoperative, be sure each operation is completed before proceeding to next.

a. To operate nose doors and lower ramp:

(1) Left engine quadrant throttle – 1500 ENGINE RPM.

(2) Nose door manual catch – UNLOCKED.

(3) Nose door lock lever – UNLOCKED.

(4) Nose door valve manual override knob – OPEN. DEPRESS, then release when doors are open.

(5) Ramp valve manual override knob – LOWER. DEPRESS, then release when ramp is down.

(6) Ramp extensions – UNHOOK AND FOLD DOWN.

b. To raise ramp and close nose doors:

(1) Left engine quadrant throttle – 1500 ENGINE RPM.

(2) Ramp extensions – FOLD UP AND SECURE.

(3) Ramp valve manual override knob – RAISE. DEPRESS, then release when ramp is up and locked.

(4) Nose door lock lever – UNLOCKED.

(5) Nose door valve manual override knob – CLOSE. DEPRESS, then release when doors are closed.

(6) Nose door lock lever – LOCKED.

(7) Nose door manual catch – LOCKED.

13–59. *Operation Without Hydraulic Power.* Operation of the nose doors and ramp without hydraulic power consists of the following procedures:

a. To open nose doors and lower ramp:

(1) Nose door manual catch – UNLOCKED.

(2) Nose door lock lever – UNLOCKED.

(3) Nose doors – OPEN MANUALLY.

(4) Ramp valve manual override knob – LOWER. DEPRESS.

(5) Emergency ramp lock levers – PULL AFT. Ramp will lower slowly.

(6) Ramp extensions – UNHOOK AND FOLD DOWN.

b. To raise ramp and close nose doors:

(1) Ramp extensions – FOLD UP AND SECURE.

(2) Ramp valve manual override knob – LOWER. DEPRESS.

Note

Ramp valve manual override knob must be placed first in LOWER position when raising ramp by emergency hydraulic power, because emergency hydraulic pressure line is connected to the ramp actuating cylinder in such a way that it is necessary to provide an outlet to utility hydraulic return line for fluid trapped in Ramp Raise line.

Ramp may be raised and locked manually by two men when there is no load on ramp.

Actuate emergency hydraulic system.

Caution

To avoid rupturing hydraulic lines while actuating emergency hydraulic pump, check emergency hydraulic pressure gage to make sure that pressure does not exceed 3000 psi.

(3) Ramp valve manual override knob – RAISE.

(4) Emergency ramp lock levers – PUSH FORWARD.

(5) Ramp valve manual override knob – OFF (extended position).

(6) Nose doors – CLOSE MANUALLY.

(7) Nose door lock lever – LOCKED.

(8) Nose door manual catch – LOCKED.

(9) When reactivating utility hydraulic system, be sure left engine is not running.

13–60. Assembly and Checking of Unloading Aids. The assembly and checking of unloading aid procedures are as follows:

a. Check traverse hoist winch, monorail extension, and boom for availability and operation for side cargo door unloading.

b. Check cargo floor shoring if a dolly or any other casters are to be used in unloading.

c. Check nose doors, ramp, and ramp extensions for nose door unloading.

13–61. Cargo Tie-Down Device Releasing. The cargo tie-down device releasing procedures are as follows:

Caution

Do not release any cargo tie-down devices until helicopter has come to a standstill and signal has been given to unload. This will avoid damage, by shifting cargo, to helicopter.

a. After signal to unload, release MC-1 tie-down device; with thumb and forefinger, push release bar hook releasing tensioning and locking lever.

b. Unhook tie-down device and return to shelf on cargo compartment wall.

13–62. Preparation of General Cargo. General cargo consists of all cargo that can be loaded in helicopter, except vehicles.

13–63. Cargo Loading Data. Prior to loading cargo, the following data should be assembled or gathered by loading crews:

a. Weight of individual items of cargo.

b. Overall dimensions of cargo expressed in inches. If there is a question as to whether an item can be loaded, see figure 13–55.

c. Contact pressure.

d. Amount of shoring required.

e. When required, location of center-of-gravity of individual items of cargo.

13–64. Cargo Size Limit Chart. Three diagrams show the largest size object that may enter the cargo compartment through the nose doors and through the cargo door.

a. Cargo size diagram for nose door loading. (See figure 13–55.) This diagram shows the largest objects that can be loaded straight through nose doors or pushed up the ramp and tipped to a horizontal position and slid aft into the cargo compartment. In some cases, slightly larger crates may be loaded by successively tipping the rear end and shoving the crate aft a little at a time.

b. Cargo size diagram for cargo door loading. (See figure 12–3.) This chart shows the largest object that can be angled through the cargo door and slid forward into the compartment.

c. Cargo size for cargo hatch loading. (See figure 13–56.) This figure shows the size of the floor hatch and the clearance from the floor to the winch. No package greater than these dimensions can be loaded through the hatch.

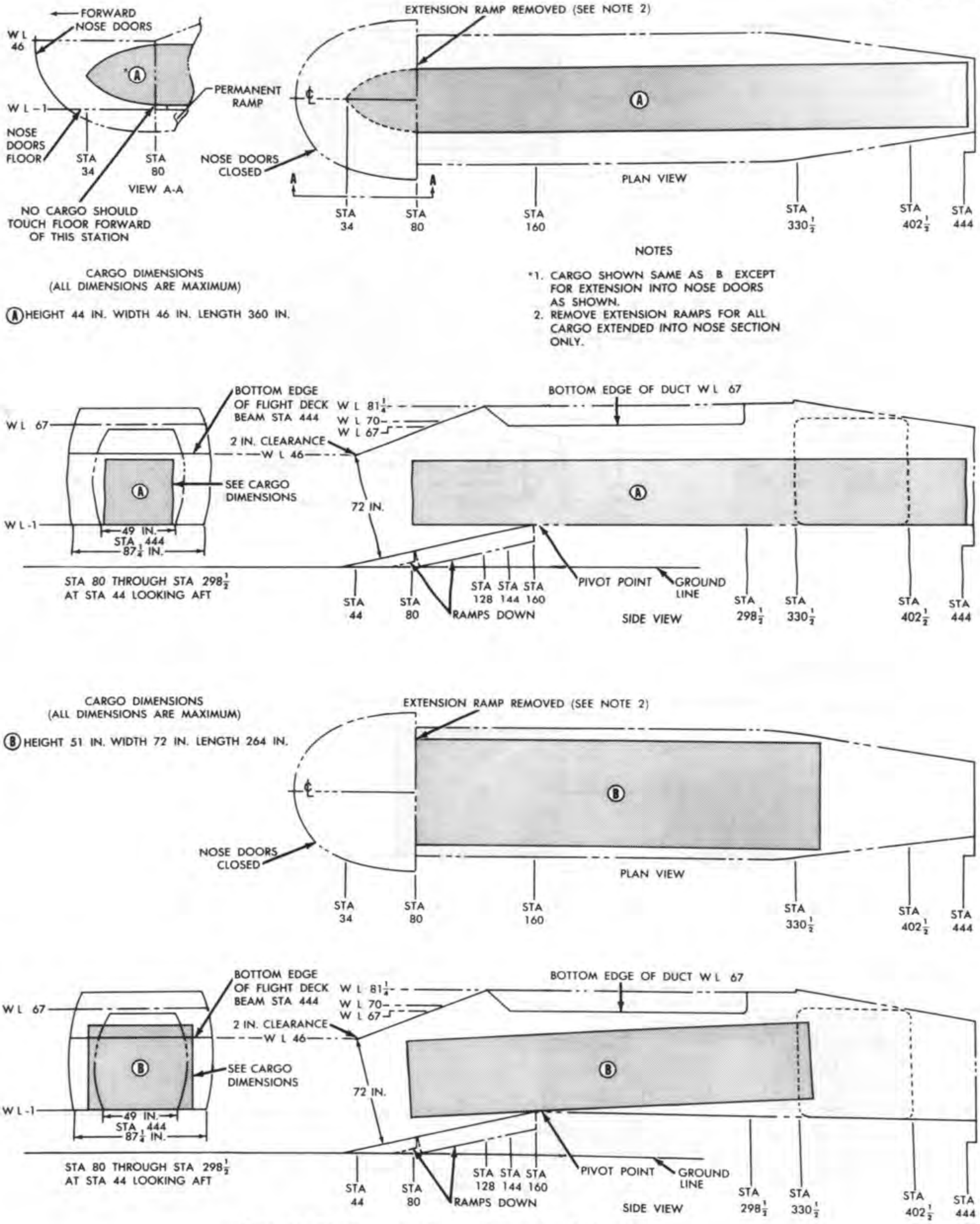


Figure 13–55. Cargo size diagram for nose door loading (Sheet 1 of 3)

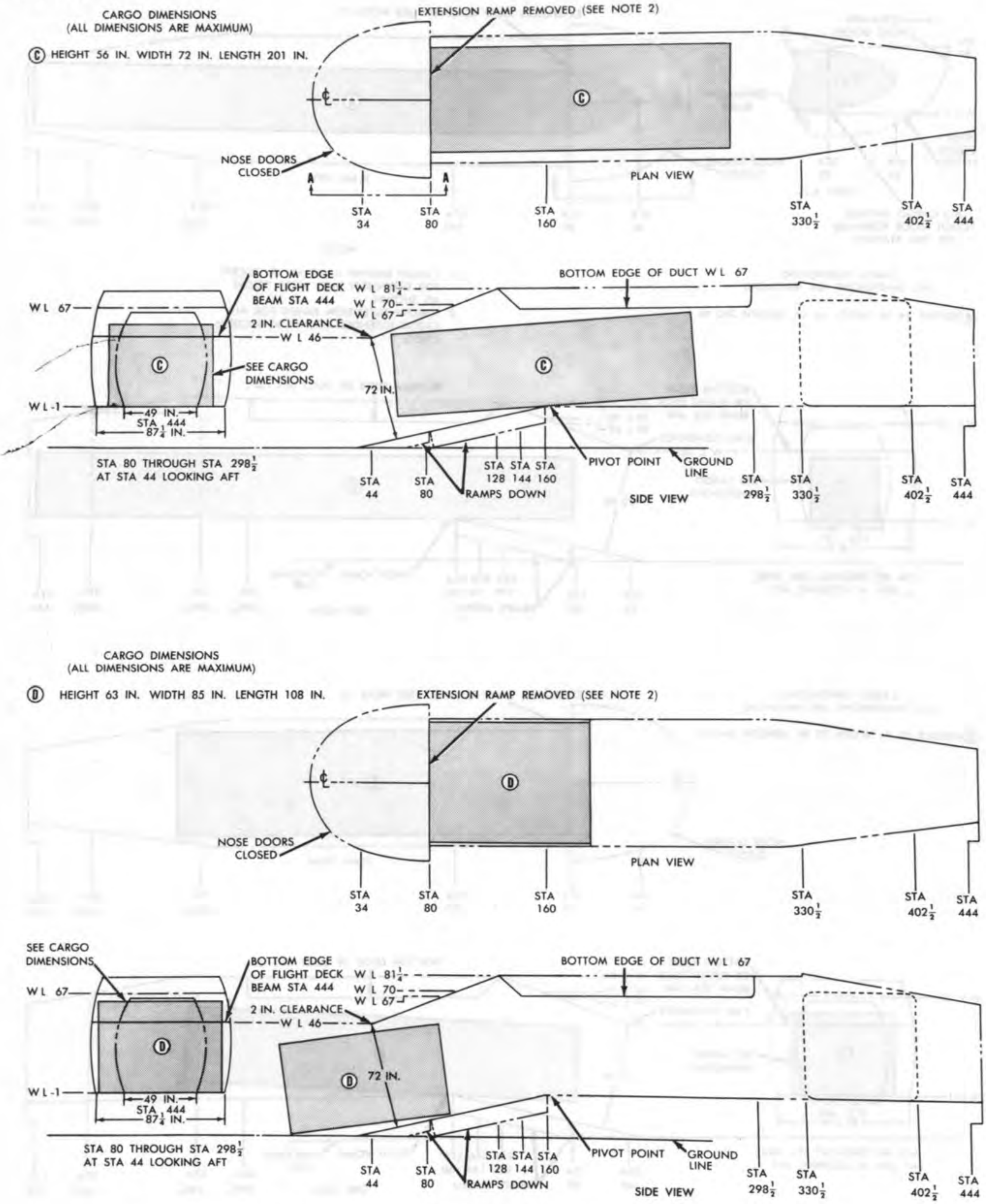


Figure 13–55. Cargo size diagram for nose door loading (Sheet 2 of 3)

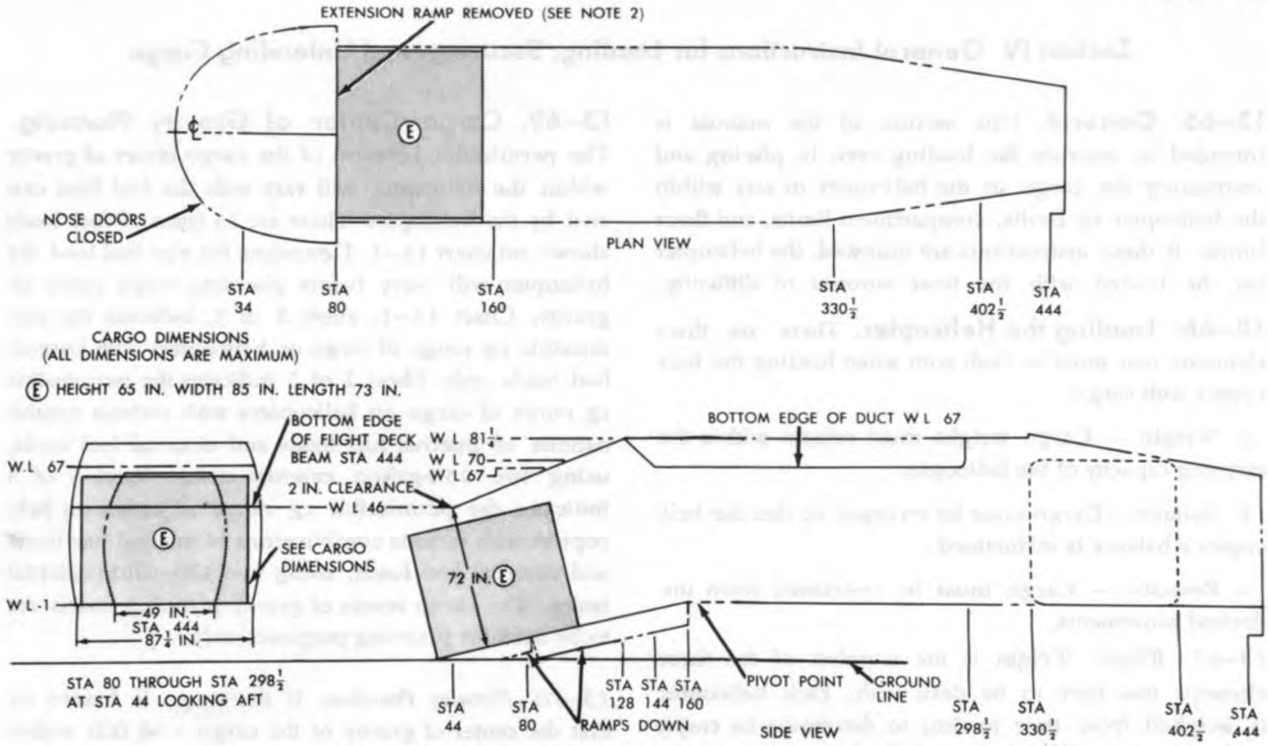
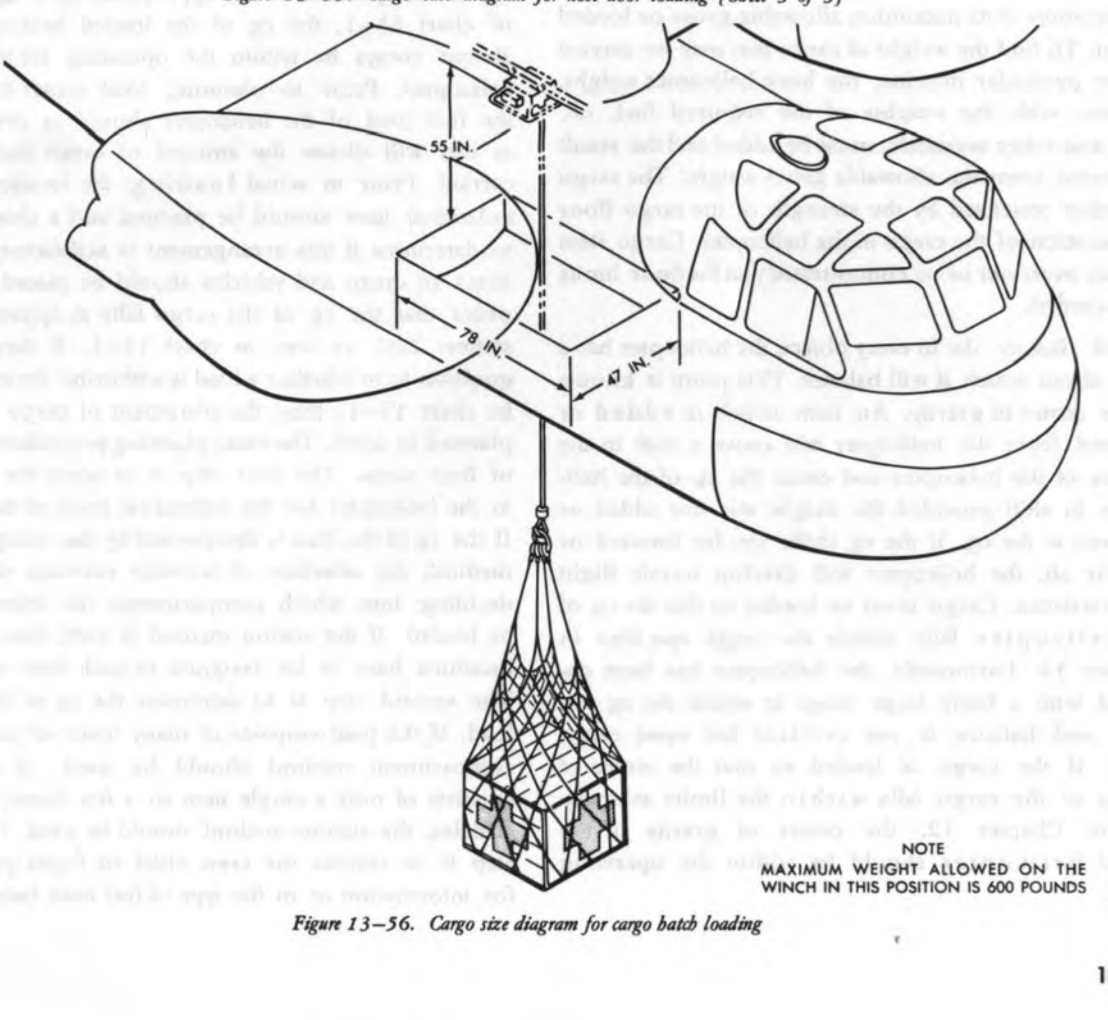


Figure 13–55. Cargo size diagram for nose door loading (Sheet 3 of 3)



NOTE
MAXIMUM WEIGHT ALLOWED ON THE WINCH IN THIS POSITION IS 600 POUNDS

Figure 13–56. Cargo size diagram for cargo hatch loading

Section IV General Instructions for Loading, Securing, and Unloading Cargo

13–65. General. This section of the manual is intended to instruct the loading crew in placing and restraining the cargo in the helicopter to stay within the helicopter cg limits, compartment limits, and floor limits. If these instructions are followed, the helicopter can be loaded with the least amount of difficulty.

13–66. Loading the Helicopter. There are three elements that must be dealt with when loading the helicopter with cargo:

a. Weight – Cargo weight must remain within the carrying capacity of the helicopter.

b. Balance – Cargo must be arranged so that the helicopter's balance is maintained.

c. Restraint – Cargo must be restrained from undesired movements.

13–67. Weight. Weight is the simplest of the three elements that have to be dealt with. Each helicopter is weighed from time to time to determine its empty or basic weight. The design of the helicopter permits computation of its maximum allowable gross or loaded weight. To find the weight of cargo that may be carried on any particular mission, the basic helicopter weight, together with the weights of the required fuel, oil, crew, and other essentials, must be added and the result subtracted from the allowable gross weight. The cargo is further restricted by the strength of the cargo floor and location of the cargo in the helicopter. Cargo item weights must not be so concentrated that the floor limits are exceeded.

13–68. Balance. As in every object, the helicopter has a point about which it will balance. This point is known as the center of gravity. An item which is added or removed from the helicopter will cause a shift in the balance of the helicopter and cause the cg of the helicopter to shift provided the weight was not added or removed at the cg. If the cg shifts too far forward or too far aft, the helicopter will develop unsafe flight characteristics. Cargo must be loaded so that the cg of the helicopter falls within the range specified in Chapter 12. Fortunately, the helicopter has been designed with a fairly large range in which the cg can travel and balance is not critical for most cargo loads. If the cargo is loaded so that the center of gravity of the cargo falls within the limits as specified in Chapter 12, the center of gravity of the loaded helicopter should be within the operating limits.

13–69. Cargo Center of Gravity Planning. The permissible location of the cargo center of gravity within the helicopter will vary with the fuel load carried by the helicopter. There are 15 types of fuel loads shown on chart 13–1. Determine the type fuel load the helicopter will carry before planning cargo center of gravity. Chart 13–1, sheet 1 of 3, indicates the permissible cg range of cargo on helicopters with internal fuel loads only. Sheet 2 of 3 indicates the permissible cg range of cargo on helicopters with various combinations of internal fuel loads and external fuel loads, using two 150-gallon external tanks. Sheet 3 of 3 indicates the permissible cg range of cargo on helicopters with various combinations of internal fuel loads and external fuel loads, using two 300-gallon external tanks. The cargo center of gravity planning charts are to be used for planning purposes only.

13–70. Planning Procedures. If the cargo is loaded so that the center of gravity of the cargo load falls within the limits specified in the appropriate placement chart of chart 13–1, the cg of the loaded helicopter will almost always be within the operating limits of the helicopter. Prior to planning load center of gravity, the fuel load of the helicopter should be determined as this will dictate the amount of cargo that will be carried. Prior to actual loading, the location of the individual item should be planned and a check made to determine if this arrangement is satisfactory. Heavy items of cargo and vehicles should be placed in such order that the cg of the cargo falls at approximately station 200, as seen in chart 13–1. If there is any question as to whether a load is within the limits shown in chart 13–1, then the placement of cargo must be planned in detail. The detail planning procedure consists of four steps. The first step is to select the location in the helicopter for the individual items of the cargo. If the cg of the load is determined by the compartment method, the selection of location consists of merely deciding into which compartments the items are to be loaded. If the station method is used, then specific locations have to be assigned to each item of cargo. The second step is to determine the cg of the cargo load. If the load consists of many items of cargo, the compartment method should be used. If the load consists of only a single item or a few items, such as vehicles, the station method should be used. The third step is to contact the crew chief or flight personnel for information as to the type of fuel load being used.

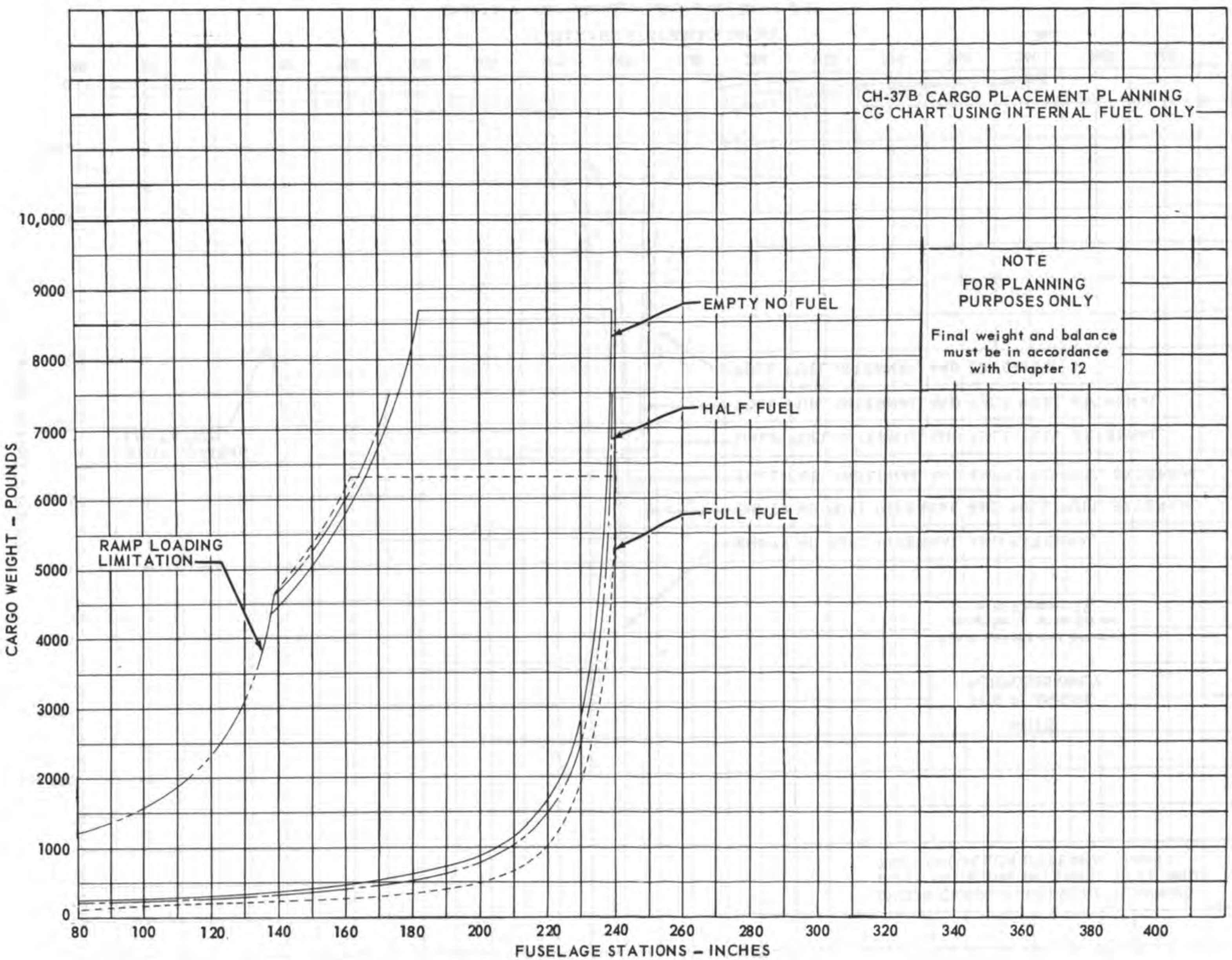


Chart 13–1. Cargo planning placement chart (Sheet 1 of 3)

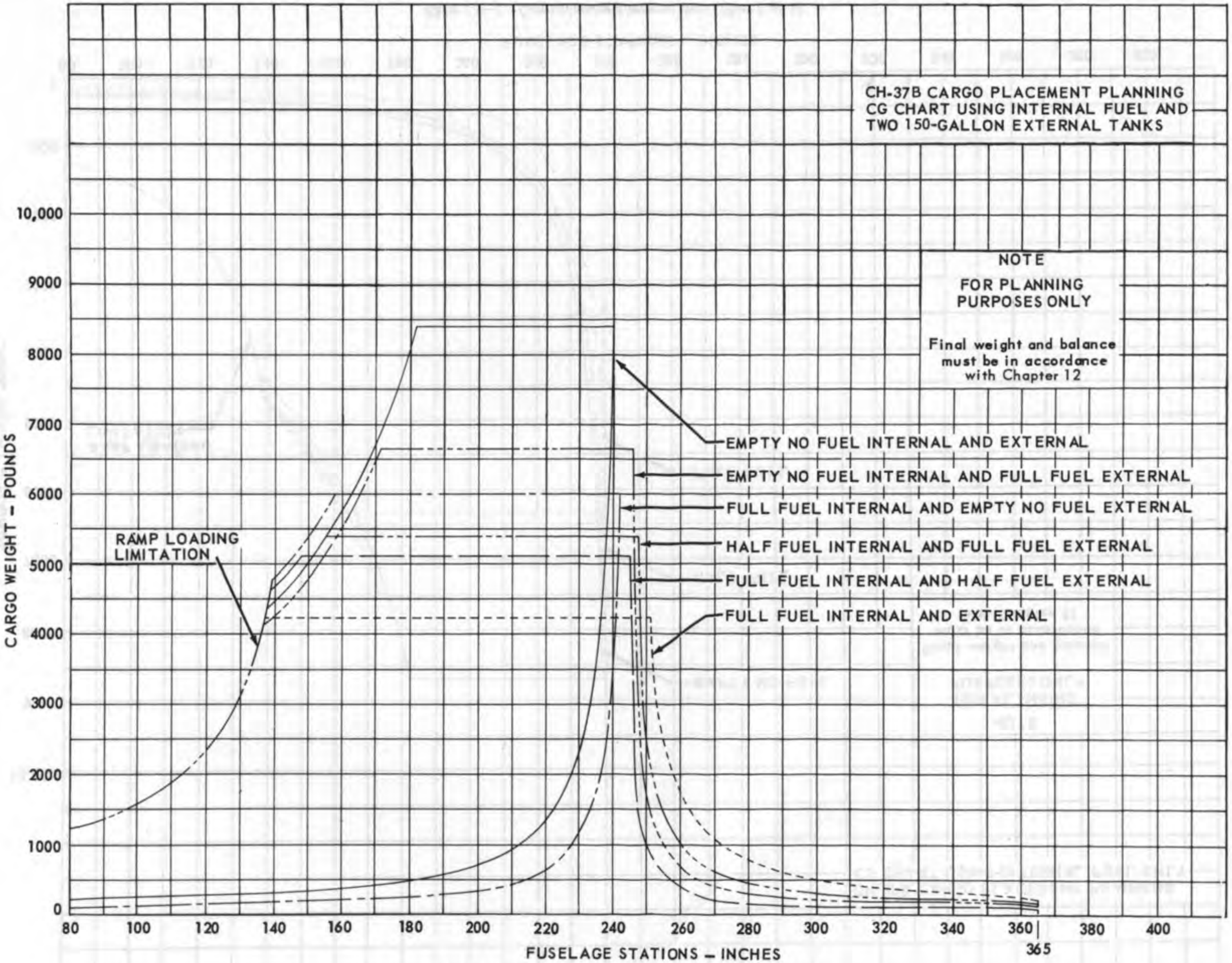


Chart 13–1. Cargo planning placement chart {Sheet 2 of 3}

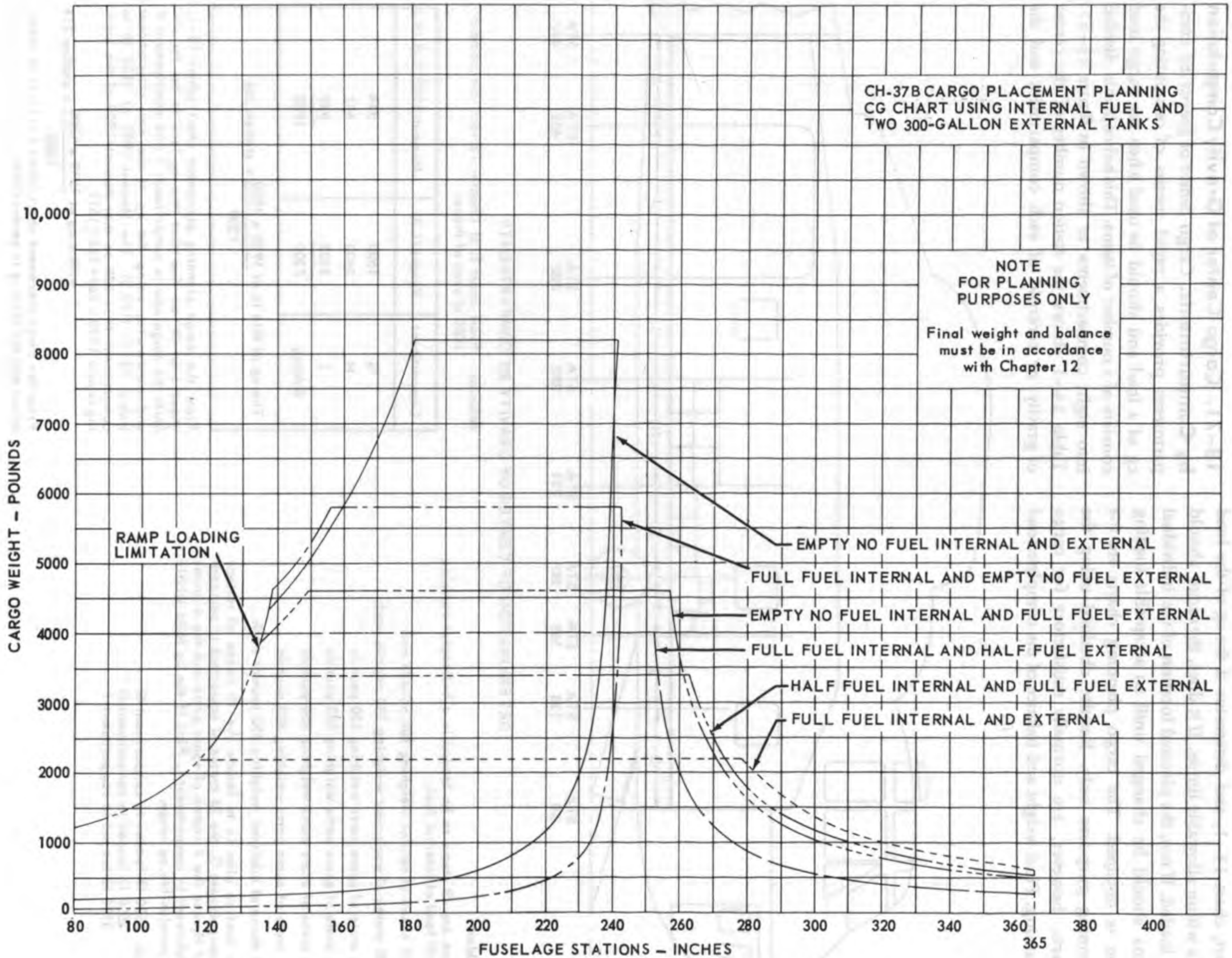
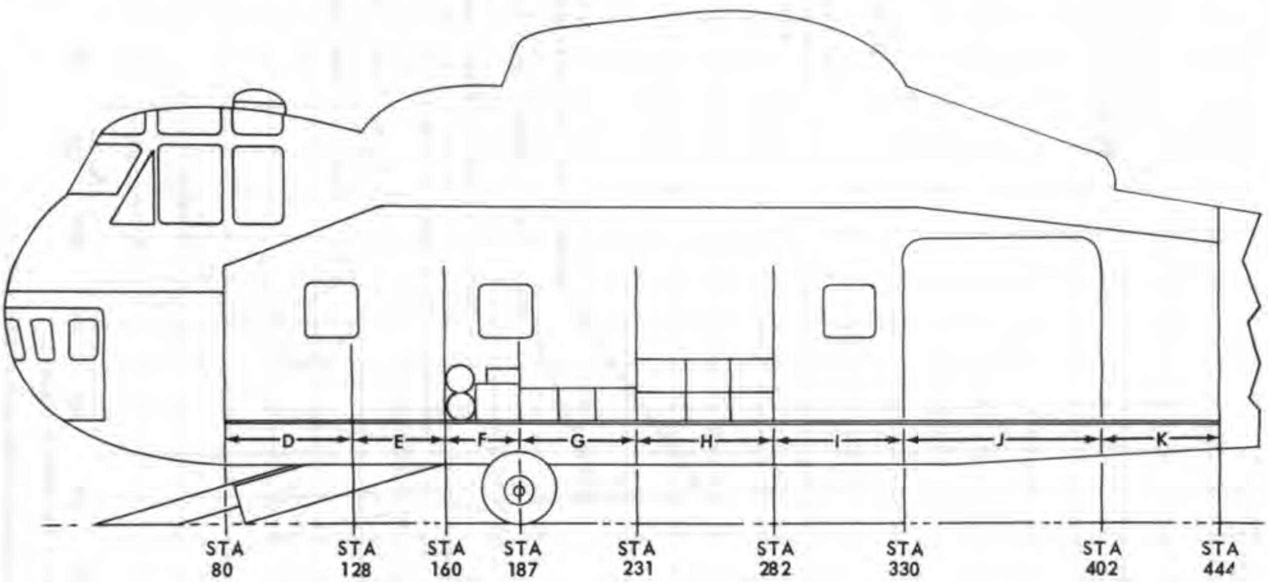


Chart 13–1. Cargo planning placement chart (Sheet 3 of 3)

The fourth step is to locate the appropriate curve on the appropriate chart of the cargo planning placement chart, chart 13–1, and determine if the cg of the load falls within allowable limits. If it does, the cargo should be loaded. If not, the planned location of the individual items should be changed until an acceptable loading plan is obtained. The cargo planning charts are for planning purposes only. Results obtained using the charts, however, are normally satisfactory for cargo planning. Final weight and balance of the complete load after it is loaded into the helicopter must always be determined in accordance with Chapter 12.

13–71. Cargo Center of Gravity Computation by Compartments. Cargo center of gravity by compartments provides a rapid means of computing the cg of a load and should be used when the cargo load consists of a number of items. This helicopter is divided into eight compartments as shown in figure 13–57. Table 13–1 shows the station number of the center of gravity or centroid of each compartment and the



DETERMINATION OF CENTER OF GRAVITY BY COMPARTMENTS

Problem:

There are 49 items to be loaded in a helicopter carrying a half load of internal fuel.

- 15 cases of rations weighing 100 pounds each
- 26 crates of equipment weighing 100 pounds each
- 1 crate of spare parts weighing 550 pounds
- 1 crate of spare parts weighing 500 pounds
- 1 crate of spare parts weighing 250 pounds
- 1 crate of spare parts weighing 400 pounds
- 4 drums of lubricant weighing 350 pounds each

The loading plan is to locate the 15 cases of rations in compartment G, the 26 crates of equipment in compartment H, and the 4 crates of spare parts and the 4 drums of lubricant in compartment I. Find if the cg falls within the permissible cg range.

Load: 1500 lb loaded in compartment G
2600 lb loaded in compartment H
3100 lb loaded in compartment I

Solution: From chart E of Chapter 12 read the moment/1000 of each of these:

Compartment	Weight (LB)	Moment/1000 (LB IN.)
G	1500	314
H	2600	667
I	3100	949
Adding	7200	1930

The cg of this is at $\frac{1930 \times 1000}{7200}$ = station 268

From the cargo planning placement chart (chart 13–1, sheet 1 of 3), we find that this cg load is too far aft. Shift the cargo now in compartment 1 into compartment F and compute, using the cg of the new compartment (table 13–1) (173.5). The Moment/1000 of 3100 lb in compartment F is 538 so that Moment/1000 of the loading is now 1930 – 949 + 538 = 1519

with a cg at $\frac{1519 \times 1000}{7200}$ = station 211

From the cargo placement chart (chart 13–1), it is determined that the loading is permissible.

Figure 13–57. Computation of center of gravity by compartment maximum weight which can be carried in each compartment without exceeding the strength of the fuselage of the helicopter. The same information is marked on the cargo compartment wall in each compartment. When using this method, it is assumed that the weight of all cargo placed in the compartment is concentrated at the center of gravity of the compartment. If an item is placed so that it extends into both compartments, the weight of the item should be proportionately distributed to each compartment. The cg of the cargo load is calculated as follows:

a. Record weight of cargo in each compartment.

b. Multiply total weight in each compartment by station number of cg of the compartment. This result is known as compartment moment. For sample problem, see figure 13–57. (This calculation can be avoided by using figure 12–3, sheets 9 and 10.)

c. Add compartment moments.

d. Add total weight in compartments.

e. Divide the sums of cargo moments by total weight. The result is location of cg load. For sample problem, see figure 13–57.

13–72. Cargo Center of Gravity Computation by Station.

Computing the center of gravity of cargo by stations provides a method of computing the precise center of gravity of the load and should be used when the load consists of a few heavy items or vehicles. In order to use this method, the cg of each item of cargo must be known.

Note

If cg of vehicles is not known, computation can be made with wheel loads. For sample problem, see figure 13–58.

The basic principle underlying the station method is that the cg of each item in the helicopter will coincide with a fuselage station number. The cg of the load is calculated as follows:

a. Set up a table similar to the one shown in figure 13–58 and record weight and station number of contact area of each item.

b. Calculate moments of each item. This is accomplished by multiplying weight of item by station number of contact area.

c. Add moments to obtain total load moments.

d. Add weight to obtain the total load weight.

e. Divide total load moment by total weight to obtain cg of load.

Table 13–1. Cargo compartment load data

LOADING LIMITS – CARGO COMPARTMENT			
COMPARTMENTS	COMPARTMENT STATION LIMITS	COMPARTMENT CENTER OF GRAVITY	COMPARTMENT MAXIMUM LOAD IN POUNDS
D	80 to 128	104	1500
E	128 to 160	144	5800
F	160 to 187	173.5	4900
G	187 to 231	209	7700
H	231 to 282	256.5	7700
I	282 to 330	306	5900
J	330 to 402	365	4500

NOTES

1. Total cargo weight including cargo sling loading must not exceed 10,000 pounds.
2. Center of gravity must be within limits of cargo placement planning chart, chart 13–1.
3. Do not load compartment D if compartment E is loaded.

13–73. Loading Procedures.

All cargo loads should normally be planned before being actually loaded into the helicopter. The degree of load planning will vary with each operation depending upon the cargo to be loaded and the experience of the loading personnel. Basic factors that must be considered in planning the placement of various cargo loads are listed in their respective checklist.

13–74. Cargo Loading Checklist. When loading cargo such as crates, sacks, jerry cans, drums, and other miscellaneous cargo, use the following checks:

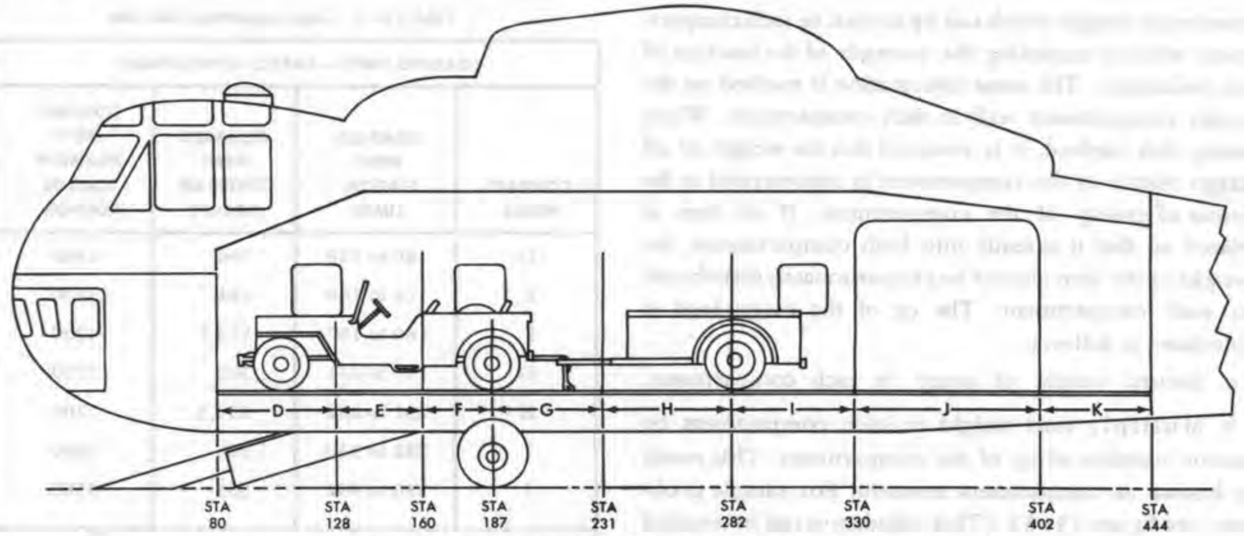
a. Cargo must be loaded so center of gravity of loaded helicopter remains within operating limits defined in Chapter 12.

b. Cargo must be loaded so maximum load weight of each compartment within cargo compartment is not exceeded. (Refer to table 13–1.)

c. Cargo exceeding maximum weight per square foot must be shored. (Refer to table 13–2.)

d. Cargo must be loaded in manner that will avoid damage to cargo floor; use shoring when using rolling casters, pinch bars, or levers to move cargo.

e. All markings on the cargo compartment walls must be observed.



DETERMINATION OF CENTER OF GRAVITY BY STATIONS

Problem: A 1/4-ton jeep and a trailer are to be carried in one load in the helicopter; find the center of gravity of the load and where it can be located in the helicopter with full internal fuel tanks and two 150-gallon external fuel tanks.

The weights and dimensions of these two vehicles, taken from TM 9-2800-1, are as follows:

	1/4-TON JEEP MODEL CJ-3A	1/4-TON TRAILER MODEL M100
Length	130 inches	109 inches
Height	54 inches	42 inches
Width	69 inches	56 inches
Front axle weight (empty)	1305 pounds	
Lunette weight (empty)		85 pounds
Rear axle weight (empty)	978 pounds	480 pounds
Wheel Base	80 inches	60 inches (estimated)

Solution: Assume that a trailer with its center of gravity unknown is backed into the helicopter and stopped with its wheel at station 284 and the lunette of the trailer resting at station 224. The 1/4-ton truck (jeep) is backed into the helicopter locating the rear wheels at station 187, and the front wheels at station 107. (The station location of the trailer's lunette and rear axle of the jeep are estimated. TM 9-2800-1 does not give the exact distance of the lunette from the trailer axle.)

Multiply wheel weight x station.

480 lb x station 284 =	136,320
86 lb x station 224 =	19,040
978 lb x station 187 =	182,886
1305 lb x station 107 =	139,635
2848	477,881

We now take the totals of the multiplication and add, this gives us a total of 477,881. We total the weight and divide it into our new sum; the result is 167.8. The center of gravity of the load is between fuselage stations 167 and 168. On chart 13–1, sheet 2, find 3000 pounds on the left border of the chart.

NOTE

IF THE CG OF THE VEHICLE WERE KNOWN, THE CG COULD HAVE BEEN USED AND THE COMPUTATION COULD HAVE BEEN SIMPLIFIED.

Following this line across to the right, we find that the center of gravity of a load of 3000 pounds with this type fuel load may not lie forward of fuselage station 128, or aft of fuselage station 253. These are the points at which the 3000-pound line enters and leaves the appropriate curve of the chart. The center of gravity of the load calculated lies between these limits. Therefore, the load can be carried without causing the center of gravity of the helicopter to fall outside its limits.

Figure 13–58. Computation of center of gravity by stations

f. Cargo must be arranged to permit free access to emergency exits and equipment during flight.

g. Boxes and crates must be loaded in accordance with any instructions marked on them.

h. All cargo must be properly stacked to prevent damage to fragile items.

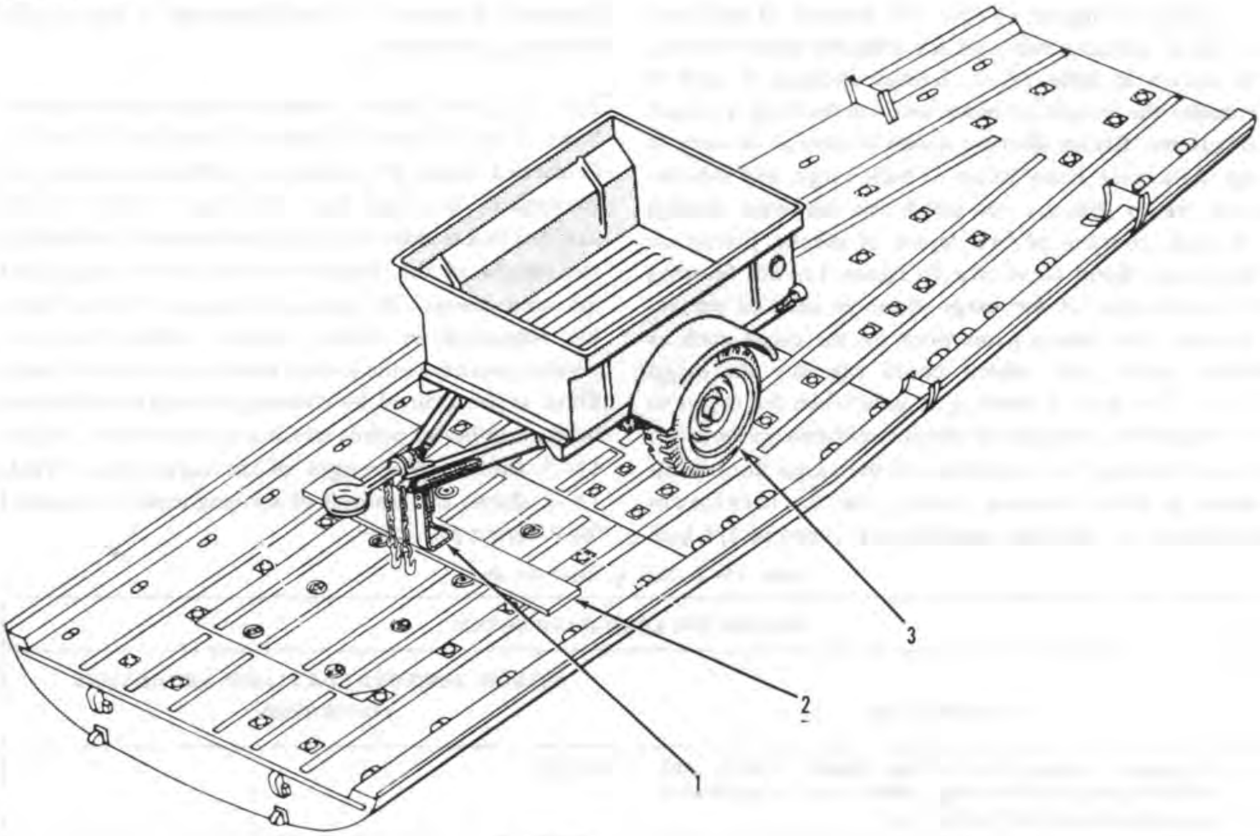
i. Cargo should be arranged to permit rapid attachment of tie-down devices.

13–75. Shoring. Shoring is used for two purposes: Load distribution and protection of the cargo floor. Shoring for load distribution consists of two types: Direct shoring and bridge shoring. Direct shoring is used to spread concentrated loads imposed by cargo on small wheels, casters, short skids, etc, over a larger area of the floor. This type of shoring consists of planks or heavy plywood placed on the cargo floor as shown in figure 13–59. The amount of thickness of direct shoring required for different types of loads is shown in table 13–2. Bridge shoring is used to transfer the weight of heavy items to the high strength treadways. Bridge shoring makes it possible to carry in the helicopter heavy items of bulk cargo and vehicles with treads that do not match the treadways. Bridge shoring consists of two layers of planks placed on the cargo floor as shown in figure 13–60. Shoring for protection of the cargo floor is used to prevent damage from sharp projections on the cargo such as cleats, studs, etc, which could dig into the cargo floor. This type of shoring is used when the cargo to be loaded has projections which could damage the cargo floor. Shoring for protection of the cargo floor is the same as direct shoring, except that the minimum thickness of shoring material to be used is 1/4 inch plywood; however, 1/4 inch plywood is not suitable for load distribution.

13–76. Contact Pressure. Contact pressure is calculated for heavy items in order to determine whether a load can be carried inside the helicopter without exceeding the strength of the cargo floor. The contact pressure of skidded boxes and crates, etc, is determined by dividing the weight of the item by the area of the cargo floor the item covers. The contact pressure of items which are supported by wheels, casters, rollers, legs, etc, which concentrate the load at several points on the cargo floor, is determined by dividing the weight of the item by the number of points which support the item. Figure 13–5 shows the strength of the cargo floor. Table 13–2 shows the amount of shoring which is required for different type loads.

Table 13–2. Rule of thumb for shoring

SHORING FOR LOAD DISTRIBUTION	
TYPE OF LOAD	SHORING REQUIRED FOR FLIGHT AND LOADING (THICKNESS)
Pneumatic tires, flat bottom boxes, crates, and skidded cargo with long skids, up to allowable pressures shown in Section II.	NONE
Pneumatic tires, flat bottom boxes, crates, and skidded cargo with long skids which cannot be placed on the treadways and have contact pressures which exceed the nontreadway pressures, but do not exceed the allowable treadway pressures shown in Section II.	Use bridge to transfer the weight of the cargo to the treadways.
Skidded cargo with short skids (less than 18 inches) and contact pressures over 300 pounds per square foot, but under the allowable treadway pressures shown in Section II.	If cargo is on treadways, 1 inch direct shoring; if cargo is off treadways, use bridge shoring.
Cargo with wheels, legs, casters, etc, that concentrate the load of the cargo on the cargo floor at several points with pressures up to 300 pounds per support.	1 inch direct shoring.
Cargo with wheels, legs, casters, etc, that concentrate the load of the cargo on the floor at several points with pressures over 300 pounds per support, but under the allowable treadway pressures. **Note** Points which fall in the same square foot, for example dual caster, should be regarded as only one support.	If cargo is off treadways, use bridge shoring to transfer the weight of the cargo to the treadways. If cargo is on treadways, use 1 inch of direct shoring for first 300 pounds and 1/4 inch for each 100 pounds added.
SHORING FOR PROTECTION OF CARGO FLOOR	
TYPE OF LOAD	SHORING REQUIRED FOR FLIGHT AND LOADING (THICKNESS)
Any load that has protrusions which can dig into the cargo floor.	Minimum of 1/4 inch of plywood.



1. Lunette
2. Plank shoring
3. Wheel contact or treadway

Figure 13–59. Direct shoring

13–77. Vehicle Loading. Vehicles may be loaded into the helicopter utilizing their own power, or they may be towed into position with cargo hoist.

Note

All loading operations will be greatly simplified if vehicles are properly centered in line with helicopter and ramps before commencing actual loading.

Vehicles, such as the 1/4-ton trucks, trailers, 75 mm and 105 mm howitzers, and several other small utility vehicles, may be carried singly or in combinations which do not exceed the size and weight limitations of the helicopter. The dimensions of the vehicle should be checked before trying to load it into the helicopter. Some vehicles that may at first appear too large can be reduced in height by taking down their top bows or deflating the tires. Their length can be reduced by removing the bumpers; however, the width can seldom be reduced.

13–78. Vehicle Loading Checklist. The following checks are to be accomplished before loading vehicle.

a. Assemble vehicles to be transported.

b. On vehicles, fold rear view mirrors, windshields, tail gates, and antennas.

c. Secure loose equipment in or on all vehicles.

d. Tighten all gas tank caps, battery caps, and oil filler caps.

e. Brakes of all vehicles should be checked for proper operation before driving into the helicopter.

f. Limit amount of fuel in each gas tank to three-fourths of its capacity to prevent air in tank forcing fuel out of filler neck while helicopter is in flight. (See figure 13–53.)

g. Align all vehicles with centerline of helicopter carefully before driving into cargo compartment.

h. Set all vehicles in lowest gear with gear case in low range.

i. Prearrange hand signals for control when loading vehicles, as shown in figure 13–61.

j. Axle load (of vehicles) – Obtained from scale or name plate and expressed in pounds.

k. Wheel load (of vehicles) – Axle load divided by number of wheels per axle and expressed in pounds.

13–79. Vehicle Loading Procedure. Vehicle loading procedures are as follows:

a. Align vehicles carefully with the ramp extensions to insure that they are positioned correctly.

b. Shore cargo floor as required.

c. Drive or tow vehicle up ramp into helicopter.

d. Position vehicle at proper location inside helicopter.

e. After vehicle is positioned, check:

(1) Vehicle ignition off.

(2) Parking brakes set.

(3) Springs chocked when applicable.

(4) Wheel chocks in place when required.

f. Tie down vehicle.

Note

If vehicle fuel is spilled:

(1) Discontinue use of cargo winch and all electrical equipment which may possibly spark and cause fuel to ignite.

(2) Ventilate cabin.

(3) Wipe up spilled fuel.

13–80. Special Vehicle Loading Considerations.

a. If a vehicle is driven into helicopter, vehicle driver must follow instructions of guide and not attempt to judge clearances himself. Prearranged maneuvering signals must be clearly understood. (See figure 13–61.)

b. Two-wheel trailers are difficult to back up cargo ramps to helicopter using a 1/4-ton truck as a prime mover. To facilitate loading, trailers should be winched into helicopter whenever possible.

c. When loading vehicles without brakes, wheel chocks should be immediately available to prevent equipment from rolling beyond its loading position.

d. When winching howitzers or trailers into helicopters, it is necessary to steer equipment. This must be done manually.

Caution

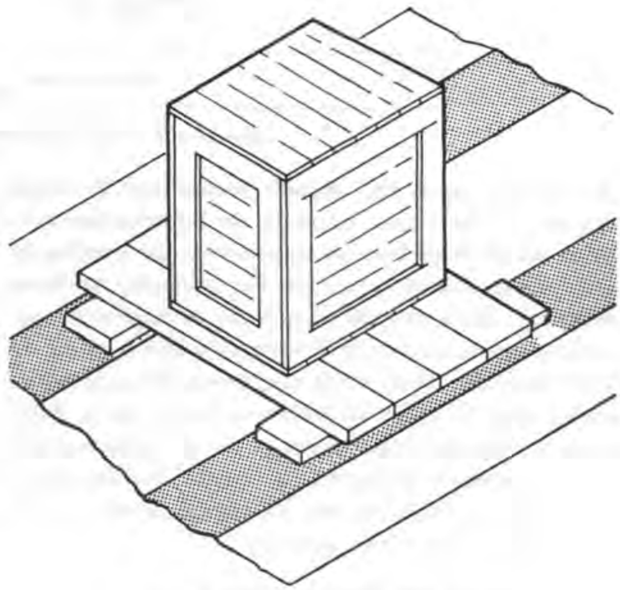
The 105 mm howitzer has minimum clearance between its hubs and cargo compartment wall.

e. Spot 105 mm howitzer wheels on the white line indicated by arrow and stencil between stations 160 and 187.

13–81. Securing Loads. The procedures used in securing loads are as follows:

13–82. Restraint Criterion. Cargo in the helicopter is subjected to forces resulting from rough air, acceleration, autorotation, vibration, rough landings, crash landings, etc. These forces act more strongly in some directions than in others and tend to shift the cargo unless it is properly restrained. Since the helicopter and the cargo both move forward during normal operation, the cargo will tend to keep on moving forward if the helicopter is suddenly slowed by change of pitch, landing on soft ground, or stopped by a crash landing. This direction of forces is the strongest that is likely to act on the cargo, but the cargo must also be secured against other forces trying to move it aft, from side to side (laterally), or up and down (vertically). The amount of restraint that must be used to keep the cargo from moving in any direction is called the restraint criterion and is usually expressed in units of force of gravity, or G's. The following are the units of the force of gravity or G's required to restrain cargo in the four directions:

Forward	4.0 G's
Aft	2.0 G's
Lateral	1.5 G's
Vertical	2.0 G's



RULES FOR CONSTRUCTIVE BRIDGE SHORING

A. Place shoring planks for distributing load on treadways.

B. Place planks at right angles to shoring planks to bridge load.

C. Place load on planks. Weight of the load is distributed over bearing area of shoring planks (A) to treadways. If bridge sags under load, rebuild it with heavier planks.

Figure 13–60. Bridge shoring

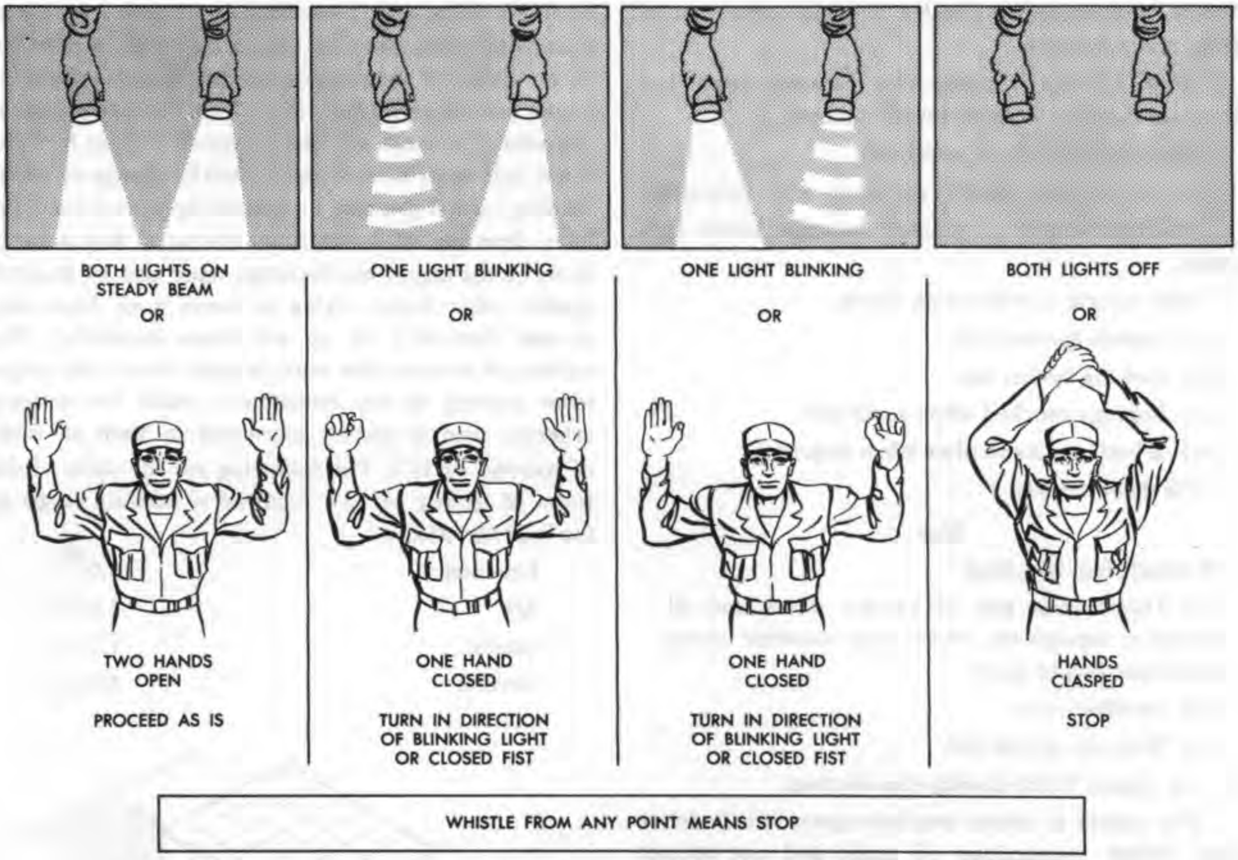


Figure 13–61. Night and day loading signals for self-propelled vehicles

In all four cases, this actually means that the force exerted by the object or cargo to be restrained may be as much as its normal weight times the number of G's of the restraint criterion. For example, an object weighing 1000 pounds may, if the helicopter is suddenly stopped, tend to move forward with a force up to 4000 pounds. Under other conditions, the same object might tend to move aft with a force of up to 2000 pounds, laterally with a force of up to 1500 pounds, or vertically with a force twice its weight. For the object to be safely carried, the restraint applied must be equal to, or greater than, these amounts.

13–83. Restraint Nomenclature. Any restraint is given the name of the direction in which it is meant to keep the cargo from moving. Forward restraint keeps the cargo from moving forward; aft restraint keeps it from moving aft; lateral restraint keeps it from moving to one side or the other. Vertical restraint keeps it from moving upward only, the downward restraint being supplied by the cargo floor.

13–84. Restraint Devices. The helicopter is equipped with a number of tie-down devices (figure 13–62) which are used to apply the required restraint to the cargo. When cargo is properly secured by the tie-down devices, it will be restrained from moving in any direction within the helicopter.

Tie-down devices that are fastened to a tie-down fitting at an angle of 30 degrees to the cargo floor and along the longitudinal axis of the helicopter will restrain about 87 percent of their rated strength along the longitudinal axis, and about 50 percent of their rated strength along the vertical axis.

Tie-down devices that are fastened at an angle of 30 degrees to the tie-down fittings and at a sideward angle of 30 degrees to the longitudinal axis will restrain values in all three planes of movement. When the tie-down device is fastened to a tie-down fitting at an angle of 30 degrees to the cargo floor and at an angle of 30 degrees to the longitudinal axis of the helicopter, it will also be at the angle of 30 degrees to the longitudinal axis of the helicopter. The restraint value is 75 percent of the rated strength of the tie-down fitting and the lateral value is 43.3 percent.

13–85. Methods of Restraining Cargo. There are two basic methods of applying tie-downs to restrain cargo. The method used depends upon whether or not the cargo has tie-down provisions. Cargo with no tie-down provisions is restrained by passing the tie-down devices (straps) over or around the cargo and attaching both ends of the tie-down device to the tie-down fittings in the cargo floor. Cargo with tie-down provisions is restrained by attaching one end of the tie-down device to the tie-down fittings in the cargo floor and the other end of the tie-down device to the tie-down point on the cargo.

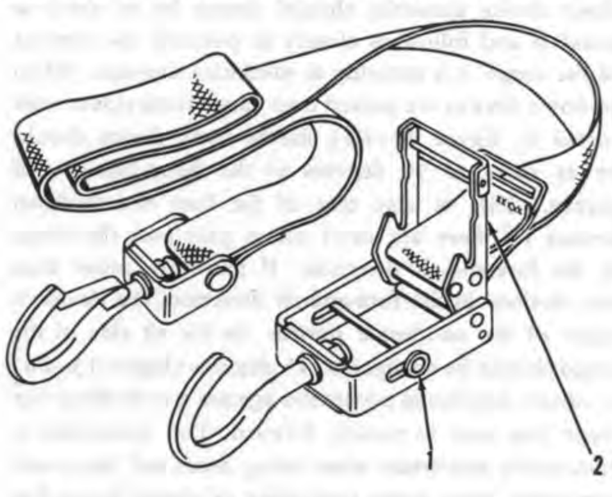
13–86. Restraining Cargo With No Tie-Down Provisions. Many cargo loads carried in the helicopter will consist of a variety of boxes, crates, etc. This type of cargo must be secured by passing tie-down devices over and around the cargo. (See figure 13–63.) When cargo is restrained in this manner, there are three factors which must always be kept in mind.

a. Amount of restraint. A tie-down device placed around an item of cargo will provide restraint equal to the effective strength of the device in the direction it prevents the cargo from moving. This means that an MC-1 tie-down device applied over cargo (detail A, figure 13–63) will provide restraint in the forward, vertical, and aft directions since it will prevent the cargo from moving in these directions.

Note

Effective strength of the MC-1 tie-down device is only 2200 pounds when attached to 2200-pound tie-down fitting.

The device applied across the front of the cargo (detail A, figure 13–64) will only provide restraint in the forward direction since this is the only direction in which it really prevents the cargo from moving. The lateral and vertical restraint from this device would be nil



1. Release
2. Tensioning lever

Figure 13–62. MC-1 tie-down device

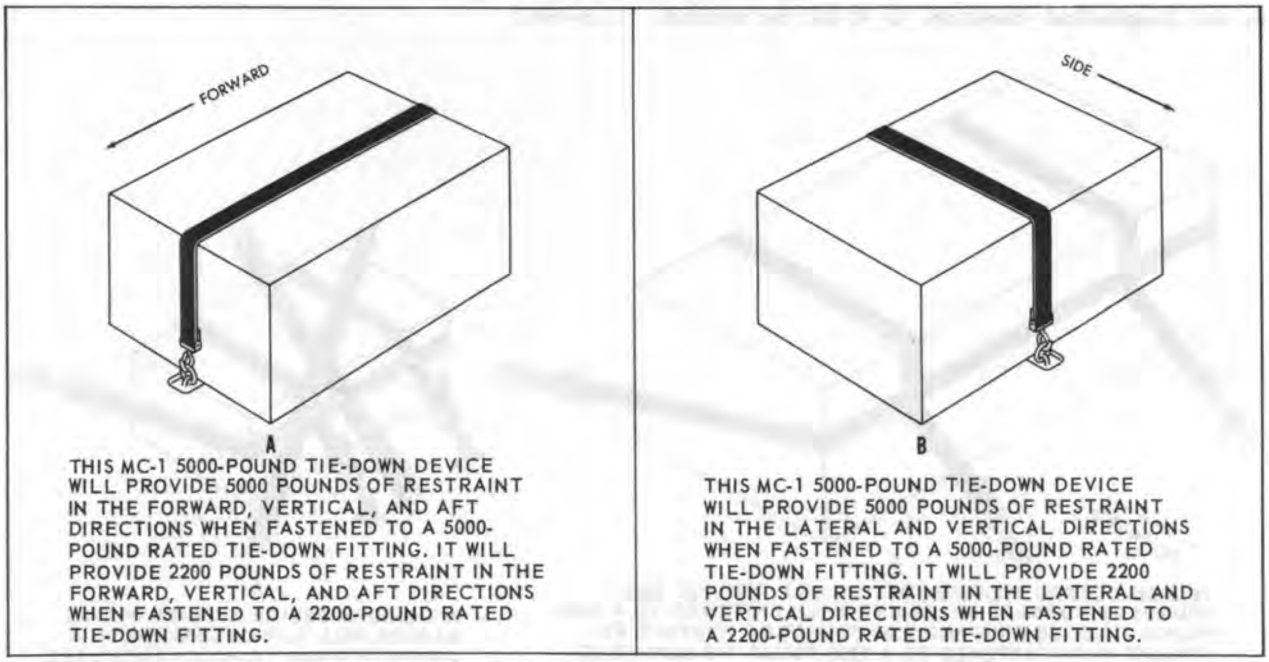


Figure 13–63. Restraint in three directions on cargo with no tie-down provisions

since the cargo can readily move in these directions and extreme care must be taken in applying devices in this manner. (See detail A, figure 13–64.) The device shown in detail B, figure 13–64, is unsatisfactory, since it would slip down to the floor and free the cargo under load. Another way of preventing this from happening is to apply an extra device as shown in detail D, figure 13–65.

b. Length and tie-down angle of the tie-down devices. A tie-down device generally should always be as short as possible and follow as closely as possible the contour of the cargo it is securing to minimize slippage. When tie-down devices are passed over cargo from side to side (detail B, figure 13–63), the tie-down device should be as close to 90 degrees as the floor fittings will permit. This is also true of the first two tie-down devices (if there are two) which pass over the cargo in the fore-and-aft direction. If there are more than two devices in the fore-and-aft direction, the tie-down angle of the additional devices on the aft side of the cargo should be changed to 45 degrees (figure 13–66) to obtain additional protection against any tendency the cargo may have to tumble forward. This procedure is particularly important when tying down tall items and composite cargo loads consisting of several boxes that are stacked. In arranging composite loads, cargo should not be stacked so that it is top-heavy. The height of a composite load should not be greater than its length in the longitudinal direction, if it can be avoided.

Caution

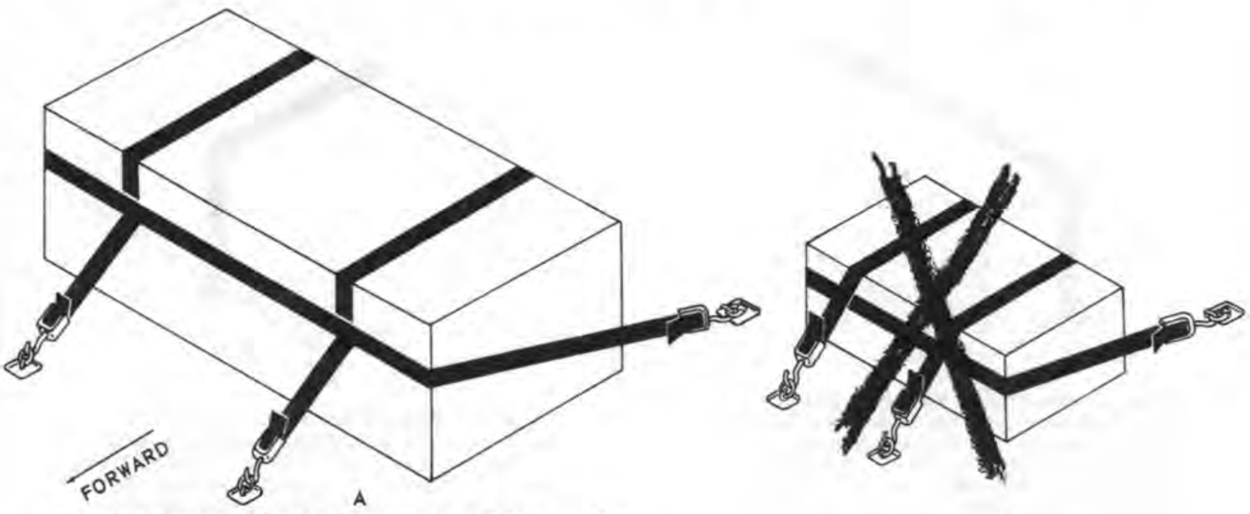
Tie-down angle should be 45 degrees with this technique. A 30-degree angle will allow cargo to shift.

c. Shifting of cargo. Since the tie-down devices are not actually attached to the cargo, care must be taken to insure that the load cannot slip out under the tie-down device. This is especially true when several items are tied down together. After the proper number of tie-down devices have been applied to comply with the restraint criteria, the load should always be checked to see if any part of it can slip free. In many instances where several items are tied down together, it may be necessary to add additional tie-down devices to completely secure the load.

13–87. Rules for Applying Tie-Down Devices to Cargo With No Tie-Down Provisions. The rules used when applying tie-down devices to cargo with no tie-down provisions are as follows:

a. Rule 1. If the item(s) of cargo to be tied down as one load is less than 2000 pounds, see figure 13–65 to determine the minimum number of tie-down devices required to provide restraint.

b. Rule 2. If the load is over 2000 pounds and consists of a single item, follow the procedure outlined in the sample problem. (Refer to paragraph 13–88.)



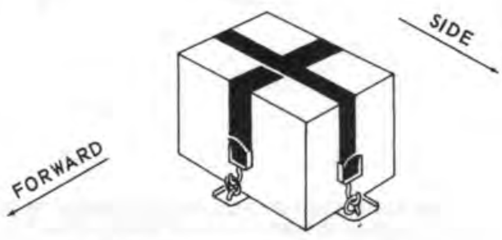
A — THIS MC-1 CARGO TIE-DOWN DEVICE WILL PROVIDE 5000 POUNDS OF FORWARD RESTRAINT WHEN FASTENED TO A 5000-POUND TIE-DOWN RING AND 2200 POUNDS OF FORWARD RESTRAINT WHEN FASTENED TO A 2200-POUND TIE-DOWN RING. THIS TIE-DOWN DOES NOT PROVIDE RESTRAINT IN ANY OTHER DIRECTION. HOWEVER, IT IS USEFUL FOR PROVIDING ADDITIONAL RESTRAINT IN THE FORWARD DIRECTION WHEN THERE IS A SCARCITY OF SUITABLE TIE-DOWN POINTS.

B — A TIE-DOWN DEVICE APPLIED IN THIS MANNER WILL SLIP UNLESS THERE IS ANOTHER STRAP TO HOLD IT IN PLACE. SEE DETAIL D, FIG. 13–65.

Figure 13–64. Forward restraint only on cargo with no tie-down provisions

THIS FIGURE PROVIDES A SIMPLE METHOD FOR DETERMINIMG THE MINIMUM NUMBER OF TIE-DOWN DEVICES REQUIRED TO MEET THE RESTRAINT CRITERIA FOR DIFFERENT CARGO WEIGHTS. THE TIE-DOWN PATTERNS ILLUSTRATED ARE APPLICABLE TO SINGLE AS WELL AS COMPOSITE LOADS; HOWEVER, FOR COMPOSITE LOADS ADDITIONAL TIE-DOWN DEVICES WILL ALMOST ALWAYS BE REQUIRED TO PREVENT THE LOAD FROM SLIPPING. FOR CARGO LOADS HEAVIER THAN THOSE SHOWN BELOW FOLLOW THE PROCEDURE OUTLINED IN THE SAMPLE PROBLEM, PARAGRAPH 13–88.

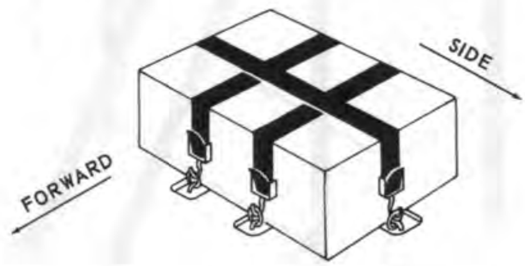
0 TO 500 LB



TIE-DOWN DEVICES REQUIRED:
FORWARD RESTRAINT – 1
SIDE OR LATERAL RESTRAINT – 1
AFT RESTRAINT – 1

A

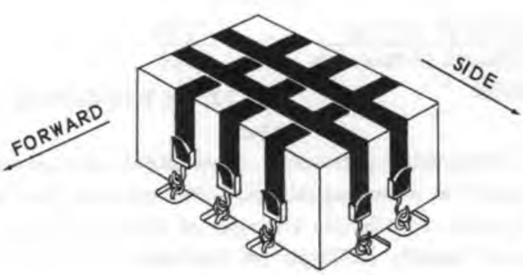
500 TO 1000 LB



TIE-DOWN DEVICES REQUIRED:
FORWARD RESTRAINT – 2
SIDE OR LATERAL RESTRAINT – 1
AFT RESTRAINT – 1

B

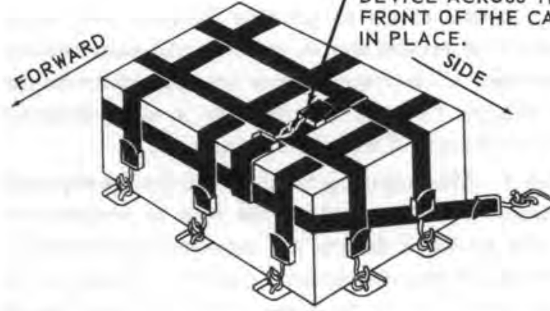
1000 TO 1500 LB



TIE-DOWN DEVICES REQUIRED:
FORWARD RESTRAINT – 3
SIDE OR LATERAL RESTRAINT – 2
AFT RESTRAINT – 2

C

1500 TO 2000 LB



TIE-DOWN DEVICES REQUIRED:
FORWARD RESTRAINT – 4
SIDE OR LATERAL RESTRAINT – 2
AFT RESTRAINT – 2

D

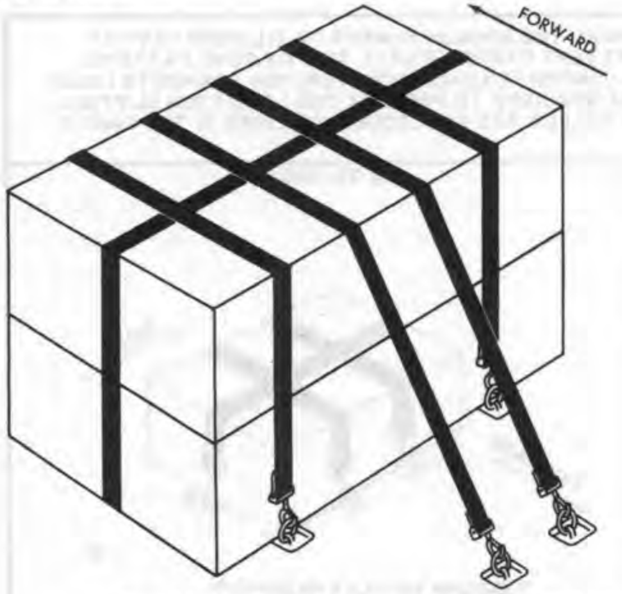
NOTE

THE TIE-DOWN DEVICES USED FOR FORWARD RESTRAINT WILL USUALLY SUPPLY MORE THAN ENOUGH AFT RESTRAINT.

NOTE

THIS FIGURE IS BASED ON THE USE OF 2200-POUND CAPACITY TIE-DOWN FITTINGS. ONE TIE-DOWN DEVICE ATTACHED TO A 5000-POUND CAPACITY FITTING WILL REPLACE TWO 2200-POUND TIE-DOWN DEVICES.

Figure 13–65. Rule of thumb for applying tie-down devices on cargo of various weights and without tie-down provisions



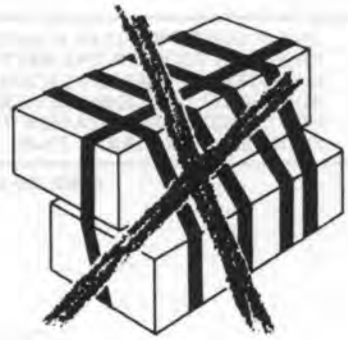


Figure 13–66. Composite load secured to provide sufficient restraint and to avoid tumbling on cargo with no tie-down provisions

c. Rule 3. If the load is over 2000 pounds and if it is a composite load consisting of several items, separate the load into two smaller loads. If this is not possible, follow the procedure outlined in the sample problem. (Refer to paragraph 13–88.)

d. Rule 4. If sufficient tie-down devices are applied over the top of the cargo to provide forward and lateral restraint, then vertical and aft restraint will automatically be provided. If tie-down devices are applied across the cargo (figure 13–65), the restraint in each direction should be checked if there is any question.

e. Rule 5. After applying the tie-down devices required for minimum restraint, check the load to determine if additional tie-down devices are required to prevent the load from shifting. Composite loads will almost always require additional tie-down devices in the lateral direction.

13–88. Sample Problem for Securing Cargo With No Tie-Down Provisions. Determine the amount of tie-down devices required to properly secure a composite load of 1800 pounds as shown in figure 13–67.

Note

The minimum number of tie-down devices required to restrain the cargo can be obtained directly from figure 13–65. This problem will be worked out in detail, however, in order to illustrate the general method.

a. Determine the amount of forward and lateral restraint. Refer to rule 4, paragraph 13–87*d*.

1800 x 4.0 G's = 7200 pounds of forward restraint

1800 x 1.5 G's = 2700 pounds of lateral restraint

b. Determine the number of tie-down devices necessary to provide the required restraint.

FORWARD

$$\frac{\text{Required restraint}}{\text{Strength of tie-down device}} = \frac{7200}{2200}$$

= 3.27; use 4 tie-down devices

LATERAL

$$\frac{\text{Required restraint}}{\text{Strength of tie-down device}} = \frac{2700}{2200}$$

= 1.22; use 2 tie-down devices

Note

In determining number of tie-down devices required in above equations, 2200 pounds should be used as effective strength of tie-down devices since usually 2200-pound tie-down devices will be used in securing cargo without tie-down provisions. If, in tying down load, some 5000-pound fittings are actually used, as may often be the case (figure 13–67), a quick rule of thumb that can be used is that one tie-down device attached between two 5000-pound fittings is equal to two tie-down devices attached between 2200-pound fittings.

Caution

If one end of a tie-down device is attached to a 5000-pound fitting and other is attached to a 2200-pound fitting, effective strength of tie-down device is still only 2200 pounds.

c. Apply tie-down devices to the load.

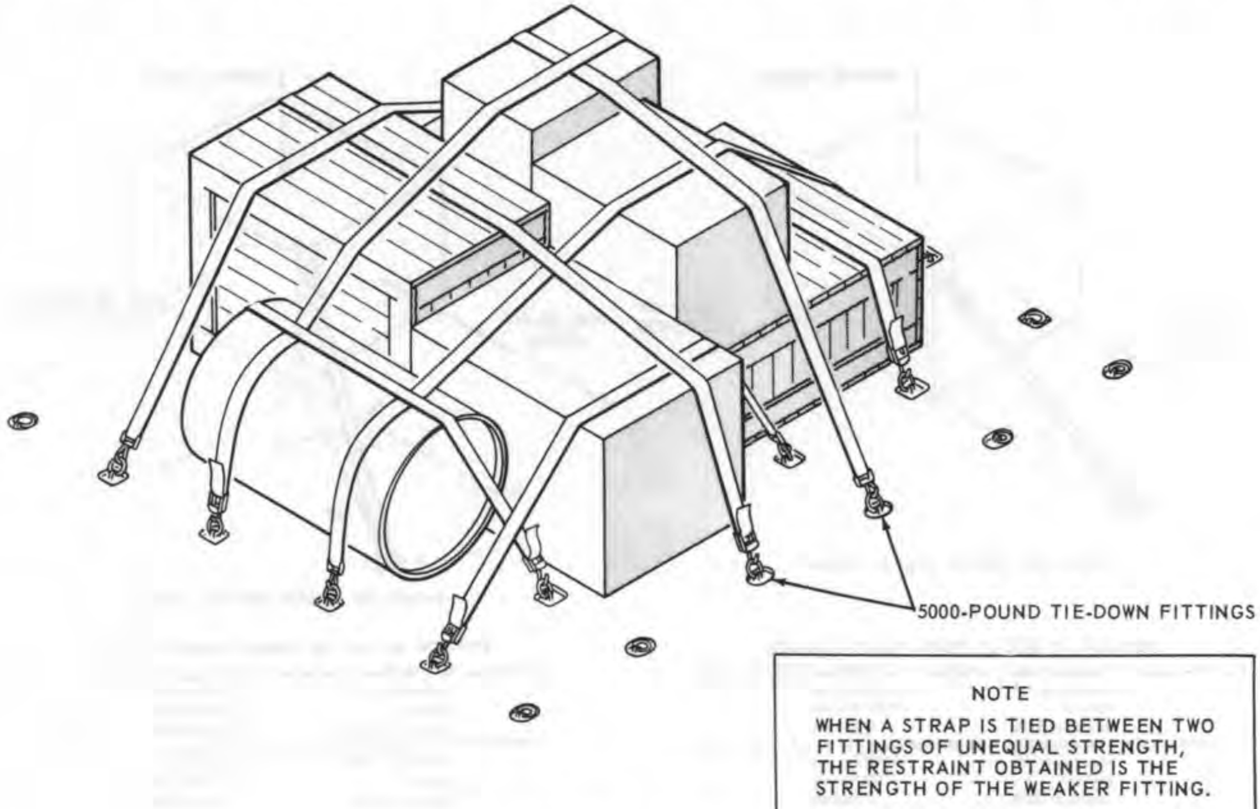
d. In accordance with rule 5, paragraph 13–87*e*, check the load to see if any additional tie-down devices are required to prevent the load from shifting. In this case, it is obvious that more than two tie-down devices are required to prevent the cargo from shifting sideward and that at least four tie-down devices will be required.

13–89. Restraining Cargo With Tie-Down Provisions.

Vehicles, special shipping containers, and some items of equipment are provided with rings or other suitable points to which cargo tie-down devices can be attached. This type of cargo should be secured as shown in figure 13–68. When cargo is secured by attaching tie-down devices directly to the cargo, there are two factors which must be kept in mind.

a. Amount of restraint. A tie-down device, attached between a tie-down ring or point on an item of cargo and a tie-down fitting in the cargo floor, will provide restraint equal to the strength of the tie-down device in the direction of the tie-down device. In practice, however, it is not feasible to attach tie-down devices purely in the direction in which restraint is required because of the location of the tie-down provisions on the cargo. Most tie-down devices out of necessity must be attached at an angle to the desired direction of restraint and consequently only a part of the effective strength of the tie-down device will be available to provide restraint in the desired direction.

b. Tie-down angle. **The tie-down angle is very important and must be considered since it determines the amount of restraint which can be obtained in any direction. To minimize the number of tie-down devices, and to simplify the calculation of the number of tie-down devices required to restrain a load, all tie-down devices should be applied as closely as possible to the two rule of thumb tie-down angles shown in figure 13–69. The amount of restraint that can be obtained in any direction when the tie-down device is applied at the recommended tie-down angles is shown in table 13–3. In tying down cargo, at least four tie-down devices should be applied at an angle of 30 degrees to the cargo floor and 30 degrees to the longitudinal axis of the helicopter, as shown in figure 13–70, in order to provide restraint in all directions. If additional restraint is needed in the forward direction, additional devices can be applied at the same tie-down angles or at an angle which is 30 degrees to the cargo floor and 0 degrees to the longitudinal axis of the helicopter. Tie-down devices applied at 30 degrees or 0 degrees do not provide any lateral restraint, because they must be used with the 2200-pound tie-down fittings which do**



NOTE

WHEN A STRAP IS TIED BETWEEN TWO FITTINGS OF UNEQUAL STRENGTH, THE RESTRAINT OBTAINED IS THE STRENGTH OF THE WEAKER FITTING.

Figure 13–67. Typical composite load on cargo with no tie-down provisions

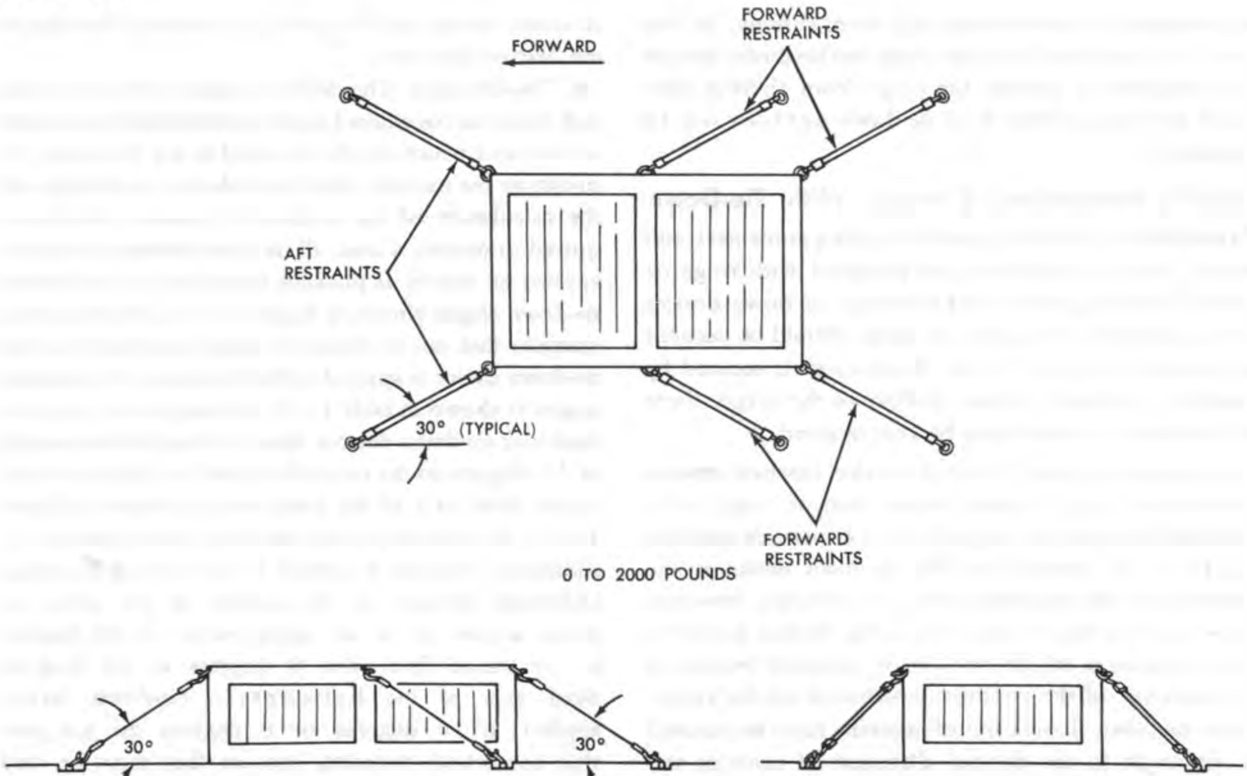
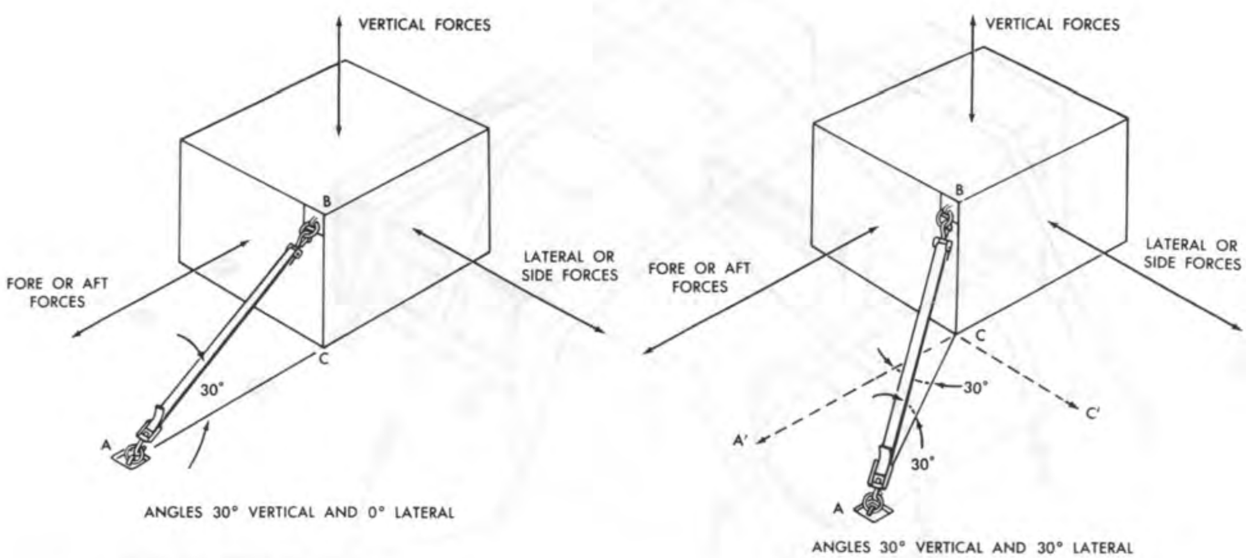


Figure 13–68. Typical application of tie-down devices to cargo with tie-down provisions



RESTRAINT AT RULE OF THUMB TIE-DOWN ANGLES

a. With one MC-1 tie-down device attached to one 5000-pound tie-down ring:

Forward or Aft	4330 Pounds
Vertical	2500 Pounds
Lateral or Side	0 Pounds

b. With one MC-1 tie-down device attached to one 2200-pound tie-down ring:

Forward or Aft	1905 Pounds
Vertical	1100 Pounds
Lateral or Side	0 Pounds

RESTRAINT AT RULE OF THUMB TIE-DOWN ANGLES

a. With one MC-1 tie-down attached to one 5000-pound tie-down fitting:

Forward or Aft	3750 Pounds
Vertical	2500 Pounds
Lateral or Side	2165 Pounds

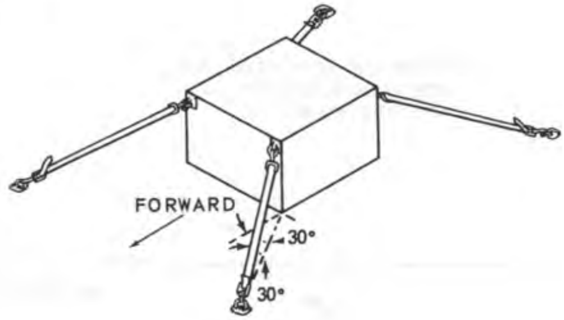
b. With one MC-1 tie-down attached to one 2200-pound tie-down fitting:

Forward or Aft	1650 Pounds
Vertical	1100 Pounds
Lateral or Side	955 Pounds

Figure 13–69. Rule of thumb tie-down angle for cargo with tie-down provisions

THIS FIGURE PROVIDES A METHOD FOR DETERMINING THE MINIMUM NUMBER OF TIE-DOWN DEVICES REQUIRED TO MEET THE RESTRAINT CRITERIA FOR DIFFERENT CARGO WEIGHTS. THE TIE-DOWN PATTERNS ILLUSTRATED ARE BASED ON THE USE OF 5000-POUND CAPACITY TIE-DOWN FITTINGS.

0 TO 1800 LB

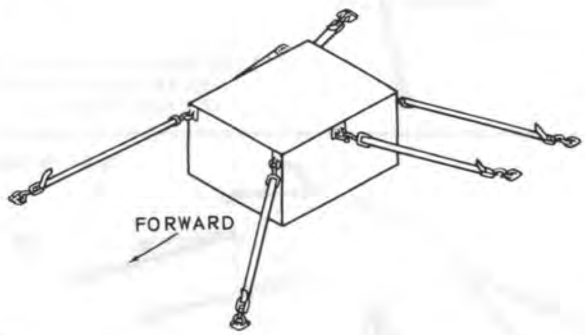


TIE-DOWN DEVICES REQUIRED:

FORWARD RESTRAINT – 2
AFT RESTRAINT – 2

A

1800 TO 3500 LB

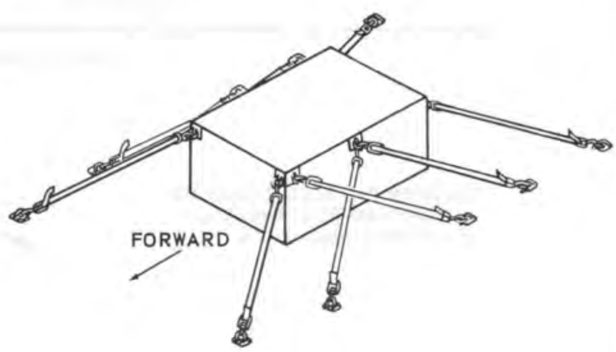


TIE-DOWN DEVICES REQUIRED:

FORWARD RESTRAINT – 4
AFT RESTRAINT – 2

B

3500 TO 5500 LB



TIE-DOWN DEVICES REQUIRED:

FORWARD RESTRAINT – 6
AFT RESTRAINT – 4

C

Figure 13–70. Rule of thumb for applying tie-down devices on cargo with tie-down provisions (Sheet 1 of 2)

THIS FIGURE PROVIDES A METHOD FOR DETERMINING THE MINIMUM NUMBER OF TIE-DOWN DEVICES REQUIRED TO MEET THE RESTRAINT CRITERIA FOR DIFFERENT CARGO WEIGHTS. THE TIE-DOWN PATTERNS ILLUSTRATED ARE BASED ON THE USE OF 2200-POUND CAPACITY TIE-DOWN FITTINGS.

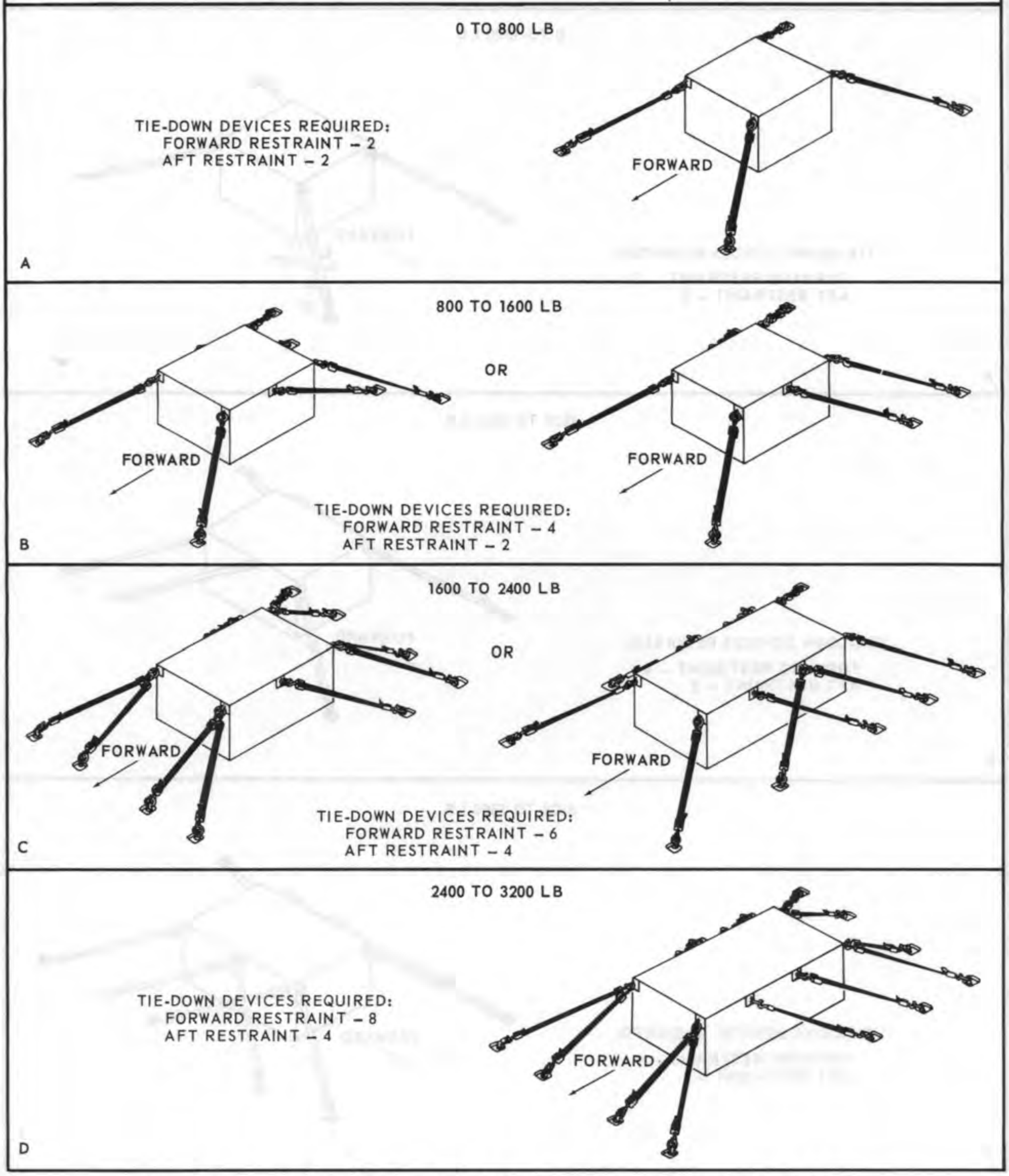


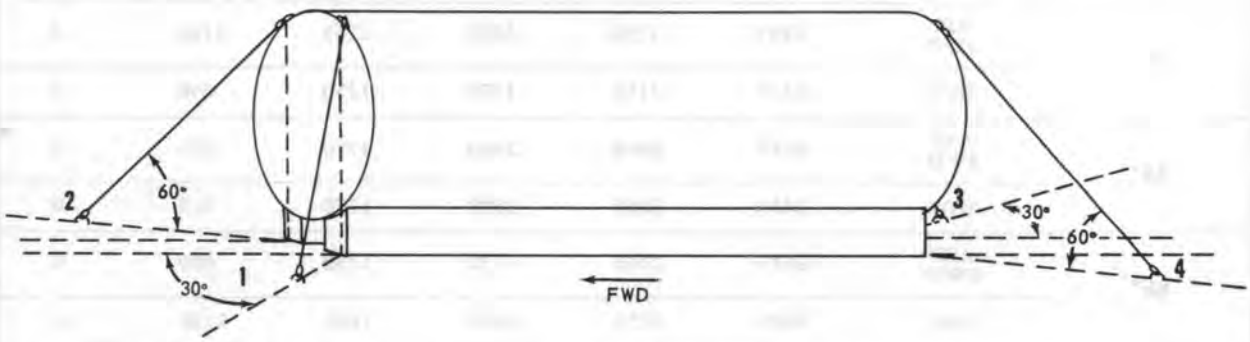
Figure 13–70. Rule of thumb for applying tie-down devices on cargo with tie-down provisions (Sheet 2 of 2)

not provide as much restraint in the forward direction as a tie-down device attached to a 5000-pound fitting and applied at a 30-degree and 30-degree tie-down angle. They do, however, concentrate more restraint in the forward direction than a tie-down device attached to a 2200-pound fitting and applied at a 30-degree and 30-degree tie-down angle, and it is for this reason that this tie-down angle is used. The amount of restraint that can be obtained at other than the rule of thumb tie-down angles is shown in table 13–3. The use of this table is explained in figure 13–71.

13–90. Rules for Applying Tie-Down Devices to Cargo With Tie-Down Provisions. The rules used when applying tie-down devices to cargo with tie-down provisions are as follows:

a. Rule 1. Always apply an even number of tie-down devices attached in pairs for forward and aft restraint.

b. Rule 2. Apply the tie-down devices as close as possible to the rule of thumb tie-down angles. Apply the first four tie-down devices so that the tie-down angle is 30 degrees with the cargo floor and 30 degrees with the longitudinal axis of the helicopter.



SAMPLE PROBLEM. Cargo with Tie-Down Provisions.

KNOWN: The shipping container shown weighs 1000 pounds and because of its shape, size, and the tie-down locations, the tie-down devices cannot be applied at an angle of 30 degrees to the cargo floor.

Problem: How many tie-down devices are required to properly secure the container?

Step 1. Determine the amount of restraint required in each direction.

1000 x 4g = 4000 pounds of forward restraint.

1000 x 1.5g = 1500 pounds of lateral restraint.

1000 x 2g = 2000 pounds of aft restraint.

1000 x 2g = 2000 pounds of vertical restraint.

Step 2. Check figure 13–70 and determine how many tie-down devices would be required if the container could be secured at the rule of thumb tie-down angles. Figure 13–70 shows that at least four tie-down devices attached to 5000-pound tie-down fittings are required (or eight attached to 2200 pound fittings).

Step 3. Tie down the container with the number of tie-down devices determined in step 2. Apply the tie-down devices as close as possible to the rule of thumb tie-down angle.

Step 4. Construct a table similar to the one shown and estimate the tie-down angle for each tie-down device.

Step 5. Obtain from table 13–3 the amount of restraint that is actually provided by each tie-down device and add the results to determine how much restraint is actually provided in each direction.

Step 6. Compare the actual restraint found in step 5 with the restraint required found in step 1; if the actual restraint is less, add additional tie-down devices and continue the procedure until sufficient restraint is obtained. In this case, no additional tie-down devices are required since the actual restraint is greater than the required restraint.

TIE-DOWN DE-VICE	STRENGTH OF TIE-DOWN FITTINGS	ESTIMATED ANGLES		RESTRAINT				
		VERTICAL	LATERAL OR SIDE	FORWARD	VERTICAL	LATERAL		AFT
						RIGHT	LEFT	
1	5000	60	30	0	4330	1250	0	2165
2	5000	60	30	0	4330	0	1250	2165
3	5000	60	30	2165	4330	0	1250	0
4	5000	60	30	2165	4330	1250	0	0
TOTAL RESTRAINT				4330	17320	2500	2500	4330

Figure 13–71. Tie-down of other than rule of thumb tie-down angles

Table 13–3. Restraint chart for 5000-pound capacity fitting

SIDE ANGLE		15°	30°	45°	60°	75°	90°
	VERT ANGLE	15°	30°	45°	60°	75°	90°
	VERT REST	1294	2500	3535	4330	4830	5000
0°	AFT FWD	4830	4330	3535	2500	1295	0
	SIDE	0	0	0	0	0	0
15°	AFT FWD	4665	4185	3415	2415	1250	0
	SIDE	1250	1120	915	650	335	0
30°	AFT FWD	4185	3750	3065	2165	1120	0
	SIDE	2415	2165	1770	1250	650	0
45°	AFT FWD	3415	3065	2500	1770	915	0
	SIDE	3415	3065	2500	1770	915	0
60°	AFT FWD	2415	2165	1770	1250	650	0
	SIDE	4185	3750	3065	2165	1120	0
75°	AFT FWD	1250	1120	915	650	335	0
	SIDE	4665	4185	3415	2415	1250	0
90°	AFT FWD	0	0	0	0	0	0
	SIDE	4830	4330	3535	2500	1295	0

NOTE: For use with 2200-pound capacity fitting, divide the amount of restraint found in table in half.

c. Rule 3. If the tie-down devices can be applied at the rule of thumb tie-down angles, see figure 13–70 to determine the number of tie-downs required to provide restraint.

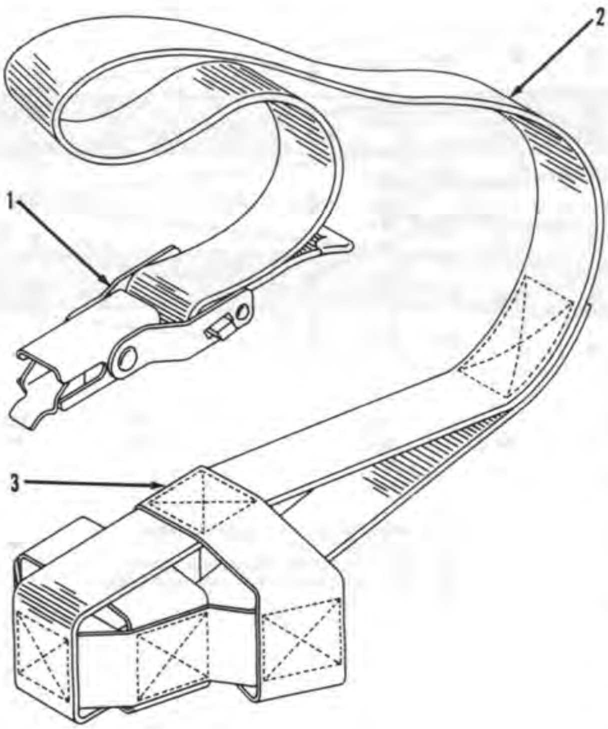
d. Rule 4. If the tie-down devices cannot be applied at the rule of thumb tie-down angles, follow the procedure outlined in the sample problem. (See figure 13–71.)

13–91. MC-1 Tie-Down Device. The MC-1 tie-down device (figure 13–62) consists of a nylon web strap on which there are two metal hooks, one stationary and one movable. The MC-1 tie-down device is rated at 5000 pounds. The movable hook has a tensioning lever which makes it possible to draw the MC-1 tie-down device up tighter when closing it. There are 30 MC-1 devices on the helicopter. The MC-1 devices are stowed in recesses located between frames along the cargo compartment wall. When the MC-1 tie-down device is faxtened to a 2200-pound tie-down fitting, its effective strength is reduced to 2200 pounds because of the tie-down fitting.

13–92. Litter Retaining Cap Assemblies. Four litter retaining cap assemblies (figure 13–72) are provided to retain the two top litters in the front tiers on the right- and left-hand sides of the helicopter. The litter retaining cap assemblies are secured to tie-down fittings located on the cargo compartment wall. The litter retaining cap assemblies are stowed with the litter support strap assemblies in shelves located on the cargo compartment wall.

13–93. Unloading Procedures. The following procedure should be used for unloading the helicopter prior to restoring it to flight status. After the helicopter has come to a halt, proceed as follows:

a. Open nose doors and/or cargo and passenger door as required.



1. Ty clip
2. Strap
3. Cap

Figure 13–72. Litter retaining cap assembly

b. Lower ramp and ramp extensions if required.

Caution

If troop seats or litter straps are connected to ramp, disconnect before lowering to avoid damage.

c. Release tie-down devices.

d. Unload helicopter as required.

e. Stow tie-down devices.

f. Remove shoring from helicopter.

g. Remove traverse hoist boom and monorail extension.

h. Secure traverse hoist winch and monorail for flight.

i. Raise ramp and secure ramp extensions to cargo compartment wall.

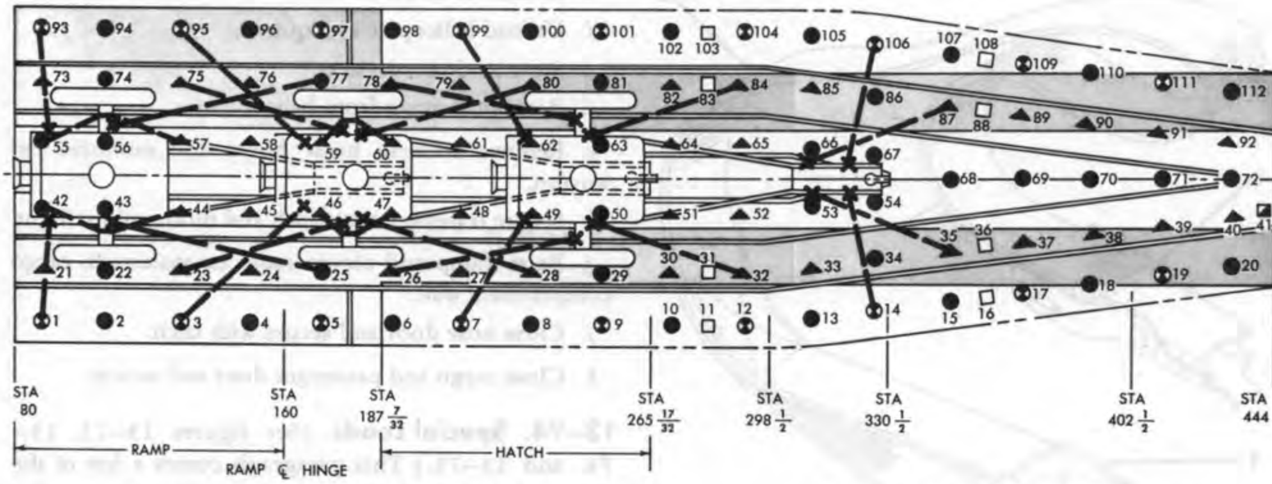
j. Close nose door and secure with latch.

k. Close cargo and passenger door and secure.

13–94. Special Loads. (See figures 13–73, 13–74, and 13–75.) This paragraph covers a few of the series of special vehicle loads that are air transportable in this helicopter. Each load has been positioned and tie-down restraint calculated, using the method set forth in this chapter. Additional information will be included when the using activities determine the special loads required. The loads contained in this paragraph include only those considered to be special due to critical dimensions, weights, or cg's of the item to be loaded. Loadings of the special cargo can be applied to the helicopter only if they conform to the following conditions:

a. Actual weights of vehicles are the same as assumed in the load illustrations.

b. The weight and balance of the helicopter must be checked by the procedures given in this section and Chapter 12.



Description of Vehicle	Vehicle Facing	Location of R P * RP	Sta	Location of C G	Weight	Moment/1000
1 75MM Howitzer (N)	Muzzle Fwd	Axle	115.5	119.5	1480	177
2 75MM Howitzer (N)	Muzzle Fwd	Axle	183.5	187.5	1480	278
3 75MM Howitzer (N)	Muzzle Fwd	Axle	251	255	1480	378

***Distinctive Reference Point (RP) for Spotting Vehicles**

Loading Instructions

1. Open nose doors and lower ramp.
2. Unfold ramp extensions.
3. Winch and manhandle howitzers into helicopter.
4. Set parking brakes.
5. Lash as indicated in diagram.

NOTE

(G) indicates howitzer carried at gross weight. (N) indicates howitzer carried at net weight. (GLC) indicates gross less crew.

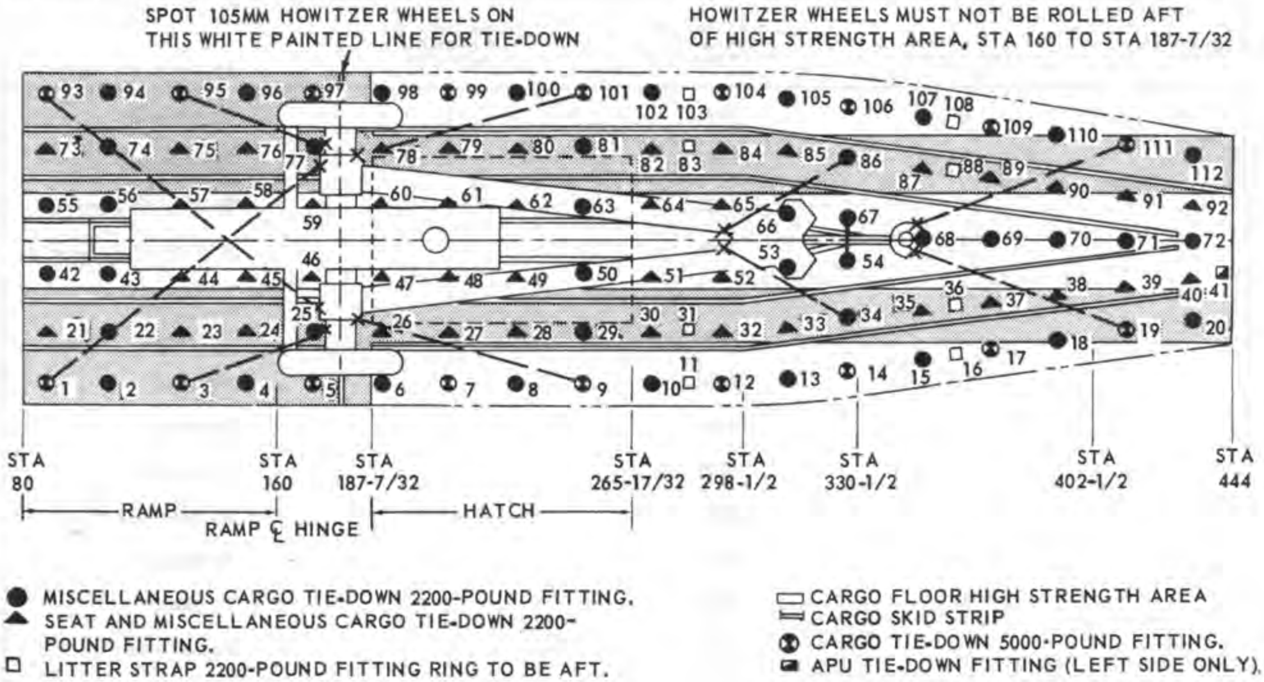
Figure 13–73. Howitzer – 75MM (Sheet 1 of 2)

VEHICLE NO.	TIE-DOWN FITTING NO.	RATING OF TIE-DOWN FITTING (LB)	QUANTITY OF TIE-DOWN DEVICES	ATTACH TO VEHICLE
3	87	2200	1	To left trail
	35	2200	1	To right trail
	106	5000	1	To left trail coupling
	14	5000	1	To right trail coupling
	84	2200	1	To frame
	32	2200	1	To frame
	99	5000	1	To frame
	7	5000	1	To frame
	78	2200	1	To left axle
	26	2200	1	To right axle
2	80	2200	1	To frame
	28	2200	1	To frame
	60	2200	1	To left axle
	47	2200	1	To right axle
	59	2200	1	To left axle
	46	2200	1	To right axle
	75	2200	1	To frame
	23	2200	1	To frame
	95	5000	1	To frame
	3	5000	1	To frame
1	77	2200	1	To frame
	25	2200	1	To frame
1	57	2200	1	To left axle
	44	2200	1	To right axle
	55	2200	1	To left axle
	42	2200	1	To right axle
	93	5000	1	To frame
	1	5000	1	To frame

NOTE

Above data is established with the MC-1, 5000-pound tie-down device.

Figure 13–73. Howitzer – 75MM (Sheet 2 of 2)



Description of Vehicle	Vehicle Facing	Location of RP* RP	Sta	Location of CG	Weight	Moment/1000
1 105MM Howitzer (N)	Muzzle Fwd	Axle	176.5	183	5150	943

*Distinctive Reference Point (RP) for Spotting Vehicles

Loading Instructions

1. Open nose doors and lower ramp.
2. Unfold ramp extensions.
3. Prepare cargo winch for dragging, if available.
4. Manhandle and winch howitzer into helicopter.
5. Center howitzer accurately to avoid damaging helicopter side frames.
6. Set parking brakes when howitzer is in position, and place chock under wheels.
7. Lash howitzer as indicated in diagram.

NOTE

(G) indicates vehicle at gross weight. (N) indicates vehicle at new weight. (GLC) indicates gross less crew. Spot howitzer wheels on white line located on high strength area between stations 160 and 187-7/32. DO NOT ROLL HOWITZER AFT OF THIS AREA.

Figure 13–74. Howitzer – 105MM (Sheet 1 of 2)

VEHICLE NO.	TIE-DOWN FITTING NO.	RATING OF TIE-DOWN FITTING (LB)	QUANTITY OF TIE-DOWN DEVICES	ATTACH TO VEHICLE
1	93	5000	1	To right axle
	1	5000	1	To left axle
	3	5000	1	To right axle
	95	5000	1	To left axle
	9	5000	1	To right side of carriage
	101	5000	1	To left side of carriage
	86	2200	1	To left trail
	34	2200	1	To right trail
	67 and 54	2200	1	Over trail
	19	5000	1	To trail ring
	111	5000	1	To trail ring

NOTE

Above data is established with the MC-1, 5000-pound tie-down device.

Figure 13–74. Howitzer – 105MM {Sheet 2 of 2}

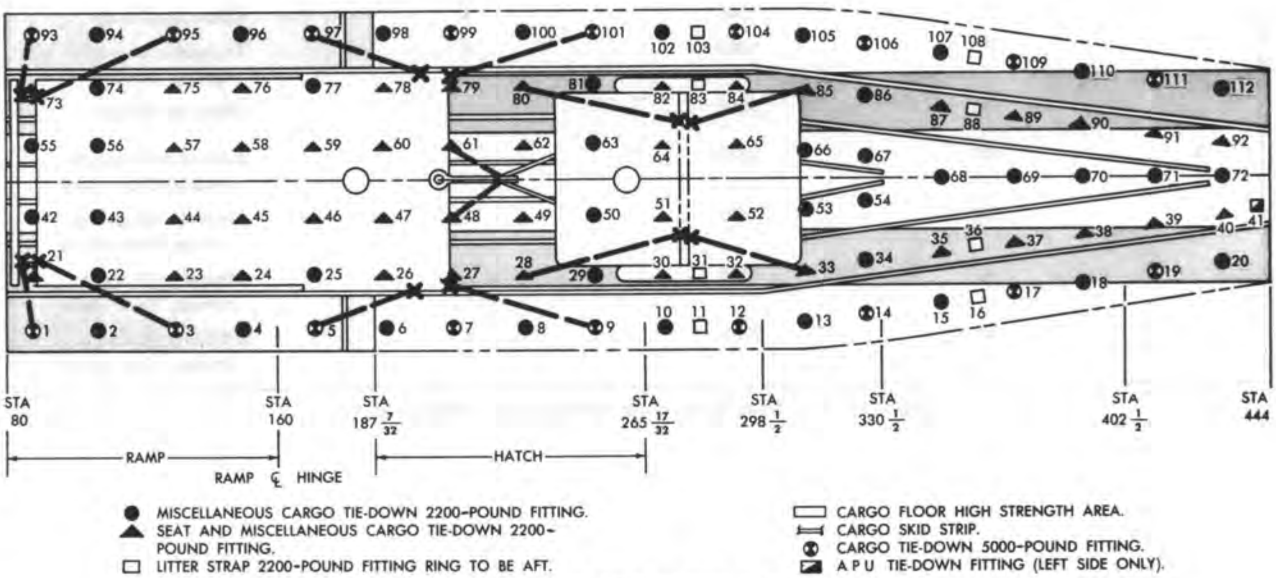


Figure 13–75. Truck, ¼-ton, 4 x 4 and trailer, ¼-ton {Sheet 1 of 2}

Description of Vehicle	Vehicle Facing	Location of R P * RP	Location of R P * Sta	Location of C G	Weight	Moment/1000
1 4 x 4 1/4-Ton Truck (N)	Fwd	Front Axle	102	140.5	2450	139
2 1/4-Ton Trailer (N)	Fwd	—	—	273	550	151

*Distinctive Reference Point (RP) for Spotting Vehicles

Loading Instructions

1. Open nose doors and lower ramp.
2. Unfold ramp extensions.
3. Back trailer and truck up ramp.
4. Chock springs.
5. Set parking brakes.
6. Leave in lowest gear and four-wheel drive.
7. Lash as indicated in diagram.

NOTE

(G) indicates vehicle carried at gross weight. (N) vehicle carried at net weight. (GLC) indicates gross less crew.

VEHICLE NO.	TIE-DOWN FITTING NO.	RATING OF TIE-DOWN FITTING (LB)	QUANTITY OF TIE-DOWN DEVICES	ATTACH TO VEHICLE
1	1	5000	1	To frame aft of front bumper support
	3	5000	1	To frame aft of front bumper support
	93	5000	1	(Same as above)
	95	5000	1	To frame aft of front bumper support
	5	5000	1	To frame forward of aft spring shackle
	9	5000	1	(Same as above)
	48	2200	1	To midpoint of trailer hitch
	61	2200	1	(Same as above)
	97	5000	1	To frame forward of aft spring shackle
	101	5000	1	(Same as above)
2	28	2200	1	Around axle and to spring, clear shock
	33	2200	1	Around axle and to spring, clear shock
	80	2200	1	Around axle and to spring, clear shock
	85	2200	1	Around axle and to spring, clear shock

Figure 13–75. Truck, ¼-ton, 4 x 4 and trailer, ¼-ton (Sheet 2 of 2)

Section V Loading and Unloading of Other than General Cargo

For loading and unloading of cargo other than general cargo, refer to the applicable references listed in Appendix I.

CHAPTER 14
PERFORMANCE DATA

Section I Scope

14—1. Purpose. The purpose of this chapter is to provide the necessary performance data used in preflight and inflight planning.

14—2. Extent of Coverage. This chapter covers the performance data charts and tables necessary for flight planning. Explanatory text on the use of the charts is also provided.

Section II Charts

14—3. Table of Symbols and Definitions. Table 14—1 lists the symbols used in the charts and tables and gives a definition of each symbol.

14—4. Airspeed Installation Correction Chart. (See chart 14—1.) The airspeed installation correction chart shows the calibrated airspeeds for various indicated airspeeds attained during forward climb, level flight, and autorotation.

Caution

To avoid erroneous reading of the airspeed indicator, keep the pilot's sliding window closed during flight. Flight with the window open can create turbulence or a low pressure area at the entrance of the pitot tubes resulting in an error of the airspeed indicating system.

14—5. Use of the Chart. Determine the calibrated airspeed during level flight when the indicated airspeed is 70 knots.

a. Enter chart at 70 knots indicated airspeed (point A).

b. From point A, proceed horizontally to level flight curve (point D).

c. From point D, proceed downward to calibrated airspeed scale (point E) and read 73.5 knots.

14—6. Density Altitude Chart. (See chart 14—2.) Density altitude is an expression of the density of the air in terms of height above sea level; hence, the less dense the air, the higher the density altitude. For standard conditions of temperature and pressure, density altitude is the same as pressure altitude. As temperature increases above standard for any altitude, the density altitude will also increase to values higher than pressure altitude. Helicopter pilots are vitally concerned with density altitude and its relation to the performance of the helicopter. A high density altitude affects the performance of both the main rotor and the engine in a decidedly adverse manner. When density altitude is high, less lift is developed by the rotor blades for any given power settings than at standard conditions. When density altitude is high, a given volume of air provides less oxygen for combustion in the cylinders, decreasing the volumetric efficiency and reducing the power output

Table 14—1. Symbols and definitions

SYMBOL	DEFINITION
ACCEL DIST	Accelerating Distance
°C	Degrees Centigrade
CAS	Calibrated Airspeed
CAT.	Carburetor Air Temperature
CG	Center of Gravity
°F	Degrees Fahrenheit
F.T.	Full Throttle
FPM	Feet per Minute
GAL	Gallon (s)
IAS	Indicated Airspeed
IN. HG	Inches of Mercury
KN	Knots
LB	Pound (s)
LB/GAL	Pounds per Gallon
LB/HR	Pounds per Hour
MANF PRESS.	Manifold Pressure
MAP	Manifold Absolute Pressure
METO	Maximum Except Take Off
MIN	Minutes, Minimum
MPH	Miles per Hour
N	Normal
OAT.	Outside Air Temperature
PRESS.	Pressure
ROC	Rate of Climb
ROD.	Rate of Descent
RPM	Revolutions per Minute
SL	Sea Level
STD	Standard
TAS	True Airspeed
TEMP	Temperature

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

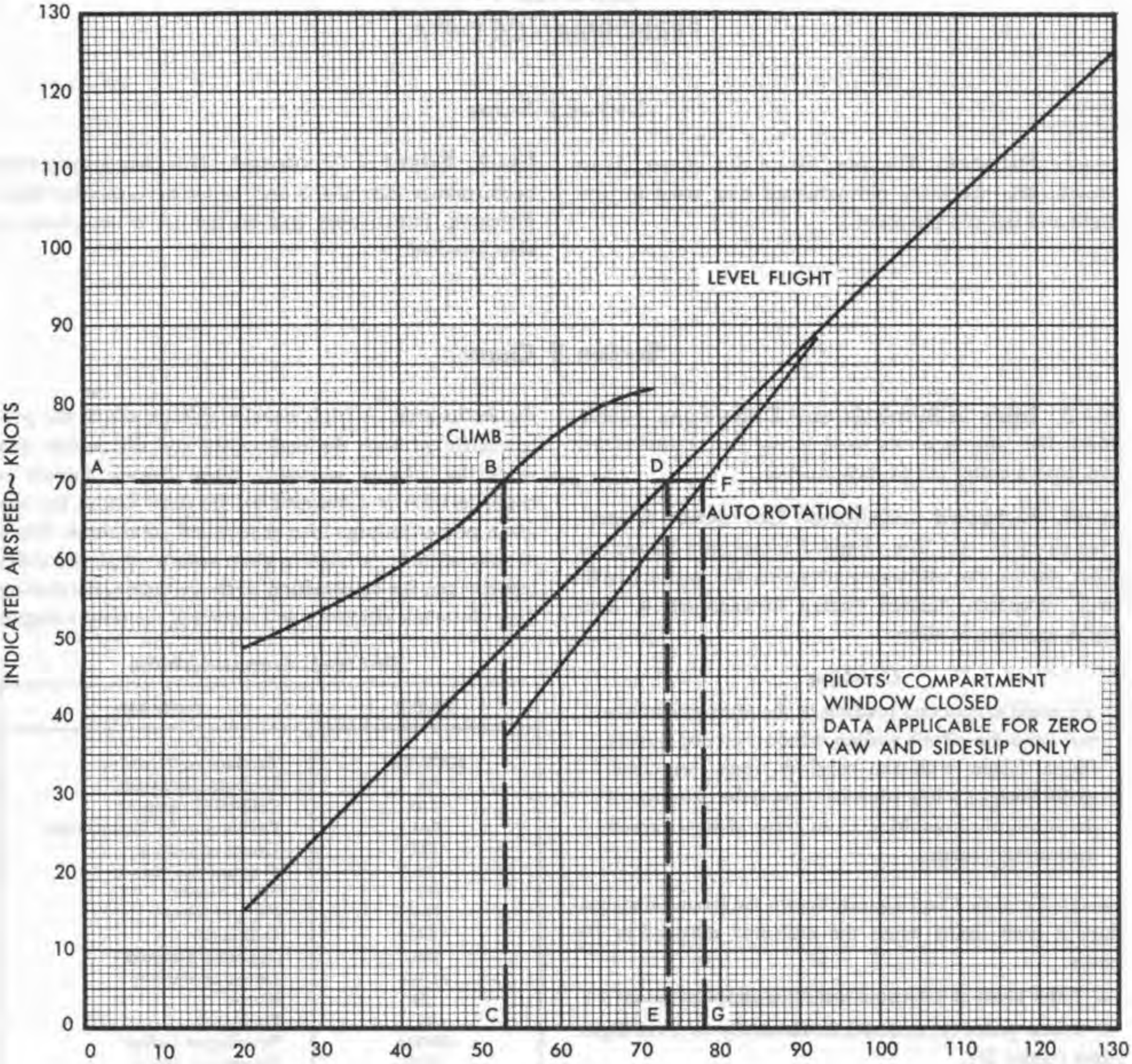


Chart 14–1. Airspeed installation correction

of the engine below the output for standard conditions. When low temperatures prevail, relative humidity has little effect on helicopter performance. When both temperature and relative humidity are high, the volumetric efficiency of the engine is reduced even more due to the water vapor displacing an equal amount of air in any given volume. As density altitude increases, useful load must be separately evaluated as density altitude may change considerably in a short period of time. The density altitude chart expresses density in terms of pressure altitude and temperature. An example of the use of the chart is contained on the chart. The value of $1/\sqrt{\sigma}$ is the conversion factor used to obtain true airspeed from calibrated airspeed by correcting for density altitude. Multiply the calibrated airspeed by $1/\sqrt{\sigma}$ to obtain true airspeed. For example, if the CAS were 100 knots and $1/\sqrt{\sigma}$ were 1.06, the true airspeed would be 106 knots.

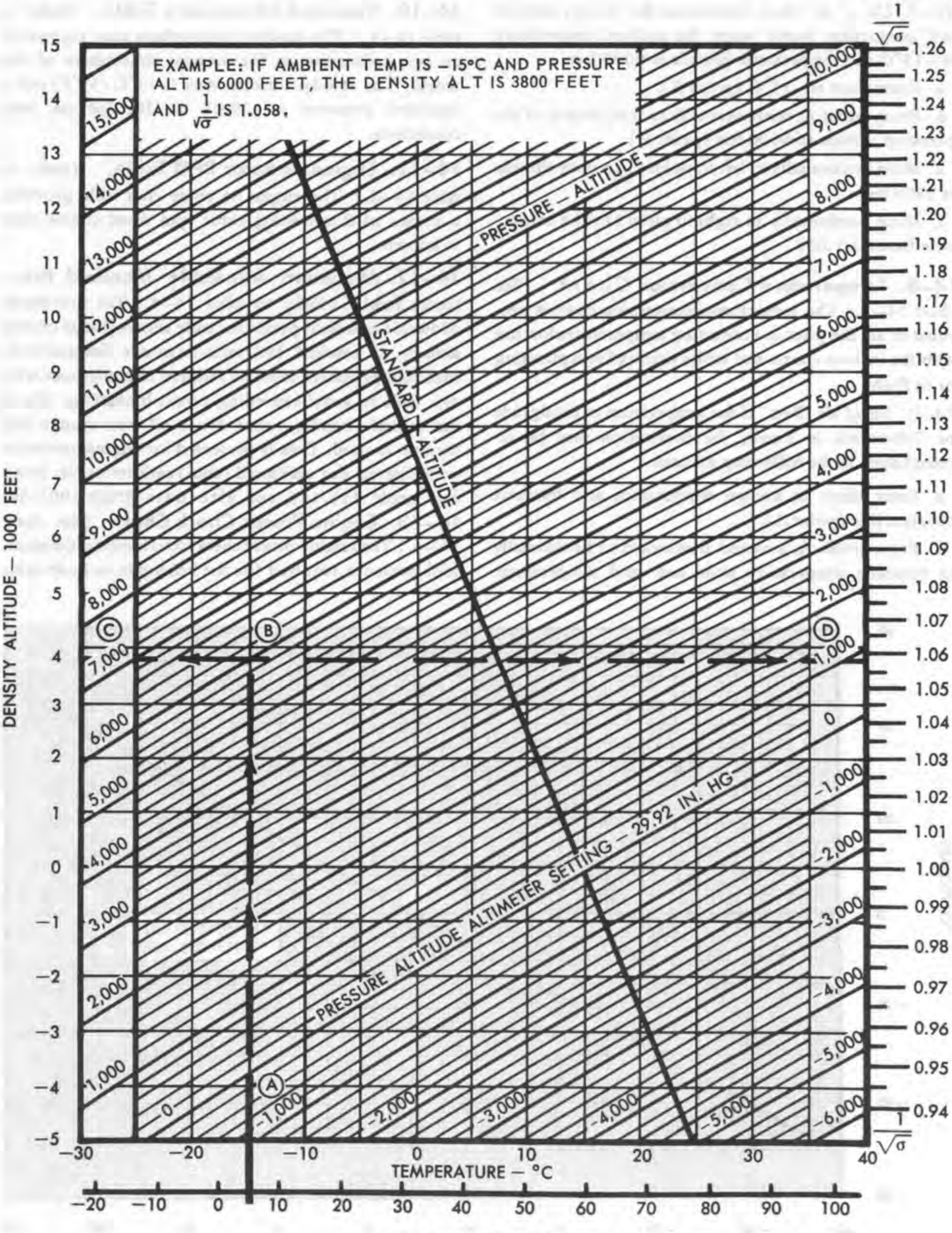


Chart 14–2. Density altitude

14–7. Use of the Chart. Determine the density altitude and conversion factor when the ambient temperature is –15°C and the pressure altitude is 6000 feet.

a. Enter chart at –15° C (point A).

b. From point A, move vertically to intersection of the pressure altitude of 6000 feet (point B).

c. Move horizontally to left to point C. Density altitude is 3800 feet.

d. Move horizontally to right to point D. The conversion factor is 1.058.

14–8. Temperature Conversion Chart.

(See chart 14–3.) The temperature conversion chart is provided to aid the pilot in converting temperatures for use with the various charts and tables during flight planning or in flight.

14–9. Use of the Chart. If the temperature in centigrade or Fahrenheit is know, the conversion may be accomplished in the following manner:

a. Enter chart at known temperature and intersect constant line (point A).

b. From point A, proceed downward or horizontally to opposite temperature scale and read temperature.

14–10. Standard Atmosphere Table.

(Refer to table 14–3.) The standard atmosphere table represents an approximation to the average atmosphere of the world. The standard temperature is 15°C (59°F) and a standard pressure of 29.92 in. Hg for sea level conditions.

14–11. Engine vs Rotor RPM Table.

(Refer to table 14–2.) The engine vs rotor rpm table provides a means of determining rotor rpm when engine rpm is known.

14–12. Maximum Allowable Manifold Pressures Table.

(Refer to table 14–4.) The maximum allowable manifold pressures table shows that as critical altitude is reached for various power designations, manifold pressures must be reduced in accordance with this table to avoid exceeding power limitations. Above the critical altitude, power drops off even though full throttle is used. Data is presented for engine operation with filtered and unfiltered (cold) carburetor air, using fuel grade 115/145 and alternate grade 100/130.

14–13. Engine Power Check Chart.

(See chart 14–4.) The engine power check chart indicates the manifold pressure required for the helicopter to hover with

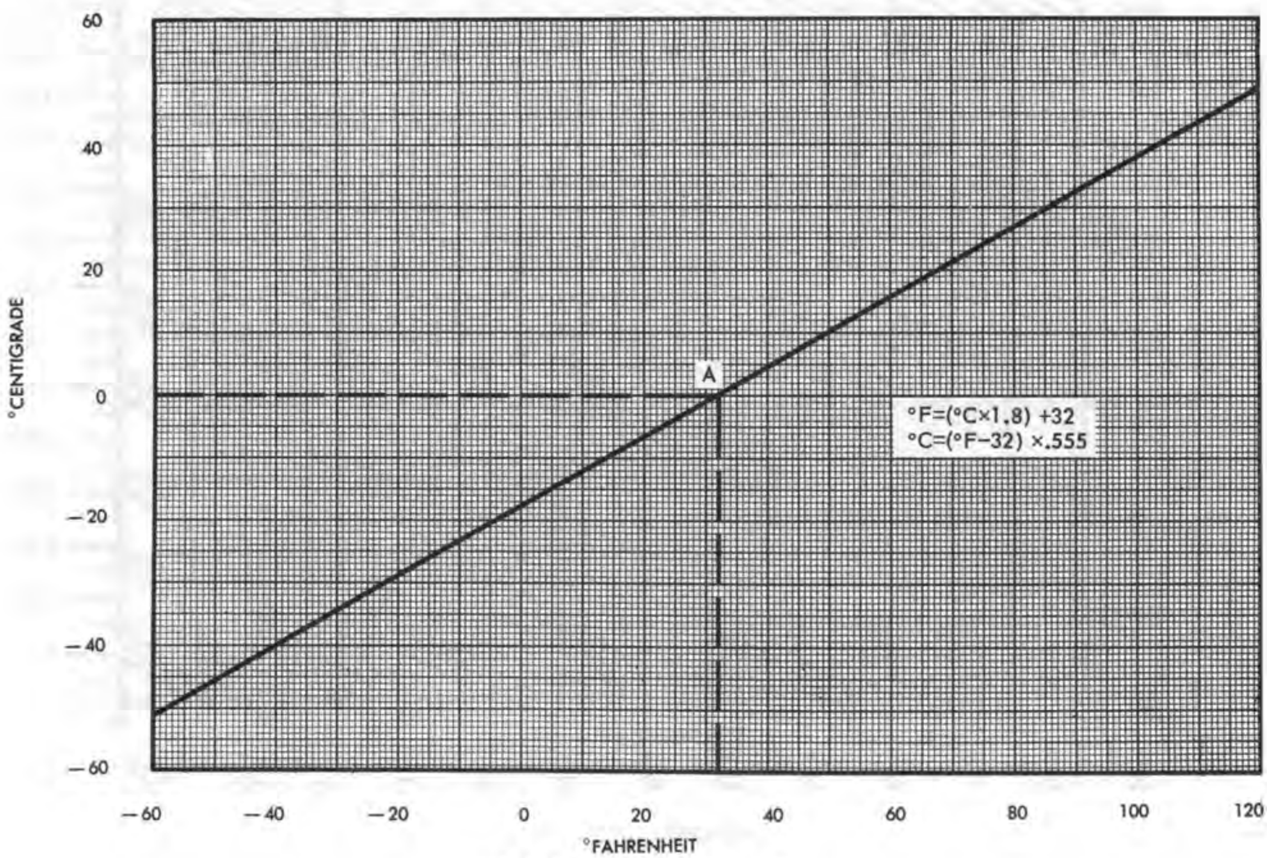


Chart 14–3. Temperature conversion

various combinations of pressure altitude, gross weight, temperature, dew point, and headwind. Chart 14–4 is based on 2600 and 2700 engine rpm.

14–14. Use of the Chart. Determine the manifold pressure required to hover with a 10-foot wheel clearance at a gross weight of 30,000 pounds and a pressure altitude of 2000 feet when the operating air temperature is 25°C, the dew point temperature is 20°C, and the surface winds are 20 knots. Engine rpm 2700.

a. Enter chart at a gross weight of 30,000 pounds (point A).

b. From point A, move vertically to an altitude of 2000 feet (point B).

c. From point B, move parallel to temperature influence lines to a temperature of 25°C (point C).

d. From point C, move vertically to 2000-foot altitude curve (point D).

e. From point D, move horizontally to dew point temperature base line (point E).

f. From point E, move parallel to dew point temperature of 20°C (point F).

g. From point F, move horizontally to head wind base line (point G).

h. From point G, move parallel to head wind influence curve to a head wind of 20 knots (point H).

i. From point H, move horizontally to altitude of 2000 feet (point I).

j. From point I, move parallel to temperature influence curves to a temperature of 25°C (point J).

k. From point J, move horizontally to manifold pressure (point K). Manifold pressure required for the above conditions is 45.2 inches Hg.

14–15. Takeoff Distance Table. (Refer to table 14–5.) The takeoff distances table has been provided for the following configuration: Two external 150-or two 300-gallon auxiliary fuel tanks and landing gear down. The takeoff distances table includes air acceleration distance to take off and the distance to clear a 50-foot obstruction for various gross weights and altitudes. Vertical takeoffs can be made under the conditions where zeros appear on the table; however, caution should be observed when operating within the red area as shown in table 14–5. Should engine failure occur with the above conditions, a safe autorotative landing would be difficult to perform. Where values other than zero appear on the table, vertical takeoffs with air accelerations in ground effect are necessary. For this type of takeoff, the helicopter should be accelerated forward in level flight, as soon as becoming airborne, to the IAS value for the particular gross weight and altitude condition

Table 14–2. Engine vs rotor rpm

ENGINE	ROTOR
1000	71
1100	78
1200	86
1300	93
1400	100
1500	107
1600	114
1700	121
1800	129
1900	136
2000	143
2100	150
2200	157
2300	164
2400	171
2500	178
2600	186
*2700	193
2800	200
3012	**215
* ENGINE RED LINE	** ROTOR RED LINE

shown on the table before beginning to climb. The distance required to attain this airspeed and the total distance required to clear a 50-foot object at the given airspeed, are shown on the table. Takeoff data is based on maximum power.

14–16. Vertical Takeoff Gross Weight Limitations Chart. (See chart 14–5.) The maximum takeoff gross weight, as limited by vertical rate of climb at maximum power, may be determined for various combinations of pressure altitude, temperature, and dew point by use of the vertical takeoff gross weight limitations chart.

14–17. Use of the Chart. Determine the maximum takeoff gross weight, using maximum power at 5000 feet with 35°C OAT. and 10°C dew point to give a 100 feet per minute vertical rate of climb.

a. Enter the chart at 5000 feet (point A).

b. From point A, move horizontally to an OAT. of 35°C (point B).

c. From point B, proceed downward to a dew point of –18°C (point C).

d. From point C, move parallel to dew point influence curve to 10°C (point D).

e. From point D, proceed downward to 0 vertical climb (point E).

Table 14–3. Standard atmosphere table

STANDARD SEA LEVEL AIR: W = 07651 LB/CU FT P_o = .002378 SLUGS/CU FT
T = 15°C 1 IN. Hg = 70.732 LB/SQ FT = 0.4912 LB/SQ IN
P = 29.921 IN. Hg
THIS TABLE IS BASED ON NACA TECHNICAL REPORT NO. 218 a_o = 1115 FT/SEC

PRESSURE ALTITUDE 1000 FEET	DENSITY RATIO P/P_o	$1/\sqrt{\sigma}$	TEMPERATURE		SPEED OF SOUND RATIO a/a_o	PRESSURE	
			°C	°F		IN. Hg	RATIO P/P_o
SL	1.0000	1.0000	15.000	59.000	1.0000	29.92	1.0000
1	0.9710	1.0143	13.019	55.434	0.997	28.85	0.9644
2	0.9428	1.0299	11.038	51.868	0.993	27.82	0.9298
3	0.9151	1.0454	9.056	48.301	0.990	26.81	0.8962
4	0.8881	1.0611	7.075	44.735	0.986	25.84	0.8636
5	0.8616	1.0773	5.094	41.169	0.983	24.89	0.8320
6	0.8358	1.0938	3.113	37.603	0.979	23.98	0.8013
7	0.8106	1.1107	1.132	34.037	0.976	23.09	0.7716
8	0.7859	1.1280	-0.850	30.471	0.972	22.22	0.7427
9	0.7619	1.1456	-2.831	26.904	0.968	21.38	0.7147
10	0.7384	1.1637	-4.812	23.338	0.965	20.58	0.6876
11	0.7154	1.1822	-6.793	19.772	0.962	19.79	0.6614
12	0.6931	1.2012	-8.774	16.206	0.958	19.03	0.6359
13	0.6712	1.2206	-10.756	12.640	0.954	18.29	0.6112
14	0.6499	1.2404	-12.737	9.074	0.950	17.57	0.5873
15	0.6291	1.2608	-14.718	5.507	0.947	16.88	0.5642
16	0.6088	1.2816	-16.699	1.941	0.943	16.21	0.5418
17	0.5891	1.3029	-18.680	-1.625	0.940	15.56	0.5202
18	0.5698	1.3247	-20.662	-5.191	0.936	14.94	0.4992
19	0.5509	1.3473	-22.643	-8.757	0.932	14.33	0.4790
20	0.5327	1.3701	-24.624	-12.323	0.929	13.75	0.4594
21	0.5148	1.3937	-26.605	-15.890	0.925	13.18	0.4405
22	0.4974	1.4179	-28.586	-19.456	0.922	12.63	0.4222
23	0.4805	1.4426	-30.568	-23.022	0.917	12.10	0.4025
24	0.4840	1.4681	-32.549	-26.588	0.914	11.59	0.3874
25	0.4480	1.4940	-34.530	-30.154	0.910	11.10	0.3709
26	0.4323	1.5209	-36.511	-33.720	0.908	10.62	0.3550
27	0.4171	1.5484	-38.493	-37.287	0.903	10.16	0.3397
28	0.4023	1.5768	-40.474	-40.853	0.899	9.720	0.3248
29	0.3879	1.6056	-42.455	-44.419	0.895	9.293	0.3106
30	0.3740	1.6352	-44.435	-47.985	0.891	8.830	0.2968
31	0.3603	1.6659	-46.417	-51.651	0.887	8.483	0.2834
32	0.3472	1.6971	-48.399	-55.117	0.883	8.101	0.2707
33	0.3343	1.7296	-50.379	-58.684	0.879	7.732	0.2583
34	0.3218	1.7628	-52.361	-62.250	0.875	7.377	0.2465
35	0.3098	1.7966	-54.342	-65.816	0.871	7.036	0.2352
36	0.2962	1.8374	-55.000	-67.000	0.870	6.708	0.2242
37	0.2824	1.8818	-55.000	-67.000	0.870	6.395	0.2137
38	0.2692	1.9273	-55.000	-67.000	0.870	6.096	0.2037
39	0.2566	1.9738	-55.000	-67.000	0.870	5.812	0.1943
40	0.2447	2.0215	-55.000	-67.000	0.870	5.541	0.1852
41	0.2332	2.0707	-55.000	-67.000	0.870	5.283	0.1765
42	0.2224	2.1207	-55.000	-67.000	0.870	5.036	0.1683
43	0.2120	2.1719	-55.000	-67.000	0.870	4.802	0.1605
44	0.2021	2.2244	-55.000	-67.000	0.870	4.578	0.1530
45	0.1926	2.2785	-55.000	-67.000	0.870	4.364	0.1458
46	0.1837	2.3332	-55.000	-67.000	0.870	4.160	0.1391
47	0.1751	2.3093	-55.000	-67.000	0.870	3.965	0.1325
48	0.1669	2.4478	-55.000	-67.000	0.870	3.781	0.1264
49	0.1591	2.5071	-55.000	-67.000	0.870	3.604	0.1205
50	0.1517	2.5675	-55.000	-67.000	0.870	3.438	0.1149

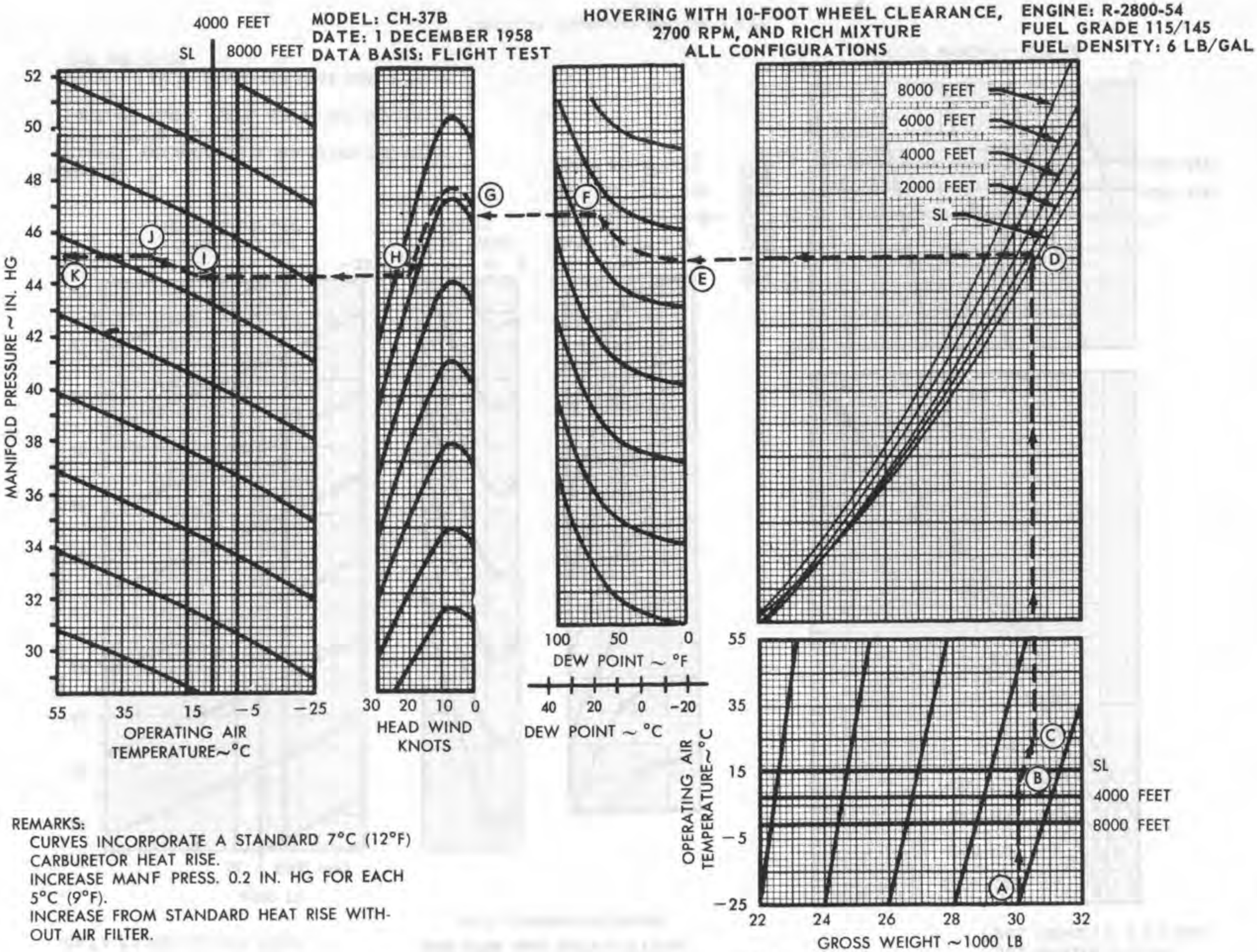
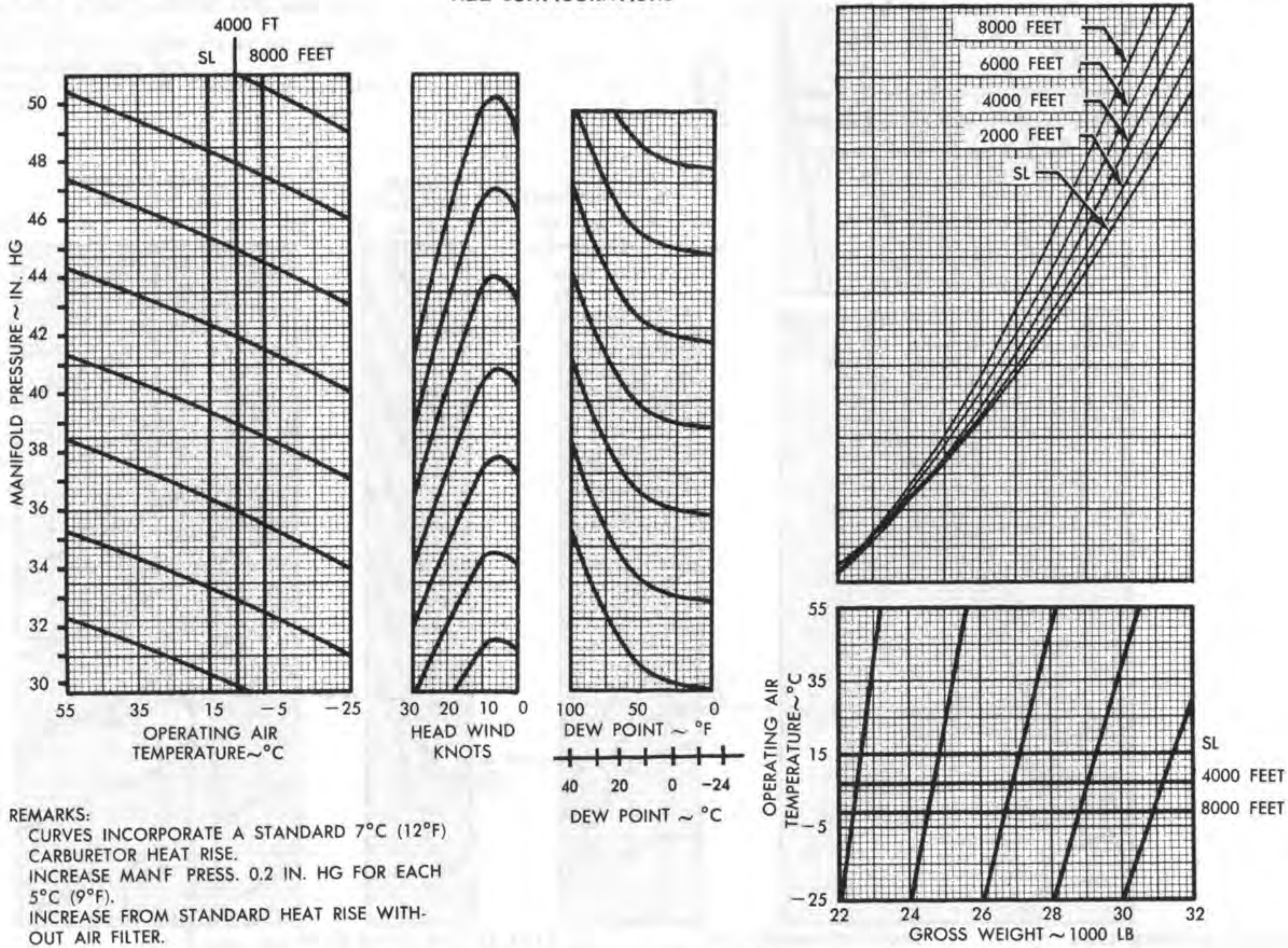


Chart 14–4. Engine power check (Sheet 1 of 2)

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

HOVERING WITH 10-FOOT WHEEL CLEARANCE
2600 RPM, AND RICH MIXTURE
ALL CONFIGURATIONS

ENGINE: R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL



REMARKS:
CURVES INCORPORATE A STANDARD 7°C (12°F) CARBURETOR HEAT RISE.
INCREASE MANF PRESS. 0.2 IN. HG FOR EACH 5°C (9°F).
INCREASE FROM STANDARD HEAT RISE WITHOUT AIR FILTER.

Chart 14–4. Engine power check (Sheet 2 of 2) *f.* From point E, move parallel to vertical rate of climb influence lines to 100 feet per minute (point F).

g. From point F, move vertically to gross weight (point G). For conditions of example, gross weight would be 24,510 pounds as read at point G.

14–18. Maximum Gross Weight for Hovering Out of Ground Effect. (See chart 14–6.) The maximum gross weights at which the helicopter can be hovered out of ground effect with maximum power at various combinations of altitude, temperature, dew point, and head winds, may be determined from this chart. The chart may be used for all configurations.

14–19. Use of the Chart. Determine the maximum hovering weight out of ground effect, using maximum power at 5000 feet, with 35°C OAT., 10°C dew point, and a 10-knot headwind.

a. Enter the chart at 5000 feet (point A).

b. From point A, move horizontally to an OAT. of 35°C (point B).

c. From point B, proceed downward to a dew point of −18°C (point C).

d. From point C, move parallel to the dew point influence curve to a dew point of 10°C (point D).

e. From point D, proceed downward to a zero head wind (point E).

f. From point E, move parallel to head wind influence curve to 10 knots (point F).

g. From point F, move downward to gross weight at point G. For conditions of example, maximum hovering weight out of ground effect with maximum power would be 26,500 pounds as read at point G.

14–20. Maximum Gross Weight for Hovering in Ground Effect. (See chart 14–7.) The maximum gross weights at which the helicopter can be hovered in ground effect at various combinations of altitude, temperature, dew point, and head winds, may be determined from this chart. This chart may be used for all configurations.

14–21. Use of the Chart. Determine the maximum gross weight to hover in ground effect with a 10-foot wheel clearance, using maximum power at 7200 feet pressure altitude with the operating air temperature of 35°C and a dew point temperature of 10°C with a 15-knot head wind.

a. Enter the chart at a pressure altitude of 7200 feet (point A).

b. From point A, move horizontally to an OAT. of 35°C (point B).

c. From point B, move vertically to dew point temperature base line (point C).

d. From point C, move parallel to dew point temperature influence lines to a dew point temperature of 10°C (point D).

e. From point D, move vertically to head wind base line (point E).

f. From point E, move parallel to head wind influence lines to a head wind of 15 knots (point F).

g. From point F, move vertically to gross weight (point G). Maximum gross weight to hover in ground effect under above conditions would be 27,620 pounds.

14–22. Climb Table for Recommended METO Power. (Refer to table 14–6.) The table for recommended METO power has been provided for the following configuration: Two 150- or two 300-gallon auxiliary fuel tanks, and landing gear down. The climb chart indicates the minimum rate of climb at best rate of climb speed. Rate of climb is based on recommended METO power at certain temperatures for various gross weight and altitude conditions. Also shown are the time-of-climb and the fuel consumed in climbing from sea level to various altitudes at various temperatures. The fuel consumed includes a warmup and takeoff allowance of 200 pounds which is equivalent to the fuel consumed for 5 minutes operation at recommended METO power. The climb table is based on recommended METO power due to transmission limitations. A rule of thumb method for obtaining clean configuration performance is included on the table.

14–23. Fuel Flow vs Manifold Pressure Chart. (See chart 14–8.) The fuel flow versus manifold pressure chart shows the rate of fuel flow (pounds of fuel consumed per hour) during flight at various combinations of pressure altitude and manifold pressure. The chart is based on dual engine operation at 2600 engine rpm with normal mixture. Note that for a specific manifold pressure, the fuel flow increases as altitude increases. For extended flight at a constant altitude, fuel flow is reduced as manifold pressure is lowered.

14–24. Use of the Chart. Determine the fuel flow with a manifold pressure of 35.0 in. Hg and a pressure altitude of 4000 feet.

a. Enter chart at manifold pressure scale 35 in. Hg (point A).

b. From point A, proceed vertically to pressure altitude of 4000 feet (point B).

c. From point B, proceed horizontally to fuel flow scale (point C) and read 1470 LB/HR.

14–25. Range Charts. (See chart 14–9.) Range charts (chart 14–9), one each for flight at a specific altitude, have been provided for operation under atmospheric conditions, using 2600 engine rpm and normal

Table 14–4. Maximum allowable manifold pressures

MODEL: CH-37B
DATA BASIS: FLIGHT TEST
DATE: 1 DECEMBER 1958

WITHOUT AIR FILTER

ENGINES: (2) R-2800-54
FUEL DENSITY: 6 LB/GAL
FUEL GRADE: 115/145

NOTE

During cold weather operation maximum manifold pressure is reduced 2 percent for each 11°C colder carburetor air temperature than NACA standard.

CARBURETOR AIR LEVER – COLD
(UNFILTERED)
(TWIN ENGINE OPERATION)

POWER DESIGNATION	BHP	RPM	TIME LIMIT ENGINE MIN	PRESS. ALT FT MIXTURE	MANIFOLD PRESSURE-IN. HG SL	2000	4000	6000	8000	10,000
MAXIMUM	2100	2700	5	Rich	57.5	56.2	F.T.	F.T.	F.T.	F.T.
METO	1900	2600	Continuous	Normal	50.5	49.8	49.0	F.T.	F.T.	F.T.
RECOMMENDED METO	1725	2600	Continuous	Normal	46.0	45.1	44.4	43.7	43.0	F.T.
RECOMMENDED CRUISE	1380	2600	Continuous	Normal	37.9	37.3	36.8	36.2	35.6	35.0

FUEL GRADE: 100/130

POWER DESIGNATION	BHP	RPM	TIME LIMIT ENGINE MIN	PRESS. ALT FT MIXTURE	MANIFOLD PRESSURE-IN. HG SL	2000	4000	6000	8000	10,000
MAXIMUM	1950	2600	5	Rich	54.5	53.0	F.T.	F.T.	F.T.	F.T.
METO	1800	2600	Continuous	Normal	48.0	47.2	46.4	45.6	F.T.	F.T.
RECOMMENDED METO	1725	2600	Continuous	Normal	46.0	45.1	44.4	43.7	43.0	F.T.
RECOMMENDED CRUISE	1380	2600	Continuous	Normal	37.9	37.3	36.8	36.2	35.6	35.0

CARBURETOR AIR LEVER-FILTER (TWIN ENGINE OPERATION)
FUEL GRADE: 115/145

POWER DESIGNATION	BHP	RPM	TIME LIMIT ENGINE MIN	PRESS. ALT FT MIXTURE	MANIFOLD PRESSURE-IN. HG SL	2000	4000	6000	8000	10,000
MAXIMUM	2100	2700	5	Rich	57.5	F.T.	F.T.	F.T.	F.T.	F.T.
METO	1900	2600	Continuous	Normal	50.5	49.6	48.8	F.T.	F.T.	F.T.
RECOMMENDED METO	1725	2600	Continuous	Normal	45.9	45.0	44.3	43.5	42.7	F.T.
RECOMMENDED CRUISE	1380	2600	Continuous	Normal	37.9	37.3	36.6	36.1	35.5	34.8

FUEL GRADE: 100/130

POWER DESIGNATION	BHP	RPM	TIME LIMIT ENGINE MIN	PRESS. ALT FT MIXTURE	MANIFOLD PRESSURE-IN. HG SL	2000	4000	6000	8000	10,000
MAXIMUM	1950	2600	5	Rich	54.5	52.4	F.T.	F.T.	F.T.	F.T.
METO	1800	2600	Continuous	Normal	48.0	47.1	46.2	45.4	F.T.	F.T.
RECOMMENDED METO	1725	2600	Continuous	Normal	45.9	45.0	44.3	43.5	42.7	F.T.
RECOMMENDED CRUISE	1380	2600	Continuous	Normal	37.9	37.3	36.6	36.1	35.5	34.8

NOTE: F.T. DENOTES FULL THROTTLE

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

ZERO WIND
MAXIMUM POWER
ALL CONFIGURATIONS

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

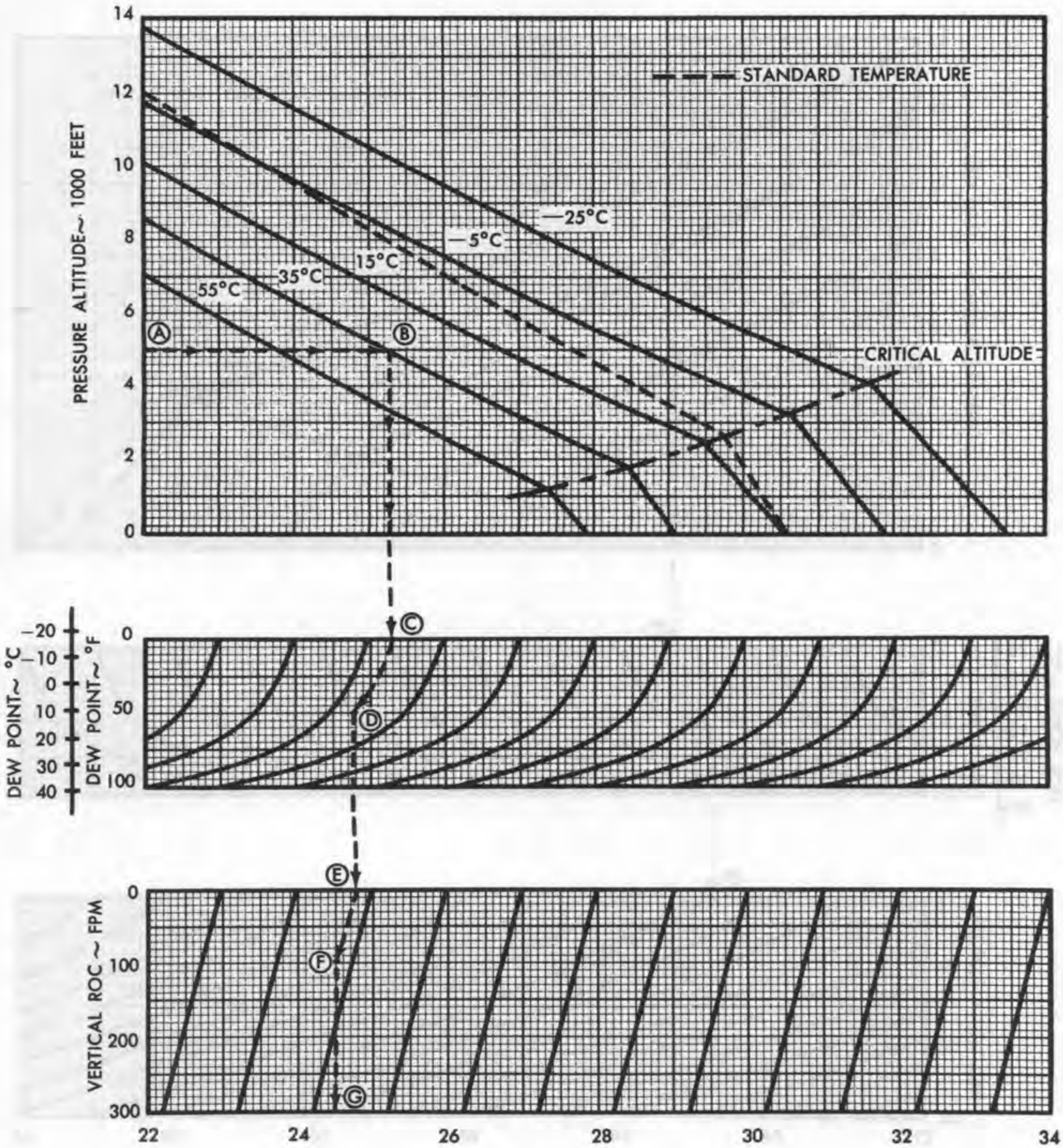


Chart 14–5. Vertical takeoff gross weight limitations

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

MAXIMUM POWER 2700 RPM
ALL CONFIGURATIONS

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

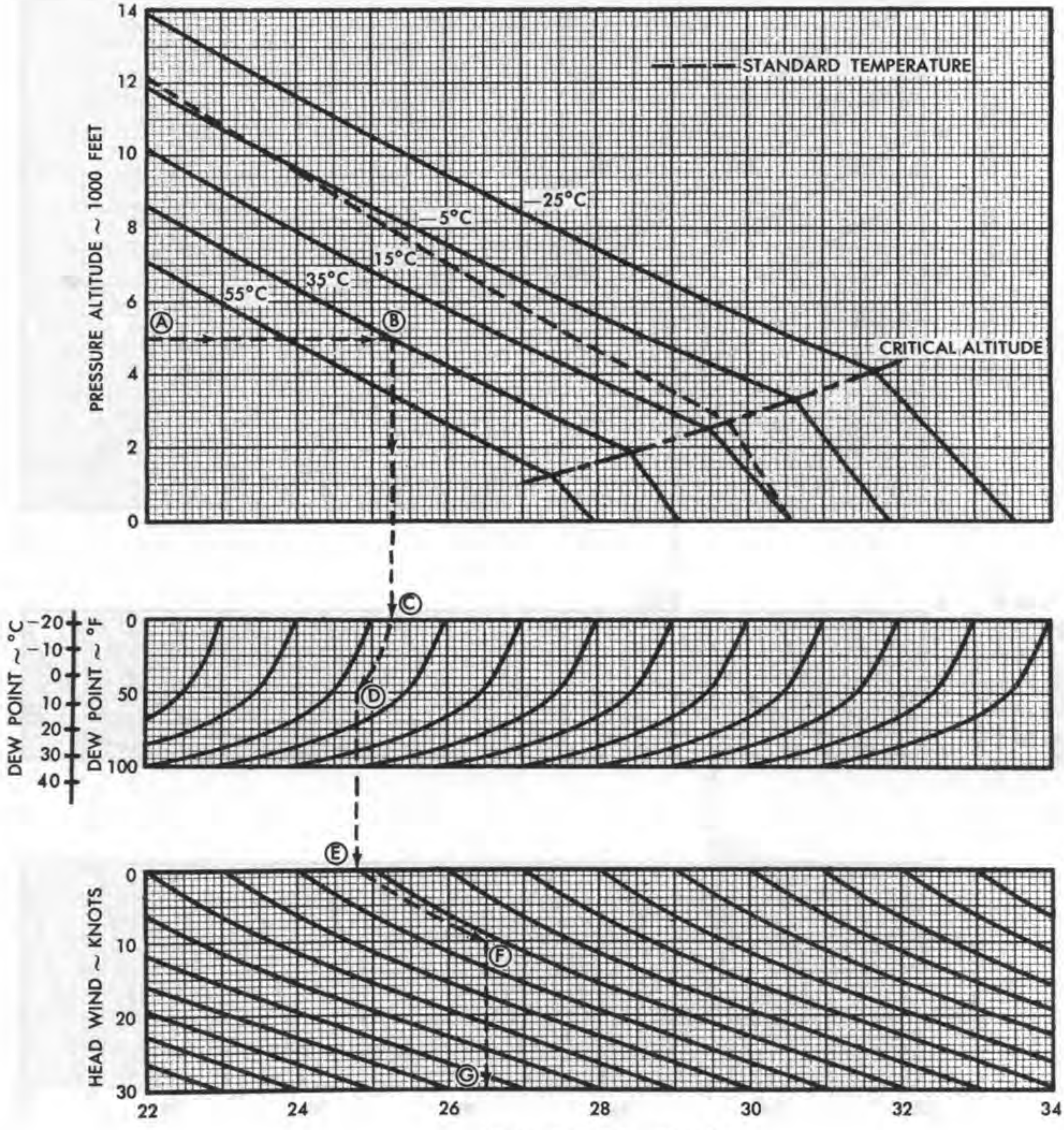


Chart 14–6. Maximum gross weight for hovering out of ground effect

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

10-FOOT WHEEL CLEARANCE
MAXIMUM POWER 2700 RPM
ALL CONFIGURATIONS

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

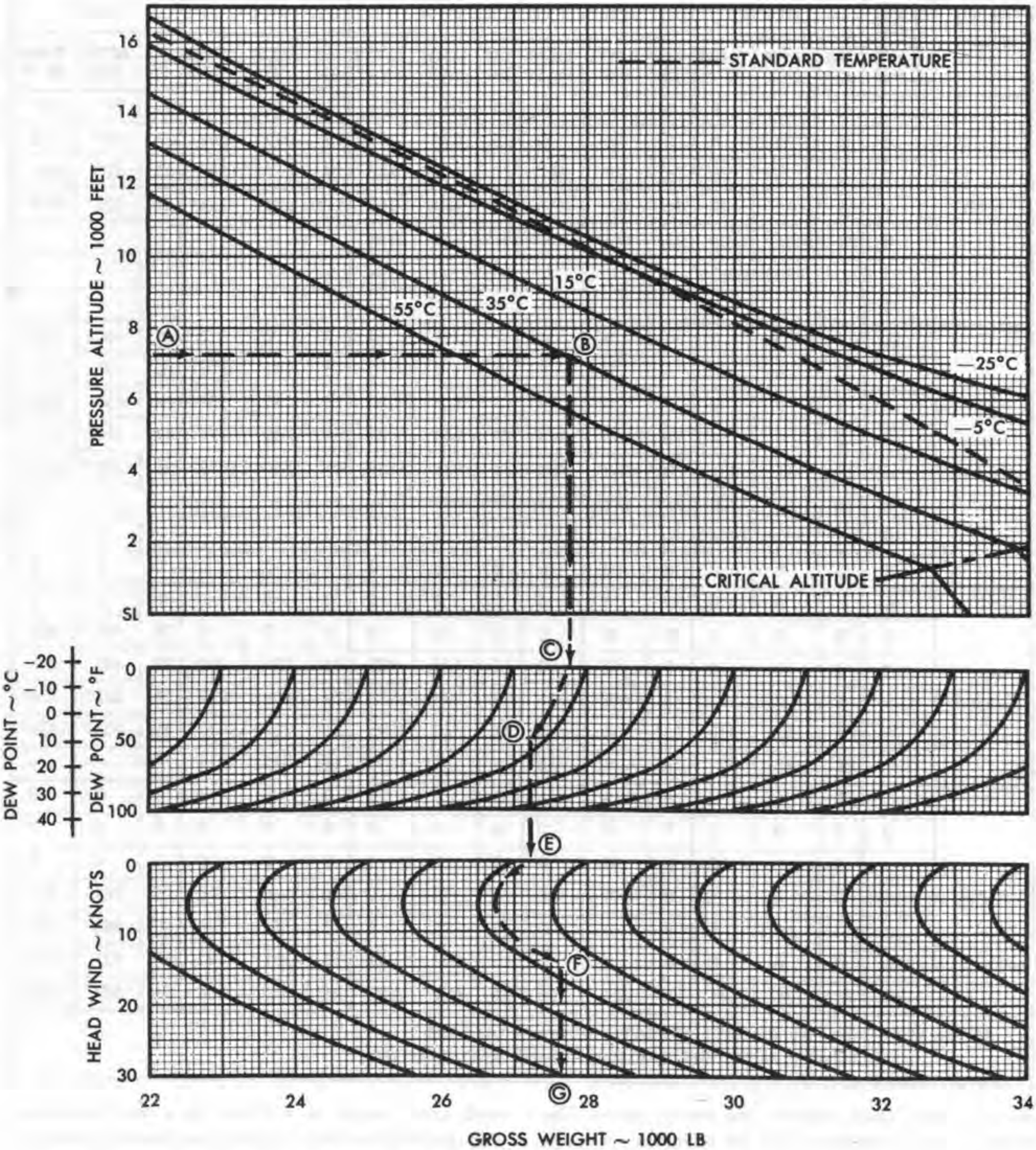


Chart 14–7. Maximum gross weight for hovering in ground effect

Table 14–5. Takeoff distances – feet

MODEL: CH-37B
DATA BASIS: ESTIMATED
DATE: 1 DECEMBER 1958

MAXIMUM POWER – ZERO WIND
FIRM DRY SOD
CONFIGURATION: TWO 150-OR TWO 300-GALLON AUXILIARY TANKS
LANDING GEAR DOWN

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

GROSS WEIGHT LB	PRESSURE ALTITUDE 1000 FEET	−25°C			−5°C			+15°C			+35°C			+55°C		
		IAS KN	ACCEL DIST	CLEAR 50 FT	IAS KN	ACCEL DIST	CLEAR 50 FT	IAS KN	ACCEL DIST	CLEAR 50 FT	IAS KN	ACCEL DIST	CLEAR 50 FT	IAS KN	ACCEL DIST	CLEAR 50 FT
	SL	0	0	0	0	0	0	15	161	316	15	184	460	20	391	759
	2	0	0	0	0	0	0	15	184	391	18	299	667	24	713	1173
	4	0	0	0	15	178	380	21	414	771	24	851	1380	35	523	1041
31,000	6	15	195	460	22	472	851	30*	345*	811*	35*	535*	1156*	44	920*	1978*
	8	31	1087	1604	35*	472*	1110*	46	886	1846*	—	—	—	—	—	—
	10	46*	828*	2093	—	—	—	—	—	—	—	—	—	—	—	—
	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	SL	0	0	0	0	0	0	0	0	0	0	0	0	15	160	322
	2	0	0	0	0	0	0	0	0	0	15	150	311	15	196	472
	4	0	0	0	0	0	0	15	161	276	15	230	558	24	633	1029
	8	0	0	0	15	161	345	17	288	644	24	748	1196	33*	460*	978*
28,500	6	15	161	403	18	345	753	24	891	1409	35*	529*	1093*	36	679*	1731*
	8	26	765	1328	35*	472*	1035*	39*	690*	1714*	—	—	—	—	—	—
	10	46*	840*	1926*	—	—	—	—	—	—	—	—	—	—	—	—
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	15	184	403
	4	0	0	0	0	0	0	15	144	288	15	196	460	20	437	840
26,000	6	0	0	0	15	144	311	15	207	523	24	638	1012	28*	328*	851*
	10	15	150	340	15	236	610	24	748	1196	31*	437*	1012*	35	633*	1426*
	12	25	581	1024	28	1070	1748	35*	564*	1415*	46*	1075*	2921*	—	—	—
	SL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23,500	6	0	0	0	0	0	0	0	0	0	0	0	0	15	161	345
	8	0	0	0	0	0	0	0	0	0	15	184	380	20	368	610
	10	0	0	0	0	0	0	15	207	437	18	391	782	24	937	1415
	12	15	138	311	15	224	506	23	621	983	26*	316*	868*	34*	598*	1265*

REMARKS: *PREPARED RUNWAY REQUIRED, ROLLING TAKE-OFF DISTANCES BASED ON MAXIMUM POWER AND 2700 RPM.

mixture. Each chart contains two sets of curves. The left-hand set of curves shows the manifold pressures required for various combinations of gross weight and TAS values. A conversion scale has been provided for changing TAS to CAS values. Maximum airspeed for each gross weight is indicated by a short horizontal line crossing the gross weight curve. Minimum airspeed for each gross weight is indicated by a short diagonal line crossing the gross weight curve. The right-hand set of curves shows the unit range, or nautical miles, that

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

FUEL FLOW VS MANIFOLD PRESSURE

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

TWO-ENGINE OPERATION

2600 RPM NORMAL MIXTURE

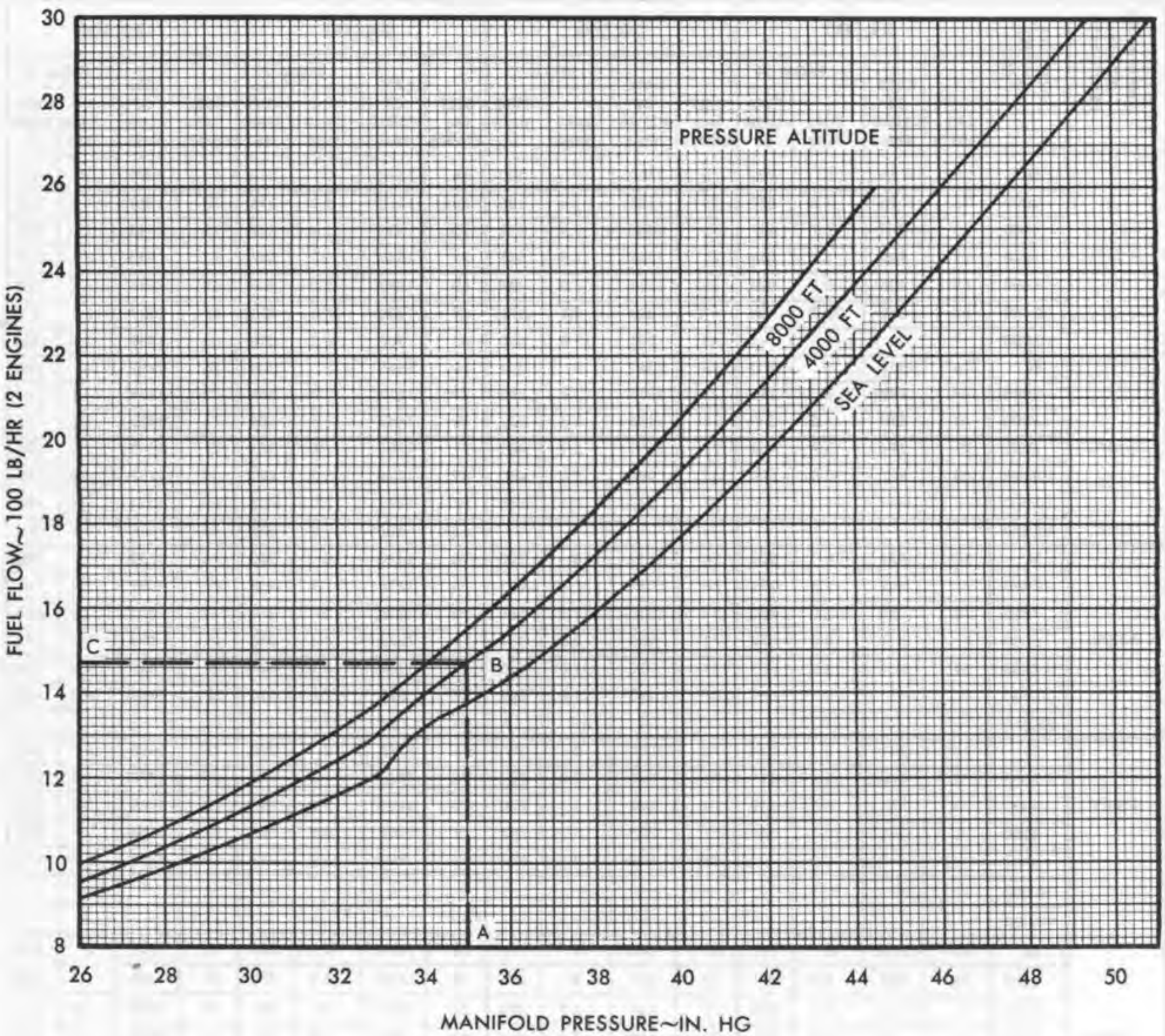


Chart 14–8. Fuel flow vs manifold pressure

can be flown per pound of fuel for various combinations of gross weight and TAS values. A conversion scale has been provided for changing TAS to CAS values. Maximum airspeed for each gross weight is indicated by a short horizontal line crossing the gross weight curve. Minimum airspeed for each gross weight is indicated by a short diagonal line crossing the gross weight curve. Note on each chart, for a fixed altitude, the unit range decreases as the gross weight increases. A rule of thumb method for obtaining clean configuration performance is noted on each chart. Performance at clean configuration, which is flight with no external tanks or supporting structure and landing gear up, varies with each altitude. For any planned extended flight using auxiliary fuel tanks, engine oil consumption should be considered.

14–26. Use of the Chart. a. Determine the fuel required, calibrated airspeed, and manifold pressure to fly a 50 nautical miles radius mission at a density altitude of sea level by a helicopter equipped with two 150-gallon auxiliary fuel tanks and with the landing gear locked in

Table 14–6. Climb table for recommended METO power

MODEL: CH-37B
DATA BASIS: FLIGHT TEST
DATE: 1 DECEMBER 1958

CONFIGURATION: TWO 150-OR TWO 300-GALLON AUXILIARY TANKS, LANDING GEAR DOWN

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

GROSS WEIGHT (LB)

TEMPERATURE DEGREE CENTIGRADE	PRESSURE ALTITUDE FEET	31,000				28,500				26,000				23,500			
		BEST IAS KNOTS	RATE OF CLIMB FPM	FROM SL TIME MIN	FROM SL FUEL USED LB	BEST IAS KNOTS	RATE OF CLIMB FPM	FROM SL TIME MIN	FROM SL FUEL USED LB	BEST IAS KNOTS	RATE OF CLIMB FPM	FROM SL TIME MIN	FROM SL FUEL USED LB	BEST IAS KNOTS	RATE OF CLIMB FPM	FROM SL TIME MIN	FROM SL FUEL USED LB
−25°C	SL	76	1141	0	200	76	1402	0	200	76	1687	0	200	76	1998	0	200
	2000	75	1090	1.8	272	75	1361	1.4	258	75	1655	1.2	248	75	1976	1.0	241
	4000	73	1025	3.7	347	73	1308	2.9	318	73	1613	2.4	297	73	1943	2.0	282
	6000	71	946	5.7	428	71	1242	4.5	381	71	1558	3.7	347	71	1900	3.1	323
	8000	69	626	8.1	526	69	1161	6.2	447	69	1490	5.0	400	69	1844	4.2	366
	10,000	67	211	12.7	709	67	826	8.1	526	67	1392	6.4	455	67	1759	5.3	410
	12,000	—	—	—	—	65	251	11.8	663	65	906	8.1	518	65	1469	6.5	456
−5°C	SL	76	1002	0	200	76	1265	0	200	76	1550	0	200	76	1861	0	200
	2000	75	943	2.0	282	75	1217	1.6	265	75	1512	1.3	252	75	1834	1.1	244
	4000	73	870	4.2	370	73	1156	3.3	332	73	1463	2.6	306	73	1795	2.2	288
	6000	71	774	6.7	466	71	1081	5.1	403	71	1401	4.0	361	71	1745	3.3	333
	8000	69	411	10.0	600	69	983	7.0	480	69	1324	5.5	420	69	1682	4.5	379
	10,000	—	—	—	—	67	546	9.5	580	67	1145	7.0	482	67	1514	5.7	428
	12,000	—	—	—	—	—	—	—	—	65	625	9.3	560	65	1218	7.1	479
+15°C	SL	76	869	0	200	76	1134	0	200	76	1420	0	200	76	1732	0	200
	2000	75	802	2.4	296	75	1079	1.8	273	75	1376	1.4	258	75	1699	1.2	247
	4000	73	720	5.0	400	73	1010	3.7	349	73	1320	2.9	316	73	1654	2.4	295
	6000	71	547	8.0	522	71	925	5.8	431	71	1250	4.4	378	71	1598	3.6	344
	8000	69	164	13.3	733	69	753	8.0	522	69	1164	6.1	444	69	1527	4.9	395
	10,000	—	—	—	—	67	243	11.8	669	67	872	7.9	516	67	1286	6.3	449
	12,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
+35°C	SL	76	741	0	200	76	1008	0	200	76	1295	0	200	76	1608	0	200
	2000	75	666	2.8	311	75	946	2.0	282	75	1246	1.6	263	75	1570	1.3	251
	4000	73	573	6.0	439	73	869	4.2	370	73	1183	3.2	329	73	1520	2.6	302
	6000	71	301	10.2	606	71	775	6.7	467	71	1105	5.0	399	71	1456	3.9	356
	8000	—	—	—	—	69	495	9.6	584	69	994	6.8	474	69	1361	5.3	412
	10,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	12,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
+55°C	SL	76	616	0	200	76	886	0	200	76	1176	0	200	76	1489	0	200
	2000	75	532	3.5	338	75	817	2.3	294	75	1120	1.7	270	75	1446	1.4	255
	4000	73	417	7.6	505	73	732	4.9	396	73	1050	3.6	343	73	1390	2.8	311
	6000	71	38	16.0	839	71	622	7.8	514	71	963	5.5	421	71	1920	4.2	370
	8000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	10,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	12,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

REMARKS: FUEL USED INCLUDES 200 LB FOR WARMUP AND TAKEOFF.

RECOMMENDED METO POWER IS 1725 BHP PER ENGINE AT 2600 RPM AS LIMITED BY TRANSMISSION TIME-POWER CRITERIA. METO POWER OF ENGINES IS 1900 BHP PER ENGINE AT 2600 RPM.

FOR CLEAN GEAR UP CONFIGURATION, RATE OF CLIMB IS INCREASED APPROXIMATELY 90 FPM AND FUEL USED IS DECREASED APPROXIMATELY 5%.

the DOWN position. The takeoff gross weight is 31,000 pounds and best range airspeeds are to be used. Allow 200 pounds of fuel for warmup and takeoff and 10 percent of total fuel for reserve.

(1) Enter chart at intersection of maximum range curve with gross weight of 31,000 pounds (point A).

(2) From point A, move vertically to airspeed scale (point B) and read 86 knots CAS.

(3) From point A, move horizontally to unit range scale and read 0.0562 nautical miles per pound (point C).

(4) To determine fuel required, divide distance to be flown by unit range, 50/0.0562=1779 pounds of fuel plus 200 pounds for warmup and takeoff=1979 pounds. This represents 0.9 of total fuel required since 10 percent of total is reserve. Total fuel required would be 1979/0.9=2199 pounds.

(5) To determine manifold pressure enter manifold pressure – speed curve at airspeed scale (point D) at 86 knots CAS.

(6) From point D, move vertically to gross weight of 31,000 pounds (point E).

(7) From point E, move horizontally to manifold pressure 37.2 inches Hg (point F).

(8) For above conditions, calibrated airspeed would be 86 knots, fuel required 2199 pounds, and manifold pressure 37.2 inches Hg.

b. For the conditions stated in subparagraph *a* determine the maximum endurance time, the calibrated airspeed, and the manifold pressure if 2000 pounds of fuel is carried.

(1) Determine the usable fuel by subtracting 10 percent of fuel for reserve and 200 pounds for warmup and takeoff. 2000 – 200 – 200 = 1600 pounds.

(2) Enter chart at intersection of maximum endurance curve with gross weight of 31,000 pounds (point G).

(3) From point G, move horizontally to unit range of 0.0482 nautical miles per pound (point H).

(4) From point G, move vertically to 63 knots TAS (point I). CAS = 63 knots.

(5) Determine fuel flow by dividing TAS by unit range. 63/0.0482 = 1308 pounds per hour.

(6) Determine endurance time by dividing usable fuel by fuel flow. 1600/1308 = 1.2 hours.

(7) To determine manifold pressure, enter manifold pressure – speed curve at airspeed scale (point J) at 63 knots CAS.

(8) From point J, move vertically to gross weight of 31,000 pounds (point K).

(9) From point K, move horizontally to manifold pressure of 33.8 inches Hg (point L).

(10) For above conditions, endurance time would be 1.2 hours, calibrated airspeed 63 knots, and manifold pressure 33.8 inches Hg.

c. For the conditions stated in subparagraph *a*, determine the maximum time at minimum speed, the calibrated air speed, and the manifold pressure if 2000 pounds of fuel is carried.

(1) Determine usable fuel by subtracting 10 percent of fuel for reserve and 200 pounds for warmup and takeoff. 2000 – 200 – 200 = 1600 pounds.

(2) Enter manifold pressure – speed curve at gross weight of 31,000 pounds (point M).

(3) From point M, move vertically to 20 knots TAS (point N). CAS = 20 knots.

(4) From point M, move horizontally to manifold pressure 45.8 inches Hg (point O).

(5) With manifold pressure of 45.8 inches Hg refer to fuel flow vs manifold pressure chart (chart 14–8) to determine fuel flow. From this chart, fuel flow at 45.8 inches Hg and sea level is 2400 pounds per hour.

(6) Time at minimum speed is then determined by dividing usable fuel by fuel flow. 1600/2400=0.67.

(7) For above conditions, time at minimum speed would be 0.67 hours, calibrated airspeed 20 knots, and manifold pressure 45.8 inches Hg.

14–27. Landing Distance – Power On. (Refer to table 14–7.) The landing distance table includes the total distance to clear a 50-foot obstacle and the landing ground roll at various gross weights, altitudes, and temperature conditions. The distances shown are the minimum distances at maximum performance with approach made at 2600 engine rpm and rate of descent at 400 fpm. Flareout should be started at 80 feet (30 feet above a 50-foot obstacle to insure tail rotor clearance) at an indicated airspeed of 48 knots and 2700 engine rpm.

14–28. Landing Distance Without Ground Roll. A hover can be accomplished provided the gross weight is at least 650 pounds lighter than indicated on the maximum gross weight for hovering in ground effect chart (chart 14–7); however, caution should be observed when operating within the red area of table 14–7. Should engine failure occur under these conditions, a safe autorotative landing would be difficult to perform.

14–29. Landing Distance With Ground Roll. When landing under conditions where a ground roll is required, the touchdown airspeeds shown on the chart are the minimum airspeeds that should be maintained to avoid power setting. Caution should be observed when operating within the red area of table 14–7. Should engine failure occur under these conditions, a safe autorotative

Table 14–7. Landing distance-feet

MODEL: CH-37B
DATA BASIS: ESTIMATED
DATE: 1 DECEMBER 1958

POWER – ON
FIRM DRY SOD – ZERO WIND
CONFIGURATION: ALL

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

GROSS WEIGHT LB	PRESSURE ALTITUDE FEET	BEST IAS KNOTS	−25°C			−5°C			+15°C			+35°C			+55°C		
		AP-PROACH	TOUCH DOWN SPEED KN	GROUND ROLL	CLEAR 50 FT	TOUCH DOWN SPEED KN	GROUND ROLL	CLEAR 50 FT	TOUCH DOWN SPEED KN	GROUND ROLL	CLEAR 50 FT	TOUCH DOWN SPEED KN	GROUND ROLL	CLEAR 50 FT	TOUCH DOWN SPEED KN	GROUND ROLL	CLEAR 50 FT
31,000	SL	48	0	0	260	0	0	281	0	0	302	0	0	322	0	0	411
	2000	48	0	0	282	0	0	303	0	0	325	0	0	374	20	147	892
	4000	48	0	0	304	0	0	326	0	0	426	22	172	957	29	290	1250
	6000	48	0	0	330	0	0	443	24	201	1030	29	294	1262	28	295	1333
	8000	48	24	187	985	25	214	1065	29	297	1277	—	—	—	—	—	—
	10,000	48	31	305	1280	—	—	—	—	—	—	—	—	—	—	—	—
	12,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28,500	SL	48	0	0	260	0	0	281	0	0	302	0	0	322	0	0	343
	2000	48	0	0	282	0	0	303	0	0	325	0	0	345	0	0	370
	4000	48	0	0	304	0	0	326	0	0	349	0	0	381	17	123	864
	6000	48	0	0	326	0	0	351	0	0	426	20	148	930	26	241	1173
	8000	48	0	0	383	0	0	462	22	174	1000	28	276	1259	27	278	1317
	10,000	48	22	161	955	24	201	1068	28	280	1276	—	—	—	—	—	—
	12,000	48	29	282	1265	—	—	—	—	—	—	—	—	—	—	—	—
26,000	SL	48	0	0	260	0	0	281	0	0	302	0	0	322	0	0	343
	2000	48	0	0	282	0	0	303	0	0	325	0	0	345	0	0	370
	4000	48	0	0	304	0	0	326	0	0	349	0	0	370	0	0	397
	6000	48	0	0	326	0	0	351	0	0	376	0	0	402	0	0	429
	8000	48	0	0	350	0	0	378	0	0	455	17	113	873	23	195	1102
	10,000	48	0	0	387	0	0	455	20	148	970	25	227	1185	26	257	1302
	12,000	48	19	127	899	22	0	1040	27	260	1276	26	257	1344	—	—	—
23,500	SL	48	0	0	260	0	0	281	0	0	302	0	0	322	0	0	343
	2000	48	0	0	282	0	0	303	0	0	325	0	0	345	0	0	370
	4000	48	0	0	304	0	0	326	0	0	349	0	0	370	0	0	397
	6000	48	0	0	326	0	0	351	0	0	376	0	0	402	0	0	429
	8000	48	0	0	350	0	0	378	0	0	405	0	0	435	0	0	509
	10,000	48	0	0	379	0	0	408	0	0	439	0	0	602	20	152	1035
	12,000	48	0	0	410	0	0	422	16	103	886	22	180	1110	25	235	1287

REMARKS: TOUCH DOWN SPEEDS ARE INDICATED AIRSPEEDS.
LANDING DISTANCES SHOWN ARE MINIMUM DISTANCES AT MAXIMUM PERFORMANCE.
APPROACH RATE OF DESCENT IS 400 FPM.

landing would be difficult to perform. Landings at touchdown airspeeds greater than 40 knots TAS should be avoided due to landing gear limitations.

14—30. Takeoff and Landing Data Card. (See figure 14—1.) The takeoff and landing data card is also included in TM 55-1520-203-10CL. The data card provides readily available information for takeoff and landing. Information required to fill out the data card may be obtained from charts and tables contained in this chapter. Conditions contained on the rear side of the data card, such as temperature, dewpoint, wind, etc, may be obtained from briefing or tower operator.

14—31. Sample Problem. It is necessary to fly 2252 pounds of cargo to a point 140 nautical miles from the point of takeoff; land, unload, and then pick up 13 men and return them to the original takeoff point. The takeoff and landing points are at sea level, but because of terrain, it is necessary to accomplish the flight at 2000 feet, using maximum range power settings. Temperature is 15°C (59°F) (standard temperature) at sea level. A flight engineer will be carried in the cabin during the flight. Determine gross weights and fuel required.

Takeoff Gross Weight:

Operating weight from chart 7—2 (adjust if required; refer to DD Form 365 series for weight status of helicopter).	=	22723 lb
Cargo	=	2252 lb
Maximum fuel load	=	6000 lb
Takeoff gross weight	=	30975 lb

Warmup, Takeoff, and Climb:

Fuel used for warmup, takeoff, and climb from sea level to 2000 feet at 30,975 (31,000) lb. (Refer to table 14—6.)	=	296 lb

Outbound Leg:

Fuel required to cruise 140 nautical miles at 2000 feet altitude with a gross weight of 30,679 (31,000) lb (See chart 14—9, sheet 2)	=	2487 lb

Power settings 2600 engine rpm and 37.2 inches Hg CAS = 88 knots.

TM 55-1520-203-10CL

TAKEOFF AND LANDING DATA CARD

TAKEOFF DATA

NORMAL AND MAXIMUM PERFORMANCE TAKEOFF:
- MAXIMUM GROSS WT ________ LB
- INDICATED AIRSPEED ________ KN
- ACCELERATION DISTANCE ________ FT
- CLEAR 50-FT OBSTACLE ________ FT

ROLLING TAKEOFF:
- MAXIMUM GROSS WT ________ LB
- INDICATED AIRSPEED ________ KN
- ACCELERATION DISTANCE ________ FT
- CLEAR 50-FT OBSTACLE ________ FT

VERTICAL TAKEOFF:
- MAXIMUM GROSS WT ________ LB
- MAXIMUM RATE-OF-CLIMB ________ FPM

LANDING DATA

APPROACH TO HOVER AND VERTICAL LANDING:
- APPROACH IAS ________ KN
- HOVER ALTITUDE ________ FT

ROLLING LANDING:
- APPROACH IAS ________ KN
- DECELERATE ALTITUDE ________ FT
- MAXIMUM GROUND SPEED ________ KN

(FRONT SIDE)

TM 55-1520-203-10CL

TAKEOFF AND LANDING DATA CARD

CONDITIONS

DENSITY ALTITUDE ________ FT
- PRESSURE ALTITUDE ________ FT
- TEMPERATURE ________ °C
- DEWPOINT ________ °C

WIND ________ KNOTS ________

RUNWAY LENGTH ________ FT. HEADING ____

GROSS WT (TAKEOFF) ________ LB

GROSS WT (LANDING) ________ LB
- TAKEOFF CG AT STA ________ (CG LIMITS)
- LANDING CG AT STA ________ (CG LIMITS)

REMARKS:

(REAR SIDE)

Figure 14—1. Takeoff and landing data card

Letdown is assumed to be with zero distance and no fuel consumed.

New Takeoff Gross Weight:

Original gross weight	=	30975 lb
Minus fuel consumed	=	2783 lb
Minus cargo	=	2252 lb
Plus 13 men at 200 lb	=	2600 lb
New gross weight	=	28540 lb

Warmup, Takeoff, and Climb:

Fuel used for warmup, takeoff, and climb from sea level to 2000 feet at 28,540 (28,500) lb. (Refer to table 14–6.)	=	273 lb

Return Leg:

Fuel required to cruise 140 nautical miles at 2000 feet altitude with a gross weight of 28,540 (28,500) pounds. (See chart 14–9, sheet 2.)	=	2284 lb

Power settings 2600 engine rpm and 36.2 inches Hg CAS = 90 knots.

Letdown is assumed to be with zero distance and no fuel consumed.

Reserve Fuel:

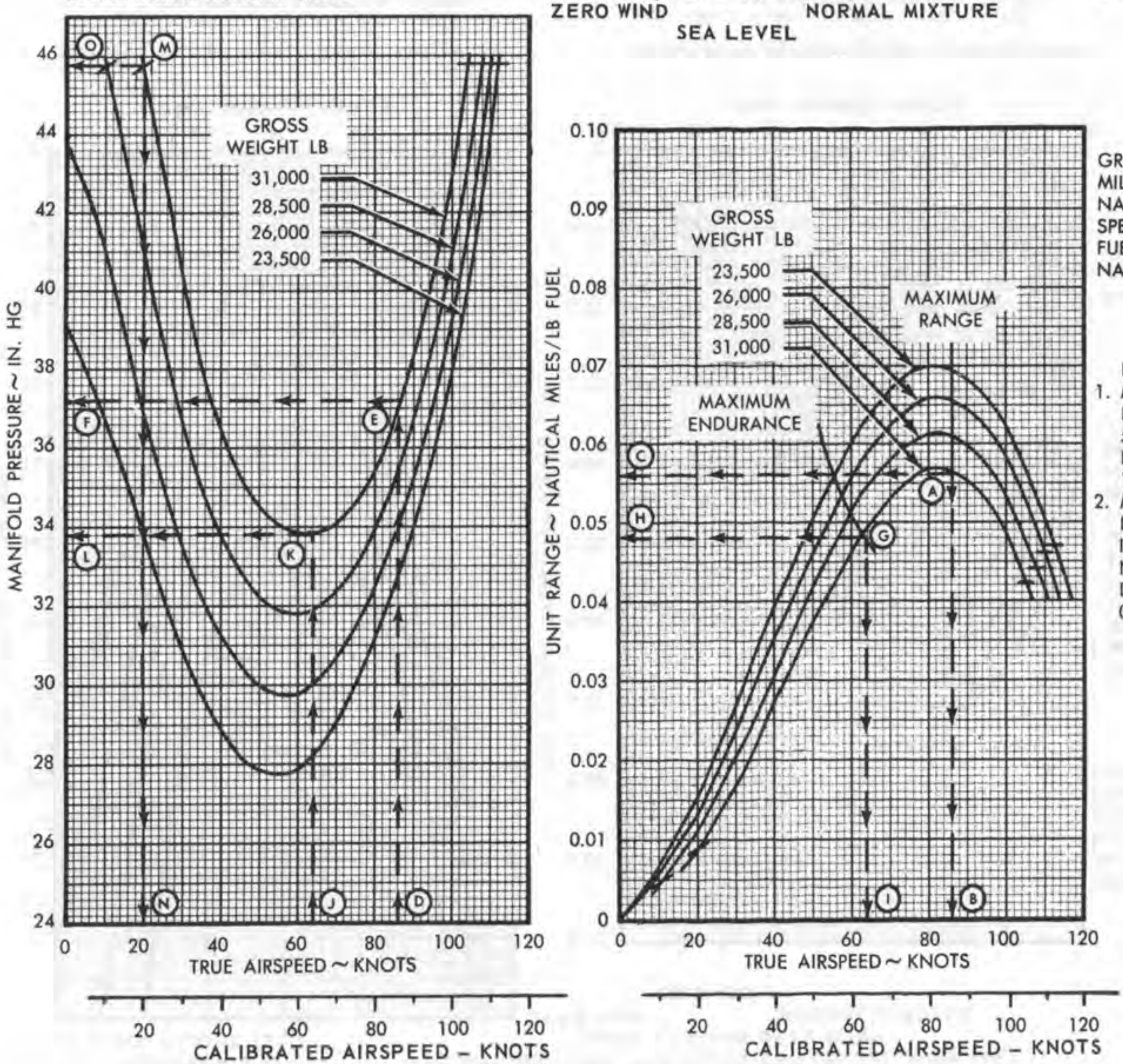
Total fuel carried	=	6000 lb
Minus fuel consumed outboard	=	2783 lb
Minus fuel consumed inboard	=	2557 lb
Reserve fuel	=	660 lb
New gross weight	=	25983 lb

Power settings for flight on reserve fuel at a gross weight of 25,983 (26,000) lb are 2600 engine rpm, manifold pressure 34.7 inches Hg, and calibrated airspeed 90 knots. (See chart 14–9, sheet 2.) From chart 14–8 fuel flow is 1400 lb per hour. Reserve time would be 660/1400 = 0.47 hours or 28 minutes at recommended cruise.

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

2600 RPM STD ATMOSPHERE
CONFIGURATION: TWO 150-OR TWO 300-GAL AUXILIARY TANKS, LANDING GEAR DOWN
ZERO WIND NORMAL MIXTURE
SEA LEVEL

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL



GROUND NAUTICAL MILES/LB = AIR NAUTICAL MILES/LB (GROUND SPEED/TAS)
FUEL FLOW LB/HR = TAS/AIR NAUTICAL MILES/LB

NOTE

FOR CLEAN CONFIGURATION

1. MAXIMUM ENDURANCE
   DECREASE FUEL FLOW 55 LB/HR
   DECREASE MANF PRESS. 1.0 IN. HG
2. MAXIMUM RANGE
   INCREASE TAS 12 KNOTS
   INCREASE UNIT RANGE 0.010 NAUTICAL MILES/LB
   DECREASE MANF PRESS. 0.5 IN. HG

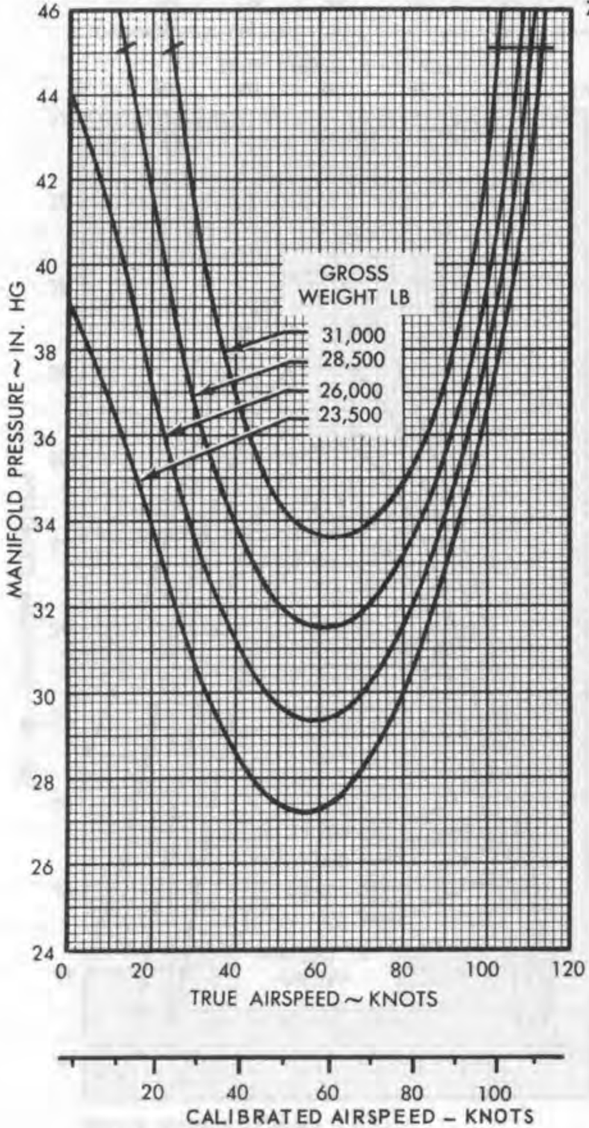
— MAXIMUM SPEED
/ MINIMUM SPEED

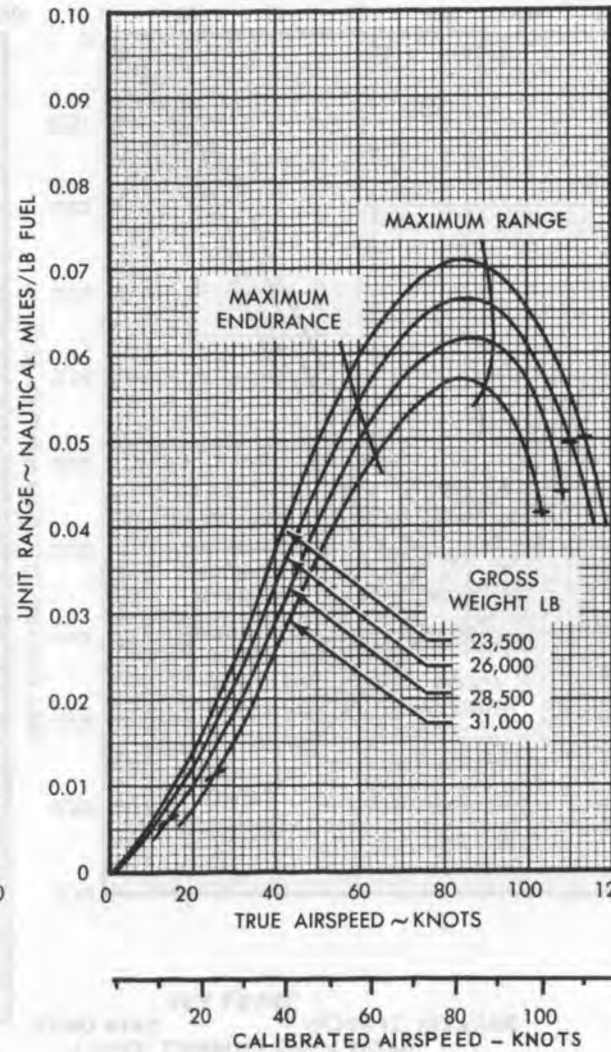
Chart 14–9. Range chart (Sheet 1 of 5)

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

2600 RPM STD ATMOSPHERE
CONFIGURATION: TWO 150-OR TWO 300-GAL AUXILIARY
TANKS, LANDING GEAR DOWN
ZERO WIND NORMAL MIXTURE
2000 FEET

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL





GROUND NAUTICAL MILES/LB = AIR NAUTICAL MILES/LB (GROUND SPEED/TAS)
FUEL FLOW LB/HR = TAS/AIR NAUTICAL MILES/LB

NOTE
FOR CLEAN CONFIGURATION
1. MAXIMUM ENDURANCE
DECREASE FUEL FLOW 70 LB/HR
DECREASE MANF PRESS. 1.0 IN. HG
2. MAXIMUM RANGE
INCREASE TAS 10 KNOTS
INCREASE UNIT RANGE 0.010 NAUTICAL MILES/LB
DECREASE MANF PRESS. 1.0 IN. HG

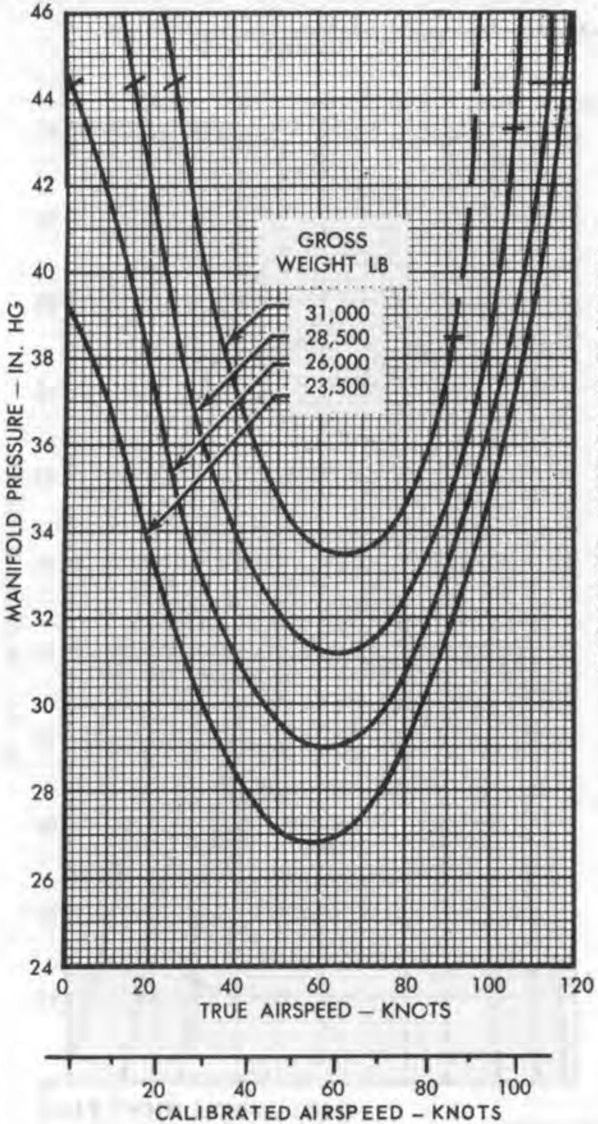
▬ MAXIMUM SPEED
⟋ MINIMUM SPEED

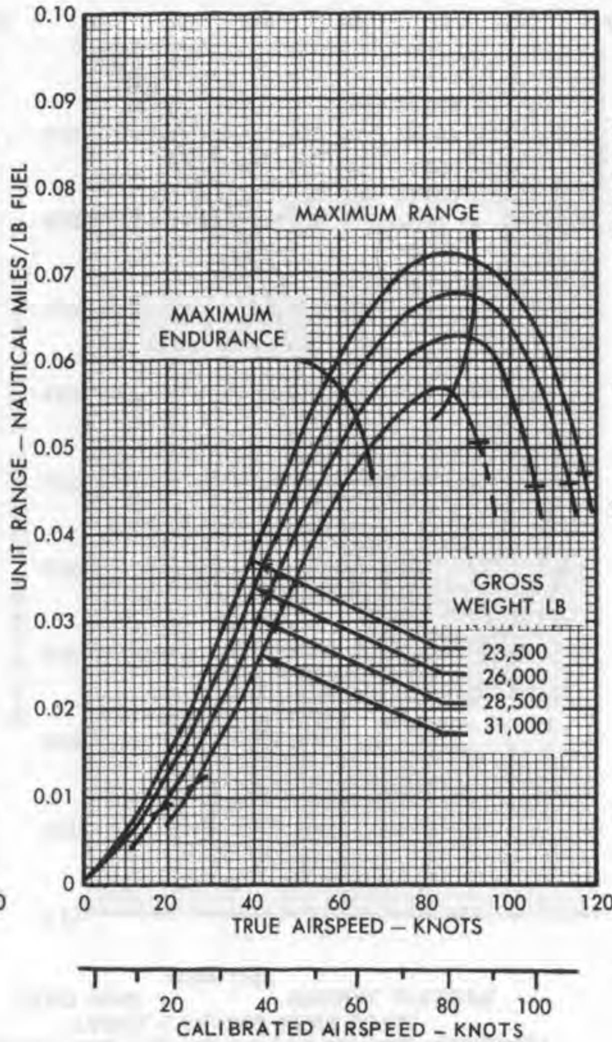
Chart 14–9. Range chart (Sheet 2 of 5)

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

2600 RPM STD ATMOSPHERE
CONFIGURATION: TWO 150-OR TWO 300-GAL AUXILIARY TANKS, LANDING GEAR DOWN
ZERO WIND NORMAL MIXTURE
4000 FEET

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL





GROUND NAUTICAL MILES/LB = AIR NAUTICAL MILES/LB (GROUND SPEED/TAS)
FUEL FLOW LB/HR = TAS/AIR NAUTICAL MILES/LB

NOTE

FOR CLEAN CONFIGURATION

1. MAXIMUM ENDURANCE
   DECREASE FUEL FLOW 65 LB/HR
   DECREASE MANF PRESS. 1.0 IN. HG
2. MAXIMUM RANGE
   INCREASE TAS 10 KNOTS
   INCREASE UNIT RANGE 0.010 NAUTICAL MILES/LB
   DECREASE MANF PRESS. 1.0 IN. HG

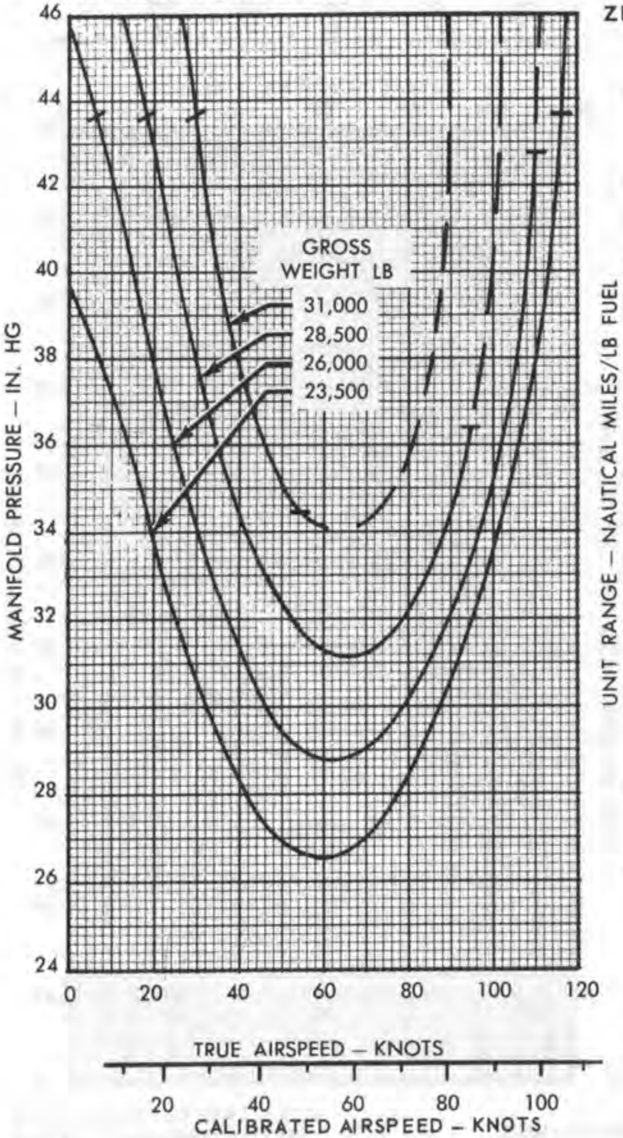
— MAXIMUM SPEED
/ MINIMUM SPEED
— — — ABOVE BLADE STALL SPEED — FOR REFERENCE ONLY

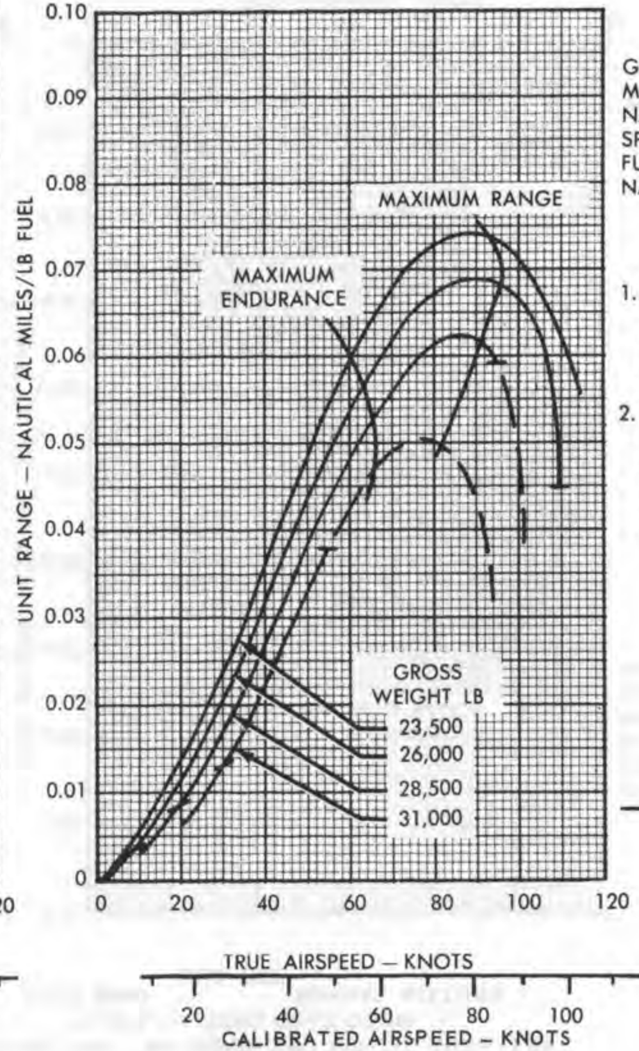
Chart 14–9. Range chart (Sheet 3 of 5)

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

2600 RPM STD ATMOSPHERE
CONFIGURATION: TWO 150-OR TWO 300-GAL AUXILIARY TANKS, LANDING GEAR DOWN
ZERO WIND NORMAL MIXTURE
6000 FEET

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL





GROUND NAUTICAL MILES/LB = AIR NAUTICAL MILES/LB (GROUND SPEED/TAS)
FUEL FLOW LB/HR = TAS/AIR NAUTICAL MILES/LB

NOTE

FOR CLEAN CONFIGURATION

1. MAXIMUM ENDURANCE
   DECREASE FUEL FLOW 60 LB/HR
   DECREASE MANF PRESS. 0.5 IN. HG
2. MAXIMUM RANGE
   INCREASE TAS 6 KNOTS
   INCREASE UNIT RANGE 0.010 NAUTICAL MILES/LB
   DECREASE MANF PRESS. 1.0 IN. HG

— MAXIMUM SPEED
/ MINIMUM SPEED
– – – ABOVE BLADE STALL SPEED – FOR REFERENCE ONLY

Chart 14–9. Range chart (Sheet 4 of 5)

MODEL: CH-37B
DATE: 1 DECEMBER 1958
DATA BASIS: FLIGHT TEST

2600 RPM STD ATMOSPHERE
CONFIGURATION: TWO 150-OR TWO 300-GAL AUXILIARY TANKS, LANDING GEAR DOWN
ZERO WIND NORMAL MIXTURE
8000 FEET

ENGINES: (2) R-2800-54
FUEL GRADE: 115/145
FUEL DENSITY: 6 LB/GAL

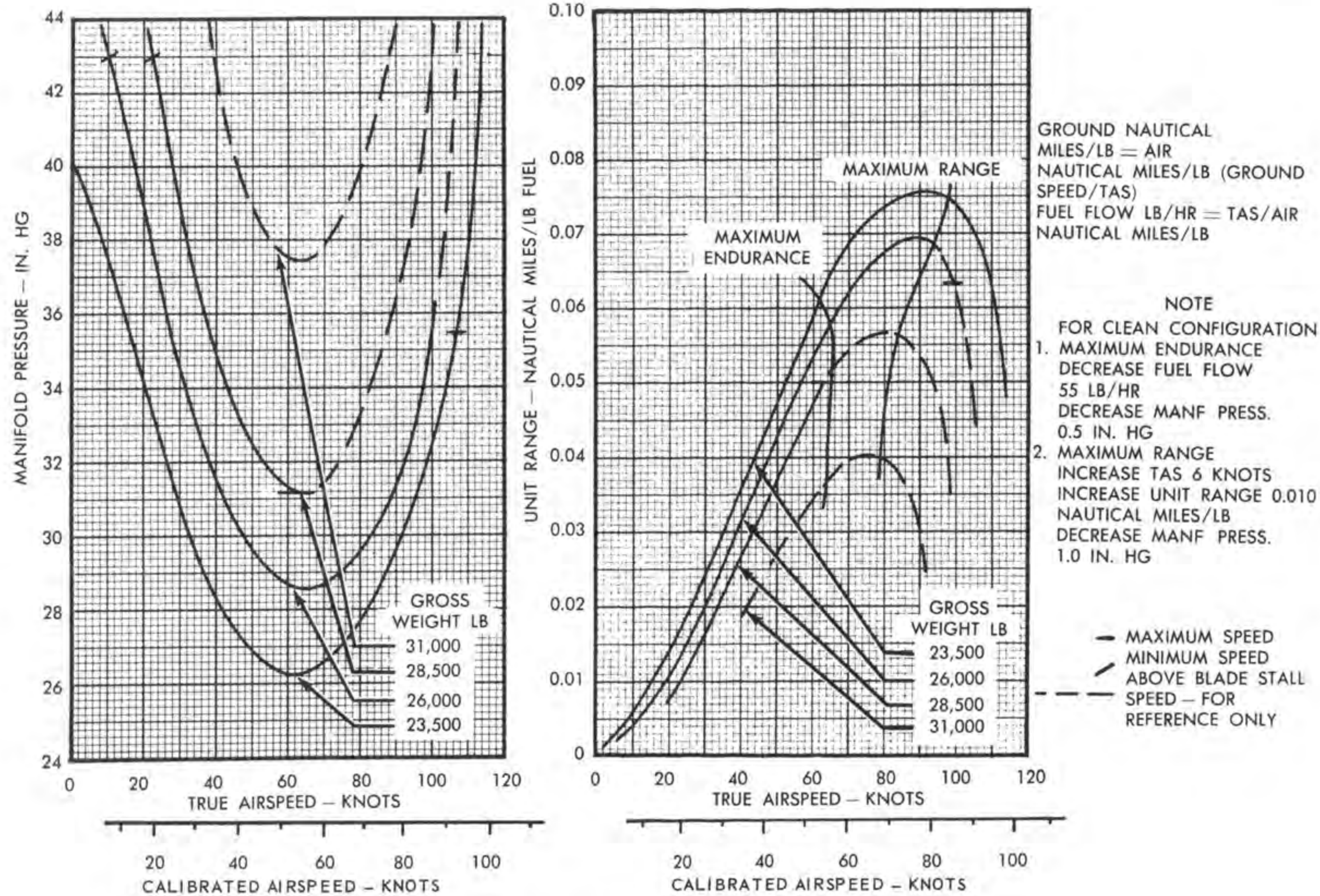


Chart 14–9. Range chart (Sheet 5 of 5)

APPENDIX I
REFERENCES

AR 310-1	Military Publications (General Policies)
AR 310-3	Department of the Army Publications – Preparations, Coordination, and Approval
AR 385-40	Accident Reporting and Records
AR 750-5	Organization, Policies, and Responsibilities for Maintenance Operation
AR 95-55	Nuclear Weapon Jettison
DA Pam 310-1	Index of Administrative Publications
DA Pam 310-2	Index of Blank Forms
DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders
FM 21-5	Military Training
FM 21-6	Techniques of Military Instructions
	Supply Catalogs, IL Series Identification Lists
TB AVN 23-16	Test Flights and Maintenance Operational Checks for Army Aircraft
TM 1-300	Meteorology for Army Aviation
TM 3-220	Chemical, Biological, and Radiological (CBR) Decontamination
TM 5-200	Camouflage Nets and Net Sets
TM 11-5821-204-12	Operator and Organizational Maintenance Manual: Radio Set AN/ARC-44
TM 11-5821-225-10	Operator Manual: AN/ARC-27, AN/ARC-55, AN/ARC-55A, and AN/ARC-55B
TM 11-5826-204-12	Operator and Organizational Maintenance Manual: Direction Finder Set AN/ARN-59(V)
TM 11-5826-215-12	Operator and Organizational Maintenance Manual: Radio Receiving Set AN/ARN-30D and AN/ARN-30E
TM 11-6605-200-12	Operation and Organizational Maintenance: Aircraft Magnetic Compass, Type J-2
TM 11-6615-202-12	Operation and Organizational Maintenance Manual: Automatic Pilot AN/ASN-23 and AN/ASN-23 (Modified)
TM 38-750	Army Equipment Record Procedures
TM 55-405-1	Army Aviation Maintenance Engineering Manual: General Practices
TM 55-1100-200-12-2	Air Transportability Procedures HONEST JOHN Warhead Section in CH-37 Helicopter
TM 55-405-9	Army Aviation Maintenance Engineering Manual: Weight and Balance
TM 55-1100-202-12-2	Air Transportability Procedures for Movement of Atomic Demolition Charge M50 Four Pack Configuration in U. S. Army CH-37 Helicopter
TM 55-1100-202-12-6	Air Transportability Procedures for Movement of Atomic Demolition Charge M50 Stock Pile Configuration in U. S. Army CH-37 Helicopter
TM 55-1100-226-12-3	Air Transportability Procedures: Atomic Demolition Charge XM127 and Remote Command Equipment in the U. S. Army CH-37 Helicopter
TM 55-1100-250-12-1	Air Transportability Procedures for Movement of NIKE HERCULES Warhead Section in Container in U. S. Army CH-37 Helicopter
TM 55-1100-300-12-2	Air Transportability Procedures: SERGEANT Warhead Section in the U. S. Army CH-37 Helicopter
TM 55-1100-400-12-1	Air Transportability Procedures: LACROSSE Warhead Section in the U. S. Army CH-37 Helicopter

APPENDIX II
MAINTENANCE ALLOCATION CHART

The Maintenance Allocation Chart will be found only in TM 55-1520-203-20, Appendix II.

APPENDIX III
AIRCRAFT INVENTORY MASTER GUIDE

The Aircraft Inventory Master Guide will be found only in TM 55-1520-203-20, Appendix III.

APPENDIX IV
OPERATOR'S AND CREWMEMBER'S CHECKLIST (TM-10CL)

The operator's and crewmember's condensed checklist is printed separately from Part I of the Technical Manual and is designated TM 55-1520-203-10CL.

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