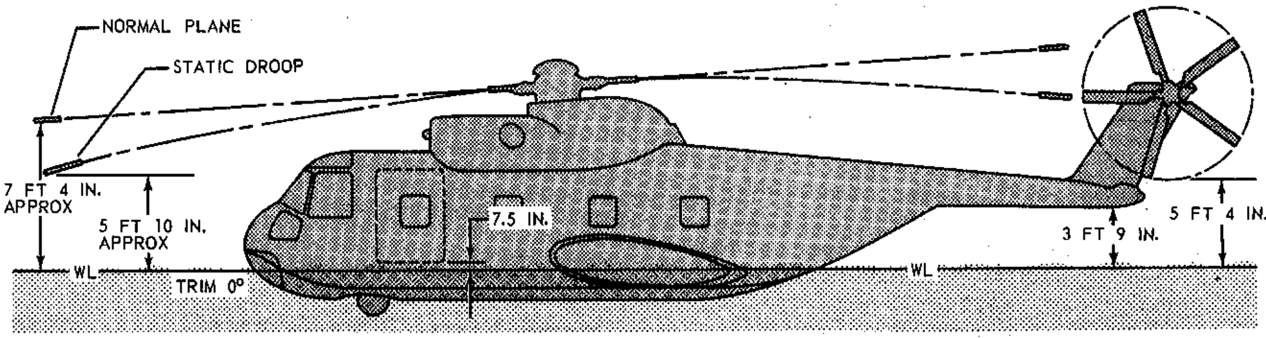


Figure 2-17. Water Clearance

ROTOR SHUTDOWN AND ENGAGEMENT (ENGINES RUNNING).

This checklist may be used for rotor shutdown and engagement (engines running) during operational stops and for water operations.

AFTER LANDING.

1. Speed selectors - 102%. (CP)
2. APU - START. (CP)

CAUTION

Failure to start the APU prior to rotor shutdown, with engines running, can result in lack of lubrication for the high speed engine drive shaft when rotors are reengaged.

3. Doppler/IFF - "STBY." (CP)

ROTOR SHUTDOWN.

1. Parking brake - "AS REQUIRED." (P)
2. AFCS - "OFF" (P)
3. Speed selectors - "GRD IDLE." (CP)
4. Droop stops - "IN." (FM)
5. Rotor brake - "ON." (P) (45% N_r OR LESS)
6. "Rotor Shutdown checklist completed." (CP)

ROTOR ENGAGEMENT AND BEFORE TAKEOFF.

1. Passenger and crew briefing - "COMPLETED." (P)
2. Ramp - "AS REQUIRED, CABLES ATTACHED." (FM)
3. Area - "CLEAR." (ALL)
4. Rotors - "ENGAGED." (P)
5. APU master switch - "OFF." (P)

15-142 SEE ADDED NOTE

6. Unloaded engine speed selector - "SET, 102%." (P)
7. Doppler/IFF - "AS REQUIRED." (CP)
8. Personnel door emergency release handle - "CHECKED." (FM)
9. Engine and transmission instruments - "CHECKED." (CP)
10. Caution and advisory lights - "CHECKED." (P)
11. AFCS - "CHECKED ON." (P)
12. Nose wheel - "UNLOCKED." (P)
13. Parking brake - "OFF." (P)
14. Passenger and crew - "READY FOR TAKE-OFF." (FM)
15. Radio call - "AS REQUIRED." (P or CP)
16. Speed selectors - "AS REQUIRED." (State Setting) (CP)
17. "Rotor engagement and Before Takeoff check-list completed." (CP)

WATER OPERATIONS.

The procedures in this section cover normal water operations as they differ from land operations. The helicopter is designed for amphibious operations which require an understanding of its capabilities in terms of sea state conditions. Refer to Figure 2-17, Water Clearance, to note the helicopter clearances when resting on the water. For normal operations with rotors turning, the helicopter may be operated in water up to and including sea state 3 as noted in Figure 2-20. Normal rotor shutdown and engagements may be conducted on water up to and including sea state 2 conditions.

Normally, aircrews operating in the vicinity of larger bodies of water or near coastlines will have information concerning sea state conditions either from the weather forecaster or from local Coast Guard units. It is imperative that pilots operating over open water become proficient in relating forecast and observed sea state conditions as seen from the air with actual conditions on the water. Figure 2-20 is provided to assist the pilot for this purpose. It should be noted that, depending on the duration that a given wind condition has existed, and the rate at which it has increased or decreased, the wave crest height and distance between crests will vary. The values shown in the table are for relatively steady state conditions of long duration. Further, the presence of ground swells makes accurate observations exceedingly difficult and requires good judgment to determine the effects of superimposing a wave system on the ground swells. When operating on the water, the pilot should be aware of several factors which will assist in determining the type and amount of control necessary. The hull and sponson design, coupled with considerable excess buoyancy, provide the helicopter with excellent roll stability characteristics. At lower sea states, this stability permits rotor shutdown with comparative ease. After rotor shut down, the helicopter will weathervane into the wind which reduces the possibility of larger roll angles being induced by the waves. When operating on the water with rotors turning, it may be necessary to use the flight controls to increase water stability. This may require use of cyclic to maintain a fairly level tip path plane as the helicopter pitches or rolls with the waves, or the use of collective to lighten the aircraft on the water and to increase rotor tip clearance and tail clearance. Usually a combination of these techniques are used, with the objective of maintaining a nominally level helicopter attitude to fully assure that neither the main nor tail rotor contacts the water.

WARNING

During water operations, airframe, rotor blade, and engine icing may occur when the temperature is at or below 5°C (41°F) OAT. Below -15°C (+5°F) the rate of accumulation will normally decrease. Icing may degrade performance to the point where flight becomes impossible, and visibility will be impaired with windscreen icing. The foreign object deflector will be installed if icing conditions are anticipated.

BEFORE STARTING ENGINES ON WATER.

Procedures are the same as in land operations; however, care must be exercised to insure the helicopter does not drift into obstacles or shallow water. If the rotor brake is not on, the helicopter will rotate to the right upon engine start.

ENGINE STARTING PROCEDURES ON WATER.

Procedures are the same as in land operations.

CAUTION

If APU is not used, generators must be turned off until the rotor accelerates to 96% N_r as underfrequency protection is not available.

ROTOR ENGAGEMENT ON WATER.

Procedures are the same as in land operations, except that the rotor brake is released prior to advancing either speed selector from GRD IDLE, and the speed selectors are advanced slowly to minimize rotation of the helicopter. As the rotor begins to accelerate, the helicopter will begin to turn to the right. To counter this rotation, full left tail rotor pedal should be applied prior to releasing the rotor brake. At approximately 30% rotor speed, the tail rotor pedal control is sufficient to stop the turn.

WARNING

Before rotor engagement, check that personnel, boats, and other obstructions are clear of the rotor blades.

BEFORE TAXIING ON WATER.

Procedures are the same as in land operations.

TAXIING ON THE WATER

All water operations should be accomplished at 100% N_r or higher to provide optimum water controllability and maximum rotor blade tip clearance above the water. Operation below 96% N_r on the water may result in electrical system damage caused by the lack of generator underfrequency protection. Water taxiing is relatively easy to perform when the water is calm, but becomes more difficult in swells or rough water. Water taxiing at normal speeds is accomplished by application of forward cyclic stick and sufficient collective to maintain the desired water speed. Lateral cyclic stick movements are used to control the rolling tendencies of the helicopter. The degree of cyclic control necessary to control the rolling tendencies becomes greater as the helicopter becomes lighter on the waves. The forward motion of the helicopter is stopped by aft cyclic stick and slightly raised collective pitch lever. Smooth taxi turns can be made by applying tail rotor pedals and cyclic stick into the direction of the turn. If turns are attempted by use of pedals only, the high vertical center of mass of the helicopter, combined with centrifugal force, will cause the helicopter to roll to the outside of the turn.

Taxiing maneuvers in rough water conditions require that the helicopter be kept in the water. Maximum tail rotor and main rotor blade clearances should be maintained by careful use of the collective and cyclic controls.

WARNING

Fast turns accomplished with tail rotor pedals only, and without cyclic stick held into the turn, may result in excessive roll angles and possible upset in rough water.

Water taxiing should be limited to approximately 15 knots. As water speed is increased above 10 knots, water will begin to build up over the bottom edge of the Plexiglas windows at the cockpit floor and may splash up to the bottom of the windshield. The nose of the helicopter may tend to pitch downward due to resistance of the water on the hull, a condition which the pilot should not allow to become excessive. To commence a taxi, twin engine power of 45 to 55% torque, or single engine topping power, should be achieved prior to placing the cyclic forward. Windshield wipers should be turned on as required. The helicopter tip-path plane must be monitored to prevent the rotor blades from striking the waves in rough water. Use of high power allows the helicopter to get as light as possible on the water and rapidly achieve maximum speed. Once desired speed has been reached, additional forward cyclic will only cause the nose to pitch down further. If this condition is reached, the taxi run should be aborted by smoothly lowering the collective. Water momentarily may spray up as high as the windshield as the collective is smoothly lowered, but the helicopter recovers to its normal attitude on the water quite readily. The position of the cyclic should be kept at neutral as the high speed taxi maneuver is aborted.

Lateral and Rearward Water Taxiing.

Sideward taxiing is limited because of the large flat plate area offered by the hull and sponsons. The large water resistance encountered by the hull and sponsons, and the relatively high helicopter center of roll, tend to make the fuselage roll in the direction of motion. Lateral taxiing has no real utility value in normal operations and should be avoided. Rearward taxiing may be accomplished but should be kept to a minimum.

Rearward taxiing is accomplished by raising the collective pitch and holding the cyclic aft, but not to the extent that it causes the blades to strike the droop stops. Rearward taxiing reduces the clearance of the tail rotor blades to the water, particularly in rough seas, and is not a recommended maneuver.

BEFORE TAKE-OFF ON WATER.

Same as land operations.

TAKE-OFF FROM THE WATER.

A normal vertical take-off from water is essentially the same as from land. There may be a tendency to drift in a hover, and a glassy sea state may cause altitude to be misjudged. It is recommended that extreme nose low take-off attitudes be avoided and the electronic altimeter be used for altitude judgment. Lifting to a hover from the water is the same as from a hard surface. As the helicopter is raised to the hovering altitude, rotor downwash will cause water spray to cover the windshield, but use of the windshield wipers will improve visibility. If prolonged hovering is to be performed over salt water, 30 to 40 feet of altitude should be maintained to reduce the amount of salt water ingestion into the engines.

RUNNING TAKE-OFF FROM WATER.

Normally a running take-off from water would be made directly into the wind. If the waves are greater than one or two feet, align the helicopter 30 degrees to either side of the waves and monitor tip-path plane for water clearance when applying forward cyclic stick. With speed selectors full forward, increase collective pitch slowly to attain a water taxi speed of no more than 15 knots. Control the helicopter's attitude with the cyclic stick to prevent any tendency of the nose to dig in. Increase collective pitch to obtain maximum power available. The copilot should be alert to operate the windshield wipers when required. Once the helicopter breaks water, altitude retention will be critical until climbing speed is reached. Attitude must be held constant by slowly and smoothly adding forward cyclic stick until airspeed builds up to approximately 40 to 50 knots, and then a climb can be initiated. When operating at a high gross weight, the helicopter may skim over the water for a few seconds before climbing speed is attained. The pilot should not pull back on the cyclic stick prematurely to establish a climb as the helicopter may settle back into the water. If the helicopter should settle into the water, the nose should be held up very slightly and the landing cushioned with power. If the helicopter has attained sufficient forward speed, it can occasionally be ballooned off the water by smoothly easing the cyclic stick back with a pumping action. However, forward cyclic stick should be carefully applied to allow the helicopter to gain airspeed.

AFTER TAKE-OFF FROM WATER.

Procedures are the same as in land operations.

CRUISE.

Procedures are the same as in land operations.

BEFORE LANDING ON WATER.

Procedures are the same as in land operations except: The landing gear remains up, the forward rotating anti-collision light off, landing light off and stowed, and the searchlight off and stowed. The external fuel tanks may be jettisoned, before landing on the water to preclude overstressing the airframe.

CAUTION

Water landings with external fuel tanks installed may be made on operational missions (rescue, recovery, etc.) at the pilot's discretion. A vertical landing with minimum forward speed and rate of descent should be made to avoid exceeding structural limitations of the sponsons/tanks.

NOTE

- Conditions permitting, the personnel door should be open for all approaches to the water and for all water taxiing, takeoffs and landings. Interaction between the cargo door assembly and the airframe could cause difficulty in opening and virtually prevent jettisoning the cargo door if the helicopter should become inverted on the water.
- If a water landing is made with external tanks installed, an entry will be made in the Form 781 and the aircraft inspected.

LANDING ON WATER.

A water landing is usually softer than its land counterpart because of the large contact area presented by the helicopter hull and sponsons.

CAUTION

In calm water, do not exceed 10 degree noseup attitude at the point of water entry to avoid tail pylon water contact; in sea state 1.0 or higher, do not exceed 7 degree nose-up attitude. Maximum water contact speed is 20 knots. Touch and go water landings are not permitted.

NOTE

On those helicopters equipped with air refueling, water landings should normally not be accomplished. If accomplished, the refueling probe, especially the MA-2 nozzle, should be inspected to insure that damage has not occurred, or the nozzle has not opened to permit water to enter the fuel system. To avoid contaminating fuel in the event of water leakage, do not extend or retract the probe after a water landing has been accomplished. Tank sumps and lines shall be drained following all water landings.

Approach to a Hover Over Water.

An approach to a hover over water differs from its land counterpart in that depth perception is more difficult because of the lack of objects on the horizon for reference. The approach should be planned to place the helicopter at the desired hovering altitude with zero ground speed. Nose high helicopter attitudes should be avoided when operating near the water. If the helicopter is to be landed in the water from a hover, a hovering altitude of approximately 15 feet should be established to allow the pilot to become accustomed to the build up of water spray caused by rotor downwash. Use of the windshield wipers will be required if prolonged hovering is to be done at this altitude or a landing is to be effected. The pilot should approach the water cautiously to allow the rotor downwash to ripple the water surface to aid in depth perception. A continuous reference to the electronic altimeter should be made.

Forward Speed Landings on Water From a Hover.

Landings should be accomplished by holding the helicopter in a level to a slightly tail low attitude and allowing it to settle smoothly on the water. As the helicopter enters the water, more forward cyclic is normally required as the tail tends to tuck slightly. Maintain collective pitch until the helicopter decelerates and levels. At this time, lower collective smoothly and position cyclic as required. Dropping the collective rapidly will cause a nose-up pitching motion which results in reduced tail rotor clearance.

WARNING

If the cargo sling is installed or if the landing gear cannot be retracted, as in the case of fixed or pinned down gear, water landings shall be accomplished from a hover with a minimum of relative water speed. This is necessary since the increased drag of the sling/landing gear will cause the helicopter to pitch or roll and may result in rotor blade contact with the water.

CAUTION

If the helicopter contacts the water in a nosedown attitude, caused by technique or striking of a wave, the nose will pitch down in proportion to the contact speed. If this occurs, proper corrective action is to lower slowly the collective pitch and hold the cyclic neutral or slightly aft. Raising collective pitch after the nose has dug in can cause the helicopter to pitch over and allow the blades to strike the water.

CAUTION

On helicopters modified for mid-air retrieval (MARS) operations, water landings will be accomplished with a minimum of forward and vertical speed.

Forward Speed Landings on Water With High Sink Rate.

Forward speed landings with high sink rate can be accomplished by maintaining a rate of descent of 300 to 500 fpm at speeds between 30 to 40 knots prior to slowing the helicopter for touchdown. The water contact will not be as light as that when higher power is used but will provide a good positive landing. Landing technique does not differ from landings made with high power settings, but the pilot should expect the helicopter to sink slightly lower into the water on touchdown and more water to splash on the cockpit windshield. Once the landing has been made, the collective should be lowered slowly and the cyclic should be held in the neutral position. Because of the forward tilt of the main rotor shaft, the helicopter will tend to taxi forward if the collective is full down and the cyclic held neutral. To prevent forward movement, it is necessary to hold the cyclic slightly aft of neutral with sufficient collective pitch to hold a steady position in the water.

CAUTION

When making water landings in unfamiliar areas, accomplish a touchdown with power and no relative water speed, since mud, rocks, or other objects could cause the helicopter to tip and may cause the rotor blades to contact the water before a recovery can be effected.

ANCHORING THE HELICOPTER.

To effectively anchor the helicopter, the anchor that is supplied with the helicopter must be deployed as shown in figure 2-18. The anchor line must be at least three to four times the depth of the water in normal conditions, and as much as six or seven times the depth in rough or windy conditions. This provides for an essentially horizontal pull from which it develops its holding power. Under extreme conditions, a ten to twenty pound weight may be attached to the anchor line with a shackle and allowed to slide about halfway down. The weight should also be attached to a tag line so that it may be retrieved. The weight on the line causes it to have more slack; however the force of a wave passing under the hull will be largely absorbed in taking up the slack in the line. The wave will usually have passed before the slack is taken up completely and a more vertical pull applied to the anchor. A line of 150 feet is supplied to attach the anchor to the anchor line shackled permanently to the tow ring. In most instances, the 150 foot line is fastened to the eye of the anchor line with the attached snap ring. The entire length is then paid out after the anchor is lowered to the bottom. It is essential that the configuration shown in figure 2-18 be maintained, since a low center-line attachment insures that the helicopter will align with the wind and waves to present minimum drag and resultant minimum strain on the anchor line.

CAUTION

In no case should the anchor line be shortened or the prescribed configuration altered by attaching the anchor line to any of the internal tie down rings in the cabin. The increased drag caused by the asymmetrical attachment, and the resultant position broadside to the wind and waves, can cause the anchor to drag or possibly could capsize the helicopter.

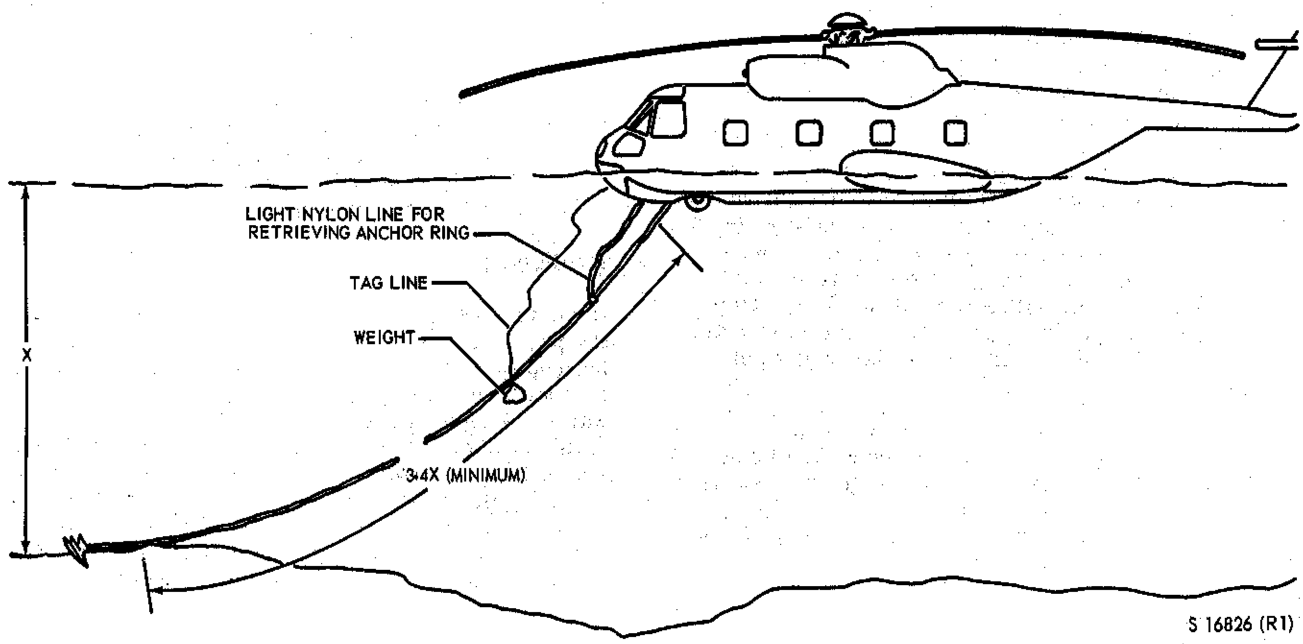


Figure 2-18. Anchoring The Helicopter

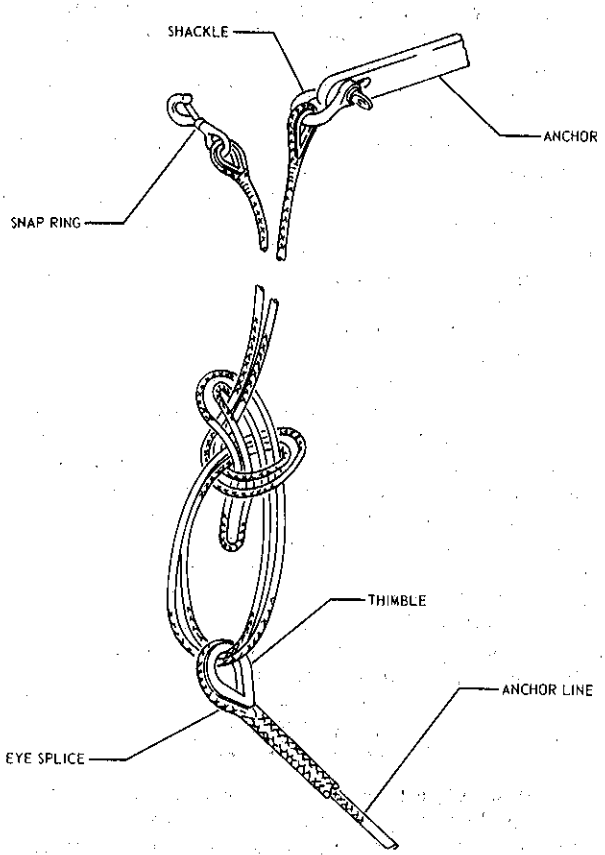


Figure 2-19. Method of Shortening The Anchor Line

If necessary to shorten the anchor line (primarily if deployment of the entire line in relatively shallow water would allow the helicopter to reach the shore or very shallow water) it may be done as shown in figure 2-19. Measure out the desired amount of the 150 foot line from the anchor end. Double it into a short loop at that point. Pass the short loop through the eye of the permanent anchor line and secure it with the knot shown (a bowline on bight). Then deploy the permanent anchor line as with the full 150 feet attached. In those instances where it is necessary to anchor in deeper water, additional line should be attached with the shackles or snap rings provided. The sea anchor should be deployed when the helicopter must remain on rough water more than 20 feet deep or on calm water more than 50 feet deep. A properly deployed sea anchor is effective in maintaining the helicopter heading into the on-coming swells.

The sea anchor, (figure 2-19a), if used, will be attached to the 150 foot anchor rope by the shackle to allow the snap ring on the other end of the rope to be connected to the helicopter mounted anchor rope as it was designed. Attach the sea anchor deployment line (red snap ring) to the crew entrance door forward hand grip by passing the red snap ring through the hand grip and attach it to its own deployment line.

After deployment assure that anchor line and retrieval line are free to allow the anchor to pull from the front center of the helicopter. If a regular sea anchor is not available, a parachute, an open litter bridled at the middle like a kite, or even a large plank, may be used to hold the helicopter into the wind and waves. This will minimize drift and rolling as much as possible.

Weighing Anchor.

Using the light nylon line provided, pull up the permanent anchor line to the cargo door then pull in the 150 foot line, drawing the helicopter into a position as close to vertical over the anchor as possible. The vertical lift thus applied should be sufficient to dislodge the anchor and allow it to be pulled into the helicopter.

NOTE

On helicopters equipped with an air refueling probe, the retracting line has been rerouted around the probe. This permits the anchor line to be lowered on the inside of the probe and retrieved on the outside of the probe. The anchor is then attached to the anchor line and lowered overboard. When retrieving, the anchor is guided to the outboard [illegible] of the probe by the retracting line. The anchor is then removed from the anchor line and stowed. The retracting line is then used to secure the anchor line and bungee cord until it can be rigged when the helicopter lands.

BEACHING.

CAUTION

It is recommended that the helicopter be flown from the water to the landing area and not beached by taxiing from water onto land to avoid damage to equipment on the hull of the helicopter.

DOCKING.

Docking helicopters requires extreme vigilance on the part of the pilot and docking crew. Because the helicopter can move in any direction, the fixed wing or boat techniques are not as important as far as water currents and winds are concerned. Adequate main rotor clearance between personnel and objects are of prime concern. Sufficient personnel should be available at all times to direct and assist in docking the helicopter. A docked helicopter should not be left unattended. The bilge pump shall be manned if the helicopter is to be docked for extended periods of time.

ROTOR SHUTDOWN ON WATER.

Use the AFTER LANDING and ENGINE SHUTDOWN checklists when the engines are to be shutdown.

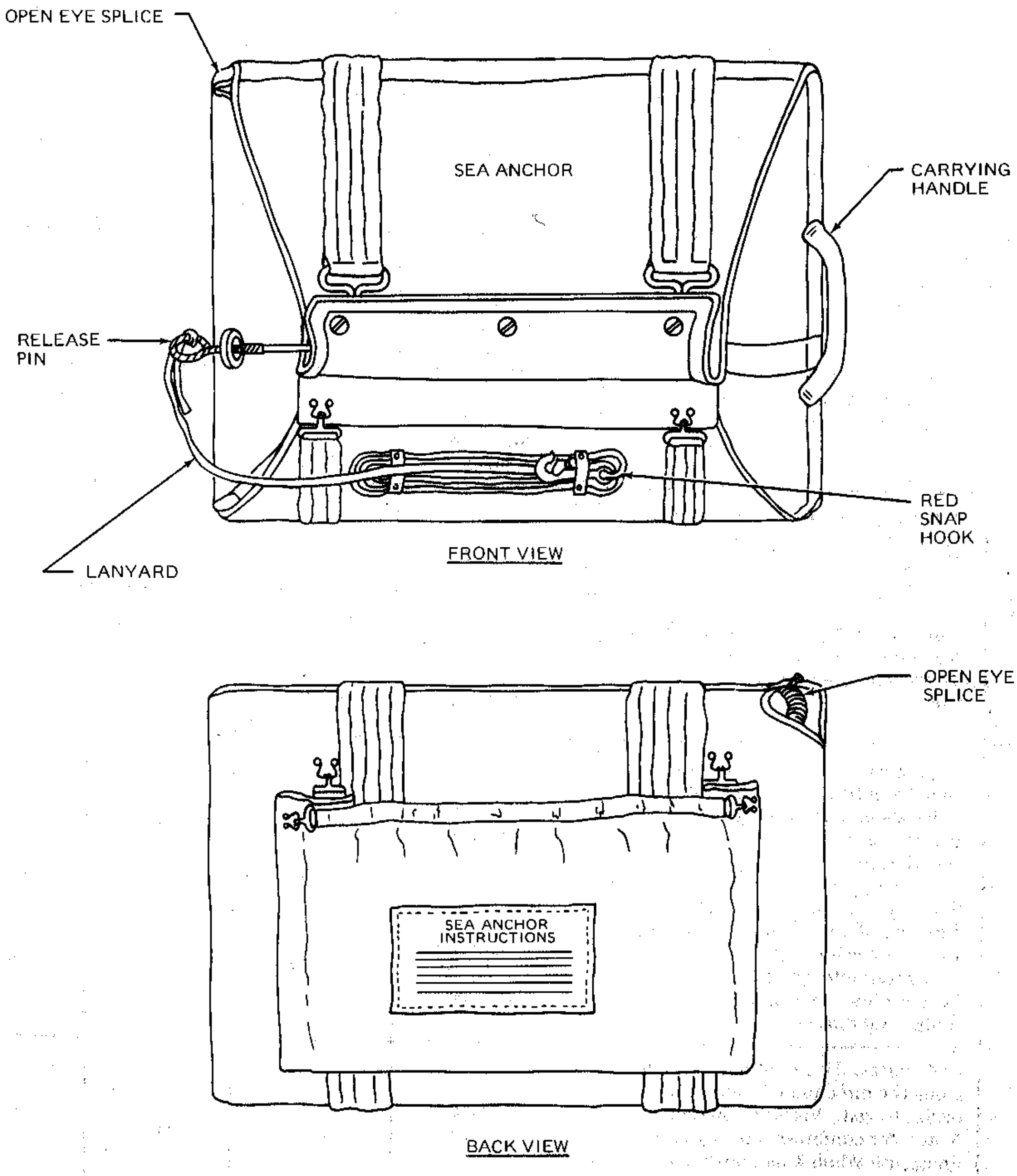


Figure 2-19A. Sea Anchor.

SEA STATE	SEA INDICATIONS DESCRIPTION	WIND DESCRIPTION	WIND VELOCITY RANGE (KNOTS)	WAVES WAVE HEIGHT IN FEET AVERAGE	WAVES WAVE HEIGHT IN FEET MAXIMUM
0	Sea may look like a mirror or small ripples with appearance of scales, but without foam crest.	Calm to light airs	0-3	0	Less than 6 inches
1	Wavelets that are short but pronounced. Crests may begin to break. Perhaps very few scattered whitecaps.	Light to gentle breeze	4-9	6 inches	1
2	Large wavelets or small waves, becoming larger. Fairly frequent whitecaps.	Gentle to moderate breeze	10-13	2	3
3	Small waves becoming larger. Frequent whitecaps.	Moderate breeze	14-16	3	5
4	Moderate waves, pronounced long foam. Many whitecaps. Change of some spray.	Fresh breeze	17-19	4.5	7
5	Moderate to large waves form. White foam crests are more extensive everywhere. Probability of some spray.	Fresh to strong breeze	20-24	8	12
6	Large waves. Sea heaps up. White foam from breaking waves begins to be blown in streaks along the direction of the wind. May begin to see spindrifts.	Strong breeze	25-28	11	18
7	Sea heaps up. Streaks along the direction of wind. Moderately high waves of greater length. Edges of crest break into spindrift. The foam is blown in well marked streaks along wind direction.	Moderate to fresh gale	29-38	25	40
8	High waves. Dense streaks of foam along the direction of wind. Sea begins to roll. Visibility limited. Note: for conditions above these limits, use Whole Gale, Storm, or Hurricane definition.	Strong gale	39-44	36	58

Figure 2-20. State of Sea

When the rotors are to be shutdown while the engines remain operating, use the ROTOR SHUTDOWN AND ENGAGEMENT (ENGINES RUNNING) checklist. Without the stability and control afforded by the rotating blades, the helicopter cannot right itself from a roll greater than approximately 13 degrees. Extending the landing gear will help somewhat by lowering the vertical CG. Wind and water conditions above sea state 2.0 or greater may cause excessive rolling and possible capsizing. After the rotors have stopped, the helicopter will normally align itself into the wind and waves. When engines are shutdown, apply rotor brake at 20% Nr. When engines are not shutdown, apply rotor brake at minimum obtainable N_r. If the rotor brake is used, the helicopter may rotate to the left as much as 360 degrees. Towing should be accomplished into the wind and at no greater water speed than 4 knots.

CAUTION

Failure to start the APU prior to rotor shutdown, with the engines running, can result in lack of lubrication for the high speed engine drive shaft when the rotors are reengaged.

CAUTION

If APU is not on, turn generators off before rotor speed is reduced below 96% N_r as underfrequency protection is not available.

TOWING OF HELICOPTER ON WATER.

The recommended attachment point for a tow line is the anchor fitting at the nose of the helicopter. Use approximately 100 feet of tow line to prevent surging up on the tow boat. Normally, a two to three inch manila rope will be used. If on salt water and time and sea conditions permit, using two ropes to each sponson, tie down fitting may prevent water from entering the nose compartment and damaging electronic equipment. If a regular tow rope is not available, the anchor line may be retrieved and used as a tow line. Whenever possible, towing should be accomplished into the wind. Maximum water speed for towing is 4 knots.

CAUTION

Avoid heading parallel to troughs of waves as this may cause excessive roll.

CAUTION

Use care to avoid damage to the helicopter when the tow boat is alongside. The tow boat should remain upwind when in close proximity to the helicopter because the helicopter will drift downwind more rapidly than the boat.

CAUTION

To prevent excessive rolling and possible upset, do not tow the helicopter in a rearward direction.

During towing operations, the sea anchor should be rigged out the aft ramp to assist in stabilizing the helicopter. The bilges must be checked periodically for water leakage. Some water in the bilges may provide additional stabilization in higher sea states.

CAUTION

Change directions gradually while towing.

AFTER LANDING ON WATER.

Procedures are the same as in land operations.

ENGINE SHUTDOWN ON WATER.

Procedures are the same as in land operations.

BEFORE LEAVING THE HELICOPTER ON WATER.

Procedures are the same as in land operation, except the bilge pump should be installed and a crew member should remain with the helicopter to man the bilge pump.

SALT WATER OPERATION.

ENGINE COMPRESSOR EFFICIENCY/PERFORMANCE

Operational experience has shown that salt spray ingestion in the T58 engine will result in reduced compressor efficiency/performance and subsequent decrease in compressor stall margin. This makes the engine susceptible to stalls during accelerations but more especially during deceleration. As the spray is ingested and contacts the compressor blades/vanes, salt is deposited. A gradual buildup results which changes the airfoil sections which in turn decreases the compressor efficiency/performance. This will be noticed by a decrease in torque (Q) and an increase in T_5 for a given N_g. Should compressor efficiency decrease to a point where the compressor actually stalls, T_5 will increase while N_g and torque will decrease. The circumstances, under which compressor stalls may occur during salt water operation, vary with a number of factors, i.e. flight regime, gross weight, wind direction/velocity, pilot technique, duration of maneuver, salinity of the water and relative density of the salt spray. Intermittent operation in moderate salt spray conditions (such as a series of landings and take-offs) can expose engines to enough salt spray to cause a noticeable change in torque and T_5 at a given Ng. This change is more apparent, and also more critical, during prolonged operations (such as hovering or taxiing) in heavier spray conditions. Maneuvers such as hovering close to the water in light winds (under about 8 knots), taxiing with high power or low flights at low speeds will generate maximum rotor downwash spray conditions. Careful operation, following the procedures and limitation contained herein, and strict adherence to the prescribed maintenance procedures when operating in these conditions will provide adequate compressor efficiency/performance to prevent stalls due to salt water ingestion.

NOTE

Following salt water operations, make appropriate entries in Form 781 reflecting operation on or over salt water.

HOVERING.

Hovering over salt water at altitudes which cause concentrated spray into the engine inlets results in gradual reduction of compressor efficiency and subsequent decrease/loss of stall margin. Operation in these conditions should be avoided or minimized. Use the altitude/time combinations in Figure 2-21 as a guide for planning salt water hover operations. The actual conditions encountered (weight, wind, etc.) and the techniques employed to minimize salt spray ingestion will combine to determine the actual hover altitude/time available. Salt spray ingestion is characterized by a noticeable and steady increase in T_5 for a given torque setting. Prior to salt water hovering accomplish the following on each engine:

1. Perform an N_g/T_5 relationship check.

2. Compare indicated T_5 to the established base line and note the difference.

3. Upon initially entering the hover, note the Ng, torque and T_5 values for each engine.

WARNING

The maximum allowable T_5 rise when hovering at a constant N_g and torque is 35°C minus the difference noted in step 2 above; i.e., if indicated T_5 in step 2 was less than, or did not exceed the baseline, a 35°C rise from the T_5 value noted in step 3 is permissible. If indicated T_5 was 10°C above the baseline, only 25°C T_5 from step 3 value is permissible.

WARNING

If salt spray ingestion during hover operations results in a limiting T_5 rise, leave the salt spray environment. Use extreme care to minimize engine acceleration and deceleration to avoid a compressor stall. If possible, use only one power application and one power reduction for return flight. Use the minimum power required for takeoff, transition, and climb; do not reduce power enroute, and initiate power reduction at destination with sufficient altitude for an autorotative landing.

4. Using Figure 2-21 as a guide for hover altitude/expose time, check T_5 rise by stabilizing as near as possible to the same N_g and torque that was used in step 3 and leave the salt spray environment when limiting T_5 is reached.

NOTE

The FOD shield provides engine protection because the air entering the engine must make two turns of approximately 90°. These turns cause the heavier water particles to centrifuge from the air stream; therefore, use of the FOD shield is recommended for salt water operations.

Hover Altitude	Hover Time
40 Feet	120 Minutes
35 Feet	90 Minutes
30 Feet	60 Minutes
25 Feet	45 Minutes
20 Feet	30 Minutes
15 Feet	15 Minutes
10 Feet	5 Minutes
2-5 Feet	2 Minutes

NOTE

The hover altitude/time combinations are to be used as a guide in conjunction with the T_5 criteria for conducting normal hovering operations. In terms of salt accretion, this figure shows maximum exposure time. Intermittent partial exposure at multiple hover altitudes accumulate as proportions of full exposure, i.e. hovering 5 minutes at 15 feet plus 10 minutes at 20 feet plus 15 minutes at 25 feet would total a maximum or full exposure.

Figure 2-21. Altitude/Time Hovering Over Salt Water

For all hovering operations salt water ingestion may be minimized by adjusting the hover attitude for all wind conditions. Salt spray concentration can be expected under the following wind conditions.

No wind. Hovering in no-wind conditions normally will result in relatively low salt spray concentrations at all hovering altitudes.

Light wind (approximately 0-5 knots). Hovering in these conditions may result in the heaviest salt spray concentrations. Spray may be further minimized by hovering cross-wind at an altitude of approximately 10 to 15 feet.

Moderate to heavy winds. (10 knots and above). Higher winds normally will result in the lowest salt spray concentrations at all hovering altitudes. In these conditions hovering should be accomplished into the wind.

POST FLIGHT CHECK.

Following salt water operations, make appropriate entries in Form 781 reflecting operation on or over salt water and insure that applicable water wash/dry cycle/rustlick procedures are accomplished. Insure all equipment exposed to salt spray/water is washed with fresh water.

ALERT PROCEDURES.

COCKING PROCEDURES.

Prior to assuming alert, the helicopter will be run up to include completion of all checks through BEFORE TAKEOFF, systems checkout, and shutdown using the AFTER LANDING and ENGINE SHUTDOWN checklists, after which the helicopter may be cocked using the COCKING checklist. When a helicopter requires to be cocked following a flight, it is considered to have all required systems checked, and it may be cocked using the COCKING checklist provided the AFTER LANDING and ENGINE SHUTDOWN checklists were accomplished. The SCRAMBLE checklist will not be used unless the COCKING checklist has been accomplished.

Cocking Checklist.

1. Parking Brake - "RESET." (P)
2. Rotor Brake - "ON." (P)
3. Overhead Switch Panel — "SET." (P) (Battery Switch off)
4. Ignition Switches — "NORMAL." (CP)
5. Fuel Management System — "SET." (CP)
   a. Fuel Shut-off Valves — Open
   b. Boost Pumps — On
6. Electronic Altimeters — "ON." (CP) (P)
7. Navigation and Communications Radios — "SET." (CP) (P) (Doppler Set Off)
8. Cocking Checklist — "COMPLETED." (CP)

SECURITY OF COCKED HELICOPTER.

When the helicopter is cocked, no one will enter the helicopter except the aircrew members assigned to that helicopter for alert. All systems checked in conjunction with cocking the helicopter need not be repeated so long as the aircraft remains cocked. Placards, reading "Entry Prohibited - Helicopter Cocked", will be placed near the helicopter. If a maintenance requirement arises while the helicopter is cocked, the alert pilot will first uncock the helicopter, using the UNCOCKING CHECKLIST. The alert pilot, using the COCKING PROCEDURES, will accept the helicopter after maintenance is accomplished.

UNCOCKING CHECKLIST.

1. All electrical switches - OFF.

2. Fuel shut-off valves — CLOSED.
3. Boost pumps - OFF.
4. Parking brake - AS REQUIRED.
5. Ignition switches - OFF.
6. Uncocking checklist completed.

SCRAMBLE CHECKLIST.

1. External power switch — "OFF" (ON IF EXTERNAL POWER USED). (P)
2. Battery switch — "ON" (OFF IF EXTERNAL POWER USED). (P)
3. Protective covers, pitot covers, engine plugs, tie-downs and ground wires — "REMOVED." (FM)
4. Safety belt and harness — "FASTENED." (P,CP)
5. Rotor brake — "LOCK — OFF, BRAKE-ON." (P)
6. Caution and advisory lights — "CHECKED." (P)
7. APU — "CLEAR." (FM), "STARTING." (CP or P)
8. Caution and advisory lights — "CHECKED." (P)
9. Transmission and hydraulic indicators — "CHECKED." (P)
10. Battery switch — "ON" (IF EXTERNAL POWER USED). (P)
11. External power switch "OFF" (IF USED) AND DISCONNECTED. (P)
12. No. 1 engine — "CLEAR." (FM) "STARTING." (CP or P)
13. No. 2 engine — "CLEAR" (FM) "STARTING" (CP or P)
14. Pins and chocks — "REMOVED." (FM)
15. Area — "CLEAR" (P, CP, FM)
16. Rotors — "ENGAGED." (P)
17. APU master switch — "OFF." (P)
18. Unloaded engine speed selector — "SET — 102%." (P)
19. Engine and windshield anti-ice — "AS REQUIRED." (CP)
20. Pitot Head — "AS REQUIRED." (CP)
21. Doppler — "STBY." (P, CP)
22. Lights — "SET." (P)
23. Radio call — "COMPLETED." (P, CP)
24. Cabin area — "SECURE." (FM)
25. Nose wheel — "UNLOCKED." (P)
26. Engine and transmission instruments — "CHECKED." (CP)
27. Flight instruments — "CHECKED." (P, CP)
28. AFCS — "ON AND INDICATORS CHECKED." (P, CP)
29. IFF and Doppler — "ON." (CP)
30. Parking brake — "OFF." (P)
31. Speed selectors — "AS REQUIRED." (CP)
32. "Scramble checklist — COMPLETED." (CP)

HOT REFUELING OPERATIONS.

The following procedures describe hot refueling operations with the rotors engaged and one engine operating. The flight engineer will refuel helicopter, insure that the pressure refueling system used is compatible with the helicopter fuel system, that the proper type fuel is used, and that the aircraft and single point nozzle are properly grounded. The aircraft commander is responsible for positioning the aircraft in the fueling area clear of all obstructions and will ensure that all procedures outlined herein are complied with.

NOTE

These procedures will be used only when authorized by the Major Command and a System Safety Engineering Analysis has been performed.

AFTER LANDING.

1. Speed selectors — "AS REQUIRED." (CP)
2. Fuel management system — "AS REQUIRED." (CP)
   a. Fuel cross-feed valve — CLOSE.
   b. Forward boost pump — ON.
   c. Aft boost pumps — OFF.

NO. 2 ENGINE SHUTDOWN.

NOTE

Shutdown No. 2 engine as soon as possible after landing and prior to taxiing to the refueling area. This allows maximum engine cooling and minimizes fire hazard during refueling operations.

1. No. 2 ignition switch - "OFF." (CP)
2. No. 2 speed selector - "GROUND IDLE." (CP)

NOTE

To provide engine cooling prior to engine shutdown, allow one minute at ground idle before moving the speed selector to the SHUT OFF position.

3. No. 2 speed selector - "SHUT OFF." (CP)
4. No. 2 fuel shut-off valve - "CLOSE." (CP)
5. "No. 2 Engine Shutdown checklist completed." (CP)

REFUELING.

WARNING

- Do not operate aircraft radio equipment (UHF, VHF, HF or FM) while in the refueling area.
- Hot refueling is not authorized when ground refueling from C-130 aircraft.

1. Parking brake - "ON." (P)
2. Windows and doors - "AS REQUIRED." (ALL)

NOTE

The personnel door will remain open to permit rapid egress of the crew in the event of an emergency while refueling. All windows, hatches, and the ramp will be closed.

3. Refueling unit - "POSITIONED." (FM)
4. Ground static wires - "ATTACHED." (FM)
   a. Helicopter - GROUNDED.
   b. Refueling unit - GROUNDED.
   c. Helicopter to refueling unit - GROUNDED.
   d. Fuel nozzle to helicopter - GROUNDED.
5. Fire guard - "POSTED." (FM)
6. Protective cap - "REMOVED." (FM)
7. Refueling nozzle - "CONNECTED." (FM)
8. Refueling panel - "AS REQUIRED." (CP)
   a. Master power switch - ON.
   b. Main tank select switches - FWD and AFT.
   c. External tank select switches - LEFT and RIGHT.
9. Fuel flow - "ESTABLISHED." (CP, FM)
10. Preshut-off test - "COMPLETED." (CP)

NOTE

Refuel helicopter at a maximum flow rate of 150 gpm or 50 psig, measured at adapter. As fuel enters helicopter, MAIN TANKS FWD and AFT and EXT TANKS LEFT and RIGHT FLOW indicating lights will illuminate. Immediately following start of fuel flow, precheck internal tank high level control valves and external shutoff valves by pressing PRE SHUT-OFF TEST switch. When switch is pressed, fuel flow will stop and FLOW indicating lights will go out. When switch is released, fuel flow will resume and FLOW indicating lights will illuminate. When tanks are full, FWD and AFT FLOW lights will go out. EXT TANKS LEFT and RIGHT FULL lights will illuminate, and LEFT and RIGHT FLOW lights will go out.

CAUTION

Failure of flow lights to extinguish when preshutoff test is accomplished indicates a system malfunction and refueling should be terminated.

11. "Refueling checklist completed." (CP)

POST REFUELING.

1. Fuel flow - "STOPPED." (CP, FM)
2. Refueling panel - "AS REQUIRED." (CP)
   a. Tank select switches - AS REQUIRED.
   b. Master power switch - OFF.
3. Refueling nozzle - "DISCONNECTED." (FM)
4. Protective cap - "INSTALLED." (FM)

5. Ground static wires - "DISCONNECTED." (FM)

6. "Post Refueling checklist completed." (CP)

ENGINE RESTART.

1. Parking brake - "OFF." (P)

WARNING

Taxi clear of the refueling area prior to restarting No. 2 engine.

2. Fuel management system - "AS REQUIRED." (CP)

   a. No. 2 engine fuel shut-off switch - OPEN.

   b. Cross-feed valve switch - CLOSED.

   c. Aft boost pump switch - ON.

3. No. 2 ignition switch - "ON." (CP)

4. Fire guard - "POSTED." (FM)

5. No. 2 engine - "START." (CP)

6. No. 2 speed selector - "MATCH TORQUE." (CP)

7. Doppler - "STANDBY." (CP)

8. Electronic altimeter - "ON." (P, CP)

9. IFF - "STANDBY." (P)

10. "Engine Restart checklist completed." (CP)

Proceed with BEFORE TAKEOFF checklist.

FUEL DUMPING SYSTEMS PROCEDURES.

The fuel dumping systems consist of an internal auxiliary fuel tank dumping (jettison) system, that may be installed on CH-3E helicopters prior to 16 . A manual fuel dumping system is provided for helicopters modified by T.O. 1H-3-505. A rapid fuel dumping system is provided for CH-3E 16 and all HH-3E helicopters. Fuel dumping may be accomplished to decrease the gross weight of the helicopter to permit continued single engine flight to an area where a safe landing may be accomplished, or if an emergency landing is necessary, to minimize the amount of fuel that will be aboard the helicopter on contact.

WARNING

Fuel off-loading operations should be conducted with the ramp closed, if installed, and the aircraft heater/vent fan off in order to preclude the possibility of fumes entering the aircraft. Smoking is also prohibited.

WARNING

Fuel dumping in an in-ground effect hover should be avoided because of possible aircraft or engine fire from recirculation of fuel vapor by rotor wash.

Internal Auxiliary Fuel Tank Dumping (Jettisoning) System.

Fuel may be dumped (jettisoned) at a rate of approximately 425 pounds per minute.

1. Auxiliary fuel jettison switch - JETTISON.

Manual Fuel Dumping System.

Fuel may be dumped from the main forward tank, when required, at a rate of approximately 150 pounds per minute.

CAUTION

The manual fuel dumping system will dump the entire fuel load from the forward tank if not monitored. The system uses the existing fuel boost pumps in the forward tank and does not provide the protection of 500 pounds reserve in each tank that the rapid fuel dumping system provides.

NOTE

When the manual fuel dump system valve is in operation, fuel booster pump failure lights and fuel filter bypass lights may illuminate. This is a normal condition caused by a drop in prime fuel pressure and the resultant pressure differential across the fuel filters. The fuel booster pump failure lights should go out when the fuel pressure stabilizes upon release of the manual fuel dump valve.

1. Heater/vent fan - OFF.

2. All boost pumps - ON.

3. Crossfeed valve - OPEN.

CAUTION

The No. 1 engine will flameout if crossfeed is not OPEN before the manual fuel close line valve is CLOSED.

4. Manual fuel close line valve - CLOSED.

5. Manual fuel dump line valve - OPEN.

6. Fuel quantity gages - MONITOR.

To Stop Fuel Dump.

1. Manual fuel dump line valve - CLOSED.
2. Manual fuel close line valve - OPEN.
3. Crossfeed valve - AS REQUIRED.
4. Boost pump - AS REQUIRED.

CAUTION

The boost pumps in forward tank will be turned OFF as soon as the forward fuel quantity gage indicates empty to avoid a possible fire from an overheated fuel pump.

Rapid Fuel Dumping System.

Fuel may be dumped from both main tanks individually or simultaneously by activating the dump switches located on the pressure refueling panel. Dump rate is approximately 880 pounds per minute.

WARNING

Ensure that heater switch and AN/ALE-20 arming switch are off prior to dumping as fuel may be ignited.

CAUTION

Turn off dump switches before fuel quantity gages indicate 500 pounds to avoid overheating the fuel dump pump.

FLIGHT CREW CHECKLIST.

Your flight crew checklist is contained in T.O. 1H-3(C)C-1CL-1.

PASSENGER INFORMATION.

1. Smoking is prohibited during ground operation, take-offs, landings, aerial refueling and when directed by the helicopter commander.

2. Safety belts will be securely fastened for all take-offs, landings, aerial refueling and flight through turbulent air.

3. Operation of portable electronic equipment is prohibited. The use of butane and/or plastic reservoir type lighters is prohibited.

4. All passengers should wear ear protective devices to avoid ear damage.

5. If it becomes necessary to evacuate the helicopter, refer to diagram on reverse side for exits.

6. If a crash landing becomes necessary, proceed as follows:

   a. Jettison emergency exits as directed by the helicopter commander.

   b. Loosen tie.

   c. Fasten safety belt tight.

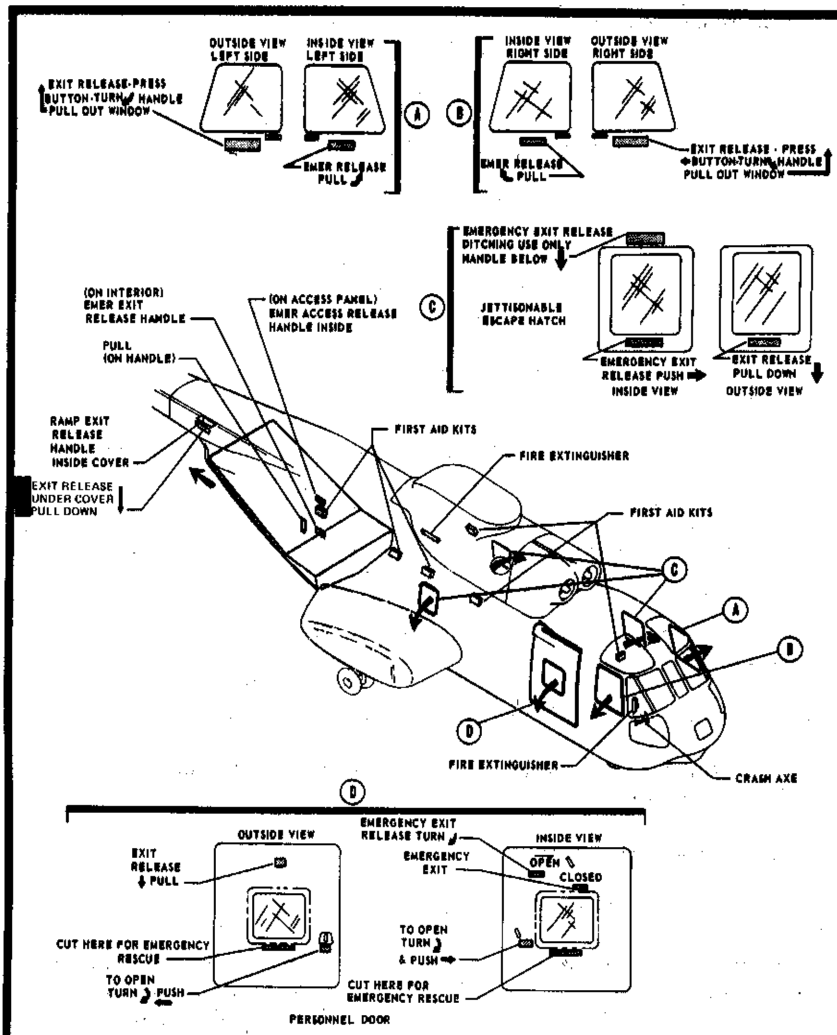
Just prior to contact with the surface, passengers will fold arms resting them on their knees. Bend body forward as far as possible and rest head firmly on arms. If available, hold pillow, blanket, or clothing in front of head to cushion possible impact.

7. Alarm bell.

   a. Bail Out: 3 short rings followed by one continuous ring.

   b. Crash Landing: 6 short rings followed by one continuous ring.

Figure 2-22. Passenger Information



EMERGENCY EXITS AND EQUIPMENT

Figure 2-23. Emergency Exits and Equipment

SECTION III

EMERGENCY PROCEDURES

TABLE OF CONTENTS

IMMEDIATE ACTION ITEMS.

This section contains the procedures to be followed to correct an emergency condition that could reasonably be encountered. Multiple emergencies, adverse weather, or other unusual conditions may require modification of these procedures. Emergency procedures are divided into critical and noncritical items. The critical items are those which must be performed immediately, without reference to the written checklists, to preclude aggravating the condition and/or avoiding further damage or injury. The critical items in this section are in capital letters and are indicated in the checklist by bold face capital letters. The noncritical items are considered cleanup items which improve the chances for the emergency action to be successful. The nature and severity of the emergency will dictate the degree of compliance necessary; therefore, aircrews must use sound judgment to determine the correct action to be taken. As soon as possible, the pilot should inform all other crewmembers and reporting agencies of the nature of the emergency and the intended course of action to be taken.

DEFINITION OF TERMS

1. LAND AS SOON AS PRACTICAL: The nature of the emergency allows that a landing be made at the first available safe landing area which provides acceptable access for corrective action.
2. LAND AS SOON AS POSSIBLE: The nature of the emergency dictates that a landing be made at the first available landing area which will assure minimum injury to the crew or minimum damage to the helicopter.
3. EMERGENCY LANDING: An immediate landing will be made regardless of the availability of a suitable landing area. Continued flight may result in serious injury to the crew and substantial damage to the aircraft.

NOTE

For an explanation of illuminated caution and advisory lights, refer to Section VII.

CAUTION AND WARNING LIGHT – INITIAL ACTION

When caution and warning lights illuminate, the crew should refer to aircraft instruments to verify a malfunction exists, then accomplish the action and procedures as follows for confirmed emergencies.

SEGMENT WORDING	FAULT CONDITION	CORRECTIVE ACTION
GENERATOR (1 & 2)	Generator not connected to bus	Accomplish emergency procedures checklist.
XMFR RECT (1 & 2)	Transformer rectifier not connected to bus	Loss of either T R drops the nonessential DC Bus. If both T Rs fail, turn off all nonessential equipment operating off the DC bus.
FWD/AFT FUEL LOW	140 to 190 pounds (approximately) fuel remaining	Turn on all boost pumps and open cross-feed. If both lights come on, avoid nose-up attitude greater than six degrees.
FWD/AFT FUEL BYPASS	1.5 psi across filter element	Ensure at least one boost pump is on per engine and land as soon as practical.
ENGINE OIL LOW (1 & 2)	Oil quantity down 0.6 gallon from full	Monitor engine instruments and land as soon as practical. Reference ENGINE OIL SYSTEM MALFUNCTION, Section III. Follow Section III, single engine procedures.
TRANS OIL PRESS	Pressure less than 4 psi	Limit flight to 30 minutes. With loss of torque indication rapid rise in N_g/T_5, MGB chip light, MGB oil temperature caution light or temperature indicator at red line, enter autorotation. Reference MAIN GEAR BOX MALFUNCTION, Section III.
TRANS OIL HOT	Temperature above 120°C	Monitor other instruments and land as soon as practical. Reference MAIN GEAR BOX MALFUNCTION, Section III.
AUX/PRIM SERVO PRESS	Pressure below 1000 psi	Accomplish emergency procedures checklist. Land as soon as practical. Reference FLIGHT CONTROL HYDRAULIC SERVO SYSTEM FAILURE, Section III.
INLET ANTI-ICE (1 & 2)	Boot temperature below 37.8°C (Switch on)	Avoid icing conditions
NOSE DOOR	Door not locked	Land as soon as practical, secure door.
CARGO DOOR	Door not locked	Do not open/close door at speeds above 115kts IAS
BLADE PRESS	Low pressure below 6.1 (plus or minus 0.4) psi	Accomplished emergency procedures checklist. Reference MAIN ROTOR BLADE IBIS PRESSURE WARNING, Section III.
CHIP DETECTED	Main Gear Box	Monitor other instruments and land as soon as practical. Reference MAIN GEAR BOX FAILURE, Section III.
	Intermediate/ tail gear box	Land as soon as possible using minimum power. Reference IMPENDING TAIL ROTOR DRIVE SYSTEM FAILURE, Section III.
ALTITUDE LOW	Altitude below index setting	Verify terrain clearance.
ROTOR BRAKE - ON	Hydraulic pressure above 10 (plus or minus 1) psi	Check the rotor brake handle OFF. During flight, if the light remains on, land as soon as possible.
HEATER	Overheat or lack of combustion 45 seconds after heater switch on	Turn off heater. Reattempt use of heater after brief wait. If light remains on, discontinue use.
IFF	Transponder computer not installed, or installed and system has malfunctioned.	Install computer as required.

Figure 3.0. Caution Light Panel Indication Chart

GROUND OPERATIONS.

This phase of operation covers ground or water emergencies that may occur while engines are being started, during taxiing, up to the point where a take-off is accomplished, and during the ground roll.

FIRE DURING GROUND OPERATIONS.

FIRE IN APU COMPARTMENT.

If possible, confirm presence of fire by sight or smell before taking action. A fire in the APU compartment would be indicated by the fire warning light on the APU control panel. Whenever the APU fire warning light is illuminated, proceed as follows:

1. APU EMERGENCY FUEL - SHUT - OFF.

2. **APU FIRE EXTINGUISHER - (ON).**

3. Master switch - OFF.

4. Fire in APU Compartment checklist completed.

ENGINE COMPARTMENT FIRE.

If an engine compartment fire occurs and it is detected visually by the fireguard and/or by activation of the fire warning system, proceed as follows:

1. **SPEED SELECTORS - SHUTOFF.**

2. **T-HANDLE (AFFECTED ENGINE) - PULL.**

3. **FIRE EXTINGUISHER - MAIN/RESERVE.**

4. Fuel management system - OFF

5. APU - OFF

6. Battery - OFF

7. Engine Compartment Fire checklist completed.

FLARE CASE FIRE.

If a fire is detected in a flare case, proceed as follows:

a. All personnel - EVACUATED.

b. Fire fighting unit - NOTIFIED.

USE OF EMERGENCY FUEL CONTROL LEVER TO ASSIST STARTING.

The emergency fuel control lever may be utilized during engine start, in the event a malfunction occurs such as the gas generator failing to accelerate to normal idle speed after engine lite-off (cold hang-up), with N_g, T_5, and fuel flow remaining low. Either engine may be started with the emergency fuel control lever when it cannot be started normally due to engine fuel control unit malfunction. Operation of the emergency fuel control lever bypasses the automatic feature of the fuel control unit to provide fuel scheduling for the engine. Accomplish normal ENGINE STARTING AND ROTOR ENGAGEMENT procedures through the point of advancing the speed selector to GRD IDLE.

CAUTION

Do not open the emergency fuel control lever prior to engine lite-off or a hot start will result.

a. Emergency fuel control lever - ADVANCE SLOWLY TO ACCELERATE GAS GENERATOR TO IDLE SPEED OF APPROXIMATELY 56% N_g.

CAUTION

Closely monitor T_5 for abnormal temperature rise. If T_5 reaches 840°C, close emergency fuel control lever. If T_5 continues to rise, abort start by pulling down on the speed selector and returning to the SHUT-OFF position. Be alert for post shutdown fire.

b. Engine instruments - CHECK. Observe N_g, T_5, fuel flow, and engine oil pressure for normal readings. (Closely monitor both engine controls until oil temperature reaches 0°C.)

c. Emergency fuel control lever - CLOSE SLOWLY.

d. If engine continues to run at idle N_g, normal procedures for rotor engagement and engine operation may be followed.

NOTE

If gas generator speed drops off as the emergency fuel control lever is closed, slowly open the emergency fuel control lever to restore idle rpm. This condition is indicative of a fuel control malfunction other than in the automatic start feature. For emergency flight, engage the rotors with the unaffected engine. The emergency fuel control lever of the affected engine will be advanced until N_f matches rotor speed, then advanced, slowly to match torques. Carefully monitor T_5 so as not to exceed 721°C.

EMERGENCY BATTERY START.

The following procedures are in addition to those outlined under ENGINE STARTING in section VII, and provide the emergency procedures for starting the engines with battery power: When advancing the speed selector toward GRD IDLE, stop speed selector just short of engaging the GRD IDLE detent. If a hot start is evident, retard the speed selector cautiously to shut off the fuel without disengaging the starter. As T_5 decreases, advance the speed selector to just short of the GRD IDLE detent. This procedure may increase the probability of obtaining an engine start using one battery. If the starter disengages during this procedure, abort the start.

TAKE-OFF.

This phase of operation covers emergencies that could occur from the time the take-off is started from land or water until the initial climb is commenced.

NOTE

The engine failure during take-off procedures are contained in the IN-FLIGHT procedures portion of this section.

SINGLE ENGINE TAKE-OFFS FROM WATER.

Single engine take-offs can be executed; however, caution must be exercised as excessive forward speed causes the forward part of the hull to dig into the water.

WARNING

If the drag caused by the forward hull digging into the water is permitted to increase as power is increased, the helicopter could possibly overturn.

Normally, all take-offs should be executed into the wind. In high sea-states it may be preferable to execute the take-off slightly off the wind line (30 degrees to waves) in order to minimize wave impact. The most difficult take-off conditions will result from calm wind, smooth sea-states, and high gross weights. Ensure that landing gear is up to avoid drag. The helicopter should be lifted until it sits high in the water (maximum power). A forward taxi should be instituted. As speed is increased, power should be maintained at a maximum. If possible, N_r should not be allowed to droop below 98%. A nose wave will be generated as the helicopter increases speed through the water. Should the helicopter fail to lift upon attaining approximately 10 knots, the pilot may attempt to break the helicopter away from the surface by easing the cyclic stick very slightly aft. Any time the helicopter attempts to "tuck", or dig into the water, the collective should be lowered to minimum and the attempted take-off aborted. As translational lift is attained, and the sponsons and most of the hull are clear of the water, it may be necessary to ease back on the cyclic stick momentarily to pull the nose of the helicopter out of the water. However, the helicopter should normally lift from the water smoothly and accelerate as drag is lost. The nose attitude will attempt to rise, but should be maintained constant until a minimum of 50 knots airspeed is attained. Once airborne, a minimum of control movements should be made until climb speed is attained. Gradually increase airspeed, being careful not to settle back in the water. Trying to climb too steeply will cause the helicopter to settle. If the helicopter becomes airborne on a single engine take-off attempt and then tends to settle, the pilot should hold the nose of the helicopter slightly above the horizon and cushion the landing with the remaining rotor rpm and power. Immediately after touchdown, reduce collective pitch lever gently. The success of an attempted single engine take-off from water depends upon sea-state, temperature, gross weight of the helicopter, and wind velocity.

IN-FLIGHT OPERATIONS.

This phase of operation is from the time the take-off is accomplished, until the descent is initiated for a landing.

ENGINE FAILURE.

The altitude and airspeed at which engine failure occurs will dictate the action to be taken to effect a safe landing. The airspeed and altitude combinations at which there is no adequate procedure for effecting a safe single engine or power off (dual engine failure) landing are reflected in the Appendix. The majority of turbine engine flameouts are the result of improper fuel flow, caused by fuel control system malfunction. The engine instruments often provide indications of fuel control system failure prior to actual engine failure. A normal air start can often be accomplished. If not, the emergency fuel control can be used to restore engine operation. In the event of apparent mechanical failure within either engine, air starts should not be attempted.

NOTE

In the event of failure of the No. 1 engine or failure of both engines, the APU may be started to insure continued power is available to the accessory section in the event of tail take-off free wheel unit failure.

ENGINE COMPRESSOR STALLS.

The usual indications of a compressor stall are: torquemeter dropoff to zero, decreasing N_g, and an abnormally rapid increasing T_5. An audible rumble or "choo-choo" sound may or may not accompany the compressor stall. Anytime a compressor stall exists, immediately retard the speed selector to GRD IDLE, then to SHUT OFF if a stall is confirmed by continuing T_5 rise. If a compressor stall occurs, it must be recorded, and if maximum T_5 exceeds 721°C, the temperature and time duration must be recorded. A compressor stall will be recorded and investigated regardless of the temperature reached.

If T_5 returns to within normal limits with speed selector at ground idle and engine is required for return flight, the emergency fuel control may be used to stabilize the engine at or above 95% N_g (95% N_g or above is the range at which the engine is less susceptible to stall). To prevent inducing stall and excessive T_5, use extreme caution in stabilizing engine and use only one power setting if possible. If a sudden/abnormal rise in T_5 is experienced immediately shut down the engine.

WARNING

Be alert for engine shutdown fire after shutting down a stalled engine.

SINGLE ENGINE FAILURE.

Single Engine Failure During Normal Flight.

If power required at the time of engine failure is less than one engine can sustain at military power, rotor decay is gradual enough to allow a decrease in collective pitch before an excessively low rotor speed is reached. Observe the engine instruments to determine which engine has failed. Engine failure is normally indicated by a rapid decrease in gas generator speed, turbine inlet temperature, power turbine tachometer and torquemeter readings in conjunction with possible loss of engine oil pressure and fuel flow. Immediately upon noticing loss of single engine, reduce collective pitch momentarily to maintain 100% minimum rotor speed and proceed as follows:

1. **SPEED SELECTORS - MAXIMUM.**
2. **LANDING GEAR - AS REQUIRED.**
3. Weight - REDUCE AS NECESSARY
4. Accomplish ENGINE SHUTDOWN or RESTART checklist

After determining which engine has failed by reference to torquemeters, gas generator tachometer, power turbine tachometer, and turbine inlet temperature indicator, accomplish Engine Shutdown or Restart checklist.

WARNING

> If icing conditions prevail after a single engine failure, and no foreign object deflector is installed, change altitude to avoid icing if possible. If it is impossible to avoid icing and no foreign object deflector is installed, proceed to the nearest landing area.

Flight Characteristics Under Single Engine Conditions.

The altitude, airspeed, and gross weight at which an engine failure occurs will dictate the action to be followed to effect a safe landing. Level flight can be maintained at low altitude and normal gross weight with standard day conditions, except when hovering or operating at low airspeed. As altitude increases above sea level, maximum gross weight at which level flight can be maintained decreases. At cooler temperatures and light gross weights, the helicopter may have hovering capability in ground effect. (Refer to Single Engine Capability Charts in the Appendix.)

Altitude Can be Maintained.

If power available is sufficient, initiate a climb at approximately 70 knots to a safe autorotational altitude. Attempt engine restart, if determined safe to do so.

NOTE

> If the decision is not to attempt a restart, or the restart is not successful, look for a landing site or proceed to destination, whichever is most feasible.

Altitude Cannot be Maintained.

If altitude cannot be maintained on single engine power, an immediate decision must be made as to what course of action should be followed. The decision should be based on power requirements, gross weight, altitude, nature of terrain, or sea-state.

NOTE

> Airspeed may be decreased to approximately 70 knots if necessary to maintain altitude.

If altitude cannot be maintained at approximately 70 knots, proceed as follows:

a. If altitude permits, and it can be determined that it is safe to do so, attempt an engine restart.

b. Observe rate-of-descent to determine possibility of maintaining level flight at a lower altitude.

c. Gross weight may be decreased by jettisoning external or internal cargo.

d. If steps a., b., and c. do not provide the helicopter with capability to maintain altitude, accomplish a single engine landing.

Single Engine Failure - Hovering and During Take-Off.

HOVERING BELOW 15 FEET.

When hovering at low altitudes (0 to 15 feet) in ground effect, maintain a level attitude and eliminate drift using cyclic control and tail rotor pedals. At these altitudes, if power available is not adequate to prevent touchdown, the collective control should be held fixed or increased as required (to maximum if necessary) to cushion the landing.

HOVERING ABOVE 15 FEET AND DURING TAKEOFF.

When hovering above approximately 15 feet, and during takeoff at airspeeds below approximately 40 knots, power requirements and helicopter control must be closely monitored. The collective pitch lever must be reduced momentarily to retain rotor speed. On takeoff, use cyclic control to decrease airspeed if above 40 knots. If possible, attain about 15 to 20 knots before ground contact, if landing on a smooth surface, or as slow as possible if landing on rough terrain. If in a hover, allow airspeed to increase slightly so that touchdown speeds will be same as for failure on takeoff. Touchdown should be made in a level attitude with an absolute minimum of drift. Just before touchdown, increase collective control as required to cushion landing. If landing on a smooth surface, allow the helicopter to roll forward slowly as brakes are applied.

ENGINE SHUTDOWN IN FLIGHT.

1. Speed selector - SHUT-OFF
2. Ignition switch - OFF
3. Fuel shutoff valve - CLOSED
4. Boost pumps - AS REQUIRED
5. Fuel crossfeed valve - AS REQUIRED
6. Engine Shutdown checklist completed.

CAUTION

If an engine fire should occur and the corresponding engine fire warning light illuminate during or after engine shutdown, proceed with steps 3 through 6 of Engine Compartment Fire in Flight Checklist.

ENGINE RESTART DURING FLIGHT.

Try to determine cause of engine failure and if it is safe to attempt a restart in flight. If it is decided to attempt a restart, proceed as follows:

1. Ignition switch - NORMAL.
2. Speed selector (inoperative engine) - SHUT-OFF.
3. Emergency fuel control lever - CLOSED.
4. Fuel shut-off valve - OPEN.
5. Boost pumps - AS REQUIRED.
6. Fuel cross-feed valve - AS REQUIRED.
7. Engine - START.
8. Engine Restart During Flight checklist completed.

CAUTION

A failed engine can be restarted in flight when it has been determined that it is reasonably safe to do so. Before attempting a restart, allow 30 seconds of gas generator coast down, with the speed selector in the SHUT-OFF position, to purge the engine of fumes and fuel. Power turbine inlet temperature (T_5) should be less than 100°C and gas generator speed 19% N_g prior to advancing the speed selector to GRD IDLE, to avoid a hot start. However, in the event power is required immediately from the failed engine to sustain flight, a restart may be attempted, provided N_g is 38% or below. Enter the N_g starter engagement in the Form 781. Starter and accessory drive damage can be anticipated.

CAUTION

When it is suspected that engine failure has resulted from contaminated fuel, the fuel cross-feed valve should be closed for the attempted restart to prevent the possibility of fuel from the contaminated tank flowing to the operative engine. If the attempt to restart fails, and a subsequent attempt to restart is made with the cross-feed valve open, the boost pumps in the tank feeding the inoperative engine should be off to prevent the possibility of fuel from the contaminated tank flowing to the operative engine.

GO-AROUND WITH ONE ENGINE INOPERATIVE.

(See figure 3-1.)

If before landing, it is determined that a safe landing cannot be made, and power available is sufficient to continue flight, initiate a go-around as early as possible to regain or maintain airspeed. Increase collective pitch to obtain maximum single engine torque up to 123% Q, while maintaining a minimum rotor speed of 98% N_r. Increase airspeed to 70 to 80 knots and establish a climb.

FAILURE OF BOTH ENGINES.

Should both engines fail, a safe autorotative landing can be accomplished except when flying at low airspeed and altitude conditions shown in the shaded areas of the Height Velocity Diagram - Two Engine Failure, in the Appendix. Continuous operation in the shaded areas should be avoided. The height-velocity diagram is meant to depict the capabilities of the helicopter, as flown by an average pilot over a paved runway, with zero wind. Under operational conditions, the altitude-airspeed combination for a safe autorotative landing is dependent upon many variables such as pilot capabilities, density altitude, helicopter gross weight, proximity of a suitable landing area, and wind direction and velocity in relation to flight path. This does not preclude any operation in the shaded area under emergency or pressing operational requirements, as a controlled landing can usually be accomplished, and minimum damage, if any, will occur to the helicopter. Generator power will be available even during times of lower rpm. Immediately upon a two-engine failure, rotor rpm will decay and the helicopter will yaw and roll to the left. This is due to the loss in power and corresponding reduction in torque. Except in those instances when a two-engine failure is encountered in close proximity to the surface, it is mandatory that autorotation be established by immediately lowering the collective pitch to minimum. Heading can be maintained by depressing the right tail rotor pedal to decrease the tail rotor thrust. Autorotative

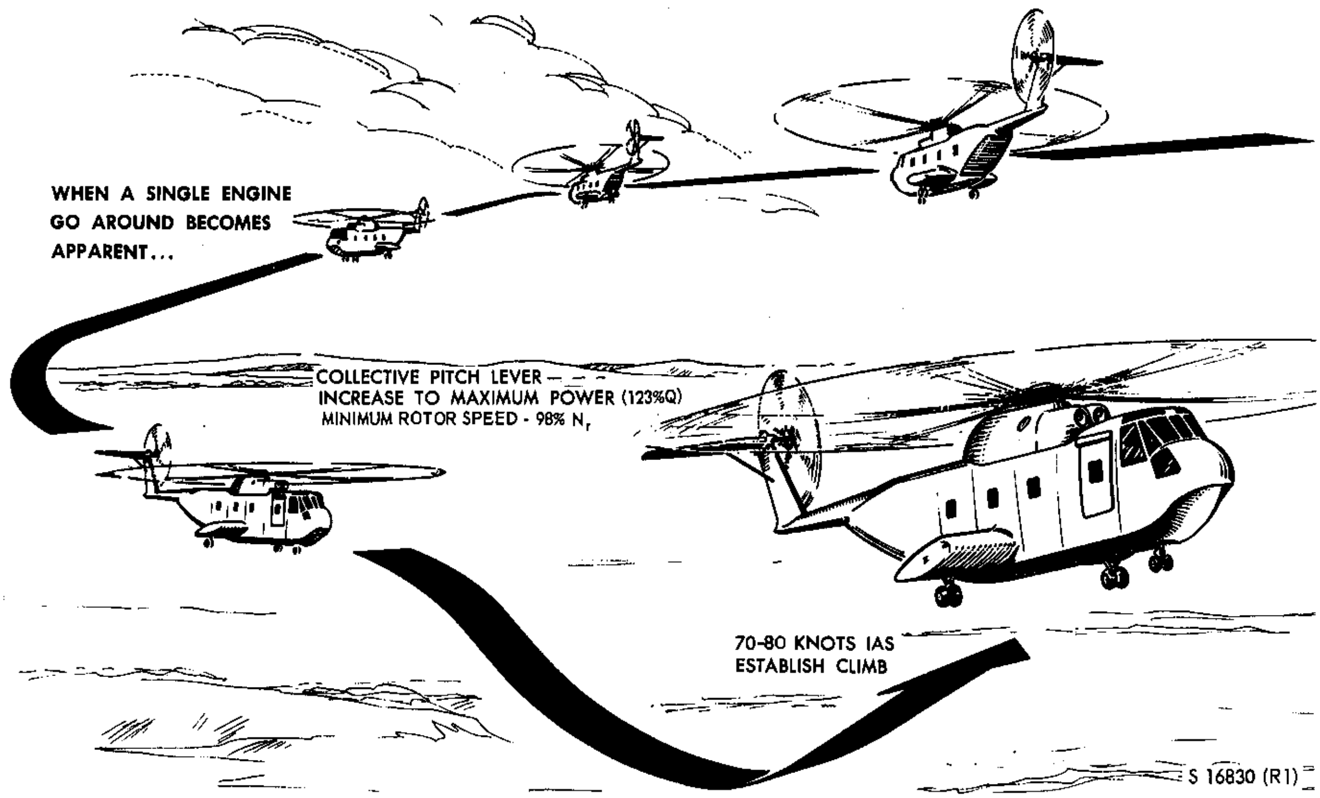


Figure 3-1. Single Engine Go-Around (Typical)

rpm will vary with ambient temperature, pressure altitude, increases in "g" loading such as in turns, and gross weight conditions. High gross weights, increased "g" loads, and higher altitudes and temperatures will cause increased rpm which can be controlled by increasing collective pitch. If altitude permits, a restart can be accomplished or emergency fuel control may be used to restore engine operation.

WARNING

If collective pitch is not reduced sufficiently to effect a safe recovery, control will be lost when rotor speed decreases to the point at which blade stall is encountered. The point at which blade stall will occur is dependent upon density altitude, airspeed, and gross weight factors.

Two-Engine Failure While Hovering.

Settling will be rapid, and immediate application of right pedal is necessary to maintain a heading. At low altitudes, landings can be cushioned by increasing collective pitch as the helicopter settles to the ground. Do not reduce collective pitch as in the event of both engines failing at higher altitude. In this case, a reduction of pitch would cause the helicopter to settle more rapidly. At touchdown, the helicopter should be held in a level attitude. When contact is made with the ground, the cyclic stick should be moved slightly forward of the neutral position. Regardless of the force with which the helicopter strikes the ground, damage will be much less if it strikes level. After ground contact is made, reduce collective pitch to minimum and apply wheel brakes, and rotor brake.

Two-Engine Failure During Take-Off and Climb (Below 60 Knots IAS).

After the climb has been started, various techniques may be employed to execute a power-off landing. When two-engine failure is experienced and altitude permits, reduce collective pitch to maintain rotor speed, accomplish a moderate flare, and reduce airspeed to below 40 knots before ground contact. Attain a level attitude at ground contact and increase collective pitch to cushion landing. After ground contact, reduce collective pitch to minimum and apply wheel and rotor brakes.

Two-Engine Failure During Flight (Autorotative Landing). (Refer to figure 3-2.)

In the event of a two-engine failure during flight, a safe autorotative landing can be accomplished provided the helicopter is being flown at a safe altitude-air-speed combination and the inflight altitude is sufficient to permit selection of a suitable landing area. A site for autorotative landing should be the same as

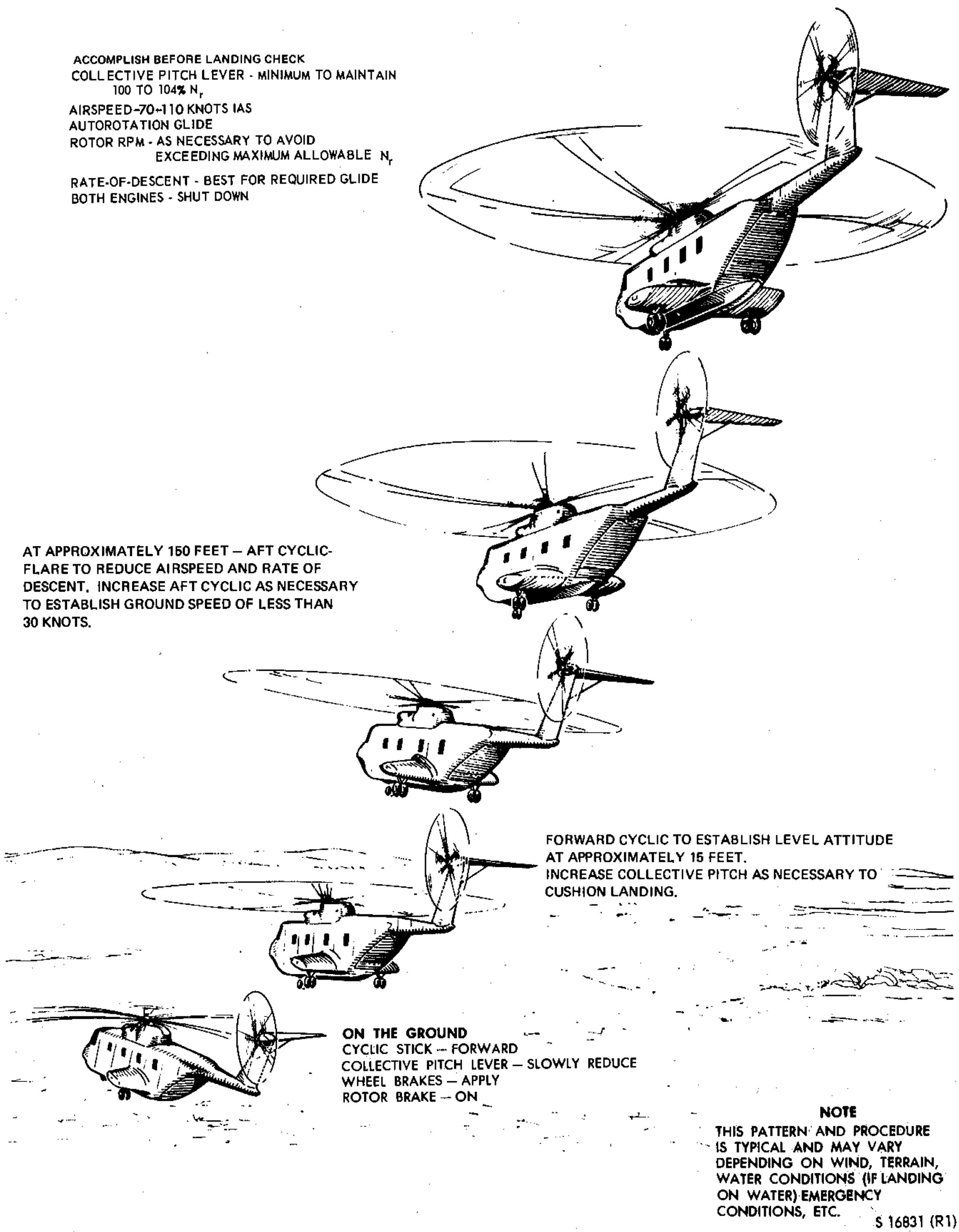


Figure 3-2. Autorotative Landings (Typical)

for single-engine landings, as ground contact should be made with some forward airspeed. Immediately upon encountering dual engine failure, reduce collective smoothly to minimum setting to maintain a rotor speed of 100 to 104% Nr. Adjust cyclic stick as necessary to maintain 70 to 110 knots. Minimum rate of descent and maximum autorotative gliding distances are shown in figure 3-3. Any increase of rotor rpm other than specified for maximum glide will result in a greater rate of descent. Therefore, if time permits, adjusting the collective pitch lever to produce the desired rotor rpm will result in an extended glide. At an altitude of approximately 150 feet, a flare should be established by moving the cyclic stick aft with no change in collective pitch. This will decrease both airspeed and rate of descent and cause an increase in rotor rpm. The amount that the rotor rpm will increase is dependent upon the rate that the flare is executed. An increase is desirable because more energy will be available to the main rotor when collective pitch is applied.

NOTE

Under certain light gross weights and low temperatures, rotor speeds may not build up to 100% N_r on straight-away autorotations.

NOTE

All autorotative landings should be made into the wind, if possible.

Maintain helicopter control and initiate autorotation.

1. **LANDING GEAR-AS REQUIRED.**
2. Speed selectors - SHUT OFF.
3. Ignition switches - OFF.
4. Fuel shutoff valves - CLOSED.
5. Boost pumps - OFF.
6. Battery - OFF.
7. Autorotation checklist completed.

While initiating a flare at approximately 150 feet, attain a ground speed of less than 30 knots with cyclic control. Level off at approximately 15 feet, while eliminating all drift and maintaining a level attitude until touchdown. Just prior to touchdown, increase collective pitch to cushion landing. After ground contact, slowly reduce collective to minimum pitch, and apply rotor and wheel brakes.

WARNING

When entering autorotation avoid abrupt cyclic movements. It has been established that during flight critical combinations of engine and rotor conditions coupled with rapid control inputs may cause rotor blade fuselage contact. Avoid retarding speed selectors prior to entering autorotations and/or rapid reduction of collective pitch especially at reduced rotor rpm. Following a loss of power, do not apply either rapid collective and/or cyclic control inputs or large displacement cyclic inputs with the collective full down.

Two-Engine Failure At High Power.

A two-engine failure at high power during high or low speed flight, climb, and hover out of ground effect, will result in rapid rotor rpm decay, and will be accompanied by a distinct yaw and roll to the left. Collective pitch must be immediately reduced to prevent excessive loss of rotor rpm, and right tail rotor pedal should be applied to compensate for loss of torque and to control heading.

Two-Engine Failure At High Power and Low Speed.

Reduce collective pitch to minimum and simultaneously apply forward cyclic stick to regain airspeed and establish a glide at a minimum airspeed of 70 knots. This action normally requires 400 to 500 feet of altitude if the recovery is initiated at zero airspeed. Accomplish landing as outlined in Two-Engine Failure During Flight (Autorotative Landing) in this section.

Two Engine Failure At High Power and High Speed.

If a constant airspeed is maintained while normal recovery procedures are being used, a loss of approximately 300 to 500 feet of altitude will be realized. This altitude loss may be reduced by simultaneously applying aft cyclic stick as the collective pitch is reduced. The rate that aft cyclic stick is applied, and the duration of the corresponding nose-high attitude, determines the rate of deceleration and/or loss of altitude. Judicious use of collective pitch during the flare, to keep rotor rpm from building up, also reduces the loss of altitude. Accomplish landing as outlined in Two-Engine Failure During Flight (Autorotative Landing) in this section.

Two-Engine Failure At High Speeds and Low Altitude.

The following procedure should be used if both engines should fail at high speed and low altitude: Immediately lower collective pitch and simultaneously apply aft cyclic stick to hold the helicopter off the surface. Accomplish landing as outlined in Two-Engine Failure During Take-Off and Climb in this section.

NOTE

Avoid abrupt control movements during high speed autorotation to preclude rotor overspeed and/or blade stall.

TAIL ROTOR SYSTEM FAILURES.

The types of tail rotor system failure can be generally classified as drive system failure and control system failure. This information is based on flight tests in which a drive system failure that resulted in loss of the tail rotor thrust was simulated. The case of a control system failure is believed to be less critical than drive system failure and was not covered during the tests. In general, for tail rotor system failure, if conditions permit, lower collective to minimum and turn off the auxiliary servo. If turning off the auxiliary servo does not alleviate the problem, the auxiliary servo should be restored. Then use collective to attempt to stabilize optimum yaw angle, power, and airspeed for controlled flight. Yaw angles as great as 40 degrees in stabilized flight may be experienced. If control of the aircraft cannot be maintained with minimum collective, the procedures outlined for tail rotor drive system failure should be followed. If control can be maintained with power, this is indicative of control system failure.

TAIL ROTOR DRIVE SYSTEM FAILURES.

A tail rotor drive system failure, whereby tail rotor rpm and thrust are lost, may be caused by fracture of the shaft, coupling, or gear box, or separation of the tail rotor assembly from the helicopter. Tail rotor separation from the helicopter is usually caused by severe vibration that has been induced by the fracture of a rotating component. A drive system failure is the most difficult type for the pilot to cope with since it is accompanied by the loss of the rotating disc area that would normally assist as a stabilizing fin in forward flight. Since tail rotor drive system failure at high speeds is expected to produce violent helicopter response, recognition of impending failure is extremely important. Excessive vibration or noise in the tail pylon section usually precedes tail rotor drive system failure. Therefore, when this occurs, airspeed should be reduced immediately to the best autorotational speed. A tail rotor drive system failure is always accompanied by loss of directional control and a sharp yaw to the right. The rate and amount of yaw are governed by the power applied and the airspeed. The yaw tendency can only be reduced by immediate reduction in power. Yaw angles in excess of 60 degrees can be expected initially upon failure of the tail rotor drive system. Immediate entry into autorotation will reduce the yaw angle to about 40 degrees. The 40 degree yaw angle that will be experienced results from the aerodynamic characteristics of the airframe during autorotation when unable to apply control to the tail rotor blades.

WARNING

Extended flight is not possible after tail rotor drive system failure. Autorotation must be entered immediately.

NOTE

Yaw servo failure may give a hardover input in either direction and could be confused with tail rotor drive system failure. Turning the auxiliary servo pressure OFF will restore manual control and the helicopter can be flown satisfactorily. (Refer to FLIGHT CONTROL HYDRAULIC SERVO SYSTEM FAILURE in this section.)

Landing without the tail rotor operating is hazardous due to touchdown in the extreme yaw attitude (about 40 degrees) and probable roll-over. If a landing is performed, final approach and landing should be made into the wind in full autorotation, with both engines shutdown. The rate of descent will be approximately 2500 fpm because of the extreme yaw attitude. This will require a modified side flare to reduce the ground speed to as near zero as possible to prevent roll-over. Because of the extremely hazardous nature of the landing, it is recommended that the helicopter be abandoned, if parachutes are worn and if sufficient altitude and time are available. Crew bailout via the right side is recommended.

Tail Rotor Drive System Failure While Hovering.

Main rotor torque will cause an immediate clockwise rotation of the fuselage. To minimize the rotation while in a low hover, immediately shut off speed selectors while maintaining a level attitude with the cyclic, and cushion the landing. If hovering at higher hover heights, lower the collective to maintain rotor speed prior to shutting off speed selectors, and at approximately 10 feet AGL apply collective to cushion the landing.

Tail Rotor Drive System Failure During Take-Off or Landing Approach.

The fuselage will commence an immediate clockwise rotation. To stop this rotation, enter autorotation immediately. Due to the large sideslip angle, a side flare is required to reduce rate of descent and forward speed to prevent roll-over on touchdown.

Tail Rotor Drive System Failure During Cruise Flight.

When a tail rotor drive system failure occurs during cruise flight, the nose will immediately yaw to the right. To stop this clockwise rotation of the fuselage, enter autorotation immediately.

Approach and Landing with Tail Rotor Drive System Failure.

If a landing is to be performed, shut down both engines and maintain approximately 70 knots IAS. The airspeed indicator, although in error due to sideslip, will indicate the approximate airspeed. Accomplish landing as outlined in Two Engine Failure During Flight (Autorotative Landing) in this section. Lower landing gear and land into the wind, if possible. Initiate a modified side flare at approximately 150 feet to reduce rate of descent and ground speed. Level off at approximately 15 feet. Use collective, as necessary, to cushion landing. Ground contact speed must be held to minimum as the sideslip condition may result in roll-over on touchdown.

TAIL ROTOR CONTROL SYSTEM FAIILURE.

A tail rotor control system failure, forward or aft of the servo, will result in a loss of tail rotor response and a possible hardover. Turning the auxiliary servo off will allow the tail rotor to go into a flat pitch condition and minimize yaw tendencies. In all cases of control system malfunction, the tail rotor will continue to rotate, usually in a low thrust condition that will help to minimize excessive yaw tendencies at higher airspeeds. The varied conditions under which tail rotor control system failure may occur preclude dictating a technique to be followed under all circumstances. Forward flight may be possible, generally at airspeeds lower than normal cruise. An approach and power-on landing may also be possible.

NOTE

A tail rotor servo or AFCS yaw channel malfunction may cause a "hardover" input in either direction and initially be confused with a control system malfunction. Turning the auxiliary servo pressure off will restore manual control.

MAIN ROTOR BLADE IBIS PRESSURE WARNING.

(For aircraft modified by TCTO 1H-3-661)

Illumination of the Blade Pressure Caution Light indicates possible loss of pressure in one or more main rotor blade spars with corresponding potential for impending spar failure.

1. Airspeed - Attain 70 to 90 KIAS.

NOTE

The 70- to 90-knot speed restriction will reduce the Vibratory Stresses in the main rotor blade spar and significantly increase the crack propagation time.

2. Land as soon as practical and visually check the IBIS indicators.

IBIS Visual Check.

a. If red is visible in any indicator, the helicopter shall not be flown until corrective maintenance has been performed.

NOTE

If BLADE PRESS caution light illuminates during flight, land as soon as practical. If red is visible on any indicator, it may be reset one (1) time. If it remains reset after a fifteen (15) minute ground run, the helicopter may be cleared for a one (1) time flight back to base.

b. If all IBIS indicators are yellow and the BLADE PRESS caution light remains on, the helicopter may be cleared for flight by (1) pulling the circuit breakers to deactivate the BLADE PRESS Caution Circuit, and (2) limiting helicopter speed and flight duration to a maximum of 110 KIAS and 6 hours.

EMERGENCY JETTISONING OF AUXILIARY FUEL TANKS.

The external auxiliary fuel tanks may be jettisoned at the discretion of the pilot to reduce weight, etc. The tanks may be jettisoned electrically by actuating the switches located on the auxiliary fuel control panel or mechanically by pulling the emergency auxiliary tank release handle located aft of the cockpit console. Tanks may be jettisoned electrically individually or simultaneously. Manual jettison will release both tanks simultaneously.

CAUTION

Do not perform an asymmetric jettison of the external fuel tanks during climb as excessive roll rates and attitudes may occur.

If for any reason one external fuel tank is dropped and fuel remains in the tank being carried, continue to transfer fuel into the main tank. Monitor the fuel gages and use crossfeed to maintain fuel management between forward and aft tank. Refer to section V for JETTISON OF EXTERNAL FUEL TANKS LIMITATIONS.

FIRE IN FLIGHT.

ENGINE COMPARTMENT FIRE IN FLIGHT.

Engine compartment fires are usually the result of an engine malfunction or failure of one of its component systems. Ruptured fuel and oil lines will usually be detected by engine instrument indications. If possible, confirm the presence of fire by other indications.

NOTE

Hovering downwind, or in a calm wind, may cause the fire warning system to activate due to recirculation of hot gases through the engine. It is possible to receive a false fire warning light due to warning system malfunction. If possible, confirm the presence of fire by sight, smell, sound or reference to engine instruments before proceeding with the checklist.

1. **SPEED SELECTORS - MAXIMUM.**
2. **SPEED SELECTOR (AFFECTED ENGINE) - SHUTOFF.**
3. **T-HANDLE (AFFECTED ENGINE) - PULL.**
4. **FIRE EXTINGUISHER - MAIN/RESERVE.**
5. **LANDING GEAR - AS REQUIRED.**

NOTE

If one fire extinguisher container has been discharged, check to ensure the FIRE EXT circuit breaker is set before discharging the remaining bottle.

6. Weight - REDUCE AS NECESSARY
7. Accomplish Engine Shutdown In Flight checklist.

CONSECUTIVE FIRES IN BOTH ENGINE COMPARTMENTS.

When a fire has been experienced in an engine compartment that necessitates using the fire extinguisher system, and a subsequent fire is experienced in the other engine compartment, enter autorotation and follow procedures for ENGINE COMPARTMENT FIRE IN FLIGHT for the second engine, except select RESERVE position of the engine fire extinguisher switch. Accomplish landing as outlined in Two Engine Failure During Flight (Autorotative Landing).

SIMULTANEOUS FIRES IN BOTH ENGINE COMPARTMENTS.

If simultaneous engine fires occur, enter autorotation and put both speed selectors in the SHUT-OFF position. After shutting off fuel to the engines, pull the selected fire emergency T-handle and move the engine fire extinguisher switch to the MAIN position. Fire extinguisher agent will then be released into the selected engine compartment. Pull the opposite fire emergency T-handle and move the engine fire extinguisher switch to the RESERVE position, releasing fire extinguisher agent into the opposite engine compartment. Accomplish landing as outlined in Two Engines Failure During Flight (Autorotative Landing).

WARNING

Do not reset the first fire emergency T-handle before attempting to extinguish the second fire. This could result in allowing fuel to re-enter the first engine.

NOTE

The second fire bottle will discharge into the last engine for which the T-handle was pulled, regardless of the position of the first fire emergency T-handle. There will be no extinguisher available if both MAIN and RESERVE were used on the first fire.

FUSELAGE/ELECTRICAL FIRE.

1. Discharge fire extinguisher at fire or jettison burning items.
2. Windows and doors - CLOSED.
3. Vent fan switch - OFF.
4. Land as soon as possible if fire persists.

In the event of an electrical fire, attempt to isolate the affected circuit by pulling circuit breakers. If flight conditions permit, turn off generators and battery if necessary to isolate the problem.

FLARE CASE FIRE.

If a fire occurs in a flare case, an internal sensing unit will jettison the case automatically. If the automatic jettison fails, jettison flare case electrically by use of the flare case jettison switch or manually jettison by use of the manual jettison lever.

SMOKE, FUME, AND ODOR ELIMINATION.

After a fire, or if fumes are detected in the helicopter, open the personnel door and the pilot's compartment windows for the elimination of smoke and/or fumes. Flight tests indicated these two openings are the most effective for smoke and fume elimination. Normally no toxic quantities of carbon monoxide gas or other gases are present from the engine exhaust. Objectionable odors of the engine exhaust gases, which are sometimes encountered in the helicopter during ground run-up, taxiing, slow speed flight, or single engine flight with one engine in ground idle may be avoided by heading the helicopter into the wind and/or closing the pilot's compartment window and the personnel door. Opening the personnel door and the pilot's compartment windows in flight will assist in removing objectionable fumes and odors. If aft ramp is open or removed, the aircraft must be yawed to the left to remove smoke and fumes. All odors not identifiable by the flight crew shall be considered toxic. If an unidentifiable odor is detected, ventilate the aircraft and land as soon as practical.

WARNING

Do not open the pilot's compartment windows if personnel door is not open, because with personnel door closed, the smoke and fumes will enter the pilot's compartment.

WARNING

Smoke accumulation in the aft cabin that cannot be eliminated by normal smoke and fume elimination procedures may be an indication of impending intermediate gear box failure. Follow procedures for IMPENDING TAIL ROTOR DRIVE SYSTEM FAILURE.

CAUTION

Do not jettison any windows, the door, or the emergency hatch while the helicopter is in forward flight as they may be carried into the rotor blades.

BAILOUT.

The decision to bailout is the pilot's, based upon evaluation of all factors at the time of the emergency and is recommended if it is impossible to make a safe emergency landing. Minimum bailout altitude should be 1000 feet above the surface. Bailout should be accomplished in level flight at approximately 70 KIAS; however, bailout is possible during autorotation.

WARNING

To avoid contacting sponsons during bailout the following speeds should not be exceeded:

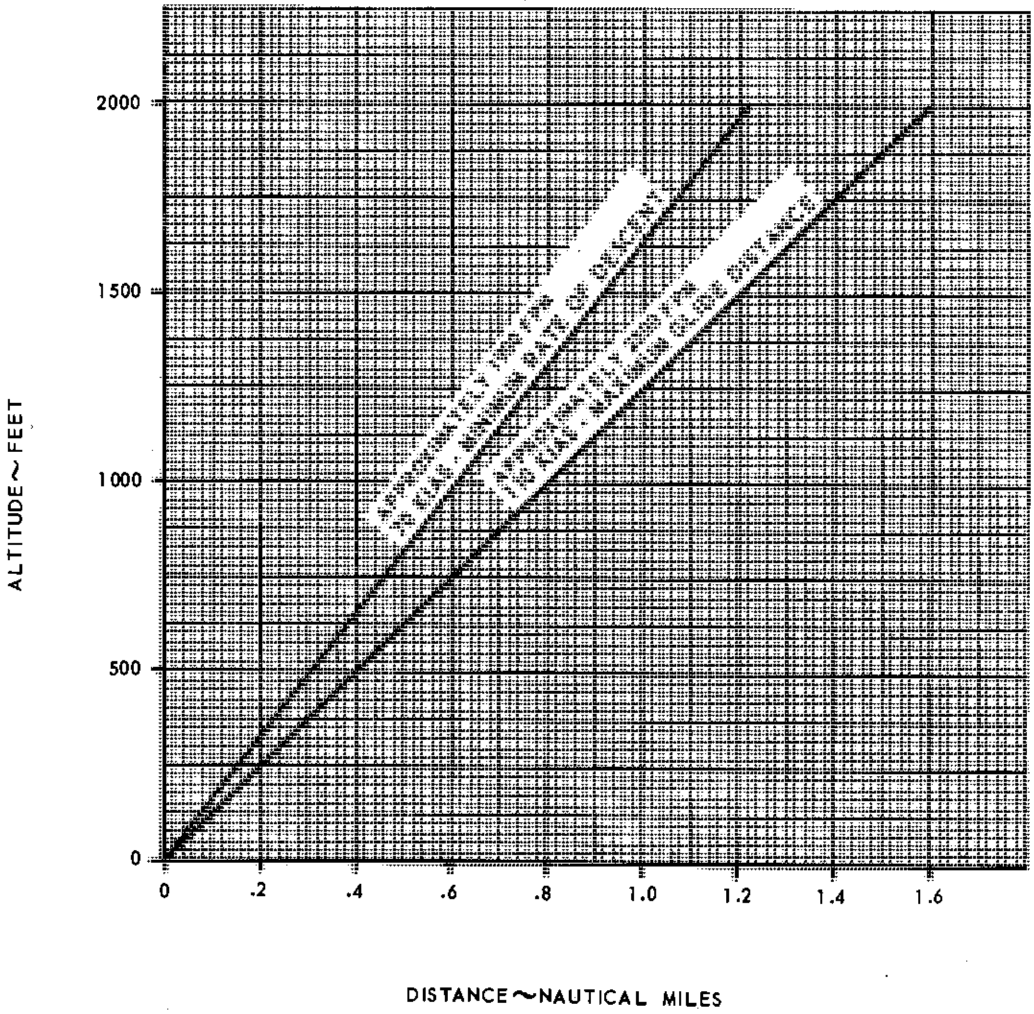
140 KIAS Maximum Powered Flight.
125 KIAS Maximum Autorotation.

Prior to abandoning the aircraft (time permitting), the IFF should be placed in emergency and a radio call accomplished. Cabin occupants should abandon

MAXIMUM AUTOROTATIVE GLIDING DISTANCE

212 ROTOR RPM **104% ROTOR SPEED**

MODELS: CH-3E & HH-3E
DATE: 1 JUNE 1965
DATA BASIS: CONTRACTOR FLIGHT TEST



S 16832 (R1)

Figure 3-3. Maximum Autorotative Gliding Distance the aircraft via the personnel door by diving down to avoid contact with the sponson. Arms should be held close to the body with the head down; wait until clear of the helicopter before opening the parachute. The pilot may, at his discretion, have personnel bailout through the ramp exit. However, no more than one person should be on the ramp at any one time to avoid a CG problem. The pilot may exit through the cockpit sliding windows or the personnel door as circumstances dictate. Time of exit through the window or door is approximately the same. If exit through the window is attempted, jettison the window, place both feet in the seat with hands on the window frame and dive down and out to clear the helicopter. Open the parachute when clear of rotor turbulence.

WARNING

The copilot must ensure that the collective pitch lever does not block his egress through the window. The pilots must also ensure that their helmet cords are not entangled in their shoulder harness. If armor plating is installed, the outboard wing armor must be released prior to attempting to bailout. The pilots' seats must not be in the full down position when the outboard wing armor is released as the armor may not clear the window opening. If time and altitude permit, accomplish the following checklist.

1. IFF - EMERGENCY
2. Radio call - MAYDAY (Give position report)
3. Cabin occupants - ALERTED (Warn occupants via interphone, loudspeaker or alarm bell.)
4. Personnel door - OPEN (Jettison if necessary).
5. Cabin occupants - BAILOUT.
6. Pilot and copilot - BAILOUT.

LANDING.

This phase of operation is from the time a descent is commenced to initiate a landing until the helicopter has touched down. This phase also contains appropriate emergency water operating procedures.

EMERGENCY DESCENT.

There is no set procedure for an emergency descent. Damage to the helicopter or engines must be considered secondary to getting the helicopter on the ground. During an extreme emergency, the condition or type of landing may be the determining factor in the type of emergency descent to be made. If a long distance must be covered to a selected landing site, a dive with power would be most feasible. A normal power-on vertical landing may be made when the landing site is reached. If a short distance must be covered to a selected landing site, attaining a rapid rate of descent with low power, minimum pitch, and slow forward speed is the most practical means of accomplishing an emergency descent.

MAXIMUM AUTOROTATIVE GLIDE DISTANCE CHART.

The maximum autorotative glide distance chart (figure 3-3) shows the maximum gliding distance attainable if power fails on both engines. Maximum autorotative gliding distance is obtained at 110 knots indicated airspeed and approximately 104% rotor speed. The rate of descent is approximately 2300 feet per minute. Minimum rate of descent is obtained at 70 knots IAS and 104% rotor speed. Minimum rate of descent is approximately 1900 fpm. Increasing rotor speed above 104% will result in a greater rate of descent and reduced gliding distance.

SINGLE ENGINE LANDINGS. (Refer to figure 3-4.)

Single engine landings can be safely accomplished provided they are not initiated within the airspeeds and altitudes shown in the areas to avoid on the Height Velocity Diagram in the Appendix. After a suitable landing site has been selected, maintain approximately 70 knots until a safe landing is assured. Adjust collective pitch and cyclic control to gradually decrease airspeed and rate of descent. Maintain level attitude and minimum practical rate of descent prior to ground touchdown. If landing on an unprepared surface or a confined area, dissipate speed gradually throughout the approach to touchdown as slow as possible to minimize ground roll. Upon ground contact, smoothly reduce collective pitch lever and control cyclic stick to maintain level attitude. Reduce the collective pitch to minimum and apply brakes to minimize the ground roll.

CAUTION

Extreme nose-high attitudes must be avoided near the surface (10 to 15 feet altitude) due to possibility of the tail pylon striking the ground. If collective pitch is increased prematurely, insufficient rotor speed may remain to cushion the landing, resulting in possible damage to the aircraft.

SINGLE ENGINE WATER LANDINGS.

A single engine landing on the water differs only slightly from that on a hard surface. However, it is necessary that touchdown speed be somewhat slower, especially over rough water, and that the rate of descent be controlled. Upon water contact (20 knots or less), reduce collective pitch slowly as the helicopter settles into the water.

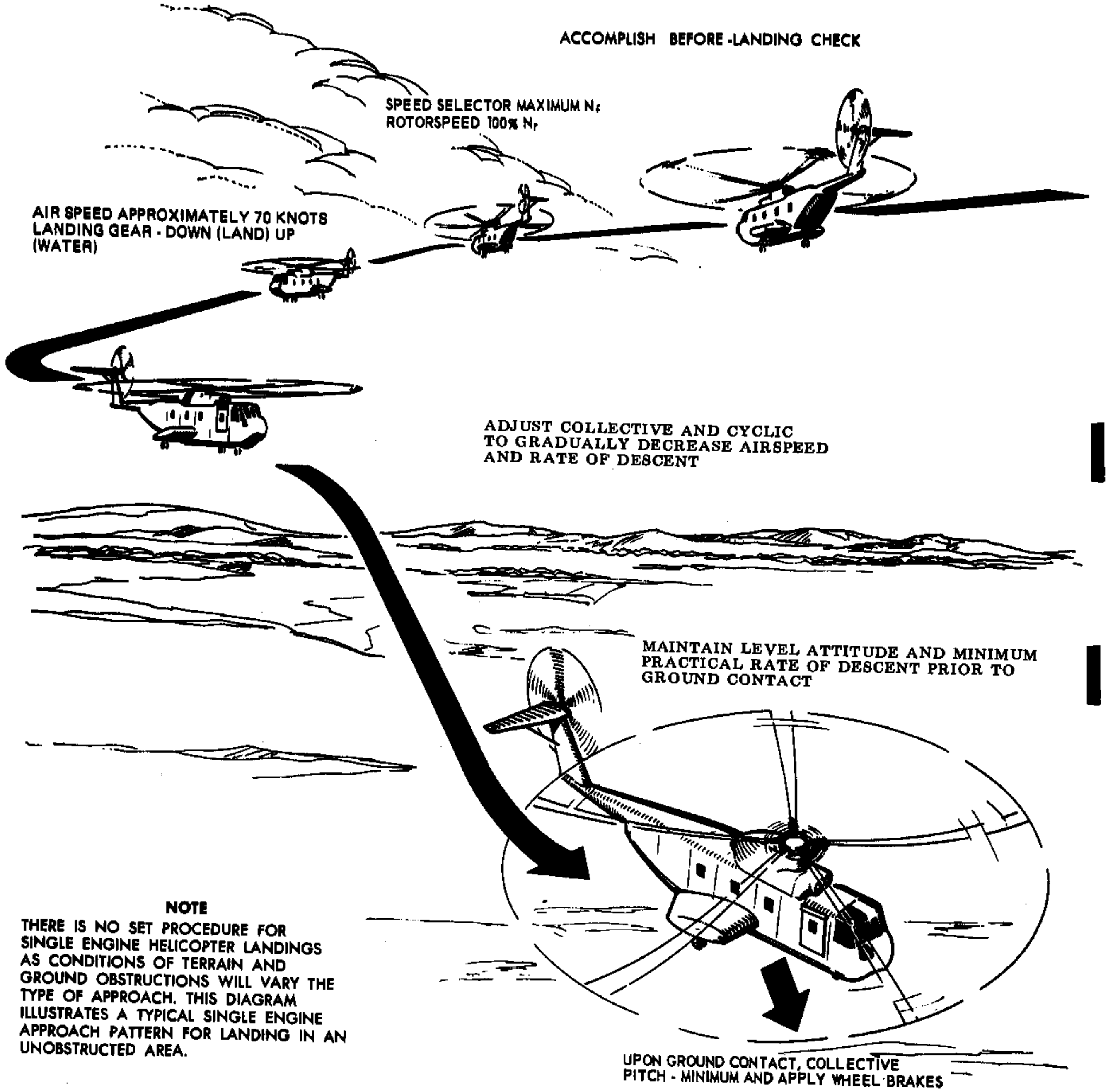


Figure 3-4. Single Engine Approach (Typical)

CAUTION

Do not exceed 10 degree nose-up attitude at touchdown on calm water, or 7 degrees in sea-state one or above, to avoid tail pylon water contact.

PRACTICE SINGLE ENGINE LANDINGS.

Practice single engine approach and landings may be performed in the same manner as described under SINGLE ENGINE FAILURE in this section except that only the first two items of the checklist will apply. Single engine failure is simulated by retarding either speed selector until the N_f needle falls to 96 - 98% N_f.

AUTOROTATIVE LANDINGS.

Refer to Two Engine Failure During Flight (Autorotative Landing), outlined under IN-FLIGHT procedures in this section.

WATER AUTOROTATIVE LANDINGS.

Autorotative landings on water differ from autorotative landings on land in that touchdown speed must be held to a minimum (less than 20 knots) and the descent from flare to water contact should be as near vertical as possible. After touchdown reduce collective slowly to minimum pitch. After collective is lowered, use tail rotor pedals to turn so that the nose of the helicopter is approximately 30 degrees to the waves. Allow the rotor to decelerate to a stop without applying the rotor brake. When rotor slows to a stop, deploy anchor to prevent helicopter from drifting ashore.

NOTE

The flare should be executed high enough to permit the airspeed and rate of descent to be reduced sufficiently to level the helicopter for a near vertical descent.

NOTE

If a sudden emergency exit from the helicopter is desired, rotor brake should be applied. Applications of the rotor brake at high N_r may result in excessive roll angles and possible upset in rough water.

PRACTICE POWER RECOVERY AUTOROTATIONS.

Practice power recovery autorotations will be entered at an airspeed of 70 to 110 KIAS and a minimum altitude of 500 feet. To enter a practice power recovery autorotation, the pilot flying the helicopter will reduce the collective pitch to minimum and instruct the other pilot to retard both speed selectors to 96 to 98% N_f. This will usually effect a clean needle split. The speed selectors should be monitored at all times during the autorotation to assure a power recovery can be made at any time. Maintain an airspeed of 70 to 110 KIAS and N_r of 98 to 104% until approximately 150 feet above the surface. At approximately 150 feet above the surface, initiate a gradual flare by applying aft cyclic control and maintain N_r within limits throughout the maneuver by use of collective pitch. During the flare and prior to establishing a level attitude, the pilot monitoring the speed selectors will smoothly advance both speed selectors to full open and the power recovery is accomplished. All practice autorotations will terminate in a power recovery, level flight, less than 30 knots ground speed and at an altitude of approximately 15 feet.

LANDING GEAR EMERGENCIES.

LANDING GEAR FAILURE.

Loss of utility hydraulic system pressure and/or loss of electrical power to the landing gear actuating valve may be preclude normal landing gear extension or retraction. If a malfunction occurs, attempt to lower the landing gear, using an alternate method. Use the following procedures as conditions dictate:

1. Landing gear handle - "DOWN"

Place the landing gear handle in the DN position. When the uplock releases, enter a shallow dive and abruptly increase collective the use "G" force to attempt to pull the gear down.

NOTE

The uplock pins must be pulled manually when the hydraulic uplock release malfunctions.

2. Alternate gear handle - "PULLED"

With the landing gear handle in the DN position, regardless of the landing gear handle warning light indication, if the green main landing gear position lights do not indicate down and locked, pull the alternate gear extension handle to release high pressure air and fluid into the down portion of the actuating cylinder.

WARNING

After successfully completing an alternate gear extension, do not attempt any normal actuation of the system. However, if attempt to extend gear with alternate system fails and it is desired to actuate the normal system, push alternate gear handle down and reset the emergency release valves, located on the right side of the main transmission well prior to resetting circuit breakers or operating the landing gear handle.

CAUTION

If the main gear position lights are flickering when the aircraft is on the ground, the alternate gear handle must be pulled prior to removing hydraulic power from the aircraft.

NOTE

This action will not preclude completion of the flight; however, the landing gear cannot be retracted.

b. If the landing gear warning system does not indicate down and locked after using the alternate gear extension, land the helicopter on mattresses using procedures contained in GROUND LANDING EMERGENCIES.

c. A water landing may be made if facilities are available.

d. If mattresses and water facilities are not available, and at the discretion of the aircraft commander in the interest of flying safety, the flight mechanic or ground personnel may be directed to install the ground lock pins while the helicopter is in a low hover.

WARNING

The helicopter should be statically grounded prior to installation of the pins to prevent possible injury to personnel making the installation.

CAUTION

After a landing gear malfunction or an unsafe landing gear condition, the aircraft will not be taxied or towed until it can be determined that the gear is down and locked and the gear pins are properly installed.

GROUND LANDING EMERGENCIES.

Landings with all wheels retracted or with any one or two wheels down may be made by placing soft objects, such as mattresses, under the malfunctioning landing gear(s) and the bottom of the fuselage. With the objects in position the pilot should be directed to a vertical landing from a hover.

Landing With All Wheels Retracted.

Choose a level site with no obstructions and a soft surface such as sand, grass, or bushes. Let down slowly and smoothly with no forward or sideward motion. As the fuselage contacts the surface reduce collective slowly and note which way the helicopter will tilt. Slowly reduce the speed selectors to GROUND IDLE and then to SHUTOFF. Maintain cyclic control as long as possible and gradually apply the rotor brake as control is lost.

Landing With Both Main Gears Retracted And The Nose Gear Down And Locked.

Attempt to retract the nose gear with the KNEELING switch to provide a symmetric configuration. If the nose gear cannot be retracted, use soft padding under the fuselage to minimize tilting during shutdown. Use the same technique as landing with all wheels retracted described elsewhere in this section. The helicopter will have a greater tendency to tilt with only the nose gear extended. The greatest damage will occur if the helicopter tilts to the left side as both the tail and main rotor blades may strike the ground.

Landing With Nose Gear Retracted.

A normal vertical landing from a hover should be accomplished at a location where the helicopter can be shut down. The aircraft should not be taxied with the nose gear retracted since the strut will not provide shock absorber action.

WARNING

Ensure that personnel remain clear of main rotor blades during landing and shutdown. The blade ground clearance in front of the helicopter is greatly reduced and may not provide man's height clearance.

NOTE

Pulling the nose gear and main gear circuit breakers may reposition the free trail valve which will enable the nose gear to lower.

EMERGENCY WATER LANDING PROCEDURES.

Planned Ditching.

Procedures and techniques required to accomplish emergency water landings are outlined in section II and III of this manual. However, should the situation develop where ditching becomes apparent, and if altitude permits, the following checklist should be accomplished in addition to the normal/emergency checklist:

1. Crew/Cabin Occupants - Alerted for ditching.
2. IFF - Emergency.
3. Distress Call - Completed (give position report).
4. Tip tanks - As Required.

NOTE

External auxiliary fuel tanks will provide additional stabilization and increase float capability while the helicopter is on the water. External auxiliary tanks will be retained with or without fuel during emergency water landings, except when in the aircraft commander's judgment, retention would further compromise safety.

5. Ramp - Closed.
6. Search and landing lights - As Required.
7. Cockpit Windows and Personnel Door - OPEN.

Immediate Egress.

If immediate evacuation is necessary upon water contact, engine/rotors should be shutdown prior to personnel egressing from the helicopter. Survival equipment should be transferred to the raft(s) as personnel egress from the helicopter.

WARNING

Raft(s) and LPU's should not be inflated until clear of the helicopter to preclude fouling.

After Landing.

Following an emergency landing the crew should immediately determine if engine and rotor shutdown is required.

CAUTION

If an emergency water landing is due to complete loss of oil from the main transmission, limit APU operation to emergency requirements only.

If required, shutdown should be accomplished in accordance with section II. Prior to rotor shutdown, consideration should be given to taxiing the aircraft to shore. If taxiing is not feasible, proceed with the after landing and engine/rotor shutdown checklist.

WARNING

During rotor shutdown, the rotor should be allowed to coast down to a stop. If blade to surface contact is probable, apply the rotor brake at as low an RPM as conditions will permit.

1. Landing Gear - Down.
2. Anchor/Sea Anchor - Deployed.
3. Bilge pump - As Required.

NOTE

Remove bilge covers to cabin and sponsons, and inspect for water accumulation. Pump out any water accumulation. Reinstall covers and panels when inspection has been completed or when bilge pump is not in use. Periodically inspect the water tight compartments for leakage.

Before Leaving the Helicopter.

If the decision is made to abandon the helicopter, accomplishing the following items to aid in the recovery operation.

1. Bilge covers - Secured.
2. Anchor Lights - ON.
3. Windows and Hatches - Closed.

DITCHING.

The decision to ditch is the pilot's, based upon evaluation of all factors at the time of the emergency. It is only recommended if it is impossible to make a safe emergency landing on shore or bailout over a firm surface. Where ditching the helicopter is imminent but not immediate, much can be done to protect personnel and survival gear by following a planned ditching procedure. Cabin occupants should abandon the aircraft via the personnel door or through the ramp exit, at the discretion of the pilot. However, no more than one person should be on the ramp at one time to avoid a CG problem. The pilot may exit through the cockpit sliding windows or the personnel door, as circumstances dictate. Time of exit through the window or door is approximately the same. Following the ditching, the helicopter will probably float if the watertight hull compartments have not been damaged, but it may not remain upright. If desired in this case, the crew may elect to remain near the capsized helicopter to increase the probability of survival and early rescue.

IMMEDIATE DITCHING.

1. Establish autorotation or maximum rate of descent into the wind - As necessary.
2. Crew/Cabin Occupants - Alerted.
3. Survival Gear - Prepared.
4. Cockpit Sliding Windows and Personnel Door - OPEN (jettison if necessary).
5. IFF - Emergency.
6. Radio call - MAYDAY (give position report).
7. Aft ramp - Closed.
8. Search and landing lights - As Required.
9. Helicopter - Ditch.

Make an autorotation approach and landing. Touchdown speed must be held to a minimum (less than 20 knots). Descent from flare to water contact should be as nearly vertical as possible. After touchdown, hold or increase collective and use tail rotor pedals to turn so that the helicopter is most stable under the existing wind/wave conditions. Allow the rotor to decelerate to a stop without applying the rotor brake, if possible. Evacuate personnel and survival gear.

NOTE

The flare should be executed high enough to permit the airspeed and rate of descend to be reduced sufficiently to level the helicopter for a near-vertical descent.

WARNING

During rotor shutdown, the rotor should be allowed to coast down to a stop. If blade to surface contact is probable, apply the rotor brake at as low an RPM as conditions will permit.

1. Landing Gear - DOWN.
2. Anchor/Sea Anchor - DEPLOYED.
3. Bilge pump - AS REQUIRED.

NOTE

Remove bilge covers to cabin and sponsons, and inspect for water accumulation. Pump out any water accumulation. Reinstall covers and panels when inspection has been completed or when bilge pump is not in use. Periodically inspect the water tight compartments for leakage.

Before Leaving the Helicopter.

If the decision is made to abandon the helicopter, accomplishing the following items to aid in the recovery operation.

1. Bilge covers - SECURED.
2. Anchor Lights - ON.
3. Windows and Hatches - CLOSED.

SYSTEM EMERGENCIES.

This phase of operation covers emergencies that could occur as a result of system failure or malfunction.

FUEL SUPPLY SYSTEM FAILURE.

Engine Driven Fuel Pump Failure.

If the engine driven fuel pump should fail, the engine will shut down due to fuel starvation. Engine shutdown should be completed using normal or inflight shutdown procedures, as appropriate.

Boost Pump Failure.

If it has been determined that a boost pump has failed, turn boost pump switch to off position. If any or all of the boost pumps should fail, the engine driven fuel pumps will supply sufficient fuel for normal engine operation, provided the helicopter is not operated when a boost pump is required. Refer to EQUIPMENT LIMITATIONS in section V. If a boost pump fails while operating in conditions requiring the use of boost pumps, turn the other boost pump on immediately to avoid possible engine flameout. Refer to GENERATOR FAILURE in this section for conditions where failure of all boost pumps and double engine flameout can occur.

Fuel Filter Bypass Caution Lights.

If a fuel filter bypass caution light should illuminate, insure at least one boost pump per engine is on and land as soon as practical.

FUEL CONTROL SYSTEM FAILURE.

Power loss resulting from complete fuel control system failure can be determined by an immediate reference to the indication on the torquemeter, accompanied by a large decrease in power turbine inlet temperature (T_5), and further verified by a drop of power turbine speed. Engine stall is usually recognized by a rapid rise in T_5 and a decrease of N_g, accompanied by an audible rumble or vibration and a possible loud report or bang. Flameouts are recognized by an immediate decrease in T_5, N_g, fuel flow, torque, and N_f on the affected engine. If no engine malfunction was observed prior to the flameout, a restart may be attempted. It should be noted that the engine instruments often provide indications of fuel control system failure prior to actual engine failure. If engine failure is due to momentary malfunction of the fuel control system, or to improper operating technique, an air start can usually be accomplished to restore engine operation, when time and altitude permit. A malfunction of the normal fuel control system can be bypassed by use of the emergency fuel control lever.

The purpose of the emergency fuel control lever is to override the automatic feature of the engine fuel control. This is accomplished by a direct connection to the fuel metering valve of the engine fuel control. This direct connection to the fuel metering valve requires that the emergency fuel control lever be used with extreme caution to prevent overtemperature or overspeeding of the engine. The sensitivity of the emergency fuel control increases with high altitudes and/or high ambient temperatures. Engine response to emergency fuel control lever movement may occur at any point of lever travel, depending upon the position of the metering valve prior to moving the emergency fuel control lever. By positioning the speed selector in the GRD IDLE position, nominal torquemeter readings equal to the properly operating engine can be maintained by use of the emergency fuel control lever.

WARNING

If the emergency fuel control lever is to be used, do not retard the speed selector beyond the GRD IDLE position. Movement beyond the GRD IDLE position will cut off engine fuel supply regardless of the position of the emergency fuel control lever.

A constant flight attitude establishes optimum conditions that will allow the properly operating engine to absorb transient torque changes that occur with minor flight condition changes. The copilot can maintain balanced engine power through other flight conditions by manually adjusting the emergency fuel control lever of the affected engine to produce power equivalent to the properly operating engine. Engine instruments should be carefully monitored.

Failure of the Fuel Control Flex Shaft.

Failure of the fuel control to sense power turbine speed, due to flex shaft failure, will be apparent to the pilot when the N_f indicator for the affected engine drops to zero, at which time the torquemeter, N_g, T_5 and fuel flow will indicate maximum power. The non-affected engine, sensing a lesser demand for power, will reduce fuel flow with a corresponding decrease in N_g, T_5, and torque. Corrective action for this condition is to maintain rotor (RPM) within limits using collective inputs. Once fuel control flex shaft failure has been positively identified, retard the speed selector of the affected engine from the governing range to GRD IDLE, and utilize the emergency fuel control lever to meet power requirements.

NOTE

> If flight conditions require the use of both engines the emergency fuel control lever should be advanced prior to retarding the speed selector from the governing range.

Failure of P3 Sensing.

Failure of P_3 sensing may cause the N_g to drop off either to or below ground idle speed with a corresponding drop in N_f and torque. Corrective action for this condition is to retard the speed selector of the affected engine to GRD IDLE and utilize the emergency fuel control lever to meet power requirements. Closely monitor T_5 as use of the emergency fuel control at lowered N_g may result in overtemperature.

FUEL QUANTITY GAGE FAILURE.

If fuel consumption does not appear to be compatible with anticipated fuel consumption or the crew has reason to suspect an incorrect fuel quantity indication, depress the fuel quantity gage test switches. Switches should be held until pointers drop to below zero. After a drop to below zero has been noted, release test switches and pointers should return to their original reading. If the fuel quantity indications do not appear to be normal or the crew still suspects incorrect fuel quantity indications: Turn on all boost pumps, open the crossfeed valve, pull the affected fuel quantity indicator circuit breaker, compute estimated fuel on board and land as soon as practical.

ENGINE OIL SYSTEM MALFUNCTION.

Engine oil pump failure may be evidenced by loss of engine oil pressure and the N_g tachometer due to the fact that both the pump and tachometer are driven by the same shaft. If an oil system malfunction (as evidenced by high or low oil pressure or excessively low oil quantity) has caused prolonged oil starvation of engine bearings, the result will be a progressive bearing failure and subsequent engine seizure. Bearing failure will progress slowly until just prior to complete failure, then the rate of failure accelerates rapidly. The time interval from the moment of oil starvation to complete bearing failure depends on such factors as condition of the bearing prior to oil starvation, operating temperature of the bearings, and the bearing loads. A possibility exists for 10 to 30 minutes of operation after experiencing a complete loss of lubricating oil. Bearing failure due to oil starvation is generally characterized by a rapidly increased rate of vibration. When the rate of vibration increases from moderate to heavy, complete bearing failure is only seconds away and the affected engine should be shut down. Since the end result of oil starvation is engine seizure, the affected engine should be shut down immediately to preclude seizure, unless critical power requirements exist. If power is required from affected engine, any reduction or change of power should be held to a minimum. The affected engine should be shut down as soon as level flight on one engine can be maintained.

NOTE

> Avoid rapid and large variation in power settings. The minimum power established after malfunction is detected should be high enough to avoid the necessity for subsequent variations.

NOTE

> If an ENG OIL LOW caution light should illuminate during extended flights, replenish supply from the auxiliary oil tanks.

ELECTRICAL SYSTEM FAILURES.

ALTERNATING CURRENT SYSTEM FAILURE.

The bilateral alternating current system, powered by two ac generators, is so designed that failure of either generator will cause the nonessential bus, normally powered by the No. 2 generator, to be dropped from the system, and the operating generator to power the essential bus, normally powered by the No. 1 generator. However, the pilot's attitude indicator, powered by the No. 2 generator, is retained. If the No. 1 or No. 2 generator light illuminates, move the appropriate generator switch to the OFF/RESET position and return to the ON position.

GENERATOR FAILURE.

Failure of either, or both generators will be indicated by the respective generator failure caution light.

Failure of One Generator.

1. No. 1 boost pumps - ON, if required.
2. Generator switch - OFF/RESET, then ON.
3. Generator switch - OFF, if power not restored.

NOTE

If respective generator is restored, the boost pump switches should be repositioned as required.

NOTE

Failure of either generator will cause the No. 2 Transformer/Rectifier and No. 2 FWD and AFT boost pumps to be inoperative.

WARNING

When operating the helicopter under conditions that require the use of fuel boost pumps, double-engine flameout and no subsequent start may be expected if all boost pumps become inoperative. Loss of all boost pumps can be expected under the following conditions:

a. One generator is inoperative and the other fails.

b. Both No. 1 boost pumps are inoperative and either of the generators fail.

Failure of Both Generators.

1. No. 1 generator switch - OFF/RESET, then ON.
2. No. 2 generator switch - OFF/RESET, then ON.
3. Generator switch(es) - OFF, if power is not restored.

NOTE

If both generators should fail, the battery will provide emergency power for approximately 15 minutes. However, as the battery voltage will hold constant until all charge is gone, decreasing voltage values will not be noted on the voltmeter. Available flight instruments are the pitot-static instruments, the standby compass, and the pilot's turn rate needle in the NORM position. It should be noted that TACAN, VOR, ADF, ILS, DOPPLER, J-4 COMPASS, IFF, ID-387, both pilot's ATTITUDE INDICATORS, AFCS, pilot's turn rate in ALT, copilot's turn rate in NORM, UHF/DF, and HF radio will be inoperative on DC electrical power. Communication and navigation needs will have to be determined by the pilot as the situation dictates.

4. If the No. 1 or No. 2 generator is not restored, turn off all unnecessary equipment, abort mission and land as soon as practical.

DIRECT CURRENT SYSTEM FAILURE.

Direct current is supplied to the dc essential and nonessential buses from two transformer - rectifiers (T/R). The system is so designed that failure of either transformer - rectifier will cause the nonessential bus to be dropped from the system. Failure of either, or both, transformer - rectifiers will be indicated by lighting of the respective caution light, located on the caution panel. If both the No. 1 and No. 2 T/R's fail, the nonessential bus will be dropped from the system, both T/R caution lights will be illuminated, and the essential bus will be powered by the battery only.

NOTE

If the No. 1 T/R fails and either generator fails, both T/R caution lights will illuminate and the essential bus will be powered by the battery only.

UTILITY HYDRAULIC SYSTEM FAILURE.

The utility hydraulic system receives pressure from a pump driven by the accessory drive section of the main gear box. The landing gear, rescue hoist, and ramp systems will be inoperative in event of failure of the utility hydraulic pump, the accessory drive, or loss of hydraulic pressure in the system. On some helicopters, if a utility hydraulic system failure occurs, and there is no failure in the oil lines between the accumulator and the APU starter or the accumulator and the alternate nose gear actuator, the accumulator may be used either to start the APU or to lower the nose gear. If one of these systems has been used, it is necessary to recharge the accumulator before the other one can be activated. This may be accomplished either by normal charging by the utility pump, if the pressure lines have not failed, or by the use of the APU accumulator hand pump. Recharging of the accumulator utilizing the hand pump can be accomplished if the pump supply and discharge lines remain intact, and if sufficient hydraulic fluid remains in the system to charge the accumulator. Since use of the hand pump cannot be accomplished except when on the ground, the accumulator should only be used in flight to lower the nose gear when a utility hydraulic pressure failure occurs. Some helicopters have the hand pump installed in the cabin compartment and provide the capability to recharge the accumulator in flight as well as on the ground.

FLIGHT CONTROL HYDRAULIC SERVO SYSTEM FAILURE.

Control of the helicopter can be maintained through either the primary or the auxiliary flight control system if one or the other should fail. However, prolonged operation on one servo system is not recommended. Either system may be turned off by actuating the servo switch, provided there is at least 1000 psi hydraulic pressure in the remaining system. When one servo system fails, it should be shut off. Flight should be terminated as soon as practical due to the possibility of failure of the remaining servo system. With the auxiliary servo system inoperative, the AFCS will be inoperative.

NOTE

Once a malfunctioning servo has been identified and corrective action taken, an airspeed of approximately 70 knots IAS will minimize the control forces.

NOTE

AFCS should be disengaged before turning the auxiliary servo off to avoid cyclic jump.

FLIGHT CONTROL SERVO UNIT MALFUNCTION.

A primary servo unit malfunction is identified by a vibratory force, with or without a coupled indication, felt at the pilot's control and throughout the helicopter. An auxiliary servo unit malfunction is identified by a single or uncoupled force without vibratory forces.

Servo Unit Malfunctions.

Malfunctions of the rotor servo units during flight will result in erratic behavior of the helicopter, roughness, uncontrollable maneuvers, or locking of the cyclic stick and collective pitch lever. Sometimes it is difficult to determine whether the auxiliary or primary servo system is causing the trouble. Whenever a servo unit malfunction is encountered, control difficulties may be eliminated by turning off the system containing the malfunctioning unit. Because of the difference in location of the two servo system, a malfunctioning primary servo unit will give different indications in the flight control system than a malfunctioning auxiliary servo unit.

SYMPTOMS OF HYDRAULIC SERVO SYSTEM MALFUNCTIONS.

Primary Servo Systems.

SYSTEM PRESSURE LOSS OR BLOCKED PRESSURE LINE.

Due to the spring-loaded bypass poppet valve, a loss of pressure causes an interconnection between both sides of the power piston. The servo then acts as a simple mechanical link between the auxiliary servo and the control rods to the rotor head. This type of malfunction can be recognized by a small amount of slop in the cyclic and the collective pitch controls.

HYDRAULIC HARDOVER.

This type of primary servo malfunction is identified by a vibratory load which will be felt in the fuselage and at the pilot's controls (cyclic and collective or cyclic only). The severity of the malfunction and the aerodynamic forces on the rotor blades will determine the amplitudes of the resulting vibratory load. This type of vibratory load differs from a similar vibration which may be caused by a malfunctioning AFCS. The hydraulic malfunction causes vibratory loads on the controls resulting in helicopter displacement, whereas an AFCS malfunction has no effect on the pilot's controls, but may cause helicopter vibrations and/or helicopter displacement. Any vibrations caused by a malfunctioning AFCS would be eliminated by depressing the AFCS REL button or turning off the appropriate channel disengage switch.

BLOCKED RETURN LINE.

A return line that is completely blocked will restrain only motion of the affected servo in one direction because of the unbalanced piston in the primary servo. The result is a ratcheting motion of the cyclic stick (motion is possible in only one direction and irrecoverable in the other). The amount of control is dependent upon the amount of blockage Anything other than a completely blocked return line will be controllable. In any event, placing the flight control servo switch in the PRI OFF position will alleviate the difficulty.

Auxiliary Servo System.

SYSTEM PRESSURE LOSS OR BLOCKED PRESSURE LINE.

Due to the spring-loaded bypass poppet valve, a loss of pressure causes an interconnection between both sides of the power piston. This type of malfunction can be recognized by a slightly heavier force required to move the cyclic stick, collective pitch lever, and the rotor pedals, plus a loss of AFCS effectiveness.

HYDRAULIC HARDOVER.

An auxiliary servo hydraulic malfunction, such as control valve linkage failure, results in erratic or hardover control forces and is identified by extreme control pressures being felt in a single channel (either pitch, roll, collective or yaw channel). This is distinguished from an AFCS malfunction in that AFCS control authority is limited and easily overcome by the pilot, whereas an auxiliary servo is eliminated only by shutting off the auxiliary servo system.

WARNING

If erratic or hardover control forces occur, turn off the auxiliary servo system immediately to avoid abrupt attitude changes or altitude loss.

BLOCKED RETURN LINE.

If closure of a return line from the auxiliary servo unit should occur, a hydraulic lock would form in all channels preventing control motion other than that allowed within the sloppy link. Approximately 2 1/2 to 3 inch displacement of the cyclic control is possible without changing the input to the rotorhead with a partially blocked return line. Because of the high degree of filtration and redundant porting in the servo valves, a block due to contamination is only a remote possibility. However, if blockage should occur, the problem can be alleviated by turning off the auxiliary servo system.

CORRECTIVE ACTION FOR SERVO MALFUNCTIONS.

The effects of any malfunctioning servo can be eliminated by use of the servo switch to shut off the system malfunctioning. An appropriate rule of thumb for determining which servo has malfunctioned is as follows:

a. If a single uncoupled force on collective pitch lever, cyclic stick, or rudder pedals is felt at the pilot's controls without vibrations, shut off the auxiliary servo system immediately.

b. If vibratory force, with or without a coupled indication, is felt in the flight controls, then turn off the primary servo system.

c. Land as soon as practical.

SERVO HYDRAULIC PRESSURE FAILURE.

Loss of pressure in either the primary or auxiliary servo systems will be indicated by either of the servo hydraulic low pressure caution lights and a lower than normal operating presure on the corresponding servo hydraulic pressure gage.

WARNING

In the event hydraulic servo flight control system is lost or malfunctions, and the system is deactivated by the servo switch, loss of or intentional removing of all electrical power to the aircraft will cause the faulty servo to return to the on position regardless of the selected position.

1. Servo switch (affected system) - OFF. Land as soon as practical.

NOTE

When AUX servo is OFF, the AFCS is inoperative.

NOTE

Because of the pressure switch interlock, it is impossible to turn off one servo system when the pressure in the other servo system is below 1000 psi.

MAIN ROTOR DAMPER MALFUNCTION.

Malfunction or failure of a rotor damper causes a dynamically unbalanced rotor condition which will be felt as a low frequency lateral or vertical vibration. The magnitude of the vibration is dependent on the severity of the malfunction and the flight condition. The effects of turbulence will increase the magnitude of the vibration similar to the effects of maneuvering and will be dependent on the degree of turbulence and flight conditions. Rotor blades will normally stay in track. It is recommended that a landing be made as soon as practical since the vibration may affect other systems and components. A shallow approach to a running landing is preferable; but, if conditions do not permit, then a normal approach to a touchdown should be made with a minimum of time spent in hover. If a rotor damper is suspected of malfunctioning, proceed as follows:

1. Airspeed - Adjust to minimize vibration.

NOTE

Maintain normal rotor speed (100 - 103% N_r). Make small, smooth control inputs and shallow turns.

2. Land as soon as practical.
3. Engine and rotor - Shutdown without using rotor brake.

WARNING

Do not increase collective or use rotor brake as this will increase the possibility of blade-to-blade contact.

WARNING

Ensure that all personnel are clear of rotor system prior to engine shutdown.

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS).

POWER SUPPLY FAILURE.

The AFCS will become inoperative in the event of failure of the auxiliary servo system, both generators, or all dc power.

Malfunction.

a. In the event that AFCS signals cause the helicopter to oscillate in pitch or roll, or if it is necessary to fly with the cyclic stick displaced from its normal position and this condition is reflected by either the vertical or horizontal bars on the AFCS indicator, switch gyros by use of gyro select switch on the channel monitor panel.

NOTE

Switching gyros may result in a momentary abrupt change of attitude while the AFCS transitions to the gyro giving the correct information. These changes are caused by the AFCS plus the pilot's correction overriding the AFCS at the time the gyros are switched. If possible the copilot shall monitor the flight controls while the pilot switches gyros.

b. If oscillations or unusual forces are encountered in the collective pitch lever, depress the BAR REL button on the AFCS control panel.

c. If the action described in steps a. and b. fails to eliminate the difficulty or unusual forces are encountered in the pedals or cyclic control, turn off the appropriate channel by use of the channel disengage switch on the channel monitor panel.

d. If the trouble persists or is such that immediate action is deemed necessary, depress the AFCS REL button on either the pilot's or copilot's cyclic stick.

e. Since the authority of AFCS in all channels is limited to a fraction of total control travel, any emergency override in case of malfunction may normally be achieved by introducing a control correction. However, if a malfunction is not corrected by step a. through d., the AFCS may be entirely eliminated from the flight control system by turning off the auxiliary servo.

NOTE

Certain AFCS electronic malfunctions can cause severe vibrations and noise throughout the airframe by applying erratic signals to the auxiliary servo valves. Disengagement of the AFCS will identify this problem.

SIMULATED AFCS MALFUNCTIONS.

Hardover switches on pilot's console may be utilized during flight to induce simulated malfunctions. Refer to AFCS Hardover Check (Pitch, Roll, Collective, and Yaw) in section VII before accomplishing this procedure.

MAIN GEAR BOX FAILURE.

Failure of the main gear box may be indicated by illumination of the chip detector caution light and/or the main gear box chip location light on the chip location panel, or by abnormal transmission temperature or pressure indications. The chip detector light indicates the presence of metallic chips in the transmission oil system which is a sign of unusual wear. Carefully monitor transmission oil pressure and temperature and land as soon as practical. The flight may be continued, if necessary to reach a safe landing area, but unnecessary delay in landing should be avoided.

WARNING

If the main gear box oil temperature indicator reads more than 145°C, it indicates either a malfunction in the main gear box or the oil cooling system. The main gear box may not be receiving proper lubrication or may be running hot due to overservicing. If reducing power does not lower the temperature to 145°C or below, refer to MAIN GEAR BOX OIL SYSTEM FAILURE in this section.

LOSS OF PRIMARY OR SECONDARY MAIN GEAR BOX OIL PUMP.

Loss of the primary or secondary oil pump will be indicated by a decrease in transmission oil pressure to the bottom of the normal operating range (Green arc) or the top of the precautionary operating range (Yellow arc), approximately 35 PSI oil pressure indication. Primary pump failure may further be indicated by loss of the torque indicating system. Secondary pump failure may be accompanied by the loss of the utility hydraulic pressure system. In the event of a primary or secondary oil pump failure, flight may be continued since either pump will adequately lubricate the main gear box.

LOSS OF MAIN GEAR BOX OIL SUPPLY.

A break in the primary lubricating system could result in loss of the oil contained in the main gear box with the exception of the oil remaining in the emergency sump. When only the 1.5 gallon emergency sump oil supply remains in the transmission, flight should be limited to 30 minutes with landing accomplished as soon as practical. The torquemeter readings will decrease and fluctuate when oil is being diverted to lubricate the input sleeve bearings (possibly momentarily indicating zero).

WARNING

If torque indications decrease to zero when flying with only the emergency sump oil supply remaining, enter an immediate autorotative descent to reduce the load on the sleeve bearings. The landing, either full autorotation or power on, must be determinded by the pilot based on the existing conditions.

MAIN GEAR BOX MALFUNCTION.

Symptoms

Any one of the following conditions:

1. TRANS OIL PRESS caution light on.
2. TRANS OIL HOT caution light on.
3. MAIN CHIP light on.
4. Main gear box oil temperature indicator at red line.
5. Main gear box oil pressure indicator at red line.
6. An indication of no transmission oil pressure (12 psi or less)
7. Abnormal transmission noises.
8. Yaw kicks accompanied by fluctuations in both torquemeters.

Corrective Action

1. Land as soon as practical.
2. AFCS yaw channel — OFF (with yaw kicks).
3. Monitor engine and transmission instruments, caution panel and torque indications.
4. Fly at minimum safe autorotation altitude.
5. Cruise between 70 and 100 KIAS.
6. Jettison unnecessary fuel and equipment.
7. Avoid high power maneuvers.

CAUTION

Flight with no indication of transmission oil pressure (12 PSI or less) can be sustained for approximately 30 minutes.

IMMINENT FAILURE OF THE MAIN GEAR BOX.

Symptoms

1. An indication of no transmission oil pressure and:
   a. Both torque needles at zero.
   b. Yaw kicks.
   c. Unusually high power requirements.
   d. A rapid Ng/T5 rise.
   e. Abnormal transmission noises.
   f. Transmission temperature caution light on.
   g. Transmission temperature indicator at red line.

   NOTE

   When operating on oil from the emergency supply system, the transmission oil temperature indicators (caution light and gauge) may not be a reliable indication of MGB temperature.

   h. MAIN CHIP light on.
2. MAIN CHIP light on and:
   a. Yaw kicks.
   b. Unusually high power requirements.
   c. Abnormal transmission noises.

Corrective Action

Enter an immediate autorotative descent to reduce the load on the sleeve bearings. The landing, either full autorotation or power-on, must be determined by the pilot based on existing conditions.

ROTOR SHUTDOWN WITH AN INOPERATIVE ROTOR BRAKE.

1. Head aircraft into wind if winds exceed 10 knots.
2. APU - ON
3. Cyclic - Neutral. Maintain this position until rotor blades have come to a stop.

WARNING

Excessive blade flapping may cause blade to fuselage contact. Egress from aircraft should not be attempted until rotor blades have come to a stop.

SHUTDOWN WITH TAIL TAKEOFF FREE WHEEL UNIT INOPERATIVE.

1. APU - START.

2. **Proceed with engine shutdown checklist (Section II) if APU is operative.**

3. Pins and chocks - IN.

4. Speed selectors - GROUND IDLE.

5. Droop stops - IN.

6. No. 2 engine - SHUTDOWN.

7. Rotor brake - ON (45% N_r or less).

8. No. 1 engine - SHUTDOWN.

9. Continue with Engine Shutdown checklist.

IMPENDING TAIL ROTOR DRIVE SYSTEM FAILURE.

Illumination of the chip detector caution light and the intermediate or tail chip detector warning lights indicates the presence of metallic particles in the respective gear box, and may be an indication of forthcoming tail rotor drive system failure. If either the intermediate or tail gear box chip detector warning light should illuminate, the following action should be taken by the pilot:

a. Land as soon as possible. If a suitable site is not available (rough terrain, over water with high sea state or at night), attain a safe autorotation altitude/airspeed (500 feet/70 Knots), and proceed to the nearest suitable landing site.

b. Descent and approach should be made with minimum power to facilitate entry into autorotation if tail drive failure occurs. A running or no hover landing utilizing minimum power should be executed as conditions dictate. High power settings require maximum performance of the tail rotor drive system and may precipitate ultimate drive failure.

WARNING

If the illumination of the chip detector caution light is accompanied by strong intermediate frequency vibrations, hot metal, oil fumes or smoke in the pylon or aft station area or any other indications of impending tail rotor drive failure, the pilot shall make an emergency landing.

EMERGENCY ENTRANCES AND EXITS.

PILOT'S COMPARTMENT SLIDING WINDOWS.

The pilot's compartment sliding windows, one located on each side of the pilot's compartment, are normally opened and closed by actuating the handle, located on the lower forward edge of the window. The windows may be opened to any detent position when the handle is released. The windows can be jettisoned from the outside by the release lever, marked EXIT RELEASE-PRESS BUTTON-TURN HANDLE-PULL-OUT WINDOW. The release lever is pushed in on one end, which causes the handle to extend outward, and the handle is then turned downward to release the window assembly. After the window has been released, it will have to be pulled out. The windows can also be jettisoned from the inside by rotating the window emergency release handle upward and pushing out the window from the bottom.

CARGO COMPARTMENT WINDOWS.

Jettisonable windows located on the left front side of the cargo compartment and over each sponson provide ground access to the outer fuselage and sponsons from inside the cabin to facilitate bilge pump operations, maintenance, and docking during water operations. The windows may be removed from the outside by pulling down on the outside release lever and pulling the window out. The windows may be jettisoned from the inside by rotating the release lever forward and pushing the window out. On aircraft modified for armament, use the forward (red) release lever to jettison the left forward window.

WARNING

Prior to removing the left jettison window for access to the left sponson, ensure the HF-103 radio is off. The HF antenna emits high voltage radiation during HF transmission.

The cargo compartment windows forward and aft of the sponsons are permanently installed and are not designed as emergency exits.

PERSONNEL DOOR EMERGENCY ENTRANCE.

The personnel door is normally opened and closed by the handle, marked TO OPEN, TURN AND PUSH, with arrows pointing direction to turn and push, located on the outside of the door. Outside the personnel door, below the window, is marked CUT HERE FOR EMERGENCY RESCUE.

RAMP.

The ramp may be lowered from the outside by pulling a handle, located below the tail pylon under a cover, marked RAMP EXIT RELEASE HANDLE INSIDE COVER. When the handle is pulled, the ramp hydraulic cylinder moves to the open position and the aft ramp uplocks unlock. The ramp will then open by its own weight, permitting entrance to the cargo compartment. The ramp may be lowered mechanically from the inside by pulling forward on the AFT RAMP RELEASE HANDLE located above the forward ramp on the right-hand side of the cargo cabin.

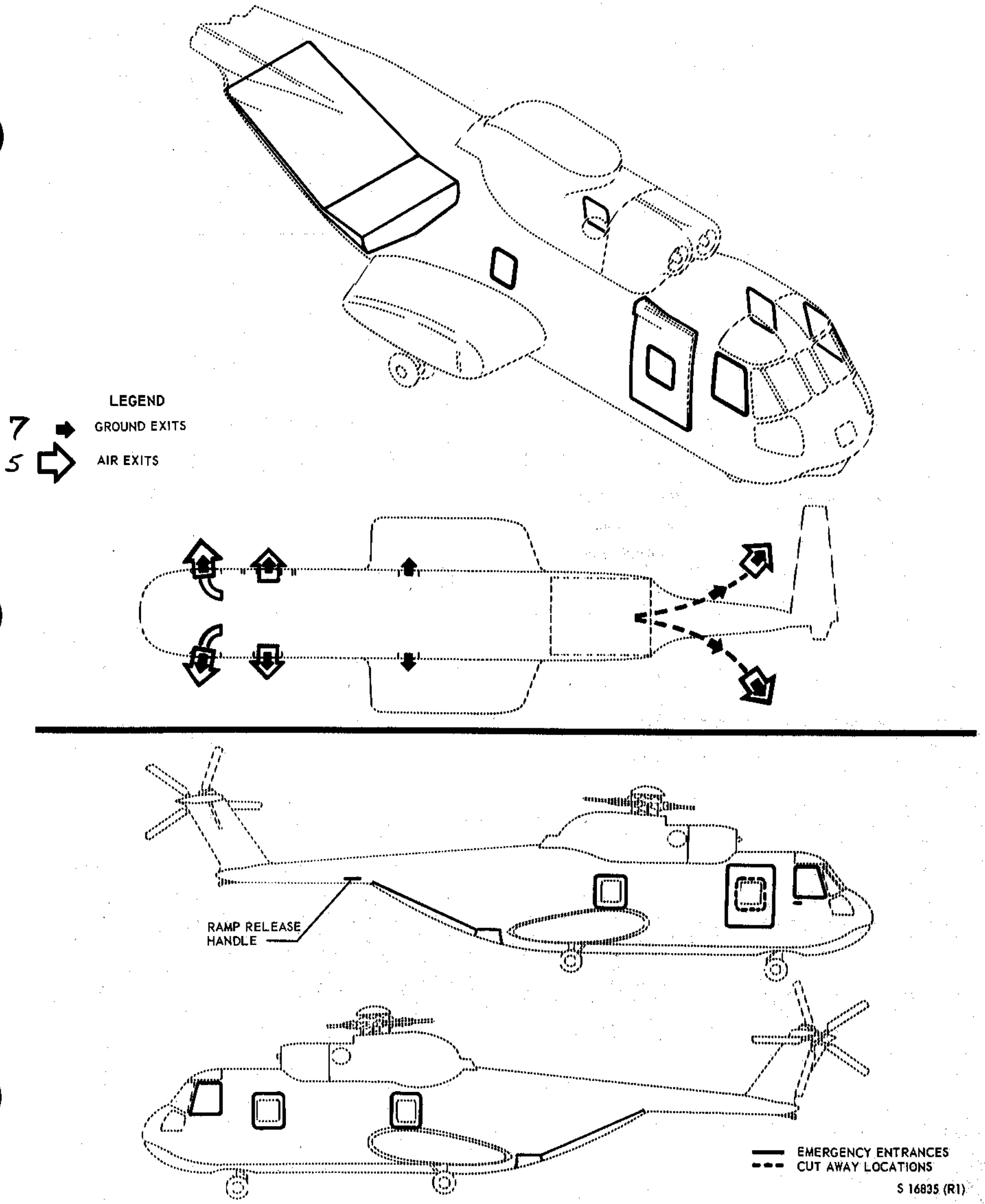
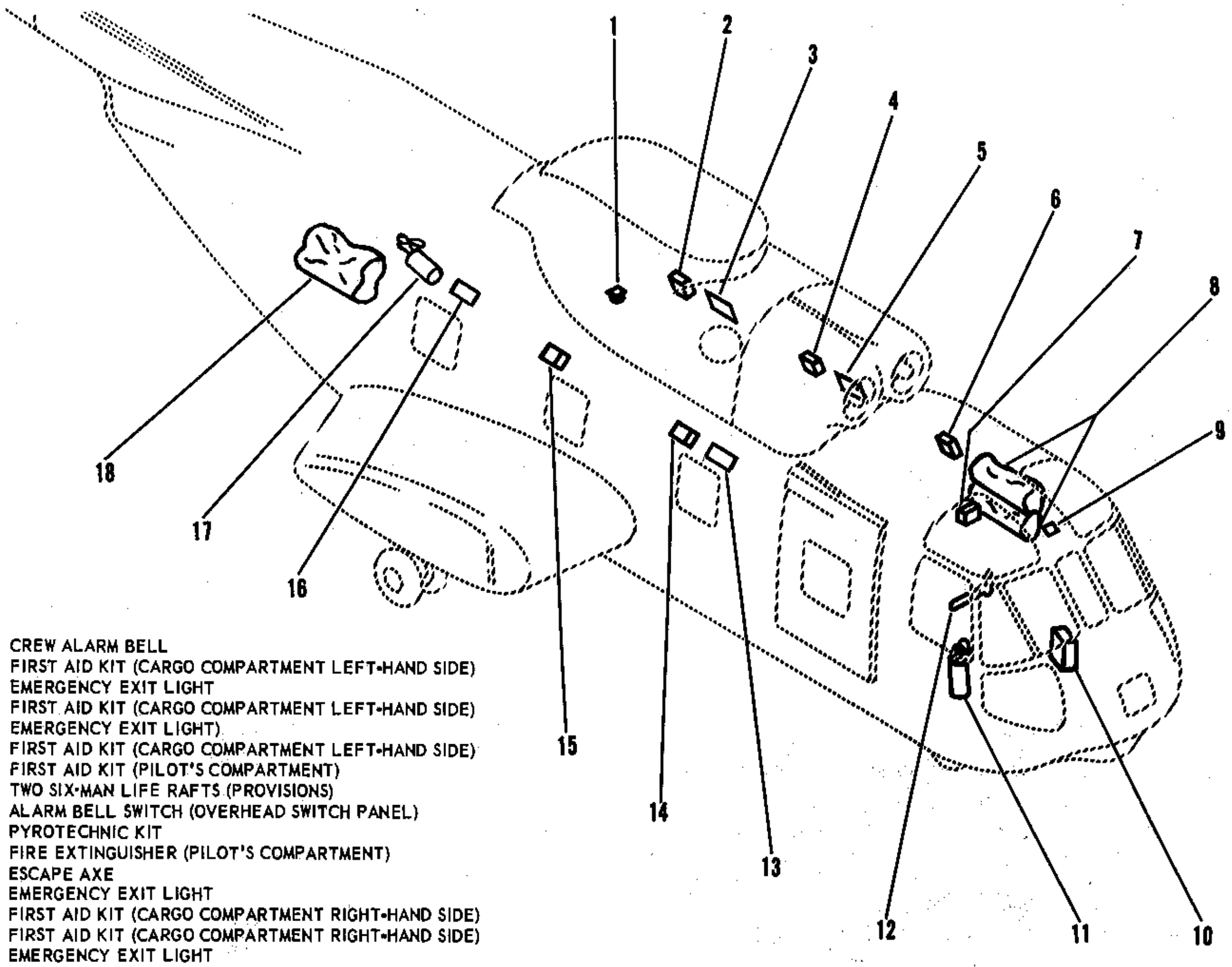


Figure 3-5. Emergency Entrances and Routes of Escape and Exits



1. CREW ALARM BELL
2. FIRST AID KIT (CARGO COMPARTMENT LEFT-HAND SIDE)
3. EMERGENCY EXIT LIGHT
4. FIRST AID KIT (CARGO COMPARTMENT LEFT-HAND SIDE)
5. EMERGENCY EXIT LIGHT)
6. FIRST AID KIT (CARGO COMPARTMENT LEFT-HAND SIDE)
7. FIRST AID KIT (PILOT'S COMPARTMENT)
8. TWO SIX-MAN LIFE RAFTS (PROVISIONS)
9. ALARM BELL SWITCH (OVERHEAD SWITCH PANEL)
10. PYROTECHNIC KIT
11. FIRE EXTINGUISHER (PILOT'S COMPARTMENT)
12. ESCAPE AXE
13. EMERGENCY EXIT LIGHT
14. FIRST AID KIT (CARGO COMPARTMENT RIGHT-HAND SIDE)
15. FIRST AID KIT (CARGO COMPARTMENT RIGHT-HAND SIDE)
16. EMERGENCY EXIT LIGHT
17. FIRE EXTINGUISHER (CARGO COMPARTMENT)
18. ONE TWENTY-MAN LIFE RAFT (ABOVE RAMP) (PROVISIONS)

Figure 3-6. Emergency Equipment