# SECTION VII

# SYSTEMS OPERATION

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## ENGINE FUEL SYSTEM

**GENERAL.** The engine fuel system (figure 7-1) consists of separate identical power section fuel systems, fuel pumps and a common torque control unit. In operation, fuel from the aircraft boost pump passes through the oil-to-fuel heater, enters the power section fuel pump housing, then passes through a 10-micron filter (with by-pass capability in the event of screen blockage), and into the fuel pump. From the fuel pump, fuel passes through a solenoid operated transfer valve, and then to either automatic or manual fuel control unit as selected.

### FUEL SYSTEM OPERATING MODES

In the automatic mode, the solenoid valve is de-energized and fuel passes into the automatic fuel control unit. The automatic fuel control system of a power section consists of an automatic fuel control unit (incorporating an Ng governor), a $T_{t5}$ limiter, a power turbine governor, and a torque control unit (common to both power sections' automatic fuel control systems) with a dual function of torque limiting and equalization. The automatic fuel control unit integrates pneumatic signals from the power turbine ($N_f$) governor and the torque control unit and the $T_{t5}$ limiter, as well as from its integral governor, and allows a fuel flow up to the maximum permissible, provided that the sensed limits are not exceeded. Metered fuel passes through a check valve and a cut-off valve in the manual fuel control unit, and then to the surge dampener, flow divider and fuel manifold.

In the manual mode of operation, the solenoid valve is energized, and this causes the transfer valve to direct fuel flow to the manual fuel control unit where fuel flow is determined solely by the position of the manual metering valve. This metered fuel passes through a check valve and cut-off valve and then to the surge dampener, flow divider and fuel manifold.

Each power section's fuel manifold is a dual one, with a combined total of 14 Simplex fuel nozzles supplying fuel to the combustion chamber. Two drain valves on each power section's gas generator case ensure drainage of residual fluids from the combustion chamber and gas generator case after power section shutdown.

### FUEL PUMP

This is a positive displacement gear-type pump, incorporating spring- and pressure-loaded bushings, driven off the accessory gearbox. A flexible coupling transmits drive to pump gears and is lubricated by oil mist from the accessory gearbox. Fuel enters the pump through a 10-micron screen and passes to the pump gear chamber. A spring-loaded piston-type relief valve provides an alternative path for unfiltered fuel in the event of a pressure build-up caused by filter screen blockage, and two pressure taps are provided to monitor pressure upstream and downstream from the screen. By-pass fuel is returned to the pump inlet downstream from the filter by an orifice, and a tapping upstream of the orifice takes fuel to pressurize pump gear bushings.

### AUTOMATIC FUEL CONTROL UNIT

The Automatic Fuel Control Unit (AFCU) is mounted on the accessory gearbox and driven at a speed proportional to compressor turbine speed. It establishes a proper fuel schedule in response to power requirements by controlling the speed of the compressor turbine through regulation of fuel flow. The AFCU can, for descriptive purposes, be divided into two sections: fuel and pneumatic.

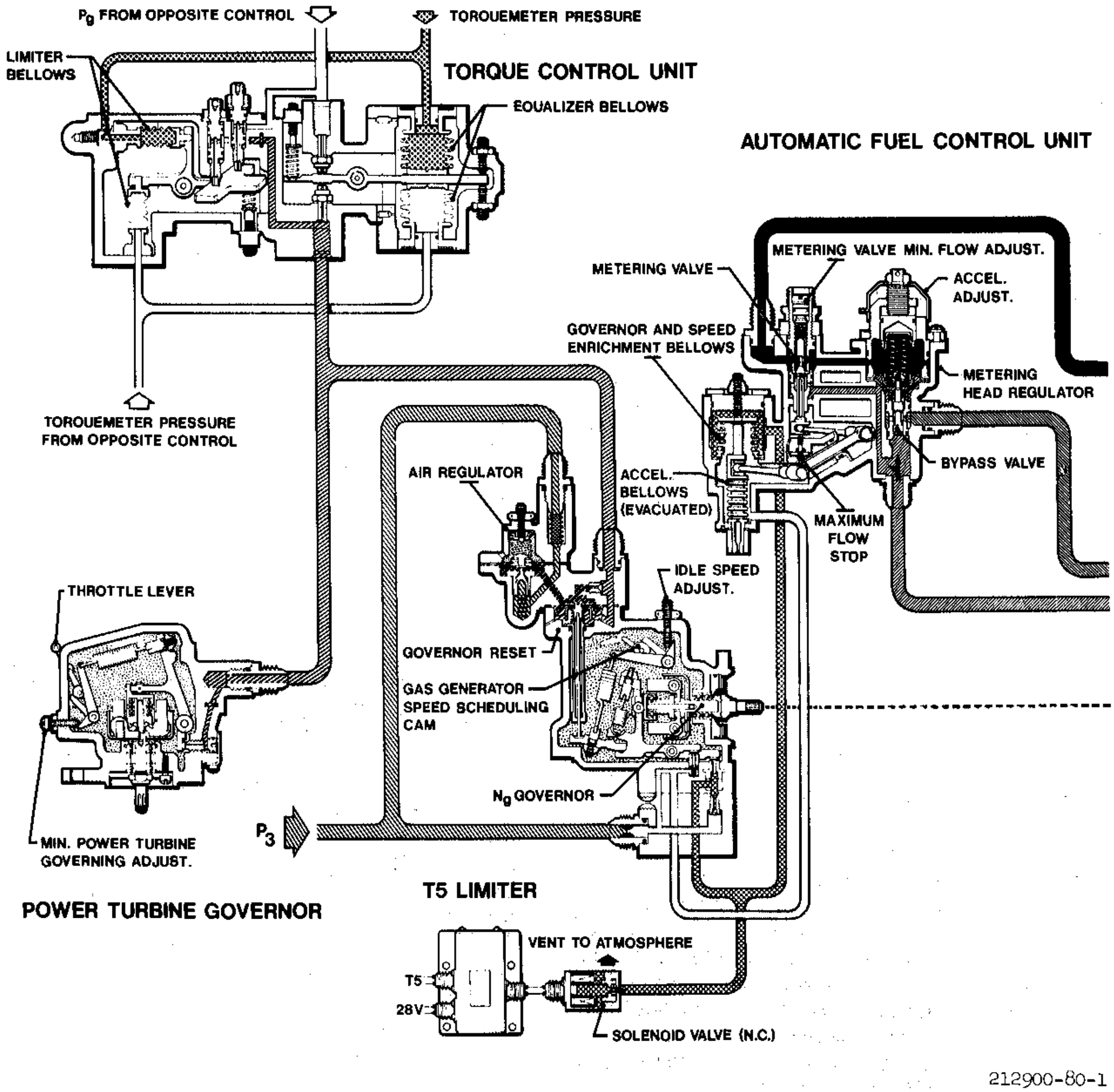


Figure 7-1. Engine fuel control system – schematic (Sheet 1 of 2)

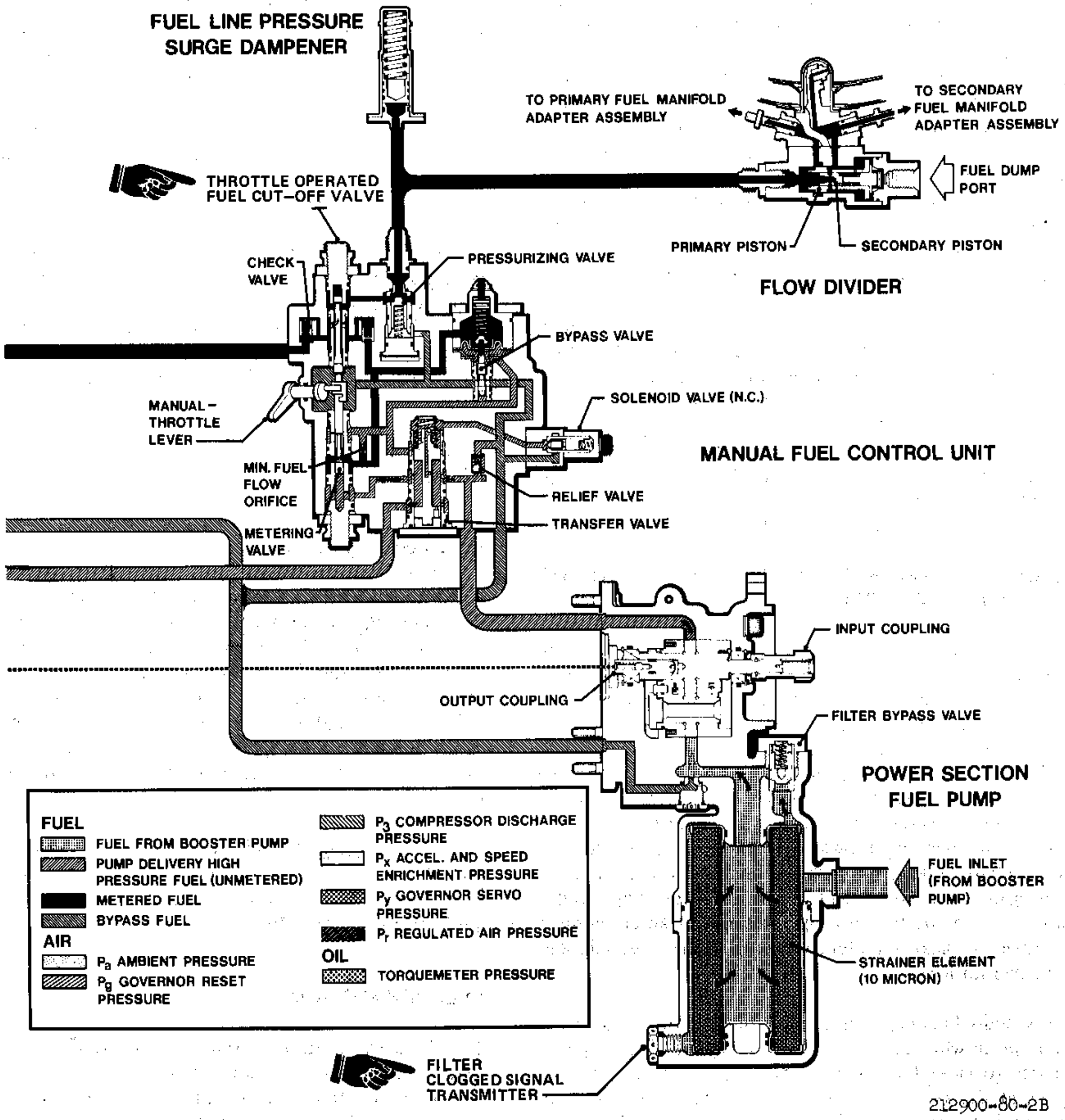


Figure 7-1. Engine fuel control system – schematic (Sheet 2 of 2)

## FUEL SECTION

The AFCU is supplied with fuel from the fuel pump by a transfer valve in the Manual Fuel Control Unit (MFCU). Fuel flow is established by a metering valve and by-pass valve system, fuel at pump ($P_1$) pressure being applied to the entrance of the metering valve. Fuel pressure immediately after the valve, metered fuel ($P_2$) pressure, is compared with $P_1$ pressure by the by-pass valve, and a constant differential ($P_1 - P_2$) is maintained. The orifice of the metering valve changes to meet specific power section requirements, and fuel pump output in excess of those requirements is returned to the pump inlet. Returned fuel is referred to as $P_0$. The by-pass valve consists of a sliding piston in a ported sleeve, actuated by a diaphragm and spring. In operation, spring force is balanced by $P_1 - P_2$ pressure differential working on the diaphragm.

The metering valve consists of a contoured needle working in a sleeve, so that needle movement changes the valve orifice area. The by-pass valve maintains an essentially constant differential fuel pressure across the orifice, regardless of variations in fuel inlet and discharge pressures.

Compensation for variations in specific gravity of the fuel, caused by fuel temperature changes, is provided by bi-metallic disks under the by-pass valve spring.

## PNEUMATIC (POWER INPUT SPEED GOVERNOR AND ENRICHMENT) SECTION.

A speed-scheduling cam on the power shaft depresses an internal lever to its maximum position during operation, and this cam follower lever is connected by a spring to the governor lever. The governor lever is pivoted, and an insert on its free arm operates against an orifice to form a governor valve. An enrichment lever is pivoted at the same point as the governor lever. It has two extensions which straddle the governor lever, and a gap between lever and straddle extensions allows the governor lever limited independent movement. A roller on the enrichment lever drive arm contacts the end of the governor spool, and a fluted pin on the free arm operates against an enrichment hat valve. A small enrichment spring connects enrichment and governor levers.

The speed-scheduling cam applies tension to the governor lever spring when increased power is demanded, and applies a force to close the governor valve. The enrichment valve opens at the same time because enrichment spring tension ensures that enrichment lever follows governor lever. As the drive shaft from the compressor turbine rotates, it turns a table on which governor weights are mounted. Small levers on the inside of the weights contact the governor spool and, as $N_g$ increases, centrifugal force causes the weights to apply increasing force to the spool. This tends to move the spool outward on the shaft against the enrichment lever, and when this force overcomes enrichment spring tension the enrichment lever moves and the enrichment valve closes.

Enrichment and governor valves operate whenever Ng increases sufficiently to overcome governor spring tension, the enrichment valve closing and the governor valve opening. At a point dependent on speed-scheduling cam position, governor spring tension overcomes enrichment spring tension, and the enrichment lever moves independently of the governor lever to close the enrichment valve. When the gap between straddle extensions and governor lever is taken up, governor lever and enrichment lever again move together. At this point the enrichment hat valve is fully closed. The governor valve will open if $N_g$ force continues to increase sufficiently.

An air pressure regulator and governor reset section also controls movement of the governor lever. The air pressure regulator consists of a spring-loaded, diaphragm-operated valve. Compressor discharge pressure is applied to the entrance of this valve. Spring-load and ambient air pressure are applied to one side of the regulator diaphragm creating a force which opens the valve; regulated air pressure ($P_r$) is applied to the other side of the diaphragm causing a force to close the valve. Thus, as $P_r$ rises, the valve closes, and vice versa.

Regulated air pressure ($P_r$) is also applied to one side of the governor reset diaphragm and passed through the reset bleed to the other side of the diaphragm, where it is designated $P_g$. An external line from the reset section $P_g$ outlet connects with the power turbine governor. When the governor reset valve (orifice) is opened, there will be a flow through the reset bleed with pressure drop ($P_r - P_g$) and $P_g$ will be reduced. Movement of the reset diaphragm will then cause the reset rod to apply a force to the governor lever to overcome the governor spring force and open the governor valve.

The main governor body incorporates a vent port to atmosphere ($P_a$). Modified compressor discharge pressures, $P_x$ and $P_y$, will be bled to $P_a$ when enrichment and governor valves respectively are open.

## BELLOWS SECTION.

The bellows assembly contains governor bellows and evacuated acceleration bellows connected by a rod. The end of the acceleration bellows opposite the connecting rod is attached to the assembly body casting and the bellows provide an absolute pressure reference. The governor bellows are secured within the body cavity, and their function is similar to that of a diaphragm. Bellows movement is transmitted to the metering valve by a cross-shaft and associated levers. The cross-shaft moves within a torque tube which is attached to the cross-shaft near the bellows lever. The tube is secured to the body casting by means of adjustment bushing at the other end, and cross-shaft rotational movement is converted to torque change in the tube. The tube forms a seal between air and fuel sections of the control unit and is positioned during assembly to provide a force tending to close the metering valve. The bellows oppose this force through pressure of $P_y$ on the outside of the governor bellows and $P_x$ on the inside of the governor bellows and outside of the acceleration bellows.

$P_x$ and $P_y$ vary with changing power section operating conditions and environment. When both increase, as a result of acceleration, the bellows open the metering valve. When Py decreases, as desired $N_g$ is approached, the bellows tend to close the metering valve. When both pressures decrease, as a result of deceleration, the bellows close the metering valve to its minimum flow stop.

## MANUAL FUEL CONTROL UNIT.

The MFCU is mounted, with the AFCU, on the fuel pump which is mounted on the accessory gearbox. Under normal operational conditions it passes fuel from the pump to the AFCU, and from the AFCU via the flow divider to the fuel manifold and nozzles. If manual control is necessary, a solenoid valve is energized to operate a transfer valve and direct fuel through the MFCU to the flow divider.

## SOLENOID AND TRANSFER VALVE

The transfer valve consists of a spring-loaded piston moving in a ported cylinder. Depending on the position of the piston, fuel is passed from an inlet port to an outlet port to the AFCU, or from the inlet port to a manually controlled metering valve. Pressures across the transfer valve piston are equalized by a piston centerbore, which allows fuel to fill the space above the piston. A spring-loaded ball-type relief valve in parallel with the transfer valve allows fuel to be by-passed back to the fuel pump if inlet pressures increases.

The solenoid valve is spring-loaded to a closed position and seals the space above the transfer valve piston while de-energized. When electrical power is applied to the solenoid valve, it opens against spring pressure to allow fuel from the transfer valve into the by-pass line. The resultant drop in pressure above the transfer valve piston causes it to move against spring pressure and block the fuel outlet port to the AFCU. At the same time it opens a port to the MFCU metering valve.

## METERING VALVE

The manual throttle lever controls a combined metering and cut-off valve. A piston, mechanically linked to the manual throttle lever, controls fuel flow in the metering valve cylinder from inlet to outlet port. Space below the piston is filled with fuel from the transfer valve, and pressure of this fuel prevents piston drift from any set position. A suitable minimum fuel flow is ensured by a by-pass restrictor across metering valve inlet and outlet ports which becomes effective when the valve approaches its minimum position.

The manual power lever also controls a piston in a ported cylinder which, when in the "Off" position, completely cuts off fuel flow to manifold and nozzles. There are two inlet ports to the cylinder, one from the AFCU and one from the manual metering valve. In each line to the cylinder is a check valve, and back pressure ensures that the inoperative system is sealed off. In the "Off" position, fuel reaching the cylinder is directed to a by-pass line.

## PRESSURIZING AND BY-PASS VALVES.

A pressurizing valve in the line from cut-off valve to flow divider ensures that no fuel flows to the flow divider until a pre-set minimum pressure has been attained. A diaphragm by-pass valve, similar to the one in the AFCU, controls by-pass fuel flow to maintain $P_1 - P_2$ constant.

## POWER TURBINE GOVERNOR.

The power turbine governor of each power section fuel control system is mounted on the appropriate side of the reduction gearbox, and driven at a speed proportional to power turbine. It supplies a signal to the AFCU to change compressor speed whenever it senses a power turbine speed change. It employs a drive body similar to that of the AFCU compressor turbine governor. A difference is the elimination of the speed enrichment mechanism. Normally, the power turbine governor lever positions the governor so as to fully close the governor valve.

Any tendency of the power turbine to change speed results in the governor valve bleeding off more or less $P_g$. If power turbine speed increases, the valve bleeds off more $P_g$ and the $P_r - P_g$ differential increases, causing the governor reset rod to increase its force on the AFCU governor lever to lower $P_y$ and reduce fuel flow. If power turbine speed decreases the process is reversed.

## TORQUE CONTROL UNIT.

A single torque control unit, mounted on the reduction gearbox, receives torquemeter oil pressure signals proportional to the torque outputs of the two power sections. By controlling $P_g$ in each power section fuel control system, the torque control unit limits engine torque output and compensates for a low power section torque output.

Engine torque is limited by sensing torquemeter pressures from the two power sections and adding them in two summing bellows. At a specific total, normally closed pneumatic orifices are opened to lower $P_g$ in both power sections, and fuel flow is reduced.

A low power section torque is compensated for by means of opposed bellows which sense any difference in torques, and move a lever to restrict one of two normally open pneumatic orifices. Each pneumatic orifice vents $P_g$ from its power section fuel control system, and closing an orifice results in increased $P_g$ from its power section and consequent fuel flow increase. Closure of the $P_g$ orifice of the low torque power section tends to increase that torque.

## FLOW DIVIDER ASSEMBLY

The flow divider receives metered fuel from the MFCU and delivers it to primary and secondary manifolds. Initially, fuel enters the flow divider and exerts sufficient pressure on the divider cylinder composite piston to allow fuel flow to the primary manifold. When pressure has built up sufficiently, the inner piston is pushed back against spring pressure to allow fuel flow to the secondary manifold. In this way a cool start is ensured by igniting initially on seven nozzles only.

When fuel is cut off from the flow divider, the composite piston moves under spring pressure to block the inlet and allow fuel in primary and secondary manifolds to drain through the dump valve.

### Fuel Manifold.

The fuel manifold assembly delivers a constant supply of high-pressure fuel and two similar sets of seven fuel manifold adapters with simplex nozzles. The dual fuel manifold consists of 28 short fuel transfer tubes fitted with preformed packings at each end and inter-connected by the 14 fuel manifold adapters. Locking plates secured by bolts to a mounting boss keep the transfer tubes in proper alignment on the circumference of the gas generator case.

### Fuel Nozzle Assembly.

The fuel nozzle assembly consists of 14 simplex fuel nozzles fitted with swirl-type tips. These provide a finely atomized fuel spray in the annular combustion chamber. Each fuel nozzle assembly is secured to an individual fuel manifold adapter which extends into the combustion chamber liner. The nozzle assembly consists of a sheath, a spray nozzle, and a tip protected by a fine strainer. The sheath, which functions as a heat shield, fits over the fuel nozzle assembly. It is perforated at the flange end to permit the entry of compressor discharge air which cools the nozzle tip and helps atomize the fuel sprayed through a hole drilled in the lower side of the sheath. The fuel nozzles are positioned on the adapters so as to produce a continuous tangential spray from one nozzle to the next in the combustion chamber. The combustion chamber liner is located and supported by alternate fuel nozzle sheaths.

# ENGINE AIR SYSTEMS

## GENERAL

Each power section has three separate systems:

Compressor interstage air bleed system: airseal and bleed system for numbers 1, 2 and 3 bearing compartments, and turbine vane and disk cooling system; and compressor discharge air for pneumatic fuel control system, and to pressurize carbon seals in the reduction gearbox, taken from bosses on the gas generator case.

## COMPRESSOR BLEED VALVE.

The compressor bleed valve is secured by four bolts over a port at the 5 o'clock position on the gas generator case inner front section. To provide anti-stall characteristics the valve opens to spill interstage compressor air ($P_{2.5}$) at low compressor speeds. The valve remains closed at higher speeds (above 91% Ng). Compressor delivery air ($P_3$) is tapped off and metered through a fixed orifice in the bleed valve, then directed across the top of the piston and out through a convergent-divergent orifice. The control pressure ($P_x$) between the two orifices acts upon the lower side of the piston, so that when $P_x$ is greater than $P_{2.5}$ the bleed valve closes. In the closed position, the port is sealed off by the piston which is forced against its seat by the action of $P_x$.

## BEARING COMPARTMENT SEALS, TURBINE COOLING SYSTEMS.

Pressure air is used to seal numbers 1, 2 and 3 bearing compartments and also to cool the compressor and power turbines and the compressor turbine inlet vanes. Labyrinth air seals protect bearing compartments and are of two-part construction with plain rotating surfaces located within stationary circular seals with deep annular grooves machined inside the bore. When parts are matched, and the clearance between rotating and stationary parts kept as small as possible, air pressure drop across the seal prevents passage of oil when power section is in operation.

Compressor interstage air is used to provide a pressure drop across the labyrinth air seal to the rear of number 1 bearing. The air is introducted via 12 holes in the third compressor spacer disk, through the center of the compressor disks to 6 outlet holes in the compressor front hub. The compressor stubshaft and sleeve have slots which allow air to the center of the double stator seal assembly. Air is allowed to pass to front and rear across annular grooves. The air across the rear half seal is returned to the main air flow in front of the compressor 1st stage rotor. The air across the front half seal passes through 10 holes in the air seal stator, and 10 matched holes in the compressor inlet case center-bore flange to the accessory gearbox.

The number 2 bearing is protected by a double labyrinth seal on the compressor side and a single labyrinth seal on the compressor turbine side. Initially, while air pressure in the power section builds up, the front labyrinth air seal is pressurized by air bled from the centrifugal impeller tip. Air is passed across the seal to be scavenged with oil from the bearing compartment through the scavenge line at the bottom of the compartment. Under running conditions, $P_3$ air from around the combustion chamber outer exit duct passes through holes in the gas generator case centerbore outer flange, and pressurizes the front labyrinth air seal via 6 hollow struts in the bearing compartment support housing. Air passes from the seal central groove forward through half the seal to rejoin the main air stream at the centrifugal impeller exit, and rearward through half the seal to be scavenged with oil.

The $P_3$ air stream which pressurizes the forward seal also passes down the leading face of the compressor turbine to cool it. Pressure differential across number 2 bearing rear seal is provided by part of this air stream flowing forward into the bearing compartment. The main air flow is through holes in the compressor stubshaft to the center bore of both turbine disks. Air passes outward between the disks to cool their surfaces, and through holes in the power turbine stubshaft to pressurize number 3 bearing labyrinth seal.

Number 3 bearing compartment is sealed at its front end by a double labyrinth seal. Air passes forward through half the stator to join the main air stream through the power section, and rearward to seal the bearing compartment.

Compressor discharge air for the fuel control system is taken from a boss at the 7 o'clock position on the gas generator case, forward to the air regulator unit of the AFCU, and from the regulator to the power turbine governor and torque control unit on the reduction gearbox. Compressor discharge air for pressurizing carbon seals in the reduction gearbox is supplied from a second boss located at the 7 o'clock position on the gas generator case directly to the reduction gearbox.

## ENGINE OPERATION

### DROOP COMPENSATOR

Droop is defined as the speed change in engine rpm (Nf) as power is demanded from a no-load condition. It is an inherent characteristic designed into the governor system. Without this characteristic, instability would develop as engine output is increased resulting in Ng overshooting or hunting the value necessary to satisfy the new power condition. Design droop of the engine governor system is as much as 12% rpm (no load to full power). If the free turbine speed were allowed to droop, other than momentarily, the reduction in rotor speed could become critical; therefore, a droop compensator is installed on the governor control to raise Nf speed as power is increased to the rpm value selected by the pilot. The compensator is a direct mechanical linkage between the collective control lever and governor lever on the Nf governor. Properly rigged, the droop compensator will hold Nf rpm to plus or minus 1% rpm from flat pitch to climb out power. On single engine operation droop will be as much as 3%.

## POWER ASSURANCE CHECK (SINGLE ENGINE)

The power assurance check (figure 7-2) is provided as a means of evaluating engine performance prior to flight without using maximum power. This check is not a mandatory requirement, but may be performed at the option of the user as often as desired. It's only intent is to alert the pilot that an engine power problem may exist prior to initiating his mission. If engine performance does not meet that shown in figure 7-2, steps should be taken to determine if an actual engine problem does exist.

**NOTE**

The only authorized engine performance (power) reject criteria is the engine topping check as contained in T.O. 1H-1(U)N-6CF-1. In the event a power section does not meet the power assurance check, but does produce adequate topping power, the topping check is the deciding factor for rejection.

## ENGINE ACCELERATION CHECK

Due to the difference in BTU content between JP-4 and JP-5 fuels, engine performance may be affected when changing or intermixing these fuels. Prior to flight, after changing from JP-4 to JP-5 fuel, or reverse, an engine acceleration check will be performed. If acceleration time exceeds that specified in Figure 7-3, an adjustment to the fuel control will be made in accordance with T.O. 1H-1 (U)N-2-2.

## ACCELERATION CHECK PROCEDURES

1. Complete all engine start and runup procedures in accordance with Section II.

2. Set throttles at flight idle (61 ± 2%), collective Full Down.

3. Lock one throttle with friction and move other throttle rapidly to full open. At 90% Ng rapidly retard throttle to flight idle. Acceleration times from 61 ± 2% to 90% should not exceed times indicated in Figure 7-3.

4. Repeat step 3 for the other engine.

## POWER ASSURANCE CHECK
## (SINGLE ENGINE)

### CHART A

| PRESS ALT. | -2000 | -1500 | -1000 | -500 | 0 | 500 | 1000 | 1500 | 2000 |
|---|---|---|---|---|---|---|---|---|---|
| % TORQUE | 49.5 | 48.8 | 47.8 | 47.0 | 46.0 | 45.0 | 44.2 | 43.4 | 42.5 |
| PRESS ALT. | 2500 | 3000 | 3500 | 4000 | 4500 | 5000 | 5500 | 6000 | 6500 |
| % TORQUE | 41.5 | 40.5 | 39.8 | 38.9 | 38.0 | 37.0 | 36.2 | 35.3 | 34.5 |
| PRESS ALT. | 7000 | 7500 | 8000 | 8500 | 9000 | 9500 | 10000 | 10500 | 11000 |
| % TORQUE | 33.5 | 32.7 | 31.8 | 30.9 | 30.0 | 29.2 | 28.3 | 27.5 | 26.5 |

EXAMPLE

1. ALTIMETER .................................... 29.92 IN. HG.
2. OBSERVED ALTITUDE ................................ 1500 FT.
3. OBSERVED CHART A TORQUE ........................ 43.4 %
4. START BOTH ENGINES
5. ON GROUND, ENGINE NO. 2 TO FLIGHT IDLE
6. STABILIZE NO. 1 ENGINE AT 97% Nf AND AT CHART A TORQUE FOR AT LEAST 30 SECONDS AND OBSERVE:
   - Ng..... 95.2%
   - ITT.... 710°C
   - OAT.... 20°C
7. OBSERVED Ng AND ITT MUST BE LESS THAN CHART B Ng AND ITT FOR OBSERVED OAT
8. REPEAT CHECK ON NO. 2 ENGINE WITH NO. 1 ENGINE IN FLIGHT IDLE
9. IF OBSERVED Ng AND/OR ITT ARE GREATER THAN CHART B Ng AND ITT FOR OBSERVED OAT, STEPS SHOULD BE TAKEN TO DETERMINE IF AN ACTUAL ENGINE PROBLEM EXISTS.
10. HOVER IGE AND CHECK NO. 1 AND NO. 2 ENGINE TORQUE NEEDLE SPLIT, NO GREATER THAN 8%.

### CHART B

| OAT | °C | 50 | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 | 5 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ng | % | 100 | 99.3 | 98.6 | 97.9 | 97.3 | 96.6 | 95.9 | 95.2 | 94.5 | 93.9 | 93.1 |
| ITT | °C | 810 | 795 | 780 | 765 | 750 | 735 | 720 | 705 | 695 | 680 | 665 |
| OAT | °C | -5 | -10 | -15 | -20 | -25 | -30 | -35 | -40 | -45 | -50 | |
| Ng | % | 92.5 | 91.8 | 91.1 | 90.5 | 89.8 | 89.1 | 88.5 | 87.8 | 87.1 | 86.4 | |
| ITT | °C | 650 | 635 | 620 | 605 | 590 | 580 | 560 | 550 | 535 | 520 | |

212947-30B

**Figure 7-2. Power assurance check**

1. ENTER GRAPH AT PRESSURE ALTITUDE AND ASCEND TO INTERSECT WITH OUTSIDE AIR TEMPERATURE LINE.

2. MOVE HORIZONTALLY LEFT TO INTERSECT CORRECTED MAXIMUM ACCELERATION TIME.

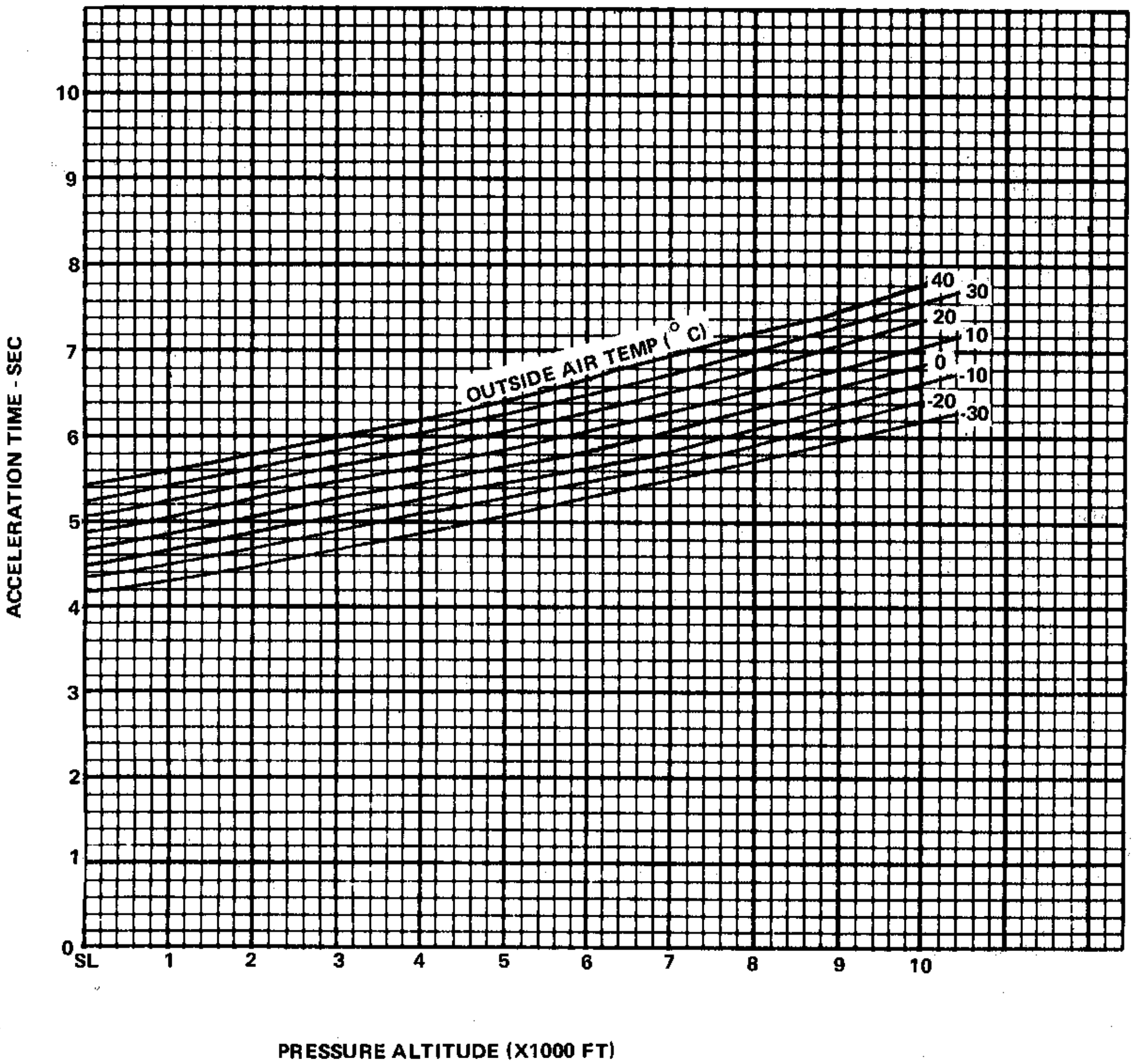


Figure 7-3. Engine acceleration time determination

# SECTION VIII

# CREW DUTIES

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## PILOT

In addition to the pilot's primary duties outlined in NORMAL PROCEDURES, Section II, the manner and proficiency with which each crewmember performs his related duty is the responsibility of the pilot. Therefore, the pilot must possess and maintain a thorough knowledge of each crewmember's duty and is responsible for crew coordination.

## COPILOT

The copilot should be familiar with the duties of the pilot and other crewmembers so that he may perform functions as directed by the pilot.

## FLIGHT MECHANIC

The flight mechanic will be responsible for maintenance, servicing, inspection, and security of the helicopter. He will also determine that all required miscellaneous equipment is aboard and properly stowed before each flight. In certain instances he may have to act as a fireguard and accomplish those duties normally performed by ground personnel. Before takeoff, he should ensure that both cargo doors are secured for flight. The flight mechanic may have to accomplish these additional duties:

1. Preflight Inspection (when delegated by pilot).
2. Rescue hoist operator.
3. Assist the pilot during external cargo operation.
4. Cargo and/or passenger loadmaster.
5. Litter attendant.
6. Gunner.

### Cargo Sling Operation

#### Pre-flight

**NOTE**

Two individuals are required to properly check operation of the cargo hook release.

1. Form 781 — CHECKED.
2. Main Fuel Switch — OFF.
3. Cargo Hook Release Circuit Breaker — IN.
4. Battery Switch/External Power — ON.
5. Cargo Release Switch — ARMED, check for light.
6. External Cargo Suspension Assembly — CHECKED. For proper installation of assembly and rigging of manual release arm (visually inspect hook for cracks and mechanical release cable for fraying).
7. Pilots Manual Cargo Release — CHECKED.
8. Pilots and Copilots Electrical Release Switches — Check Operation.
9. Cargo Release Switch — OFF.
10. Battery Switch/External Power — OFF.

**NOTE**

The flight mechanic will be responsible for the entire cargo sling preflight checklist and will properly brief the individual assisting with the preflight.

## RESCUE HOIST OPERATOR

This portion of the flight manual contains itemized procedure with necessary amplification for operation of the rescue hoist by the hoist operator. The line items in the flight manual and checklist are identical with respect to arrangement and item number. When a checklist item is followed by a crew position designator i.e. (P), (CP), (HO) etc. that crew member takes the action and if the action is in quotes, the hoist operator will request the action and response by the crew member designated. The hoist operator will not proceed to the next checklist item until the response has been received. If the action is not in quotes, he completes the action and remains silent.

The rescue hoist operator may be any crewmember designated to that position as the mission dictates. Therefore, this duty should be thoroughly understood by all crewmembers.

## RESCUE HOIST OPERATION – HOIST OPERATOR

Preflight

1. Forms 781 – CHECKED.

2. Hoist Forms – CHECKED.

3. Battery Switch/External Power – OFF.

4. Cabin door by rescue hoist – FULL OPEN.

5. Hoist assembly – CHECK CONDITION AND INSTALLATION.

a. Base of hoist assembly positioned on cabin floor stud at station 82.0, BL 35.10 or station 131.01, BL 39.50 either side.

b. Top of hoist assembly aligned to cabin roof stud at station 82.0, BL 35.10 or station 131.01, BL 39.50 on either side and lock nut secured.

**CAUTION**

Tighten the lock nut only by hand. Excessive force may result in damage to the cabin roof.

c. Check hoist general condition and security.

d. Actuator Plate – INSTALLED AND SECURE.

**CAUTION**

Do not use stud adapters if they cannot be manipulated to the snap-to-lock position.

e. Actuator Lever – POSITIONED AND SECURE.

f. Actuator – INSTALLED AND SECURE.

g. Electrical Connectors – CHECKED.

h. Hoist Boom – CHECKED.

(1) Retaining Pin Installed

(2) Turnbuckle Adjusted and Secure (Insure boom head clears airframe).

**WARNING**

Failure to install the hoist boom retaining pin properly could result in boom failure.

i. Boom Head – CHECKED.

(1) Boom swivel head rotates freely. (Approximately 45 degrees in both directions).

(2) Hoist hook is secured and free to rotate with a minimum of 50 lbs. on hook.

(3) Slide lock safety pin is installed and slide lock condition and security.

6. Pilot's Cable Cut Switch Guard – DOWN AND SAFETIED.

7. HOIST Operator's Cable Cut Switch Guard – DOWN AND SAFETIED.

8. Circuit Breakers – CHECKED.

a. Cable Cut Circuit Breaker – IN.

b. Hoist Control Circuit Breaker – IN

c. Hoist Power Circuit Breaker – IN.

d. Boom Actuator Circuit Breaker – IN.

9. Battery Switch/External Power – ON.

**NOTE**

Recommend external power be used for ground checking the rescue hoist system.

10. Non-Essential Bus Switch – MANUAL.

11. Hoist Power Switch – ON.

12. Rescue hoist Caution Lights – ON (Both pilot's panel and hoist control box).

13. Pilot's Rescue Hoist Switch – CHECKED.

a. RIGHT – Boom pivots outward to the fully extended position.

b. NEUTRAL   Boom remains in the fully extended position.

c. DOWN   Cable extends.

d. NEUTRAL   Cable holds position.

e. UP   Cable retracts.

f. LEFT   Boom pivots inward to the stowed position.

14. Hoist Operator's Pendant   CHECKED.

a. Boom switch   OUT (Boom pivots outward to the fully extended position).

b. Pendant Cable Control Switch   RIGHT AND TOWARD DOWN (Cable extends).

(1) Traction sleeve motor is operational (as cable extends hold cable in a fixed position by hand to insure slack is not introduced from traction sleeve to hoist motor).

(2) Rescue hoist caution lights - OFF AT 5 TO 8 FEET OF CABLE EXTENSION.

**CAUTION**

To avoid excessive heating of the motor and gearbox, the hoist should be normally operated at full speed except when the cable end is within 5 to 8 feet of end of travel.

(3) Hoist oil sight gauge – CHECKED (Check hoist oil level sight gauge during fast mode only. Oil level should be 1/2 of the sight gauge, minimum).

(4) Hoist cable – CHECK CONDITION.

**NOTE**

When live hoist is anticipated, check full cable length and down limit switch operation.

**WARNING**

Ensure that pendant switch returns to center when released, thus stopping hoist cable travel.

c. Pendant cable control switch   LEFT AND TOWARD UP (Cable retracts)

(1) Check deceleration mode.

**NOTE**

Operation of the hoist at the full slow speed may result in cable racheting. This is normal and is not damaging to the cable or hoist.

(2) Up Limit Switch   CHECKED. Manually actuate up limit switches individually after cable is within three feet of boom. If satisfactory, slowly reel in the cable until the up limit switches shut off hoist operation.

**WARNING**

If a suspected up limit switch or deceleration malfunction has occurred (indicated by either a completely flattened rubber boot, a taut cable or a sound of hoist motor attempting to continue operation after switch contact) immediate cable and boom head replacement prior to next pick up is required.

d. Boom Switch - IN (Boom pivots inward to the stowed position).

15. Hoist Power Switch - OFF.

16. Audio Control Panel - CHECK.

a. ICS Position – CHECKED.

b. Hot Mike Position – CHECKED.

c. Loudhailer Position 5 – CHECKED (If applicable).

17. Non-Essential bus switch – NORMAL.

18. Battery switch/external power – OFF.

19. Gunners Harness – CHECK CONDITION.

20. Forest Penetrator – CHECK CONDITION AND OPERATION.

## INFLIGHT

**WARNING**

Internal rescue hoist is restricted from operation and shall remain in the stowed position any time the M-23 gun system is in operation or in the FIRE mode.

**WARNING**

When any crew member is not in his seat and is in the vicinity of the open cargo door, he shall be secured with a gunner's harness attached to any floor tie-down ring or bulkhead mounted seatbelt attachment ring.

1. Safety harness -- ON.

2. Cabin interphone control – SET.

3. Gloves. ON.

4. Non-essential Bus Switch – "MANUAL" (P).

5. Pilot's Cable Cut Switch Guard – "DOWN AND SAFETIED" (P)

6. Loudhailer – AS REQUIRED (On aircraft modified by TCTO 1H-1(U)N-513).

7. Hoist Operator's Cable Cut Switch Guard – "DOWN AND SAFETIED" (HO).

8. HOIST CON, HOIST PWR, AND HOIST CABLE CUT Circuit Breakers – "IN" (P).

9. HOIST ACTUATOR CIRCUIT BREAKER (on control box) – IN (HO).

**WARNING**

When operating hoist part number BL-8300-30, do not allow slack in cable. The forest penetrator or rescue device of equal weight (minimum ten pounds) will provide sufficient tension on the cable); however, this tension must be maintained by pulling down on the cable during hook-up of rescuee or grounding of the cable.

10. Door – FULL OPEN AND LOCKED (HO) (Obta: clearance from pilot prior to opening door).

11. Hoist Power Switch – "ON" (P).

12. Rescue Device -- ATTACHED (HO).

13. Hot Mike – CHECKED (HO) (To conduct this check, place the interphone on HOT MIKE and inform the pilot "Hoist Operator's Checklist is complete and ready for pick up." His acknowledgement completes the check. Return the HOT MIKE switch to OFF until on final approach, then ON).

**WARNING**

Aircrews will cease operation (unless life of rescuee is at stake) immediately upon detecting an accleration or deceleration mode failure or up limit switch failure.

**WARNING**

When operating the hoist, periodically observe the operation of the storage drum to ensure that it is working properly. Watch particularly for slack loops of cable between storage drum and the primary pully. To prevent clothing entanglement, do not wear loose clothing while operating the hoist.

**CAUTION**

With a load attached on the hoist hook, it is advisable not to make abrupt changes in the helicopter attitude until the load is aboard or raised as far as possible. "G" forces on an extended load could become excessive.

Ensure the hoist load and/or forest penetrator remain clear of the skids.

## SMOKE/FLARE DROP CHECKLIST

1. Safety harness – ON.

2. Interphone control – SET.

3. Gloves – ON.

4. Door – OPEN.

5. Smoke/flare device – PREPARED.

6. Smoke/flare drop checklist – "COMPLETED" (HO).

**MULTIPLE HOIST (AFTER PICK UP)**

1. "SURVIVOR IN AND SECURE, READY FOR TAKEOFF" (HO).

2. Hot Mike – OFF (HO).

3. "After pick up checklist – COMPLETED" (HO).

**CAUTION**

The cargo door will remain open and locked any time the hoist power switch is "ON."

**INFLIGHT (AFTER PICK UP – MISSION COMPLETE).**

* SEE Supp 15-94

* SOS SUPP 15-94



a. Boom Switch - OUT (Boom pivots outward to the fully extended position).

b. Pendant Cable Control Switch - RIGHT AND TOWARD DOWN (cable extends).

**WARNING**

Ensure that pendant switch returns to center when released, thus stopping hoist cable travel.

**CAUTION**

- The Hoist Operator's Pendant check requires an additional crewmember to maintain cable tension and prevent damage to the hoist cable.
- To avoid excessive heating of the motor and gearbox, the hoist should be normally operated at full speed except when the cable end is within 5 to 8 feet of end of travel. Slow speed operation is automatic in last 5 to 8 feet of travel during reel-in mode.

**NOTE**

Operation of the hoist at the full slow speed may result in cable racheting. This is normal and is not damaging to the cable or hoist. If objectionable, a slight increase in cable speed will eliminate this racheting.

DELETE

c. Rescue Hoist Caution Light - OFF AT 5 TO 8 FEET OF CABLE EXTENSION.

d. Hoist Oil Level Sight Gauge - CHECK. Check hoist oil level sight gauge during pendant reel in and reel out. Oil level should be one half of the sight gauge.

e. Hoist Cable - CHECK CONDITION AND DRUM ATTACHMENT. (Check for Broken Strands, Kinks, and Corrosion.)

f. Pendant Cable Control Switch - LEFT AND TOWARDS UP (cable retracts).

g. Check deceleration mode for proper operation (approximately 50% speed reduction) at approximately 5 feet from up limit switches.

h. Hoist Cable Swage — CHECK. Stop cable approximately 5 inches from up limit switch and visually check cable condition at swage attachment point by lifting rubber boot.

i. Up Limit Switch — CHECK. Manually actuate up limit switches individually after cable is within three (3) feet of boom. If satisfactory, slowly reel in the cable until the up limit switches shut off hoist operation.

**WARNING**

If a suspected up limit switch or deceleration malfunction has occurred (indicated by either a completely flattened rubber boot, a taut cable, or sound of hoist motor attempting to continue operation after switch contact) immediate cable and boom head replacement prior to next pick-up is required.

j. Boom Switch — IN (Boom pivots inward to the stowed position.)

13. Hoist Power Switch - OFF.

14. Audio Control Panel - CHECK.

    a. ICS Position - CHECK.

    b. Hot Mike Position - CHECK.

    c. Loudhailer Position 5 - CHECK.

15. Non-Essential Bus Switch - NORMAL.

16. Battery Switch/External Power - OFF.

17. Gunner's Harness - CHECK CONDITION.

18. Forest Penetrator - CHECK.

## IN FLIGHT

**WARNING**

When any crew member is not in his seat and is in the vicinity of the open cargo door, he shall be secured with a gunner's harness.

* SEE SUP: 15-91

1. Gunners Harness - ON (HO) (Properly adjusted and secured to helicopter.)

2. Cabin Interphone Control - INTERPHONE (HO).

3. Gloves - ON(HO).

4. Door - FULL OPEN AND LOCKED (HO). (Obtain clearance from pilot prior to opening door).

* SEE SUPP 1S-94

NOTE

Steps 5 and 6 below will be accomplished only when smoke is used. When smoke is used the hoist operator may continue through item 14 for hoist pickup.

5. "Smoke Device/Devices Prepared to Drop" (HO)

6. "Smoke Device/Devices Away" (HO)

7. Non-essential Bus Switch — "MANUAL." (P)

8. Pilot's Cable Cut Switch Guard - "DOWN AND SAFTIED" (P).

9. Loudhailer - AS REQUIRED. (On aircraft modified by TCTO 1H-1(U)N-513).

10. Hoist Operator's Cable Cut Switch Guard - "DOWN AND SAFTIED" (HO).

11. HOIST CONT, HOIST PWR, AND HOIST CABLE CUT Circuit Breakers - "IN" (P).

12. HOIST ACTUATOR CIRCUIT BREAKER (on control box) - IN (HO).

WARNING

When operating hoist part number BL-8300-30 do not allow slack in cable. The forest penetrator or rescue device of equal weight (minimum ten pounds) will provide sufficient tension on the cable; however, this tension must be maintained by pulling down on the cable during hook-up of rescuee or grounding of the cable.

13. Hoist Power Switch - "ON" (P).

14. Rescue Device - ATTACHED (HO).

15. Hot Mike - CHECKED (HO) (To conduct this check, place the interphone on HOTMIKE and inform the pilot "Hoist Operator Checklist completed and ready for pickup." His acknowledgement completes the check.)

WARNING

- Aircrews will cease operation (unless life of rescuee is at stake) immediately upon detecting an acceleration or deceleration mode failure or an up limit switch malfunction.
- To prevent high impact loads on the up limit switch, operate the hoist only in the low speed mode when the cable is within (3) feet of the boom.
- If a suspected up limit switch or deceleration malfunction has occurred (indicated by either a completely flattened rubber boot, a taut cable, or sound of hoist motor attempting to continue operation after switch contact) immediate cable and boom head replacement prior to next pick-up is required.
- When operating the hoist periodically observe the operation of the storage drum to ensure that it is working properly. Watch, particularly, for slack loops of cable between the storage drum and the primary pulley. (Refer to T.O. 1H-1(U)N-2-1).

CAUTION

- In order to prevent clothing entanglement, do not wear loose clothing while operating the hoist.
- With a load attached on the hoist hook it is advisable not to make abrupt changes in helicopter attitude until the load is aboard or raised as far as possible. "G" forces on an extended hoist could become excessive during abrupt movements of the helicopter.
- Ensure the hoist load and/or forest penetrator remain clear of the skids.

DELETE

## INFLIGHT (AFTER PICKUP)

1. "SURVIVOR IN AND SECURE, READY FOR TAKEOFF" (HO).

2. Hot Mike - OFF (HO).

3. Hoist - SECURED (HO).

4. Hoist Power Switch - "OFF" (P).

5. Non-Essential Bus Switch - "AS REQUIRED" (P).

6. "After Pickup Checklist COMPLETED" (HO).

## POSTFLIGHT

Enter "Hoist Used" in AFTO Form 781A after any flight where the hoist was utilized, to insure a thorough maintenance BPO of the hoist system is accomplished.

## GUNNER

The gunner will be responsible for maintenance, servicing, inspection, and security of the Armament Subsystems. He will perform duties as directed by the Pilot and be familiar with the duties of the flight mechanic. Refer to T.O. 1H-1(U)N-84-1-1.

## MEDICAL TECHNICIAN

The medical technician will be a fully qualified medic, capable of accompanying patients on medical evacuation flights.

### PREFLIGHT

1. Crew Medical Briefing – given.
2. Medical supplies and equipment – checked.
3. Litters – installed.
4. Fluid hanging devices – installed.
5. Oxygen/respirator equipment – checked and off.
6. Fire extinguisher – checked.
7. Communications/hot mike – as required.

### LOADING

1. Litters – installed.

**NOTE**

Patients should be loaded on the left first, from top to bottom, then on the right, from top to bottom.

2. Local fire/range equipment – in place.
3. Patients – secured.
4. Patients – briefed.

**WARNING**

**Smoking is prohibited when oxygen equipment is in use due to the possibility of fire/explosion.**

### INFLIGHT

1. Monitor patient/IV fluid status.

### BEFORE LANDING

1. Local fire/rescue equipment – alerted.
2. Patients – alerted and secured.
3. Equipment – secured.

### UNLOADING

1. Rescue equipment/patient transport – in place.
2. Patients – deplaned.

### BEFORE LEAVING AIRCRAFT

1. Medical supplies and equipment – inventoried and removed.
2. Oxygen equipment – off and secured.
3. Suction equipment – cleaned and secured.
4. Litter stanchions and straps – removed and stowed.

## CREW AND PASSENGER BRIEFING GUIDES

The following briefing guides are provided to assist the pilot in conducting assigned mission briefings:

**Crew Briefing Guide.** The following checklist includes the items to be discussed during the briefing:

1. Mission requirements.
2. Flight plan.
3. Fuel load.
4. Emergency/survival equipment.
5. Weather.
6. Special equipment.
7. Personal equipment.
8. Weight and balance.
9. Crew duties and responsibilities.
10. Formation procedures (if applicable).

**Passenger Briefing Guide.** When the helicopter is used to transport personnel, they will be briefed before flight and during flight as necessary. The pilot or his representative will perform this duty. The following checklists include the items to be discussed during the briefing:

**Predeparture Briefing Guide.**

1. Introduction of crew.
2. Designate compartment commander.
3. Destination.
4. Flight altitude.
5. Departure time and estimated time enroute.

6. Enroute weather.

7. Seats and safety belts.

8. Movement in the helicopter.

9. Smoking.

10. Emergency exits (location and operation).

11. Emergency landings or autorotations.

12. Emergency/survival equipment.

13. Bailout.

14. Use of portable electronic devices.

15. Helicopter characteristics.

**Over Water Briefing Guide.** If flight plan includes the crossing of any extensive bodies of water, the following items will be included in addition to the emergency procedures contained in Predeparture Briefing Guide.

1. Use of survival equipment.
2. Escape from parachute after entering water.
3. Emergency landing (signals, positions, exits, location of first aid kits and emergency radio).

# SECTION IX

# ALL WEATHER OPERATION

## TABLE OF CONTENTS



## INSTRUMENT FLIGHT

### INTRODUCTION

The helicopter has been provided with the necessary instruments and navigation radio equipment to accomplish missions from prepared or unprepared take-off or landing areas, under instrument operations including trace icing conditions, day or night. Instrument flights should be carefully planned, keeping in mind that icing conditions, turbulent air and thunderstorms will greatly affect the flight. Except for some repetition which is necessary for continuity of thought, the instrument flight procedures contain only the procedures that differ, or are in addition to normal procedures covered in other sections.

**NOTE**

Two pilots are recommended for planned instrument flight operations.

### INSTRUMENT FLIGHT PROCEDURES

The hydraulic control boost, force trim, stabilizer bar and fuel control governing features give this helicopter a high degree of stability and good handling and control characteristics for instrument flights. However, precision instrument flying requires proficiency in basic instrument flying and applies the proper techniques and procedures. The inflight fluctuations of the turn and slip indicator dictate that much greater use be made of the attitude indicator. Otherwise, this helicopter is adaptable to all phases of instrument flying by application of basic instrument techniques.

To lessen pilot fatigue during instrument flight (cruise, steady state descents, etc), full utilization should be made of the force trim to "trim out" opposing control forces. The fatigue factor will also be considerably reduced if the pilot controls the helicopter as smoothly as possible.

**WARNING**

Instrument flying is not to be attempted without an operative attitude indicator. In the event of AC failure, the inverter switch must be manually placed in the Standby position to regain operation of the attitude indicators. In the event of a generator failure with Standby inverter on, the Non-Essential Bus Switch must be positioned to MANUAL to retain operation of attitude indicators.

All instrument flying is to be accomplished with the Nf speed set at 97 to 100% rpm. This rpm setting decreases the chance of encountering retreating blade stall in turbulence.

The recommended angle of bank for all turns is the angle which will provide a standard rate turn (approximately 15 degrees). Steeper bank angles result in high rates of turn which will cause difficulty with aircraft pitch control.

### PREFLIGHT AND GROUND CHECKS

Perform the normal preflight inspections, as outlined in the normal operating instructions in Section II. Particular attention should be paid toward proper operation of flight instruments, navigation equipment, external and internal lighting, windshield wipers and defrosters, pitot heat, generators and inverters.

### INSTRUMENT TAKE-OFF

In addition to those conditions which normally require an instrument takeoff, (e.g., precipitation, low ceilings, and night takeoffs) helicopter induced restrictions to visibility such as snow or dust, circulated by rotorwash, may require an instrument takeoff. There are two recommended instrument takeoffs; the normal and the induced restriction to visibility.

Prior to take off the attitude indicators should be adjusted by aligning the pitch and roll adjustment knobs reference marks with the zero trim dots. These settings will provide a constant attitude reference for the ITO regardless of aircraft attitude at the time of adjustment.

**WARNING**

The airspeed, vertical velocity and altimeter are unreliable below 25 KIAS because of rotor downwash effect on the pitot static system. During take-off, do not rely on these instruments until airspeed indicator reads at least 25 KIAS.

### NORMAL INSTRUMENT TAKEOFF

If visibility permits, the takeoff may be accomplished using takeoff procedures described in Section II and the flight instruments should be referenced to provide a smooth transition from VFR to IFR flight. After accelerating to 70 KIAS adjust the attitude to maintain this airspeed and position the collective pitch as required to maintain desired rate of climb. Climbs at vertical velocity over 1500 feet per minute are not recommended.

### RESTRICTED VISIBILITY TAKEOFF

Align the helicopter with the desired takeoff heading and cross check the heading indicator. Smoothly increase the collective pitch to obtain the desired power for takeoff. As the aircraft clears the ground change the aircraft attitude to a five degree nose low indication. Maintain a level bank attitude and the takeoff heading with the tail rotor pedals until the airspeed increases to approximately 40 knots indicated, then transition to a normal instrument cross-check. Check the vertical velocity indicator and altimeter for positive climb indications and adjust the attitude if necessary. After accelerating to 70 KIAS adjust the attitude to maintain this airspeed and position the collective pitch as required to maintain desired rate of climb.

### INSTRUMENT CLIMB

The helicopter handles well in climbs and climbing turns at the recommended speed of 70 to 80 KIAS dual engine and 55 KIAS single engine. Climbs with vertical velocities over 1500 fpm are not recommended.

### INSTRUMENT CRUISING FLIGHT

The recommended cruise speeds are provided in Appendix I. Other speeds may be used consistent with pilot comfort, weather conditions, and cruise requirements.

### NORMAL DESCENTS

Normal descents are made at cruising airspeeds. Adjust power as required to obtain desired rate of descent. Rate of descent over 1000 fpm is not recommended.

### AUTOROTATIVE DESCENTS

Autorotative descents are not difficult on instruments. However, due to the high rate of descent, they are recommended for emergencies (loss of engine, etc.) only.

The following procedures are recommended for establishing and conducting autorotations on instruments.

1. Immediately reduce collective pitch to maintain desired rotor rpm.

2. Establish a one bar width nose high attitude, and maintain directional control with the foot pedals. The airspeed will gradually decrease to 60 KIAS. Approximately a one bar width nose high attitude will give this speed, and a reasonable rate of descent which should be maintained until visual contact is made. As soon as the autorotation is established and the helicopter is under positive control, complete the ENGINE FAILURE DURING FLIGHT, Section III, check list. During the descent, limit the angle of bank in turns to 30 degrees.

### HOLDING

Holding presents no handling or control problems at instrument cruising airspeeds. Use standard instrument approach procedures and utilize cruise airspeeds throughout the holding pattern.

### INSTRUMENT APPROACHES (Figure 9-1)

Use standard instrument approach procedures.

### MISSED APPROACH

If a missed approach is necessary, establish a positive rate of climb and initiate a normal instrument climb.

## ICE AND RAIN

### RAIN

In heavy rain properly adjusted wipers can be expected to adequately clear the windshield. However, when poor visibility is encountered while cruising in rain, it is recommended the pilot fly by reference to the flight instruments. Rain has no noticeable effect on handling or performance of the helicopter but may effect depth perception during flight.

**NOTE**

If the windshield wiper does not start in LOW or MED position, turn the control to HIGH. After the wiper starts, the control may be set at the desired position.

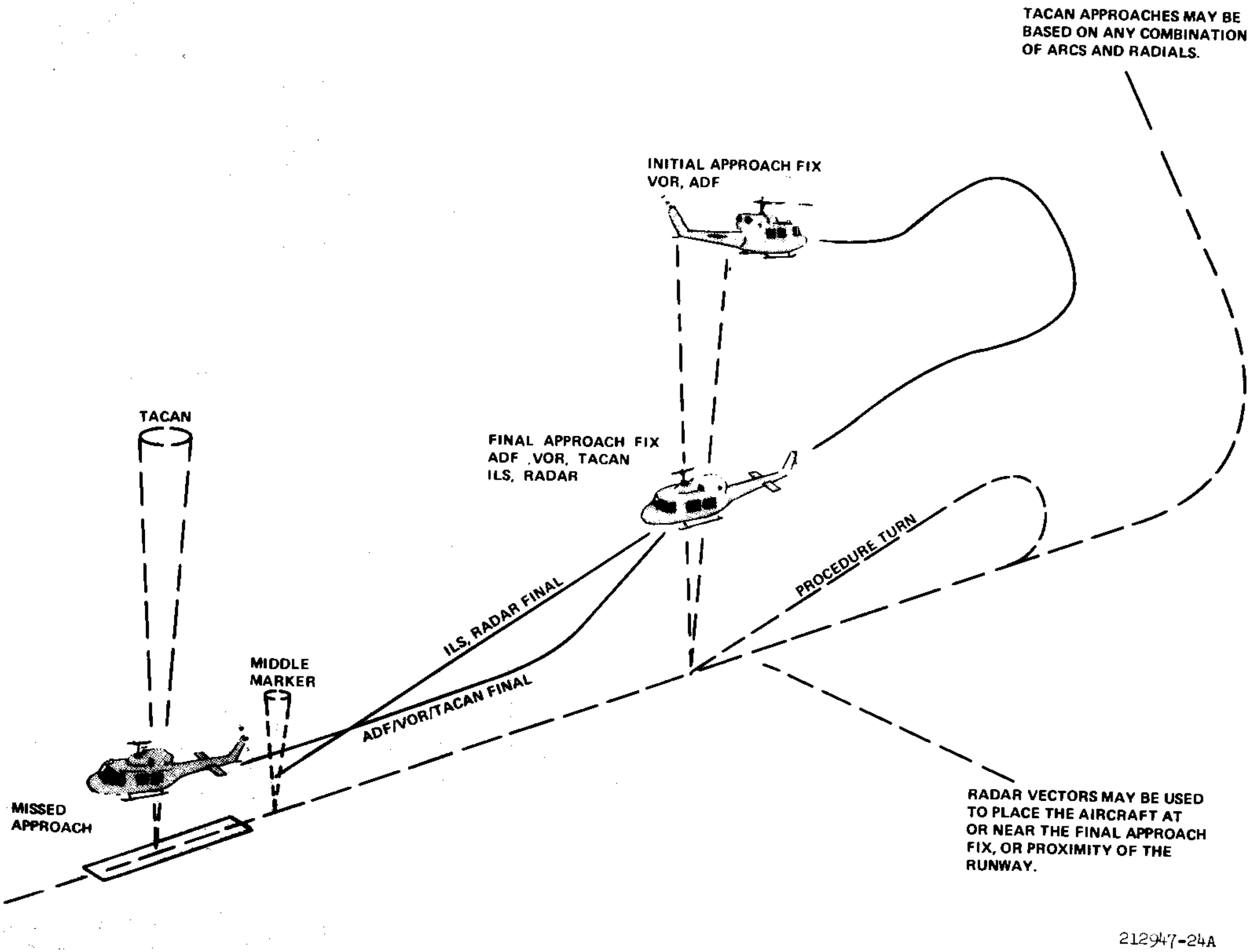


**Figure 9-1. Typical instrument approach**

## FLIGHT IN ICING CONDITIONS

Intentional flight through known icing conditions with OAT colder than minus 5 degrees C is prohibited.

**WARNING**

This helicopter is restricted from flight in icing conditions other than trace ice. Continuous flight in trace icing conditions is not recommended, because the ice shedding from the inlet duct could cause engine damage.

**NOTE**

- The particle separator switch should be in AUTO when visible moisture is evident at temperature below 5 degrees C.
- Before entering possible icing conditions, (visible moisture with temperature below 10°C), the pilot should actuate pitot heat.
- If flight in icing conditions results in ice accumulation on the helicopter, enter in information on Form 781.

## TURBULENCE AND THUNDERSTORMS

**CAUTION**

Flight through thunderstorms or other areas of extreme turbulence must be avoided whenever possible. Maximum use of weather forecast facilities, and radar, to aid in avoiding thunderstorms and turbulence are essential. If a storm cannot be avoided, and a landing is practical, land and wait for the storm to pass.

The helicopter handles well in light or moderate turbulence. As turbulence levels, increase airspeeds should be reduced for comfort, ease of control, and reduced blade stall effects. The key to proper flight technique through turbulence is attitude. Extreme gust will cause large attitude changes. Use smooth and moderate cyclic inputs to re-establish the desired attitude. To avoid overstressing the helicopter, do not make large or abrupt attitude changes. Adjust Nr 100%, torque to that normally required to maintain 80 to 90 knots, and trim for level flight. Turbulence may cause large and/or rapid variations in indicated airspeed. Do not chase the airspeed. It may also affect altitude. Sacrifice altitude to maintain the desired attitude, and do not chase the altimeter.

**WARNING**

Do not intentionally encounter severe to extreme turbulence.

**NOTE**

When lightning is encountered at night, the interior and instrument lights should be turned to full intensity to preclude temporary blindness.

## LIGHTNING STRIKES

Although the possibility of a lightning strike is remote, with increasing use of all-weather capabilities the helicopter could inadvertently be exposed to lightning damage. Therefore, static tests have been conducted to determine lightning strike effects on rotors.

Simulated lightning tests indicate that lightning strikes may damage helicopter rotors. The degree of damage will depend on the magnitude of the charge and the point of contact. Catastrophic structural failure is not anticipated. However, lightning damage to hub bearings, blade aft section, trim tabs, and blade tips was demonstrated. Also adhesive bond separations occurred between the blade spar and aft section between the spar and leading edge abrasion strip. Some portions of blade aft sections deformed to the extent that partial or complete separation of the damaged section could be expected. Such damage can aerodynamically produce severe structural vibration and serious control problems which, if prolonged, could endanger the helicopter and crew.

**WARNING**

Avoid flight in or near thunderstorms especially in areas of observed or anticipated lightning discharges.

If lightning damage occurs, as indicated by control problems or vibration changes, especially abnormal noise, the pilot's assessment of the extent of damage, the mission requirements, and the demands of the current flight situation will determine the required action.

**NOTE**

Abnormal operating noises almost always accompany rotor damage, but loudness or pitch are not valid indications of the degree of damage sustained.

If lightning strike occurs but there are no indications of damage to the helicopter, the following precautions are recommended to minimize further risk:

1. Reduce airspeed as much as practical to maintain safe flight but keep power on and maintain normal NR.

2. Proceed to the nearest suitable landing site, and descend with partial power, avoiding abrupt control movements.

3. Do not autorotate, but accomplish precautionary landing, shutdown, and visually inspect rotors for damage before proceeding.

4. Record suspected lightning strike in maintenance forms.

If minor lightning damage is suspected but vibration indication is slight and no control problems appear, flight may be continued to a safe landing site, but avoid unnecessary delay in landing to assess damage.

If lightning damage is moderately serious immediate landing is recommended.

**NOTE**

If mission requirements dictate resuming flight with damaged rotor blade, an aerodynamically smooth profile will minimize vibration and control problems.

In the event severe lightning damage makes the helicopter difficult or impossible to control make an emergency landing or bail out.

## MOUNTAIN AND ROUGH TERRAIN FLYING

Many helicopter missions require operation at other than prepared landing areas. These areas may be at sea level, over forest, desert, high altitude, mountains, or any combination of these features. Landing site condition, wind direction and velocity, gross weight limitations, and effect of obstacles are but a few of the considerations for each landing or take-off. In a great many cases, meteorology facilities and information are not available at the site of intended operation. The effects of mountains and vegetation can greatly vary wind conditions and temperatures. For this reason, landing site must be evaluated at the time of intended operation. Altitude and temperature are major factors in determining helicopter power performance. Gross weight limitations under specific conditions can be computed from the performance data in the Appendixes. A major factor improving helicopter lifting performance is wind. Weight carrying capability increases rapidly when increases in wind velocity are related to the rotor system. However, accurate wind information is more difficult to obtain and more variable than other planning data. It is therefore, not advisable to include wind in advanced planning data except to note that any wind encountered in the operating area may serve to improve helicopter performance. In a few cases, operational necessity will require landing on a prepared surface at an altitude above the hovering capability of the helicopter. In these cases, a slide landing and take-off will be necessary to accomplish the mission. Data for these conditions can be computed from the charts in the Appendixes.

**WIND DIRECTION AND VELOCITY.** There are several methods of determining the wind direction and velocity in rough area. The most reliable method is by the use of a smoke device. However, it must be noted that the hand held day/night distress signal and the standard ordnance issue smoke device are satisfactory for wind indication, but constitute a fire hazard when used in areas covered with combustible vegetation. Observation of foliage will indicate to some degree the direction of the wind, but is of limited value in estimating wind velocity. Helicopter drift determined by eyesight without the use of navigational aids is the first method generally used by experienced pilots. The accuracy with which wind direction may be determined through the drift method becomes a function of wind velocity. The greater the wind value the more closely the direction may be defined.

**CAUTION**

Depending on wind velocity, the apparent airspeed/ground speed relationship changes when turning downwind. After the turn less airspeed is required to maintain ground speed. Reducing airspeed may result in loss of translational lift which increases the power required to maintain altitude. When operating close to the surface, especially during downwind manuevers, airspeed and power required must be monitored closely.

## LANDING SITE EVALUATION

Five major considerations in evaluating the landing area are: (1) height of obstacles which determine approach angle; (2) size and topography of the landing zone; (3) possible loss of wind effect; (4) power available; and (5) departure route. The transition period is the most difficult part of any approach. As helicopter performance decreases, the transition period becomes more critical, and of necessity approaches must be shallower and transition more gradual. Therefore, as the height of the obstacle increases, larger areas will be required. As wind velocity increases, so does helicopter performance; however, when the helicopter drops below an obstacle, a loss of wind generally occurs as a result of the airflow being unable to immediately negotiate the change prevalent at the upwind side of the landing zone where a virtual null area exists. This null area extends toward the downwind side of the clearing and will become larger as the height of the obstacle and wind velocity increases. It is therefore, increasingly important in the landing phase that this null area be avoided if marginal performance capabilities are anticipated. The null area is of particular concern in making a take-off from a confined area. Under heavy load or limited power conditions, it is desired to achieve a significant value of forward velocity and translation lift, prior to transitioning to a climb, so that the overall climb performance of the helicopter will be improved. If the take-off cycle is not commenced from the most downwind portion of the area, and translational velocity achieved prior to arrival in the null area, a significant loss in lift may occur at the most critical portion of the take-off. It must also be noted that in the vicinity of the null area, nearly vertical downdraft of air may be encountered which will further reduce the actual climb rate of the helicopter. It is feasible that under certain combinations of limited area, high obstacles upwind, and limited power available, the best take-off route would be either crosswind or downwind, terrain permitting. The effects of detrimental windflow and the requirement to climb may thus be minimized or circumvented. Even though this is a departure from the cardinal rule of "take-off into the wind", it may well be the proper solution when all factors are weighed in their true perspective. Never plan an approach to a confined area wherein there is no reasonable route of departure. The terrain within a site is considered from an evaluation of vegetation, surface characteristics, and slope. Care must be taken to avoid placing the rotor in low brush or branches. Obstacles covered by grass may be located by flattening the grass with rotor wash prior to landing. Power should be maintained so that an immediate take-off may be accomplished, should the helicopter start tipping from soft earth or a gear being placed in a hidden hole. Cross-slope, or down-slope landings can be accomplished. Landing up-slope affords maximum tail rotor clearance.

**WARNING**

Landing down-slope affords an easier go-around, but greatly reduces the tail rotor clearance to the ground and should be avoided whenever possible.

**EFFECTS OF HIGH ALTITUDE.** Decreased hover performance, decreased forward airspeed limits, and increased susceptibility to blade stall are associated with high altitude operations. Operating limitations and performance data should be carefully reviewed prior to operating at high altitudes. Maneuverability is generally decreased, and shallower turns at slower airspeeds are required to avoid blade stall than at lower altitudes. Smooth and timely control application, and anticipation of power requirements are of prime importance in fully utilizing the performance capabilities of the helicopter at high altitude.

**TURBULENT AIR FLIGHT TECHNIQUES.** Helicopter pilots must be constantly alert to evaluate and avoid areas of severe turbulence; however, if encountered, immediate steps must be taken to avoid continued flight to preclude exceeding the structural limits of the helicopter. Turbulent effect can be reduced by decreasing airspeed and/or increasing $N_r$. An increase in $N_r$ will improve the helicopter's gust response, provide a smoother ride, and decrease susceptibility to blade stall. The most frequently encountered type of turbulence is orographic turbulence. It can be dangerous, if severe, and is normally associated with updrafts and downdrafts. It is created by moving air being lifted by natural or manmade obstructions and most prevalent in mountainous regions and is always present in mountains if there is a surface wind. Orographic turbulence is directly proportional to the wind velocity. It is found on the upwind of slopes and ridges near the tops and extending down the downwind slope (figure 9-2). It will

**Note**

1. APPROACH THE UPWIND SIDE PARALLEL TO, OR, AT AS SLIGHT AN ANGLE AS POSSIBLE TO THE RIDGELINE, RATHER THAN PERPENDICULAR TO THE RIDGELINE.
2. IF TERRAIN DOES NOT PERMIT A PARALLEL APPROACH, MAKE APPROACH AS STEEP AS SAFELY POSSIBLE TO AVOID LEEWARD BURBLE AND DOWN DRAFT.
3. PLAN AN ABORT ROUTE.

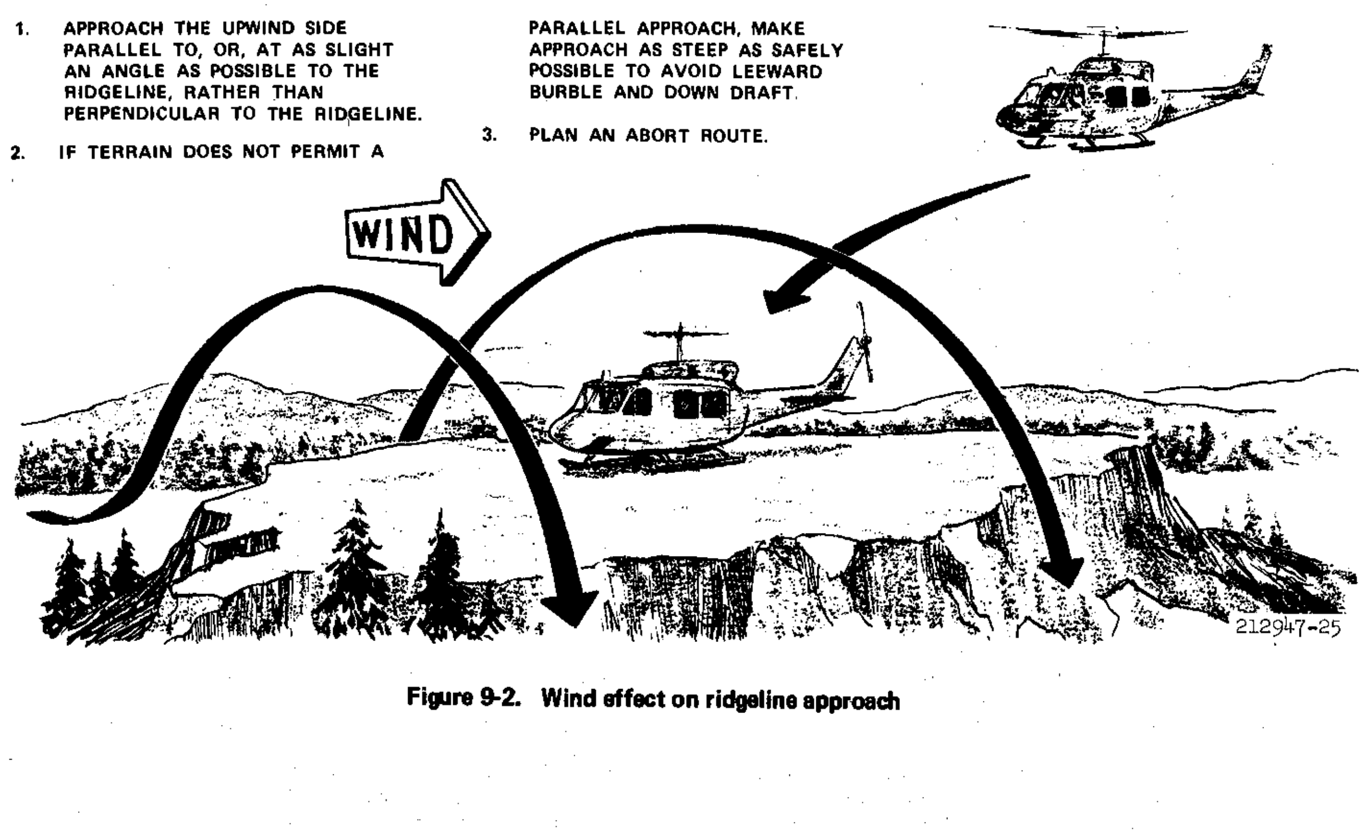


**Figure 9-2. Wind effect on ridgeline approach**

always be found on the tops of ridges associated with updrafts on the upwind side and downdrafts on, the downwind side. (figures 9-3 and 9-4). Its extent on the downwind slope depends on the strength of the wind and the steepness of the slope. If the wind is fairly strong (15 to 20 knots) and the slope is steep, the wind will have a tendency to blow off the slope and not follow it down. However, there will still be some tendency to follow the slope. In this situation, there will probably be severe turbulence several hundred yards downwind of the ridge at a level just below the top. Under certain atmospheric conditions, a cloud may be observed at this point. On more gentle slopes, the turbulence will follow down the slope but will be more severe near the top. Orographic turbulence will be affected by other factors. The intensity will not be as great when climbing a smooth surface as when climbing a rough surface and will not follow sharp contours as readily as gentle contours. As man-made obstructions and vegetation will also cause turbulence, extreme care should be taken when hovering hear buildings, hangars, and similar obstructions. The best method to overfly ridge lines from any direction is to acquire sufficient altitude prior to crossing to avoid leeside downdrafts. If landing on ridge lines, the approach should be made along the ridge in the updraft, or select an approach angle into the wind that is above the leeside turbulence. When the wind blows across a narrow canyon or gorge, it will often veer down into the canyon. Turbulence will be found near the middle and downwind side of the canyon or gorge. When a helicopter is being operated at or near its service ceiling, and a downdraft of more than 1.6 feet per second is encountered, the helicopter will descend. Although the downdraft does not continue to the ground, a rate-of-descent may be established of such magnitude that the helicopter will continue descending, and crash, even though the helicopter is no longer affected by the downdraft. Therefore, the procedure for transiting a mountain pass shall be to fly close abroad that side of the pass or canyon which affords an upslope wind (figures 9-4 and 9-5). This procedure not only provides additional lift but also provides a readily available means of exit in case of emergency. Maximum turning space is available and a turn into the wind is also a turn to lower terrain. The often used procedure of flying through the middle of a pass to avoid mountains invites disaster. This is frequently the area of greatest turbulence (figures 9-5 and 9-6) and in case of emergency, the pilot has little or no opportunity to turn back due to insufficient turning space. Rising air currents created by surface heating causes convective turbulence. This is most prevalent over bare areas. Convective turbulence is normally found at a relatively low height above the terrain, generally below 2000 feet. It may however, under certain conditions, and in certain areas, reach as high as 8000 feet above the terrain. Attempting to fly over convective turbulence should be carefully considered, depending on the mission assigned. The best method is to fly at the lowest altitude consistent with safety. Attempt to keep your flight path over areas covered with vegetation. Turbulence can be anticipated when transitioning from bare areas to areas covered by vegetation or snow. Convective turbulence seldom gets severe enough to cause structural damage.

**ADVERSE WEATHER CONDITIONS.** When flying in and around mountainous terrain under adverse weather

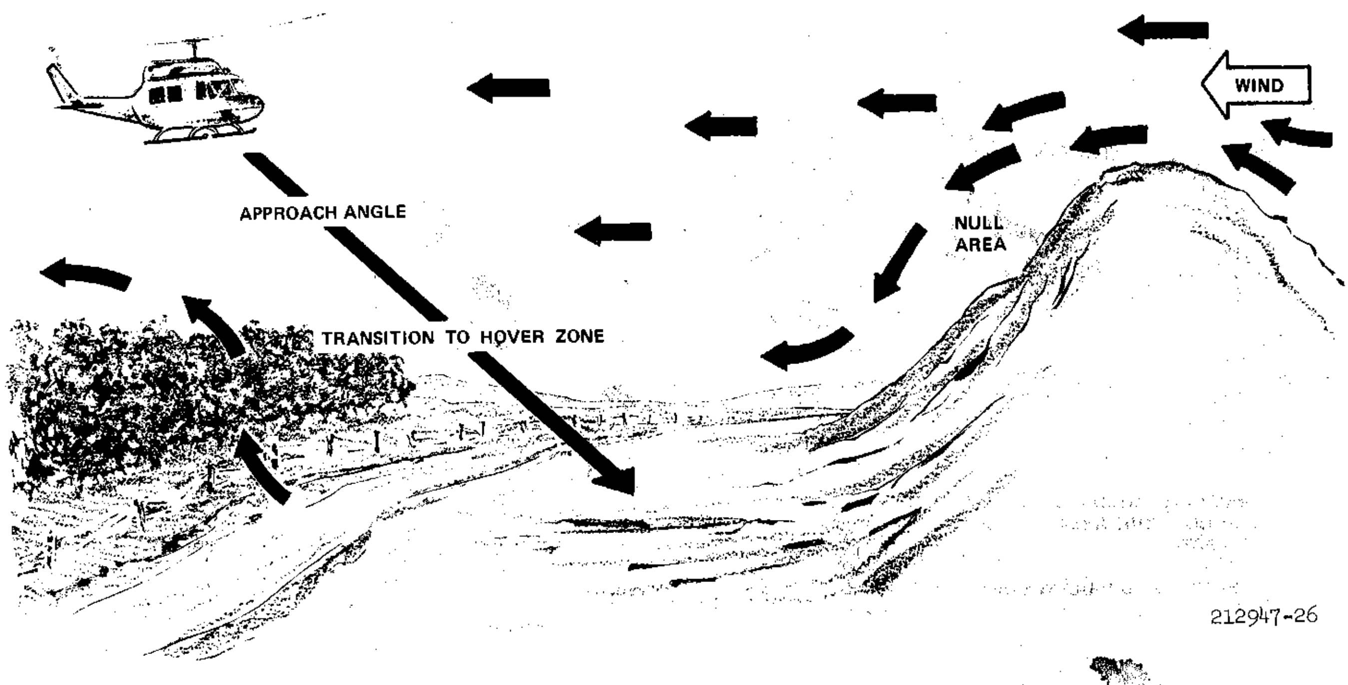


**Figure 9-3. Wind effect in a confined area**

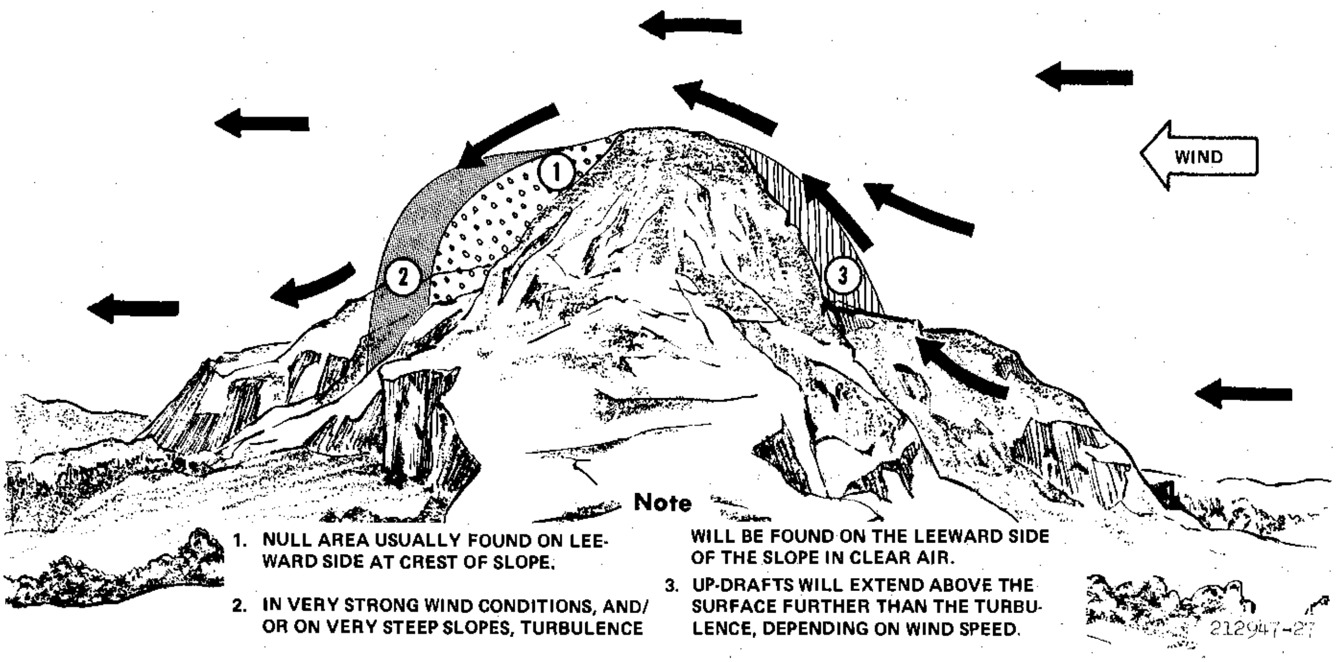


**Figure 9-4. Wind flow over and around peaks**

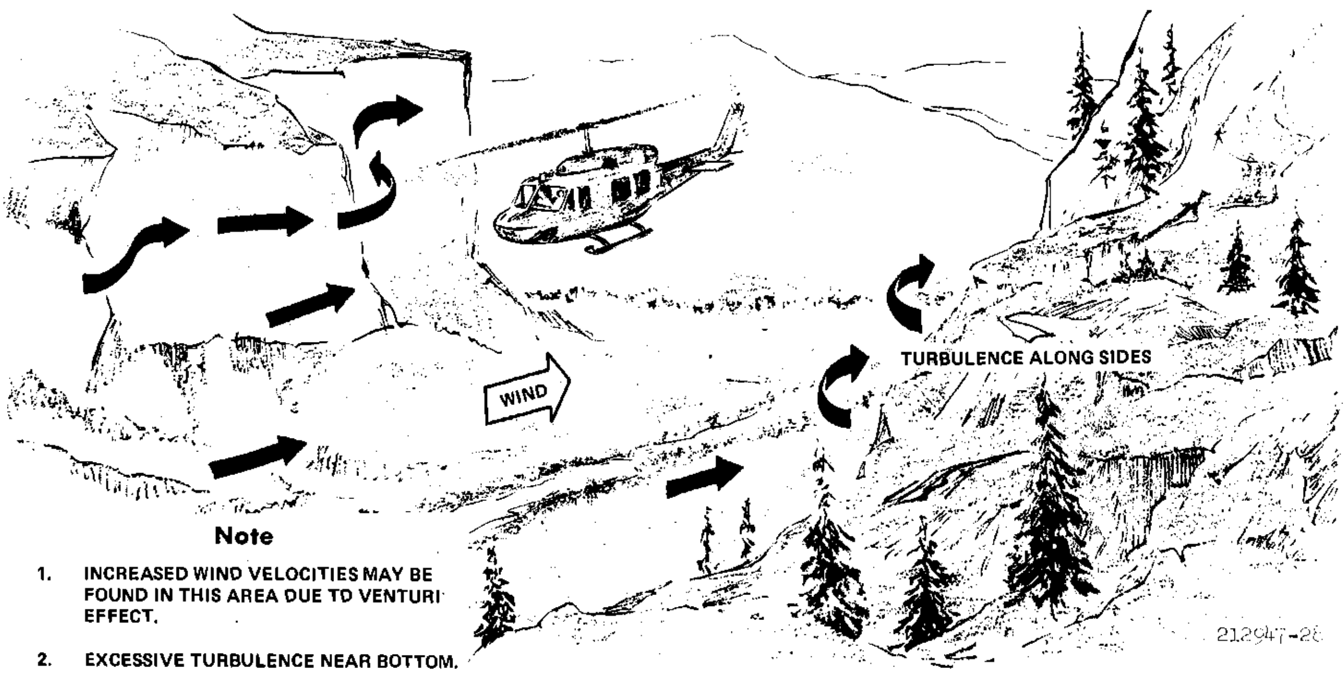


**Figure 9-5. Wind flow in valley or canyon**

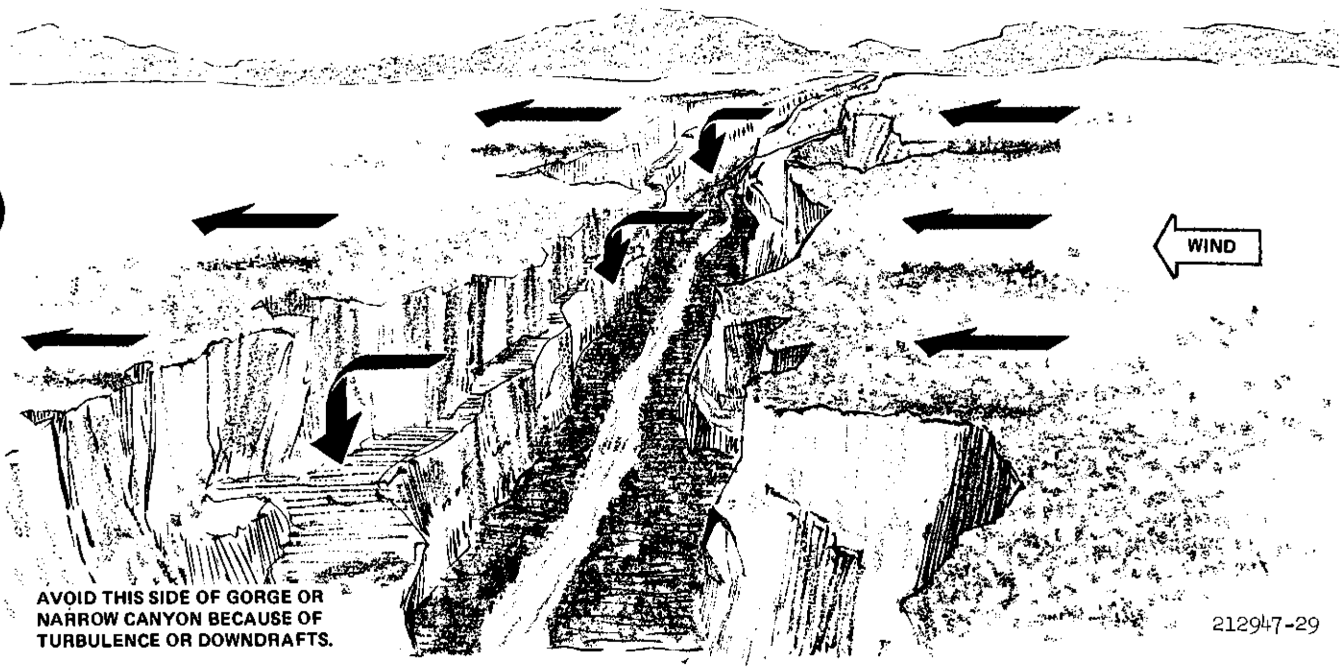


**Figure 9-6. Wind flow over gorge or canyon**

conditions, it should be remembered that the possibility of inadvertent entry into clouds is ever present. Air currents are unpredictable and may cause cloud formations to shift rapidly. Since depth perception with relation to distance from cloud formations and cloud movement is poor, low hanging clouds and scud should be given a wide berth at all times. In addition to being briefed, the pilot should carefully study the route to be flown. A careful check on the helicopter flight instruments should be maintained in event of inadvertent entry into the clouds.

SUMMARY. The following guide lines are considered to be most important for mountain and rough terrain flying:

1. Make a continuous check of wind direction and estimated velocity.

2. Plan your approach so that an abort can be made downhill and/or into the wind without climbing.

3. If wind is relatively calm, try to select a hill or knoll for landing so as to take full advantage of any possible wind effect.

4. When evaluating a landing site in noncombat operations, execute as many flybys as necessary before conducting operations into a strange landing area.

5. Evaluate the obstacles in the landing site and consider possible null areas and routes of departure.

6. Landing site selection should not be based solely on convenience but consideration should be given to all relevant factors.

7. Determine ability to hover out of ground effect prior to attempting a landing.

8. Fly as smoothly as possible and avoid steep turns.

9. Cross mountain peaks and ridges high enough to stay out of downdrafts on the leeside of the crest.

10. Avoid downdrafts prevalent on leeward slopes.

11. Plan your flight to take advantage of the updrafts on the windward slopes.

12. Whenever possible, approaches to ridges should be along the ridge rather than perpendicular.

13. Avoid high rates of descent when approaching landing sites.

14. Know your route and brief well for flying in these areas.

15. When operating below ridge lines, be alerted for power and telephone lines.

## NIGHT FLYING

Night flying presents some of the same problems as instrument flying, plus additional problems introduced by illumination of the instruments and cockpit, and exterior reflections.

**WARNING**

Due to rotor downwash effect on the pitot static system; the airspeed indicator, vertical velocity indicator and barometric altimeter should not be relied upon below 25KIAS.

**WARNING**

When operating in the clouds at night, turn navigation lights to steady and anti-collision light off, to reduce distracting reflections from the clouds. These reflections can result in spatial disorientation. Turning the navigation lights to dim will aid in reducing the reflections in the cockpit.

For night take-offs and approaches, set the landing light approximately 15 degrees "down" from horizontal. This will give the pilot a reference point during take-off and also light the approximate touchdown area following a normal approach. During take-offs, climbs and approaches, use the search light as desired to illuminate the intended flight path. The search and landing lights should be positioned for immediate use in the event of an immediate landing.

**WARNING**

Night approaches into unlighted areas over smooth, featureless terrain such as water, snow, drylake beds, and salt flats can result in complete loss of depth perception and inadvertent ground contact.

**NOTE**

- Night landing can be made with the navigation lights on steady if the landing and search lights are inoperative. However, exercise extreme caution, since the navigation lights do not furnish sufficient illumination for depth perception until just before touch-down.
- During night approaches the lower nose canopy visibility is extremely restricted due to landing light reflection; however, the visibility improves as the lighted touch-down area comes beneath the helicopter.

Non-essential bus to MANUAL for night operations.

## COLD WEATHER OPERATION

### INTRODUCTION

Operation of the helicopter in cold weather or an arctic environment presents no unusual problems if the pilot is aware of the changes that take place and conditions that may exist because of the lower temperatures and freezing moisture. The pilot must be more thorough in the walk-around inspection when temperatures have been or are below zero degrees C. (plus 32 degrees F).

Additional cover kits are available for protecting main rotor blades, tail rotor blades and hub assembly, main rotor hub and mast assembly, complete cabin, and 90 degree gear box. These covers will provide protection against rain, freezing rain, sleet, and snow when installed on a dry helicopter prior to precipitation. Those parts not covered and those adjacent to cover overlap requires closer attention especially after a blowing snow or freezing rain.

### ENGINE SERVICING

Fuel and oil servicing should be accomplished immediately after engine shutdown to prevent condensation within the tanks due to temperature change. Refer to the Servicing Diagram figure 1-21.

### ENGINE GROUND OPERATION

During extreme conditions, install covers after engine shutdown. In extreme cold weather ground heater unit may be used.

Snow, slush, or ice shall be removed from any area where jet engines may be operated. Keeping the areas clean will prevent cinders, sand, or chunks of ice from being sucked into the engines or blown at high velocity into other aircraft that might be in the vicinity.

During extreme cold weather, external vents and drains shall be inspected prior to operating engines and prior to flight.

**CAUTION**

Should the engines fail to accelerate to proper idle speed (cold hang-up) or the time from light-off to idle is excessive, abort start. Refer to utilization of Manual Fuel for Cold Start Section III.

An auxiliary power unit should be used, when available, to ensure a smooth, fast engine acceleration.

A sudden loss of oil pressure in cold weather, other than a drop caused by relief valve opening, is usually due to a broken oil line. Shutdown and investigate for cause.

Install engine inlet and exhaust covers after shutdown.

## PREPARATION FOR FLIGHT

Preparation for cold weather flights should include normal procedures in Section II with the following exceptions or additions: All vents and openings such as fuel vents, battery vents, cabin ventilators, transmission breather, heater exhaust and intake, and engine air intakes must be checked for ice.

**WARNING**

*Accumulation of snow and ice will be removed prior to flight. Failure to do so can result in hazardous flight, due to aerodynamic and center of gravity disturbances as well as the introduction of snow, water and ice into internal moving parts and electrical systems. The pilot should be particularly attentive to the main and tail rotor systems and their exposed control linkages.

**NOTE**

*At temperatures of minus 35 degrees C (minus 31 degrees F) and lower, the grease in the spherical couplings of the main transmission drive shaft may congeal to a point that the couplings cannot operate properly. If found frozen, apply heat to thaw the couplings, before attempting to start the engines. Indication of proper operation is obtained by turning the main rotor blade opposite to the direction of rotation while an observer watches the drive shaft to see that there is no tendency for the transmission to "wobble" while the drive shaft is turning.

## PREHEATING

Flight and engine controls may be difficult to move after the helicopter has been cold soaked. If the controls are not sufficiently free for a safe start and low power warm-up, have the affected controls thawed by heating. It may also be advisable to apply preheating to other areas such as the engines, transmission and cabin.

**NOTE**

When moving the helicopter into or out of a heated hangar where there is an extreme difference in outside temperature, a window should be open slightly to equalize the temperature inside the cabin. Extremely unequal temperatures on opposite sides of plexiglas can cause differential contraction and breakage.

## MAIN ROTOR BLADES AND ELEVATOR

Visually check upper surfaces to be free of ice and snow. Untie the blades and walk through 360 degrees in the direction of rotation and check to see that there is no restriction in operation due to ice formation. Check its flapping action, observing the operation of the stabilizer bar. Check synchronized elevator for ice and snow on surface and for restricted movement due to ice and snow between fuselage and elevator.

## BEFORE STARTING ENGINES

An auxiliary power unit should be used when available to ensure a smooth, fast engine acceleration to preclude a hot start.

**CAUTION**

*Avoid operation on glare ice or any slick surface whenever possible. The surfaces are inducive to aircraft torque yaw when changing power (throttle) settings or applying the rotor brake upon shutdown.

## STARTING ENGINES

*When outside air temperature is between minus 18 degrees C and minus 32 degrees C (zero degrees F and minus 25 degrees F), do not advance beyond 71% Ng until both engines, combining gearbox, and transmission oil pressures are stabilized within desired operating range.

**WARNING**

Under cold weather conditions, make sure all instruments have warmed up sufficiently to ensure normal operation. Check for sluggish instruments before take-off.

## TAKE-OFF

Cold weather presents no particular take-off problem unless the cold weather is accompanied by snow. The problem of restricted visibility due to blowing or swirling snow (from rotor wash) can be acute and may require a maximum power take-off, or perhaps even an instrument take-off without hover to get the helicopter safely airborne. If the take- off is surrounded by a large expanse of smooth, unbroken snow, there is danger that the pilot may become disoriented because of the absence of visible ground reference objects. In this case, use any available objects for reference, such as smoke grenades, oil drums, rocks, seat cushions, etc.

NOTE

*Before take-off under winter conditions, check that landing gear and external loads are not frozen to the surface or hooked under ice or crusty snow layers.

## LANDING

In normal operations helicopters are often required to land or maneuver in areas other than prepared airfields. In cold weather this frequently involves landing and taking off from snow covered terrain. The snow depth is usually less in open areas where there is little or no drift effect. The snow depth is usually greater on the downwind side of ridges and wooded areas. Whenever possible, the pilot should familiarize himself with the type of terrain under the snow (tundra, brush, marshland, etc.).

On all snow landings anticipate the worst conditions; that is, restricted visibility due to loose whirling snow and an unfirm ice crust under the snow. When loose or powdery snow is expected, make an approach and landing with little or no hover to minimize the effect of rotor wash on the snow. If possible, have some prominent ground reference objects in view during the approach and landing. If no such objects are available, a smoke grenade, seat cushion, etc. dropped from the helicopter may suffice.

CAUTION

* • Whenever possible, avoid landing on glare ice in order to reduce bending loads on the cross tubes.
* • Radio and radar waves can penetrate the surface of snow and ice fields, (such as the polar region) therefore when radio and radar equipment are used for measuring terrain clearance, they may indicate greater terrain clearance than actually exists.

WARNING

*If visual reference is lost, accomplish a go-around.

After contacting the surface, maintain rotor rpm and slowly decrease collective pitch, while slightly rotating the cyclic stick until the helicopter is firmly on the ground. Be ready to take off immediately if, while decreasing collective pitch, one landing gear should hang up or break through the crust. Do not reduce rotor rpm until it is positively determined that the helicopter will not settle. If possible, have a crew member get out and check the surface before reducing rpm.

If the landing terrain is known to be flat, with a shallow snow cover, a slide landing may be accomplished. Plan to touch down slightly above translational lift. After contact slowly lower the collective to allow skid friction to slow forward speed. After aircraft comes to a complete stop, reduce collective slowly and maintain rotor rpm until aircraft is firmly on the ground.

CAUTION

*An abrupt reduction of collective pitch upon ground contact may cause the helicopter to nose over resulting in main rotor blade contact with the ground or tail boom.

## TAXIING

A slide taxi is made by using slide take-off techniques. Proceed slowly to clear the taxiing path. If outside visual references are lost due to re-circulating snow, slowly lower the collective and bring the helicopter to a complete stop. If hover taxiing is necessary over loose powdery snow, slowly increase the collective to place the helicopter lightly on the skids. Allow time for the rotor wash to clear the area before attempting to hover taxi. Maintain a low hover taxi, two foot skid height, and taxi at a ground speed slightly above translational lift. This taxi speed will maintain the rotor down wash and whirling snow behind the helicopter eliminating most restriction to visual references.

CAUTION

*Hover taxiing over loose or powdery snow is not recommended in a congested area.

## BEFORE LEAVING THE HELICOPTER

Perform the following checks in addition to those listed in Section II: Open pilot's and copilot's windows approximately one and one-half inches to permit free circulation of air to retard frost formation and reduce cracking of transparent surfaces due to differential contraction. Check that moisture accumulations are drained as soon as possible after engine shut down. Check fuel cell sumps, fuel strainer, transmission oil sump, and engine oil systems. Check all vents for ice stoppage.

## HOT WEATHER OPERATION

Operations when outside air temperatures are above standard day conditions do not require any special handling technique or procedures, other than a closer monitoring of oil temperatures and ITT. As ambient temperature increases, engine efficiency decreases; power can become critical under high gross weight conditions on extremely hot days.

### DESERT OPERATION

Desert operation generally means operation in a very hot, dusty, and often windy atmosphere. Under such conditions sand and dust will often be found in vital areas of the helicopter. Severe damage to be the affected parts may be caused by sand and dust. The helicopter should be towed into take-off position, which if at all possible, should be on a hard, clear surface, free from sand and dust. Ensure the engine inlets are free of sand, heavy dust accumulation, and other foreign matter. Use normal starting procedures.

**NOTE**

During warm weather, oil temperature will probably be on the high side of the operating range.

Install engine inlet and exhaust covers after shutdown.

### PREPARATION FOR FLIGHT

Plan the flight thoroughly to compensate for existing conditions by using the charts in Appendix I. Check for the presence of sand and dust in control hinges and actuating linkages. Inspect for, and ensure removal of any sand or dust deposits on instrument panel and switches, and on and around flight and engine controls.

## SALT WATER OPERATION

Prolonged hovering over salt water which results in spray ingestion, indicated by spray on the windshields, should be avoided. The amount of spray observed on the windshield and the necessity of using windshield wipers to maintain visibility is an immediate indication of spray ingestion into the engine inlets. If a noticeable increase in ITT occurs not caused by a corresponding increase in gross weight, wind velocity or hover height, make an immediate departure from the hover, land and have the engines washed prior to the next flight. Following salt water operations, appropriate entries should be made in the Form 781.

a. For salt water hover operation, hover clear of salt spray using lowest hover altitude where spray impingement on the windshield is nonexistent or limited to very fine mist. Spray impingement on the windshield is a good indication of spray ingestion by the engines. Minimum hover altitude will vary with wind conditions and aircraft gross weight.

b. Tests indicate that no spray impingement on the windshield will occur at any hover height down to five feet under wind conditions of six knots or less. However, hovering in salt spray should be kept to the minimum time required to accomplish an operational mission, and the hover altitude should be as high as is practical for that mission.

c. With wind conditions of 6 to 16 knots, takeoff gross weight of approximately 9,000 lbs, will produce windshield spray impingement at hover height of up to 25-30 ft. Takeoff gross weights of 10,000 lbs will cause windshield spray impingement up to 40-45 ft hover height.

d. Prior to initiation of hovering in salt spray, a topping power check should be performed to determine initial acceptability. If an engine demonstrates two percent excess power or more, its condition need not be checked during the salt water mission. If the engine shows less than two percent excess power, a topping power check should be performed after each 30 minutes of hovering in salt spray.

e. Hovering in salt spray will cause accelerated aircraft corrosion. Also sustained hovering in salt spray will cause salt incrustation on the main rotor and tail rotor blades. Such salt incrustation may cause abnormal aircraft vibrations which may be felt as a one per revolution beat from an out-of-track main rotor blade, tail rotor pedal buzz or higher frequency airframe vibrations trasmitted from the tail rotor.