TM 1-1H-21 Y -1

T.O. 1H-21(Y)-1
(FORMERLY AN 01-250HDA-1)

Flight Handbook

USAF SERIES YH-21 & H-21A HELICOPTERS

This publication replaces Supplements T.O. 1H-21 (Y)-1C, D, F, and H through R. Supplements E and G remain active as well as any new ones published subsequent to R.

1 DECEMBER 1955
REVISED 1 MAY 1956

LIST OF REVISED PAGES ISSUED

INSERT LATEST REVISED PAGES. DESTROY SUPERSEDED PAGES.

NOTE: The portion of the text affected by the current revision is indicated by a vertical line in the outer margins of the page.

Page No.	*Date of Latest Revision*
i	1 May 1956
1	1 May 1956
5	1 May 1956
9	1 May 1956
12	1 May 1956
31	1 May 1956
36	1 May 1956
36A	1 May 1956
38	1 May 1956
39	1 May 1956
40	1 May 1956
41	1 May 1956
42	1 May 1956
44	1 May 1956
44A	1 May 1956
45	1 May 1956
46	1 May 1956
47	1 May 1956
54	1 May 1956
58	1 May 1956
58A	1 May 1956
60	1 May 1956
91	1 May 1956
96	1 May 1956
96A	1 May 1956
97	1 May 1956
110	1 May 1956
114	1 May 1956
114A	1 May 1956
114B	1 May 1956
115	1 May 1956
122	1 May 1956
123	1 May 1956
157	1 May 1956
158	1 May 1956
159	1 May 1956

* The asterisk indicates pages revised, added or deleted by the current revision.

USAF

ADDITIONAL COPIES OF THIS PUBLICATION MAY BE OBTAINED AS FOLLOWS:

USAF ACTIVITIES.—In accordance with Technical Order No. 00-5-2.

NAVY ACTIVITIES.—Use Publications and Forms Order Blank (NavAer 140) and submit in accordance with instruction listed thereon.

For listing of available material and details of distribution see Naval Aeronautics Publications Index NavAer 00-500.

Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

USAF MODEL

YH-21 and H-21A

HELICOPTER

This publication supplements T.O. No. 1H-21(Y)-1 (formerly 01-250HDA-1). Reference to this supplement will be made on the title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

19 MARCH 1954

1. PURPOSE.

This supplement sets forth additional cold weather restrictions for the subject helicopters.

2. GENERAL.

Instructions in paragraph 3. below shall be complied with until such time as suitable winterization modifications are incorporated. At the present time investigation is being conducted to determine the extent of the modifications necessary. When these investigations are completed, kits will be distributed to modify the aircraft and new instructions will be issued.

3. INSTRUCTIONS.

The subject helicopters are restricted from operation at temperatures below -20°F.

END

AF-WP-O-23 MAR 54 3,400

Fs Fs Fs Fs Fs SAFETY OF FLIGHT Fs Fs Fs Fs Fs

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

USAF MODEL

YH-21 and H-21A

HELICOPTER

This publication supplements T. O. No. 1H-21(Y)-1 (formerly 01-250HDA-1). Reference to this supplement will be made on the title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

10 APRIL 1954

1. PURPOSE.

This supplement provides additional flight restrictions for the subject helicopters.

2. GENERAL.

The restriction indicated in paragraph 3. is necessary because of the inherent instability of helicopters which require special instrument flight techniques.

3. INSTRUCTIONS.

The subject helicopters are restricted from IFR operation pending completion of the Phase V testing.

END

AF-WP-O-6 APR 54 2,600

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

USAF SERIES

YH-21 H-21A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1H-21(Y)-1. Reference to this supplement will be made on title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

4 SEPTEMBER 1956

1. PURPOSE.

To prohibit takeoff with snow or ice on the aircraft.

2. GENERAL.

Failure to remove snow and ice accumulated on the helicopters while on the ground can result in serious aerodynamic and structural effects when flight is attempted. Depending on the weight and distribution of the snow and ice, takeoff, hovering and climb-out performances can be adversely affected. This roughness, pattern and location of the snow and ice can affect blade stall speeds and handling characteristics to a dangerous degree. In-flight structural damage can also result due to vibrations induced in flight by unbalanced loads of unremoved accumulations. These hazards can be eliminated by following the instructions contained herein.

3. INSTRUCTIONS.

Remove all snow and ice accumulations prior to flight.

END

AF Olmsted AFB, Pa., 25 Oct 56, 1M REPRINT

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

USAF SERIES

YH-21 H-21A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1H-21(Y)-1. Reference to this supplement will be made on title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

10 SEPTEMBER 1956

1. PURPOSE.

To impose an additional requirement relative to use of rich fuel mixture.

2. GENERAL.

When reaching an altitude of 10,000 feet above sea level, the use of rich fuel mixture is necessary to prevent engine overheating and possible engine detonation. To preclude such an occurrence, it is required that the instructions herein be followed.

3. INSTRUCTIONS.

A rich fuel mixture must be used at all times when operating at or above an altitude of 10,000 feet above sea level. This requirement applies regardless of high or low blower operation.

END

AF Olmsted AFB, Pa., 13 Nov 56 1700 REPRINT

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

USAF SERIES

YH-21 H-21A

HELICOPTERS

THIS PUBLICATION SUPPLEMENTS T.O. 1H-21(Y)-1. Reference to this supplement will be made on title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

2 OCTOBER 1956

1. PURPOSE.

To include an additional requirement in the procedure for rotor clutch engagement.

2. GENERAL.

A clutch out-of-phase condition may result from slippage which can occur during actuator clutch disengagement. With the occurrence of this out-of-phase condition, direct jaw engagement may be experienced when friction engagement is attempted, resulting in premature jaw engagement with consequent damage to the rotor system. To preclude the occurrence of the above described condition, it is required that the instructions contained herein be followed.

3. INSTRUCTIONS.

At all times that rotor clutch engagement is to be accomplished, and immediately before the pilot moves the friction switch to ENGAGE position, a qualified observer shall enter the cargo/passenger compartment (from where operation of the clutch actuator can be observed) and visually check that the clutch actuator output arm is in the required up-right position.

END

AF Olmsted AFB, Pa., 13 Nov 56 1700 REPRINT

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

USAF SERIES

YH-21 H-21A

HELICOPTERS

THIS PUBLICATION SUPPLEMENTS T.O. 1H-21(Y)-1. Reference to this supplement will be made on title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

10 OCTOBER 1956

1. PURPOSE.

To provide landing procedures for conditions of gross weight or altitude which limit hovering performance.

2. GENERAL.

A high, steep approach to a landing under the above cited conditions is extremely critical, because uncontrolled settling can occur with a resultant high impact shock upon touchdown. To preclude the occurrence of uncontrolled settling or high impact shock during landing under the cited conditions, it is required that the instructions herein be followed.

3. INSTRUCTIONS.

a. When operating at gross weights or altitudes which limit hovering performance, a running landing with a shallow approach should be performed whenever possible.

b. High, steep approaches to landings under conditions of gross weight or altitude which limit hovering performance may be accomplished only under emergency operation. Such approaches will be planned so that the helicopter arrives over the intended landing spot when approximately 25 to 35 feet above the ground and at a minimum forward speed of 35 knots IAS. At this point, apply full power to decrease rate of settling and to reduce the impact shock as the helicopter settles to the ground.

WARNING

Forward speeds of less than 35 knots IAS will result in uncontrollable settling.

END

Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK
USAF SERIES

YH-21 H-21A

HELICOPTERS

THIS PUBLICATION SUPPLEMENTS T.O. 1H-21(Y)-1. Reference to this supplement will be made on title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

17 OCTOBER 1956

1. PURPOSE.

To provide additional information regarding blade stalls.

2. GENERAL.

Under certain flight conditions (or during power-off touchdowns), it is possible to manipulate the controls in such a manner as to cause a severe blade stall through loss of lift by the retreating rotor blade. Such a condition causes the forward rotor blade to drop downward (as the blade approaches the fuselage) to the extent that the forward blade can strike the fuselage. To preclude the occurrence of the above cited blade stall, it is necessary that the flight conditions and information contained in the instructions herein be known by the pilot.

3. INSTRUCTIONS.

a. The pilot should avoid the following flight control factors:

(1) Excessive Control. -- Application of large amounts of collective pitch and aft cyclic control can cause the forward rotor blades to exceed that blade angle of attack which will result in a blade stall condition. Flight conditions during which the cited blade stall is most apt to occur are:

(a) During steep flare maneuvers.

(b) During attempts to cushion the nose-wheel touchdown when landing in autorotation.

(c) During severe turbulence.

AF Olmsted AFB, Pa., 15 Nov 56, 1700 REPRINT

Fs Fs Fs Fs Fs SAFETY OF FLIGHT Fs Fs Fs Fs Fs

(2) Insufficient Rotor Speed. -- This condition reduces the effectiveness of collective pitch and longitudinal control to the extent that the pilot may tend to employ excessive control.

(3) Steep Turns. -- During this maneuver when collective pitch is used to maintain altitude, the angle of attack of the rotor blades is increased, tending toward a blade stall condition.

(4) High Airspeed. -- During any one or combination of the above three conditions, a high IAS will increase the chances of a blade stall or will result in a more severe blade stall condition.

END

Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs Fs

T.O. 1H-21B-1Y

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

USAF SERIES

H-21B H-21C

HELICOPTERS

THIS PUBLICATION SUPPLEMENTS T.O. 1H-21B-1 AND REPLACES SAFETY OF FLIGHT SUPPLEMENT T.O. 1H-21B-1T, DATED 10 OCTOBER 1956. Reference to this supplement will be made on title page of the basic handbook by personnel responsible for maintaining the publication in current status.

NOTE COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

22 JANUARY 1957

1. PURPOSE.

To provide a basic technique for approach and landings which must be performed under such conditions of gross weight and altitude which limit hovering performance.

2. GENERAL.

Occasionally a requirement exists for an approach and landing to be made into a confined area. The gross weight of the helicopter and the altitude can make such an operation extremely hazardous, because if the pilot must perform a steep approach at low airspeeds, control of the rate of descent prior to touchdown becomes highly critical. Precise control and accurate judgment are necessary to avoid high impact loads at touchdown. One complete procedure for such an operation cannot be established, because of the numerous variables that can affect the overall procedure. The procedures contained in the instructions herein provide a basic technique for the pilot to follow. The basic procedures will apply at all times but the pilot should implement the procedures presented with whatever additional action the pilot deems necessary.

3. INSTRUCTIONS.

a. When the gross weight and the altitude are such that the hovering performance of the helicopter is marginal, approaches and landings into confined areas are not recommended and should not be attempted unless, in the pilot's judgment, an emergency condition exists which demands that such an operation be performed.

b. When the approach and landing cited in paragraph a. must be performed, a shallow approach with a running landing should be made whenever possible.

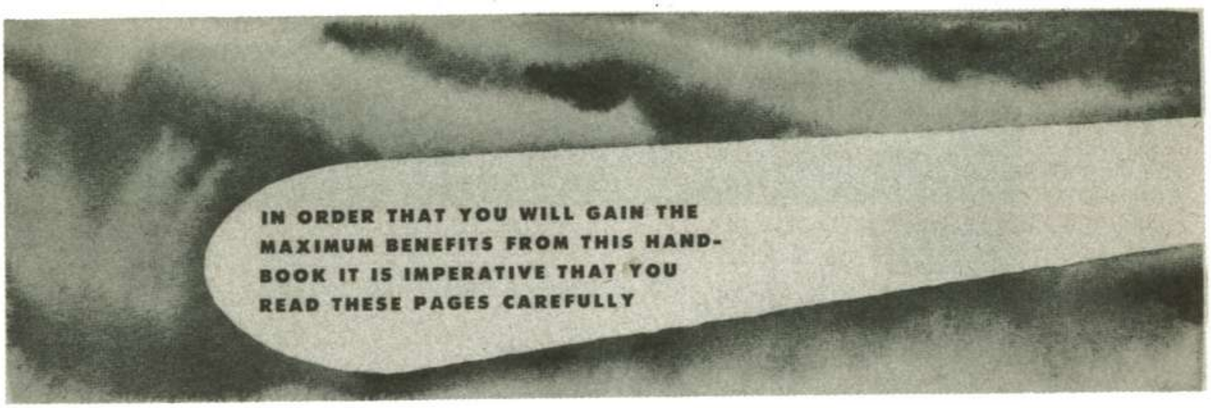
c. Should a steep approach be required, the maneuver should be so planned as to approach the intended landing spot with transitional lift. Speed dissipation should begin as near to the ground as possible to utilize ground effect as a means to retard the descent and in turn minimize landing impact loads.

WARNING

Precise control and judgment are required to maintain control of rate of descent and prevent the occurrence of high impact loads upon touchdown.

END

TABLE OF CONTENTS



It is the pilot's and co-pilot's responsibility to read thoroughly the handbook applicable to their helicopter.

The only source of technically accurate and constantly current operating instructions is your Flight Handbook. These instructions are based on the technical knowledge of the aircraft manufacturer and the Air Force as well as the experience of the using commands. You would never recognize these new books as your old familiar, undesirable -1 technical order. These new books have considered your specific problems and have therefore been made attractive, accurate, current, and very easy to use. Not all of the books have been prepared to the new requirements, but you can tell the old from the new very easily. The new type handbook has a full page cover illustration whereas the old book has a small "spot" illustration.

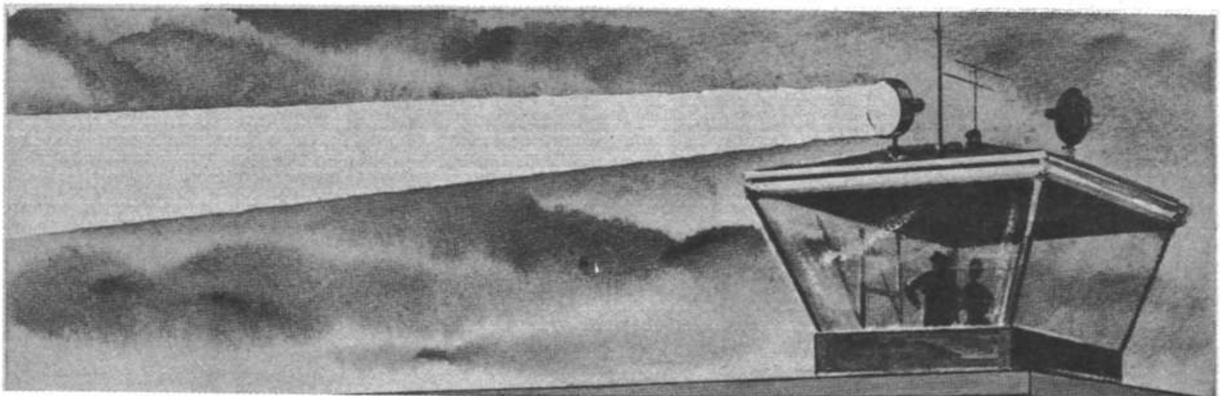
Each flight crewmember **(except those attached to an administrative base)** is entitled to have a personal copy of the Flight Handbook while he is stationed at a given base. Don't let anyone tell you differently; **Air Force Regulation 5-13**, issued in 1953, specifically makes that provision.

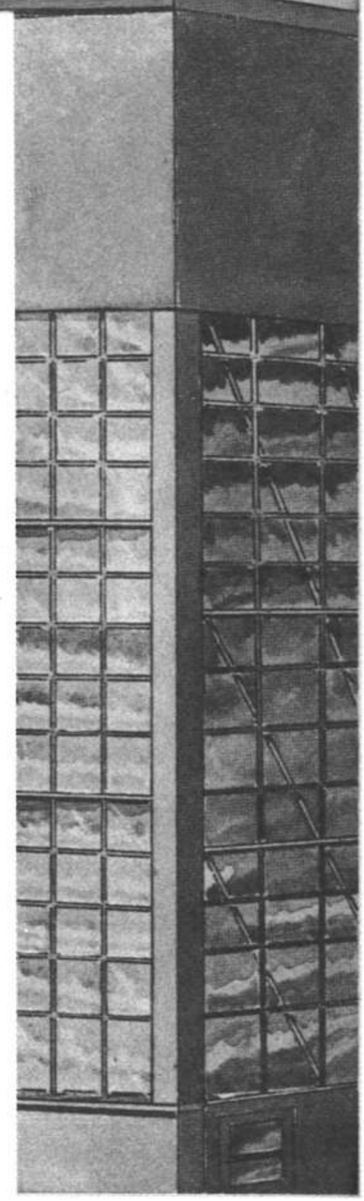
You would be surprised how well the technical order distribution system will work if you just do your part. Order your required quantity of handbooks before they are needed instead of waiting until the need arises. If you order them early, the Air Force will print enough to cover your requirements. If you delay, you will probably be kept waiting a long time when you do order because sufficient copies may not have been originally printed to cover your request—sometimes it takes a discouragingly long time to get new printing!

The technical order system is very easy to cope with. **Technical Order 00-5-2** explains, in just a few pages, the easy means by which you can set the automatic machinery into motion. Actually, all you have to do is reflect your required quantities on the **Publications Requirements Table, T.O. 00-3-1,** and all the revisions, reissues, and supplements will be automatically forwarded to you in the same quantities. Talk to your base supply officer—he should know all about the system since it is his job to fulfill your technical order requests. Of course, each base must develop a system of feeding these books and related data to its flight crewmembers so that no one will be using an obsolete book.

One more thing—we admit it takes a long time to revise the Flight Handbook. Since the time lag is excessive for Safety of Flight information, a new program has been put into effect to get such information to you in a hurry. This is done by means of Safety of Flight Supplements, which use the same number as your Flight Handbook except for the addition of a suffix letter. Supplements covering loss of life will get to you in 48 hours; those concerning serious damage to equipment will make it in six days. And what do you have to do to get these supplements? Absolutely nothing! If you have ordered your Flight Handbook on the Publications Requirements Table, you will automatically receive all supplements pertaining to your helicopter. Technical Order 00-5-1 covers some additional information regarding these supplements.

Your comments and questions regarding any phase of the Flight Handbook program are invited and should be directed to the Wright Air Development Center, Attention: WCSOH.





The handbook is divided into nine sections, an appendix and an alphabetical index. The information to be found in each section is as follows:

SECTION I, DESCRIPTION—Describes the helicopter and all its systems and controls which contribute to the physical act of flying the helicopter and the location of all items of emergency equipment.

SECTION II, NORMAL PROCEDURES—Contains the steps and procedures to be accomplished from the time the helicopter is approached by the flight crew until it is left parked on the ramp after accomplishing one complete non-tactical flight under normal conditions.

SECTION III, EMERGENCY PROCEDURES—Describes the procedures to be followed in meeting any emergency (except those in connection with auxiliary equipment) that could reasonably be expected to be encountered.

SECTION IV, DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT—Includes the description, normal operation and emergency operation of all equipment not directly contributing to flight but which enables the helicopter to perform certain specialized functions.

SECTION V, OPERATING LIMITATIONS—Covers all important ground and flight limitations that must be observed during normal operation.

SECTION VI, FLIGHT CHARACTERISTICS—Describes the unique flight characteristics of the helicopter, with emphasis on flight control positioning for ground and flight operations.

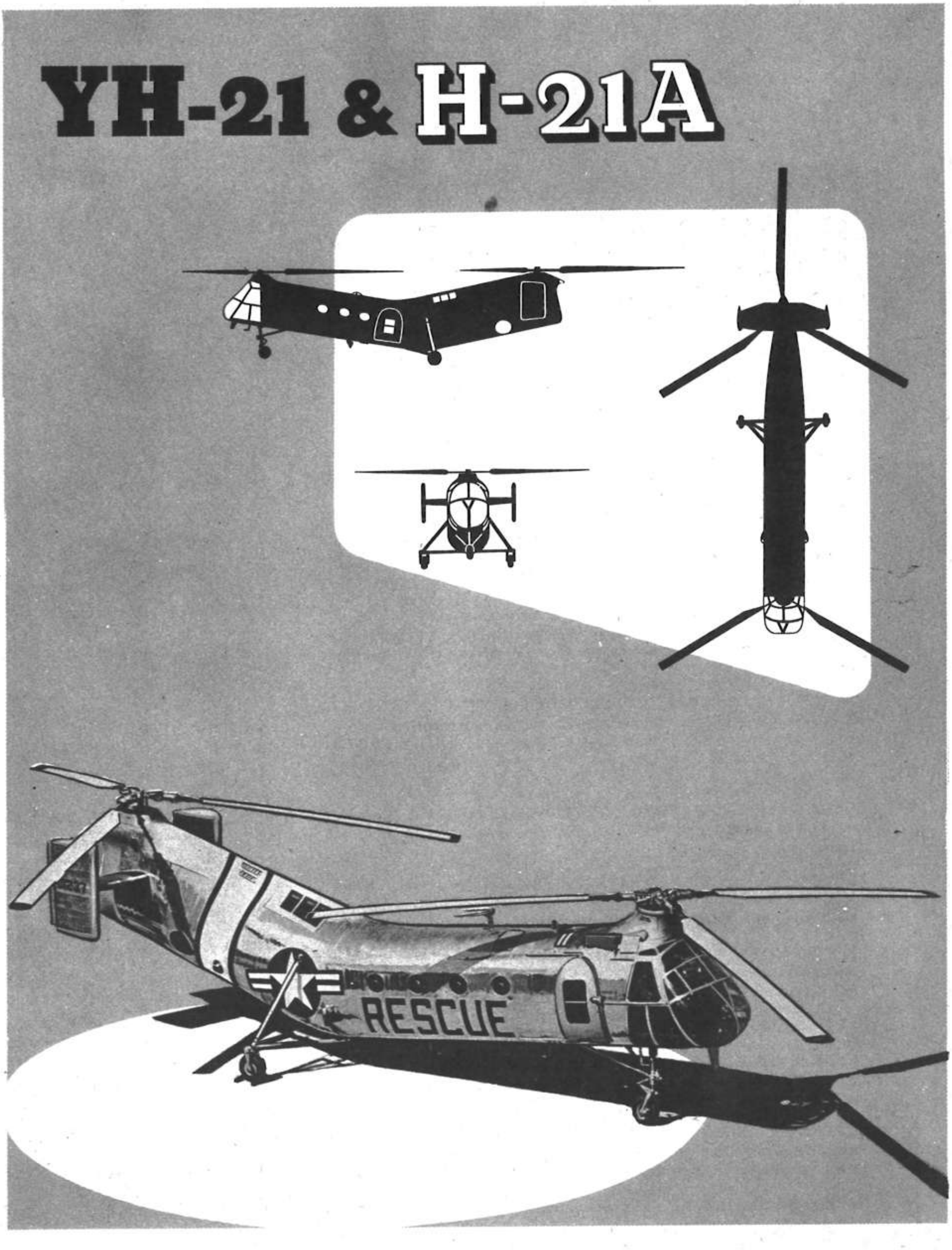
SECTION VII, SYSTEMS OPERATION—Describes operation of systems peculiar to this helicopter, with definite information on the more unusual systems involved.

SECTION VII, CREW DUTIES—Not applicable to this handbook.

SECTION IX, ALL WEATHER OPERATION—Describes precautions to be observed for operating the helicopter under adverse conditions, such as extremes of temperature and desert conditions.

APPENDIX I, PERFORMANCE DATA—Contains all operating data charts necessary for preflight and inflight mission planning and includes explanatory text on the use of the data presented.

ALPHABETICAL INDEX—Provides a ready reference to all items discussed in the handbook.

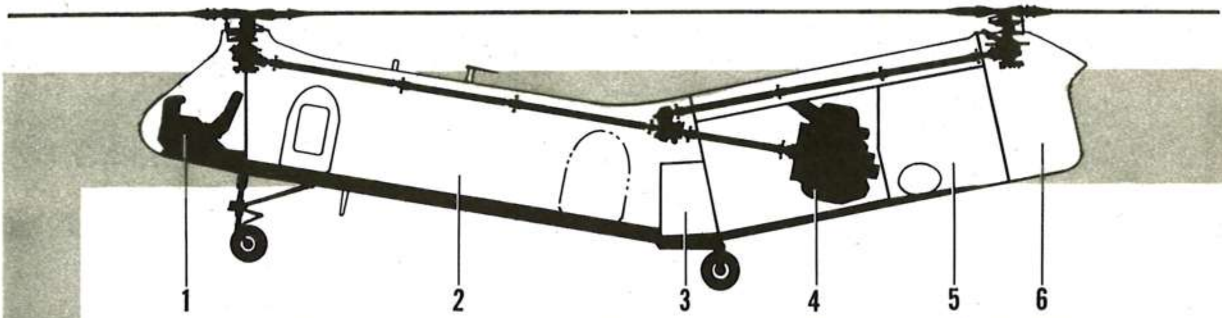

YH-21 & H-21A
RESCUE

Section I DESCRIPTION

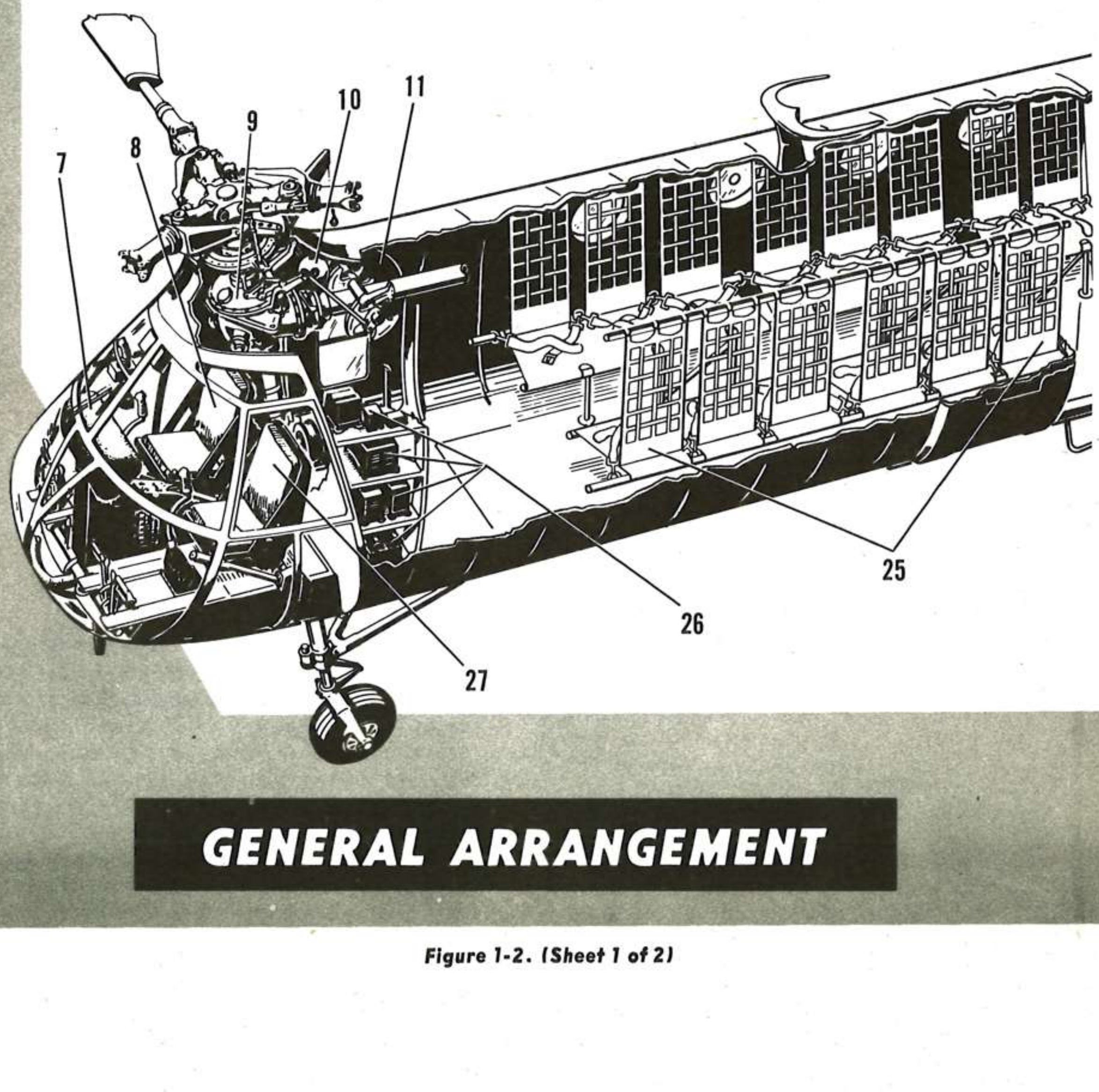
TABLE OF CONTENTS

THE HELICOPTER.

The models YH-21 and H-21A (figure 1-1) are 16 place, single engine, tandem rotored, rescue and utility helicopters manufactured by the Vertol Aircraft Corporation. Power is supplied by a Wright R-1820-103 air-cooled radial engine, located within the fuselage aft of the cabin section. The engine (20, figure 1-2) simultaneously drives two three-bladed rotors, longitudinally disposed, through drive shafts and reduction transmissions. The rotor blades, constructed of wood on a steel spar, are plywood covered, and have an aluminum trailing edge. All-metal rotor blades, when available, will be interchangeable with wooden blades. The fuselage is of all-metal stressed skin construction. The cockpit incorporates side-by-side pilot seating with the pilot seat on the right. The cockpit is arranged to provide for easy observation and manipulation, from either seat, of such instruments and controls as necessary for the safe and efficient flight of the helicopter. Dual flight controls are provided. The main entrance

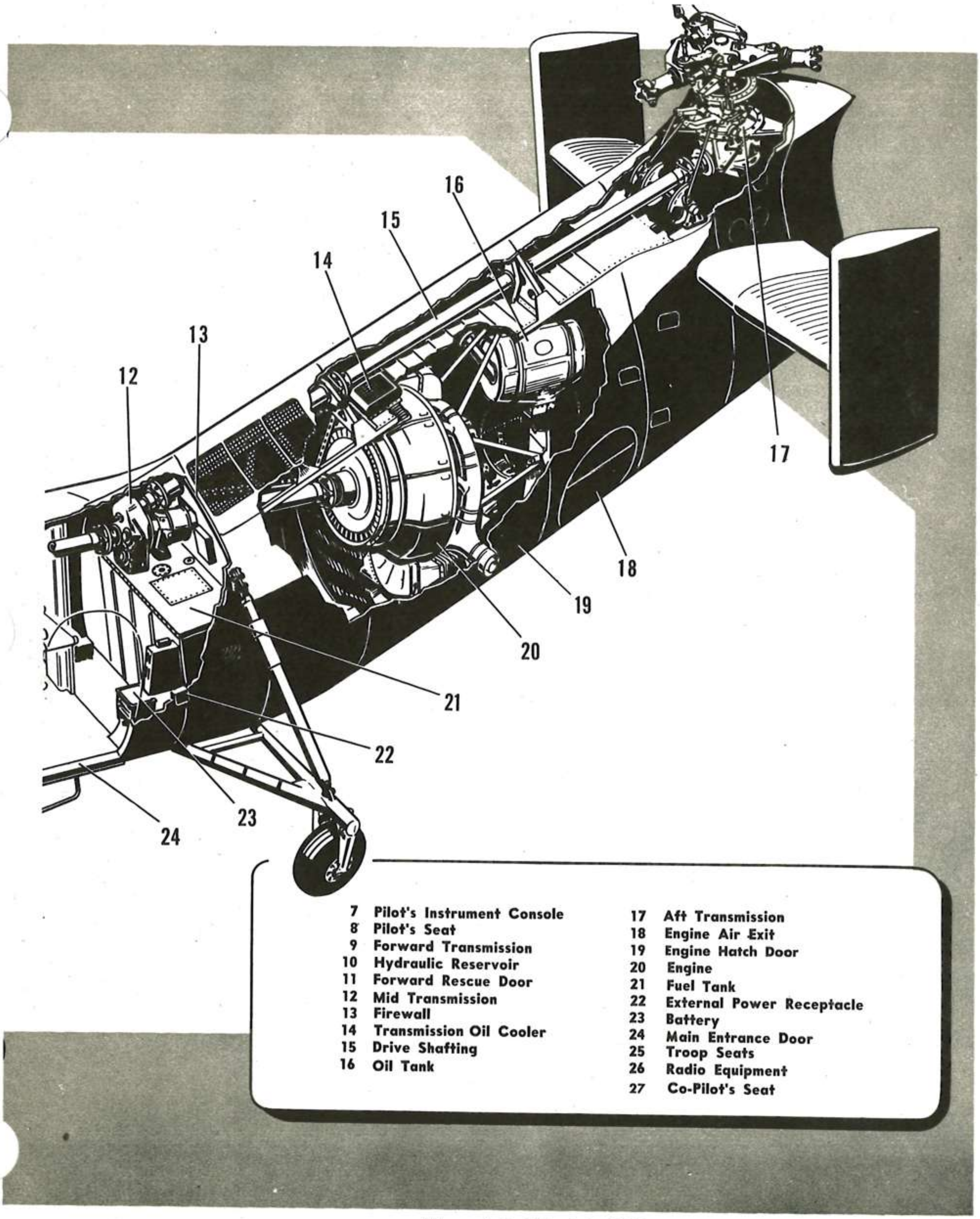


1 Pilots' Compartment
2 Cargo-Passenger Compartment
3 Fuel Cell Compartment
4 Engine Compartment
5 Engine Accessory Compartment
6 Tail Section



GENERAL ARRANGEMENT

Figure 1-2. (Sheet 1 of 2)



7 Pilot's Instrument Console
8 Pilot's Seat
9 Forward Transmission
10 Hydraulic Reservoir
11 Forward Rescue Door
12 Mid Transmission
13 Firewall
14 Transmission Oil Cooler
15 Drive Shafting
16 Oil Tank
17 Aft Transmission
18 Engine Air Exit
19 Engine Hatch Door
20 Engine
21 Fuel Tank
22 External Power Receptacle
23 Battery
24 Main Entrance Door
25 Troop Seats
26 Radio Equipment
27 Co-Pilot's Seat

Figure 1-2. (Sheet 2 of 2)

MAIN DIFFERENCES

COCKPIT	YH-21	H-21A	H-21B	H-21C
Automatic Pilot	No	No	Yes	No
Fuse Box (on Console)	Yes	Yes	No	No
Fuse Box. (behind Co-Pilot)	No	No	Yes	Yes
CARGO/PASS. COMPARTMENT				
Flooring	Wood	Metal	Metal	Metal
Main Entrance Door (Rounded Top)	Yes	Yes	No	No
Main Entrance Door (Rectangular)	No	No	Yes	Yes
Windows	7	7	9	9
Dome Lights	2	3	3	3
Cargo Tie-Down Rings (Fixed)	Yes	Yes	No	No
Cargo Tie-Down Rings (Fixed and Removable)	No	No	Yes	Yes
Auxiliary Fuel System (Internal)	Yes	Yes	No	No
Passenger Accommodations	14	14	20	20
ENGINE COMPARTMENT				
Air Exit Door	Yes	Yes	No	No
Carburetor Air Filter	No	No	Yes	Yes
Manifold Pressure Limiter	Yes	Yes	No	No
Self Sealing Oil Tank	No	No	Yes	Yes
FUSELAGE EXTERIOR				
External Fuel Tanks	No	No	Yes	No
Provisions for External Fuel Tanks	No	No	Yes	Yes
Formation Lights	No	No	Yes	Yes
Rotor Blades	Wood	Metal*	Metal*	Metal*
Landing Gear (Straight, Welded Tubing)	Yes	No	No	No
Landing Gear (Extruded, Tapered Tubing)	No	Yes	Yes	Yes

*Wooden blades to be used until metal blades are available.

Figure 1-3

door is located on the center, left side of the fuselage. A rescue door and a swinging boom type rescue hoist are located on the forward, right side of the fuselage immediately behind the pilot. The cabin can be fitted with troop seats and litters. The basic flight crew consists of a pilot. (Refer to Section V.)

DIMENSIONS.

The principal dimensions are as follows:

	YH-21	H-21A
Length, Over-All		
Rotors Turning	86 ft 5 in.	86 ft 4 in.
Rotors in Phase and Static	75 ft 3 in.	75 ft 6 in.
Blades Folded	52 ft 6 in.	52 ft 9 in.
Height, Over-All	16 ft	16 ft
Width (Blades Folded)	14 ft 2 in.	14 ft 6 in.
Width (Blades Turning)	44 ft	44 ft
Tread (Main Landing Gear)	13 ft 6 in.	13 ft 4 in.

APPROXIMATE WEIGHT.

The approximate weights are as follows:

	Rescue		Cargo or Passenger	
	YH-21	H-21A	YH-21	H-21A
Useful Load	2740	2797		3534
Weight Empty	8282	8242		7966
Gross Weight	11,022	11,039		11,500

Refer to Section V for Weight Limitations. Rescue weight is normal empty weight less items listed under Cold Weather Operation in Section IX.

ENGINE.

The helicopter is powered by a Wright R-1820-103 air-cooled radial engine, which is mounted within the fuselage aft of the cabin (figure 1-2). The engine does not contain reduction gears. The speed of the drive shaft between engine and mid transmission is the same as engine speed. An injection type carburetor supplies fuel to the engine. A single-stage, two-speed supercharger is installed for high altitude flight.

THROTTLE.

The controls are located on the pilot's and co-pilot's collective pitch levers (11 and 28, figure 1-4). Throttle control action is synchronized with the collective pitch control which will tend to automatically maintain an rpm setting when the collective pitch is increased or decreased. The throttle may be operated independently by rotating the turnable (motorcycle) grip from right to left to increase rpm or from left to right to decrease rpm.

A white index mark on the pilot's and co-pilot's throttle grips indicates closed throttle. The throttle override allows the throttle grip to be turned past the index mark.

THROTTLE FRICTION.

The throttle friction knob (figures 1-4 and 1-5) is located on the collective pitch lever at the end of the throttle control. By rotating to the left, the amount of friction in the throttle control can be increased as desired; and by rotating to the right, the friction can be decreased.

WARNING

When the throttle friction knob is rotated fully to the right (decrease friction), it is possible to jam the throttle in a locked position. Until such time as a stop is incorporated which will prevent this possibility, extreme care should be taken, when decreasing throttle friction, not to rotate the friction knob to the extreme right.

MANIFOLD PRESSURE LIMITER.

The manifold pressure limiter, mounted on the supercharger section of the engine, automatically limits the maximum power available during all engine operations to avoid overstressing of the helicopter transmissions and drive shafts. It also serves to establish the starting speed of the engine under no-load conditions. The unit varies the carburetor throttle opening to limit the maximum manifold pressure with regard to surrounding atmospheric pressure and the position of the supercharger drive (low or high ratio).

MIXTURE CONTROL LEVER.

The mixture control lever (figure 1-5) is located on the console below the switch panel. The positions of the mixture control are as follows:

1. RICH—Full forward position of the lever, identified by RICH on the console.
2. NORMAL—Midpoint position of the lever, identified by NORMAL on the console.
3. IDLE CUT-OFF—Movement of the lever to its full aft position is IDLE CUT-OFF, so identified on the console.

In moving the lever from RICH to NORMAL, a slight hesitation can be felt at the NORMAL position. This is the only detent for this lever position. A series of safety detents are provided aft of the NORMAL position to prevent inadvertent movement from NORMAL mixture range into IDLE CUT-OFF. To move the lever into IDLE CUT-OFF, it is necessary to operate the ratchet release.

CARBURETOR HEAT CONTROL LEVER.

The carburetor heat control lever is located on the console (figure 1-5) to the right of the mixture control. The forward position is COLD; the aft position is HOT. There are three detents for positive positioning of this control between COLD and HOT. There is enough friction designed into the system so that any position may be selected between the detents and the control will not move. Experience has shown that adequate heat is available when operating at −54°C with the heat control set in the vicinity of the mid point (second detent) between COLD and HOT. When the carburetor heat control lever is placed in the COLD position, air is forced by the fan through the carburetor air duct located above the engine. When this control is positioned at HOT, heated air from around the engine cylinders and exhaust shroud is channeled through the air duct into the carburetor air intake. Refer to figure 1-6 for air flow.

SUPERCHARGER.

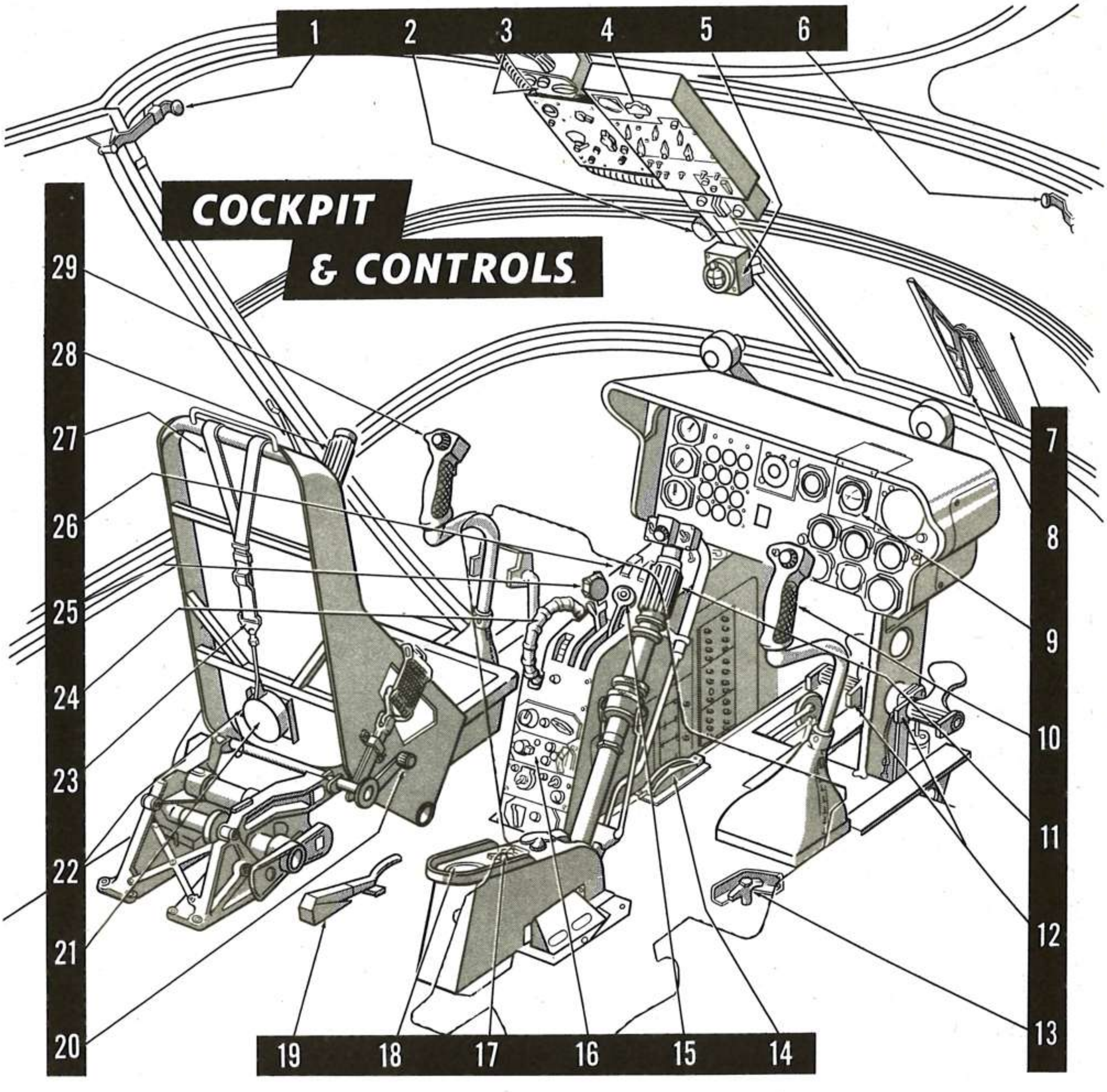
The Wright R-1820-103 engine is equipped with a two-speed, gear-driven supercharger. The supercharger control at the engine is actuated by oil pressure and is controlled by an electrically actuated solenoid.

SUPERCHARGER CONTROL SWITCH.

The supercharger control switch (figure 1-5) is mounted on the console just below and to the left of the ignition switch. This is 2-position, HIGH-LOW, toggle switch which, when flipped to HIGH, actuates the engine selector valve to the high blower position, and inversely, when on LOW, provides for engine operation in low blower.

ENGINE COOLING SYSTEM.

An engine air cooling system (figure 1-6) is necessary since ram air is not available during ground operations and hovering of the helicopter. The system consists of a fan, stator ring, cylinder head baffles and a cowling, plus the necessary air



1 Co-Pilot's Window Jettison Handle
2 Free-Air Thermometer
3 Co-Pilot's Interphone and Radio Compass Control Panel
4 Overhead Switch Panel
5 Standby Compass
6 Pilot's Window Jettison Handle
7 Windshield
8 Windshield Wiper
9 Instrument Panel
10 Pilot's Cyclic Stick
11 Pilot's Collective Pitch Lever
12 Directional Control Pedals
13 Parking Brake Handle
14 Longitudinal Stick Position Indicator
15 Carburetor Heat Control Lever
16 Pilot's Radio Controls
17 Hydraulic Control Valve
18 Hydraulic System Gage
19 Nose Wheel Lock
20 Co-Pilot's Seat Adjustment
21 Inertia Reel
22 Shoulder Harness Release Cable
23 Co-Pilot's Shoulder Harness
24 Stick Positioner
25 Mixture Control Lever
26 Electrical Distribution Panel
27 Co-Pilot's Seat
28 Co-Pilot's Collective Pitch Lever
29 Co-Pilot's Cyclic Stick

Figure 1-4. (Sheet 1 of 2)

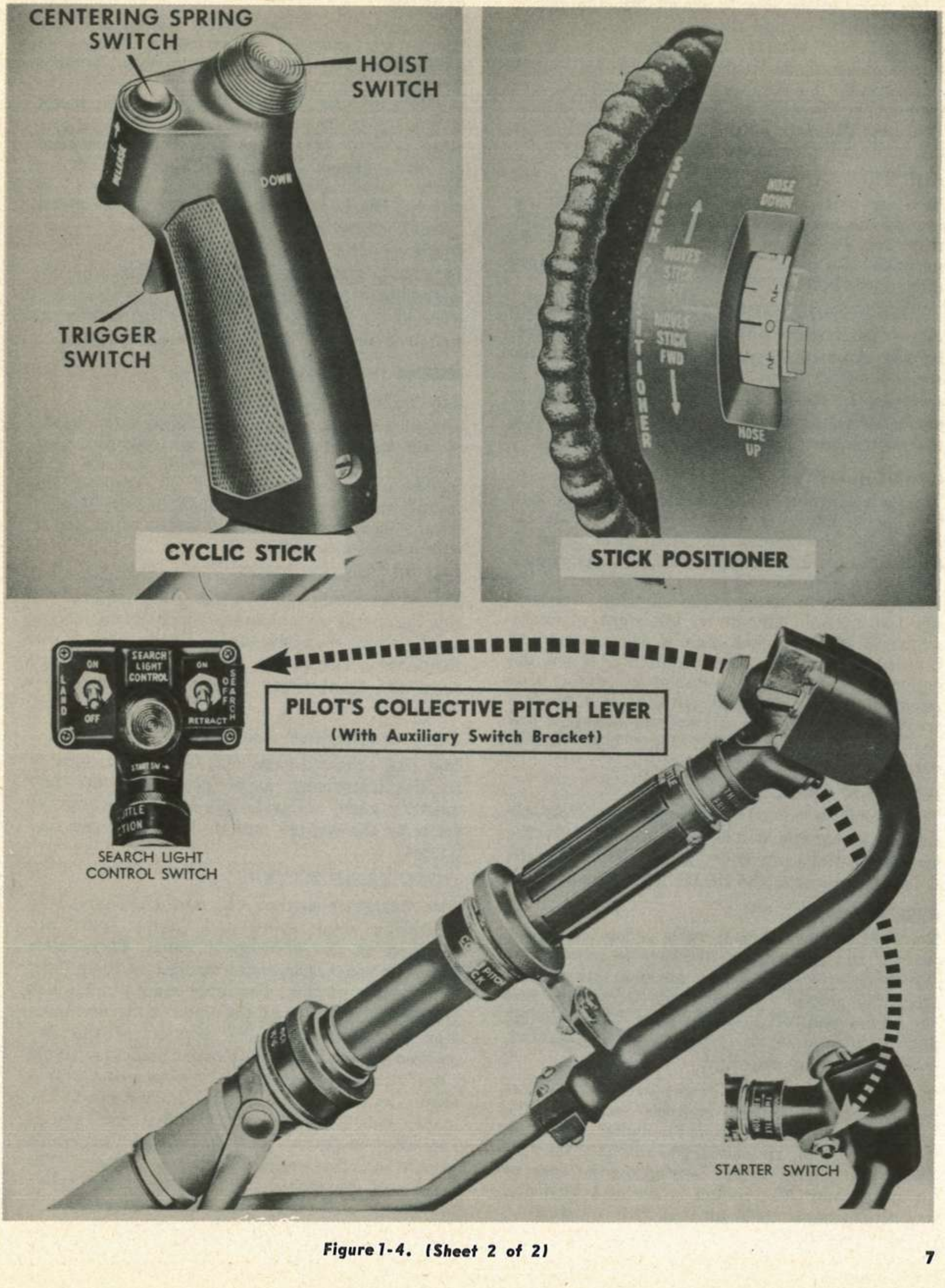


Figure 1-4. (Sheet 2 of 2)

inlets and outlets. Air is drawn into the engine compartment through the inlet in the top of the fuselage just aft of the cabin. The air is forced through the cowling around the engine cylinders by the engine-driven fan and expelled through the two circular outlets aft of the engine. The fan also acts as an engine flywheel when the rotors are disengaged.

AIR EXIT DOORS.

Two air exit doors, to control the flow of air around the engine, are provided but not normally installed. These are manually operated on the ground. The pilot should check for desired adjustment before flight.

ENGINE COOLING SWITCH. The engine cooling switch (figure 1-5), which operates the electrically actuated air exit door, is mounted on the console switch panel and is a momentary 3-position, OPEN-OFF-CLOSED, switch. However, since the electric actuators have been removed, the switch has no function.

IGNITION SYSTEM.

This is a conventional dual magneto system with two spark plugs per cylinder. When the starter switch on the pilot's collective pitch lever is pressed, current from the external power supply or battery is furnished to the starter and to the vibrator. The function of the vibrator is to supply low tension current to the right magneto, which in turn supplies high tension current to the spark plugs for engine starting. When the engine is running and the starter switch has been released, the starter and vibrator will be disconnected from the circuit, and the magnetos will continue to supply the necessary high tension current to the spark plugs.

IGNITION SWITCH.

This switch is located on the engine controls section of the console switch panel (figure 1-5). The switch positions are OFF, R for right magneto, L for left magneto, and BOTH for both magnetos.

FUEL PRIMER.

The fuel primer solenoid valve is located on the rear of the carburetor. Pressure is supplied by the electrically-driven fuel booster pump. Fuel from the primer solenoid valve is sprayed into the intake manifold just above the impeller throat and is diffused to all cylinders by the impeller.

FUEL PRIMER SWITCH.

The fuel primer, ON-OFF, switch (figure 1-5) is installed on the engine controls section of the console switch panel. When the switch is held in the ON position, an electrically actuated solenoid opens the primer valve, located on the rear of the carburetor. The switch is spring-loaded and will return to the OFF position when released.

STARTER.

The engine is provided with a 28-volt, d-c electric, direct cranking starter motor. The starter mechanism consists of an electric motor, a multiple disc clutch, and a crank jaw assembly. The engine is cranked directly when the starter motor is energized. The multiple disc clutch is provided to ease the torsion load when the starter jaw is engaged. The clutch also protects the starter mechanism by cushioning the shock in case the engine backfires while the starter motor is being energized.

ENGINE STARTER SWITCH.

This is a button type switch installed on the underside of the pilot's collective pitch lever, forward of the throttle grip (figure 1-4). When the switch is pressed, the starter is energized.

ENGINE INSTRUMENTS.

OIL TEMPERATURE GAGE.

The oil temperature gage (27, figure 1-7), located on the instrument panel, is connected to a temperature bulb in the oil system Y-drain, and registers the temperature of oil entering the engine in degrees centigrade. This gage is electrically actuated by heat changes which occur within the temperature bulb.

OIL PRESSURE GAGE.

The oil pressure gage (28, figure 1-7), located beside the engine oil temperature gage on the instrument panels, registers engine oil pressure in psi. Pressure is electrically transmitted to the gage from the transmitter in the engine accessory section.

FUEL PRESSURE GAGE.

The fuel pressure gage (13, figure 1-7), located on the instrument panel just below the fuel quantity gage, indicates fuel pressure units put forth by the engine- and electrically-driven fuel pumps.

DUAL TACHOMETERS.

Two dual tachometers (12 and 17, figure 1-7) indicating rotor speed and engine speed are mounted on the instrument panel. These dials have two concentric scales marked on their faces in hundreds of rpm. The inner scale graduations denote rotor rpm and the outer scale markings signify engine rpm. The shorter of the two needles shown in the illustration indicates actual rotor rpm and is actuated by a tachometer generator located on the central transmission. The longer needle shows actual engine rpm and is similarly energized by a tachometer generator located on the engine accessory section. The needles of the tachometers will be aligned when the engine and rotor speeds are synchronized.

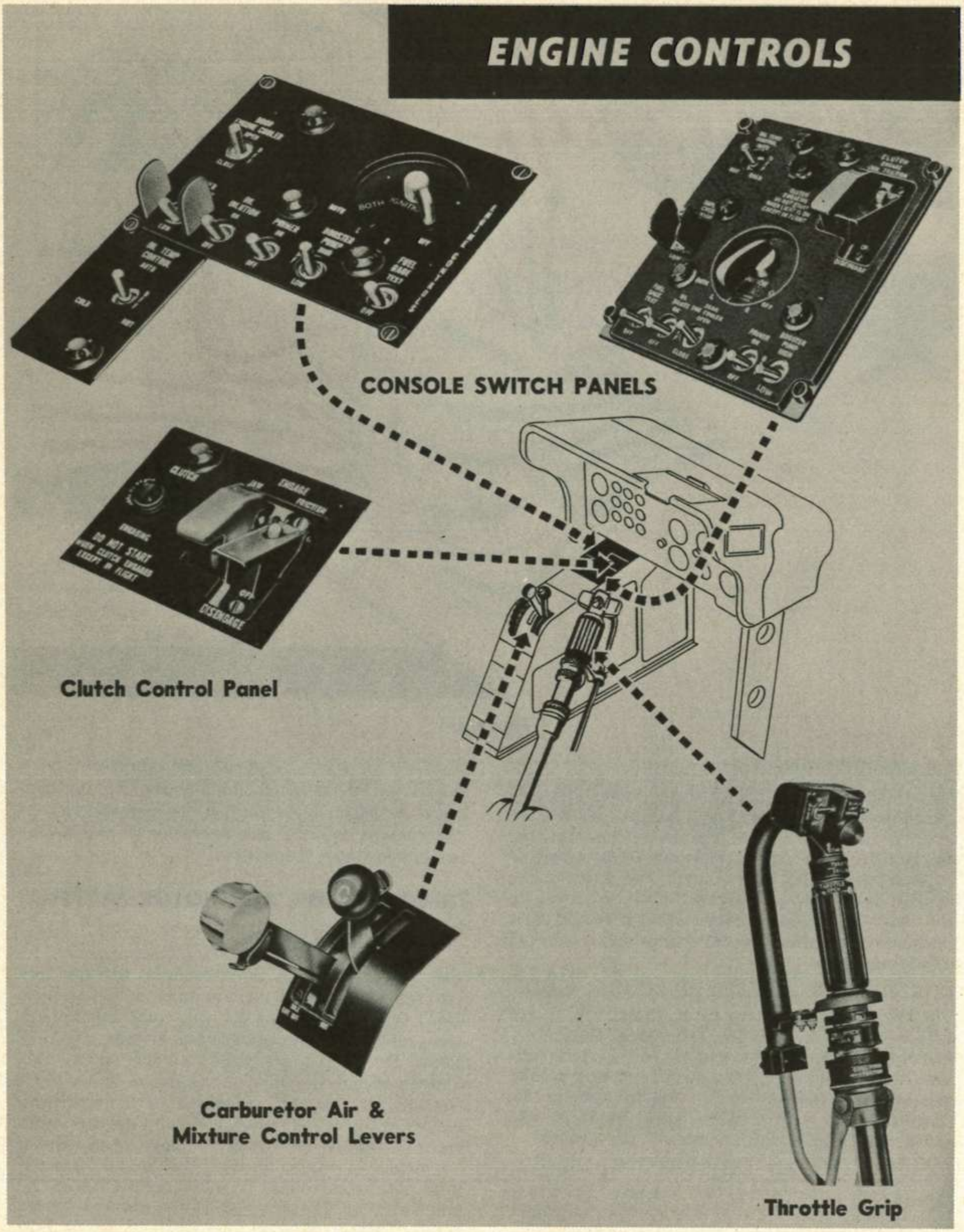

ENGINE CONTROLS
CONSOLE SWITCH PANELS
Clutch Control Panel
Carburetor Air &
Mixture Control Levers
Throttle Grip

Figure 1-5

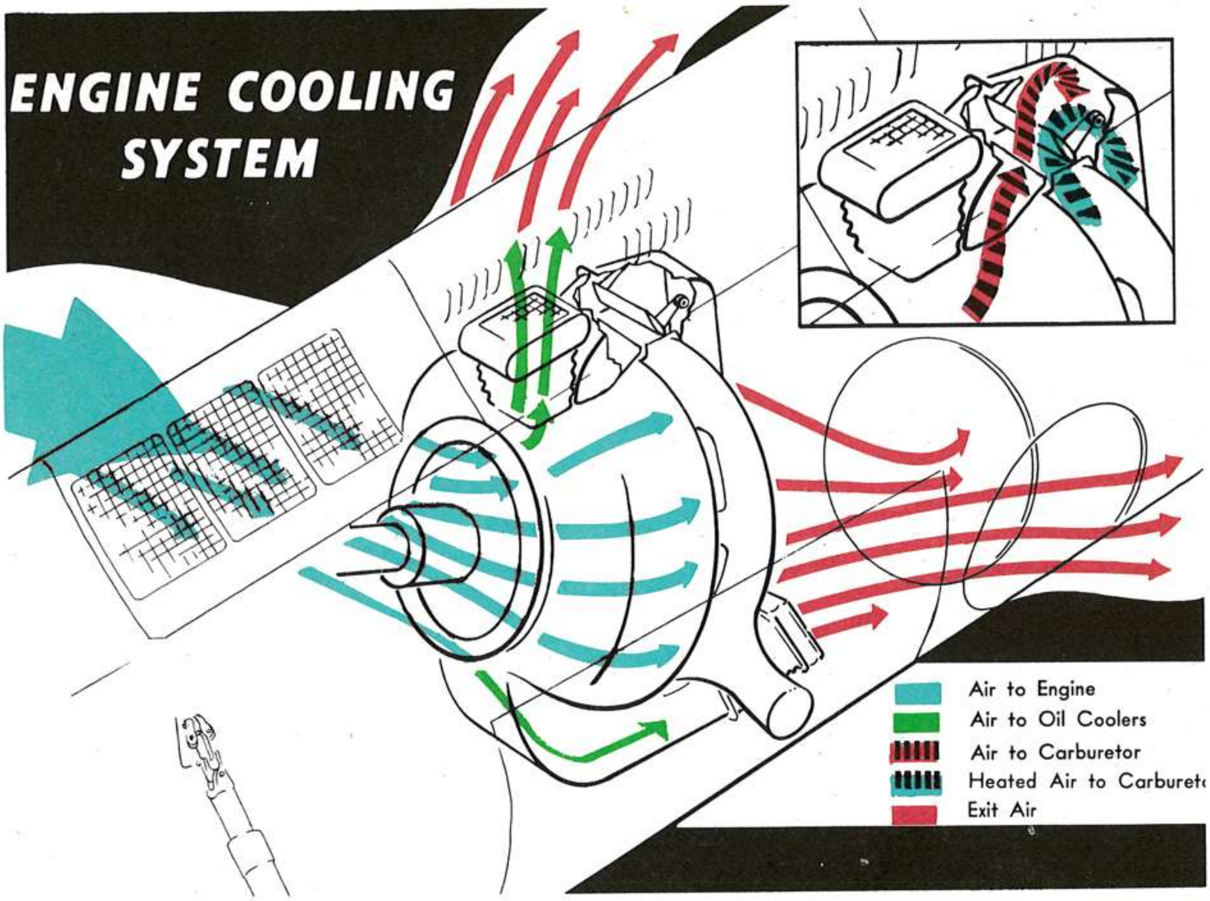


Figure 1-6

MANIFOLD PRESSURE GAGES.

Two identical manifold pressure gages (25 and 29, figure 1-7), one for the pilot and one for the co-pilot, are located on the lower part of the instrument panel. These gages indicate manifold pressure in inches of mercury. The purge valve control is a button marked PUSH adjacent to the manifold pressure gage. When this button is pushed, the manifold pressure lines will be purged of any moisture.

CARBURETOR AIR TEMPERATURE GAGE.

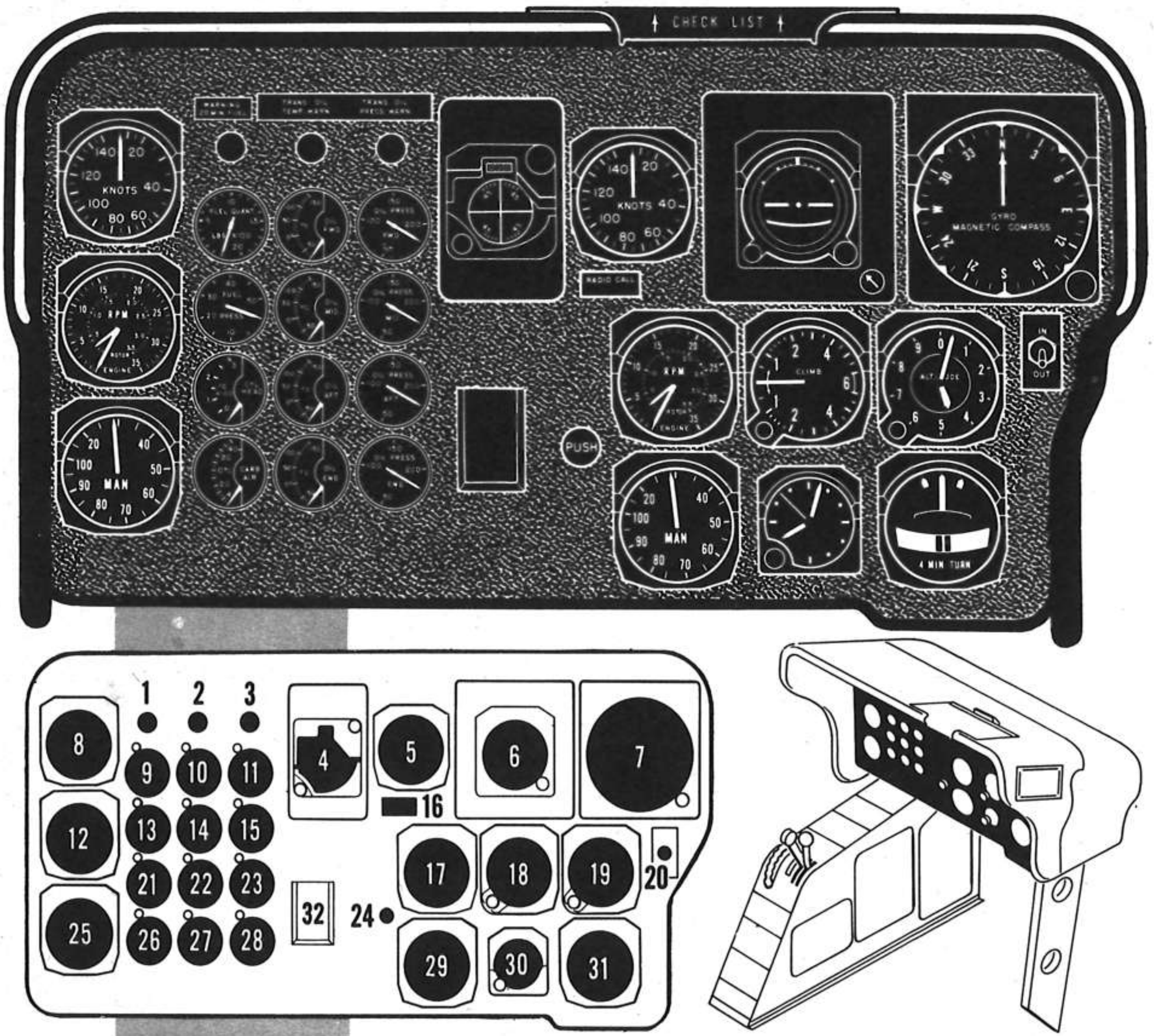
The carburetor air temperature gage (26, figure 1-7) is located on the lower left side of the instrument panel. The gage is connected to a temperature bulb located at the carburetor air intake and indicates temperature in degrees centigrade. Carburetor air temperature is regulated by the carburetor heat control lever on the console.

CYLINDER HEAD TEMPERATURE GAGE.

The cylinder head temperature gage (21, figure 1-7) is located on the left side of the instrument panel above the carburetor air temperature gage. The cylinder head temperature is registered in degrees centigrade from a temperature bulb installed in the hottest cylinder head. Engine temperature can be controlled by proper selection of the fuel-air mixture and operation of the engine air outlet doors, if installed.

TRANSMISSION AND ROTOR SYSTEM.

The transmission system (9, 12 and 17, figure 1-2) is composed of two rotor transmissions, located at each end of the helicopter, and one mid transmission located just forward of the firewall. Each transmission has its own complete lubrication system. Three oil coolers located together above the engine are cooled by the engine fan. Engine torque is supplied through a drive shaft connected to the mid transmission. This turning movement is transferred to the forward and aft rotor transmissions from the mid transmission by means of interconnecting drive shaft assemblies. The rotor shaft is an integral part of the transmission. The drive shafts operate at engine speed. This is reduced to a ratio of 9.7 to 1 in the rotor transmissions.



1 Fuel Warning Light
2 Transmission Oil Temperature Warning Light
3 Transmission Oil Pressure Warning Light
4 Course Indicator
5 Pilot's Airspeed Indicator
6 Attitude Gyro Indicator
7 Gyro Magnetic Compass
8 Co-Pilot's Airspeed Indicator
9 Fuel Quantity Gage
10 Forward Transmission Oil Temperature Gage
11 Forward Transmission Oil Pressure Gage
12 Co-Pilot's Dual Tachometer
13 Fuel Pressure Gage
14 Mid Transmission Oil Temperature Gage
15 Mid Transmission Oil Pressure Gage
16 Radio Call Number
17 Pilot's Dual Tachometer
18 Rate of Climb Indicator
19 Altimeter
20 Compass Slaving Switch
21 Cylinder Head Temperature Gage
22 Aft Transmission Oil Temperature Gage
23 Aft Transmission Oil Pressure Gage
24 Purge Valve (Push Button)
25 Co-Pilot's Manifold Pressure Gage
26 Carburetor Air Temperature Gage
27 Engine Oil Temperature Gage
28 Engine Oil Pressure Gage
29 Pilot's Manifold Pressure Gage
30 Clock
31 Turn and Bank Indicator
32 Compass Correction Card

INSTRUMENT PANEL

Figure 1-7

ROTOR CLUTCH.

A clutch is installed as part of the mid transmission assembly. This is a combination clutch containing a multiple plate friction clutch to synchronize the engine and rotors for engagement and an overrunning jaw clutch for positive drive and autorotation.

ROTOR CLUTCH OPERATIONAL FUNCTIONS.

This clutch system provides for engine starting independently of rotor engagement. When the engine is operating smoothly, the rotor system is engaged by the electrically actuated friction clutch. After the rotor rpm has synchronized with the engine rpm, the jaw clutch is engaged and the friction clutch disengaged simultaneously, thus supplying direct torque from the engine to the rotors. Refer to Section VII for this procedure. If, at any time, the rotor rpm should be greater than the engine rpm (such as during autorotation or power failure), the jaw clutch will overrun. The jaw clutch is constructed of two jaws, one of them spring-loaded, with tapered teeth designed to override, against the spring pressure, when the the rotor speed exceeds the engine speed. When the engine rpm is again increased to match the rotor rpm, the system will return to direct drive.

To stop rotors, increase the rotor and engine rpm then reduce the engine rpm sharply. This will permit the jaw clutch to overrun. Disengage the jaw clutch by placing the friction switch in the DISENGAGE position while the tachometer needles are separated. Shut down the engine as outlined in Section II. After the engine has stopped, engage friction switch to bring the rotors to a complete stop as described in Section VII.

When the helicopter is in autorotation, rotor rpm is maintained by the passage of air up through the blades. If overrunning clutch action were not possible, the rotors would stop when complete engine failure occurred. Since it is necessary that the engine be brought into direct drive at any time during a simulated autorotative descent, and since it may be desired to restart the engine during power-off descent, overrunning clutch action for these flight conditions is mandatory.

CLUTCH CONTROLS.

FRICTION SWITCH. This switch is located on the center portion of the console switch panel (figure 1-5). When the switch is moved to ENGAGE, the friction clutch is actuated, connecting the engine with the rotor system. This switch must remain in ENGAGE position for all rotor operation. Moving the switch to DISENGAGE position will disengage the engine from the rotors.

JAW SWITCH. This switch (figure 1-5) is adjacent to the clutch friction switch. It is a momentary type switch and must be held in JAW position during jaw clutch engagement until the clutch engaging light goes out. It will return to the OFF position when released. If the jaw switch is moved to JAW position before the friction switch is engaged, no action will occur.

CAUTION

> Do not operate the jaw switch until the tachometer indicates that the engine and rotors are synchronized.

The switch is placed in JAW position after the engine and rotors are fully synchronized with the friction clutch. After jaw clutch engagement, the rotors are in positive drive with the engine and are free to overrun the engine as required for autorotation.

CLUTCH ENGAGING LIGHT. The clutch engaging light (figure 1-5) is located on the console adjacent to the clutch switches and illuminates when the friction clutch switch is put in the ENGAGE position. This light will stay on until the jaw clutch switch is thrown on and the jaw clutch is fully engaged. This action should occur within two to four seconds.

Note

> Since this light is connected to both the central transmission oil pressure transmitter and the jaw clutch mechanism, it will not go out until the jaw clutch is fully engaged and the oil pressure has been stabilized to the proper point.

ENGINE OIL SYSTEM.

The engine oil system is composed of a tank assembly and an oil cooler. The total tank capacity is 21.47 US gallons. An internally contained hopper is provided for quick warm-up and to limit the required amount of oil dilution. Refer to Servicing Diagram (figure 1-15) for oil specification and grade.

OIL COOLER.

Engine oil is cooled during engine operation by passage through the oil cooler located on the lower section of the engine mount. When the oil is cold, it is diverted around the cooler by a thermostatic bypass valve located in the cooler. When the oil is hot, it passes through the cooler where it is cooled by air from the engine fan.

OIL TEMPERATURE CONTROL SWITCH. The oil temperature control switch (figure 1-5) has four positions, AUTO-OFF-HOT-COLD. However, since the thermostat located in the Y-drain and the oil cooler duct shutter have been removed, this switch has no function.

OIL DILUTION SYSTEM.

OIL DILUTION SWITCH.

The ON-OFF switch is located on the engine controls section of the console switch panel (figure 1-5). When the switch is placed ON, the engine oil is diluted with fuel. The oil should never be diluted for longer than nine minutes. Refer to Section IX for correct procedure.

TRANSMISSION OIL SYSTEM.

The forward, mid, and aft transmissions (9, 12 and 17, figure 1-2) each have a complete and separate lubrication system. Located above the engine are three oil coolers in one unit, one cooler for each transmission, which obtain forced air from the engine fan for cooling. System pressure is obtained from an oil pump located in each transmission case. Mounted adjacent to the transmissions are pressure and temperature transmitters. Gages for these units are located on the left side of the instrument panel (figure 1-7). Pressure for the forward, mid, and aft transmissions is registered on the inner row of gages, (11, 15 and 23, figure 1-7) and temperature for these installations is transmitted to the gages immediately to the left of the pressure gages (10, 14 and 22, figure 1-7). Warning lights (2 and 3, figure 1-7), are mounted above these gages, indicating high or low pressure and high temperature.

FUEL SYSTEM—MAIN.

The main fuel system (figure 1-8) consists of one fuel compartment, centrally located in the helicopter, containing a non self-sealing nylon tank, an electric fuel booster pump located integrally in the fuel tank, a fuel strainer and fuel shut-off valve located below the fuel tank, an oil dilution solenoid located in the engine compartment, and an engine driven fuel pump located on the engine. The fuel quantity and fuel pressure gages are located on the console. The system is suitable for aromatic fuels. Refer to figure 1-9 for fuel quantity data.

FUEL SPECIFICATION AND GRADE.

For fuel grade and specification, refer to the Servicing Diagram (figure 1-15).

FLUIDS SHUT-OFF SWITCH.

A 2-position fluids shut-off switch, located on the overhead switch panel (figure 1-10), provides emergency shut-off for the fuel and oil systems. The switch operates the two electric shut-off valves in the engine compartment. The switch has two positions (NORMAL and SHUT-OFF) and it remains in the NORMAL position during all normal operation. The switch should be moved to the SHUT-OFF position only when a fire or other such emergency requires that the fuel and oil be shut off.

FUEL SHUT-OFF VALVE.

The electrically operated fuel shut-off valve located beneath the fuel tank, is positioned in the fuel system between the fuel booster pump and the fuel strainer. This unit is accessible through an opening forward of the engine hatch keel.

FUEL BOOSTER PUMP SWITCH.

This is a 3-position switch (HIGH-LOW-OFF) for operating the electrically-driven fuel pump. The switch is located on the console switch panel (figure 1-5). The pump is inoperative when the switch is in the OFF position. Use HIGH position for starting the engine, for take-off, landing, and for operating above 10,000 feet or below 1000 feet altitude. Use HIGH position also, in event of engine pump failure. Use LOW position for flight between 1000 and 10,000 feet altitude and in autorotative descent.

CAUTION

Failure of the engine-driven pump will be indicated by a drop-off in pressure on the gage. Switch the electrically-driven fuel booster pump to the HIGH position immediately, and land as soon as possible.

FUEL BOOSTER PUMP.

The electrically operated two-speed fuel booster pump, attached to the bottom of the fuel cell, supplies sufficient pressure at the engine-driven fuel pump inlet to prevent a vapor lock. This pump also supplies pressure for the fuel supply to the cabin heater. If the engine-driven fuel pump should fail, the fuel booster pump will deliver fuel to the engine at high pressure for a limited period of time.

FUEL QUANTITY GAGE.

A fuel gage (9, figure 1-7), calibrated to measure fuel quantity in pounds, is located on the left side of the instrument panel below the fuel reserve warning light.

The capacitance type fuel quantity gage system consists of a tank unit, a bridge unit, an amplifier, and a fuel quantity gage. The tank unit consists of a cylindrical capacitor extending into the fuel tank. The capacitance of the tank unit is balanced against a fixed capacity condenser in the bridge unit called a reference condenser. Any change in capacitance of the tank unit due to a change in fuel quantity causes a voltage unbal-

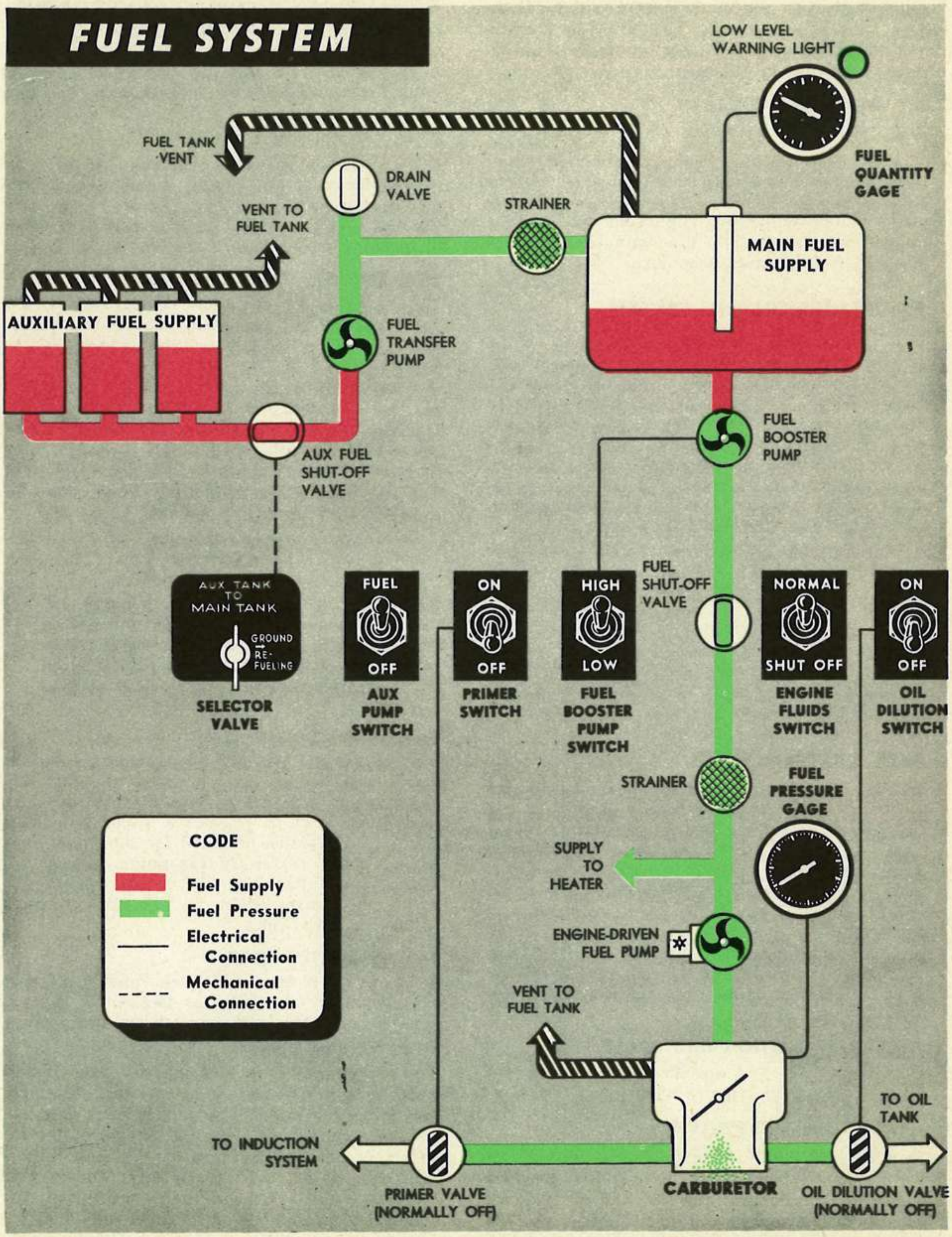

FUEL SYSTEM
LOW LEVEL WARNING LIGHT
FUEL TANK VENT
DRAIN VALVE
FUEL QUANTITY GAGE
VENT TO FUEL TANK
STRAINER
MAIN FUEL SUPPLY
AUXILIARY FUEL SUPPLY
FUEL TRANSFER PUMP
FUEL BOOSTER PUMP
AUX FUEL SHUT-OFF VALVE
FUEL SHUT-OFF VALVE
AUX TANK TO MAIN TANK
GROUND RE-FUELING
SELECTOR VALVE
FUEL
OFF
AUX PUMP SWITCH
ON
OFF
PRIMER SWITCH
HIGH
LOW
FUEL BOOSTER PUMP SWITCH
NORMAL
SHUT OFF
ENGINE FLUIDS SWITCH
ON
OFF
OIL DILUTION SWITCH
STRAINER
FUEL PRESSURE GAGE
CODE
Fuel Supply
Fuel Pressure
Electrical Connection
Mechanical Connection
SUPPLY TO HEATER
ENGINE-DRIVEN FUEL PUMP
VENT TO FUEL TANK
TO INDUCTION SYSTEM
TO OIL TANK
PRIMER VALVE (NORMALLY OFF)
CARBURETOR
OIL DILUTION VALVE (NORMALLY OFF)

Figure 1-8

ance in the bridge unit. This unbalance is amplified by the amplifier unit and is sent to the rotor of the gage where it causes a rotation of the pointer. This action turns an arm on a potentiometer located inside the gage until a new position of balance is established.

FUEL QUANTITY GAGE TEST SWITCH.

This spring-loaded, two-position, TEST-OFF, switch is installed on the engine controls section of the console switch panel (figure 1-5). When operated, the switch grounds one side of the bridge and causes the indicator pointer to rotate continuously counter-clockwise. It is necessary to create a test condition just long enough to displace the pointer an observable amount. The pointer should return to its original position when the switch is released. Failure to do so indicates a malfunction in the system.

FUEL RESERVE WARNING LIGHT.

A red warning light (1, figure 1-7) above the fuel gage will illuminate when 20 minutes of fuel remaining is indicated on the gage. This period is based on the take-off power of the engine. However, at cruising power (2400 rpm and 33 inches Hg) this quantity of fuel will last approximately 40 minutes. The signal is transmitted to the lamp by means of a cam located on the shaft of the fuel quantity gage pointer. The cam makes contact and completes the circuit of the warning light. Provisions have been built into the light for testing the lamp. This is done by pressing the case, causing the lamp to light if the circuit is operating. Due to interconnection, malfunction of the gage will also cause malfunction of the warning light.

FUEL SYSTEM—AUXILIARY.

The auxiliary fuel system (figures 1-8 and 1-9) consists of three 100 gallon C-47 type auxiliary fuel tanks, a selector valve and an electric fuel pump mounted on a single base. These are secured to the cargo tie-down fittings on the cabin flooring. The tanks (figure 1-8) are interconnected so that fuel can be drawn from all three tanks. However, dependent upon the mission, one, two or three tanks may be used.

Servicing of the tanks is accomplished through the filler neck provided at the top of each tank. The fuel is transferred to the main fuel tank by the pump.

It is possible to fill the main fuel tank from supply cans outside the helicopter by turning the selector valve to the ground refueling position and turning on the auxiliary fuel system pump.

A hose, permanently attached to the selector valve, is used for ground refueling the main fuel tank. Another hose, permanently attached to the drain valve, provides for draining the auxiliary fuel tanks onto the ground or into containers.

AUXILIARY FUEL SYSTEM SELECTOR VALVE.

A 2-position, AUX TANK to MAIN TANK and GROUND REFUELING, manually operated selector valve (figure 1-8) is provided between the auxiliary tanks and the auxiliary fuel pump. The selector valve and electric fuel pump are mounted on the auxiliary tank cradle. This valve is used for transferring fuel from the auxiliary tanks to the main fuel tank or for ground refueling of the main fuel tank. Refer to Section VII for procedure.

AUXILIARY FUEL PUMP SWITCH.

A 2-position, ON-OFF, toggle switch (figure 1-8) is located just above the electric fuel pump on the base of the auxiliary fuel tank unit.

AUXILIARY FUEL SYSTEM FLOW VALVE AND DRAIN VALVE.

Two additional valves are provided inboard of the electric fuel pump. One, a drain valve, is for draining the auxiliary fuel tanks; and the other, a fuel flow valve, is for transferring fuel to the main fuel tank. Refer to Section VII for procedure.

These valves are manually opened or closed. There are no independent switches or controls for their operation. Refer to Section VII for their positions during refueling of the main fuel tank or draining of the auxiliary tanks.

ELECTRICAL POWER SUPPLY SYSTEM.

Power for operating the various units of electrical and electronic equipment is supplied by the 28-volt electrical system (figure 1-11). The generator, battery, or external power supply can be used independently. The direct current system is converted to alternating current by a 500-VA main inverter. A 250-VA standby inverter is also provided.

D-C OPERATED INSTRUMENTS AND EQUIPMENT.

Refer to figure 1-11.

BATTERY.

The battery (23, figure 1-2) is located on the floor, in front of the fuel cell, on the left side of the helicopter. It has a potential of 24 volts and a 34 ampere hour capacity. Use of the battery for ground operation and starting of the engine should be avoided if an external source of power is available.

BATTERY SWITCH.

The battery switch (figure 1-5), located on the console, has three positions (ON, OFF, and EMERG). Damage may result if the battery switch is ON while external power is being used. To prevent unnecessary drainage of the battery, the switch is left in the OFF position until the engine is started. The battery switch EMERG

FUEL QUANTITY DATA
US GALLONS

Tank or Cell Configuration	Usable Fuel in Level Flight	Fully Serviced	Expansion Space	Total Volume
Main Fuel Tank	300	304	10	314
Main Fuel Tank & One Auxiliary Tank	400	404	13	417
Main Fuel Tank & Two Auxiliary Tanks	500	504	16	520
Main Fuel Tank & Three Auxiliary Tanks	600	604	19	623

Note: 1, 2 or 3 Auxiliary Tanks may be used.

Figure 1-9

position is used if the generator fails. When the switch is placed in the EMERG position, non-essential electrical equipment on its major circuit is disconnected to avoid drain on the battery. With the switch in the EMERG position, the equipment which will continue to operate directly from the battery is illustrated in figure 1-11.

When the battery switch is ON, power is supplied to the aft bus, console bus, and emergency bus. If the generator should fail, the battery switch should be placed in the EMERG position and the inverter switch in the SPARE position. This disconnects all non-essential radio and electrical equipment but does permit operation of certain units of electrical equipment directly off the battery as illustrated in figure 1-11.

GENERATOR.

The engine-driven 400 ampere capacity generator (figure 1-11) provides direct current at 30 volts, and is the primary source of electrical power. However, the electrical system is supplied with only 28 volts of this output. The function of the generator and its associated relays is to supply the required amount of regulated voltage for maintaining a fully-charged battery and the proper operation of all electrical and electronic equipment, except when the battery switch is in the EMERG position.

GENERATOR CONTROLS.

The generator has its own over-voltage control which disconnects the generator from the d-c distribution system in the event of high generator voltage. This system of regulation contains the voltage regulator, over-voltage relay, reverse current relay, generator field control relay, generator warning light and its relay.

VOLTAGE REGULATOR. This unit maintains the generator voltage at a predetermined value by automatically controlling the generator field current.

OVER-VOLTAGE RELAY. If the generator voltage rises above 31 volts, this relay automatically energizes the generator field control relay and warning light relay which causes the generator to be cut out of the electrical circuit and the warning light to glow.

REVERSE CURRENT RELAY. This relay prevents the battery from discharging through the generator whenever the generator voltage falls below that of the battery.

GENERATOR FIELD CONTROL RELAY. This relay works in conjunction with the over-voltage relay. When the over-voltage relay is energized by excessive generator voltage, it trips the field control relay which cuts the generator out of the electrical circuit.

GENERATOR WARNING LIGHT AND RELAY. These units are actuated by the over-voltage relay when the generator is producing excessive voltage. The warning light indicates that the generator has been cut out of the electrical system.

GENERATOR SWITCH. The generator switch (figure 1-5) is on the console, and it has three positions (ON, OFF, and RESET). After the engine is started, the generator switch is placed in the ON position. To turn the generator off, place the switch in the OFF position. If the generator warning light, located on the overhead panel, comes on, it indicates an over-voltage or under-voltage condition. Hold the generator switch in the RESET position momentarily to reset the relays, then move the switch to the ON position. If the warning light goes out, the system has returned to normal. If the light stays on, the generator is not functioning properly; the battery switch should then be placed in

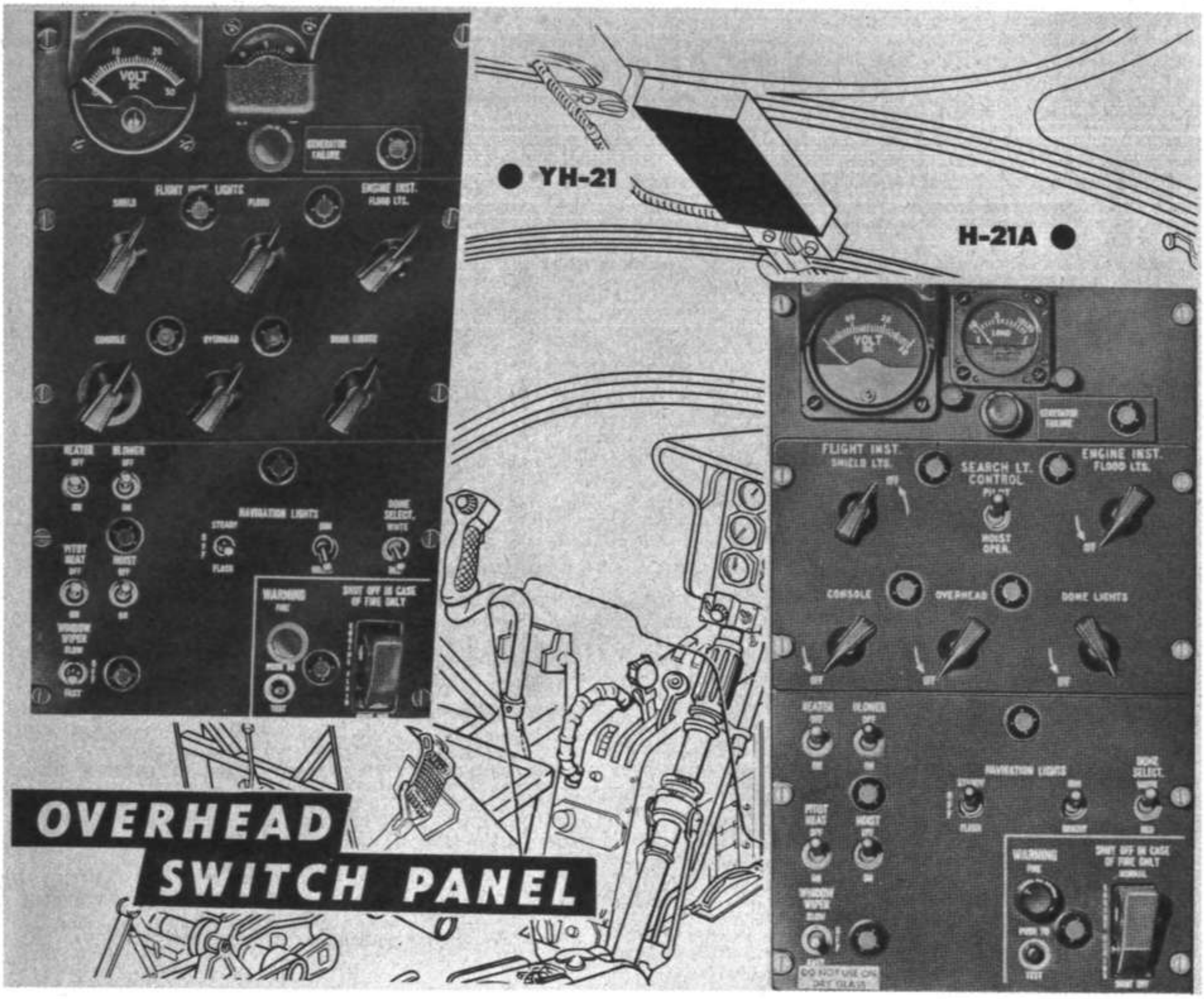


Figure 1-10

the EMERG position and the inverter switch in the SPARE position. This disconnects all non-essential equipment from the system but does permit operation of the inverter, utility lights, and the turn and bank indicator directly from the battery. Refer to figure 1-11.

VOLTMETER.

The voltmeter is located in the upper left corner of the overhead switch panel (figure 1-10). Its purpose is to indicate voltage output of the generator.

The voltmeter will read zero when the generator switch is in the OFF position, as it is connected to the generator side of the reverse current relay.

LOADMETER.

The loadmeter (figure 1-10) is adjacent to the voltmeter in the overhead switch panel. This instrument records the percentage of amperes being used by the system when the generator switch is in the ON position. The loadmeter will read zero when the generator switch is in the OFF position as it is not connected to the emergency system.

TRANSFORMER.

The transformer, consisting of many turns of wire wound as a single coil, is connected to the A-phase of the output from the inverters by means of the inverter change-over relay. A wire connected to a pre-calculated point on the winding supplies 26 volts a-c for the operation of the magnosyn indicators and transmitters.

EXTERNAL POWER RECEPTACLE.

Provision is made for the use of external power by means of a receptacle located just aft of the main entrance door of the helicopter (22, figure 1-2). The external power unit plug must be fully inserted so that the third prong makes a definite contact. When the third prong makes contact, the

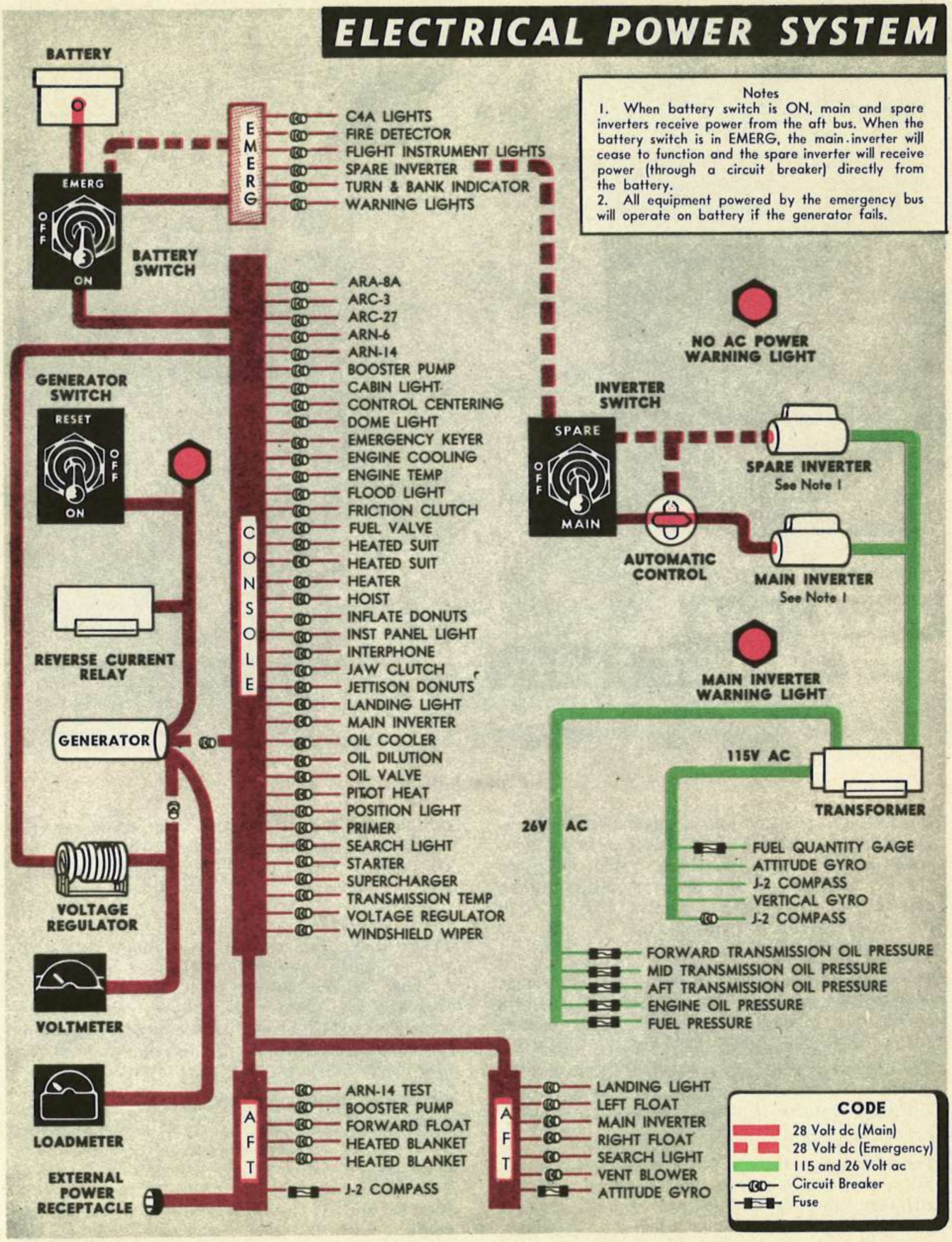

ELECTRICAL POWER SYSTEM
Notes
1. When battery switch is ON, main and spare inverters receive power from the aft bus. When the battery switch is in EMERG, the main inverter will cease to function and the spare inverter will receive power (through a circuit breaker) directly from the battery.
2. All equipment powered by the emergency bus will operate on battery if the generator fails.
BATTERY
EMERG
OFF
ON
BATTERY SWITCH
EMERG
C4A LIGHTS
FIRE DETECTOR
FLIGHT INSTRUMENT LIGHTS
SPARE INVERTER
TURN & BANK INDICATOR
WARNING LIGHTS
GENERATOR SWITCH
RESET
OFF
ON
REVERSE CURRENT RELAY
GENERATOR
VOLTAGE REGULATOR
VOLTMETER
LOADMETER
EXTERNAL POWER RECEPTACLE
CONSOLE
ARA-8A
ARC-3
ARC-27
ARN-6
ARN-14
BOOSTER PUMP
CABIN LIGHT
CONTROL CENTERING
DOME LIGHT
EMERGENCY KEYER
ENGINE COOLING
ENGINE TEMP
FLOOD LIGHT
FRICTION CLUTCH
FUEL VALVE
HEATED SUIT
HEATED SUIT
HEATER
HOIST
INFLATE DONUTS
INST PANEL LIGHT
INTERPHONE
JAW CLUTCH
JETTISON DONUTS
LANDING LIGHT
MAIN INVERTER
OIL COOLER
OIL DILUTION
OIL VALVE
PITOT HEAT
POSITION LIGHT
PRIMER
SEARCH LIGHT
STARTER
SUPERCHARGER
TRANSMISSION TEMP
VOLTAGE REGULATOR
WINDSHIELD WIPER
NO AC POWER WARNING LIGHT
INVERTER SWITCH
SPARE
OFF
MAIN
SPARE INVERTER
See Note I
AUTOMATIC CONTROL
MAIN INVERTER
See Note I
MAIN INVERTER WARNING LIGHT
115V AC
TRANSFORMER
26V AC
FUEL QUANTITY GAGE
ATTITUDE GYRO
J-2 COMPASS
VERTICAL GYRO
J-2 COMPASS
FORWARD TRANSMISSION OIL PRESSURE
MID TRANSMISSION OIL PRESSURE
AFT TRANSMISSION OIL PRESSURE
ENGINE OIL PRESSURE
FUEL PRESSURE
AFT
ARN-14 TEST
BOOSTER PUMP
FORWARD FLOAT
HEATED BLANKET
HEATED BLANKET
J-2 COMPASS
AFT
LANDING LIGHT
LEFT FLOAT
MAIN INVERTER
RIGHT FLOAT
SEARCH LIGHT
VENT BLOWER
ATTITUDE GYRO
CODE
28 Volt dc (Main)
28 Volt dc (Emergency)
115 and 26 Volt ac
Circuit Breaker
Fuse

Figure 1-11

external power unit relay in the helicopter is energized and the power unit commences to supply electrical power to the main battery bus and the emergency bus for distribution.

WARNING

The helicopter battery switch must be OFF while external power unit is connected.

Reversed polarity between the helicopter's electrical system and external power unit can result in damage to electrical parts and may cause a serious fire wherein the helicopter itself may be endangered.

AUXILIARY POWER PLANT.

An auxiliary power plant is provided on some helicopters to provide extra power for ground operation and starting in cold weather when operation is conducted away from the main base of operation where no auxiliary equipment is available. Refer to Section IV for information on this unit.

A-C OPERATED INSTRUMENTS AND EQUIPMENT.

Refer to figure 1-11.

INVERTERS.

The main and spare inverters (figure 1-11) are located in the forward end of the engine compartment. Their function is to convert d-c to a-c flow for the operation of certain instruments.

INVERTER SWITCH AND LIGHTS.

Note

The inverter switch should be kept in the OFF position for a minimum of one minute after external or internal power is applied to allow the regulator tubes within the inverter unit to warm up properly.

A 3-position, OFF-MAIN-SPARE, switch (figure 1-5) on the console switch panel is used to control inverter operation. Normally, the inverter switch is kept in the MAIN position. For checking the operation of the spare inverter, the switch is placed in SPARE position. In the event of a main inverter failure, indicated by its warning light becoming illuminated, the inverter change-over control will automatically disconnect the faulty main inverter and connect the spare inverter into the system. In the case of a generator failure, indicated by its warning light becoming illuminated, the battery switch should be placed in the EMERG position and the inverter switch placed in the SPARE position. This will cause the main inverter warning light to illuminate but does not mean that the main inverter is malfunctioning. If, under the above conditions, the spare inverter should fail, indicated by the NO AC warning light, a-c power to the instruments can be made available by placing the battery switch ON and the inverter switch to MAIN. This connects all the radio and electrical equipment directly to the battery alone. All non-essential circuit breakers should be pulled as soon as possible in order to conserve battery power.

CIRCUIT BREAKERS.

The circuit breakers (figure 1-12) are on three panels; one located on the left side of the console; the second on the right side of the console; and the third circuit breaker panel is above the aft distribution box to the right of the entrance door.

FUSES.

The main fuse box (figure 1-12) is located on the right side of the console. A single a-c fuse protecting the B-7A amplifier of the J-2 compass and the AN/ARN-14 is located in the a-c junction box mounted on the firewall above the fuel cell. Two d-c fuses, one to protect the J-2 compass and the other to protect the vertical gyro (if installed) are located inside the aft distribution box. This box (figure 1-12) is situated on the left side of the helicopter just aft of the main entrance door.

HYDRAULIC POWER SUPPLY SYSTEM.

The hydraulic system (figure 1-13) is provided for operation of the rescue hoist and the flight controls. A hydraulic reservoir supplies both the hoist and flight control systems, and one filter is common to both return lines. The system includes a hoist pump and a flight control pump, both of which are driven by the forward transmission. The hoist and control systems both incorporate pressure relief valves, and the control system includes a hydraulic boost control valve, a by-pass valve, and a hydraulic pressure gage. A solenoid operated 4-way valve and a flow control valve are part of the hoist system. See the following paragraphs on this page for further information on the Flight Control System. For detailed information on the Rescue Hoist, see Section IV.

FLIGHT CONTROL SYSTEM.

Basically, the helicopter is controlled by changing the angle of the blades either collectively or individually. The controls required to obtain these changes include the cyclic stick, collective pitch lever, directional pedals, and longitudinal trim mechanism. The collective pitch control, directional control and cyclic control are hydraulically operated to reduce the force necessary for displacement. The hydraulic flight control system

FUSE & CIRCUIT BREAKER PANELS

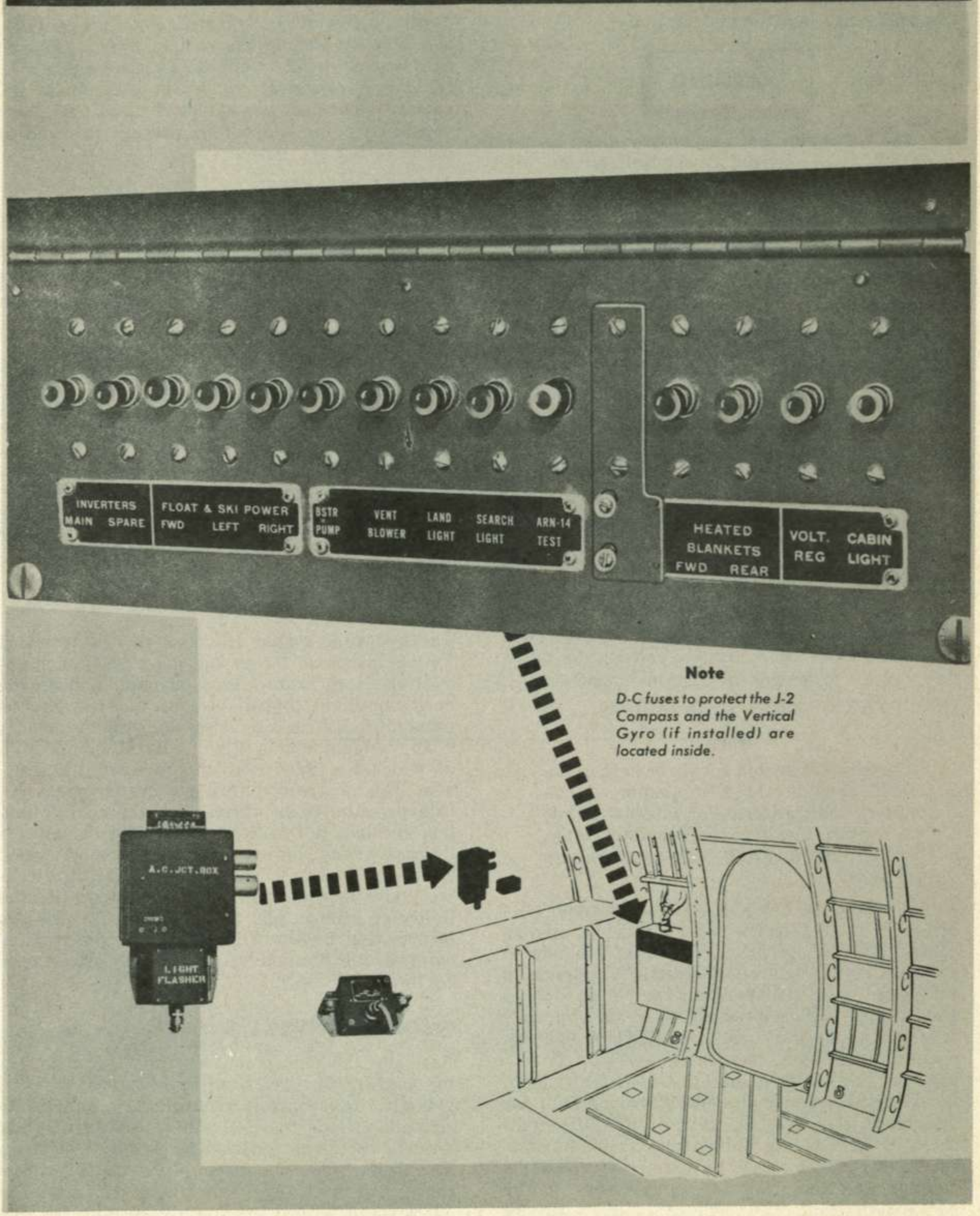


Figure 1-12. (Sheet 1 of 2)

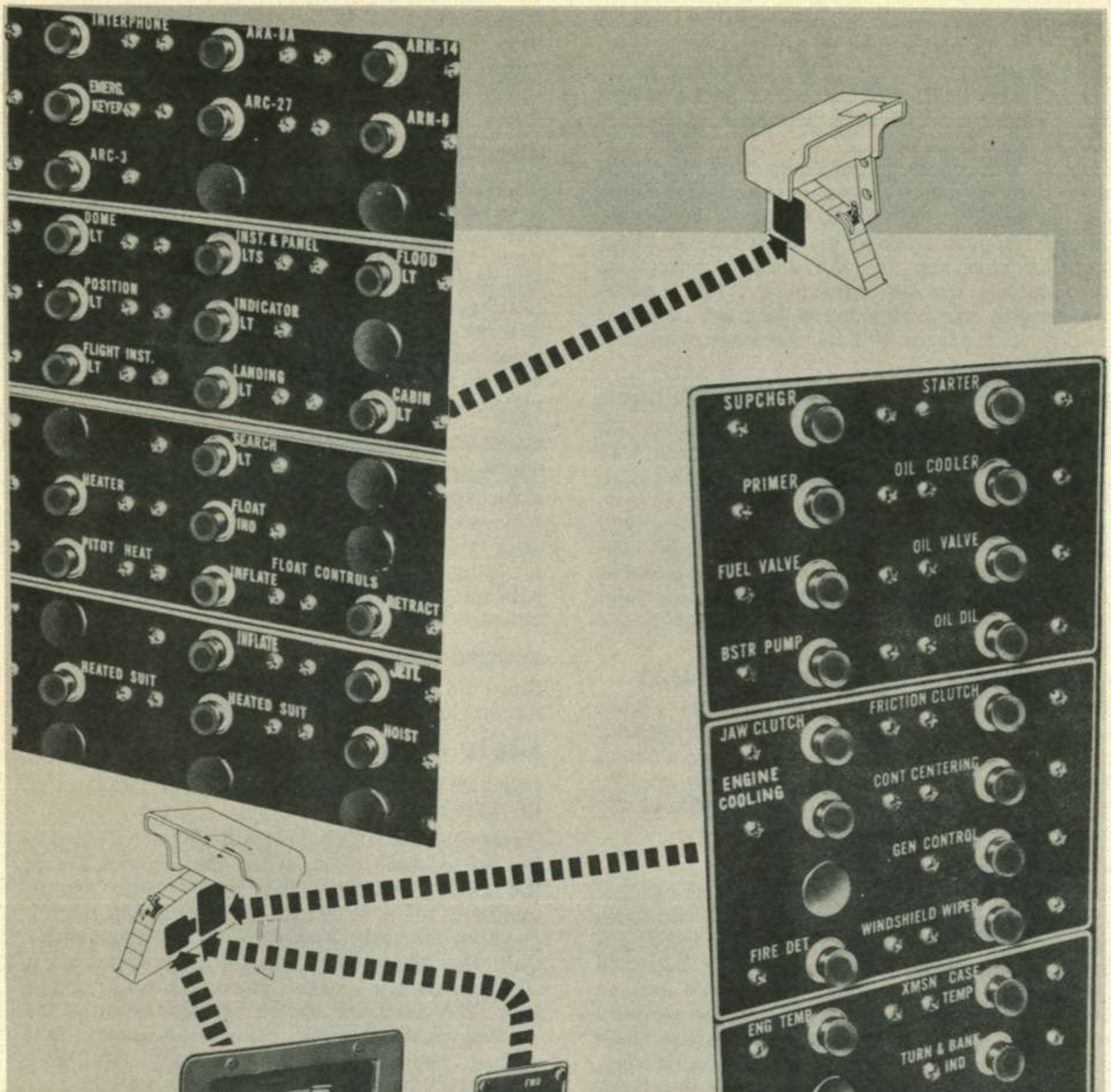


Figure 1-12. (Sheet 2 of 2)

senses the movement imparted to the cockpit flight controls by the pilot. When the system is on, the hydraulic pressure is 1000 psi, varying as the controls are displaced. The valves and passages within the four hydraulic actuators are so arranged that movement of the cockpit flight controls will direct fluid, under pressure, to either side of the actuator pistons (figure 1-13). These pistons are linked to the lower flight controls and position them to transfer movement to the upper flight controls for the desired flight condition. The controls can be operated and flight maintained with the hydraulic system off. Stronger control stick forces will be necessary when the system is off.

BOOST CONTROL VALVE AND PRESSURE GAGE.

The ON-OFF hydraulic boost control valve (12, figure 1-4) and pressure gage (18, figure 1-4) are located on the floor to the left of the pilot. When the valve is turned to the ON position, pressure will be indicated and the system will operate with movement of any of the flight controls. The slightest movement of the control will operate the corresponding hydraulic actuator and allow the pressure to move the actuator in the desired direction.

ACCUMULATOR AND AIR PRESSURE GAGE.

The accumulator and air pressure gage (figure 1-13) are located below the cockpit flooring and, therefore, are not visible to the pilot or co-pilot. To check the amount of pressure in the accumulator, the access panel on the underside of the cockpit enclosure must be removed.

LONGITUDINAL CONTROL.

Acceleration and forward or aft flight are gained by the fore and aft movement of the cyclic stick. For example, if the cyclic stick is displaced in a forward direction, the rotor plane of both the forward and aft rotors will tilt forward and, at the same time, the blade angles of the forward rotors will decrease collectively while the blade angles of the aft rotor will increase collectively. This condition will place the helicopter in a nose-down attitude for acceleration and forward flight.

LONGITUDINAL TRIM.

Movement of the stick positioner (24, figure 1-4) on the console imposes a differential movement to the forward and aft rotors so that the blade angles of one rotor will decrease collectively while the blade angles of the other rotor will increase collectively. This action compensates for variation of center of gravity location in the helicopter and positions the cyclic stick in a geometric neutral location longitudinally.

LATERAL CONTROL.

Sideward flight is gained by the lateral movement of the cyclic stick. For example, if the cyclic stick is displaced to the right, the rotor plane of both the forward and aft rotors will tilt to the right. This condition will cause the helicopter to roll to the right and to enter sideward flight in that direction.

DIRECTIONAL CONTROL.

Rotation of the helicopter about its vertical axis is gained by movement of the directional pedals. For example, if the left pedal is displaced forward, the forward rotor plane will tilt to the left and the aft rotor plane will tilt to the right, causing the helicopter to rotate to the left about a vertical axis. The rotor plane of the forward rotor always tilts in the direction of the pedal used, to the left with left pedal, to the right with right pedal.

CONTROL COORDINATION.

The controls are coordinated in any normal flight maneuver to obtain the desired attitude of the helicopter. For example, by applying lateral cyclic stick and depressing a directional pedal while hovering, the vertical axis turning point of the helicopter can be moved to any desired point between the two rotors.

TORQUE CONTROL.

Since the rotor blades turn in opposite directions, no anti-torque control is necessary.

PILOTS' FLIGHT CONTROLS.

COLLECTIVE PITCH AND THROTTLE CONTROLS.

These controls (figures 1-4 and 1-5) are located to the left of each pilot. When the controls are in the DOWN position, the rotor blades are in minimum pitch. When the controls are in the UP position, the rotor blades are in maximum pitch. Only the pilot's lever (figure 1-4) contains an auxiliary switch bracket, down lock, and friction lock. The auxiliary switch bracket contains the landing light ON-OFF switch, the search light control switch, the search light ON-OFF-RETRACT switch, and the starter switch.

WARNING

Heavy "up stick" forces, with the rotors in a static condition, can cause possible injury to personnel or damage to the controls. Refer to Section VII, Systems Operation, for correct handling of these controls under the condition noted above.

COLLECTIVE PITCH LEVER DOWN LOCK.

The down lock (figure 1-4) is located at the lower end of the pilot's throttle grip. To prevent unintentional locking when the lever is in the extreme

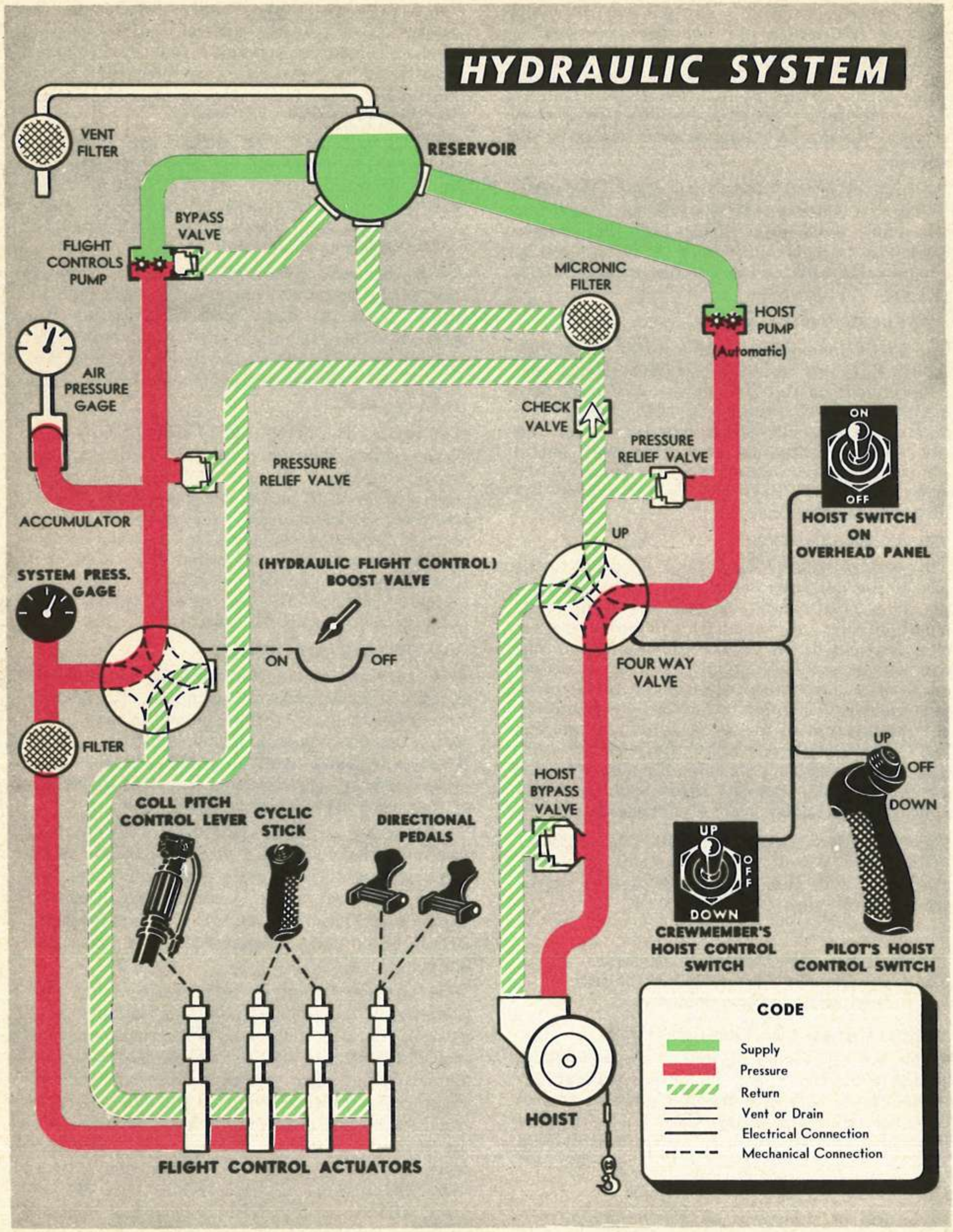

HYDRAULIC SYSTEM
VENT FILTER
RESERVOIR
BYPASS VALVE
FLIGHT CONTROLS PUMP
MICRONIC FILTER
HOIST PUMP (Automatic)
AIR PRESSURE GAGE
CHECK VALVE
PRESSURE RELIEF VALVE
PRESSURE RELIEF VALVE
ON
OFF
HOIST SWITCH ON OVERHEAD PANEL
ACCUMULATOR
UP
(HYDRAULIC FLIGHT CONTROL) BOOST VALVE
SYSTEM PRESS. GAGE
ON
OFF
FOUR WAY VALVE
FILTER
UP
OFF
DOWN
HOIST BYPASS VALVE
COLL PITCH CONTROL LEVER
CYCLIC STICK
DIRECTIONAL PEDALS
UP
OFF
DOWN
CREWMEMBER'S HOIST CONTROL SWITCH
PILOT'S HOIST CONTROL SWITCH
CODE
Supply
Pressure
Return
Vent or Drain
Electrical Connection
Mechanical Connection
HOIST
FLIGHT CONTROL ACTUATORS

Figure 1-13

low position, the lock is spring-loaded to hold it clear of the locking position. The lever may be locked DOWN when in the extreme low position by pulling aft on the lock and turning one-quarter turn to the left. A quarter turn to the right will unlock the lever. The lever should be locked down before starting the engine and engaging the rotors.

COLLECTIVE PITCH LEVER FRICTION CONTROL. A collar type friction device is located on the pilot's pitch lever (figure 1-4). The desired amount of friction on the lever can be obtained by turning the collar to the left for increase and to the right for decrease.

CYCLIC CONTROL STICK.

The pilot's and co-pilot's cyclic sticks (10 and 29, figure 1-4) are used to maintain lateral and longitudinal control. The pilot's cyclic stick grip contains the hoist control switch, radio transmitting switch, interphone control switch, and the lateral, longitudinal, and directional control centering device release switch. The co-pilot's cyclic stick is identical to the pilot's except that it has no hoist control switch.

STICK POSITIONER.

This control wheel (figure 1-4) is located to the left of the mixture control. The control permits the pilot or co-pilot to position the cyclic stick, longitudinally, to compensate for various center of gravity conditions so that full longitudinal control will be available at all times. An indicator adjacent to the control wheel shows the direction and amount of trim used. This is not a device for eliminating control forces which may be present but serves as a longitudinal cyclic control positioner only. Nose-up trim provides more available aft control displacement. Nose-down trim provides more available forward displacement.

LONGITUDINAL STICK POSITION INDICATOR. This is provided on the right side of the console to show the longitudinal position of the cyclic control stick. (See figure 1-4.)

Note

Extreme care should be exercised to avoid stepping on or kicking the longitudinal stick position indicator.

DIRECTIONAL CONTROL PEDALS.

Pedals, for directional control, are conventionally located at the pilot's feet. Toe brakes are provided on the upper portion of the pilot's pedals (figure 1-4). The co-pilot's pedals have no toe brakes. The pedals can be adjusted to suit the individual pilot by releasing the lever on the pedal support.

CENTERING DEVICE RELEASE.

This unit is composed of spring-loaded rods linked to the flight controls to hold them in a force-free position about neutral. They give the pilot a "feel" for the neutral control position. Electric actuators, operable from the cockpit, provide for adjustment of centering springs in flight. This enables the pilot to alter the force-free neutral position of a control.

CENTERING DEVICE RELEASE SWITCH. The centering device release switch is located on the cyclic stick (figure 1-4). To neutralize the cyclic and directional forces in any desired position, first position the control, then press the centering device release switch.

As an alternate method of operation in helicopters where stronger centering springs are installed, allow the flight controls to assume the spring neutral position. Press the centering device release switch and move the flight controls to the desired position, then release the centering device release switch.

COLLECTIVE PITCH LEVER BUNGEE.

Two ground-adjustable collective pitch bungees provided in this helicopter will cause the collective pitch lever to balance when in cruising flight with the hydraulic system inoperative. The first, for the forward rotor, is located above the heater ducting opposite the rescue door. The second, for the aft rotor, is located overhead in the engine accessory section. The same ground adjustments must be made to both bungees.

LONGITUDINAL BUNGEE.

The purpose of the longitudinal bungee is to assist in equalizing unbalanced longitudinal stick forces when the cyclic control stick is held in any longitudinal position during flight operation. When the stick is moved away from HOVER, the compressed spring will add a force in the direction of movement thereby assisting the pilot.

The assembly is located under the cabin flooring just aft of the cockpit and is attached to the lower flight controls. The bungee can be adjusted on the ground to a desired position. It is normally adjusted so that zero force is applied when at HOVER on the longitudinal stick position indicator.

When bungee action is not required, only the longitudinal bungee assembly and long link are installed in each helicopter. The remaining rod and short link are included in the fly-away equipment. When bungee action is required, the rod along with either the long or the short link is installed and the remaining link is included with the fly-away equipment. Starting with helicopter serial number 51-15258 and subsequent, a notation will be made in Part II and Part III of form DD-781 as to which longitudinal bungee configuration has been incorporated.

LANDING GEAR SYSTEM.

The helicopter is equipped with fixed tricycle type landing gear. The nose wheel gear consists of a swivel type oleo strut equipped with a shimmy damper and a mechanical swivel lock. The swivel lock is controlled by a handle located on the right side of the co-pilot's seat (19, figure 1-4). The nose wheel is locked when the handle is in the raised position. The model YH-21 main landing gear consists of three assemblies: an oleo (air and oil) strut, a welded V-strut and wheel fork, and a wheel and tire assembly. The nose gear consists of an oleo (air and oil) strut and wheel fork, a welded V-strut, and a wheel and tire assembly. The nose and main gear shock struts should be checked for proper extension. (See figures 2-1 and 9-1.)

The model H-21A main and nose gear is of lighter construction than the YH-21 gear. The strut assemblies are bolted together for ease of maintenance. The main landing gear does not incorporate the wheel fork assembly.

FLOTATION EQUIPMENT.

Provisions for do-nut type flotation equipment are installed on models YH-21 and H-21A. The flotation equipment, including inflating mechanism, is available separately in kit form. For information on inflating procedure, refer to Section VII, Systems Operation. For information on flight characteristics with flotation equipment, refer to Section VI.

BRAKE SYSTEM.

Hydraulic brakes are installed on the main wheels of the landing gear and are a self-contained system. No brake is provided for the nose wheel.

WARNING

Do not pump the brake pedals when parking helicopter. Excessive pressure can rupture the lines or blow the brake plungers of the wheel brake system.

Braking action is obtained on each main wheel by pressing the corresponding toe brake on the pilot's directional pedals. When both toe brakes are pressed simultaneously and the parking brake handle, located on the floor at the pilot's right (13, figure 1-4) is pulled up, the main wheel parking brakes are locked on. To release the brakes, the button should be depressed and the handle pushed down.

INSTRUMENTS—FLIGHT.

The pilot's instruments are mounted on a single panel located on top of the console. (See figure 1-7.) The flight instruments are located in front of the pilot and the engine instruments are grouped in the center above the console. A primary group of flight instruments is located on the left side of the panel for the convenience of the co-pilot. All instruments are front mounted and have individual light shields. Since the engine and transmission instruments have been discussed previously, this text will cover only the remaining instruments with which the pilot should be familiar.

AIRSPEED INDICATORS.

Two identical airspeed indicators (5 and 8, figure 1-7) are mounted on the instrument panel. One is located on the extreme upper left side and one is located in the upper central section of the panel. Pressure differences introduced into these instruments through the pitot static system cause them to register air speeds in knots. A conventional pitot static tube with the static ports in the pitot head (figure 4-4) is located on the underside of the cockpit enclosure.

ALTIMETER.

The altimeter (19, figure 1-7) is located centrally on the extreme right side of the instrument panel. This instrument registers height above sea level in thousands of feet and is actuated by static air in the pitot static system.

WARNING

As operation of the airspeed indicator, altimeter and rate of climb indicator are dependent upon the pitot static system, the pitot static head located below the nose enclosure should be covered during inactive periods to prevent moisture or dirt from entering the system.

RATE OF CLIMB INDICATOR.

The rate of climb indicator (18, figure 1-7) located on the instrument panel to the left of the altimeter registers ascent and descent in feet per minute. This instrument is actuated by changing air density which is brought into the instrument through the pitot static system.

TURN AND BANK INDICATOR.

The turn and bank indicator (31, figure 1-7) is located in the lower right corner of the instrument panel. This instrument is controlled by an electrically-actuated gyro.

ATTITUDE GYRO.

The attitude gyro (6, figure 1-7) is located in the upper section of the instrument panel above the rate of climb indicator. This instrument, actuated by an electrically-driven gyro, provides the pilot with a visual indication of the attitude of the helicopter relative to the face of the earth.

CAUTION

Since an error in attitude within stated limits can be introduced into this instrument when performing normal turns, caging of this gyro should be kept to a minimum and accomplished only when the helicopter is in straight and level flight. Do not pull the caging knob violently.

GYRO MAGNETIC COMPASS.

The gyro magnetic compass (7, figure 1-7) is located in the extreme upper right-hand corner of the instrument panel. This unit may be used as a directional gyro or it may be "slaved" to the remote transmitter control unit by a two-position, IN-OUT, switch located just below it. When the switch is in the IN position, the remote transmitter is in operation. This picks up the lines of force from the earth's magnetic field and transmits these signals to the gyro causing it to follow these signals. The switch in the OUT position disconnects the transmitter from the system and the electrically-actuated gyro detects movement about the vertical axis of the helicopter.

CLOCK.

The clock (30, figure 1-7) is located just below the altimeter. This is a manually wound, eight-day clock with a sweep second hand.

STANDBY COMPASS.

The standby compass (5, figure 1-4), located centrally on the framework of the nose enclosure, is a direct reading type. It is composed of a compass card mounted on a magnetic element in a liquid filled bowl.

FREE-AIR THERMOMETER.

The free-air thermometer (2, figure 1-4) is located in the windshield adjacent to the central rib.

EMERGENCY EQUIPMENT.

FIRE DETECTOR WARNING SYSTEM.

Eighteen fire detectors are strategically placed around the engine, fuel cell, oil tank and transmission oil coolers. In the event of excessive heat from any of these sources, the fire warning light (figures 1-10 and 3-4), located on the overhead panel, will illuminate.

A test switch is also located in the overhead switch panel. Holding the test switch on furnishes a current which heats the thermocouple element in the thermal test unit. If there is continuity through all parts of the detector circuit, including the detector thermocouples, the output of the thermal test unit will close the sensitive relay and cause the light to come on. Do not hold the test switch on for more than 15 seconds. If a warning has not been indicated in that time, the circuits should be checked for trouble.

Next to the warning light is the fluids shut-off switch with a NORMAL and a SHUT-OFF position. In the event of a fire, the switch is placed in the SHUT-OFF position which will stop the flow of fuel and engine oil.

FIRE EXTINGUISHERS.

HAND PORTABLE.

Two A-20 fire extinguishers (figure 3-6) are provided, one behind the pilot's seat, the other forward of the cabin aft bulkhead, on the right side. Each extinguisher is filled with one quart of bromochloromethane, referred to as CB. There is a gage indicating 300 pounds with a usable pressure above 150 pounds marked in green. Anytime the gage shows below 150 pounds (when corrected to 70°F) the extinguisher should be recharged.

WARNING

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

ENGINE.

There is no engine fire extinguishing system installed on these helicopters.

PILOT'S SEAT & HARNESS

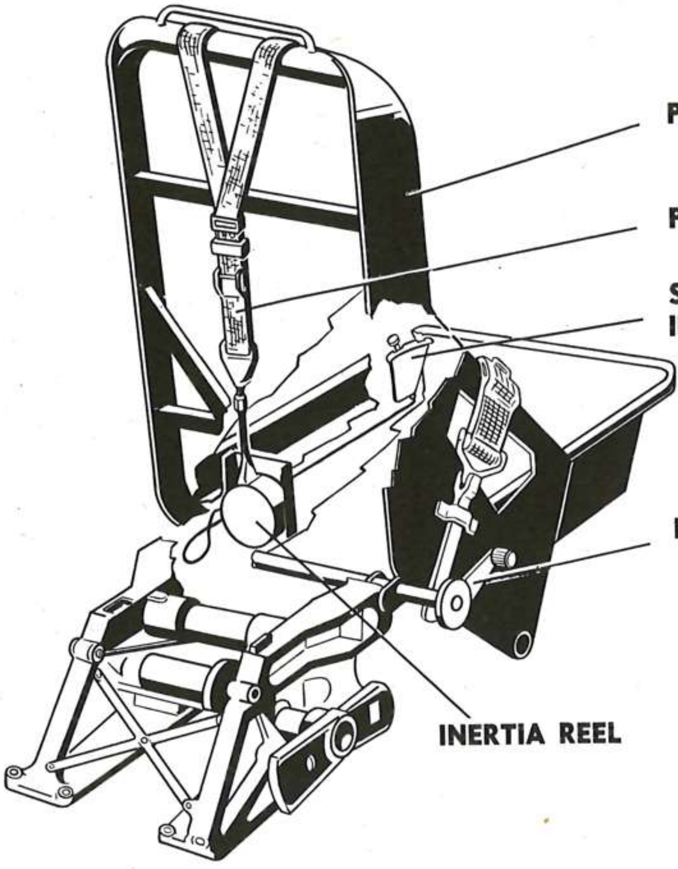


Figure 1-14

FIRST AID KITS.

One first aid kit (figure 3-6) is located on the cockpit bulkhead behind and to the left of the co-pilot. Two others are located in the cabin, one on each side.

LIFE RAFTS.

A six-man life raft (figure 3-6) can be stowed across from the entrance door or across from the rescue door. The pilot's and co-pilot's seats can each contain a one-man life raft.

EMERGENCY EXITS.

Providing emergency exits from the helicopter are the main entrance door, located at the left aft end of the cabin; the rescue door, forward and on the right side of the cabin; the pilot's and co-pilot's windows, and two overhead panels. (See figure 3-5.) Both doors have emergency release handles and plastic knockout panels. Both doors may be jettisoned by pulling the emergency handle located beside each door. The pilot's and co-pilot's windows can be jettisoned by pulling the jettison handle which is located at the top of each window. Two removable panels are provided in the top of the cabin for emergency exit after the rotors have stopped turning. These panels can be removed by pulling the tabs and pushing out.

DOORS AND WINDOWS.

WINDOWS.

The pilots' cockpit (figure 1-4) is made up of plexiglas panels supported on structural frames. A laminated glass panel located on the right side provides the pilot clearer vision and a scratch-proof surface for the windshield wiper. The sliding window panels, located on each side of the cockpit, provide emergency exits for the pilot and co-pilot. A window panel can be jettisoned by pulling the emergency handle (figure 3-5). This turns a cam assembly attached to the window tracks. The cam thrusts the track forward off its tapered mounting pins allowing the window to fall free. The windows are normally operated by depressing the trigger located at the forward lower corner of the window and by pulling back on the handle located above the trigger.

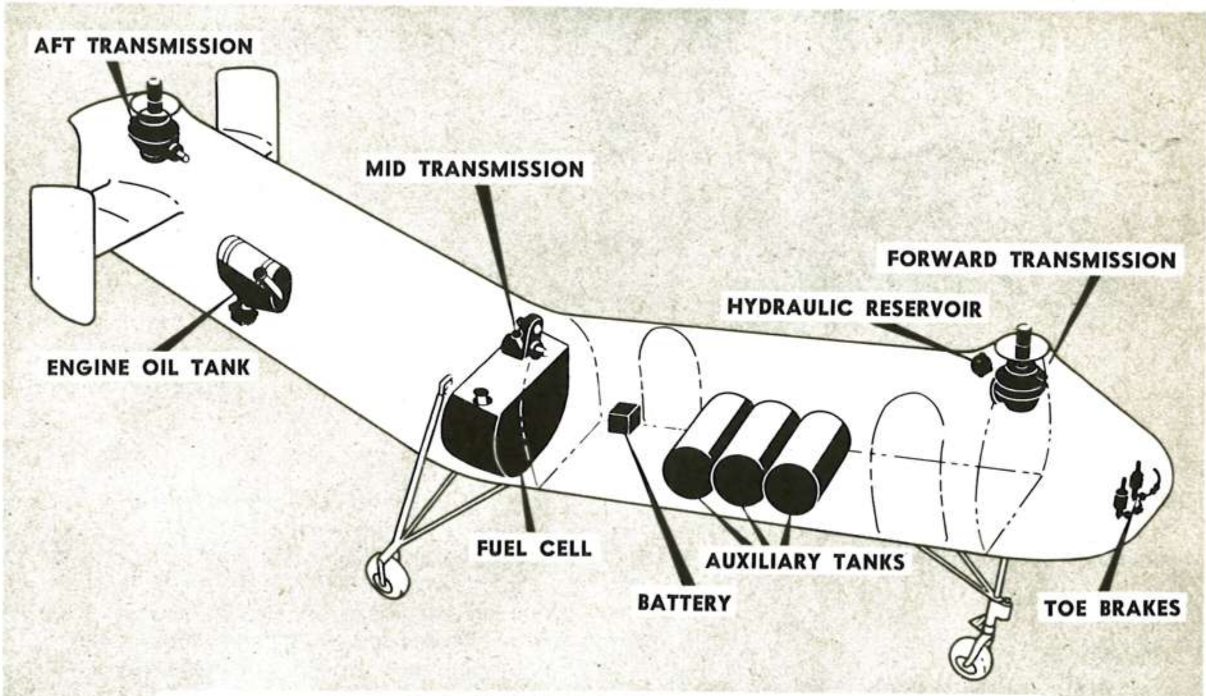
CABIN AND RESCUE DOORS.

The main entrance door (24, figure 1-2) is located at the center of the left side of the fuselage. The rescue door is located forward on the right side and just aft of the cockpit, and is open during rescue operations. Both doors contain plexiglas knockout panels for emergency escape. The doors are suspended from slotted tubular tracks bolted to the outside of the fuselage. The doors are on roller assemblies and may be secured in open or closed position. Either door may be jettisoned by pulling the emergency handle located at the right of each door. The handle turns a cam assembly forcing the door tracks forward and off their attachments. This permits the entire door assembly to fall free.

ENGINE HATCH DOORS.

There are two engine hatch doors (19, figure 1-2) located aft of the main landing gear on both lower sides of the fuselage. Do not operate engine and engage clutch with the engine hatch doors removed since they are structural members.

SERVICING DIAGRAM



SPECIFICATIONS

ENGINE OIL: MIL-L-6082, grade 1100
(Dilute below 5°C)

TRANSMISSION OIL:
Above —1°C MIL-L-6082, grade 1100
+38° to —12°C MIL-L-6082, grade 1065
—12° to —54°C MIL-L-7808

HYDRAULIC OIL: MIL-O-5606

FUEL: MIL-F-5572
Recommended grade 100/130

AUXILIARY POWER PLANT LUBRICANT: MIL-L-8383

Figure 1-15

SEATS.

PILOTS' SEATS.

The pilot and co-pilot seats (figure 1-14) are adjustable through five inches, vertically only. The adjustment control is located on the right aft side of each seat.

SAFETY BELTS.

Pilot and co-pilot seats have adjustable safety belts.

SHOULDER HARNESS INERTIA REEL.

The pilot and co-pilot seats each have a shoulder harness with an inertia reel (figure 1-14), which allows freedom of movement when unlocked, and prevents the pilot from leaning forward when locked. A handle with LOCKED and RELEASED positioning is located at the left forward corner of each pilot's seat. A latch is provided for positive retention of the handle at either position of the quadrant. By pressing down on the top of the handle, the latch is released and the handle may then be moved freely from one position to the other. When the handle is in the RELEASED position, the reel harness cable will extend to allow freedom of movement, however, the reel will automatically lock when an impact force of 2 to 3g is encountered. When the reel is locked in this manner it will stay locked until the handle is moved to the LOCKED position, and then returned to the RELEASED position. When the handle is in the LOCKED position, the harness cable is manually locked and the crewmember is prevented from bending forward.

WARNING

The LOCKED position is used during landings and take-offs and when a crash landing is anticipated. This position provides an added safety precaution over and above that of the automatic safety lock.

AUXILIARY EQUIPMENT.

The auxiliary equipment in the following list is described fully in Section IV.

- Heating and Defrosting System
- De-Icing System
- Ventilation System
- Communications Equipment
- Auxiliary Power Plant
- Lighting System
- Rescue Hoist System
- Cargo and Troop Carrying Equipment
- Miscellaneous Equipment


R FOR

Section II NORMAL OPERATION

TABLE OF CONTENTS

PREPARATION FOR FLIGHT.

FLIGHT RESTRICTIONS.

Refer to Section V for flight limitations and restrictions imposed on the helicopter.

FLIGHT PLANNING.

All data necessary to fly an operational mission will be found in Appendix I. The Appendix includes information on airspeeds, power settings, and fuel consumption of the helicopter at various gross weights.

WEIGHT AND BALANCE.

1. Refer to Handbook of Weight and Balance Data, T.O. 1-1B-40, for loading information.
2. Check take-off and anticipated landing gross weight and balance.
3. Refer to Appendix I to determine weight of fuel and oil, and other related factors incident to the mission to be performed.
4. Check weight and balance clearance (Form F).
5. For weight limitations information, refer to Section V.

VISUALLY INSPECT THE FOLLOWING ITEMS:

1 LEFT FORWARD FUSELAGE

a. Skin for dents, wrinkles, loose or missing rivets.
b. Transparent plastic enclosure for cracks, looseness, and cleanliness.
c. Work platform stowed.

2 NOSE SECTION

a. Pitot static and cockpit covers and rigging pins removed.
b. Sliding windows for binding.
c. Transparent plastic enclosure beneath brake cylinders for traces of leakage.
d. Wiper blades for presence of oil.
e. Air-oil shock strut for cleanliness and proper inflation (2-11/16 inches from gland nut to top of oleo).
f. Tires for inflation, cuts, slippage, and blisters.

3 FORWARD ROTOR

a. Rotor head and blades for damage and security. (Disengage clutch when checking rotors to facilitate turning.)
b. Index marks on forward and aft rotors to determine if blades are properly phased.

4 RESCUE DOOR & RIGHT FORWARD FUSELAGE

a. Rescue door (from ground).
b. Transparent plastic window for cracks, looseness, and cleanliness.
c. Work platform stowed.
d. Skin for dents, wrinkles, loose or missing rivets.

5 RIGHT AFT FUSELAGE

a. Air inlet screen for damage or obstructions.
b. Fuel quantity (with locally-manufactured dipstick, if available).
c. Fuel and oil caps for security.
d. Access doors for secure closure.
e. Air-oil shock strut for cleanliness and proper inflation (1-11/16 inches from the gland nut to red band).
f. Braking disc for scoring and discoloration.
g. Tire for inflation, cuts, slippage, and blisters.
h. Float rigger for pressure leaks (if equipped with floats).

6 AFT ROTOR

a. Rotor head and blades for damage and security. (Disengage clutch when checking rotors to facilitate turning.)
b. Index marks on forward and aft rotors to determine if blades are properly phased.

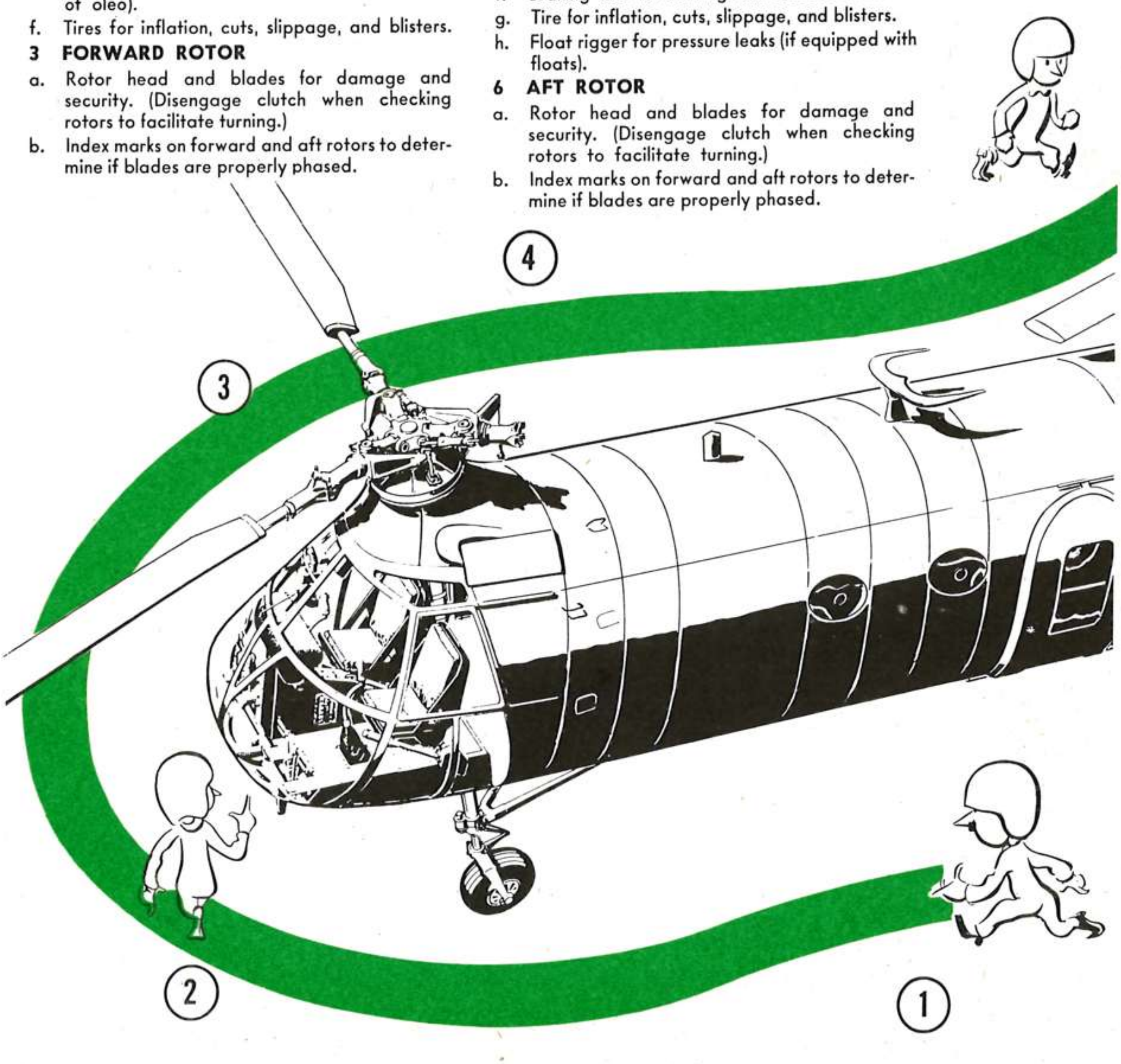


Figure 2-1. (Sheet 1 of 2)

7 EMPENNAGE & ENGINE ACCESSORY SECTION

a. Horizontal and vertical stabilizers for damage and tightness.

b. Engine accessory compartment for leaks, loose wiring, tools, rags, etc.

8 LEFT AFT FUSELAGE

a. Air inlet screen for damage or obstructions.

b. Access doors for secure closure.

c. Tire for inflation, cuts, slippage, and blisters.

d. Braking disc for scoring or discoloration.

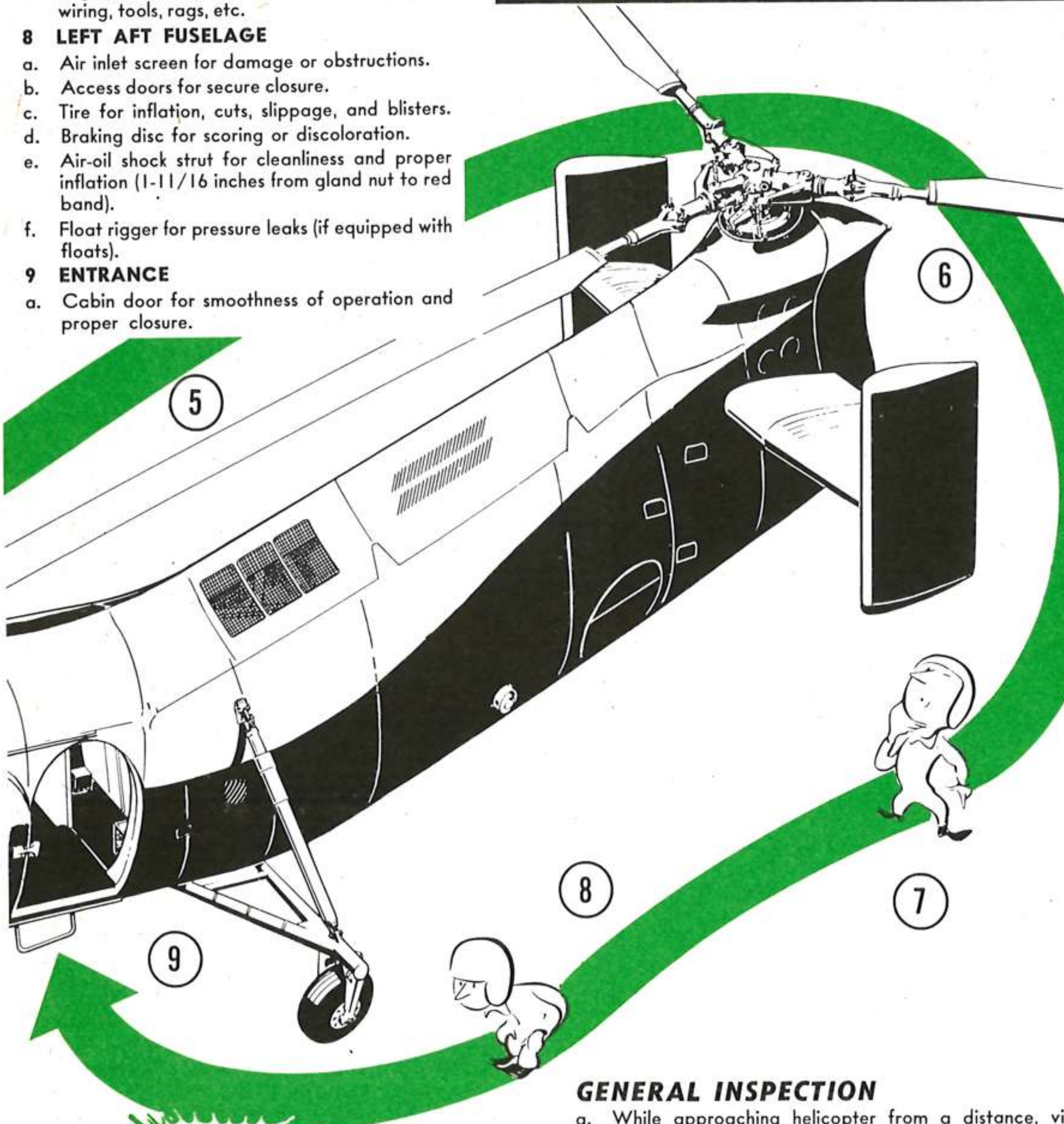
e. Air-oil shock strut for cleanliness and proper inflation (1-11/16 inches from gland nut to red band).

f. Float rigger for pressure leaks (if equipped with floats).

9 ENTRANCE

a. Cabin door for smoothness of operation and proper closure.

EXTERIOR INSPECTION



WARNING

Helicopter operation with the blades out-of-phase will cause damage to the blades and possible injury to personnel. Make sure that the blades are phased before attempting any operation. Re-check the blade phasing if any part of the drive shafting has been disconnected.

GENERAL INSPECTION

a. While approaching helicopter from a distance, view it critically for over-all appearance. Ascertain that rotor covers are removed, blades are phased and clear of obstructions.

b. Check radio antennas and other protuberances for damage and positioning.

c. Look underneath the helicopter for evidence of fuel, oil, and hydraulic leaks.

d. Be sure all excess grease is removed from flotation equipment as it will deteriorate the fabric.

Figure 2-1. (Sheet 2 of 2)

Note

A balance computer is not required for this helicopter.

ENTRANCE TO THE HELICOPTER.

Entrance to the helicopter is gained through the cabin doorway located centrally on the left side of the fuselage (figure 2-1). The door and latch are accessible from the ground. The cockpit is reached by proceeding forward through the cabin area (figure 1-2). Alternate entrance may be effected through the rescue doorway.

BEFORE EXTERIOR INSPECTION.

This check covers those items that would directly affect the safety of personnel making an exterior inspection. Check the following items:

1. Ignition switch: OFF.
2. Throttle: CLOSED.
3. Mixture control lever: IDLE CUT-OFF.
4. Fuel booster pump switch: OFF.
5. Battery switch: OFF.
6. Collective pitch lever: DOWN and LOCKED.
7. Friction clutch switch: ENGAGE (as rotor parking brake. Battery switch must be ON to operate).
8. Parking brake lever: ON.
9. Nose wheel handle: LOCKED.

EXTERIOR INSPECTION.

Consult USAF DD-781 for engineering status and make sure the helicopter has been properly serviced. See figure 2-1 for complete inspection.

INTERIOR INSPECTION (ALL FLIGHTS).

Inspect interior of the helicopter for loose equipment and see that all baggage and cargo are properly secured. Check cabin and cockpit fire extinguishers for security and pressure.

INTERIOR INSPECTION (NIGHT FLIGHTS).

The helicopter is equipped with instrument, navigation and landing lights for night flying operations. Items noted must be checked in addition to those listed in Interior Check (All Flights):

1. Instrument lights: Check.
2. Navigation lights: Check.
3. Landing light: Check.
4. Retracting and rotating search light: Check with the aid of ground crew and with external electrical power connected or after the engine is operating.

Before take-off, position light forward so that it can again be illuminated and quickly utilized for approach and landing.

5. Flashlight: Check.

BEFORE STARTING ENGINE.

INITIAL CHECK.

1. Seat: Adjust to comfortable level.
2. Safety belt and shoulder harness: Fasten.
3. Inertia reel: Check for operation.
4. Directional pedals: Adjust to comfortable position.
5. Flight controls: Check for freedom of movement and correct range of travel; set in neutral.

CAUTION

Excessive pressures with any of the control locks or pitch locks in place can cause bending of control push rods.

6. Collective pitch lever: DOWN and LOCKED.
7. Throttle: CLOSED.
8. Nose wheel handle: UNLOCKED.
9. Parking brake lever: ON.

CONSOLE CHECK.

1. External power: Check (connected).

WARNING

The battery switch must be OFF before connecting the external power source.

2. Circuit breakers: In.
3. Radio switches: OFF.
4. Centering springs switch: Check for operation; set in neutral.
5. Longitudinal stick positioner: ZERO (check operation).
6. Mixture control lever: IDLE CUT-OFF.
7. Carburetor heat control lever: COLD.
8. Inverter switch: SPARE. (After approximately three minutes, change to MAIN.)
9. Generator switch: Check ON.
10. Battery switch: OFF. (Leave battery switch off until the engine is running smoothly and the external power unit is disconnected. Place switch on when external power is not in use.)
11. Clutch: Visually check for proper friction and jaw operation. (Refer to Section VII.)
12. Friction switch: DISENGAGE (with warning light out).
13. Supercharger switch: LOW.
14. Fuel booster pump switch: OFF.
15. Fuel quantity test switch. TEST. (Needle rotates and should return to original position when switch is released.)

16. Ignition switch: OFF.

17. Warning lights: Press to test lights. Check console, instrument panel and overhead switch panel.

OVERHEAD SWITCH PANEL.

1. Fire warning light switch: Press to test system.
2. Engine fluids switch: NORMAL.
3. Pitot heat switch: OFF.
4. Hoist switch: OFF.
5. Heater switch: OFF.
6. Blower switch: OFF.
7. Navigation lights switch: OFF.
8. Instrument lights switch: OFF.
9. Cockpit lights switch: OFF.

STARTING ENGINE.

CHECK FOR HYDRAULIC LOCK.

If the engine has been shut down for any period of time, clearing the engine must be accomplished by pressing the starter switch intermittently for periods not exceeding four to five seconds until engine turns freely. If hydraulic lock is present, the starter low torque clutch will slip and the engine will not turn over. If this occurs, or, if the engine seems to turn through with difficulty, have the spark plugs removed from the lower cylinders, and drain all liquid by cranking the engine through a minimum of two revolutions.

STARTING PROCEDURE.

CAUTION

Engine operation or clutch engagement with the engine hatch doors removed is prohibited, as these doors are structural members.

1. Fuel booster pump switch: HIGH (after checking LOW position).
2. Throttle: CLOSED.
3. Starter switch: ENGAGE.

CAUTION

It is possible to engage the starter with the clutch engaged in either friction or jaw with resultant damage to the rotor system. The pilot should check to ascertain that the clutch switches are in DISENGAGE before attempting to start the engine.

4. Ignition switch: BOTH (after engine has turned two revolutions).
5. Primer switch: ON (as necessary when engine is turning over).

CAUTION

Do not use primer until engine has turned over for approximately three seconds. This forestalls possibility of raw fuel causing hydraulic lock in the lower cylinders.

6. Mixture control lever: IDLE CUT-OFF (move to RICH when the engine is running smoothly on the prime. Continue to operate the prime intermittently as necessary).

Note

Should the engine fail to start within 30 seconds, let the starter cool for two minutes, then repeat the starting procedure.

For instructions on procedure in event of fire, refer to Engine Fire, Section III.

7. Throttle: Reset for 1200 rpm.

CAUTION

With the clutch disengaged, the throttle is extremely sensitive. If held open, it will cause excessive engine speed while the engine is still cold.

8. Manifold pressure purge valve: PUSH (to purge with engine at idling speed).
9. Battery switch: ON (after external power is disconnected).
10. Oil pressure and temperature: Check. Stop engine if the oil pressure does not register within 10 seconds or reach 40 psi within 20 seconds.

ENGINE GROUND OPERATION.

Note

All engine ground operations should be accomplished using RICH mixture.

ENGINE WARM-UP.

Warm up engine by operating between 1200 and 1400 rpm. This speed will provide smoothest operation of engine while the lubricating oil is cold. After the engine oil temperature rises 6°C above the prestart temperature, the oil is then warm enough to make performance checks and take-off.

Note

If oil dilution has been used, check oil supply after thorough warm-up.

IGNITION SWITCH CHECK.

After engine warm-up and prior to engaging rotors, check the ignition switch for proper connection of ground wire. Idle the engine on BOTH magnetos at approximately 1000 rpm. Turn the ignition switch OFF momentarily and observe if the engine stops firing. If it stops firing, and it should, return the ignition switch to BOTH position. Make this check as quickly as possible to prevent engine backfire when the switch is returned to BOTH.

CAUTION

If violent backfiring occurs during ground run of the engine, a shutdown must be made to inspect the engine, induction system, and accessory section for damage.

ENGINE IDLE SPEED CHECK.

Idles at 1000 rpm with closed throttle.

STARTING ROTORS.

CAUTION

Rotor engagement must not be attempted when the clutch warning light is already on. Under this condition, the clutch will travel immediately into the jaw position instead of starting friction engagement. Damage to the rotor system, the same as during any other premature jaw clutch engagement, will result.

A qualified helicopter pilot or a qualified crew chief will be at the controls when the rotors are engaged. No minimum warm-up of the engine is required before rotor engagement, nor is there any time restriction on running the engine with the rotors disengaged; however, the engine should be running smoothly and the helicopter headed into the wind. Refer to figure 2-2 for the rotor blade clearance.

1. Parking brake lever: ON.
2. Nose wheel handle: UNLOCKED.
3. Throttle: Set to 1100–1200 rpm.
4. Collective pitch lever: DOWN and LOCKED.
5. Cyclic stick and directional pedals: Neutral.
6. Rotors: ENGAGE (refer to Section VII for procedure).
7. Transmission pressure: Check. If no pressure is indicated, shut down and determine cause.

BEFORE TAXIING.

1. Hydraulic pressure control valve: ON. (Check pressure 1000 psi. Operate the hydraulic flight controls for proper response in all directions.)
2. Generator output: Check for 28-1/2 volts with warning light out (above 1250 engine rpm).
3. Battery Switch: Place in EMERG position and functionally check proper operation of emergency electrical equipment. (See BATTERY SWITCH, Section I.)

Note

When the battery switch is placed in the EMERG position, a momentary loss of a-c power will occur until the spare inverter completes its automatic starting cycle.

4. Carburetor heat control lever: Check temperature within limits. Refer to Section V.
5. Supercharger control operation: Check.
   a. Throttle: Advance until engine speed reaches 1600 rpm.

CAUTION

Do not repeat the supercharger clutch shift check at less than five minute intervals. Extreme heat is created within the clutch during the shift.

   b. Supercharger switch: HIGH (a momentary decrease in engine oil pressure indicates blower shift).
   c. Collective pitch and throttle: Increase to obtain 25 inches Hg manifold pressure and 2300 rpm.
   d. Supercharger switch: LOW (sudden decrease in manifold pressure and increase in rpm indicates that the two-speed mechanism is working properly).
6. Ignition system: Check as follows at a power setting of 25 inches Hg and 2300 rpm:
   a. Place the switch in the L position and observe rpm drop.
   b. Return the switch to the BOTH position to stabilize rpm.

c. Place the switch in the R position and observe rpm drop.

d. Return the switch to BOTH position. A drop of 100 rpm or less when operating on one magneto is satisfactory, providing there is no engine roughness.

7. Transmission temperature: Check within limits. Refer to Section V.

8. Transmission pressure: Check within limits. Refer to Section V.

9. Jaw clutch: Check for overrunning action of the jaw clutch after the ignition system check. With the engine at 2300 rpm and the blades in minimum pitch, close the throttle just enough to desynchronize (split) the tachometer needles to indicate overrunning action. Synchronize engine and rotor speed and reduce both to the desired range for continuance of ground testing.

CAUTION

Do not take off if clutch does not overrun freely, as autorotation would be impossible. If the clutch does not overrun, it is an indication that the clutch is in full friction and not jaw.

10. Engine accessories: Check with the collective pitch lever DOWN and LOCKED and the engine operating between 1500 and 1800 rpm:

a. Fuel pressure: Check within green line on pressure gage. This check should be made with the fuel booster pump switch in HIGH, LOW and OFF positions.

b. Engine oil pressure: Check within green line on pressure gage. When extremely cold temperatures are encountered, a stabilized oil pressure of 75 ± 5 psi at 1800 rpm with a 6°C rise in oil temperature is satisfactory.

c. Engine oil temperature: Check. High range of green line on temperature gage is desired; red line on gage is maximum; no minimum oil temperature required for take-off provided a rise of 6°C above the pre-start temperature has occurred with stabilized pressure.

d. Cylinder head temperature: Check. No minimum required for take-off, providing the engine will accelerate properly without backfire.

e. Carburetor air: Check for desired temperature.

f. Dual tachometer: Check that engine and rotor needles coincide. Spread of the needles, unless clutch is overrunning, indicates a faulty instrument and should be checked before take-off.

11. Radio switch: ON. (Check squelch and sensitivity. Controls checked for operation. See Section IV.)

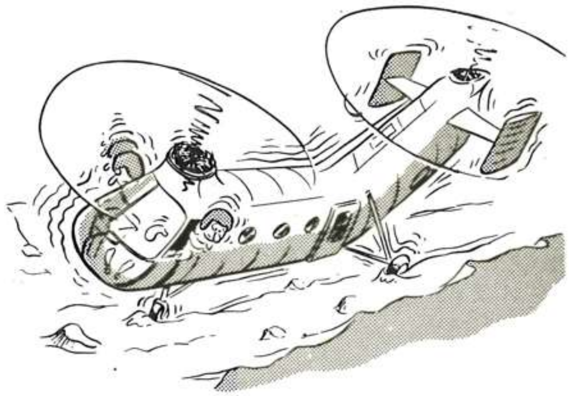
12. Instruments: Check that they respond correctly through various ranges of power and are free from undue fluctuation.

13. Compass: Check that readings are consistent with heading of helicopter.

14. Wheel chocks: Removed.

TAXIING.

Thrust to move forward, rearward, or to turn is obtained from the rotor system. Use the cyclic stick for fore, aft, and lateral control; use the pedals for directional control. It is not necessary to use wheel brakes for control when taxiing.



NOTE

Fly, don't taxi over rough terrain.

PROCEDURE.

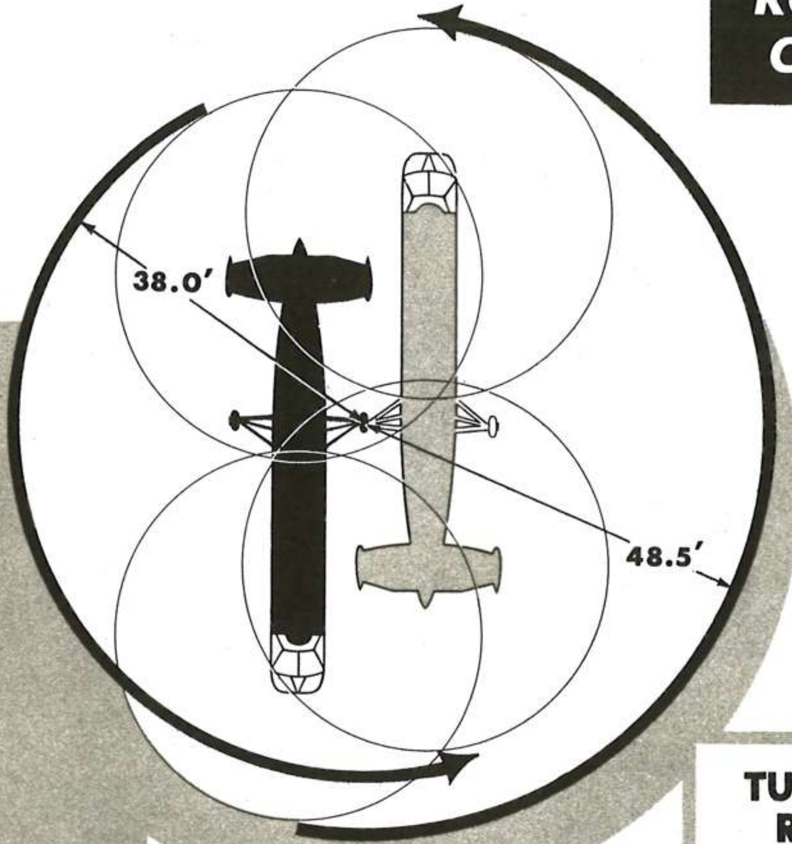
1. At an engine speed of 2000–2300 rpm, with the nose wheel unlocked and the brakes released, increase collective pitch to obtain approximately 20–23 inches Hg manifold pressure.

2. Use pitch control and displacement of the cyclic stick to control speed.

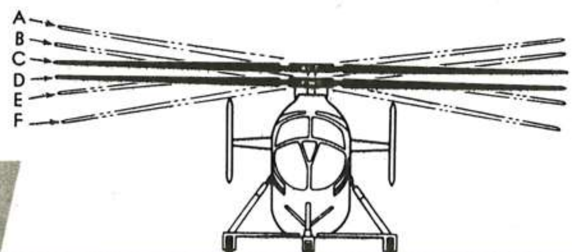
CAUTION

Care should be taken to prevent the blades from hitting the droop stops. This can be recognized by a heavy thumping noise and strong vibration throughout the fuselage and console.

ROTOR BLADE CLEARANCE



TURNING RADII



ITEM	ROTOR BLADE ATTITUDE	YH-21	H-21A
A	Aft Blades Coned (FLIGHT)	18.50 ft	18.00 ft
B	Fwd Blades Coned (FLIGHT)	16.50 ft	16.48 ft
C	Aft Blades Level (IDLING)	15.66 ft	15.16 ft
D	Fwd Blades Level (IDLING)	13.77 ft	13.75 ft
E	Aft Blades Drooped (STATIC)	13.13 ft	12.63 ft
F	Fwd Blades Drooped (STATIC)	11.25 ft	11.22 ft

VERTICAL CLEARANCES

Figure 2-2

3. To slow or stop the helicopter, displace the cyclic stick rearward and, at the same time, increase collective pitch and rotor rpm. Here again, care should be taken to prevent the blades from hitting the droop stops. When the helicopter stops, return cyclic stick to neutral and reduce collective pitch and engine rpm. Brakes are normally used for slow-speed taxiing in conjunction with cyclic controls.

4. When taxiing or turning in strong crosswinds, caution must be used. Should a rolling-over tendency be noticed, the helicopter must be airborne immediately. The best practice is to keep the cyclic stick into the wind and maintain a high rotor rpm in order that take-off power may be applied more rapidly.

TAXIING WITH FLOATS.

Lock the nose wheel for all operations with floats to prevent the nose wheel float from turning. See Section V for limitations and Section VI for flight characteristics.

IMMEDIATELY BEFORE TAKE-OFF.

1. Nose wheel handle: UNLOCKED.
2. Controls: Check for freedom and correct movement.
3. Longitudinal stick positioner: ZERO (for take-off).
4. Attitude gyro: PULL (caging knob to set horizon).
5. Gyro magnetic compass switch: Desired position.
6. Altimeter: SET (adjust as required).
7. Hatches: Closed.
8. Cabin heater switch: As desired.
9. Fuel booster pump switch: HIGH.
10. Mixture control lever: RICH.
11. Crew: Alerted and ready for take-off.
12. Shoulder harness: LOCKED.

Note

The inertia reel will lock under a forward impact acceleration of 2 to 3g. However, in a helicopter where flight on take-off can be sideward or rearward, as well as forward, the inertia reel cannot function as a safety measure under all of these conditions. Therefore, it is recommended that it be placed in the LOCKED position before take-off.

13. Hydraulic pressure gage: Check within prescribed limits.
14. Area: Check clear for take-off.
15. Parking brake lever: OFF.

NORMAL TAKE-OFF.

EMERGENCIES DURING TAKE-OFF.

Refer to Section III.

CONTROL FORCES CHECK.

Perform control forces check peculiar to the helicopter as described in Section VI.

THROTTLE AND COLLECTIVE PITCH OPERATION.

With the collective pitch lever in the minimum pitch position and unlocked, increase throttle until engine is operating at 2500 rpm. Increase collective pitch until the helicopter is airborne. If the throttle and collective pitch synchronization is not perfect, small adjustments of the throttle may be necessary to prevent changes in rpm as pitch is increased. Refer to the Appendix for information on take-off power settings for various conditions and gross weights.

Note

Check engine fuel and oil pressures, transmission pressures and temperatures while in hovering flight immediately after leaving the ground.

TAKE-OFF TO HOVERING POSITION.

Attention should be given to keeping the helicopter steady as it leaves the ground. If practical, take-off should be made with the helicopter headed into the wind. When cross-wind take-off is made, drift and weather-vaning tendencies will be evident. When a cross-wind take-off is made, attention must be given to correcting the above tendencies. As soon as the rotors begin to lift, increase the collective pitch steadily until the helicopter leaves the ground. This will minimize the possibility of the occurrence of ground resonance (refer to Section VI for explanation).

WARNING

Whenever airborne, tighten the friction lock on the collective pitch lever before turning the hydraulic flight control system on.

HOVERING.

The helicopter may be hovered with normal load.

Note

It is not desirable to hover at zero airspeed between 15 and 600 feet altitude. If an engine failure occurs while at zero airspeed between 15 and 600 feet, exceptional technique will be necessary to avoid a hard landing.

JUMP TAKE-OFF.

Jump take-offs with this helicopter are not recommended. There is sufficient power reserve and overload gross weight margin to execute a high speed emergency take-off using normal procedure.

TAKE-OFF WITH HIGH GROSS WEIGHT.

The following types of take-off may be made under high gross weight conditions.

1. Hovering.
2. Vertical.
3. Rolling.

Charts for the various types of take-off are covered in the Appendix.

Note

When operating at or near maximum gross weight with marginal performance, (due to altitude, temperature, humidity, etc) increases in power for take-off must be accomplished by increasing the throttle ahead of an increase in collective pitch. By leading with the throttle, a loss of rpm will not occur. It is possible, under marginal conditions, to lose rpm to the point that it cannot be regained without reducing collective pitch. When such a situation occurs, the helicopter will usually settle in, even though the throttle is against the full open stop. It is, therefore, very important to lead the throttle under the above conditions.

HOVERING TAKE-OFF.

In making a hovering type take-off, attain a hovering position with the main wheels at least eight feet off the ground. Enter forward flight by a gradual forward motion of the cyclic stick. Maintain a sufficiently safe clearance of the nose wheel above the ground during transition and acceleration to climb-out airspeed. See the Appendix and figure A-2 for data on this type of take-off.

VERTICAL TAKE-OFF.

Vertical take-offs are used where the area is restricted and it is necessary to gain altitude before entering forward flight.

WARNING

Vertical climb-out necessitates operation in the "AVOID" region of the curve Minimum Height for Safe Landing After Power Failure (figure 3-2).

See the Appendix and figure A-2 for data on this type of take-off.

ROLLING TAKE-OFF.

Rolling take-offs may be made where the ground surface conditions permit. This type of take-off makes it possible to increase the maximum gross weight. In making rolling take-offs, it is possible to obtain a condition in which ground resonance can occur. This condition exists when the main gear shock struts are extended about 90 per cent. If a tendency towards ground resonance occurs during the rolling take-off, make an immediate jump take-off. In other cases in making rolling take-offs, the main landing gear will come entirely free of the ground. In such an instance there will be no tendency for ground resonance. However, lateral control, particularly on rough ground and at low speeds, will be more difficult than normal due to the nose wheel rolling on the ground. See the Appendix and figure A-2 for data on this type of take-off.

AFTER TAKE-OFF.

Decrease power when clear of immediate take-off obstacles, then proceed as follows:

1. Mixture control lever: NORMAL (refer to the Appendix for power settings).

Note

The NORMAL mixture position may be used as long as the cylinder head temperature can be maintained within the applicable limits and engine operation is normal. Leaning the mixture beyond NORMAL is not permissible since it will result in improper fuel-air mixture and can cause severe engine detonation.

2. Fuel booster pump switch: LOW, at 1000 feet or when clear of all obstacles.
3. Carburetor heat control lever: As desired.

TRANSITION FROM HOVERING TO FLIGHT.

In order to prevent the slight loss of altitude when moving off the "ground cushion" into forward or sideward flight, it may be necessary to increase the collective pitch slightly until translational lift is attained.

CAUTION

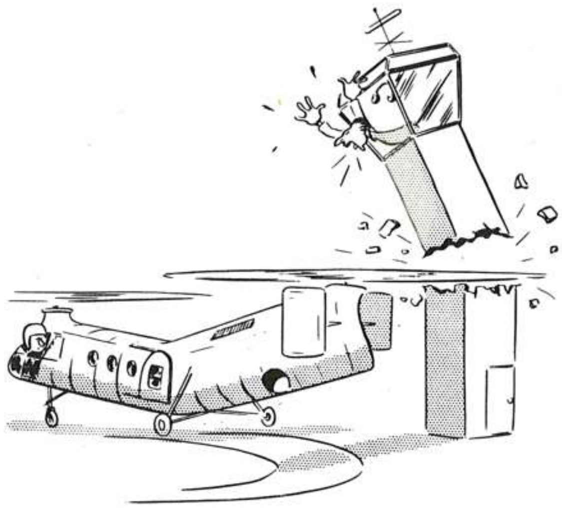
Operation within the transitional flight region (10–40 knots) must be held to a minimum due to an increase in airframe vibration. However, if it is mandatory to operate within these speed ranges, the vibration may be reduced somewhat by yawing the helicopter approximately 45 degrees to the relative wind.

TRANSITION TO FORWARD FLIGHT.

Displace the cyclic control stick slightly forward. As the helicopter gains forward speed and translational lift is attained, neutralize the control stick or position it for climbing or cruising.

TRANSITION TO REARWARD FLIGHT.

The helicopter can be flown readily in rearward flight by displacing the control stick in the desired direction. Due to the impaired visibility, limit rearward flight speed to 20 knots.



CAUTION

There is 65 feet of helicopter behind you. Check the area thoroughly before attempting rearward or sideward flight.

TRANSITION TO SIDEWARD FLIGHT.

Sideward flight can be accomplished up to 40 knots without loss of control. Displace the cyclic stick toward the desired direction of flight.

CRUISE CONTROL.

FLIGHT PROCEDURE.

To effect maximum range with optimum fuel economy the following procedures must be used, as flight experience has shown that any deviations from these procedures will result in adverse fuel consumption:

Note

Although the power settings and cruise speeds are tabulated in Appendix I for several gross weight ranges and altitudes, it may be expected that the actual cruise settings will vary as a result of weight differences, variations from standard temperature, engine condition, etc, under actual flight conditions. It will be noted in Figure A-7, however, that over a wide range of typical weights (10,000 lb thru 13,000 lb) and cruising altitudes (S L to 6,000 feet) best range can be obtained at a *true* airspeed of approximately 85 knots. For this reason the "Cruise Control" technique described below is based on this typical zero-wind value.

1. Establish cruise speed with reduced power in a slight dive (approximately 200 feet above desired altitude required). Adjust power slowly to hold desired altitude at 85 knots TAS, with manifold pressure as required.

Note

The 85 knot TAS is applicable only to a "no-wind" condition. For best range, Increase TAS two knots for each 10 knots of headwind component and, conversely, decrease TAS two knots for each 10 knots of tailwind component. Example: A headwind component of 20 knots requires TAS of 89 knots.

2. Hold cruise steady at 85 knots TAS. Decrease manifold pressure as weight is reduced through fuel consumption. This is most important as power settings in excess of those actually required will adversely affect average fuel consumption. Check IAS or altitude frequently to determine if reduction of manifold pressure is possible. For weights above 11,500 pounds, best range is obtained at minimum practical altitude. For lower weights, best range is obtained at altitudes up to 5000 feet.

3. Use minimum rotor rpm consistent with desired airspeed within a relatively vibration-free range. It is possible that a lower rotor rpm may be used to achieve this vibration free range. Engine speeds below 2300 rpm are not recommended.

WARNING

NORMAL mixture position must be used. Manual leaning beyond NORMAL is not permissible since it will result in improper fuel-air ratio and cause engine detonation, which is wasteful of fuel and harmful to engine components.

CLIMB AT NORMAL GROSS WEIGHT.

SETTINGS FOR BEST CLIMB.

The best rate of climb for sea level is achieved at approximately 60 knots, 2500 engine rpm and 42.4 inches Hg manifold pressure. For information incident to climb at other altitudes, refer to the Climb Chart in the Appendix.

CLIMB AND FORWARD SPEED.

Adjust collective pitch to maintain the required power setting. Regulate the forward speed with the cyclic stick and the rate of climb with the collective pitch lever.

Note

In executing a climb after take-off, it is desirable to reach an altitude that will allow sufficient height for a safe landing if the engine fails.

FLAPS AND SHUTTERS.

There is no automatic control of the engine air exit doors. These doors shall be adjusted or removed prior to take-off. Cylinder head temperature is not to exceed the limit red lined on the cylinder head temperature gage. If the temperature is increasing too rapidly, decrease the rate of climb and increase forward speed.

FLIGHT CHARACTERISTICS.

Refer to Section VI.

SYSTEMS OPERATION.

Refer to Section VII.

DESCENT.

POWER-ON DESCENT.

Accomplish power-on glides by reducing collective pitch for the desired rate of descent (figure 2-3), being careful to maintain a safe rotor speed (green line on rotor tachometer indicator).

POWER-OFF DESCENT.

PRACTICE AUTOROTATIVE DESCENTS. Refer to Section III.

EMERGENCY AUTOROTATIVE DESCENT.

Refer to Section III.

VERTICAL DESCENT.

Vertical descent at zero airspeed may be accomplished. Vertical descent in autorotation is smoother than with partial power. Refer to Section VI for Flight Characteristics.

PRE-TRAFFIC PATTERN CHECK.

Before entering the traffic pattern prior to landing, make the following check:

1. Mixture control lever: RICH.
2. Fuel booster pump switch: HIGH.
3. Carburetor heat control lever: As desired.
4. Hydraulic pressure gage: Check within prescribed limits.
5. Altimeter: Adjust as desired.
6. Supercharger control switch: LOW.
7. Rescue boom and cable: Check for security.
8. Crew and passengers: Alerted for landing.
9. Nose wheel handle: UNLOCKED.
10. Parking brake lever: OFF.

TRAFFIC PATTERN CHECK.

1. After radio permission to land has been granted, observe that the landing area is cleared for the type of helicopter landing that is to be effected.
2. Landing and/or searchlight: ON (as desired).
3. Pilot and co-pilot windows: As desired.

APPROACH AND LANDING.

APPROACHES.

1. Airspeed: Reduce to zero gradually as ground is approached (figure 2-3).
2. Angle of approach: Make approaches to landing areas long and low or nearly vertical as the terrain and ability to hover (as determined by gross weight and altitude) demand.

NORMAL APPROACH.

1. Enter approach at 300–400 feet and 55–60 knots IAS. When the point is reached at which an autorotation could be made into the intended landing area, reduce collective pitch and maintain a constant angle of descent. During the first two-thirds of the approach the airspeed (55–60 knots) is maintained with 2500 engine rpm and 260 rotor rpm.
2. At approximately 50–75 feet begin a cyclic flare, dissipating airspeed and altitude simultaneously, and coming to a hover over the landing area.

CAUTION

. A critical point of the approach is reached when the airspeed drops below 40 knots at any altitude above 10 feet. Care must be taken, therefore, to apply sufficient collective pitch to prevent settling into the ground.

SLOW, STEEP APPROACH.

1. Enter the approach at 150–200 feet above the terrain, with an airspeed of 30–40 knots and 2500 engine rpm. When an approximate 60-degree angle of descent is reached, decrease collective pitch and establish the desired rate of descent. Center attention on *rate of* descent rather than airspeed. As the ground is approached enough collective pitch is added to come to a hover or to cushion the landing, whichever is desired.

CAUTION

This type of approach is more critical because of the use of low airspeed at altitudes above 10 feet, and is used only in confined areas.

180-DEGREE DOWNWIND APPROACH.

1. Enter the approach at 400 feet altitude when 180 degrees downwind from the intended landing spot. Initiate a turn in the desired direction, decelerating to an approach airspeed of 55-60 knots. When a point is reached at which autorotation could be accomplished into the landing area, reduce collective pitch and maintain a constant angle to descent to the landing area. The turn into the wind may be increased or decreased in order to hit the landing area.

2. At 50–75 feet altitude initiate a cyclic flare, and dissipate airspeed and altitude simultaneously. As the helicopter nears the ground increase collective pitch gradually to come to a hover at 8–10 feet altitude. Hold the helicopter in a nose-high attitude until all forward speed is stopped. This procedure will minimize vibration at the bottom of the flare.

FAST, SHALLOW APPROACH.

Fast, shallow approaches are not recommended for this helicopter.

TRANSITION FROM APPROACH TO HOVERING.

1. Cyclic stick: Ease the cyclic control stick rearward until the helicopter slows down to the desired rate, then neutralize it.

2. Collective pitch lever: Decrease collective pitch to prevent climbing. The more abrupt the stop, the more decrease of collective pitch will be required.

3. Make the transition from approach to hovering at least 10 feet above the ground.

Note

When operating at or near maximum gross weight with marginal performance, (due to altitude, temperature, humidity, etc) increases in power for recovery from approaches must be accomplished by increasing the throttle ahead of an increase in collective pitch. By leading with the throttle, a loss of rpm will not occur. It is possible, under marginal conditions, to lose rpm to the point that it cannot be regained without reducing collective pitch. When such a situation occurs, the helicopter will usually settle in, even though the throttle is against the full open stop. It is, therefore, very important to lead the throttle under the above conditions.

DESCENT FROM HOVERING POSITION TO THE GROUND.

1. Collective pitch lever: Decrease slightly.

2. Throttle: Maintain 2500 engine rpm.

3. Allow the helicopter to become stabilized in hovering position before contacting the ground.

4. As soon as the wheels are on the ground, decrease collective pitch.

Note

When a landing is made with no forward or rearward motion, the tires tend to "roll-under." It is desirable to roll forward (approximately six feet) to avoid this.

5. When landing is completed, close throttle.

CROSS-WIND AND DOWN-WIND LANDINGS.

Cross-wind and down-wind landings may be effected. Exercise care to prevent drift by applying cyclic control against the wind and increasing power if necessary. After touch down, continue to hold the cyclic stick slightly into the wind until rpm has decreased.

SLOPE LANDINGS.

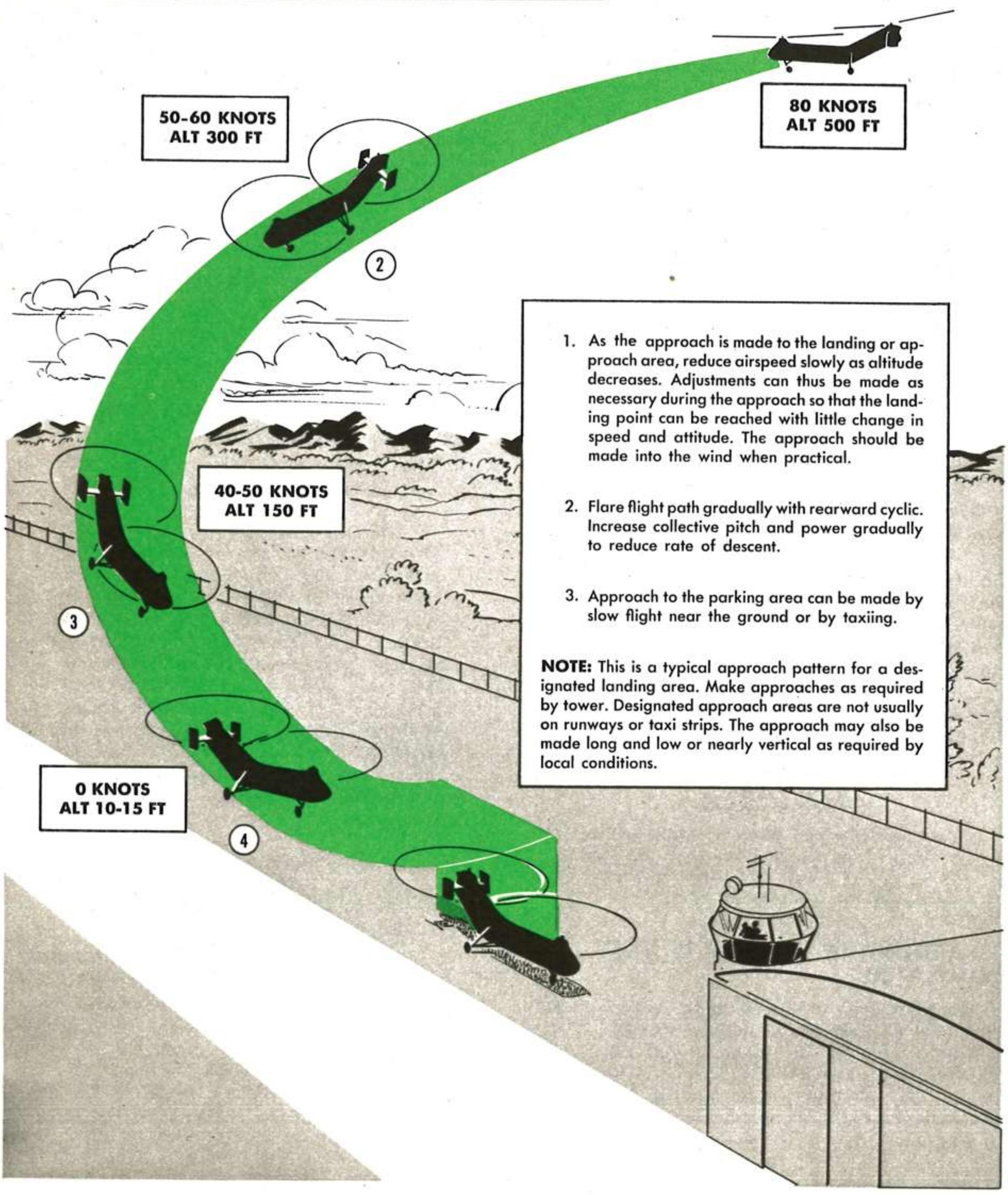
Landings on uneven terrain may be safely accomplished provided that a careful approach is made and the touchdown is accomplished Up Slope or Cross Slope.

CAUTION

Down Slope landings are to be avoided because of the danger of striking the ground with the tail surfaces when reducing altitude.

The maximum slope angle on which landings may be attempted is 20° (see figure 5-3, Section V). To make a safe slope landing, 2500 engine rpm should be maintained until the landing is completed (in case a recovery becomes necessary) and the nose wheel and wheel brakes should be locked prior to touchdown.

APPROACH & LANDING POWER-ON



1. As the approach is made to the landing or approach area, reduce airspeed slowly as altitude decreases. Adjustments can thus be made as necessary during the approach so that the landing point can be reached with little change in speed and attitude. The approach should be made into the wind when practical.

2. Flare flight path gradually with rearward cyclic. Increase collective pitch and power gradually to reduce rate of descent.

3. Approach to the parking area can be made by slow flight near the ground or by taxiing.

NOTE: This is a typical approach pattern for a designated landing area. Make approaches as required by tower. Designated approach areas are not usually on runways or taxi strips. The approach may also be made long and low or nearly vertical as required by local conditions.

Figure 2-3

On Up Slope landings the nose wheel will touch the ground first. Maintain 2500 rpm while decreasing collective and displacing the cyclic stick forward until the helicopter settles evenly onto its gear.

On Cross Slope landings the wheel on the high side will touch the ground first. From this point the landing is completed by displacing cyclic to the high side of the slope while reducing collective until the helicopter is firmly on the ground. After a slope landing has been completed, the cyclic stick should be neutralized in its Up Slope position by means of the centering spring switch. This procedure will hold the stick in its proper position for take-off. Take-off is easily accomplished by slowly applying power to bring the helicopter to a level attitude before breaking clear of the ground on all sides.

CAUTION

Do not displace the cyclic stick Down Slope at any time while landing or taking off.

LANDING ON UNFAMILIAR TERRAIN.

Helicopter landings in unprepared areas are hazardous and should be planned and carried out with the utmost caution to prevent the possibility of blade damage caused by debris striking the rotors. Circle the intended landing spot at a safe altitude but sufficiently low to permit detection of obstacles, debris or loose gear prior to landing. If there is any doubt of the nature of the terrain, hover the helicopter and lower a crewmember to the ground to inspect the terrain and direct the pilot to a safe landing.

CAUTION

Exercise extreme care in approaching landing areas which have been marked by strips of cloth or other temporary markings not firmly held down.

GO-AROUND IF LANDING IS NOT COMPLETED.

If excessive drift or swinging is evident as the helicopter touches down, apply power to lift the helicopter free of the ground, stabilize it by counteracting undesirable movement with cyclic control, and attempt a new landing or proceed into forward flight. If instructions are received to go-around during an approach and descent, add power smoothly, but rapidly, to minimize additional altitude loss and to increase forward speed to that required for climb.

AFTER LANDING.

1. Throttle: Adjust for 2000-2300 engine rpm.
2. Collective pitch lever: As desired for taxiing.
3. Nose wheel handle: Check unlocked for taxiing.

POSTFLIGHT ENGINE CHECK.

Postflight engine and transmission check is to be made after each flight. All discrepancies noted must be entered in DD-781. Check items as follows:

1. Transmission: Check pressures and temperature within specified ranges.
2. Ignition system (magnetos): Check. Accomplish as described in Preflight Engine Check.
3. Parking brake lever: ON.
4. Throttle: 1800 engine rpm; reduce throttle rapidly to 1000 rpm.
5. Friction clutch switch: DISENGAGE (while rotors are overrunning the jaw clutch).
6. Idle mixture adjustment: Check with the clutch disengaged.

Note

The mixture control lever may be adjusted through a 90-degree range in increments of 15 degrees. Full aft position is IDLE CUT-OFF and full forward position is RICH. While making the idle mixture adjustment check, be certain that the cylinder head temperature is at least 150°C. If the temperature should be lower, engage rotors and operate the engine at 2300 rpm and 25 inches Hg for a short warm-up. Disengage rotors and continue idle check.

a. With Primer:

(1) Put mixture control lever in RICH position. Adjust throttle so that engine idles at 1000 rpm and lock the throttle in this position.

(2) Flick the primer switch momentarily and note any change in manifold pressure and rpm. A momentary decrease in manifold pressure accompanied by a corresponding increase in rpm indicates that the mixture is too lean. If the idling mixture is either correct (i.e., at best power) or too rich, a momentary decrease in rpm and increase in manifold pressure will occur when the primer is energized. To determine if mixture is too rich or at best power, proceed as follows:

b. Without Primer:

(1) Recheck that cylinder head temperature is at least 150°C. Warm up engine if necessary.

(2) With mixture control lever in RICH position, adjust throttle so engine will idle at 1000 rpm and lock the throttle in position.

(3) Move mixture control lever from RICH position to NORMAL position. No change in rpm or manifold pressure will be noted.

(4) Slowly move the mixture control lever toward the IDLE CUT-OFF position until a change in rpm and manifold pressure is noted. A decrease in manifold pressure with an increase in rpm indicates that the mixture is too rich. If a decrease in rpm and an increase in manifold pressure occurs, then the mixture is at the desired best power setting.

CAUTION

The ignition switch check and the idle mixture adjustment check must be made with the rotors disengaged.

7. Ignition system: Check. Accomplish as described under Engine Ground Operation and Ground Tests.

Note

If an unacceptable magneto check occurs, refer to Spark Plug Fouling, Section VII.

8. Oil dilution: Check. When stopping the engine, and it is anticipated that the next start will be made in low temperatures, dilute the engine oil. Refer to oil dilution table, Section IX.

CAUTION

Do not dilute oil when oil temperature is above 50°C as it will cause partial evaporation of fuel and result in improper dilution.

STOPPING OF ENGINE AND ROTORS.

Note

Idle the engine with closed throttle for a minimum of 30 seconds prior to shutdown to insure maximum oil scavenging and to preclude liquid lock, plug fouling, and smoky starts.

1. Mixture control lever: IDLE CUT-OFF. (Cylinder head temperature should be down to 150°C before shut-down. Refer to Section VII.)
2. Ignition switch: OFF.
3. Clutch friction switch: ENGAGE (when rotors have slowed to 100 rpm or less. Refer to Section VII for procedure).
4. Fuel booster pump: OFF.

BEFORE EXIT FROM THE HELICOPTER.

INTERIOR CHECK.

1. Friction clutch switch: ENGAGE.
2. All switches: OFF.
3. Radio switches: OFF.
4. Parking brake lever:
   a. ON.
   b. OFF (after wheels are chocked).
5. Check the form DD-781 and enter all discrepancies discovered in flight.
6. Make an interior visual inspection.

AFTER EXIT FROM THE HELICOPTER.

Make an exterior walk-around inspection and enter all discrepancies in Form 1.

WARNING
Be sure to set wheel brakes before leaving the helicopter.

HELICOPTER TIE-DOWN UNDER VARIOUS WIND CONDITIONS.

Since damage to the helicopter's fuselage and/or blades can result if suitable tie-down is not accomplished, the following information is presented as a guide to the pilot in determining if helicopter is securely moored against extreme weather conditions.

CONDITION "A."

When prevailing or forecast surface wind velocities do not exceed values listed under this con-

dition (figure 2-4) and the corresponding gross weight of the helicopter is equal to or greater than shown, the following precautions should be observed:

1. Parking: Head helicopter into the wind and check for:
   a. Sufficient clearance for maintenance, servicing, and fire protection.
   b. Sufficient distance from established runways (750 feet measured at approximately 90° to the runway).
   c. Sufficient distance from connecting taxi strips (250 feet).
   d. Sufficient rotor blade clearance from buildings, obstacles, or other helicopters (slightly more than rotor diameter).
2. Nose wheel: Positioned fore and aft.
3. Nose wheel lock handle: Check LOCKED.
4. Friction clutch: ENGAGED.
5. Parking brake knob: ON.
6. Main wheels: Chocked, and chocks secured to prevent their slipping from the tires.
7. Rotor blades: Properly secured as outlined in applicable Maintenance Instructions Handbook.

CONDITION "B."

Note

The mooring procedures outlined in the subsequent text are applicable when the helicopter is to be parked for an extended period and/or when wind and gross weight values shown under condition "B" (figure 2-4) are existent.

Check to see that the following has been accomplished in addition to items noted under condition "A":

1. Main wheels: Chocked as required for wind velocity, ground conditions, and gross weight. Chocks secured.
2. Tie-down: Check the following:
   a. Helicopter secured to as many ground mooring points or temporary anchoring devices as possible. Use dead man anchors for mooring in soft ground.
   b. Tie-downs at an approximate angle of 45° to the ground.
   c. Slack provided to allow for moisture absorption.
3. Main oleos: Deflated.
4. Fuel tanks: Filled to capacity.
5. Rotor blades: Folded, if time permits and wind velocity at time of folding does not exceed 30 knots. Otherwise, secure blades as noted under condition "A."
6. Cockpit windows: Closed.
7. Battery: Disconnected.
8. Protective covers: Installed, if time and weather conditions permit.
9. Maintenance stands and loose equipment: Removed or secured.

WARNING

Tie-down must not be attempted if forecast surface wind velocities exceed 75 knots. Evacuation of the helicopter to a lesser wind area is recommended.

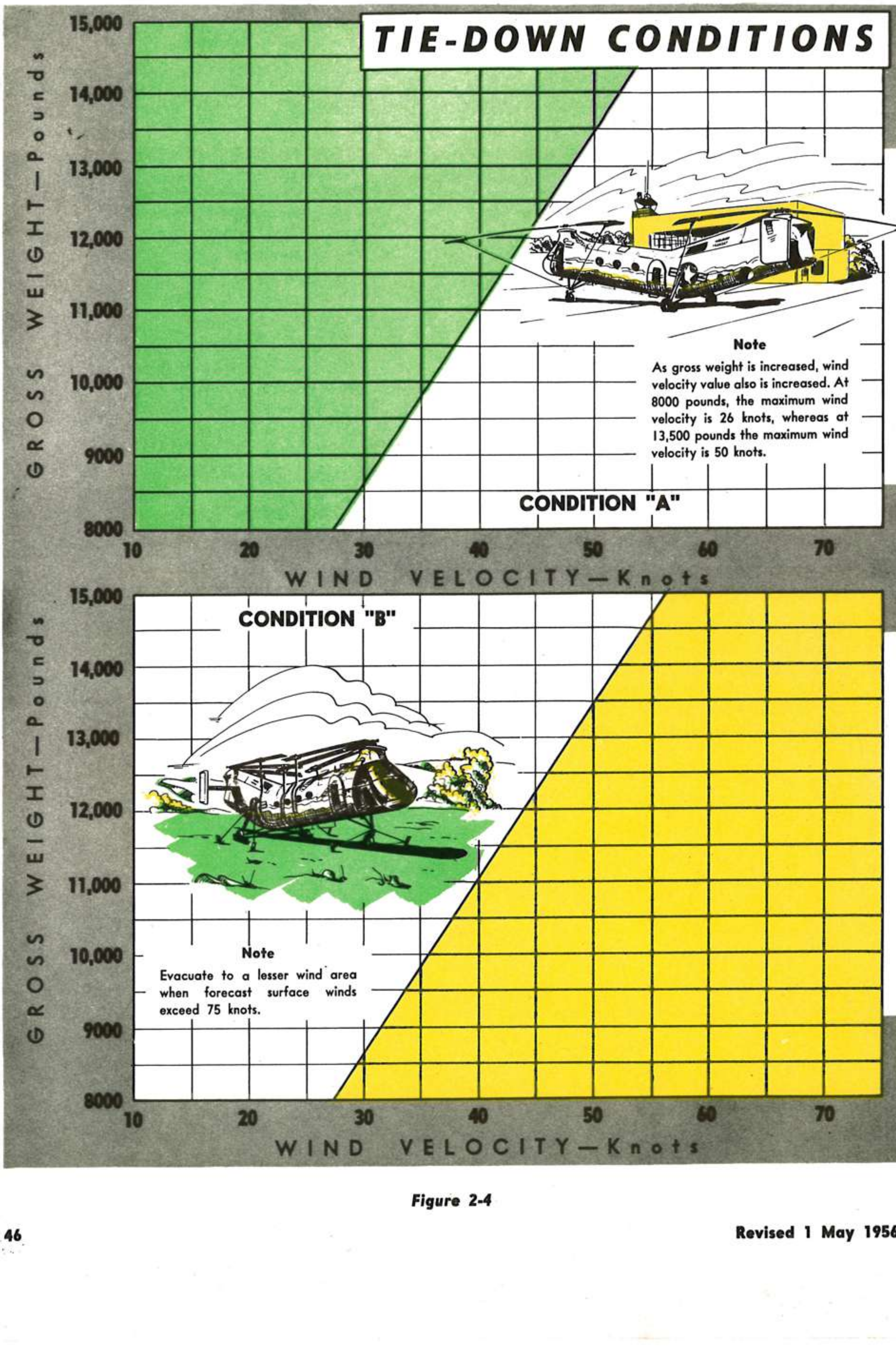
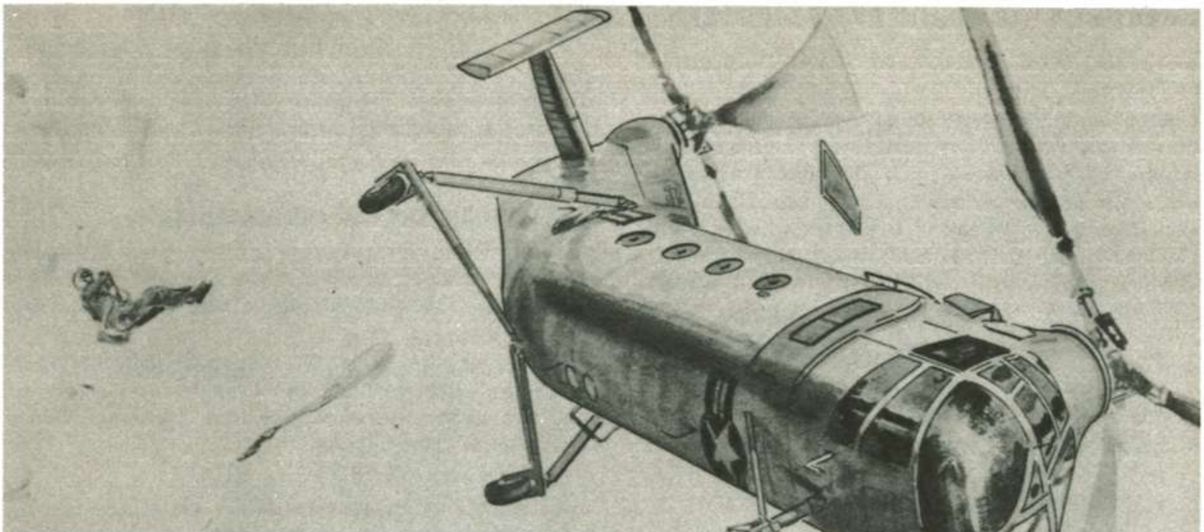

TIE-DOWN CONDITIONS
CONDITION "A"
Note
As gross weight is increased, wind velocity value also is increased. At 8000 pounds, the maximum wind velocity is 26 knots, whereas at 13,500 pounds the maximum wind velocity is 50 knots.
GROSS WEIGHT—Pounds
15,000
14,000
13,000
12,000
11,000
10,000
9000
8000
10
20
30
40
50
60
70
WIND VELOCITY—Knots
CONDITION "B"
Note
Evacuate to a lesser wind area when forecast surface winds exceed 75 knots.
GROSS WEIGHT—Pounds
15,000
14,000
13,000
12,000
11,000
10,000
9000
8000
10
20
30
40
50
60
70
WIND VELOCITY—Knots

Figure 2-4



Section III EMERGENCY OPERATION

TABLE OF CONTENTS

ENGINE FAILURE.

PARTIAL FAILURE.

If the engine is misfiring or causing an uneven power supply to the rotor system, autorotate to the nearest possible landing area to avoid damage to the rotor drive system. If there is a noticeable lack of power but the engine is operating smoothly, continue with partial power to the nearest suitable landing area. Be prepared for complete failure. Both of the above conditions may be accompanied by loss of altitude. No torque corrections are required due to the tandem configuration of this helicopter.

FAILURE WITH EXTERNAL CARGO.

Engine failure while carrying external cargo is not critical as no control problem is encountered during transition from powered flight to autorotation; however, the suspended weight should be released as soon as possible after entering autorotative flight.

COMPLETE FAILURE AT TAKE-OFF, HOVERING, OR SLOW FLIGHT UNDER 15 FEET ALTITUDE.

Rapidly increase the collective pitch and keep the helicopter level. The inertia of the rotors will be sufficient to prevent an unreasonably hard landing.

COMPLETE FAILURE ABOVE 15 FEET ALTITUDE.

Instantly reduce the collective pitch, turn into the wind if altitude permits, and obtain the best autorotative speed of 55 knots IAS. Perform emergency autorotative descent.

EMERGENCY AUTOROTATIVE DESCENT.

Procedure for emergency autorotative descent is as follows:

Decrease collective pitch and establish airspeed between 50 and 60 knots. It is of the utmost importance that collective pitch be reduced immediately upon power failure in order that the rotor speed does not fall below the minimum safe limit (233 rpm). As rotor speed builds up, increase collective pitch sufficiently to maintain desired rpm (260–280).

Note

> The optimum rotor speed to minimize the rate of descent is 260 rpm with gross weights up to 12,000 pounds and 280 rpm above 12,000 pounds. (Higher rotor speeds tend to increase the rate of descent.)
>
> Directional control response at high airspeeds (80 knots or above) is not as positive as it is at lower airspeeds (40–60 knots). Positive directional control can be accomplished by using cyclic stick and directional pedals in combination.

For autorotative descents from high altitudes, utilization of minimum rotor rpm (233–260) will give slower rate of descent. When below 1000 feet altitude, allow rotor rpm to build back up to desired limits (300–310) for proper ground cushioning effect. Refer to figure 3-1 for glide distances in autorotative flight.

When failure occurs at high forward speed, above 80 knots IAS, displace the cyclic stick rearward and effect a partial cyclic flare with a simultaneous decrease in collective pitch. This will maintain rotor speed and reduce the airspeed to the best autorotative speed. If this procedure is not followed, the rotor speed will be greatly reduced during the transition into autorotation. If power failure occurs at slow airspeeds, 0–30 knots IAS, use forward cyclic stick to maintain the helicopter in a level attitude and discourage a "tail down" tendency during the transition period. Once the collective pitch has been reduced to autorotative angles, allow the rotor speed to build up to desired steady autorotative speed. Vertical autorotation is possible, but it is preferable to maintain forward speed which greatly reduces the rate of descent. After establishing autorotative descent, proceed with landing as described under Power-Off Landing.

If no attempt is to be made to restart the engine, position the engine controls as follows:

1. Fluids shut-off switch: SHUT OFF.
2. Ignition switch: OFF.
3. Fuel booster pump switch: OFF.

If low altitude prevents attempt to restart engine, and if landing conditions permit, make a normal power-off landing. After landing, examine helicopter to determine possible cause of failure. If there is no visible trouble, proceed to restart engine.

ENGINE RESTART IN AUTOROTATION.

If the situation warrants, and sufficient altitude permits, attempt to restart the engine. After establishing autorotative flight, use the following procedure:

1. Set engine controls to proper positions for starting. Throttle back to "cracked" position to prevent high engine surges and possible shock loads to the drive system.
2. Mixture control lever: RICH.
3. Fuel booster pump switch: HIGH.
4. Starter switch: ENGAGE.
5. After engine is started, proceed with normal recovery from autorotation.

WARNING

> When attempting to restart the engine in the air, do not disengage the clutch as time will not permit performance of the clutch engaging cycle.

PRACTICE AUTOROTATIVE DESCENTS.

Intentional autorotative descents are to be kept to a minimum and are to be made only as necessary to develop and maintain pilot proficiency. During autorotation a high rotor rpm can cause an increase in vibration. This can be kept to a minimum by maintaining a rotor speed within the range of 260–280 rpm (not to exceed 300 rpm).

The subsequent text is presented to familiarize the pilot with the recommended handling of the flight and engine controls on entry, descent and power recovery during practice autorotative landings.

Note

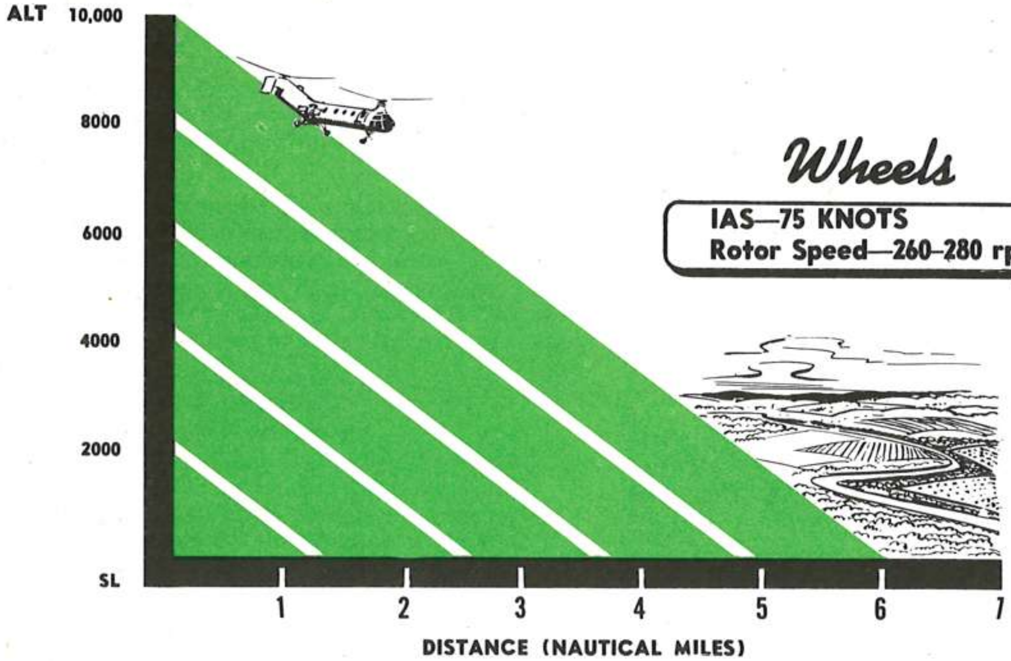
> Practice autorotational landings should be practiced at gross weights under 11,500 pounds and with normal centers of gravity between 15 and 25 inches forward.

AUTOROTATION ENTRY.

Utilize the following procedure:

1. Airspeed: Cruising condition 60–80 knots.
2. Collective pitch: Reduce completely with a positive motion. During the reduction of the collective pitch, the cyclic stick should be moved aft

AUTOROTATIVE GLIDE DISTANCES



AUTOROTATIVE GLIDE DISTANCES

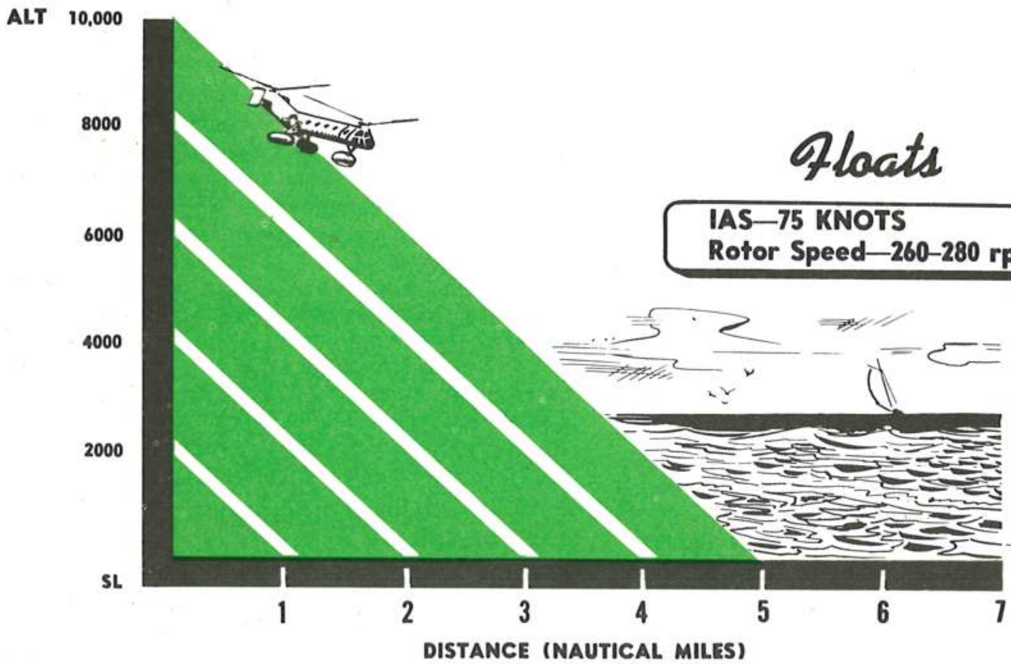


Figure 3-1

slightly to reduce the feeling of abruptness during entry into autorotation.

Note

The throttle must be retarded slightly as the collective pitch is reduced to prevent an excessive increase in engine rpm as the engine is unloaded and to separate the engine from the rotor system for autorotative flight.

3. Throttle: Adjust to maintain 2150 rpm. (This is the optimum engine speed recommended for practice autorotation to reduce wear on the overrunning clutch and adjacent parts, to keep the engine clear, and to prevent high impact on the rotor system during power recovery.)

4. Mixture control lever: RICH.

5. Carburetor heat control lever: COLD. (If carburetor icing conditions exist or the weather is extremely cold, position the carburetor heat control lever to maintain a temperature of 25 to 35°C.)

RPM IN AUTOROTATION.

The best collective pitch angle for autorotative descent is that angle which will maintain rotor speed within the range of 260 to 280 rpm. Rotor speed is affected by weight, altitude, and to a lesser degree by airspeed and is stabilized by the collective pitch. For minimum rate of descent, keep the helicopter between 50 and 60 knots IAS, maintaining desired rotor rpm. For maximum glide distance (figure 3-1) the best airspeed is 75 to 80 knots IAS.

WARNING

The low limit of rotor speed (210 rpm) is permissible during transition to autorotation, and rotor speed should be increased to the desired range as rapidly as possible.

POWER RECOVERY.

Extreme care must be taken in handling the engine controls during power recovery from practice autorotation. Incorrect application of throttle can cause engine overspeed to the point that engine replacement will be required.

Recommended procedure for executing a smooth power recovery follows:

1. Flare: Maintain 50–60 knots to 75–100 feet altitude. Slowly enter a cyclic flare so that the airspeed is reduced to an IAS of 20–30 knots by the time approximately 10 feet of altitude is reached. The altitude at which the flare is started depends upon the rate of descent and forward speed that must be dissipated. Do not increase collective pitch until recovery is begun.

Note

As the flare is executed, the rotor rpm will increase. This is desirable during practice autorotation or emergency autorotative touchdown as more energy is available to the rotors when collective pitch is applied during the final transition to landing.

2. Collective pitch: Increase at end of flare when the helicopter is no higher than 10 feet above the ground to bring the rotor rpm back to the normal operating range. A noticeable drop in lift and a settling of the helicopter will be evident as energy from the flare is lost.

CAUTION

During autorotative landings the pilot must exercise caution to avoid an excessively nose-high attitude. This can result in dragging the aft point of the fuselage (causing damage to the fiberglas fairing and possibly to the structure) dependent on the severity of impact. The optimum nose-up attitude is 30 degrees with respect to the ground. This places the aft part of the fuselage parallel with the ground. Steep flares just prior to touch down which allow the nose-up angle to increase after touch down are to be avoided.

3. Throttle: Apply slowly until engine and rotor rpm are synchronized.

Execution of power recovery as outlined prevents engine overspeed and extreme shock loads to the rotor system. In addition, the pilot becomes familiar with the effect of collective pitch required for emergency power-off landings.

See Section V for limitations on autorotational landings with floats.

MINIMUM HEIGHT FOR SAFE LANDING AFTER ENGINE FAILURE.

Charts on the minimum height for safe autorotative landing (figure 3-2) are presented to provide a combination of heights above the ground and airspeeds from which an autorotative landing can safely be performed under varying conditions of gross weight.

RED AREAS.

The red areas indicate the heights above the ground and the airspeeds that should be avoided whenever possible. Successful recovery from power failure within these areas requires immediate control action and exceptional technique (even by an experienced pilot) to effect a safe landing.

MINIMUM HEIGHT FOR SAFE LANDING AFTER ENGINE FAILURE

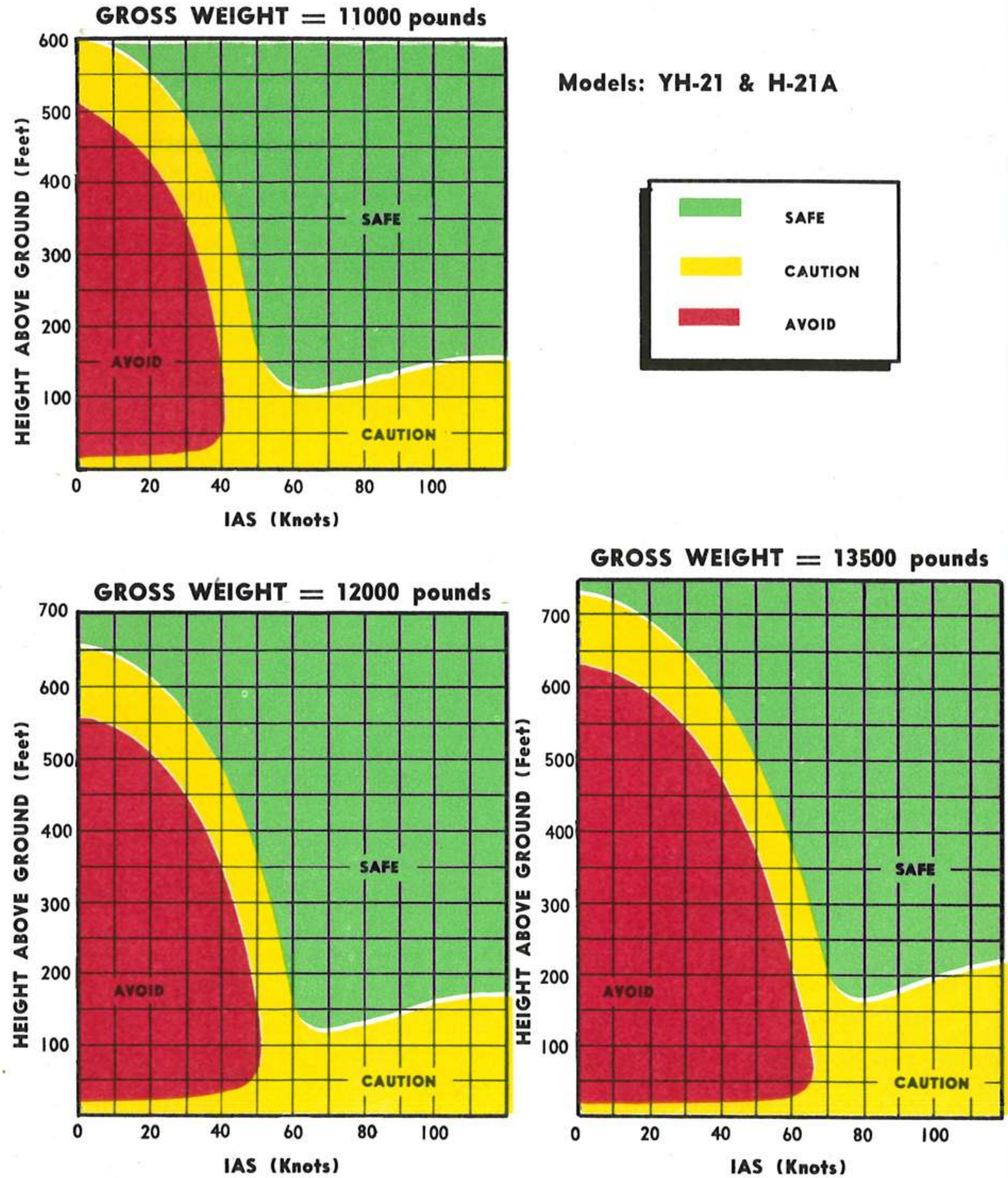


Figure 3-2

YELLOW AREAS.

The yellow areas represent the region of flight where caution is required because the pilot must react with minimum delay in order to effect a landing without damage to the helicopter or possible injuries to personnel.

GREEN AREAS.

The green areas define the heights above the ground and the airspeeds at which recovery from power failure can safely be accomplished. However, it is recommended that no time be lost in effecting proper control displacement to attain the best flight attitude, airspeed, and rotor rpm for autorotational descent.

POWER-OFF LANDINGS.

Note

Two types of power-off landings may be accomplished. Refer to the Appendix for tabular data on Power-Off Landing Distances.

FLARED LANDING WITH FORWARD SPEED (ROLL-ON LANDING FOR SMOOTH TERRAIN).

The following procedure (figure 3-3) should be followed to accomplish a smooth and safe landing:

Note

A turning flare is practical for an emergency landing in a confined area, but should not be practiced at low altitude where recovery from the turn is simultaneous with landing, since it is possible under this condition to hit the runway with the tail.

1. Approach: Establish an airspeed of 50 knots for weights up to 12,000 pounds and 60 knots for weights over 12,000 pounds (when sufficient time and altitude are available).

WARNING

The rotor speed for the approach just prior to the flare must be 300 to 310 rpm.

2. Flare: Make flare primarily with the cyclic control, starting at an altitude of approximately 80 feet. Execute the flare so that minimum collective pitch is required for an easy touch down. When collective pitch is required to cushion the landing, it must not be increased until the last 10 feet of descent is entered. The use of minimum collective pitch provides higher rotor rpm and augments controllability during the landing and after touch down.

Note

The above procedure should not require the use of more than two-thirds of the available collective pitch or one-quarter of the available aft cyclic control.

3. Touchdown airspeed: Maintain so that airspeed at point of touchdown is 25 to 35 knots.

WARNING

After touchdown of the main wheels, do not apply any additional collective pitch, and use little or no aft cyclic control until the nose wheel is safely on the ground.

During a usual roll-on autorotational landing, there will be a loss of 90 to 120 rotor rpm between the beginning of the flare and the time the nose wheel touches down. Therefore, the flare must begin with at least 300 rpm and the application of collective pitch kept to a minimum or the rotor speed will reach a dangerously low value before the nose wheel is safely rolling along the ground.

CONDITIONS TO AVOID.

Sudden rotor blade stalling, dangerously excessive rotor blade flapping, and the possibility of the forward rotor blades striking the fuselage may be caused by the following conditions when they occur in certain combinations:

1. Low rotor speed: Reduces the effectiveness of the collective pitch and longitudinal control. The pilot will be inclined to apply full up collective pitch and full aft cyclic control to cushion the landing.

2. Overcontrol: Application of full up (or nearly full up) collective pitch and full aft (or nearly full aft) cyclic control during the interval between ground contact of the main wheels and the nose wheel can cause extreme stalling of the forward rotor. The stalling of the forward rotor will result in a sudden loss of forward rotor thrust which, in turn, will cause the nose to drop more quickly. Thus, in addition to causing excessive flapping, the application of extreme control can cause the nose to drop rapidly rather than cushion the ground contact of the nose gear.

3. High touch down airspeed: Will increase the possibility of excessive blade flapping when occurring in combination with the other two factors.

FLARED LANDING WITH LITTLE OR NO FORWARD SPEED (FOR ROUGH TERRAIN OR WATER).

A second type of landing (figure 3-3) may be accomplished on relatively rough terrain if neces-

APPROACH & LANDING POWER-OFF

1. Approach: Establish an airspeed of 50 knots for weights up to 12,000 pounds and 60 knots for weights over 12,000 pounds. The rotor speed just prior to the flare must be 300 to 310 rpm (when sufficient time and altitude are available).

2. Flare: Make flare primarily with the cyclic control, starting at an altitude of approximately 80 feet for smooth terrain and 150 feet for rough terrain. Execute the flare in such a manner that as little as possible collective pitch is used.

3. Touch down airspeed: Maintain so that airspeed at point of touch down is 25 to 35 knots on smooth terrain (little or no forward roll on rough terrain).

4. After touch down of the main wheels: Do not apply any additional collective pitch and use little or no aft cyclic control until the nose wheel is safely on the ground.

5. Stopping: Use rearward cyclic whenever possible to bring the helicopter to a stop. Use toe brakes with caution.

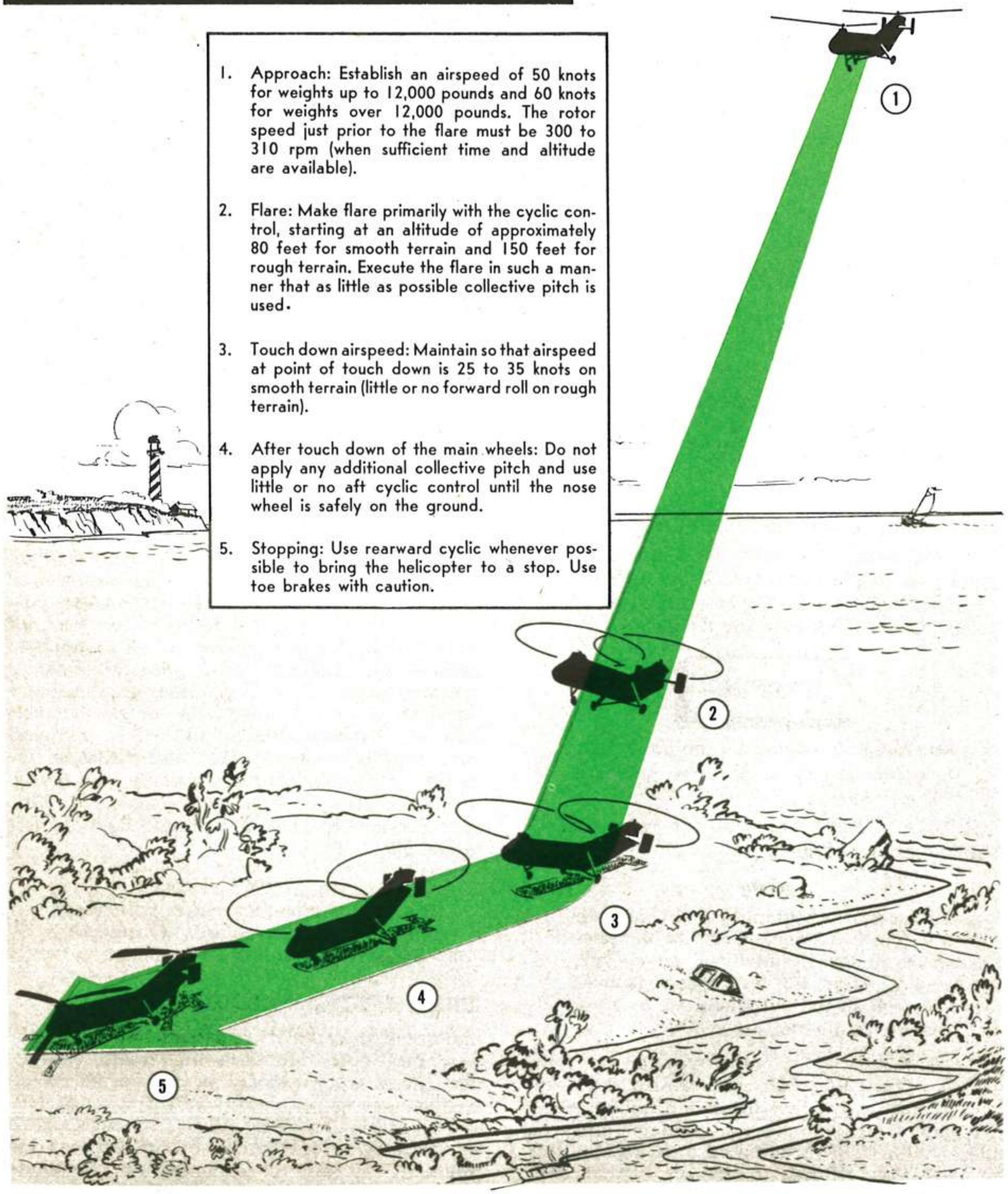
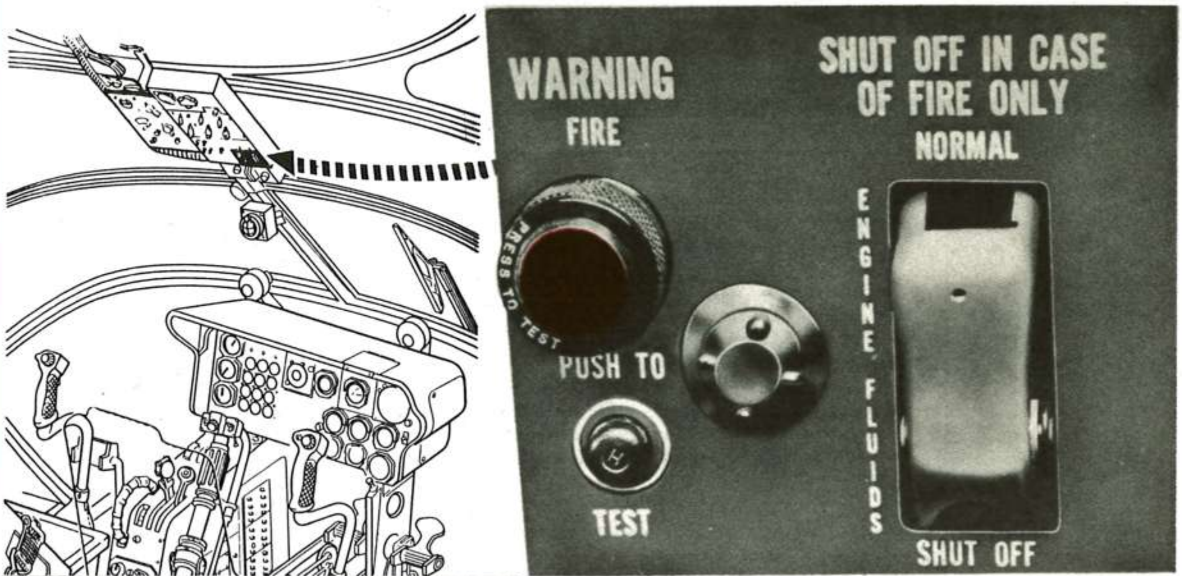


Figure 3-3



FIRE DETECTION

Figure 3-4

sary. To accomplish this type of landing, the technique to be used should be as follows:

1. Approach: Establish an airspeed of 50 knots for weights up to 12,000 pounds and 60 knots for weights over 12,000 pounds (when sufficient time and altitude are available).

WARNING

The rotor speed for the approach just prior to the flare must be at least 300–310 rpm.

2. Flare: Make flare with aft cyclic control, starting at an altitude of 150 feet.

Note

The entry, on beginning of the flare for this type of landing, should be the same as the previously described roll-on flare landing except for the higher altitude. Airspeed should be reduced as much as possible by the use of cyclic control.

3. Touchdown: Use collective pitch to cushion the impact. Keep aft cyclic control motion to a minimum, especially when using full-up collective pitch. If the flare has been initiated properly, there will be little or no forward roll at the point of touchdown. Normal touchdown attitude will generally be nose high.

TRANSMISSION FAILURE.

Trouble developing in the forward, central, or aft transmission can be identified by excessively high oil temperature or excessively high or low oil pressure, as indicated by the instruments and warning lights. Should these indicators warn of difficulty, land as soon as possible with minimum use of power, autorotating if practical. Should a warning occur while over water or unlandable terrain, attempt to reach the closest landable area at minimum altitude, 10–25 feet, and slow airspeed, 30–40 knots IAS. This will lessen the chance of injury to personnel or damage to the helicopter in event of complete failure. The decision to land or continue flight is left to the pilot.

Note

The use of minimum power will relieve the failing part and may considerably delay complete failure.

DRIVE SYSTEM FAILURE.

Failure of the rotor drive system resulting in the severance of the interconnecting shafts between the transmissions should be considered as an extreme emergency condition. This type of failure will be noticeable by either a runaway engine or an unequal distribution of lift between the rotors. If at altitude sufficient for parachute descent (over 500 feet), make exit from the helicopter. (See figure 3-5 for emergency exits.) If at low altitudes, immediately reduce the collective pitch to minimum pitch position, shut off engine, and autorotate to a landing.

ROTOR BLADE FAILURE.

If a rotor blade should fail, make immediate exit from the helicopter. Use emergency exits shown in figure 3-5.

FIRE.

FIRE DETECTOR WARNING LIGHT.

Refer to Section I for description and to figures 1-10 and 3-4 for location.

ENGINE FIRE WHEN STARTING.

If the engine catches fire when attempting to start, it is due to flooding from excessive priming. Make every attempt to complete the start. If not successful, use the following procedure to extinguish the fire:

1. Starter switch: ENGAGE.
2. Ignition switch: BOTH.
3. Fuel booster pump switch: OFF.
4. Mixture control lever: IDLE CUT-OFF.
5. Throttle: OPEN.

This procedure will normally extinguish the fire. If the fire continues, use a fire extinguisher. For location of this item and other emergency equipment, refer to figure 3-6.

ENGINE FIRE DURING FLIGHT.

If engine catches fire during flight, proceed as follows:

1. Collective pitch lever: Reduce to autorotative position.
2. Throttle: CLOSED.
3. Mixture control lever: IDLE CUT-OFF.
4. Fluids shut-off switch: SHUT OFF.
5. Ignition switch: OFF.
6. Autorotate to landing if below 500 feet altitude. Above 500 feet it is left to the pilot's discretion whether to bail out or autorotate to a landing. (See figure 3-5 for emergency exits.)

FUSELAGE FIRE.

Two fire extinguishers are provided to fight fires within the cockpit and cabin (figure 3-6). One extinguisher is mounted behind the pilot's seat and one is mounted in the aft end of the cabin. If fire cannot be controlled, all personnel bail out if at sufficient altitude (500 feet). (See figure 3-5 for emergency exits.)

ELECTRICAL FIRE.

Electrical circuits are protected by circuit breakers and fuses so that any electrical fire will be isolated. If electrical fire occurs and cannot be controlled by the crew, turn battery and generator switches OFF and land as soon as possible.

Note

> The two fire extinguishers provided in the cockpit and cabin are suitable for use in fighting electrical fires.

SMOKE ELIMINATION.

After the fire is extinguished, open the cockpit windows and both rescue and main entrance doors. Yaw the helicopter to the left to create airflow toward the main entrance door. For increased ventilation, snap vents in the cabin windows may be opened.

LANDING EMERGENCIES (EXCEPT DITCHING).

Landing emergencies in a helicopter may be construed broadly as that type of landing wherein the pilot feels that he can bring the helicopter down without undue injury or danger to personnel or the helicopter rather than bailing out. Such emergencies would be partial failure of one of the helicopter's major components, fire, or damage by gunfire to rotor blades, fuselage or nose section. Conditions incident to the attempting of such a landing would be as follows:

1. Seriousness of the emergency.
2. Altitude of the helicopter.
3. Terrain over which the helicopter is being flown.
4. Weather conditions.
5. Type and weight of load being carried.
6. Pilot's opinion as to his available control of the helicopter for a reasonably safe landing.

WITH OR WITHOUT POWER.

During descent, accomplish as much of the following as time permits:

1. Warn crew to prepare for an impact landing. Stand by to abandon the helicopter after landing and be ready to pull emergency equipment, fire extinguishers, etc.
2. Lock shoulder harness.

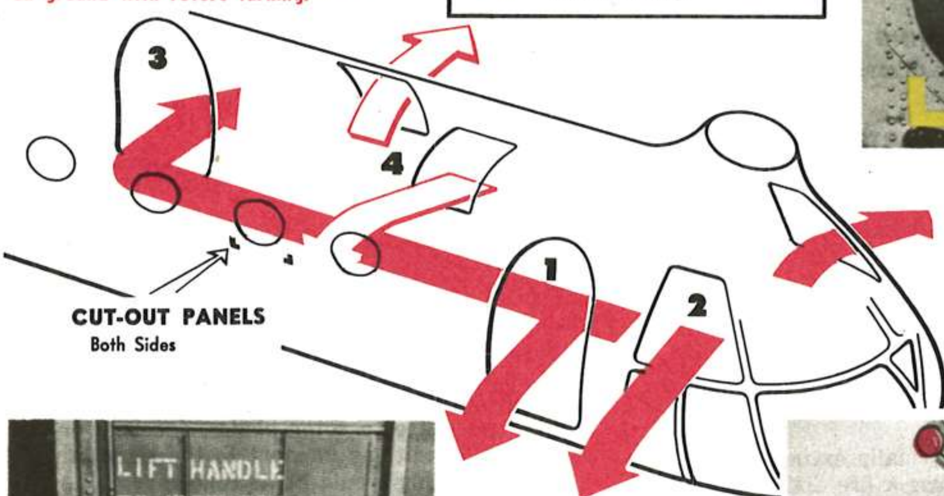
WARNING

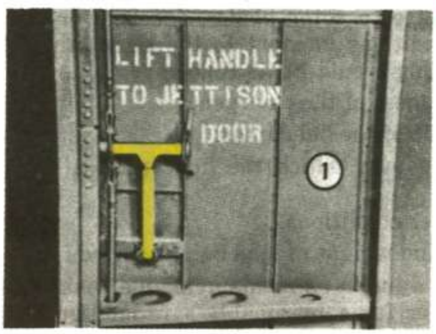
> When the shoulder harness reel handle is in the LOCKED position, the cable is manually locked and the crewmember is prevented from bending forward. The pilot should make a prior check to determine which controls he is able to reach with the harness locked.

EMERGENCY EXITS

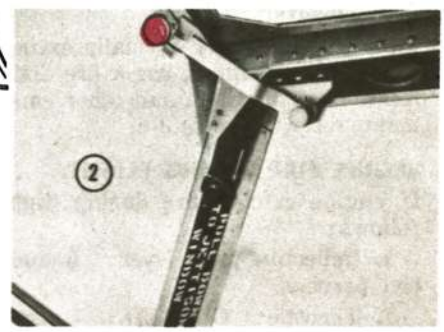
WARNING:
Do not remove overhead escape panels while in flight or when helicopter is on ground with rotors turning.

■ (red)	Emergency exits during flight
□	Emergency exits after ditching or crash landing

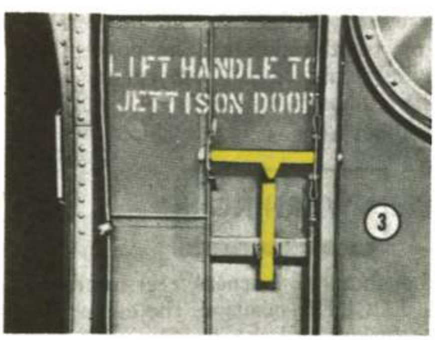




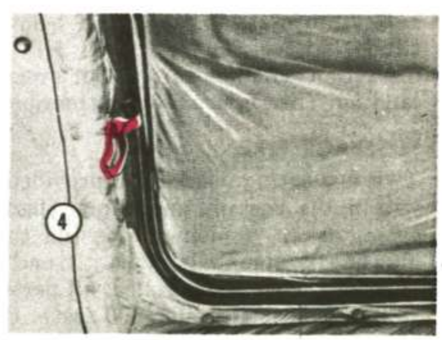
1 RESCUE DOOR
Lift Handle to Jettison



2 PILOT'S & CO-PILOT'S WINDOWS
Pull Handle to Jettison



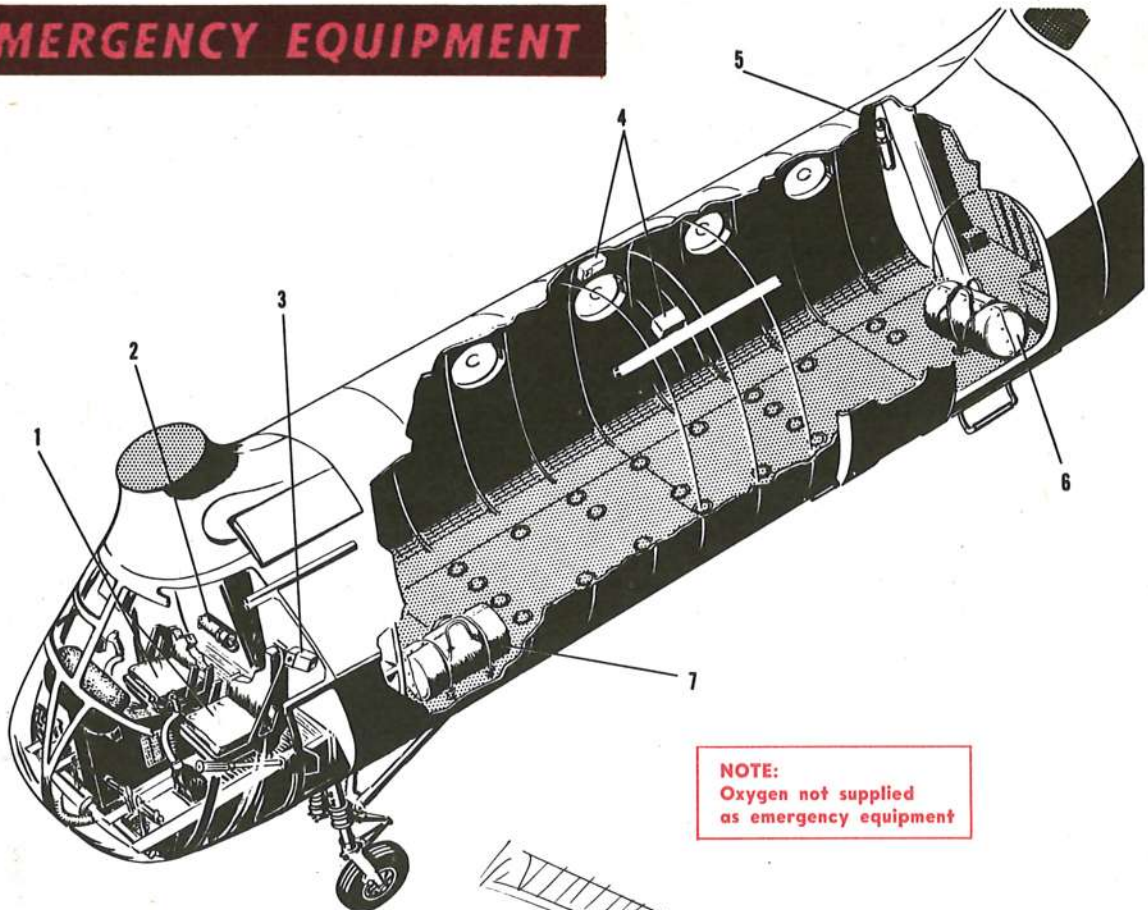
3 CABIN DOOR
Lift Handle to Jettison



4 OVERHEAD ESCAPE PANELS
Pull Tab, Push Out

Figure 3-5

EMERGENCY EQUIPMENT



NOTE:
Oxygen not supplied as emergency equipment

1. **Pilot's and Co-Pilot's Seats with Life Rafts**
2. **Fire Extinguisher in Cockpit**
3. **First Aid Kit in Cockpit**
4. **First Aid Kits in Cabin**
5. **Fire Extinguisher in Cabin**
6. **Alternate Stowage for Life Raft**
7. **Preferred Stowage for Life Raft**

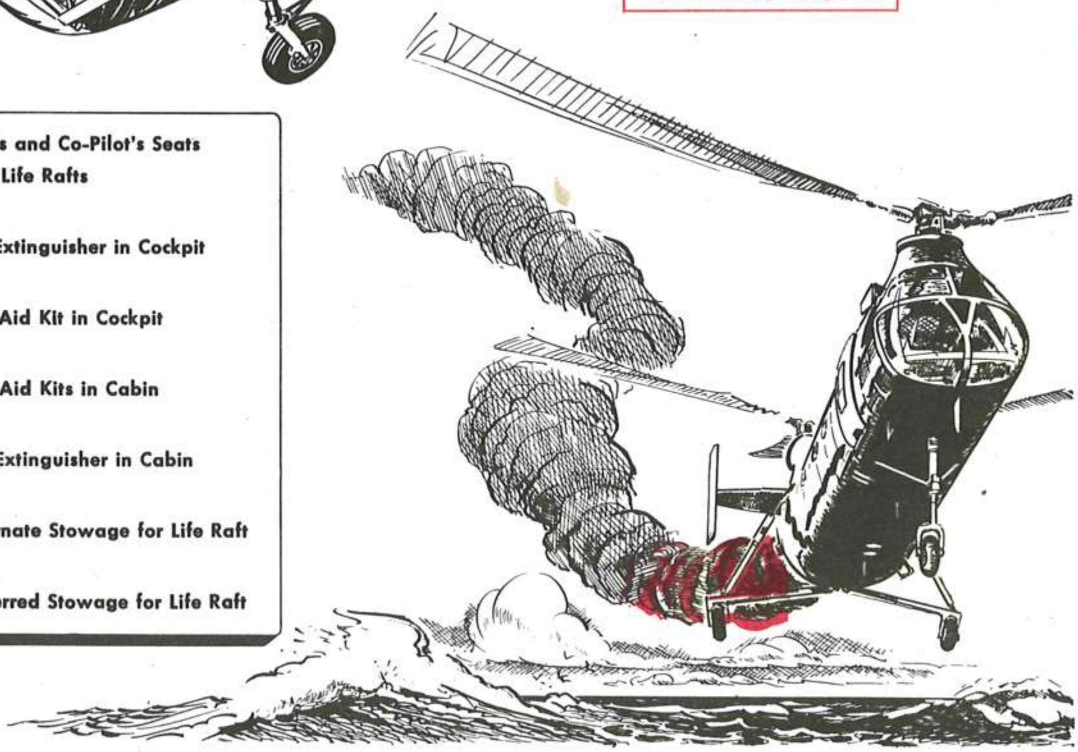


Figure 3-6

3. Unbuckle parachute harness.

4. Just prior to landing, execute an abrupt flare to cushion the impact, or if with power and time permits, a brief hover may be used.

5. Land, cut all switches, pilot and co-pilot jettison windows, crew jettison cabin door and rescue door.

WARNING

Windows and doors must be jettisoned (with or without power) at or near the point of touch down to eliminate the possibility of their fouling the rotor blades.

6. Clear helicopter immediately.

EMERGENCY LANDING IN HEAVILY WOODED AREAS.

When flying over heavily wooded areas, the pilot must always be aware of the possibility of a forced landing into trees and, consequently, should be prepared for such an emergency.

The procedure for landing into small trees need vary only slightly from a normal autorotation with zero airspeed at point of touchdown.

Emergency landings into large or tall trees require a normal autorotative descent almost to tree top level. As tree top level is approached, stop all forward speed and allow the helicopter to settle into the trees in a nose-high attitude. Apply collective pitch as needed to minimize the rate of descent, but complete application of collective pitch before blade contact, as the helicoper settles into the trees.

WARNING

If sufficient time is available turn off the ignition, battery, and fluids shut-off switches during the descent to minimize the danger of fire.

OPERATION WITH FLAT TIRES.

Do not take off.

If a tire becomes deflated during flight or on touch down, use extreme care while landing. Do not attempt a roll-on landing.

Note

Land on firm ground whenever possible to prevent damage to wheel castings.

Use the following procedure:

1. Bring helicopter to a steady hover.

2. Touch down with minimum control motions. (Helicopter must not be turning or drifting at time of touch down.)

3. Reduce collective pitch steadily but continuously to minimum pitch, maintaining 2500 rpm, when contact is made. Do not remain in a condition of being very light on the landing gear.

4. Disengage rotors immediately and shut down if no oscillations are apparent.

If resonance is felt when wheels touch, take off and perform another landing. It must be remembered resonance is more likely to occur when landing with a flat tire at weights above normal gross.

EMERGENCY OPERATION WITH FLOATS.

The flotation equipment is not constructed with separate compartments; therefore, care must be exercised when landing to determine that all floats are inflated sufficiently to support the weight of the helicopter. Should the floats be under-inflated, take-off immediately. If an emergency occurs, the flotation equipment may be jettisoned. Refer to Section VII for this procedure.

EMERGENCY ENTRANCE.

Make emergency entrance through the same openings that are used for exit. Tabs are provided to pull the locking strip from the rubber grommet which surrounds each emergency exit panel. In case emergency entrance cannot be effected through the conventional openings, cutout locations are painted on both sides of the fuselage as shown in figure 3-5.

DITCHING.

WITHOUT POWER.

Establish autorotative descent into the wind. During descent, accomplish as much of the following as time permits:

1. Warn crew to prepare for ditching.
2. Lock shoulder harness.

WARNING

When the shoulder harness reel handle is in the LOCKED position, the cable is manually locked and the crewmember is prevented from bending forward. The pilot should make a prior check to determine which controls he is able to reach with the harness locked.

3. Unbuckle parachute harness.
4. Jettison pilot and co-pilot windows.

5. Just above the surface (approximately 20 to 30 feet) execute an abrupt flare. Passengers or crewmembers jettison main entrance door and rescue door at this point.

6. Spill flare to a moderately "tail low" attitude, using rotor energy to cushion the impact.

7. As tail contacts the water, apply full left lateral control. This procedure will cause the rotor blades to be stopped by contact with the water and eliminate the possibility of the blades injuring personnel abandoning the helicopter.

8. Release safety belt.

9. Remove life raft and clear helicopter immediately.

Note

If the entrance and rescue doors were not jettisoned, the transparent panels can be pushed out by applying pressure to the center of panel. Two overhead panels (figure 3-5) also are provided in the cabin. To release, pull the tab which is attached to the filler strip in the grommet surrounding these panels. Push the panel out. Never push these two overhead panels out while in flight or when on the ground with rotors turning.

WITH POWER.

During descent, accomplish as much of the following as time permits:

1. Warn crew to prepare for ditching.
2. Lock shoulder harness.

WARNING

When the shoulder harness reel handle is in the LOCKED position, the cable is manually locked and the crewmember is prevented from bending forward. The pilot should make a prior check to determine which controls he is able to reach with the harness locked.

3. Unbuckle parachute harness.
4. Jettison pilot and co-pilot windows.
5. Establish hovering flight five to ten feet above the water.
6. Passenger or crewmember jettison the main entrance door and/or rescue door while hovering.
7. Remove life rafts.
8. Passengers and non-essential crewmembers board life rafts.
9. Effect a normal landing and, as the landing gear touches the water, apply full left lateral control to stop rotor blades.
10. Release safety belt.
11. Remove life raft and clear helicopter immediately.

As an alternate procedure when sufficient fuel is not available for extensive hover, the following is recommended:

1. Perform operations as outlined in steps 1. through 6. above.
2. Effect a normal landing and, as the landing gear touches the water, apply full left lateral control to stop the rotors.
3. Release safety belt.
4. Leave the helicopter immediately.

BAILOUT PROCEDURE.

Many different procedures can be employed for bailout. However, experience has proved that the safest procedure is to make immediate exit from the helicopter through the nearest emergency exit.

Note

Many factors such as a pilot's height, weight, physical size and agility as well as altitude, attitude, and forward speed of the helicopter may affect a pilot's method of bailout.

Since the fastest and safest procedure for bailout depends upon the individual, *it is recommended that Flight Personnel practice (on the ground) the general procedure given in the subsequent text, and adopt a similar method best suited to the individual for the quickest exit.* It is estimated that bailout should be accomplished in four seconds.

Note

Many combinations of attitudes of flight may be obtained in the helicopter. Therefore, the standard bailout procedures used in fixed wing aircraft are not applicable to helicopter bailout in every instance.

PILOT BAILOUT.

A sliding window (figure 3-5) is provided on either side of the cockpit. For rapid emergency exit, proceed as follows:

1. Window jettison: Accomplish as noted below:
   a. Open to at least first notch.
   b. Pull jettison handle at top of window.
   c. Push out at upper rear corner of window.
2. Safety belt and shoulder harness: Release.
3. Exit: Accomplish as noted below:
   a. Grasp lower window ledge with both hands, pull up out of seat, and exit head first, or grasp upper window ledge and exit backwards.
   b. Push against console or seat with feet to gain added impetus.
4. Parachute release: Make a short, free fall before opening the parachute to prevent the possibility of its entanglement with the helicopter.

CAUTION

When releasing the safety belt for emergency exit, throw the ends outward so that the parachute harness will not catch on the adjustment buckles of the shoulder harness.

PASSENGER OR CREWMEMBER BAILOUT.

For passengers in the main cabin, the main entrance door and rescue door (figure 3-5) are jettisonable. These doors may be jettisoned by pulling the designated jettison handle. This allows the entire door assembly to fall free. For rapid emergency exit, proceed as follows:

1. Safety belt and shoulder harness: Release.
2. Cabin door or rescue door: Open or jettison. Plexiglas panels in both these doors can be pushed out if the door cannot be opened or jettisoned.
3. Exit: Go out head first.
4. Parachute release: Make a short, free fall before opening the parachute to prevent the possibility of entanglement with the helicopter.

GROUND RESONANCE.

Ground resonance is a vibratory condition present in a helicopter while on the ground with its rotors turning. Refer to Ground Resonance, Section VI.

RECOVERY.

Should ground resonance occur, the most positive and safest means of recovery is to apply enough power to become airborne immediately. If resonance is severe before take-off is accomplished, it may continue for two or three oscillations before dampening even after the helicopter is clear of the ground. When resonance has stopped, the flight may be continued or a new landing performed. If take-off is not possible, cut collective pitch and rotor speed at once.

FUEL SYSTEM EMERGENCY OPERATION.

FUEL PUMP FAILURE.

DURING GROUND OPERATION.

If fuel pressure drops below the operating limits, but engine continues to operate normally, *do not take off*. Shut down immediately, investigate the cause, and correct.

DURING FLIGHT.

If a drop in fuel pressure is noted during flight, switch the fuel booster pump switch to the HIGH position immediately. The electric fuel booster pump will then supply the necessary fuel to the engine. If fuel pressure drops below operating limits but the engine operates normally, the cause may be one or more of the following:

1. Primer solenoid leakage.
2. Oil dilution solenoid leakage.
3. Engine-driven fuel pump bypass valve leakage.
4. Clogged pressure line.
5. Instrument failure.
6. Line leakage.

While on the ground, serious leakage may be detected by the presence of fuel beneath the helicopter. While in flight, the seriousness of a leak in the fuel tank compartment or in the engine compartment cannot be determined due to the inaccessible location of these compartments. If a fuel leak is suspected during flight, effect a landing as soon as possible and check to determine whether it is safe to continue the mission or if repairs must be made. Closely observe the fire warning light in the overhead switch panel during flight and while landing if trouble of this nature is suspected.

ELECTRICAL SYSTEM EMERGENCY OPERATION.

POWER FAILURE.

Electrical power failure during flight, due to an overvoltage or undervoltage condition, will be indicated by the illumination of the generator failure warning light located on the overhead switch panel. If the warning light illuminates, hold the generator switch in the RESET position, momentarily, then throw the switch to the ON position. If the warning light goes out, the system has returned to a normal condition. Continued illumination of this light indicates that the generator is not functioning properly. Place the battery switch in the EMERG position and the inverter switch in the SPARE position to disconnect all non-essential equipment from the system. The utility lights (C4A), fire detector light, flight instrument lights, spare inverter, turn and bank indicator, and warning lights will operate.

The main inverter warning light will illuminate even though no failure of the main inverter has occurred.

If the spare inverter fails, indicated by the NO AC warning light, place the battery switch ON and the inverter switch to MAIN. All radio and electrical equipment will then be operating on the battery alone. Pull all circuit breakers not required for flight to conserve battery power.

Figure 3-7 presents a general procedure for Flight Crew trouble shooting of electrical system.

HYDRAULIC CONTROL SYSTEM EMERGENCY OPERATION.

PRESSURE FAILURE.

If the hydraulic flight control system pressure is lost due to pump failure, etc, turn the control valve off and fly the helicopter manually.

Note

> If any of the above systems fail, the helicopter can be operated only on an emergency basis. It is recommended that landing be made as soon as possible.

MANUAL CLUTCH ENGAGEMENT.

See Section VII for procedure.

DESCRIPTION OF MALFUNCTION GENERATOR DC ELECTRICAL SYSTEM

Visual Indication of Electrical System Failure with Generator Switch in On Position			Probable Causes of Electrical System Failure	Immediate Action (which can be accomplished by Flight Crew)
Voltmeter normal or below	Loadmeter high, off scale	Generator warning light may be ON or OFF	1. If the warning light is ON, a ground fault is probably between the generator and the distribution box. If the warning light is OFF, a ground fault is probably on the main or emergency bus.	1. Place the battery switch in EMERG position; turn the generator switch OFF. Inspect the main bus to clear the fault.
Voltmeter reads above 30V	Loadmeter reads normal	Generator warning light OFF	1. Voltage regulator not properly adjusted. 2. Defective rheostat in voltage regulator. 3. Contact points in voltage regulator stuck. 4. Open circuit to voltage coil in voltage regulator.	1. Turn rheostat on voltage regulator counter-clockwise to lower the voltage. If the voltage cannot be reduced, turn the generator switch OFF and the battery switch to EMERG.
Voltmeter reads below normal	Loadmeter reads normal	Generator warning light OFF	1. Voltage regulator not properly adjusted. 2. Poor connection in generator field circuit. 3. Poor contacts at base of voltage regulator. 4. Defective voltmeter.	1. Turn rheostat on voltage regulator clockwise to obtain proper reading. If unable to obtain proper voltmeter reading, turn generator switch OFF and battery switch to EMERG.
Voltmeter reads normal	Loadmeter reads zero	Generator warning light ON	1. Generator switch not turned ON. 2. Defective loadmeter. 3. Defective shunt. 4. Improperly connected loadmeter. 5. Defective reverse current relay. 6. Defective generator field control relay.	1. Place generator switch in ON position. 2. If condition still exists, place generator switch in OFF position and battery switch in EMERG position.
Voltmeter reads normal	Loadmeter reads normal	Generator warning light ON	1. Press-to-test feature of the warning light assembly is stuck. 2. Indicating needle of voltmeter is stuck. 3. Warning light relay defective.	1. Operate press-to-test feature of warning light to determine proper operation. 2. Tap voltmeter lightly to determine whether or not needle is stuck. 3. If, after tapping the voltmeter, the needle indicates excessively high voltage, turn generator switch OFF and battery switch to EMERG.
Voltmeter reads zero	Loadmeter reads zero	Generator warning light ON	1. Generator not developing voltage. 2. Open circuit in voltage regulator. 3. Generator armature burned out. 4. Brushes excessively worn. 5. Generator armature or field shorted or grounded. 6. Commutator very rough, pitted, or dirty. 7. Contacts in overvoltage relay stuck. 8. Defective generator switch. 9. Open voltage regulator circuit breaker.	1. Place generator switch in the OFF position. 2. After a few minutes, momentarily hold the generator switch in the RESET position. 3. If the voltmeter reading is normal, place the generator switch in ON position. 4. If the failure still exists, place generator switch in OFF position and leave off. 5. Place battery switch in EMERG position.

Special Notes

1. It is assumed that all electrical equipment is operating properly at the start of flight.
2. The generator switch controls the reverse current relay, overvoltage relay, and generator field control reset coil, as follows:
   a. Generator switch in ON position closes circuit to overvoltage relay and reverse current relay.
   b. Generator switch in OFF position disconnects circuit to overvoltage relay and reverse current relay.
   c. Generator switch in RESET position closes circuit to generator field control reset coil.
3. No means are available to energize the field relay "trip" coil except by actuation of overvoltage relay by overvoltage condition.
4. The generator warning light will light if:
   a. Press-to-test case is operated.
   b. Overvoltage occurs and overvoltage relay disconnects generator from system.
   c. Generator voltage is less than battery voltage and reverse current relay disconnects generator from system.
   d. Generator switch is not turned ON.
   e. Warning light relay should become defective.

Figure 3-7

DESCRIPTION AND OPERATION OF

Section IV AUXILIARY EQUIPMENT

TABLE OF CONTENTS

HEATING SYSTEM.

The helicopter recirculating air heater system (figure 4-1) is composed mainly of a combustion type burner with an output potential of 200,000 BTU/hour, an electrically-powered blower, and ducting for the transfer of heated air from the unit to the cockpit and cabin areas. The helicopter heating and ventilating unit is located forward of the rescue door on the right side of the cabin. Fuel for the combustion unit is supplied from the engine fuel system by means of the fuel booster pump. Refer to figure 4-1 for location of fuel transfer components.

The heating system may be operated by either the pilot or the co-pilot and can be started with or without the engine running. However, the battery switch must be in the ON position. The pressure regulator on the heating unit is set for 15 psi which provides for proper operation of the heater with the fuel booster pump switch in either LOW or HIGH position. The heater switch (figure 4-1) energizes the blower motor and supplies current to the air pressure switch. Air pressure induced against the diaphragm of the air pressure switch, forces its contact against the point previously electrically energized by the closing of the heater switch. This automatically closes the circuit which opens the fuel solenoid at the firewall, fires the igniter, and also actuates the cycling solenoid in the fuel transfer line. The cycling solenoid is automatically controlled by the cycling thermal switch in the heater, thus regulating the amount of fuel supplied to the heater combustion unit. A portion of the air from the blower is forced into the heater combustion chamber, mixed with the fuel, is ignited, and when burned, is voided through the exhaust. The remaining air circulates around the combustion chamber, is heated, and is forced through the heat ducts.

HEATER SWITCHES.

The 2-position, ON-OFF, switches for the heater, blower, and battery are located on the overhead switch panel. The 2-position, HIGH-LOW, fuel booster pump switch is located on the console switch panel.

Note

Use of the blower ON-OFF switch is only required when air recirculation is desired and need not be placed ON for heater operation.

The cycling thermal switch on the YH-21 is fixed to keep the heater at a pre-set temperature during operation. The cycling thermal switch on the H-21A has a control located on the top of the heater that can be set to a desired temperature for heater operation.

BALANCE VALVE CONTROL.

A balance valve (figure 4-1) divides the flow of heated air between the cabin and the cockpit and provides a range of air flow to the cockpit from just below 50 per cent, to a full flow of 100 per cent of the heater output. This control is located at the top of the heater on the outboard side. Instructions for proper positioning are located on

HEATING & VENTILATING SYSTEM

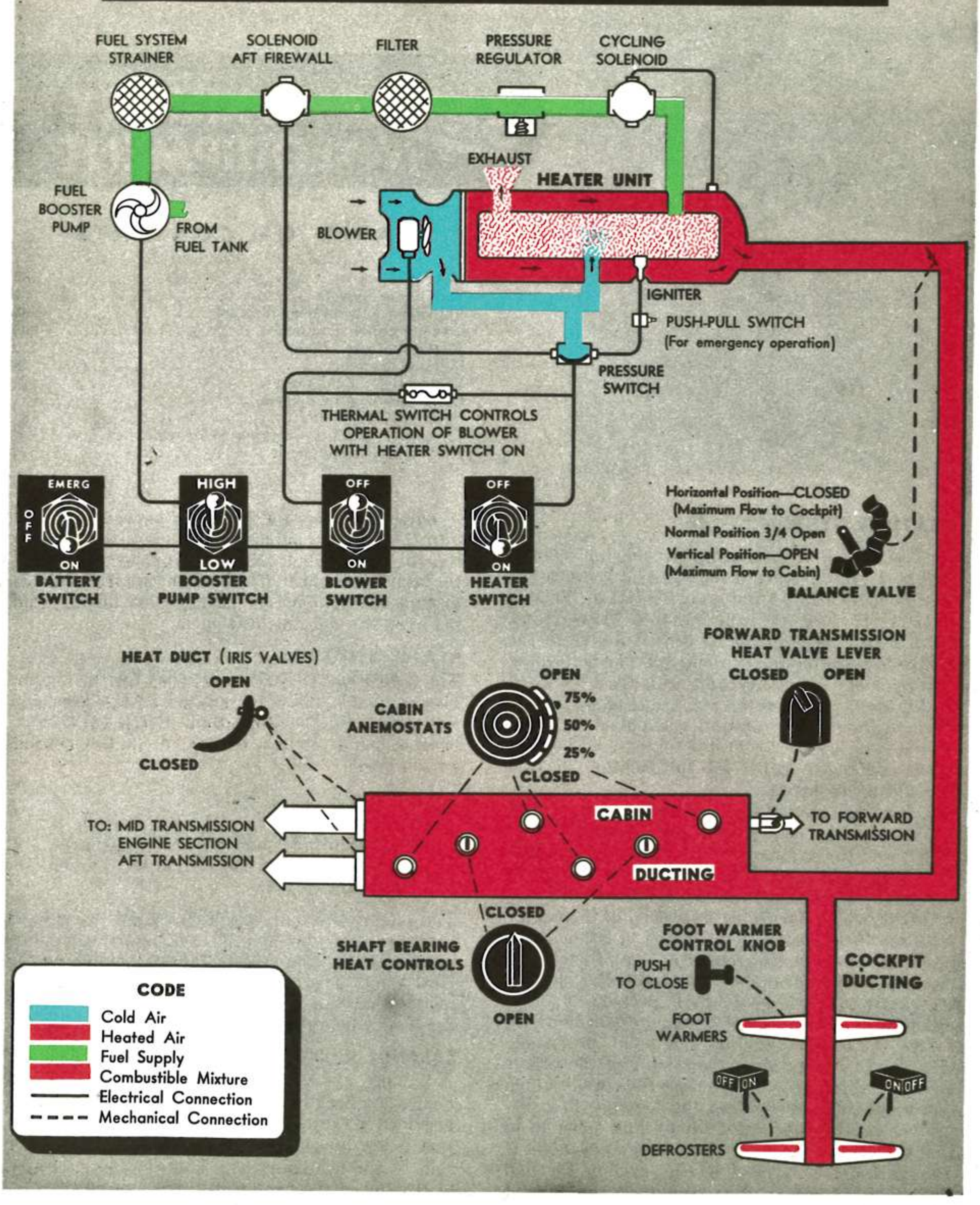


Figure 4-1. (Sheet 1 of 2)

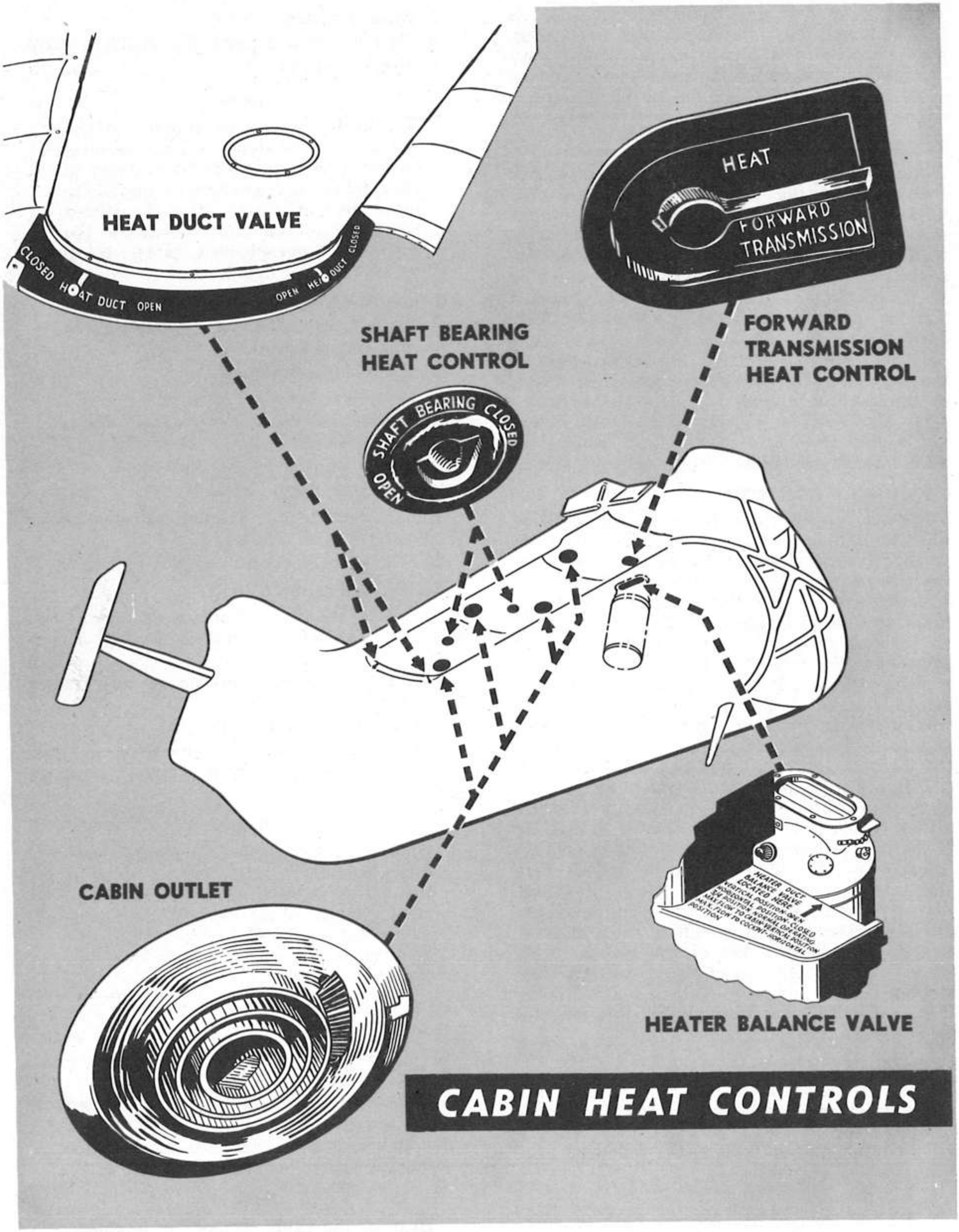


Figure 4-1. (Sheet 2 of 2)

the top of the fairing surrounding the heater. As will be noted, the 3/4-open position provides the optimum flow to both the cockpit and the cabin, the vertical position of the valve provides maximum flow to the cabin, and the horizontal position of the valve provides maximum flow to the cockpit.

COCKPIT HEAT CONTROLS.

Ducts lead from the heater to the pilots' foot warmers and the windshield defrosters. The amount of heated air required for the foot warmers is metered through two anemostats (controllable air outlets). The PUSH-PULL manual control lever for the foot warmers is located on the co-pilot's side of the console. Full forward position closes the foot warmer outlet and full aft opens it. The lever may be positioned at any intermediate point. When closed, the entire output of the cockpit heat is sent to the defrosters where, by opening the defroster control knobs (figure 4-1), anti-icing or de-icing of the pilot's clear vision glass panel and the co-pilot's transparent plastic panel may be accomplished.

CABIN HEAT CONTROLS.

Ducts also go rearward, from the heater, along the cabin ceiling for cabin heating. The ducts also provide heat for the transmissions, two drive shaft bearings, and the engine compartment in order to preheat the engine prior to starting. Refer to Ground Heating for Engine in Section IX. Several types of controls (figure 4-1) are provided in the ducting to distribute heat to components of the helicopter. These controls are manually operated. To direct heat to the forward transmission, a 2-position, OPEN-CLOSED, valve (figure 4-1) is located on the forward end of the ducting, left side. A 2-position, CLOSED-OPEN, valve (figure 4-1) is located below each of the two shaft bearings in the cabin. Two iris valves (figure 4-1) limit the flow of heated air to the mid transmission, engine section, and aft transmission. In addition, the cabin has four anemostats (controllable air outlets) at evenly spaced intervals in the overhead ducting. These can be operated by the passengers. The anemostat controls (figure 4-1) are of the manual type, located on the outer edge of the air outlets. They are marked to indicate CLOSED, 25%, 50%, 75%, and OPEN positions. Refer to figure 4-2 for heated air flow in flight.

NORMAL OPERATION—HEATER.

In order to ascertain that there is sufficient air pressure (especially in flight) to actuate the air-actuated pressure switch which controls ignition and fuel flow for the heater, the following procedure is recommended:

1. Balance valve: CLOSED.
2. Foot warmer control lever: Push to close.
3. Defroster controls: OFF.
4. Battery switch: BAT.
5. Fuel booster pump switch: HIGH or LOW.
6. Heater switch: ON.

Note

The heater should be turned off five minutes before stopping the helicopter engine. However, the fuel remaining in the combustion chamber will continue to burn until exhausted after the heater has been turned off, eliminating the danger of uncontrolled fumes being present in the helicopter.

NORMAL OPERATION—HEATING SYSTEM.

Four basic heat flow variations may be obtained from this system as follows:

1. Maximum cockpit heat.
2. Defroster operation.
3. Desired heat level for both cockpit and cabin.
4. Maximum cabin heat.

MAXIMUM COCKPIT HEAT (FOOT WARMERS).

1. Heater controls: Position as noted under Normal Operation—Heater.
2. Foot warmer control lever: Pull to open.

DEFROSTER OPERATION.

MAXIMUM HEAT. To obtain maximum heat flow from the defroster outlets, proceed as follows:

1. Heater controls: Position as noted under Normal Operation—Heater.
2. Defroster control levers: ON.
3. Foot warmer control lever: Push to close.
4. Balance valve: CLOSED. (Horizontal position.)

Note

Since heat flow from the defroster outlets while other heating system controls are OPEN is lessened considerably, the pilot should adjust cockpit heat and cabin heat as required under this condition to obtain sufficient flow for defroster operation.

CABIN AND COCKPIT HEAT.

1. Heater controls: Position as noted under Normal Operation—Heater.
2. Defroster control levers: OFF.
3. Foot warmer control lever: Pull to desired position.
4. Cabin heat anemostat outlets: Position as required for desired heat flow.

Note

Heat in the cabin cannot be obtained unless the anemostats (adjustable cabin heat outlets) are open. Hot air from the heater will then be forced through these louvers.

5. Balance valve: Move to 3/4 OPEN or adjust to obtain desired heat level in both cabin and cockpit.

6. Shaft bearing heat controls: CLOSED.

7. Forward transmission heat control: CLOSED.

8. Heat duct valves (in aft part of cabin): CLOSED.

MAXIMUM CABIN HEAT.

1. Heater controls: Position as noted under Normal Operation—Heater.

2. Foot warmer control lever: Push to close.

3. Defroster control levers: OFF.

4. Balance valve: OPENED. (Vertical position.)

5. Cabin heat anemostat outlets: OPENED.

6. Shaft bearing heat controls: CLOSED.

7. Forward transmission heat control: CLOSED.

8. Heat duct valves (in aft part of cabin): CLOSED.

EMERGENCY OPERATION.

The heater ignition unit has a reserve set of vibrator contacts for use in case the main contacts burn out or become fouled. The spare contacts can be put in operation by pulling out the push-pull switch on the bottom of the ignition unit.

VENTILATING SYSTEM.

The blower may be used for circulation of air throughout the cockpit and cabin when outside air temperatures are high. Air from beneath the cabin floor is forced through the ducting and out the anemostats to provide the desired circulation. No cooling of air occurs in this process. Snap vents in the cabin windows may be opened and set to permit the entrance of outside air as desired.

BLOWER CONTROL SWITCH.

A 2-position, ON-OFF, blower switch is located on the overhead switch panel (figure 1-10).

NORMAL OPERATION

1. Blower switch: ON.
2. Heater switch: OFF.

ANTI-ICING AND DE-ICING SYSTEMS.

PITOT HEAT.

To prevent ice accumulation in the pitot tube, locted on the underside of the fuselage, a heating element is provided in the pitot head. Electricity (d-c) is supplied to the heating element

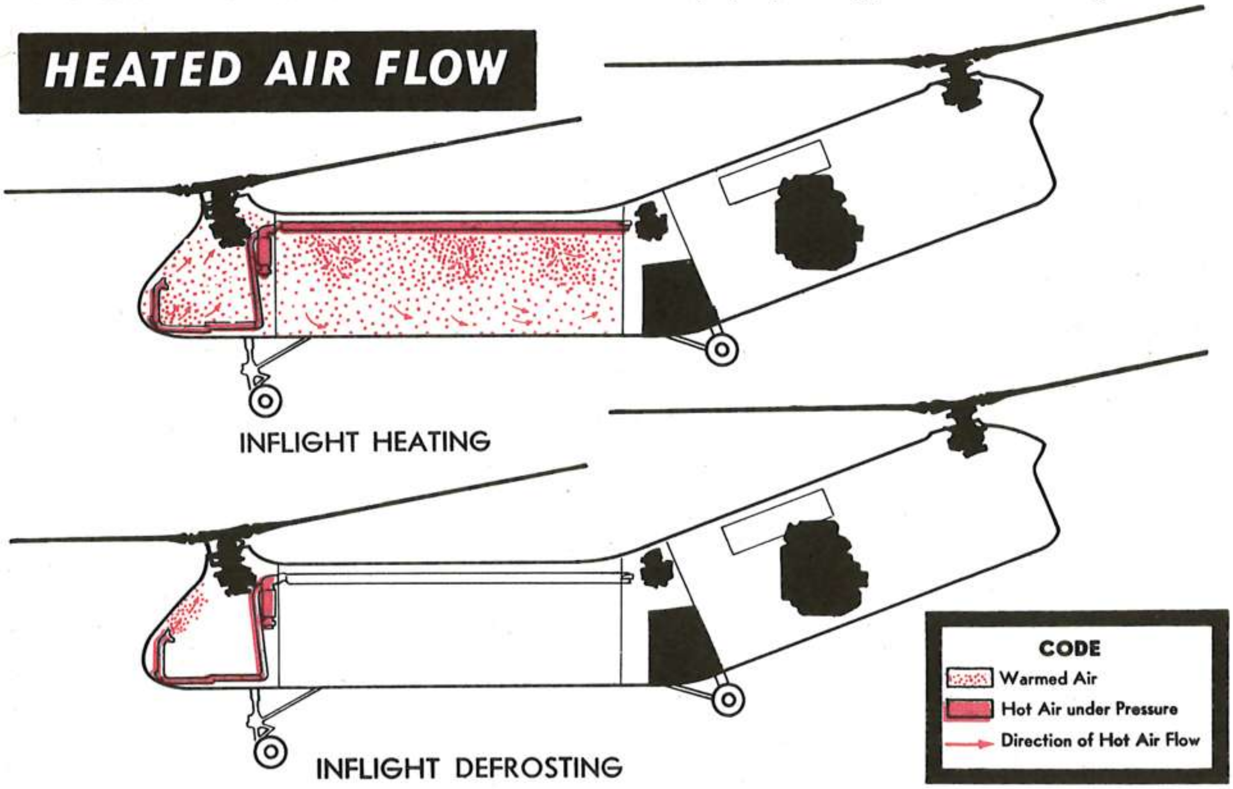


Figure 4-2

when the battery switch and pitot switch are placed ON.

WARNING

Do not operate for more than five minutes on the ground.

COMMUNICATION EQUIPMENT.

The communication equipment (figure 4-3) consists of radio and interphone systems to provide communication between the helicopter and ground stations, between the helicopter and other aircraft, reception of automatic direction finder bearings, automatic homing bearings, and interphone communication between members of the

COMMUNICATION EQUIPMENT

Type	Designation	Function	Operator	Range	Location of Controls
Interphone	USAF Combat Interphone	Intercommunication Between Crewmembers	Pilot Co-Pilot Crew	Between Crewmembers	Console Hoist Station Litter Station
LF Receiver	AN/ARN-6	Automatic Radio Direction Finding	Pilot	50 to 100 miles for range signals 100 to 250 miles for broadcast signals	Overhead Switch Panel
VHF Receiver	AN/ARN-14	Reception of Radio Aids to Navigation	Pilot Co-Pilot	30 miles at 1000 feet 135 miles at 10,000 feet	Lower part of Console
VHF Command	AN/ARC-3	Two-way Voice Communication	Pilot Co-Pilot	30 miles at 1000 feet 135 miles at 10,000 feet	Lower part of Console
UHF Command	AN/ARC-27	Two-way Voice Communication	Pilot Co-Pilot	30 miles at 1000 feet 135 miles at 10,000 feet	Lower part of Console
Homing Adapter	AN/ARA-8A	Radio Navigation and Homing	Pilot Co-Pilot	30 miles at 1000 feet 135 miles at 10,000 feet	Lower part of Console
Keyer	AN/ARA-26	Emergency Keying Adapter	Pilot Co-Pilot	30 miles at 1000 feet 135 miles at 10,000 feet	Overhead Switch Panel

Notes: The communication range in miles of the VHF and UHF equipment depends on many factors. It can be estimated as approximately 1.5 $\sqrt{H}$, where H = Altitude in feet.

Due to the fact that the electronic equipment can be interchanged in field operation, depending upon use of the helicopter, no attempt is made to note the effectivity of installation.

Figure 4-3

crew of the helicopter. Antennas for these units are located as shown in figure 4-4. The equipment listed in figure 4-3 is available in four different combinations depending upon the mission of the helicopter. The various radio controls are located in the cockpit. The transmitters, receivers and amplifiers are located at the forward cabin bulkhead on the left side. Headset and microphone jack boxes are located at the pilot's, co-pilot's, rescue hoist operator's station, and litter attendant's station. A functional breakdown of the radio equipment is given in the following paragraphs.

USAF COMBAT INTERPHONE.

This system is conventional and provides for interphone communication between pilots and crewmembers. The system is started when the battery switch is placed ON. The amplifier switch will normally be safety wired ON.

There are junction boxes on the bulkhead behind the pilot and co-pilot for plugging in the headset jacks. The rescue station and litter station have junction boxes for similar use by the crewmembers for intercommunication only.

SELECTOR SWITCH—COCKPIT.

This switch (figure 4-5) located on the console, allows use of this equipment as follows:

1. INTER: Interphone communication between crewmembers.
2. RADIO: Transmission and reception by means of the AN/ARC-27 or AN/ARC-3.
3. NAV RECEIVER: Reception of navigation facilities by means of the AN/ARN-6 or the AN/ARN-14. The volume control enables the pilot and co-pilot to adjust the signals from the above facilities to the proper level of headset volume. There is an ICS-RADIO trigger switch on each of the pilots' cyclic sticks marked RADIO and INTERPHONE.

SELECTOR SWITCH—CABIN.

A 3-position MIKE (microphone) ON, MOM (momentary) ON-OFF switch (figure 4-6) is located on the hoist operator's panel. The litter attendant's panel (figure 4-6) is equipped with a 3-position NORMAL—HOT—INTERPHONE—CALL switch.

INTERPHONE CONTROLS.

Volume to and from all helicopter stations is controlled by the control knob marked VOLUME (figure 4-5) on the interphone control panel.

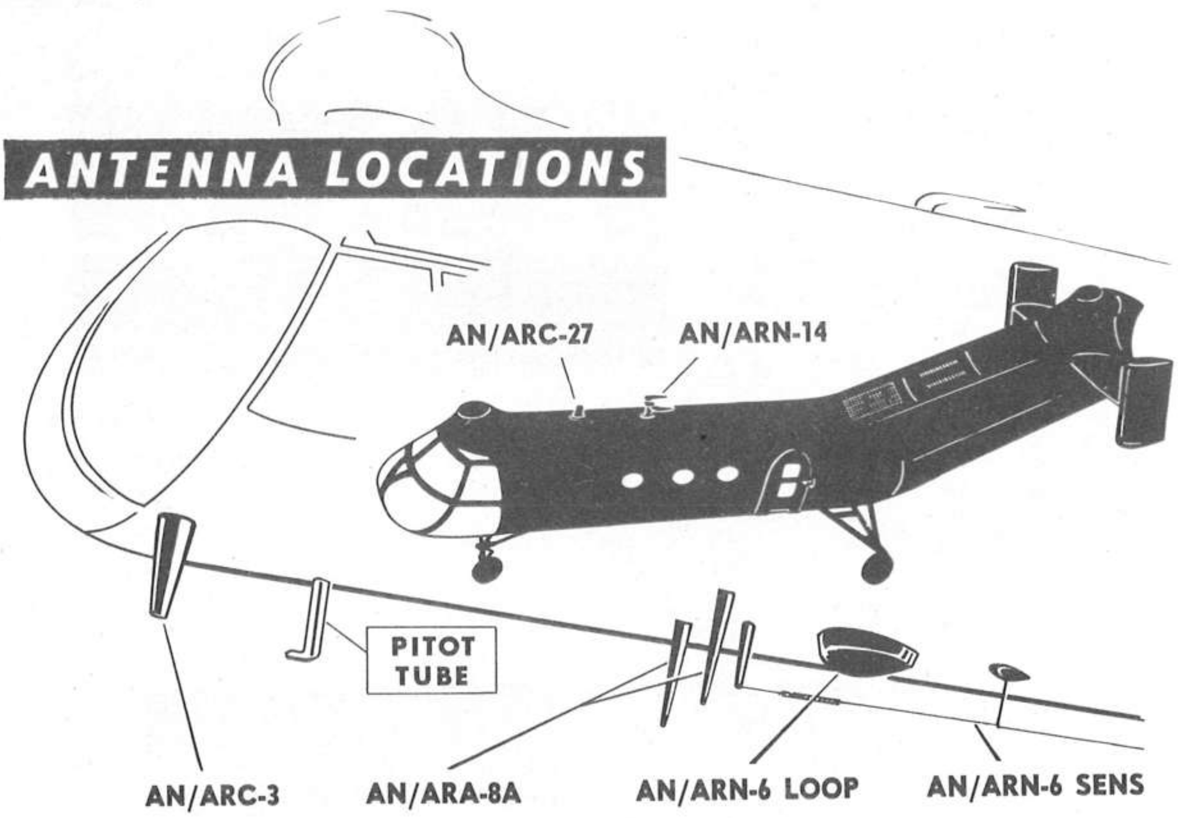


Figure 4-4

NORMAL OPERATION—COCKPIT.

1. Battery switch: BAT.
2. Selector switch: Desired position.
3. Trigger switch: Press to first detent to transmit, release to receive.

Note

The trigger switch (figure 4-7) is held at the first detent for interphone operation and is positioned at the second detent for transmitting on the AN/ARC-3 or AN/ARC-27 radio units.

NORMAL OPERATION—CABIN.

RESCUE HOIST OPERATOR. Proceed as follows:

1. Selector switch: OFF (for receiving).
   a. Press pickle switch to transmit.
2. Selector switch: MON ON (for transmission of urgent messages—will interrupt other transmission).
3. Selector switch: MIKE ON (for hands free operation).

LITTER ATTENDANT. Reception or transmission of messages can be accomplished as follows:

1. Selector switch: NORMAL (for receiving).
   a. Press pickle switch to transmit.
2. Selector switch: CALL (for transmission of urgent messages—will interrupt other transmission).
3. Selector switch: HOT INTERPHONE (for hands free operation).

Note

The MOM ON and CALL positions are momentary contacts, and the switch will return to the center position when released. The switch must be returned manually to the center position from the MIKE ON or HOT INTERPHONE positions.

AN/ARN-6 RADIO COMPASS.

The radio compass (figure 4-8) is an airborne automatic direction finder capable of providing automatic visual bearing and simultaneous aural reception of the direction of a modulated or unmodulated radio frequency signal. The frequency range, covered in four bands, is from 100–1750 kilocycles.

SWITCHES AND CONTROLS.

The control box, located on the overhead instrument panel, contains all the controls necessary

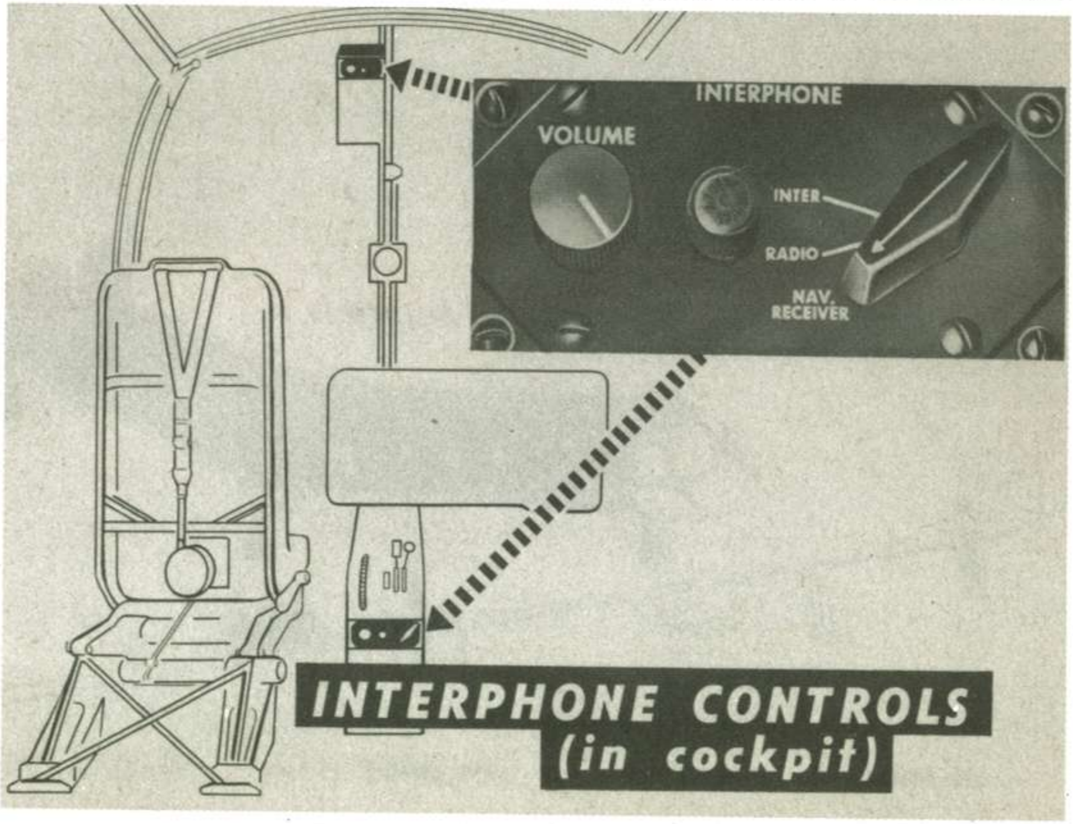


Figure 4-5

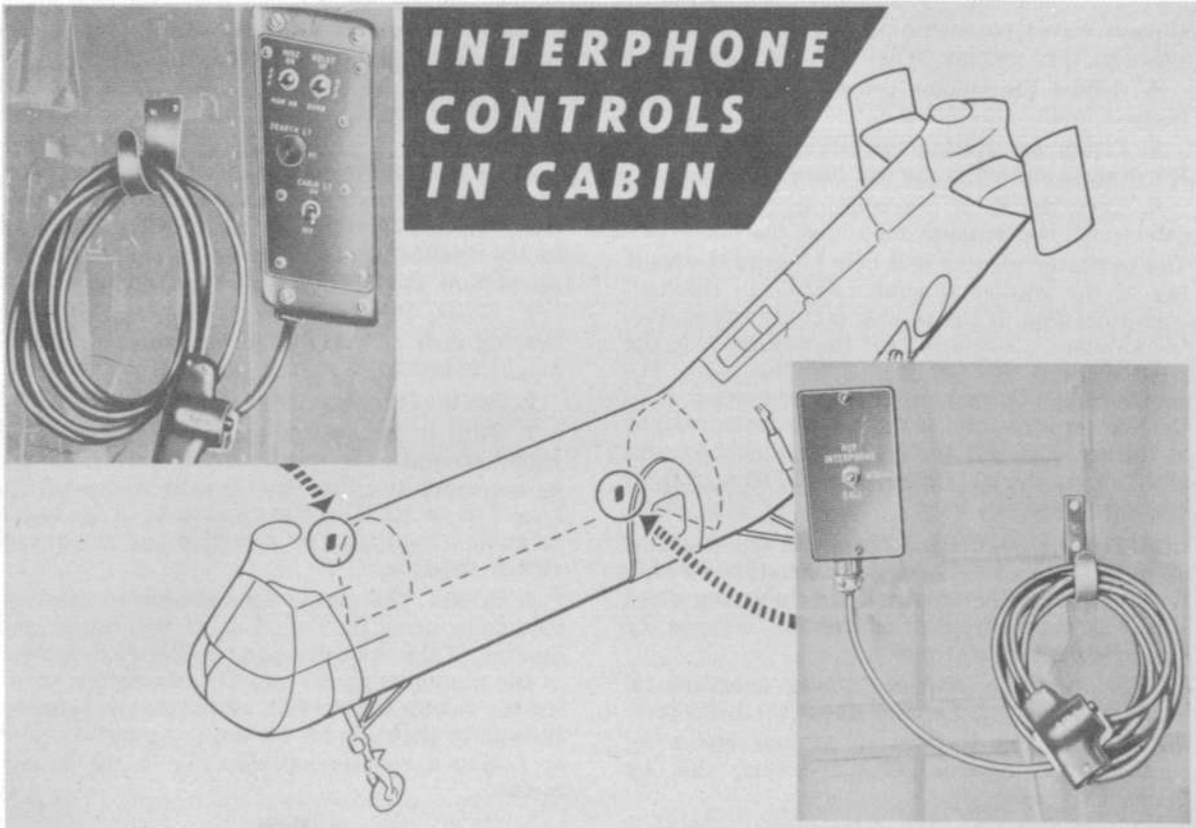


Figure 4-6

for the operation of the equipment. They are: function switch, antenna tuning meter, LOOP L-R switch, frequency selector switch, volume control, CW-Voice switch, light dimming switch, tuning crank, and spare lamp receptacles. Indirect lighting of the panel is provided by the use of recessed panel lights.

The purpose of the function switch is to turn the equipment on or off and permit the selection of one of the three methods of operation. The antenna tuning meter is used as a visual indication of the strength of the received signal. The Loop L-R switch is used when it is necessary to rotate the loop to the right or left. The frequency selector switch permits the selection of any one of the four available reception bands. The volume control adjusts for comfortable volume in the headsets. The light dimming switch connects or disconnects a resistor in the panel light circuit to change the brilliance of the lights. The function of the tuning crank is to permit the tuning in of a selected broadcasting station after the frequency selector switch has been turned to the proper band. The purpose of the CW-Voice switch is to permit the selection of reception of continuous wave signals or modulated signals (voice or tone). Greater accuracy in tuning may be obtained by placing this switch in the CW position. A 900-cycle tone will be heard in the headset along with the station modulation to aid in accurate tuning. After tuning, the switch is returned to VOICE to eliminate the 900-cycle tone. The equipment is placed in an operating condition by turning the function switch from the OFF position.

Note

> The CONT (control) position of the function switch does not apply to this installation. However, if the switch is placed in the CONT position, it must be returned to OFF before one of the three switch positions is selected.

NORMAL OPERATION.

HOMING COMPASS. To use the radio compass as a homing device, proceed as follows:

1. Turn the function selector switch to COMP (compass).

2. Rotate the band selector switch to the frequency band in which operation is desired.

3. Turn the tuning crank to the desired station and tune for maximum swing on the antenna tuning meter. (Greater accuracy may be obtained by placing the CW-Voice switch in the CW (con-

tinuous wave) position until the station has been tuned in, then placing switch in VOICE position.)

4. Adjust the volume control for comfortable headset level.

5. Listen for station identification to be sure the desired station is the one being received.

6. Turn the VAR (variable) knob on the indicator until the azimuth zero is at the index. The indicator pointer will now indicate the bearing of the station antenna relative to the helicopter heading. If the pointer is to the left of zero, the antenna is to the left; if the pointer is to the right of zero, the antenna is to the right. The course should be changed to the right or left until the pointer is at zero. If the pointer is maintained at the zero reading, the helicopter should eventually fly over the station antenna. To fly a straight line, compensation must be made for wind drift.

POSITION FINDING. There are two methods of position finding, automatic and aural-null. Before using either method, the following steps should be taken in order to shorten the time for a complete set of bearings:

1. Select three stations whose geographical locations are equally spaced about the helicopter.

2. Tune in the stations as outlined under the preceding paragraphs, identify them, and log their dial readings.

Automatic Method. The following procedure is recommended:

1. Adjust VAR knob on the indicator until its bearing scale at the index is the same as the magnetic heading.

2. Set the function switch to COMP.

3. Tune in the three selected stations as quickly as possible and record the bearings. The recorded bearings will be the station-to-helicopter bearings from north.

4. On a chart, project lines from the stations at the recorded bearings. The position of the helicopter should be within the small triangle formed by the intersection of the projected lines.

Aural-Null Method. Proceed as follows:

1. Adjust VAR knob on the indicator until its bearing scale at the index is the same as the true magnetic heading.

2. Set the function switch to LOOP.

3. Tune in the desired station. To obtain good signal strength for station identification, it may be necessary to rotate the loop by means of the Loop L-R switch. Direction and speed of the loop's rotation is controlled by direction and amount of switch rotation.

4. Rotate the loop for minimum headset volume by using the Loop L-R switch. Record the bearing of the indicator pointer. Better definition of the minimum signal may be obtained by turning the volume control fully clockwise and locating the null by listening for the minimum audio signal or noting a counterclockwise dip in the tuning meter.

Note

Position finding with function switch in LOOP position is subject to a 180-degree error since there are two null points. This condition may be overcome by

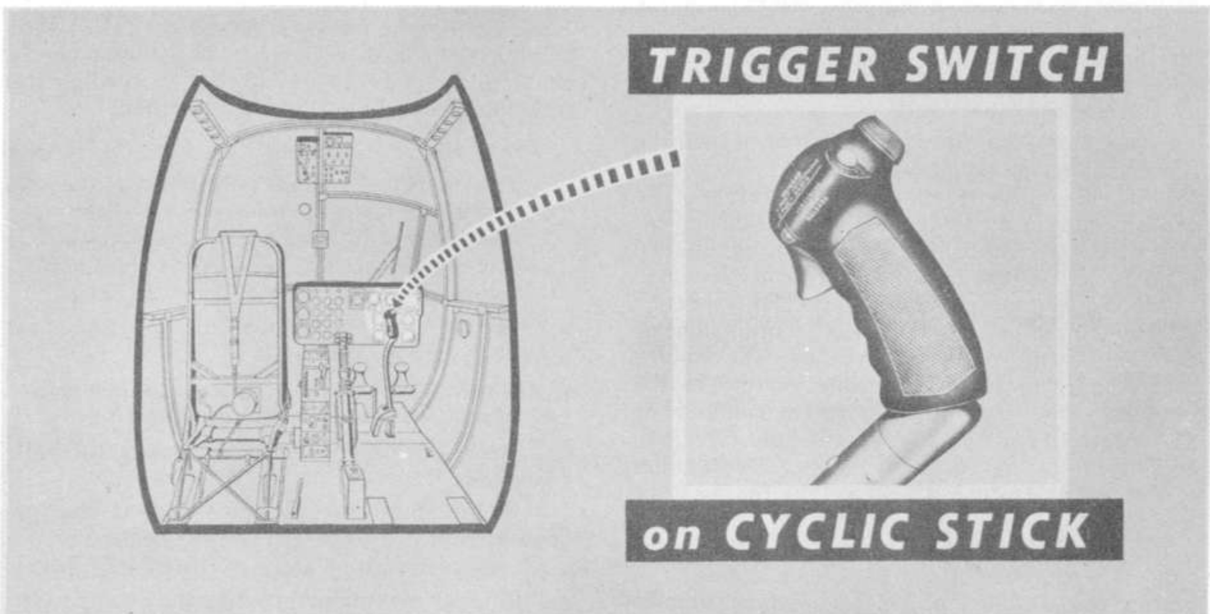


Figure 4-7

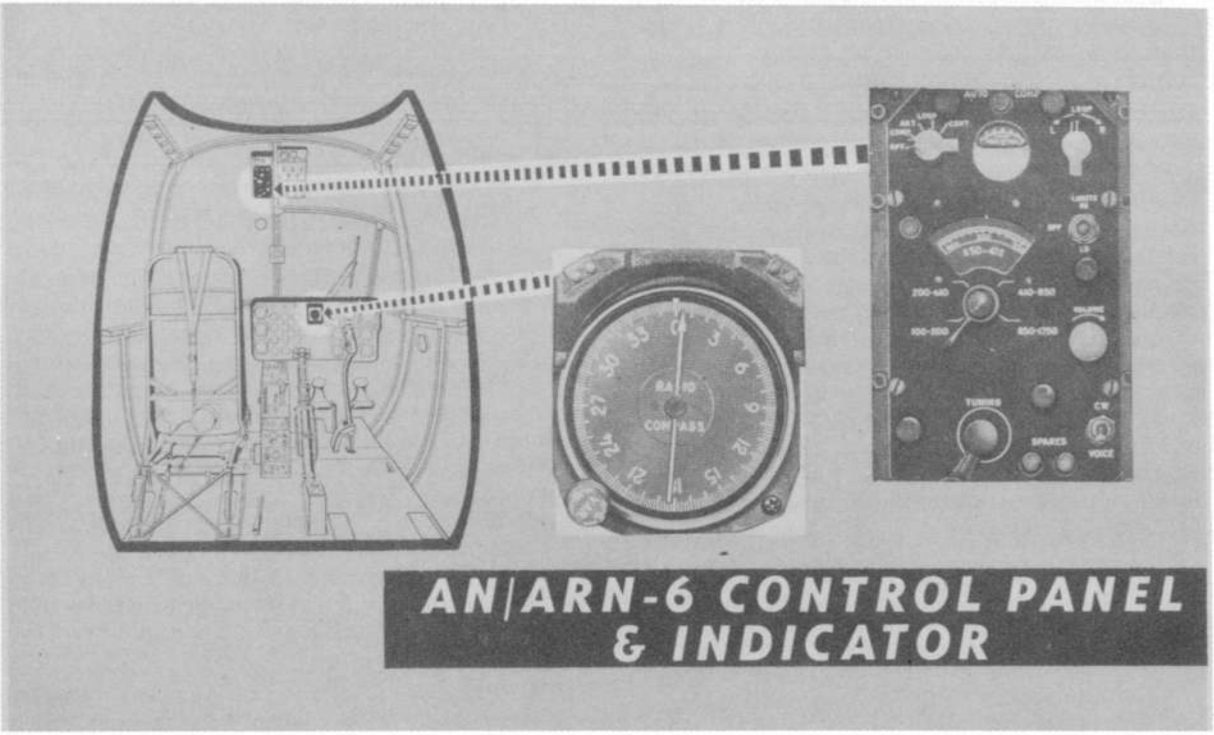


Figure 4-8

keeping aware of the general geographical location and selecting stations located well to the left or right of the course being flown.

RECEIVER OPERATION. The AN/ARN-6 may be used as a receiver.

Antenna Operation. Adjust switches and controls as follows:

1. Turn function selector switch to ANT position.
2. Turn frequency selector switch to desired frequency band.
3. Use the tuning crank to tune in desired station.
4. Adjust the volume control for desired headset volume. For best definition of radio range stations, adjust the volume control for the lowest usable volume and continue to reduce volume as the A-N signals increase in strength.

Loop Reception. If reception on ANT is noisy due to static, better results may be obtained by operating in LOOP position as follows:

1. Turn the function switch to LOOP position.
2. Turn the frequency selector switch to the desired frequency band.
3. Tune in desired station.
4. Adjust volume control for desired headset volume.
5. Rotate loop with Loop L-R switch until maximum signal is obtained.
6. For best definition of radio range A-N signals with function switch in LOOP, it is necessary to maintain the loop near the 90- or 270-degree position and adjust the volume control for lowest usable headset volume.

Note

Cone of silence indications are not always reliable with function switch in LOOP. In some cases, an increase instead of a decrease in signals may be noted. This is the result of certain types of radio range transmitting antennas and the loop location on the helicopter.

OPERATING PRECAUTIONS. It is recommended that the following be observed during operation of this equipment:

1. Select radio stations that provide stable bearings.
2. Use only a station for bearing that can be identified by headset signal with function switch in COMP position.
3. Use high powered, clear channel stations when possible.

4. Tune the receiver accurately.

5. Check station identification, especially stations broadcasting network programs.

6. Use at least three stations with bearings spaced at approximate equal intervals throughout the 360 degrees for greatest accuracy.

7. Always keep helicopter on a steady level heading while taking bearings.

Night effect or reflection of radio waves from the sky may be recognized by fluctuations in bearings. Night effect is worse at sunrise and sunset. The higher the frequency of operation, the greater the night effect. It may be present at distances over 20 miles when receiving 850–1750 kilocycle stations; however, with 100–450 kilocycle stations, reliable bearings above 200 miles can be taken even when night effect is present. To remedy night effect increase altitude, thereby increasing signal strength of direct wave, and use stations operating on lower frequencies.

AN/ARN-14 VHF NAVIGATION SYSTEM.

Note

All AN/ARN-14 equipment has been removed from the helicopters; however, the electrical wiring for this equipment will remain installed.

The AN/ARN-14 navigation system (figure 4-9) is a radio receiving system which provides all the radio navigational aids now available in the VHF range of 108–135 megacycles.

CONTROLS.

All the controls which are necessary for the operation of the AN/ARN-14 are located on the control panel and consist of an ON-OFF switch, volume control knob, frequency selector knobs (whole frequency, large outer knob, and tenth megacycle frequency, small inner knob) and a frequency indicator. The frequency indicator consists of a window through which the selected frequency appears. Frequency bands and types of service are shown below.

Tone Localizer (Runway Location)	108.0–111.9 mc
VHF Visual-Aural Range (Airway Location)	108.3–110.3 mc
Weather Broadcasts	111.0–111.9 mc
Omni-Directional Range (Radial Location)	112.0–117.9 mc
Tower Communications	118.0–121.9 mc
General Communications	122.0–135.9 mc

NORMAL OPERATION.

FREQUENCY SELECTION. The desired frequency is selected as follows:

Note

Since all frequencies covered by this equipment have the numeral 1 as their first digit, this number is fixed underneath FREQ in the window.

1. Rotate the whole megacycle selector knob on the control panel until the second two digits of the desired frequency appear on the frequency indicator.

2. Rotate the tenth megacycle selector knob until the last digit of the desired frequency appears on the frequency indicator.

Effective Receiving Range. Signals within the frequency range covered by this equipment travel in straight lines, and reception is primarily governed by the unobstructed line-of-sight distance of the receiver from the transmitting antenna. In order for the effective receiving range of each service to be fully utilized, the altitude must be sufficiently high so that the straight line distance between the helicopter and the transmitting antenna is not interrupted by the horizon. The maximum effective receiving range for tone localizer service is approximately 20 miles, for omnidirectional service approximately 175 miles, and for vhf visual-aural service approximately 150 miles.

COURSE SELECTOR. The course selector (figure 4-9) is, primarily, an instrument by which the pilot may observe visually the lateral positional deviation from a selected course. The indicator provides facilities for use on all three navigational services covered by the equipment. It consists of a radial selector Set knob (figure 4-9) course marker, to-from indicator, vertical pointer, horizontal pointer, relative heading pointer, flag alarms, and marker beacon indicator.

Note

The marker beacon indicator, horizontal pointer, and horizontal flag alarm require additional receivers which are not part of the installation.

TONE LOCALIZER SERVICE. This runway locating service identifies the right or left position of the helicopter with respect to the runway when a normal approach is being made. The procedure for operating the equipment for this service is as follows:

1. Select the tone localizer station frequency as previously outlined under Frequency Selection. Reception of a tone localizer signal of usable strength is detected aurally in the headset and visually by means of the movement of the vertical pointer on the course indicator and by the disappearance of the vertical flag alarm. Identification of the station is obtained from the aural signal which is an international Morse code two-or-three-letter group.

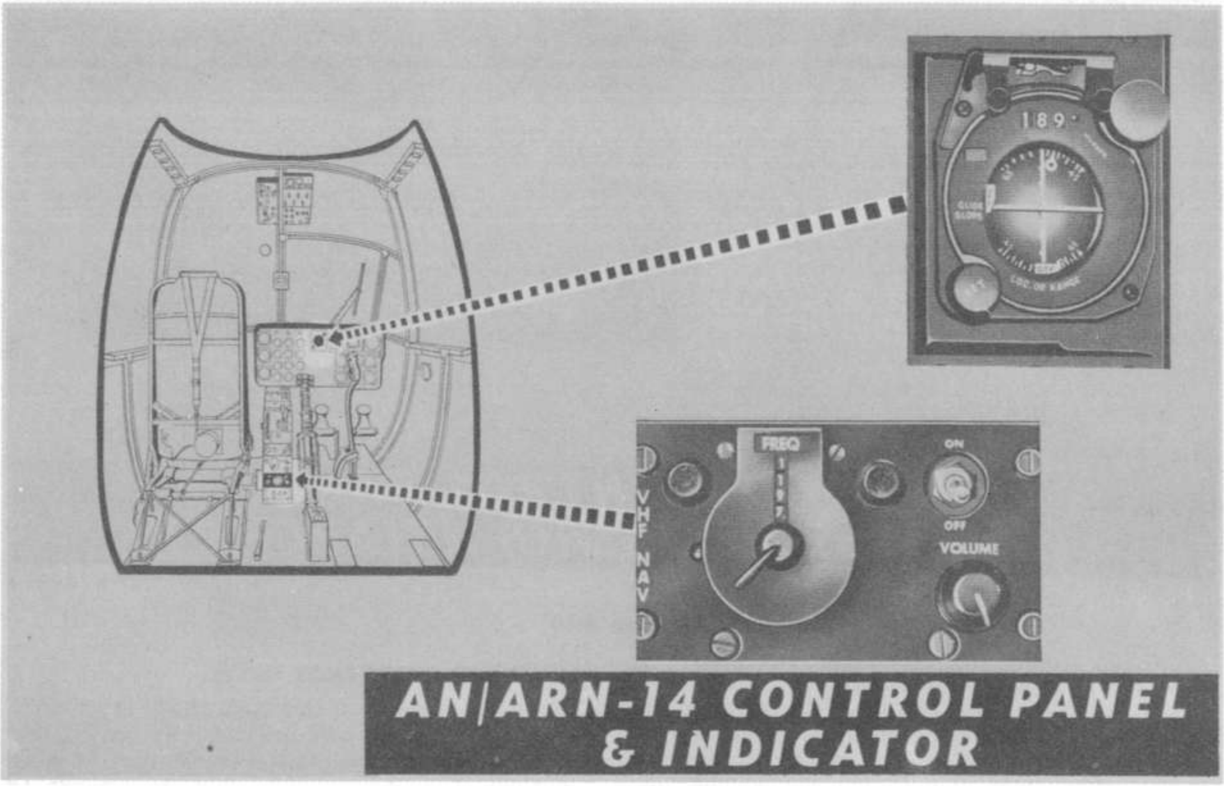


Figure 4-9

CAUTION

Make sure the vertical flag alarm has disappeared before using the vertical pointer indication.

2. Make a normal approach to the station as instructed by the Radio Facilities Chart.

3. Consider the helicopter in the center of the dial of the course indicator and fly toward the pointer when flying toward the final approach to the station.

VHF VISUAL-AURAL RANGE. This is an airway locater which gives the lateral location, with respect to a visual and aural course, of the helicopter flying within the range of the visual-aural station. The procedure for operating the equipment for the service is as follows:

1. Select the station frequency as previously outlined under Frequency Selection. Reception of the VAR signal is detected aurally on the headset and visually by means of the vertical pointer on the course indicator and by the disappearance of the vertical flag alarm. The aural signal is either the international Morse code letter A or N when off the course or a 1020 cycle per second steady tone when on course. The visual signal causes the vertical pointer to move to the right or left of the dial center when off course or to be in the center of the dial when on course.

2. Observe the position of the visual pointer and listen to the aural signals in the headset.

3. Fly toward the airway using the visual and aural information obtained.

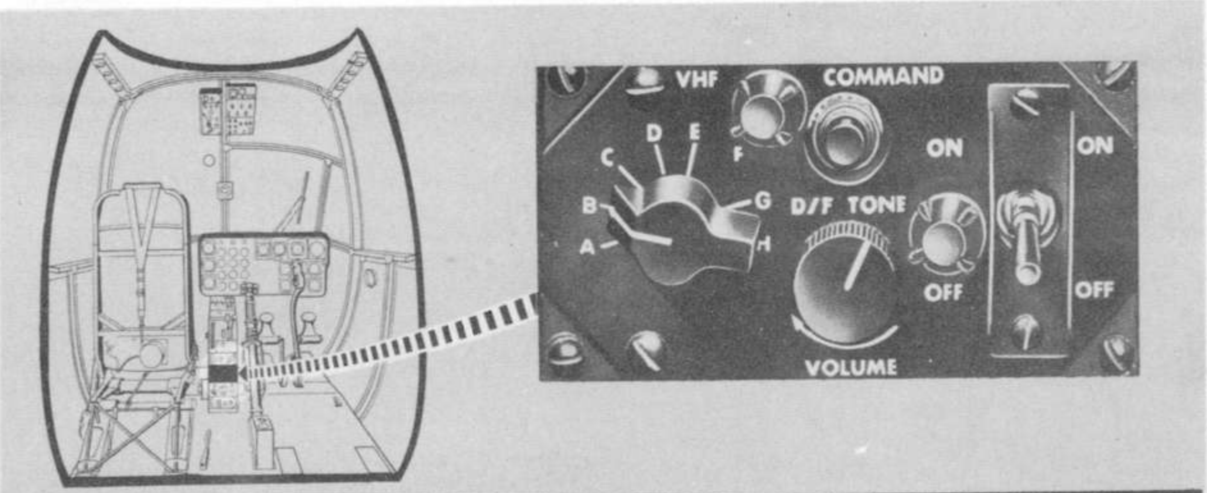
NON-NAVIGATIONAL COMMUNICATIONS. These services include general and tower communications, and weather broadcasts. The procedure for operating the equipment to receive these services is merely to select the proper receiving frequency as previously outlined under Frequency Selection. Reception of these services is by means of the headset only.

AN/ARC-3 VHF COMMAND TRANSMITTER AND RECEIVER.

The AN/ARC-3 is airborne transmitting and receiving equipment designed to provide radio communication between helicopters and/or between the helicopter and ground stations. The frequency range covered is 100–156 megacycles. The transmitter and receiver are tuned to eight pre-selected frequencies.

SWITCHES AND CONTROLS.

The control panel (figure 4-10) contains the necessary switches for the remote control of the



AN/ARC-3 CONTROL PANEL (interchangeable with AN/ARC-27)

Figure 4-10

radio equipment. On the left side of the panel is an 8-position rotary switch, lettered from A to H; in the center, a volume control and a DF/TONE push button; and on the right side, an ON-OFF toggle switch. The purpose of the DF/TONE push button is to permit the pilot to transmit tone modulated signals for stations to take direction finder bearings on the helicopter. Volume may be adjusted by use of the Volume Control on the interphone control panel or the control box.

NORMAL OPERATION.

To communicate by means of this equipment proceed as follows:

1. Turn ON-OFF switch on control panel ON and wait approximately one minute for the tubes in the transmitter and receiver to reach operating temperature.
2. Rotate selector switch to desired channel and wait a few seconds for channeling mechanism to select desired frequency.
3. Turn the switch on the interphone control panel to the RADIO position.
4. To transmit, press the RADIO-ICS switch on the cyclic control stick to the second detent.
5. To receive, release the RADIO-ICS switch and adjust volume for comfortable signal strength.

Note

The trigger switch is held at the first detent for interphone operation and is positioned at the second detent for transmitting on the AN/ARC-3 or AN/ARC-27 radio units.

AN/ARA-26 EMERGENCY KEYER.

The keyer, located on the radio shelf, is an electrical device which will automatically operate an airborne command or liaison transmitter in case of emergency.

SWITCHES AND CONTROLS.

A control panel (figure 4-11) is located on the lower right side of the overhead switch panel and contains a starting switch, an indicator lamp and a panel light. The starting switch is a double pole single throw, ON-OFF, toggle switch protected by a guard to prevent accidental starting of this equipment. The indicator lamp is the press-to-test type which also provides a means of checking to determine if power is available to the keyer.

NORMAL OPERATION.

The keyer is turned on by placing the ON-OFF switch in the ON position. After completion of the channeling cycle, it will transmit signals in the following sequence:

1. S O S three times.
2. Last four digits of the helicopter's serial number three times.
3. A series of four-second dashes spaced one second apart, for bearings, six times.

It will continue to repeat the above signals until the ON-OFF switch is placed in the OFF position. Should the ON-OFF switch be placed in the OFF position after the keyer has been operating, the transmitter will rechannel to its original position and the keyer will continue to operate without sending out any signals until it returns to the beginning of the sequence.

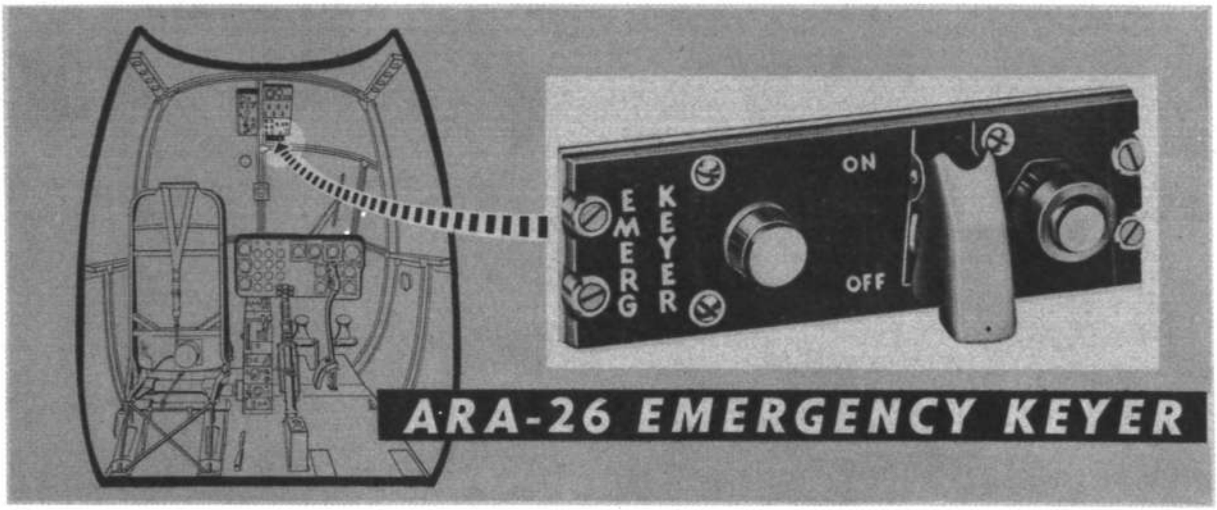


Figure 4-11

CAUTION

When the keyer is turned off, always close the red switch guard over the switch. This prevents accidental tripping of the keyer ON-OFF switch.

AN/ARC-27 UHF TRANSMITTER-RECEIVER.

The AN/ARC-27 is a transmitter-receiver unit designed for communication between helicopters and/or ground stations in the frequency range of 225–399.9 megacycles. The equipment provides 1750 frequency channels in the above range. Provisions are included for the remote selection of any one of 18 preset frequencies or operation on a guard frequency. The transmitter may be tone modulated at 1020 cycles per second for emergency or direction finder purposes. Transmission and reception are on the same frequency and by the same antenna. Any one of 1750 frequency channels may be selected by using the controls located on a radio shelf and any one of 18 preset channels or the guard channel may be selected by using the controls on the console.

SWITCHES AND CONTROLS.

All the controls (figure 4-12) required for the normal operation of the ARC-27 are located on the console with the exception of the TONE-VOICE switch. This switch is located on the control box on the radio shelf. The console control panel contains a 4-position function switch, a 19-position frequency selection switch, and a volume control. The 4-position function switch provides the following:

Switch Position	Function
OFF	Transmitter-Receiver and ADF OFF
T/R + G REC	Transmitter on STANDBY Main Receiver ON ADF on STANDBY Guard Receiver ON
T/R	Transmitter on STANDBY Main Receiver ON ADF on STANDBY
ADF	Transmitter on STANDBY Guard Receiver on STANDBY Main Receiver ON ADF ON

The 19-position switch permits the selection of the (G) guard frequency or any one of the 18 preset frequencies. The volume control permits the headsets to be adjusted for comfortable signal level.

NORMAL OPERATION.

The recommended procedure is as follows:

1. Function switch: Turn from OFF position to method of operation desired.
2. Selector switch: Rotate to (G) or any of the 18 preset frequencies.
3. Volume control: Adjust to proper headset level.
4. Trigger switch: Press to second detent to transmit; release to receive.

AN/ARA-8A HOMING ADAPTER.

The AN/ARA-8A homing adapter is a unit which is used in conjunction with a vhf receiver to provide the pilot with a means to home on any transmitter carrier within the frequency range of 120–140 megacycles.

SWITCHES AND CONTROLS.

The control panel (figure 4-13) located on the console, contains a HOMING-COMM-TRANS

Figure 4-12

switch and a CW-MCW switch. In HOMING position, it is possible to home on any modulated (switch in MCW position) or unmodulated (switch in CW position) radio frequency signal within the range of the adapter. When the switch is placed in TRANS position, the vhf transmitter, is used in conjunction with the adapter, is turned on continuously without the necessity of holding in the push-to-talk switch on the cyclic stick.

NORMAL OPERATION.

In order to use the adapter for homing, select the proper channel of the vhf equipment and place the switch in HOMING position. If the station being received is transmitting an unmodulated signal, place the CW-MCW switch in the CW position. If the signal being received is tone modulated or audio-pulse rate modulated, place the switch in the MCW position. These steps place the equipment in operation and ready for use.

Homing by means of this equipment is accomplished by properly interpreting the signals received on the vhf receiver with the homing adapter in operation as outlined above. Indication in the headset will consist of a repetition of one of the Morse code characters D(— • •) or U(• • —) or a relatively continuous audio tone. If the tone is steady, it will indicate to the pilot that he is heading directly toward the station or that he is heading directly away from the station.

Figure 4-13

This 180-degree difference can be resolved as follows:

1. If the code character U (• • —) predominates in the headset, always turn right until the region of steady tone is reached.

2. If the code character D (— • •) predominates in the headset, always turn left until the region of steady tone is reached.

3. In both the above cases, the helicopter will be headed directly toward the transmitting station.

4. Continue to follow steps 1. and 2. and attempt to fly the path of continuous tone to the transmitting station.

If it becomes necessary or desirable to have ground stations take a bearing on the helicopter, proceed as follows:

1. Contact the desired stations by normal radio communications and request they take bearings. Use at least three stations if possible.

2. Place function switch in TRANS position. The transmitter will send out a signal as long as the switch is in this position.

3. After sufficient time has elapsed for the stations to take bearings, return the switch to COMM position.

4. Contact the radio stations and request bearings.

5. Plot the bearings on a chart. The projected lines should form a small triangle. The position of the helicopter will be approximately in the center of the triangle.

OPERATING PRECAUTIONS. It is recommended that the following be observed during operation:

1. As the signal becomes louder indicating approach to the transmitting station, decrease the volume control and also decrease altitude if conditions permit.

2. In the immediate vicinity of the station, overloading of the receiver may cause serious distortion of the aural homing indication. If the helicopter should pass over the station without recognizing it, as soon as the heading changes from "on course", the character in the headset will indicate that a turn of 180 degrees is required in order to head back toward the station.

3. Homing on one station in the presence of another station is possible only if the desired station has a distinctive tone and is strong enough to override the undesired station.

4. Homing on one of two stations, both of which are unmodulated and of nearly equal signal strength, is not possible with this equipment.

5. Home on no frequency lower than 120 megacycles (120,000 kilocycles) or higher than 140 megacycles (140,000 kilocycles) as it will seriously affect the accurate functioning of the set.

EMERGENCY OPERATION OF COMMUNICATION EQUIPMENT.

There is no provision for emergency operation of the communication equipment. If there is a generator failure, place the generator switch in the OFF position and the battery switch in EMERG. This will disconnect all non-essential equipment. If a radio facility is desired, pull all unnecessary circuit breakers, place the battery switch in BAT position, and use radio as required.

AUXILIARY POWER PLANT.

A gasoline-powered generator, for auxiliary electrical power, is located on the cabin floor aft of the radio shelf. An extra long cable is provided so that it can be plugged into the external power receptacle. This auxiliary power unit is to be used only for starting and ground operation of equipment.

NORMAL OPERATION.

In order to start and operate the auxiliary power unit, proceed as follows:

1. Auxiliary power unit: Move to rescue door to properly exhaust fumes.

2. Auxiliary power plug: Connect to the external power receptacle.

3. Battery switch: ON.

4. Auxiliary power unit switch: START (Prime as necessary).

5. Battery switch: OFF (after APU is running).

6. Auxiliary power unit switch: RUN.

Note

The three-position, START-OFF-RUN, auxiliary power unit switch is located aft of the main entrance door.

LIGHTING SYSTEM.

EXTERIOR LIGHTS.

The exterior lights (figure 4-14) consist of the navigation lights and the landing lights. The navigation lights are: A red light on the left side of the fuselage, a green light on the right side of the fuselage, a yellow light on the tail, and two white lights, one on the top and one on the underside of the fuselage. On the bottom of the fuselage there is a fixed and a controllable landing light (search light).

NORMAL OPERATION.

The position lights switch (figure 4-15) is located on the overhead switch panel. A type C-2 flasher flashes the side and tail lights alternating

EXTERIOR LIGHTING

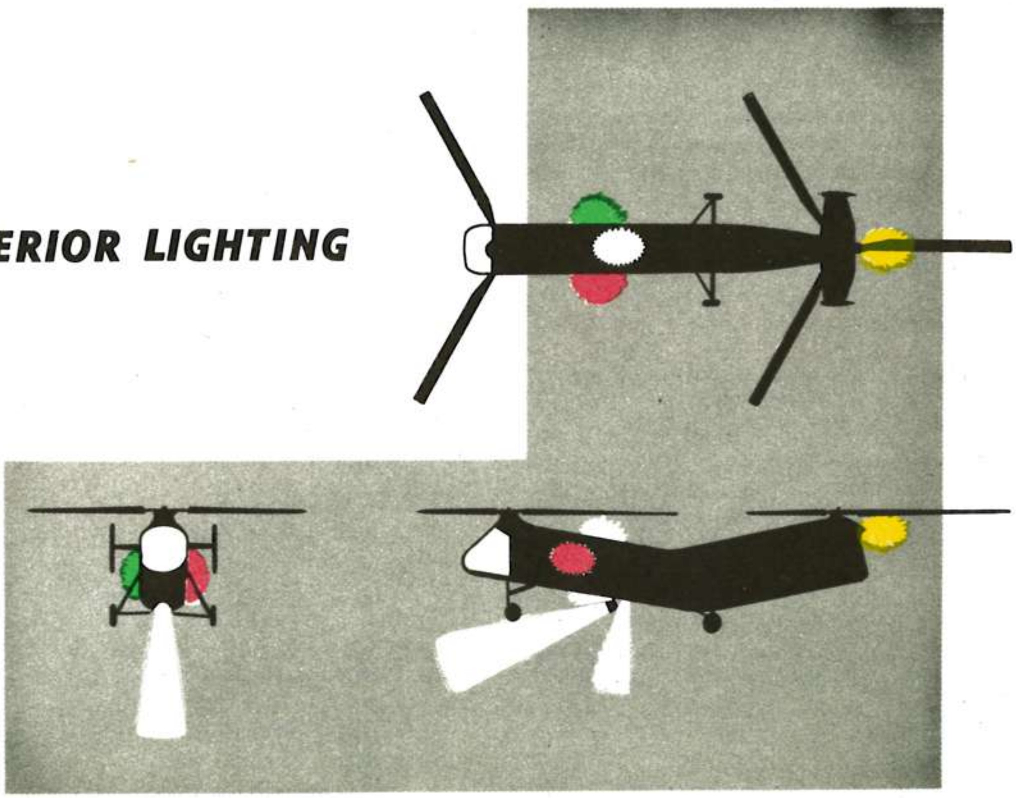
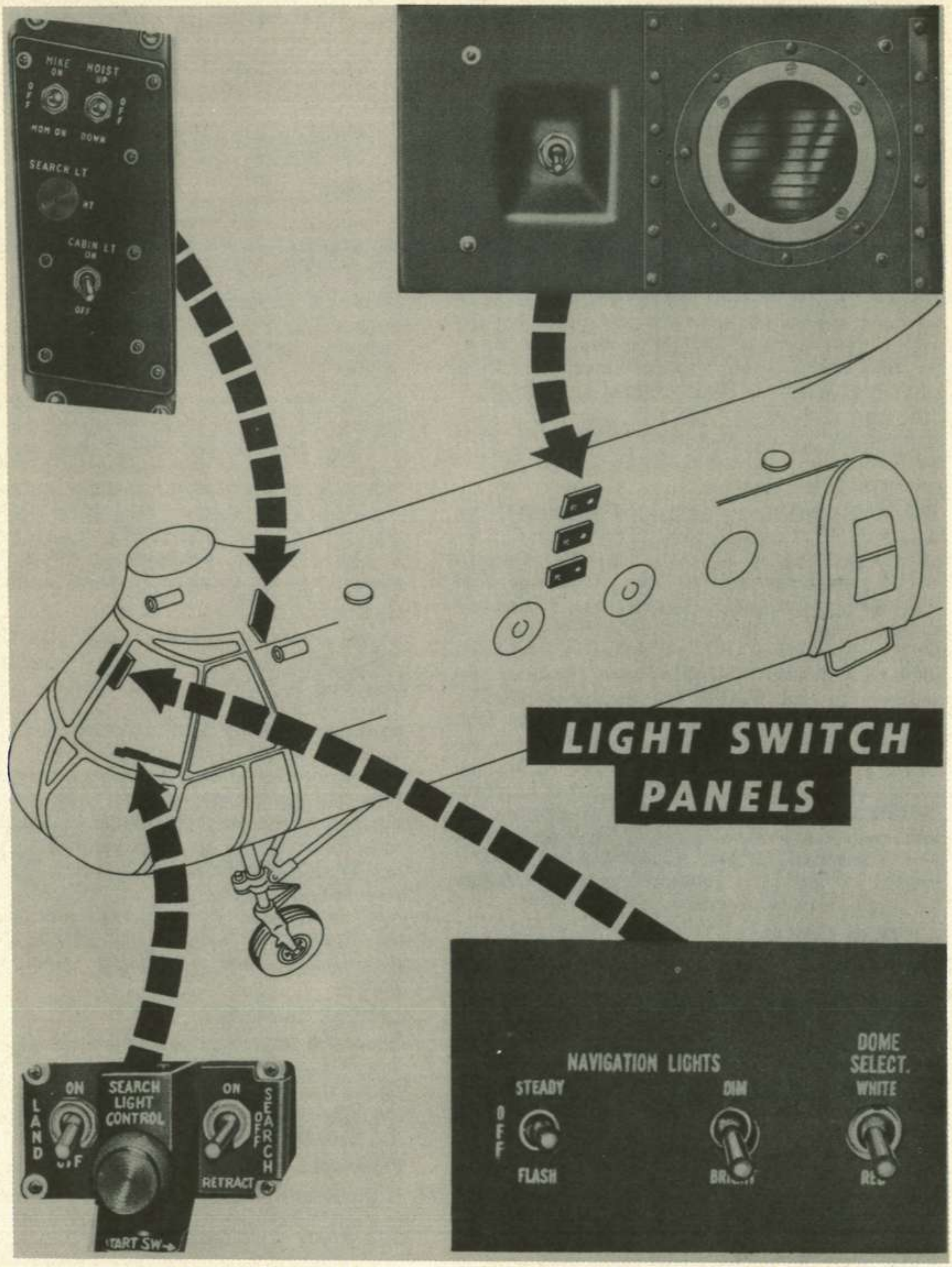


Figure 4-14

HOIST OPERATOR'S PANEL **LITTER LIGHT PANEL**



COLLECTIVE PITCH LEVER SWITCHES **OVERHEAD SWITCH PANEL**

Figure 4-15

with the white lights, with the switch in the FLASHER position. With the switch in the STEADY position, the navigation lights burn steadily.

LANDING LIGHT. The YH-21 and H-21A have an ON-OFF switch (figure 4-15) located on the collective pitch lever for turning the landing light on or off. This is a fixed light and shines straight down.

SEARCH LIGHT. The YH-21 has three switches (figure 4-15) for controlling the search light. Two are located on the collective pitch lever and the third on the hoist operator's switch panel. The toggle switch on the collective pitch lever is labeled ON-OFF and RETRACT. When this switch is turned off, the light will go out but the search light will not retract. By means of the 4-position Search Light Control switch, the light can be extended, retracted, rotated to the right or left, and stopped in any position. The 4-position switch on the hoist operator's switch panel duplicates the operation of the switch on the collective pitch lever.

The H-21A has four switches for controlling the search light. Two are located on the collective pitch lever (figure 4-15), one on the overhead switch panel (figure 1-10), and one on the hoist operator's switch panel (figure 4-15). The toggle switch on the collective pitch lever is labeled ON-OFF and RETRACT. This switch permits the pilot to turn the light off without changing the position of the light. The 4-position Search Light Control switch performs the same function previously described. The 2-position switch located in the overhead switch panel is labeled SEARCH LIGHT CONTROL PILOT-HOIST OPERATOR and permits the pilot to override the hoist operator in the control of the search light. The 4-position Search Light Control switch located on the hoist operator's panel performs the same function as previously described.

INTERIOR LIGHTS.

The cockpit lighting consists of the instrument panel lights, cockpit dome light, and two utility flood lights. The panel lights have individual shields, and the utility instrument flood lights serve as a secondary instrument lighting system. The cabin lighting system consists of two dome lights for the YH-21 helicopter and three for the H-21A.

COCKPIT LIGHTS AND SWITCHES.

The instrument panel lights, console lights, overhead switch panel lights and cockpit dome lights are controlled by rheostat type switches located in the overhead switch panel. (See figure 1-10.) The brightness of these lights may be increased by turning the switch pointer controlling the specific lighting circuit clockwise. The switch markings for these various circuits are as follows:

Switch Marking	Lights Operated
SHIELD	Flight instrument shield lights
FLOOD LIGHTS	Flight instrument and engine instrument bayonet lights
CONSOLE	Console lights
OVERHEAD	Overhead switch panel lights
DOME	Cockpit dome lights

A 2-position, RED-WHITE, selector switch in the overhead switch panel permits a choice of a red or white dome light by the pilot.

UTILITY LIGHTS.

Each utility light has a rheostat type ON-OFF switch as an integral part of its assembly. This switch, located on the aft part of the light, will regulate the intensity of the light from the OFF position to full power. A red button in the light housing, opposite the switch, may be used for flashing the light. The red plastic cover may be left on or removed from the main lens to produce the color light desired. The entire light can be removed from its mount and used as a hand light. A lock screw on the barrel of the light, when loosened, allows adjustment of the beam.

CABIN LIGHTS.

There are two cabin dome lights in the model YH-21 (figure 4-15). They are separately controlled by switches located beside each cabin door. The switch beside the main entrance door controls the aft dome light without the helicopter's electrical system being turned on. The switch beside the rescue door controls the forward dome light but cannot be operated without the main battery switch ON. The model H-21A has three dome lights in the cabin. The forward two lights are operated by the switch beside the rescue door with the main battery switch ON. The aft dome light is operated by the switch forward of the main entrance door and can be operated independently of the helicopter's main electrical system.

LITTER LIGHTS.

There are three blue lights for litter illumination located on the right side of the helicopter. Each light (figure 4-15) has a separate switch beside the light and can be operated independently of the helicopter's main electrical system.

EMERGENCY OPERATION.

If the generator fails and with the battery switch in the EMERG position, the utility lights, instrumen lights, warning lights, aft dome light, and litter lights will continue to function.

Since the aft dome light and the litter lights are connected directly to the battery, these are the

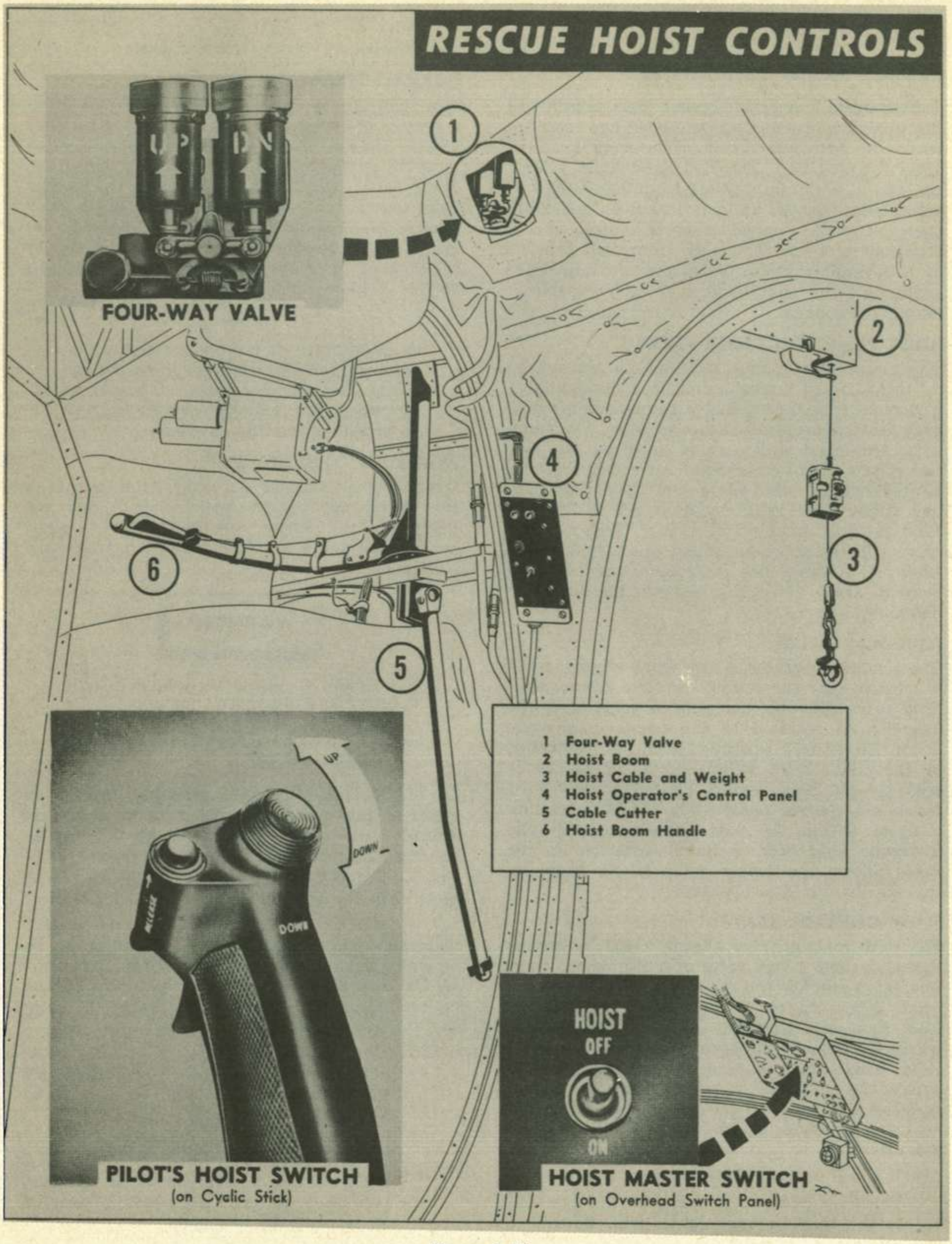

RESCUE HOIST CONTROLS
FOUR-WAY VALVE
UP
DN
1
2
3
4
5
6
1 Four-Way Valve
2 Hoist Boom
3 Hoist Cable and Weight
4 Hoist Operator's Control Panel
5 Cable Cutter
6 Hoist Boom Handle
UP
DOWN
PILOT'S HOIST SWITCH
(on Cyclic Stick)
HOIST
OFF
ON
HOIST MASTER SWITCH
(on Overhead Switch Panel)

Figure 4-16

only lights that can be turned on when all the cockpit switches are off.

RESCUE HOIST EQUIPMENT.

A hydraulically-operated rescue hoist is provided for raising and lowering personnel and material while the helicopter is in a hovering position. (See figure 4-16.) The hydraulic hoist system consists of a hydraulic pump mounted on the forward transmission, an electrically- or manually-operated 4-way valve, a relief valve, and a flow control valve. The hoist equipment consists of a reversible hydraulic motor, an adjustable swinging boom and 100 feet of cable capable of lifting 400 pounds.

HOIST PUMP AND RELIEF VALVE.

The rescue hoist pump, mounted on and driven by the forward transmission, is a constant displacement, constant delivery piston pump which provides a non-pulsating flow of fluid. The pump is not equipped with a relief valve but the system is protected by the relief valve (figure 1-13) located between the pump and the 4-way control valve. This relief valve is set to open at 1350 psi and provide full flow at 1500 psi. The valve will reseat when system pressure drops to 1200 psi. A drain line is provided on the pump body to drain the cavity between the mounting pad and the pump body.

FOUR-WAY VALVE.

The solenoid operated 4-way valve (figure 4-16) is located near the ceiling over the rescue door. This valve provides a means of controlling the direction of rotation of the rescue hoist cable drum. Electrically operated solenoids, controlled by the pilot's hoist switch located on the cyclic stick or the hoist switch located on the hoist operator's control panel (figure 4-16), position a spool within the valve which controls the hydraulic fluid flow. A handle attached to the valve allows the 4-way valve to be manually operated by the hoist operator.

FLOW CONTROL VALVE.

The flow control valve (figure 1-13) is located just above the 4-way valve over the rescue door. The valve controls the reel-in speed of the rescue hoist. When the rescue hoist is lifting a heavy load, hydraulic pressure builds up to a point where it "cracks" the spring-loaded flow control valve. This allows some of the hydraulic fluid to bypass the hoist and thereby reduces the reel-in speed. A light load on the rescue hoist cable will not cause a sufficient pressure build-up to "crack" the valve.

Note

The flow control valve acts on the flow to the hoist during reel-in only. When the flow is reversed for reel-out, the valve merely acts as a carrier for the fluid as it returns from the hoist.

NORMAL OPERATION.

The hoist may be controlled from the cockpit by a switch located on the pilot's cyclic control stick (figure 4-16) or by a remote control switch mounted on the hoist operator's switch panel (4, figure 4-16) beside the rescue door. The master hoist switch located on the overhead switch panel (figure 1-10) must be in the ON position for either control to operate. The switch on the pilot's cyclic stick will override the hoist operator's switch should the pilot deem it necessary.

Note

A safety harness is provided at the rescue door for an attendant operating the hoist. The harness allows freedom of movement but will prevent the wearer from falling out the doorway.

HOISTING OVER WATER.

Overwater hoisting of personnel from a raft or the water may be accomplished both day and night. Ability to make numerous hoists in a short period of time is dependent upon practice and technique.

WARNING

The weight on the end of the hoist cable is heavy and unpadded. Personnel to be hoisted may be struck and bruised if care is not exercised while lowering the hoist cable to them.

DAYLIGHT HOISTING. Hoisting over open water at any time in any helicopter is extremely difficult. Lack of reference points combined with moving water produce a form of vertigo.

The recommended method of hoist pick-up where hoist visibility to the pilot is limited is as follows:

1. Approach: Execute at slow speed. As the helicopter passes slowly over the person to be hoisted, the hoist operator (who at this time must act as controller) directs the movement of the helicopter and at the same time lowers the sling into the water.
2. During rescue:
   a. After contact is made, slowly back off the helicopter until the person to be hoisted is in view of the pilot.
   b. After hook-up is completed, the helicopter is again moved up into position and under direction from the hoist operator who then brings the hoisted person or object into the helicopter.

3. Flight control operation: Control movements in all cases must be small to prevent overcontrolling. Hovering higher than normal will help to reduce the water motion and salt water spray. This also reduces the possibility of the rotor wash upsetting a raft (if used) and ejecting the personnel into the water.

NIGHT HOISTING. Locating of personnel in the water at night is difficult and the hoisting operations are more hazardous than during daylight. The procedure for daylight overwater hoisting must be followed. When close to the water at night, extreme care must be exercised to avoid striking the water with the landing gear. It is recommended that an extra crewmember be stationed at the rear exit door to determine the hovering altitude.

HOISTING OVER LAND.

The pilot's visibility when hoisting over land, as over water, is the only limiting factor. Under critical conditions this also requires close coordination between pilot and hoist operator, especially at night. The landing light provides adequate light for the hoist operator, and the searchlight can be used by the pilot in illuminating the area for reference points.

Note

Operation over dry snow will often result in static electricity in the hoist cable. Refer to Section IX, Cold Weather Operation, for recommended hoisting procedure under this condition.

EMERGENCY OPERATION.

The 4-way valve (1, figure 4-16) can be operated manually by a crewmember if the electrical system fails.

CAUTION

The up limit switch does not function during manual operation. Check cable rewind to avoid injury to personnel or damage to hoist equipment.

CABLE BOOM, WINCH, AND CABLE.

The winch is located on the floor forward of the rescue door. The cable (3, figure 4-16) leads up from the winch, through the emergency cable cutter and out the swinging boom located forward and above the rescue door. The boom (2, figure 4-16) can be locked in any of six positions. The forward position is opposite the pilot's lateral line of sight so that he can see the cable hanging below the helicopter. The most rearward position of the boom allows the cable to hang partially inside the helicopter due to the curvature of the side of the fuselage. Between the most forward and most aft positions of the boom, are four intermediate positions. A spring-lock handle (6, figure 4-16) above the cable cutter, turns the boom to any desired position and incorporates a lock release on the handle. At the end of the cable is a swiveling safety hook, and above the hook is a weight which aids the pilot in judging the length of the cable paid out, and helps in placing the hook.

CAUTION

There is no down limit switch. Do not let out more than 100 feet of cable or it will start to rewind around the winch drum in a reverse direction, causing damage to the hoist system. The last five feet of cable are painted red and white to give warning of the approaching limit.

When the cable is raised as far as it should go, the weight will trip the up limit switch and stop the cable.

CABLE CUTTER.

A cable cutter (5, figure 4-16) is provided to shear the cable if the cable hook becomes entangled or "snags" during a hoisting operation. The cable cutter is located forward of the rescue door on the right side and consists of a handle attached to a small cylinder which rotates in a fitting through which the cable passes. If it becomes necessary to cut the cable, pull the cutter arm away from the side of the fuselage. This causes a shearing action and severs the cable.

CARGO LOADING EQUIPMENT.

Tie-down rings are provided in the cabin for securing cargo. Refer to Section V for C-G and Weight Limitations.

EXTERNAL CARGO SLING.

An external hook and sling (figure 4-17) is provided to lift objects too large to fit the cargo compartment. The sling is attached to fuselage fittings so that the load will be suspended beneath the cg of the helicopter. The sling can be stowed against the bottom of the fuselage. Bungees are attached to take up any slack in the external cables.

NORMAL OPERATION.

To pick up an object larger than would fit under the helicopter on the ground, hover over the object and have an attendant attach the hook to it. To release the object at any time, pull either of two release handles (figure 4-17). One is located to the left of the pilot on the cockpit floor and the

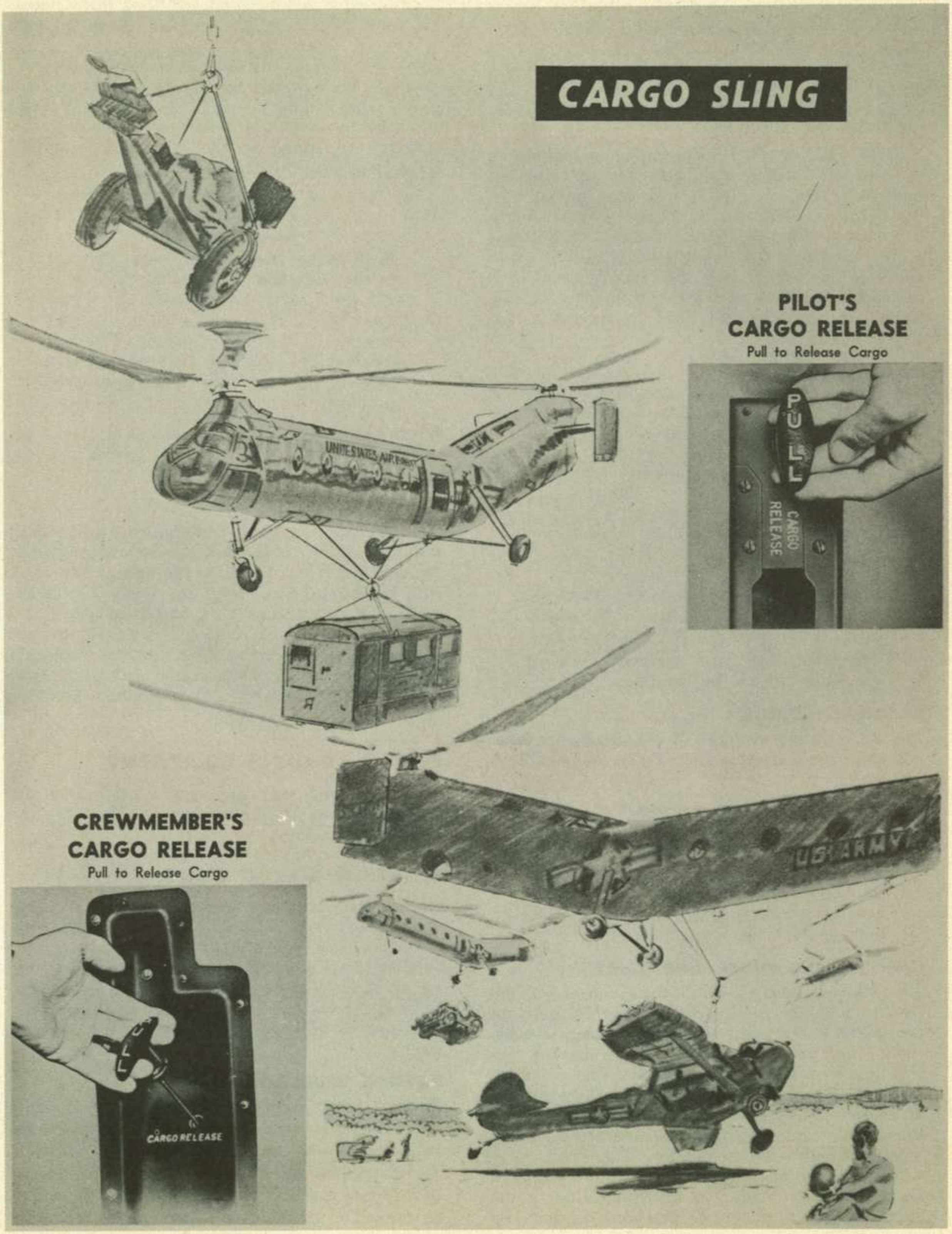

CARGO SLING
PILOT'S
CARGO RELEASE
Pull to Release Cargo
PULL
CARGO RELEASE
CREWMEMBER'S
CARGO RELEASE
Pull to Release Cargo
CARGO RELEASE

Figure 4-17

other is located forward of the main entrance door. These handles are stenciled Cargo Release and have the word PULL in raised letters on the handle. The YH-21 cargo hook will not release when the cockpit release is actuated if the cargo is resting on the ground. Under such conditions it is necessary for the co-pilot or crewmember to hold up on the release handle while the pilot lifts the helicopter, placing tension on the hook which in turn causes it to open. The H-21A cargo hooks will release regardless of whether the load is resting on the ground or is airborne. The hook on both models will remain open until closed by an attendant.

TROOP AND CASUALTY CARRYING EQUIPMENT.

The helicopter has a capacity for carrying 14 fully equipped ground troops. Provisions are made to carry up to 12 litters. Fittings for stokes litters are provided on the bottom positions of the tiers, but pole litters can also be used in the bottom positions as well as other positions.

TROOP SEAT AND LITTER INSTALLATION.

The helicopter cabin can be fitted with a combination of troop seat and litter installations. The troops seats are fitted with individual safety belts and shoulder harnesses. These can be adjusted to the individual but do not have inertia reels. The various combinations (figure 4-18) are:

Capacity	Litter Tiers (3-man)	Seats (2-man)	Seats (3-man)
14 men............	0	1	4
14 men............	1	1	3
14 men............	2	1	2
14 men............	3	1	1
12 men............	4	0	0

LITTER LOADING.

The helicopter may be adapted to accept litters by two men in about five minutes by folding and storing the troop seats against the side of the cabin. The litter straps may then be dropped from their standard canvas containers and secured to the floor. Ground loading normally requires four crewmen to stow loaded litters in the optimum time. For loading while hovering, two crewmen are required. However, when flight conditions permit and time is important, a crew of three may be used; two men stowing litters and one man operating the hoist and pulling litters in the rescue doorway. The microphone switch should be placed in the MIKE ON position so the hoist operator will have both hands free.

The recommended procedure for ground handlers of litters during loading from a hover position require them to carry the litters individually to the hovering position. By doing this, the patients are spared the discomfort caused by extended wind blasts and blowing matter such as sand. However, when time is essential, the pick-up time may be reduced considerably by placing the litters side by side and moving the helicopter to each in turn. Note, however, that it is desirable to have protective covering for the patients.

The recommended method for litter loading through the front rescue door is to load the two rear tiers first, top to bottom, as in conventional aircraft, then the two top litters in the front two tiers. Load the bottom litters of the two front tiers by placing one litter as far back down the aisle as possible and slanting it toward the right wall; place the next litter in position on the left straps and bring up the one from the aisle for the bottom right. There is no problem loading litters from the main entrance door, loading from top to bottom and front to back.

PASSENGER LOADING.

With the litters removed, the litter straps stowed, and the seats in place, personnel may be conveniently seated in the cabin. However, when combat troops are aboard, it is recommended that the back seat webbing be removed or at least loosened, since bayonets and shovels tend to become entangled in them and the back pack provides all the support necessary.

MISCELLANEOUS EQUIPMENT.

ELECTRICAL RECEPTACLES.

HEATED SUITS.

Two receptacles are provided for heated suits of the pilot and co-pilot. These are located on the bulkhead behind the pilots, one to the right of the pilot and one to the left of the co-pilot.

HEATED BLANKETS.

Six receptacles are located on the right side of the cabin to be used for plugging in electrically heated blankets.

COVERS.

For the protection of the helicopter, covers are provided for the following parts: plastic nose, engine air intake, exhaust outlet, rotor blades, rotor hubs, and pitot tube.

RELIEF TUBES.

There are two relief tubes in the helicopter. One is located under the pilot's seat, the other is aft of the co-pilot's seat and can be made available to the passengers.

DATA CASES.

There are two data cases provided in the helicopter. One (Map Case) is located behind the co-pilot's seat. The other (Data Case) is located on the aft side of the radio shelf in the cabin.

TROOP SEATS & LITTERS

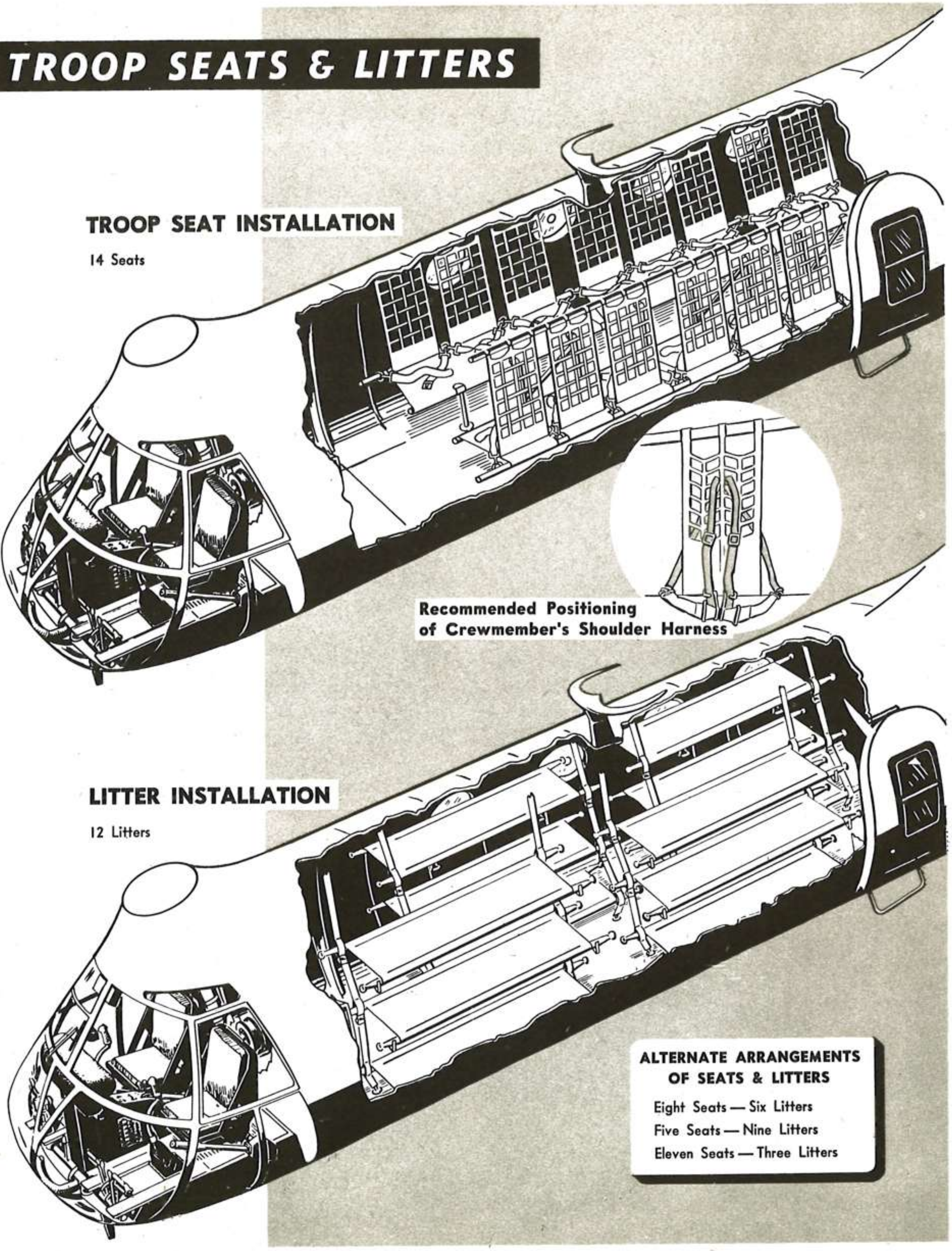


Figure 4-18

ANTIGLARE CURTAIN.

A fabric curtain which can be placed in the cockpit entrance is provided.

BLACKOUT CURTAINS.

Fabric blackout curtains are provided for all passenger compartment windows and the transparent panels in the entrance and rescue doors.

TIE-DOWN FITTINGS.

Fittings are provided on the cabin floor and walls to secure litters, seats, and cargo.

WINDSHIELD WIPER.

One windshield wiper (figure 1-4) is provided on the right, or pilot's side of the windshield. The wiper is driven by an electric motor, located between the windshield and the console. The operating switch is located on the overhead switch panel and it has three positions, OFF, SLOW, and FAST. Do not operate the wiper on dry glass or motor will stall and cause the resistor to fail.

ASH TRAYS. **H-21A**

The model H-21A has two ash trays located in the cockpit. One is located to the right and forward of the pilot, and the other is located to the left and forward of the co-pilot.

SPARE LAMP STOWAGE.

There is a container mounted to the left of the co-pilot's seat at floor level. This container holds a variety of spare lamps that are readily available.

RESCUE DOOR LADDER.

A removable ladder has been provided on some H-21A helicopters for entrance to the cockpit through the rescue door when the cabin main entrance is obstructed by auxiliary fuel tanks or cargo. There are no stowage provisions made in the helicopter for this ladder.


RESCUE

Section V OPERATING LIMITATIONS

TABLE OF CONTENTS

OPERATING LIMITATIONS.

The operating limitations of the helicopter discussed in this section are a result of extensive flight testing and experimentation. The limitations which are marked on the instruments, illustrated on the following pages, are not necessarily discussed in the text. Further explanation of the instrument markings, when necessary, is covered under the appropriate headings.

MINIMUM CREW REQUIREMENTS.

The minimum crew required to fly the helicopter safely, under normal non-tactical conditions, is a pilot. Additional crewmembers, such as co-pilot or litter attendant, as required to accomplish a specific mission, will be added at the discretion of the Commanding Officer.

ENGINE LIMITATIONS.

All engine limitations are as shown in figure 5-1 and covered below.

Continuous engine operation at more than 2500 rpm is prohibited.

The engine must be inspected if the following conditions occur:

1. Engine overspeeds between 2780 and 3000 rpm.
2. When power exceeds take-off MAP for less than 15 seconds and does not exceed 61.5 inches Hg.

The engine must be removed under the following conditions:

1. Engine overspeeds exceeding 3000 rpm.
2. When take-off MAP is exceeded for more than 15 seconds, or the MAP exceeds 61.5 inches Hg.

Note

Any occurrences of excessive MAP or engine overspeeds must be noted in Form DD-781.

INSTRUMENT MARKINGS

Note:

Continuous operation above 2500 engine rpm not permitted.

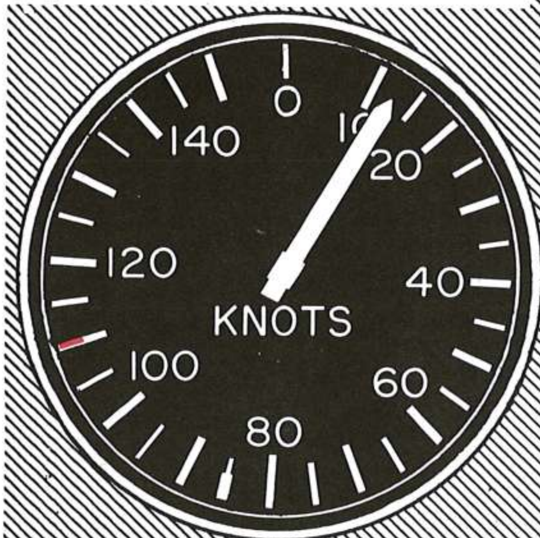
DUAL TACHOMETER

Rotor

- (red) 233 rpm Minimum
- (green) 233 to 258 rpm Normal
- (red) 350 rpm Maximum Overspeed

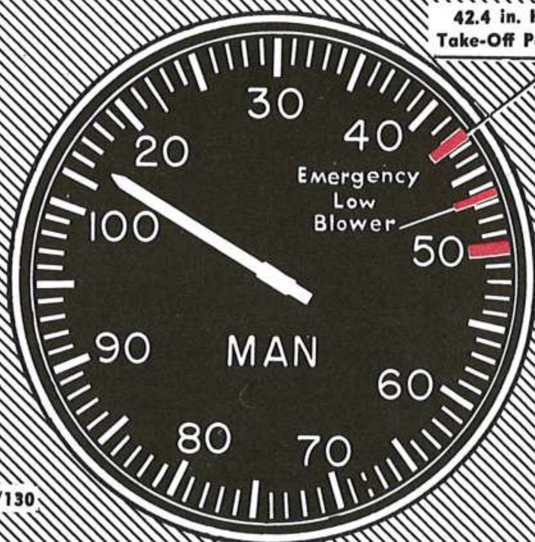
Engine

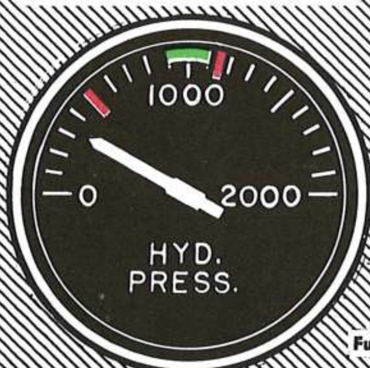
- (red) 2260 rpm Minimum for Flight
- (green) 2260 to 2500 rpm Normal
- (red) 2600 rpm Maximum



AIRSPEED

- (red) 110 Knots Maximum (See Airspeed Limitations)





Fuel Grade 100/130

HYDRAULIC PRESSURE

- (red) 500 psi Minimum
- (green) 900 to 1100 psi Desired
- (red) 1150 psi Maximum

MANIFOLD PRESSURE

- (red) 42.5 in. Hg Maximum—Low Blower
- (red) 46.5 in. Hg Maximum—Emergency Low Blower
- (red) 50 in. Hg Maximum—High Blower

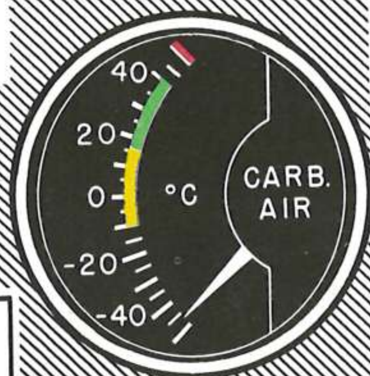
Figure 5-1. (Sheet 1 of 4)

FUEL QUANTITY

- 360 Pounds (Twenty Minute Fuel Reserve at Take-Off Power)

FUEL PRESSURE

- 17 psi Minimum
- 19 to 21 psi Desired
- 25 psi Maximum



MAX CAT
HIGH BLOWER OR
CARB HEAT +40°C

CARBURETOR AIR TEMPERATURE

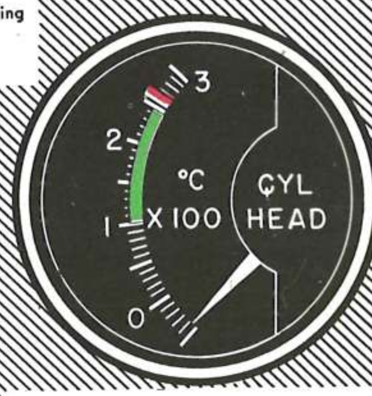
(Ser No. 51-15258 and subsequent)

- −10 to +15°C Danger of icing
- +15 to +40°C Desired
- +50°C Maximum

CARBURETOR AIR TEMPERATURE

YH-21 Ser No. 50-1231 thru 50-1248
H-21A Ser No. 51-15238 thru 51-15257

- −10 to +15°C Danger of Icing
- +15 to +40°C Desired
- +40°C Maximum



CYLINDER HEAD TEMPERATURE

- +100 to +245°C Normal
- +260°C Maximum

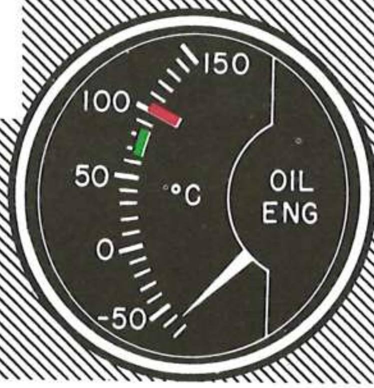
Figure 5-1. (Sheet 2 of 4)

AFT TRANSMISSION OIL TEMPERATURE

- (green) —70 to +95°C Normal
- (red) +95°C Maximum

AFT TRANSMISSION OIL PRESSURE

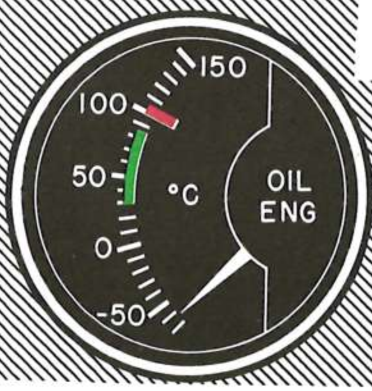
- (red) 20 psi Minimum
- (green) 20 to 85 psi Normal
- (red) 85 psi Maximum



ENGINE OIL TEMPERATURE

(Ser No. 51-15258 and subsequent)

- (green) +65 to +85°C Normal
- (red) +104°C Maximum



ENGINE OIL TEMPERATURE

YH-21 Ser No. 50-1231 thru 50-1248
H-21A Ser No. 51-15238 thru 51-15257

- (green) +30 to +85°C Normal
- (red) +100°C Maximum

ENGINE OIL PRESSURE

- (red) 50 psi Minimum
- (green) 65 to 75 psi Desired
- (red) 90 psi Maximum

Figure 5-1. (Sheet 3 of 4)

FORWARD
TRANSMISSION OIL TEMPERATURE

—70 to +95°C Normal
+95°C Maximum

FORWARD
TRANSMISSION OIL PRESSURE

20 psi Minimum
20 to 85 psi Normal
85 psi Maximum

MID TRANSMISSION
OIL TEMPERATURE

—70 to +95°C Normal
+95°C Maximum

MID TRANSMISSION
OIL PRESSURE

20 psi Minimum
20 to 85 psi Normal
85 psi Maximum

Figure 5-1. (Sheet 4 of 4)

MANIFOLD PRESSURE.

The maximum manifold pressure for take-off in low blower at sea level is at the first red line on the manifold pressure gage. The engine may be operated at the second red line at any time for emergency use only. There is no time limit on the use of take-off power for this helicopter. Maximum manifold pressure in high blower is at the third red line on the manifold pressure gage. (See figures 5-1 and 5-2.)

HIGH RATIO BLOWER LIMITATIONS.

An unsatisfactory setting of the Stromberg PD-12K19 carburetor makes it mandatory that the rich mixture be used for high ratio blower operation.

CARBURETOR AIR TEMPERATURE.

Carburetor air temperature is restricted to a maximum of 40°C when the engine is operated in high blower or with carburetor heat. The maximum carburetor heat in low blower with the carburetor heat control lever positioned in COLD is 50°C.

CYLINDER HEAD TEMPERATURE LIMITATIONS.

Cylinder head temperatures must not exceed 260°C during Military Power operation (2600 engine rpm at 50 inches Hg manifold pressure), or 245°C for continuous operation at or below Normal Rated Power (2500 engine rpm at 42 inches Hg manifold pressure).

Note

Military Power is restricted to 30 minutes continuous operation.

FUEL GRADE LIMITATIONS.

This helicopter is restricted to fuels with 100/130 or 115/145 octane rating.

POWER SETTINGS

MANIFOLD PRESSURE LIMITS vs RPM

	LOW BLOWER			HIGH BLOWER		
Engine Rpm	Manifold Pressure at SL (inches Hg)	Manifold Pressure at 3000 feet (inches Hg)	Approx Full Throttle Alt (Feet)	Blower Shift Altitude (Feet)	Manifold Pressure (inches Hg)	Approx Full Throttle Alt (Feet)
2260	36.5 (940 hp)	36 (940 hp)	35 at 8900	As altitude is increased, the vibration increases and the cyclic stick moves forward. To reduce vibration and keep the stick in the proper position, increase rpm with altitude.		
2300	38.0 (1000 hp)	37.5 (1000 hp)	36.5 at 8000			
2400	41.5 (1125 hp)	41 (1125 hp)	40 at 6200			
2500	42.5 (1150 hp)	42*	40.5 at 6800	12,000	43 (980 hp)	42 at 16,700
2600	Not permitted in low blower.			10,000**	50 (1100 hp) †Limited to 30 minutes.	49 at 14,400

Notes

†Continuous operation above 2500 rpm is prohibited.

Use RICH mixture for all High Blower operation.

Above manifold pressures are for standard atmospheric conditions.

*For 2500 rpm only the manifold pressure is increased 1/4 inch for each 6°C (outside air temperature) above standard temperature and is decreased 1/4 inch for each 6°C (outside air temperature) below standard temperature. (For other rpm, manifold pressure limits for warmer than standard outside air temperatures are as shown on chart, but are decreased 1/4 inch for each 6°C (carburetor air temperature) below standard temperatures).

**A blower shift can be made at 8000 feet in order to use a higher rpm. However, this will be accompanied by a loss of power.

Figure 5-2

NEW ENGINE LIMITATIONS.

It is desirable but not mandatory that the following limitations shall be followed for the first 10 hours after a new or overhauled engine has been installed in a helicopter:

1. Operate at minimum gross weight.

2. Conduct all flight operations at 2350 engine rpm.

3. Use the minimum manifold pressure required to take off and to perform initial hovering. Take off slowly. A rapid take-off requires excessive power.

4. Eliminate all unnecessary hovering.

5. Climb at reduced power.

6. Avoid the following maneuvers:

   a. Autorotation.

   b. High speed flight.

   c. Quick starts.

   d. Quick stops.

These flight manuevers require rapid changes in power and high power settings, both of which are detrimental to new engine operation.

7. Conduct cruising flight at 70 knots TAS to permit the use of minimum power.

ROTOR LIMITATIONS.

The minimum rotor speed in powered flight is the low range marked on the tachometer indicator (green line). The maximum rotor speed in powered flight is the high range marked on the tachometer indicator (green line). The minimum for autorotative flight is 233 rpm. Maximum permissible rotor overspeed in autorotation is the red line on the tachometer indicator.

If the engine stops and cuts in again during flight, inspect the blades thoroughly for cracks.

Rotor speeds below the minimum will result in blade coning beyond the safe limits. Rotor speeds in excess of the maximum limit will lower blade lift efficiency.

CONTROL LIMITATIONS.

Under certain extreme conditions, it has been found possible to excite large blade flapping

motions which can result in the helicopter's rotor blades striking the fuselage. Accordingly, abrupt simultaneous application of aft cyclic control with up collective pitch in flight at high forward speeds at any operational rpm or in autorotational descent at low rpm shall be avoided.

AIRSPEED LIMITATIONS.

NORMAL CONFIGURATION.

Maximum operational airspeed is restricted to 100 knots. The speed at any altitude shall not exceed the maximum speed attainable at that altitude in sustained level flight using normal rated power.

There are no present airspeed restrictions when flying with cabin or rescue doors open.

TAILS OFF.

Maximum airspeed with tails off is restricted to 70 knots. Refer to Section VI for flight characteristics with tails removed.

PROHIBITED MANEUVERS.

Aerobatics are prohibited in the helicopter.

FLIGHT RESTRICTIONS.

See Section IX for restricted flight under IFR conditions and in heavy rain.

HOVERING LIMITATIONS.

Do not hover the helicopter at zero airspeed between 15 and 600 feet unless emergency rescue operations or attachment of external cargo sling demand it. These "no-hover" altitudes represent heights at which it is extremely difficult to make consistently successful autorotative landings after sudden power failure.

EXTERNAL CARGO SLING LIMITATIONS.

The auxiliary sling should, preferably, be a close coupled multi-strand suspension attached directly to the cargo hook.

The maximum approved load limit of the external cargo sling is 2200 pounds for the YH-21 and 3000 pounds for the H-21A provided the approximate gross weight does not exceed 13,500 pounds.

RESCUE HOIST LIMITATIONS.

Rescue hoist operation is temporarily limited to a maximum unit weight of 250 pounds, pending current testing of higher unit weight loading.

CENTER OF GRAVITY LIMITATIONS.

For temporary center of gravity changes, such as personnel moving about within the cabin, displacement of the cyclic stick rearward from the normal hovering position will compensate for forward center of gravity stationing, and inversely, displacement of the cyclic stick forward will counteract an aft center of gravity shift. For permanent center of gravity changes, position the cyclic stick in hovering or at 80 knots by means of the stick positioner, so that the stick position indicator will be correlated with the actual flight condition. This will provide full fore and aft stick travel for longitudinal control. With a crew and normal load, the center of gravity is a point midway between the rotors; the forward limit is 31 inches forward of this point, and the aft limit is 6.5 inches aft of this point.

TERRAIN SLOPE LIMITATIONS.

Refer to Landing Limitations, figure 5-3.

LIMITATIONS WITH FLOATS.

These helicopters are restricted against intentional autorotational landings on water. During any landing with floats inflated, touchdown shall be made at zero ground speed to avoid damage to main floats.

The maximum permissible taxiing speed for the YH-21 helicopter is 10 knots, for the H-21A helicopter, five knots. Taxiing above 10 knots with the YH-21 helicopter causes the nose float to tuck under, and taxiing above five knots with the H-21A helicopter can cause damage to the main floats.

Floats must not be inflated during flight at more than 40 knots IAS. After float inflation, 85 knots is the maximum permissible IAS.

Note

> The recommended maximum IAS with floats inflated is 72 knots, since higher speeds require excessive power settings.

For data on float inflation at specific altitudes and low temperatures, refer to Cold Weather Operation, Section IX.

WEIGHT LIMITATIONS.

The helicopter is designed for a maximum inflight load factor of 2.0 at Overload Gross Weight (14,500 pounds). However, the chart value will remain at 1.6 (80 per cent of design figure) until actual testing substantiates this value. This load factor is the recommended maximum for any loading, and if conditions which affect the

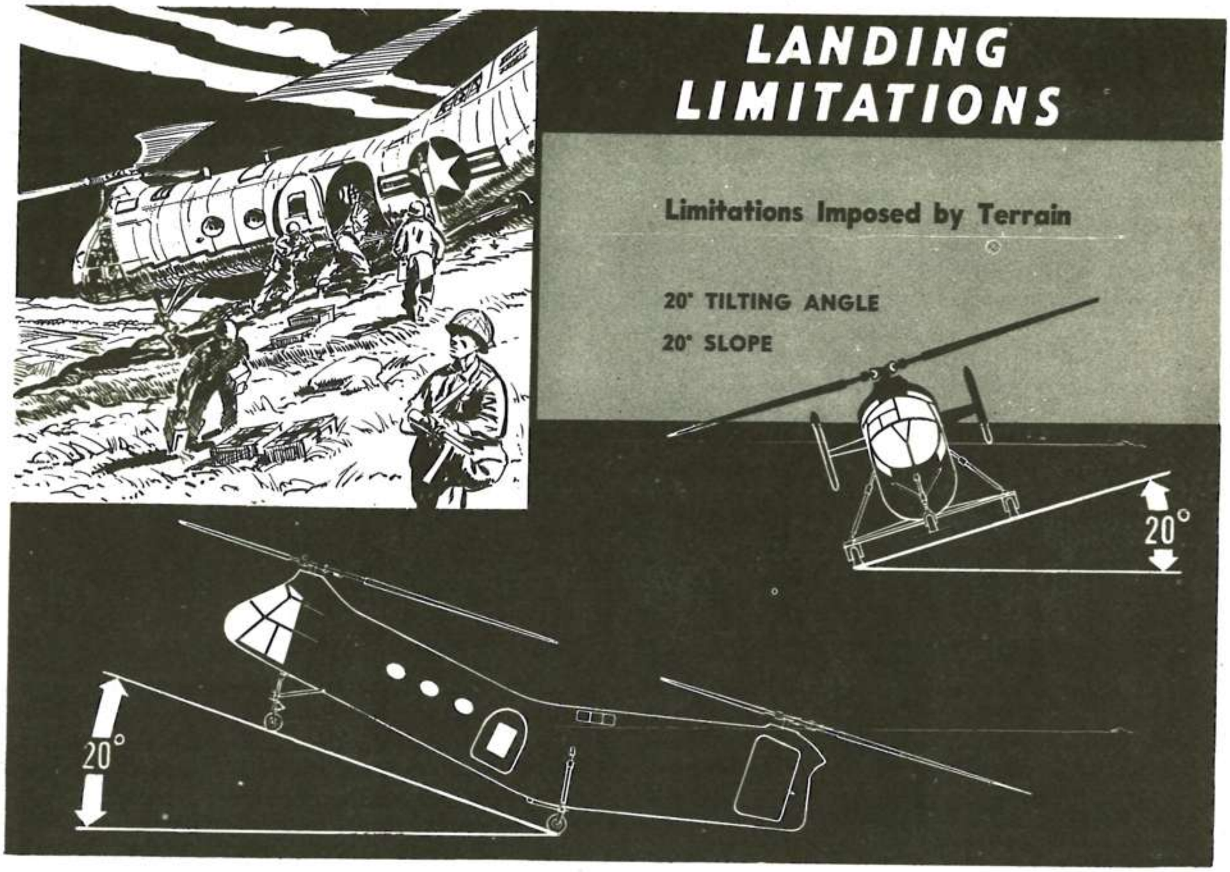


Figure 5-3

load factor are present, such as turbulent or gusty air, the gross weight must be varied accordingly. Due to current restrictions, maximum permissible operational gross weight is 13,500 pounds. To reduce the basic weight of the helicopter, the items listed in figure 5-4 may be removed. The weight, arm and moment of each item is listed in the Handbook of Weight and Balance Data (T.O. 1-1B-40).

WEIGHT LIMITATIONS CHART.

The purpose of the Operational Weight Limitations Chart (figure 5-5) is to illustrate the useful load carrying capabilities of the helicopter with respect to safe operating limits. The various combinations of fuel and alternate load that the helicopter can safely operate with will be found below the 14,500 pound line. Built-in fuel tank capacity is 300 gallons (1800 pounds). The maximum alternate load the helicopter can carry with a full fuel load is 3700 pounds.

OPERATING WEIGHT.

The operating weight on which the weight limitations chart is based is 9000 pounds. This value is an approximate weight which includes the aircraft basic weight as obtained from T.O. 1-1B-40, Handbook of Weight and Balance, plus standard crew and full oil capacity. Since individual helicopter weights vary, it will be necessary to adjust the chart for a specific helicopter. The intersection of the alternate load and the fuel load axes at "O" represents the helicopter operating weight of 9000 pounds.

GROSS WEIGHT.

The gross weights of the loaded helicopter are indicated by the diagonal lines.

DISTRIBUTION OF LOAD.

No variations in weight limitations are required due to unusual loading, providing the load of the helicopter is within weight and balance limits and does not exceed structural limitations. For anticipated loads on the hoist, a weight and balance problem should be computed to establish the maximum forward center of gravity location available for alternate load. If the actual hoist load is not known, compute the problem using the hoist limit load (400 pounds). With the hoist

MODELS YH-21 & H-21A HELICOPTERS

STRIP LIST

GENERAL ITEMS

§ Cabin Flooring
Cargo Tie-Down Fittings
† Blackout Curtains
Curtain Installation (Station 359)
Interior Fixed Lights
Data Case
Map Case
§ Windshield Wiper
Work Platform Installations
† Rheostats & Outlets for Heated Clothing and Blankets
* Pilot's & Co-Pilot's Sliding Window and Track Assembly
† Cabin Heater & Blower Installation
Soundproofing & Installation
Heater Ducting Drive Shaft Cover
* Air Outlet Regulator Doors
§ Search Light & Relay
§ Landing Light & Relay
¶ Co-Pilot's Seat, Belt & Harness
¶ Co-Pilot's Cyclic Stick
¶ Co-Pilot's Collective Pitch Lever
Portable Fire Extinguisher Installation
* Rescue Door & Track Assembly
* Cabin Door & Track Assembly

REMOVABLE FLIGHT INSTRUMENTS

§ Airspeed (2)
§ Altimeter
§ Clock
§ Standby Compass
§ Attitude Gyro
§ Inverter Installation
§ Gyro Compass Indicator
§ Gyro Control
§ Amplifier (J-2 Compass)
§ Amplifier (J-2 Compass)
§ Turn & Bank Indicator
§ Transformer (A-C Instrument)
§ Free Air Thermometer
§ Pitot Tube
§ Rate of Climb

COMMUNICATION EQUIPMENT

AN/AIC-4
- Amplifier
- Mount
- Interphone Installation (Cabin)
- Interphone Installation (Cockpit)
- Control Panel

AN/ARA-8A
- Antenna Installation
- Auto Volume Control
- Mount
- Control Panel
- Modulator
- Mount
- Antenna
- Antenna Relay
- Mount

AN/ARN-6
- Mount
- Coupling Unit
- Sens Antenna Installation

AN/ARC-3
- Transmitter
- Mount
- Receiver
- Mount
- Control Panel
- Antenna Mast
- Dynamotor (DY-21)
- Dynamotor (DY-22)
- Power Junction
- Mount

AN/ARN-14
- Receiver
- Mount
- Dynamotor
- Mount
- Course Indicator
- Control Panel
- Antenna
- Transformer

ITEMS NOT INCLUDED IN EMPTY WEIGHT

Rescue Hoist
Hoist Operator's Belt
Troop Seats
Troop Seat Belts & Harness
Outboard Litter Brackets
Hydraulic Flight Control System
Flotation Equipment
First Aid Kits (2)
Inboard Litter Straps & Container
Troop Seat Supports

Notes

* Weather conditions permitting
¶ If no co-pilot
† Operating conditions permitting
§ When not needed or considered essential

Figure 5-4

loads considered, care must be taken not to exceed the maximum gross weight.

LANDING GEAR LIMITATIONS.

The design weight criteria for the landing gear is such that it will support a gross weight of 14,500 pounds with a sinking speed limit of five feet per second and a weight of 11,500 pounds with a sinking speed limit of 8.5 feet per second. Landings should not be scheduled for weights in excess of 14,500 pounds because of reduced landing gear life, brake limitations, and increased accident risk.

EXPLANATION OF CHART.

1. The green area represents the loading conditions that present no particular problem in regard to strength or performance of the helicopter. Therefore, this weight should not be exceeded unless the dictates of the mission require it.
2. The yellow area represents loadings of progressively increasing risk as the red area is approached. Therefore, care must be exercised in the yellow region as performance is marginal depending upon helicopter configuration, altitude, and ambient temperature.
3. The red area represents loadings which are not recommended. Under conditions of extreme emergency when safety of flight is of secondary importance, the commanding officer will decide whether the degree of risk warrants operation in the red zone.

Note

Operating weight should never exceed that required for the mission or unnecessary risk and equipment wear will result. The data herein described is for information and guidance. However, take-off weight must be considered with regard to available take-off areas, surrounding terrain, altitude, atmospheric temperatures, mission requirements, and urgency of the mission.

SAMPLE PROBLEM—WEIGHT LIMITATIONS.

Determine the alternate load that the helicopter may carry with a fuel load of 1000 pounds, and a maximum gross weight of 13,500 pounds.

SOLUTION:

a. From Form F of the Weight and Balance Handbook (T.O. 1-1B-40), the Operating Weight of the helicopter is found to be 9000 pounds. This weight is the zero point on the chart.

b. Enter the Weight Limitations Chart at the 1000 pounds of fuel line and follow this line up to the 13,500 pound gross weight line.

c. Read to the left to determine the alternate load of 3500 pounds.

WEIGHT LIMITATIONS

Weight Less Alternate Load & Fuel = 9000 lb

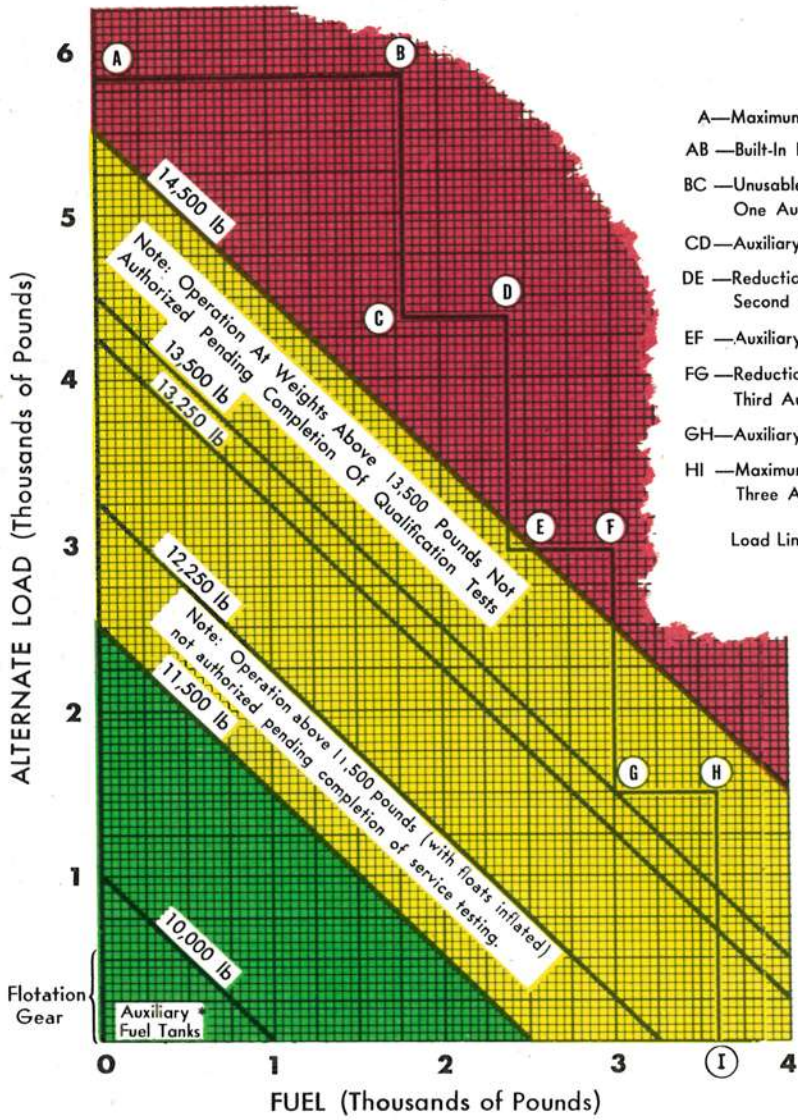
14,500 lb—Maximum Overload Gross Weight based upon:
1. Helicopter Flight Load Factor = 1.6
2. (Performance Limitation of 500 Fpm Best R/C @ Sea Level)

13,500 lb—Rotor Blade Limit Load Factor = 2.2

13,250 lb—Performance limitation of Hovering Out of Ground Effect @ Sea Level

12,250 lb—Performance Limitation of 500 Fpm Vertical R/C @ Sea Level

11,500 lb— Design Gross Weight based upon:
1. Helicopter Flight Load Factor = 2.2
2. Landing Gear Limit Load Factor = 3.00



*When carried, to be considered as initial alternate load.

Notes

A—Maximum Cabin Cargo Capacity (5830 lb).

AB —Built-In Fuel Capacity (1800 lb maximum).

BC —Unusable Cargo Capacity with One Auxiliary Fuel Tank Installed.

CD—Auxiliary Fuel Capacity, First Tank (600 lb).

DE —Reduction in Cargo Capacity with Second Auxiliary Fuel Tank Installed.

EF —Auxiliary Fuel Capacity, Second Tank (600 lb).

FG —Reduction in Cargo Capacity with Third Auxiliary Fuel Tank Installed.

GH—Auxiliary Fuel Capacity, Third Tank (600 lb).

HI —Maximum Cargo Capacity with Three Auxiliary Fuel Tanks Installed (1500 lb).

Load Limit of External Cargo Sling = 2200 lb YH-21
3000 lb H-21A

Figure 5-5

Section VI FLIGHT CHARACTERISTICS

TABLE OF CONTENTS

GENERAL.

Normal flight for the helicopter is defined as follows:

a. Taxiing, take-off, hovering, and landing.

b. Cruising in a normal attitude.

GROUND RESONANCE.

Ground resonance is a vibratory condition present in a helicopter while on the ground with its rotors turning. It cannot occur in flight. Resonance results when unbalanced forces in the rotor system cause the helicopter to rock on its landing gear at or near its natural frequency. The problem of its elimination is complicated by the fact that as lift is applied to the rotors, the natural frequency of the helicopter changes. The design of the helicopter is such that with all parts operating properly, the landing gear oleos and rotor blade lag dampers will, by energy dissipation, prevent the resonance from building up to dangerous proportions. Improper adjustment of the oleos, incorrect tire pressure, and defective lag dampers are the major causes of ground resonance.

WARNING

It is recommended that whenever flights must be conducted at excessive gross weights, the take-off should be made by using 250 rotor rpm and conducting a normal straight-up take-off. The area between 50 and 90 per cent airborne should not be encountered for prolonged periods. Operation in this critical area should also be avoided on landing by following through with a reduction of power immediately after touchdown. Encountering resonance is most likely when operating at 270 rotor rpm and being over 50 per cent airborne.

FLIGHT CONDITIONS CAUSING GROUND RESONANCE.

It is possible to enter ground resonance when operating under the following conditions:

a. Taxiing with a high power setting allowing the helicopter to be very light on the wheels.

b. When operating at high power without forward motion but the helicopter very light on the wheels.

c. The helicopter light on the wheels and rapidly oscillating the lateral cyclic control. Refer to Section III for recovery.

WARNING

If ground resonance is allowed to build up, it can cause destruction of the helicopter.

STALLS.

The helicopter is not subject to conventional stalls; however, rotor speed should be kept above the minimum to prevent excessive coning and stress of the rotor blades.

BLADE STALL.

As the helicopter rotor moves into forward flight at a given rpm, it is clear that as the blade moves in the direction of flight (advancing blade) it experiences a velocity which is composed of its rotational velocity added to the forward speed. On the other hand, as it moves away from the direction of flight (retreating blade) it experiences a velocity lower than its rotational velocity by the amount of the forward speed component. Since the blade lift is proportional to the square of the velocity, the blade angle of attack must be varied cyclically (by feathering, or flapping, or both) to compensate for the variation in lift as the blade rotates.

As the helicopter gains forward speed, more and more increase in retreating blade angle is required to maintain the lift until the blade reaches its stalling angle and the resulting loss of lift, increase in drag and change in pitching moment cause a cyclical roughness described as "blade stall."

The advancing blade, however, in spite of operating at a lower and lower angle as forward speed increases, ultimately encounters a difficulty of its own. Since the velocities are added, the resultant speed at the blade tip begins to approach the speed of sound as rotor speed and forward speed increase, and it may be expected that a similar cyclical roughness will finally develop, as described above.

Note

Vibration from blade stall will not feed back to the controls with hydraulic flight control system on, but will react on the directional pedals only with hydraulic flight control system off.

Execution of one or a combination of the following will overcome blade stall:

1. Increase rotor rpm.
2. Decrease airspeed.
3. Reduce collective pitch.
4. Decrease altitude (if possible).

CAUTION

Maneuvers will increase the tendency to stall and must be avoided under the conditions described above.

GENERAL FLIGHT ENVELOPE.

At airspeeds in excess of those labeled "Incipient Blade Stall" (figure 6-1, sheet 1 of 2), vibration will become excessive and a considerable increase in power will be necessary. Operation at airspeeds outside of the other limiting values of the curves is not possible due to power limitations and will result in power settling. Hovering ceiling is indicated at the points where the weight curves intersect the zero airspeed line. The service ceiling is indicated by the peaks of the weight curves.

VARIATIONS OF INCIPIENT BLADE STALL SPEED.

Incipient blade stall speeds vary with changes in altitude, temperature, engine rpm and gross weight. To provide information on incipient blade stall speeds which can be used in conjunction with the General Flight Envelope, figure 6-1, sheet 2 of 2 is provided.

SAMPLE PROBLEM.

Determine incipient blade stalling speed on a standard day at 4000 feet pressure altitude, outside air temperature is 15° Centigrade, engine rpm is 2500, and gross weight is 12,000 pounds.

1. On the pressure altitude scale, move right along the 4000-foot altitude line to intersect the 15° Centigrade temperature line.

2. Drop directly down to the base line of the engine rpm scale and follow the parallel lines to the 2500 engine rpm line. From this point drop down to the base line of the gross weight scale and follow the parallel lines to the 12,000-pound gross weight line.

3. From this point, drop directly to the bottom of the chart and read 99 knots IAS. This represents the incipient blade stalling speed for the conditions existing.

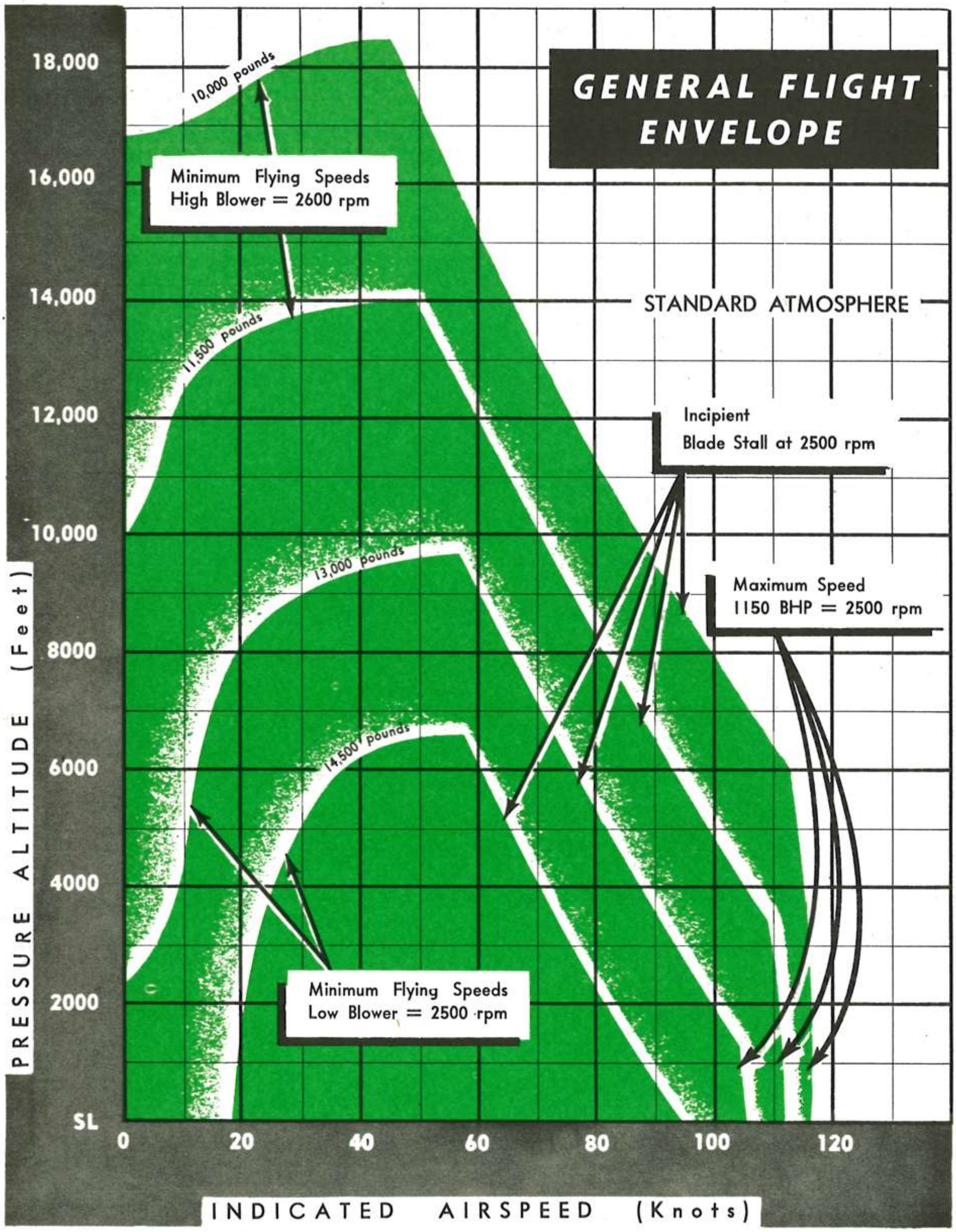


Figure 6-1. (Sheet 1 of 2)

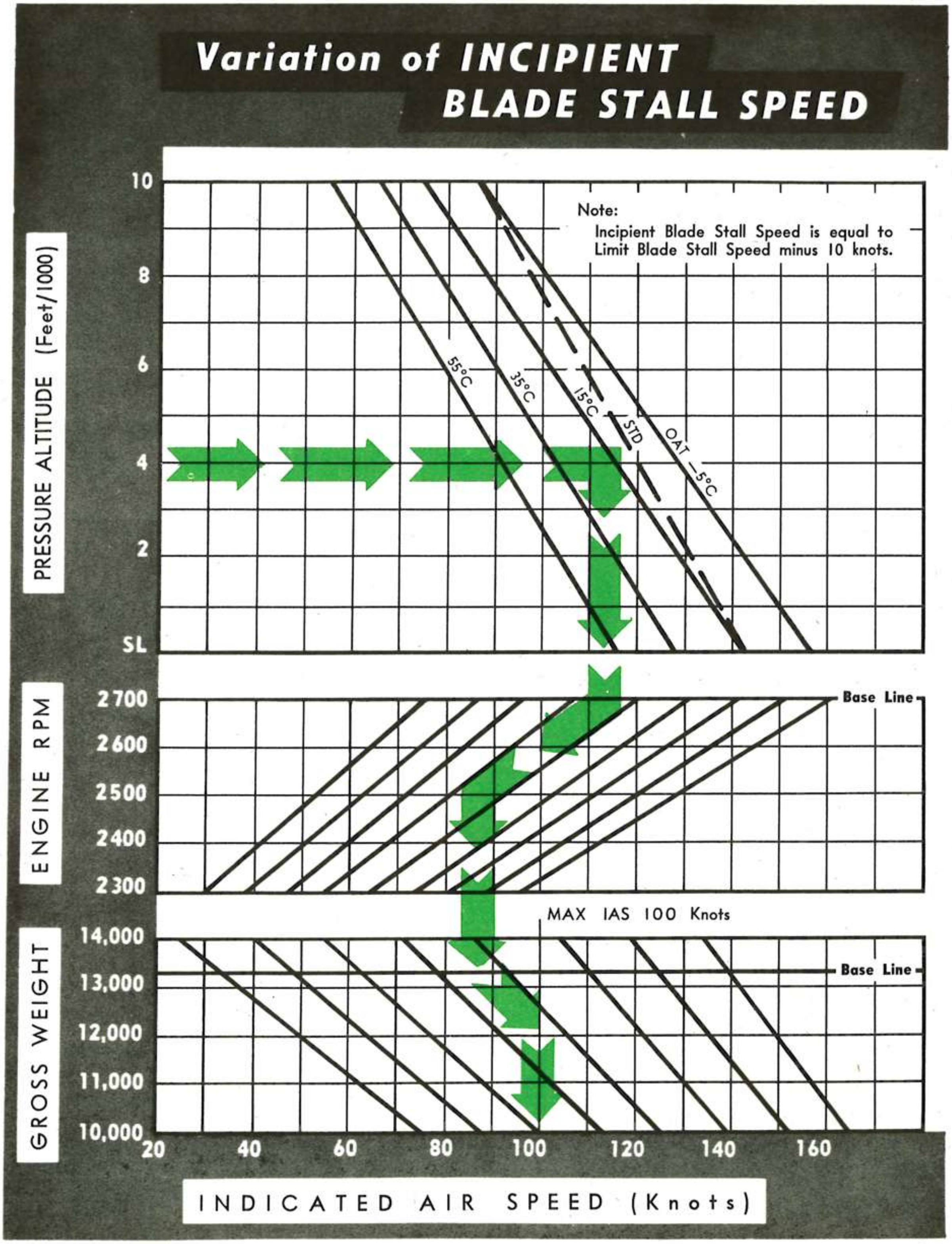


Figure 6-1. (Sheet 2 of 2)

POWER SETTLING.

Power settling may occur at rates of descent varying from approximately 400 to 1200 feet per minute in conditions of low airspeed. Flight experience has shown that it seldom occurs in helicopters with tandem rotor configuration. Indication of power settling is inability to appreciably change rate of descent by application of power. It can easily be eliminated by transition into forward, sideward, or rearward flight.

WARNING

Recovery from power settling is necessarily accompanied by a loss of altitude. Conditions that might cause it should be avoided at low altitude.

SPINS.

The helicopter is not subject to conventional spins.

TAILS-OFF FLIGHT.

Tails-off flight is recommended only in an extreme emergency because of the sluggishness of the directional controls.

This condition is aggravated by low rpm when entering autorotative flight. However, if autorotation is required due to engine failure or some similar emergency, the initial entry and subsequent autorotative flight must be performed with utmost caution. Refer to Section V for airspeed limitations with tails removed.

FLIGHT CONTROLS.

TAXIING.

If it is noted that the blades are hitting the droop stops (recognized by heavy thumping sound) while taxiing with lower power settings, increase the collective pitch which will cause the blades to cone and clear the stops.

ROTOR BLADE FLAPPING.

When the rotor blades hit the droop stops, it is the result of excessive blade flapping, perpendicular to the plane of blade rotation. This condition can be readily recognized by a heavy thumping sound and strong vibration throughout the fuselage and instrument panel. The frequency at which it occurs is three times every rotor revolution. The droop stops will be hit more readily on the aft rotor during forward flight since the higher collective pitch on this rotor (differential collective) causes greater flapping. Blade contact with the droop stops is possible under the following conditions:

1. High forward speed and low rotor rpm.
2. Improper longitudinal stick positioning (excessive nose down).
3. Abrupt displacement of controls during forward flight and at high speeds.
4. Taxiing with low rotor rpm and low collective pitch.
5. Excessive displacement of controls while taxiing.

CORRECTIVE MEASURES.

Excessive blade flapping during flight and/or while taxiing can be prevented as follows:

1. When taxiing, use 2000–2300 engine rpm and 20–23 inches Hg manifold pressure. This will provide sufficient power for full control and necessary rolling speed. Turns can easily be made by displacing cyclic stick and directional pedals corresponding to the desired direction of turn. This technique places greater lateral thrust on the forward rotor.

2. When in hover, there is very little tendency towards blade flapping to the extent of contact with the stops, even under severe control displacement. However, if this condition be experienced, increase rotor rpm and reduce collective pitch to cone the blades and clear the stops.

3. When in forward flight, blade flapping can be reduced by increasing rotor rpm and by using nose up longitudinal stick positioning. If this corrective action is not sufficient, due either to overload gross weight and/or severe turbulence, then a reduction in indicated airspeed is required. Maintain rotor speed above 233 rpm. Basically, the longitudinal stick positioner is used to compensate for center of gravity positioning. However, adjustments from the normally-trimmed position can be used advantageously to eliminate striking of the stops and to reduce vibration. The use of Nose-Up position decreases the collective angle on the aft rotors and reduces the possibility of excessive blade flapping. It must be remembered that when extreme Nose-Up position is used to eliminate hitting the droop stops

under loadings where an extreme aft center of gravity can occur, the forward control travel will be limited when recovering from a quick stop or any maneuver where extreme forward longitudinal control is necessary.

When an extreme aft center of gravity exists, the resultant trim for equal fore and aft longitudinal control travel will be nose down. It is possible for the pilot to reduce this nose-down trim in forward flight. If it has been used to compensate for center of gravity location, he must remember that the control travel will be limited for any abrupt maneuvers. It is more desirable to reduce airspeed and increase engine rpm than to make too large a change in trim.

CAUTION

Excessive blade flapping resulting in continued contact of the droop stops will induce high stresses to the upper rotor controls. All flight operations must be conducted to avoid this condition.

HOVERING.

Hovering into the wind will normally require displacement of the cyclic stick forward and slightly to the left and displacement of the left directional pedal. Hovering cross-wind will necessitate displacement of the cyclic stick into the wind, and the directional pedal on the down-wind side of the helicopter will have to be displaced to prevent weather-vaning. Down-wind hovering will require displacement of the cyclic stick rearward. No weather-vaning tendency will be present as long as the aft end is directly into the wind.

FORWARD FLIGHT.

During the transition from hovering to forward flight or from forward flight to hovering, transitional vibration will be noticed in the low airspeed range. As airspeed increases, it will be necessary to increase the forward displacement of the cyclic stick and the right pedal.

ROTOR RPM IN FLIGHT.

For safe and efficient operation of the helicopter, adequate control of the rotors must be maintained. Recommended rotor speeds are dependent upon conditions of gross weight, altitude, forward speed, and proximity to the ground. In general, high gross weight, high altitude, or high forward speed require high rpm for operation of the helicopter. However, lower rpm will provide optimum fuel economy.

POWERED FLIGHT.

In powered flight the rpm range is the green line range on the rotor tachometer.

WARNING

Do not operate at less than the low limit of the green line on the rotor tachometer in powered flight. Under no conditions of flight should the rotor speed exceed the rpm limit red lined on the tachometer. Allowing the rotor to drop below 233 rpm is permissible only during transition to autorotation.

AUTOROTATION.

The right pedal will be displaced forward during high speed autorotation. Maximum permissible overspeed in autorotation is noted by the red line on the rotor tachometer.

HYDRAULIC FLIGHT CONTROLS.

The controls displacement is not affected by the hydraulic flight control system; however, with the system off, it is necessary to exert considerable pressure to move the controls thus making such flight for extended periods undesirable. (See Control Forces Check.)

CONTROL FORCES CHECK.

When the hydraulic control system is on, the pilot feels no forces in the collective and cyclic controls except from the centering springs. When the hydraulic system is off, greater forces will be present in the controls. In order to thoroughly familiarize the pilot with these forces and to make flying easier in the event of a hydraulic system failure, the following procedure is desirable and should be part of the daily procedure, if practical from an operational standpoint.

1. Take off with the hydraulic control system off. (Collective pitch friction fully released to check extent of control forces. However, for extended flight with the hydraulic system off, the friction is to be used to help hold the collective pitch lever at the proper setting.)

2. Hover momentarily to determine the extent of the control forces. These should not exceed those shown in the table below:

YH-21 & H-21A BOOST-OFF FORCES
Acceptable Limits

Control Check	Limit
Lateral and Longitudinal	Maximum 8 pounds
Directional	1. Hover: 15 pounds Maximum 2. V/Max: 70 pounds Maximum
Collective Pitch	1. Hover: ±15 pounds Maximum 2. 80 Knots 3. Autorotation 4. Climb at Normal-Rated Power (2–4) Must be safe for controllability

3. Correct unbalanced forces by adjustment of the bungees.

CAUTION

If unbalanced forces exist in the collective pitch bungees, the collective pitch lever may travel to extreme positions when the hydraulic system is turned on. The friction lock must be tightened or the collective pitch lever must be held by the co-pilot to prevent such action.

LEVEL FLIGHT CHARACTERISTICS UNDER VARIOUS CONDITIONS.

At all operational altitudes the level flight characteristics of the helicopter are good. The helicopter is highly controllable and maneuverable at all speeds. However, during slow flight a slight vibration will be noticed.

LEVEL FLIGHT CHARACTERISTICS WITH HYDRAULIC SYSTEM ON.

The characteristics of flight are good. There are no unusual flight characteristics with the hydraulic system on.

LEVEL FLIGHT CHARACTERISTICS WITH HYDRAULIC SYSTEM OFF.

As airspeed of the helicopter increases, the friction forces in the controls will increase, and the controls will be more difficult to move without hydraulic control. The controls will remain balanced, but directional forces increase so that it is necessary to hold right pedal. Hovering flights and autorotative descents with the hydraulic system off are comparatively easy to control and maintain.

CRUISING AT NORMAL GROSS WEIGHT.

For sea level cruise use 27 inches Hg manifold pressure and a rotor speed of 245 rpm. This will give an IAS of approximately 85 knots.

FLIGHT CHARACTERISTICS WITH EXTERNAL CARGO.

It is recommended that pilots assigned to helicopters equipped with external cargo slings be thoroughly checked out before assignment to a mission as a tendency exists to overcontrol or fight the oscillations of the weight.

When a pilot has become accustomed to the feel of the helicopter with a suspended external weight, he will find little difference in its flying qualities or controllability. It will be necessary to make frequent minor lateral stick corrections to offset the effect of lateral oscillations of the weight upon the helicopter. There are no critical stick positions when flying with external cargo; however, maneuvers conducted with external weights should be gradual and well coordinated.

Yawed flight results in an increased rolling tendency opposite to the direction of yaw, particularly noticeable with a low density cargo.

It is most important that the adjustable collective pitch friction be set up to hold the lever securely so that the lever will not creep while the pilot is actuating the cargo sling release mechanism. When possible, it is more practical for the co-pilot or a crewmember to actuate the release handle. When the release handle is pulled abruptly, a relatively small effort is required on the part of

Figure 6-2 Flotation Equipment

the pilot. The approximate pull load required to actuate the release is 45–50 pounds with 3000 pounds of cargo on the sling, but this pull load is not apparent when a positive straight-up pull is performed.

SLING LOADS.

The maximum forward speed for various sling loads is determined by the handling characteristics of the particular load. Normally, 60 to 70 knots is the optimum speed for good handling characteristics and minimum power required. Some loads may require lower speeds, while others can be flown in excess of 85 knots.

TOWING.

Aerial towing of surface objects is accomplished by use of a special towing rig attached to the helicopter.

WARNING

Towing with the cargo sling is prohibited since it induces an extreme nose-down condition which can result in loss of control.

TAXIING WITH FLOATS.

The helicopter (figure 6-2) is quite maneuverable when taxiing with floats. Spot turns of 360 degrees, S-turns, and rearward taxiing can be performed with good control response.

FLIGHT CHARACTERISTICS WITH FLOATS.

There are no unusual flight characteristics. Inflation of floats in flight will not cause any change in attitude of the helicopter or the controls due to the slow rate of inflation. When floats are inflated on the ground the minimum recommended air pressure is 1.5 psi. This insures sufficient pressure for flight operations and prevents float buffeting from rotor downwash. The following conditions will change float pressure:

1. Inflating the floats in a warm hangar and moving the helicopter outside into colder temperatures.
2. Flying at a warm altitude and landing on cold water.

For additional information, refer to Section IX and the charts in Appendix I.

MANEUVERING FLIGHT.

During all operational maneuvers, the helicopter is highly controllable. Excellent maneuvering qualities will be noticed in operations close to the ground.

Note

A 30-degree angle of bank is usually sufficient to accomplish all turns under normal flight conditions. However, if operations require steeper turns, banks up to 45 degrees can be made without adverse effects.

DOWN-WIND TURNS AT LOW ALTITUDES.

Down-wind turns at low altitude can be made in this helicopter. Although the helicopter will not stall or spin, loss of airspeed will result in loss of translational lift and, consequently, loss of altitude. There is a tendency to judge speed by reference to the ground. This method is deceptive and unreliable. The correct technique for executing this maneuver at low altitude requires that the pilot observe indicated airspeed from the instrument without making reference to the ground.

CAUTION

When down-wind turns are made at low altitudes, the pilot should be certain to maintain airspeeds above 20 knots IAS or be prepared to apply pitch and power at a rapid rate to prevent an unintentional landing.

DIVING.

The helicopter maintains good controllability to maximum allowable indicated air speed. (See Instrument Markings, Section V.)

VERTICAL DESCENT.

Vertical descent at zero airspeed may be accomplished. During vertical descent with power, considerable vibration, similar to transitional vibration, will be present and the helicopter will be unsteady because it is settling through the rotor wash. However, full control can be maintained. Vertical descent in autorotation is smoother than vertical descent with partial power.

CAUTION

Vertical descents are not recommended. Due to lower rate of descent and better controllability at forward speeds of 50–60 knots IAS, it is more desirable to perform a power-on glide.

Section VII SYSTEMS OPERATION

TABLE OF CONTENTS

ENGINE.

MIXTURE CONTROL.

After the engine is stopped, leave the mixture control lever in the IDLE CUT-OFF position until the next start. The mixture control lever in the NORMAL or RICH position will allow the fuel which is left in the carburetor after shutdown to drain out. When the carburetor is again placed in operation, the air that replaced the lost fuel is difficult to remove and will cause surging of the engine. The carburetor diaphragms will dry out and not function properly if the carburetor is drained.

CARBURETOR ICE.

IMPACT ICE.

Impact ice may be caused on the carburetor by snow or sleet. However, because of the carburetor installation on this helicopter, icing of this nature should be infrequent.

THROTTLE ICE.

Throttle ice develops when moisture in the air becomes frozen at the carburetor butterfly valve. This condition results from the extreme cooling effect that takes place in the venturi section of the carburetor.

INTERNAL ICE.

Ice can be formed within the carburetor by the rapid evaporation of fuel as it is sprayed into the air intake. This can occur even in warm weather under certain atmospheric conditions.

RESULTS OF CARBURETOR ICE.

Carburetor ice will affect engine performance as follows:

1. Decrease in manifold pressure and power.
2. Roughness in engine operation.

REMOVAL OF CARBURETOR ICE.

The alternate air system is provided to prevent icing if used when icing conditions are anticipated but is not intended to remove large formations of ice once they have formed. If ice is already present, shift to the HOT position and proceed to an altitude where icing conditions do not exist.

CAUTION

Avoid operating in heat ranges that increase tendency to carburetor icing.

BACKFIRING.

Backfiring of cold engine after initial start can result from the following causes, any one of which upsets the fuel-air ratio:

1. Overpriming.
2. Underpriming.
3. Engine speed above the prescribed idling rpm.
4. Throttle pumping.

Note

Avoid conditions causing backfiring as it is harmful to the induction system and can result in engine fire.

SPARK PLUG FOULING.

The buildup of residue on the spark plug electrodes is known as spark plug fouling. It is a result of the use of an overly rich fuel-air mixture, particularly during idling and starting, incorrect shut-down procedure, and/or oil vapor leaking past the piston rings into the combustion chamber. This can cause failure to start, rough running, detonation, and loss of power.

REMOVAL OF RESIDUE.

An excessive rpm drop during the Ignition System Check indicates the probability of fouled plugs. No damage to the engine can result from using the following procedure in an attempt to remove residue:

1. Throttle: Idle engine, with rotors disengaged, at 1400–1500 rpm.
2. Mixture control lever: Manually lean until rpm drops no less than 50 or no more than 100 rpm. (This gives best mixture for clearing the plugs. Leaning less than 50 rpm is ineffective. Total movement of the mixture control lever from point that rpm starts to drop to CUT-OFF is approximately one-quarter inch.)
3. Engine: Run approximately two minutes without changing mixture or throttle setting.
4. Mixture control lever: RICH.
5. Clutch: ENGAGE and check magneto drop. If excessive, flick primer switch three or four times and recheck.

Note

Flicking the primer switch at magneto check point will some times clear a small excessive drop after the leaning procedure but seems to have very little effect if used before leaning.

Should the above procedure fail to reduce the roughness and improve the magneto check, replace the spark plugs.

High power or "burn-out" procedures merely increase the difficulty by glazing the deposit on the spark plugs and make it impossible to clean them except by spark plug overhaul. "Burn out" also can make a glow plug of the fouled plug which can cause serious damage to the engine by starting detonation.

CYLINDER HEAD TEMPERATURE.

The cylinder head temperature should never exceed the maximum indicated on the gage and, if possible, the engine should be operated within the optimum range shown on the dial. Cylinder head temperature may be lowered during climb by decreasing the rate of climb and increasing forward speed. Use of rich mixture and lower power settings will also produce a cooler operating range.

DETONATION.

Detonation is caused in an engine by the extreme or a combination of extremes of the following:

1. Cylinder head temperature.
2. Manifold pressure.
3. Spark advance.
4. Carburetor air temperature.
5. Lean mixture.

With the high cylinder head temperature that any one of these conditions produce, the induced fuel is pre-ignited and explodes instead of burning evenly. This detonation can cause damage to the pistons and other engine components, as well as resulting in extreme loss of power. If detonation is experienced during flight, it can be counteracted as follows, dependent upon which operational factor the pilot feels is causing it:

1. Decrease carburetor heat.
2. Enrich mixture.
3. Decrease manifold pressure and rpm.
4. Change from climb to forward flight or from forward flight to long gliding flight to reduce cylinder head temperatures.

PRIMING.

Priming supplies fuel to the engine induction system for starting. Pressure is supplied by the fuel booster pump to the primer valve, located on the rear of the carburetor. The primer valve is energized by an electrically-actuated solenoid, controlled by the two-position, ON-OFF, primer switch located on the console switch panel. Two lines are routed from this valve to the carburetor just above the impeller throat. Fuel sprayed into this section by the primer valve is diffused to all cylinders by the impeller. When the engine is running, priming is not required, as fuel is drawn into the induction system by the impeller. Priming this engine in warm or cold weather is accomplished by flicking the primer switch intermittently until the engine fires and runs smoothly.

WARNING

Avoid priming a hot engine in warm weather as there is normally sufficient fuel remaining in the induction system from prior running. An added charge of fuel in this case could result in engine fire from backfiring.

OVERPRIMING.

Overpriming is not desirable on engine starting as it produces the following bad effects:

1. Makes engine starting difficult.
2. Increases danger of engine fire from backfiring.
3. Washes lubricating oil from the cylinder walls.
4. Causes hydraulic lock in extreme cases.

Overpriming can be detected by the tendency of the engine to fire weakly and emit heavy black smoke from the exhaust. If overpriming has occurred, and the engine will not start, the pilot should cut the ignition switch immediately and return the mixture control lever to the IDLE CUT-OFF position. The engine should then be cranked through intermittently by pressing the starter button for periods not exceeding four to five seconds. This action should clear the engine of excess fuel. A new start may then be attempted with none or a minimum of priming.

UNDERPRIMING.

Underpriming on engine start is not desirable as it develops engine backfiring conditions. Characteristics of underpriming are failure of the engine to start and white smoke from the exhaust system. If a start is made, the engine will run roughly with low power. If underpriming is prevalent, check to see that the fluids shut-off switch is NORMAL, the mixture control lever is in the RICH position and the fuel booster pump switch is in the HIGH position. Check to ascertain that the fuel pump is delivering the minimum pressure required.

MANIFOLD PRESSURE LIMITER.

PROCEDURE FOR CHECKING OPERATION.

Although the manifold pressure limiter is automatically operated, the following check should be made when there is a question as to its operating properly or if the required manifold pressure has not been obtained:

1. Rescheduling arm: Ground check (engine not running) by shifting to high blower then to low blower. Check for full motion and direction of the rescheduling arm (short arm adjacent to the lever from the limiter to the carburetor) during each shift. The rescheduling arm should move to the forward stop in low blower and to the aft stop in high blower.

LOW BLOWER. Check as follows with engine running:

1. Mixture control lever: NORMAL (sea level).
2. Throttle: Open to obtain full available manifold pressure at 2500 rpm. (Do not exceed 47 inches Hg; throttle may be held open a maximum of two minutes, if necessary, to obtain stabilized readings.)
3. Manifold pressure gage: Check. Full available must not be less than 46 inches Hg or more than 47 inches Hg.

HIGH BLOWER. Check as follows:

1. Mixture control lever: RICH (at any altitude between 10,000 and 13,000 feet).
2. Throttle: Open to obtain full available manifold pressure at 2600 rpm. (Do not exceed 51 inches Hg; throttle may be held open a maximum of two minutes, if necessary, to obtain stabilized readings.)
3. Manifold pressure gage: Check. Full available must not be less than 49.5 inches Hg or more than 50.5 inches Hg.

Note

Any regulator which does not limit the power or permit the above powers to be obtained or does not shift the rescheduling lever shall be replaced and rechecked.

SUPERCHARGER.

HIGH BLOWER.

USE IN FLIGHT.

Use of the high blower is recommended for continuous flight operations at altitudes above 9000 feet. High blower should not be used below 9000 feet for the following reasons: The power required to operate the blower substantially reduces the power available for take-off, climb, etc. The additional adiabatic heating of the air when it passes through the impeller at the high blower setting increases the temperature of the mixture which enters the combustion chamber and thus causes higher cylinder head temperatures. Maximum BMEP of the engine can be obtained in low blower up to 9000 feet and therefore no advantage is gained by the use of high blower below this altitude.

PROCEDURE FOR SHIFTING BLOWER.

Shifting of the blower from the LOW ratio drive to the HIGH ratio drive should be accomplished as follows:

1. Mixture control lever: RICH.

2. Collective pitch and the throttle: Decrease to obtain 2300–2400 engine rpm and a reduction of four inches in manifold pressure.

3. Supercharger switch: HIGH.

4. Increase the engine rpm and the collective pitch to return the helicopter to the desired condition of flight. Use care to avoid blade tip stalling when slowing the engine down, as this condition causes undersirable vibration in the rotor system.

CAUTION

Do not shift to HIGH blower at engine speeds above 2400 rpm. A shift at higher speeds can result in engine operation at manifold pressures above limits.

TRANSMISSIONS.

OIL TEMPERATURE.

There is no minimum oil temperature for transmission operation. The oil in the transmissions will be warm enough for take-off by the time the engine is warmed up. Usual operating oil temperature of the transmissions is 65–70°C. However, the normal operating temperatures vary with the outside temperature and it is permissible to operate at a stabilized temperature to the limit of the red line on the transmission oil temperature gage.

PRESSURE.

The oil pressure of the forward, mid, and aft transmission will normally be observed at 55–65 psi. However, the pressure will vary with conditions and it is permissible to operate at a stabilized pressure within the range of the red lines on the pressure gage. It is permissible to take-off with excessive transmission pressure and the red warning light on, since the indicated pressure may exceed the maximum continuous operating pressure when the oil temperature is low and take-off rpm is applied. However, during flight the temperature and pressure must be checked for stabilization within the normal operating range. If it is not obtained in 15 minutes, land immediately. Transmission temperature and pressure warning lights can be actuated by any one of the following:

1. Oil pressure below the low limit.
2. Oil pressure above the high limit.
3. Oil temperature above the high limit.
4. Malfunction of the warning light system.

Should warning light come on but the temperature and pressure remain normal (stabilized at or within the red line limits), the pilot can continue his flight and investigate the cause upon landing. However, any time an excessive temperature is accompanied by excessive changes in pressure, landing should be made immediately.

Note

During autorotative landings with high rotor rpm, the transmission oil pressures can build up as high as 100 psi. Under these conditions the warning light will come on. This is not an indication of a malfunction and is normal provided that:

1. Warning light was not on prior to autorotation.

2. Warning light goes out when normal rotor rpm is resumed.

CLUTCH ACTUATOR CHECK.

The friction and jaw clutch switches should be placed on in proper sequence to check the actuator cycle. This test should be made twice by the pilot, while a crewmember watches the actuator arm from the left side of the mid transmission. This is necessary since too much torque can be applied to the clutch actuator motor and cause it to slip. This slippage will be apparent (with the clutch switch in the DISENGAGE position) by continued illumination of the clutch warning light on the console. This condition permits the clutch actuator to move the clutch engaging mechanism directly into the jaw position, thereby damaging the rotor system. The arm is upright when both clutches are disengaged. It moves aft for friction clutch engagement and down at 45 degrees for jaw clutch engagement. This visual check will show that the actuator arm is working through its full range of travel and stopping at its designated points to minimize the possibility of damage to the helicopter resulting from actuator failure.

Note

The clutch actuator slippage described above can only occur on helicopters equipped with Airesearch actuators models 31708 and 31708-1. A modified actuator, Airesearch model 38162, which eliminates the possibility of clutch slippage, is installed on some helicopters.

PREFLIGHT CHECK PROCEDURE.

This detailed check procedure shall be performed prior to each starting of the engine. A qualified crewmember, perhaps a co-pilot or mechanic, should stand in the cargo/passenger compartment adjacent to the clutch where he can observe the clutch actuator.

Pilot	Crewmember
1. Friction clutch switch: ENGAGE. 2. Jaw clutch switch: ENGAGE. 3. Friction clutch switch: DISENGAGE.	Observe that desired action takes place and signal confirmation to the pilot.

CLUTCH ENGAGING LIGHT CHECK.

This check should be made simultaneously with the Clutch Actuator Check. The jaw clutch amber light on the console is operated by two interdependent microswitches. One is mechanically actuated, and the other is actuated by oil pressure. The mechanically actuated switch is set to break the light circuit when the jaw clutch is in full engagement position. This will cause the light to go out if there is oil pressure in the mid transmission. If the light does not go out after the visual Clutch Actuator Check has been made and when there is oil pressure in the mid transmission, it is probable that the limit switches in the clutch actuator are malfunctioning. This warrants shut-down and inspection for adjustment or repair except when flight is absolutely necessary. The procedure to follow in an emergency to determine engagement status is to perform the Functional Engagement Check presented hereinafter under Rotor Clutch Engagement.

ROTOR CLUTCH ENGAGEMENT.

CAUTION

Rotor engagement must not be attempted when the clutch warning light is already on. Under this condition the clutch will travel immediately into the jaw position instead of starting friction engagement. The resultant damage to the rotor system will be the same as during any other premature jaw clutch engagement.

To engage the rotors, first throttle the engine to indicate 1100–1200 rpm. Lift the friction clutch switch guard and place the switch in the FRICTION position. Lock switch in this position with the guard. Maintain constant throttle until the engine tachometer indicates approximately 900 rpm. This throttle setting may then be maintained until engine and rotor rpm are synchronized. Engine and rotors should synchronize in 8–15 seconds. An adjustment of the friction clutch may be required if engagement requires more, or less, time than aforementioned. Do not permit engine speed to drop below 800 rpm during engagement.

Note

In cold weather, it may be necessary to engage at a higher rpm but the engine speed should not exceed 1500 rpm nor fall below 800 rpm.

The jaw clutch may be engaged only when the tachometer needles are synchronized. Synchronization of the needles is essential during the entire time required for jaw clutch engagement.

WARNING

If jaw clutch has been actuated before synchronization of engine and rotor rpm, shut down immediately and inspect rotor and drive system for damage.

The jaw clutch light will go out when clutch is fully engaged. Release the jaw clutch spring-loaded switch, and it will return to the DISENGAGED position. The friction switch must remain in the FRICTION position until the clutch is to be disengaged.

Do not run up engine when friction clutch only is engaged. Such action warps the bronze friction plates and discolors the steel plates due to the extreme heat generated when the clutch plates slip.

Disengage clutch immediately if oil pressures are not indicated in the forward, mid, and aft transmissions within approximately two minutes.

CAUTION

Make certain the rotor and engine tachometer needles are synchronized before engaging jaw clutch.