SECTION V

OPERATING LIMITATIONS

This section contains all the limitations which must be observed during normal operation. Limitations characteristic to specialized phases of operation are not repeated in this section. Examples of these specialized phases include turbulent air flight, arctic operations, water operations, etc.

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INTRODUCTION

The operating limitations contained in this section are derived from experience gained during the design, production, and flight test of the helicopter. These limitations, which must be observed if safe and efficient operations are to be attained, should be studied carefully to familiarize the pilot with proper operation of the helicopter and associated equipment. The instruments in the helicopter are marked as shown in figure 5-1 to indicate to the pilot that flight operation is being accomplished in a safe, desirable, or unsafe region. Appropriate explanations are provided where the markings are not self-explanatory. In addition, other limitations on operational procedures, maneuvers, and loading are covered.

NOTE

If any of the limits included in this section of the Flight Manual are exceeded, remarks concerning the degree to which the limits were exceeded and the time duration should be entered on CG-4377.

INSTRUMENT RANGE MARKINGS

Instrument markings shown in figure 5-1 and other operating limitations in this section are not repeated elsewhere in the manual. The instrument markings used in figure 5-1 are explained in the following paragraphs:

LOWER RED RADIAL

The red radial having the lowest numerical value on an instrument indicated that a dangerous condition would exist if the pointer should drop to or below that value during flight.

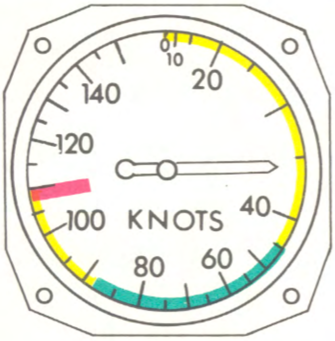
YELLOW ARC OR RADIAL

A yellow arc or radial indicates that danger may exist under certain specified conditions. These conditions are noted on figure 5-1 or covered in the text.

GREEN ARC

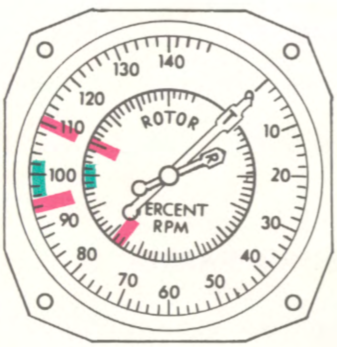
A green arc indicates the region for continuous in-flight operation.

AIRSPEEDS



YELLOW ARC 0-45 KIAS
GREEN ARC 45-88 KIAS
YELLOW ARC 88-109 KIAS
RED RADIAL 109 KIAS

DUAL TACHOMETER



POWER TURBINE (Nf) TACHOMETER
RED RADIAL 94% Nf MINIMUM POWER ON
GREEN ARC 96-103% Nf NORMAL POWER ON
RED RADIAL 110% Nf MAXIMUM

ROTOR TACHOMETER
RED RADIAL 77% Nr MINIMUM POWER OFF
GREEN ARC 96-103% Nr NORMAL POWER ON
RED RADIAL 110% Nr MAXIMUM

SEE ROTOR LIMITATIONS (SECT. V)

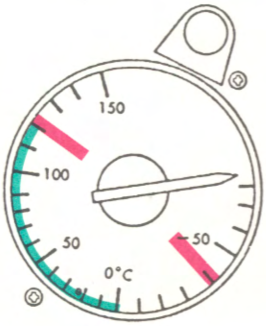
TORQUEMETER

GREEN ARC 41-96% Q NORMAL OPERATING RANGE
YELLOW ARC 96-100% Q PRECAUTIONARY RANGE (5 minute limit)
RED RADIALS 100% & 116% Q MAXIMUM

SEE TORQUE METER (SECT. V)

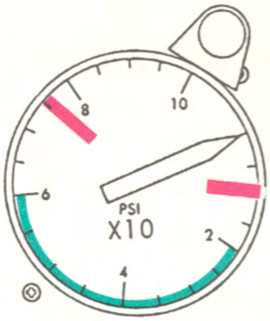
S 55582.1 (R)

Figure 5-1. Range Markings (Sheet 1 of 4)



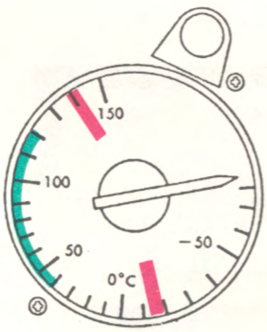
ENGINE OIL TEMPERATURE

- RED RADIAL -40°C MINIMUM
- GREEN ARC 0-121°C NORMAL OPERATING RANGE
- RED RADIAL 121°C MAXIMUM



ENGINE OIL PRESSURE

- RED RADIAL 10 PSI MINIMUM
- GREEN ARC 20-60 PSI NORMAL OPERATING RANGE
- RED RADIAL 75 PSI MAXIMUM

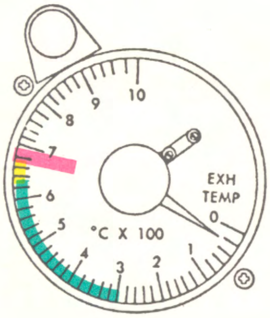


TRANSMISSION OIL TEMPERATURE

- RED RADIAL -15°C MINIMUM
- GREEN ARC 40-120°C NORMAL OPERATING RANGE
- RED RADIAL 140°C MAXIMUM

S 55582.2 (R)

Figure 5-1. Range Markings (Sheet 2 of 4)

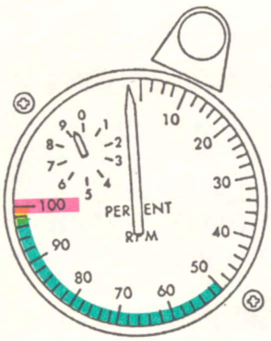


POWER TURBINE INLET TEMPERATURE (T5)

GREEN ARC 300-635°C NORMAL OPERATING RANGE

YELLOW ARC 635-677°C 30 MINUTE LIMIT RANGE

RED RADIAL 677°C MAXIMUM EXCEPT FOR STARTING AND TRANSIENT CONDITIONS SEE FIGURE 5-2

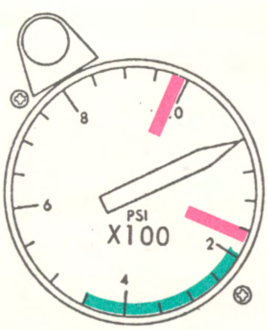


GAS GENERATOR (Ng) TACHOMETER

GREEN ARC 50-97.5% Ng NORMAL OPERATING RANGE

YELLOW ARC 97.5-100% Ng PRECAUTIONARY RANGE

RED RADIAL 100% Ng MAXIMUM



ENGINE FUEL PRESSURE

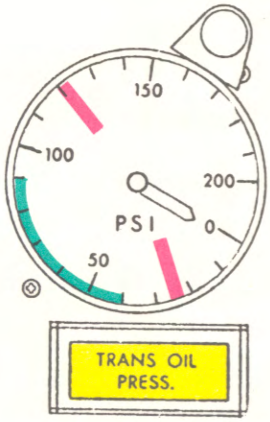
RED RADIAL 160 PSI MINIMUM

GREEN ARC 190-450 PSI NORMAL OPERATING RANGE

RED RADIAL 995 PSI MAXIMUM

S 55582.3 (R)

Figure 5-1. Range Markings (Sheet 3 of 4)



TRANSMISSION OIL PRESSURE

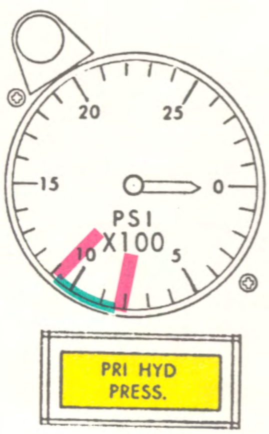
RED RADIAL 25 PSI MINIMUM

GREEN ARC 40-90 PSI NORMAL OPERATING RANGE

RED RADIAL 120 PSI MAXIMUM

CAUTION LIGHT

THE TRANSMISSION OIL PRESSURE CAUTION LIGHT COMES ON WHEN THE MAIN GEAR BOX OIL PRESSURE DROPS BELOW APPROXIMATELY 25 PSI .



PRIMARY HYDRAULIC SERVO PRESSURE

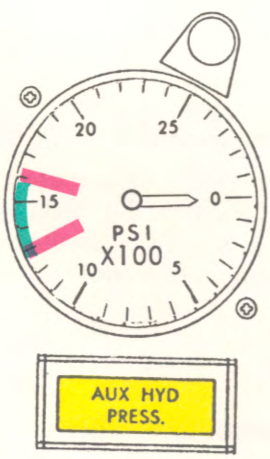
RED RADIAL 850 PSI MINIMUM

GREEN ARC 850-1100 PSI NORMAL RANGE

RED RADIAL 1100 PSI MAXIMUM

CAUTION LIGHT

THE PRIMARY SERVO PRESSURE CAUTION LIGHT WILL COME ON WHEN PRESSURE DROPS BELOW 750 PSI.



AUXILIARY HYDRAULIC SERVO PRESSURE

RED RADIAL 1300 PSI MINIMUM

GREEN ARC 1300-1600 PSI NORMAL RANGE

RED RADIAL 1600 PSI MAXIMUM

CAUTION LIGHT

THE AUXILIARY SERVO PRESSURE CAUTION LIGHT WILL COME ON WHEN PRESSURE DROPS BELOW 1000 PSI.

S 55582.4 (R)

Figure 5-1. Range Markings (Sheet 4 of 4)

UPPER RED RADIAL

The red radial having the highest numerical value on an instrument indicates that a dangerous condition would exist if the pointer should reach this value and that operation above this point is prohibited.

UNMARKED AREAS

Unmarked or blank areas between upper and lower radials, or between a green arc and red radial, or between red radials indicate regions that should be avoided except for transient conditions such as starting, ground operation, etc.

FLIGHT LIMITATIONS

MAXIMUM, NEVER EXCEED SPEED (V_{ne})

The data below are indicated airspeeds for 2000 feet density altitude. Consult the Incipient Blade Stall Chart, figure A-36, for V_{ne} values above 2000 feet density altitude or for maneuvering flight.

Gross Weight	V_{ne} at 96%/100% N_r
6500	109/109
7000	102/106
7500	95/102
8000	86/94
8300	82/88

V_{ne} is the airspeed beyond which operation of the aircraft becomes dangerous.

MAXIMUM AIRSPEED (V_{max})—figures A-21 thru A-30, A-38

The highest obtainable airspeed at maximum continuous power. V_{max} values are always V_{ne} limited.

MAXIMUM SIDEWARD FLIGHT SPEED

25 knots

MAXIMUM REARWARD FLIGHT SPEED

20 knots

HOVERING TURNS

Hovering turns shall not exceed a rate of 360 degrees in 10 seconds.

ICING

Flight into known icing conditions is prohibited.

AUTOROTATION LIMITATIONS

Refer to figure A-37. (Height Velocity Diagram)

POWER LIMITATIONS

Refer to figures 5-3 and 5-4.

Engine power limits normally are not reached in this aircraft because the transmission design horsepower limit is reached first. Nevertheless, engine power instruments are marked to indicate design limits.

TORQUEMETER Q

Maximum continuous torque is 96% due to the main transmission rating. 96-100% Q is a precautionary range and is limited to 5 minutes. Operation over 100% Q will advance the elapsed time indicator, which is limited to 1 hour of recorded time. When 116% Q is exceeded for approximately 5 seconds, a red flag will appear in the window of the event indicator. (See TORQUE SENSING SYSTEM Section I.) See figure A-31 for max. cont. Q setting.

NOTE

Operation above 100% Q will result in extremely reduced transmission life.

POWER TURBINE INLET TEMPERATURE T_5

Refer to figure 5-2.

CAUTION

During compressor stalls or any other over temperature condition, if maximum T_5 is not observed, it is to be assumed that the limits have been exceeded.

ROTOR LIMITATIONS

A rotor overspeed occurs whenever N_r exceeds 110%. Rotor overspeed imposes a severe overload on the rotor system, transmission and components.

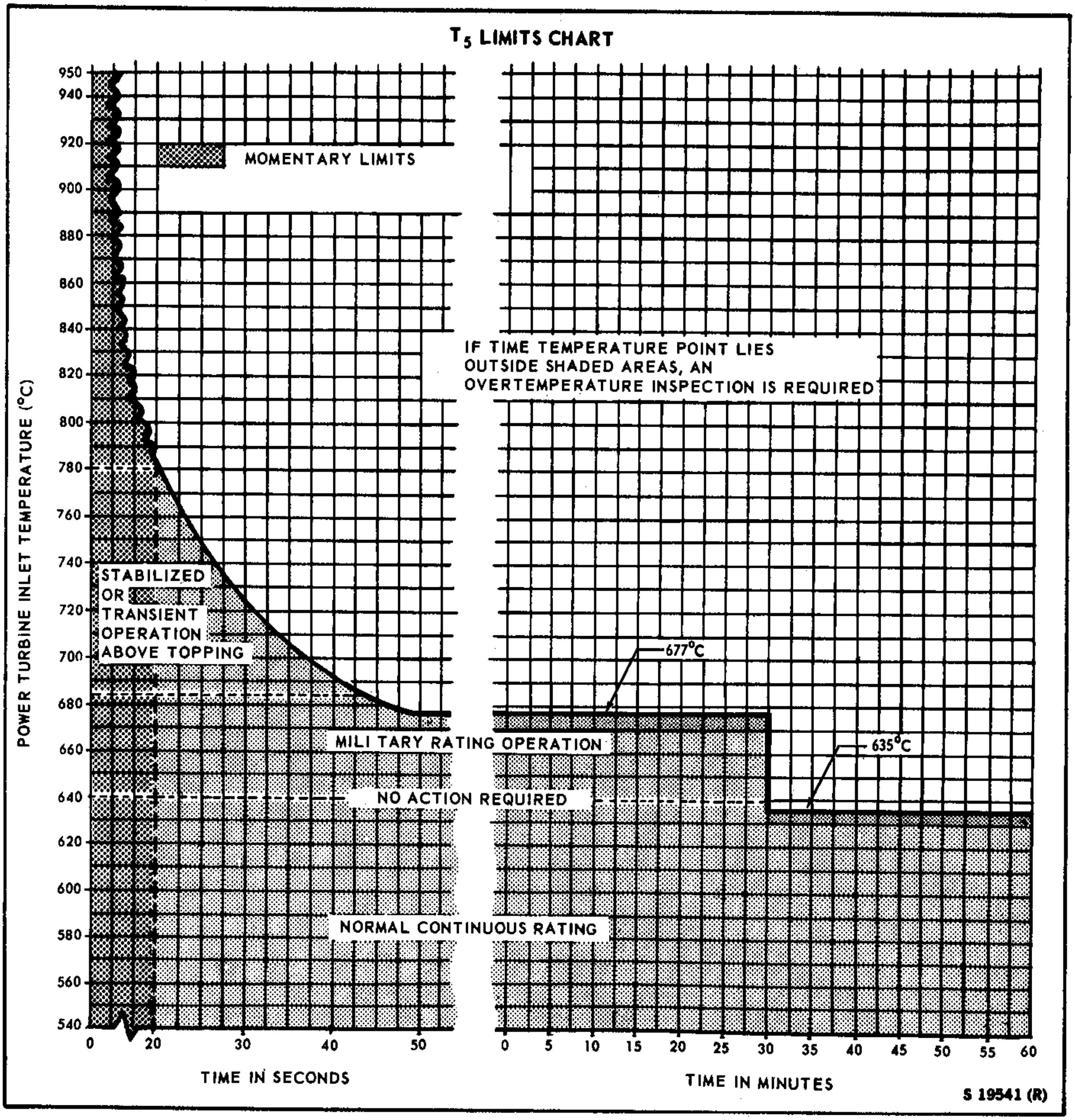


Figure 5-2. T5 Limits Chart

NOTE

When an overspeed occurs, the pilot will write up a detailed description, including the highest Nr attained, on the aircraft flight record. The helicopter should not be flown until the special inspection requirements contained in the HH-52A Maintenance Manual are performed.

MANEUVER LIMITATIONS

The helicopter is restricted to normal flying maneuvers. No acrobatics are permitted and flight controls

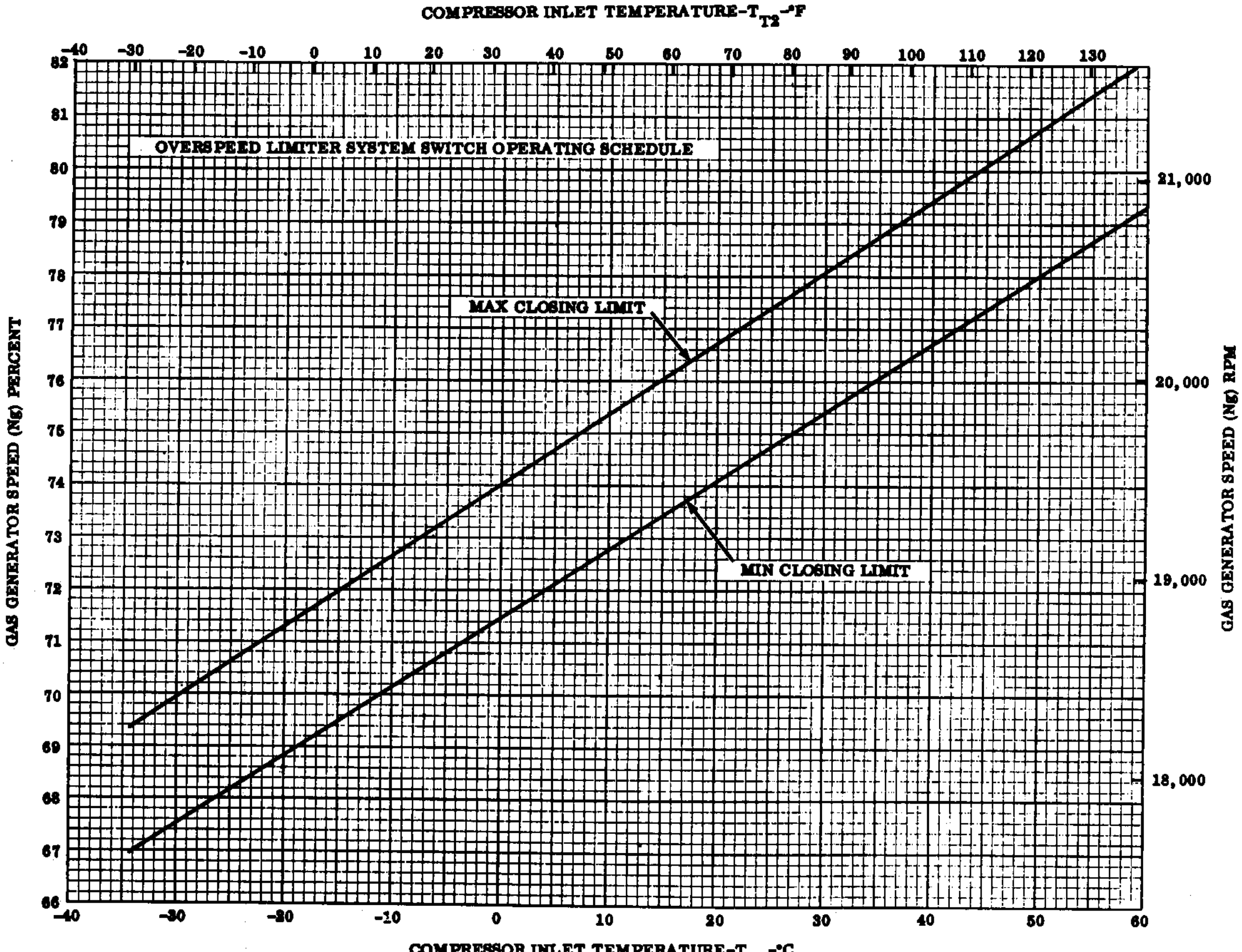
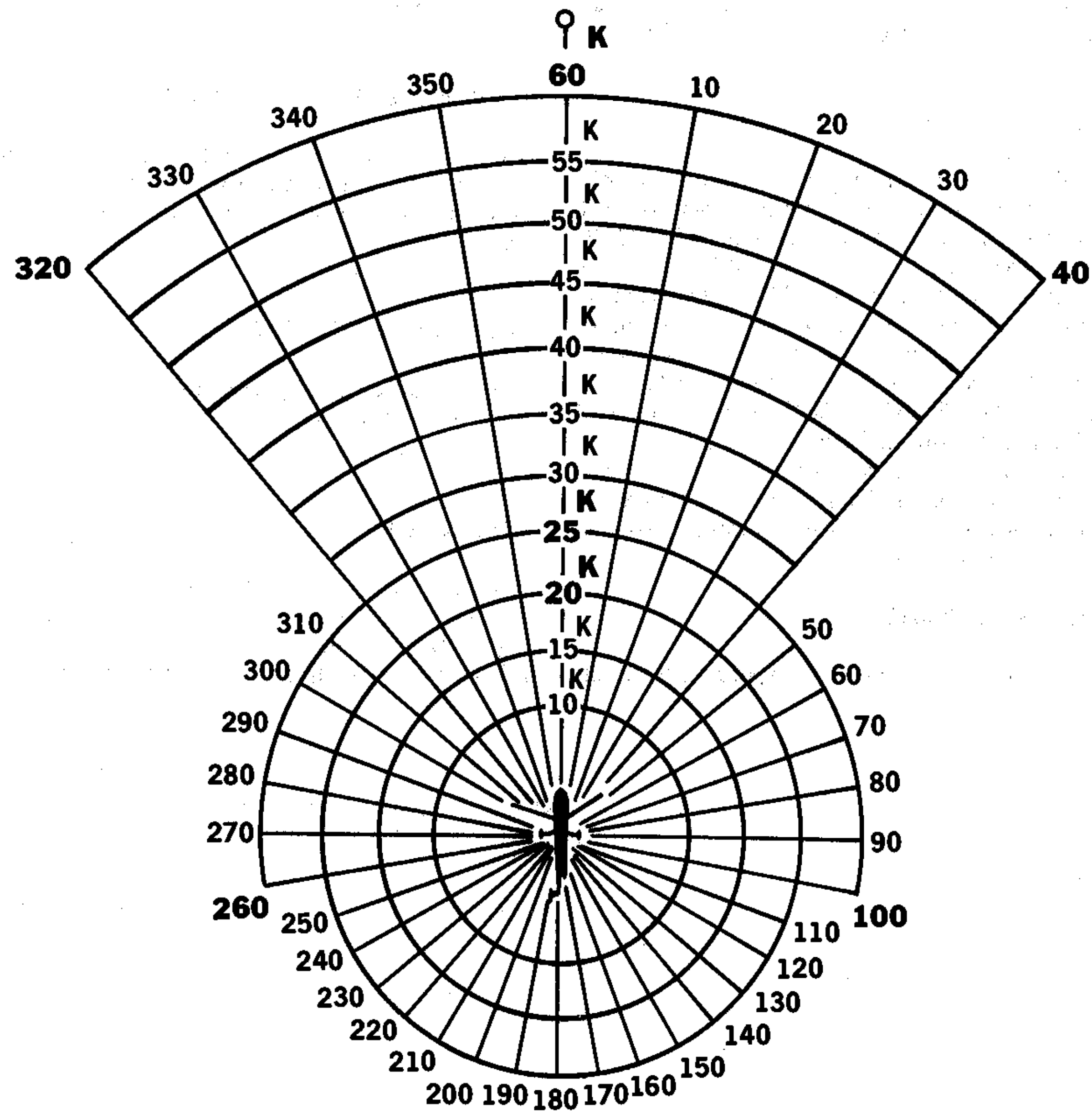


Figure 5-3. Test #1 Limits Chart



S 55587 (R)

Figure 5-4. Maximum Steady State Wind for Rotor Engagement/Disengagement must not be moved abruptly. Hovering turns should not exceed a rate of 360° in 10 seconds. Maximum angles of bank, dependent on airspeed and blade load factors, are determined using blade stall chart, (figure A-36). The maximum angle of bank is 50°.

CENTER OF GRAVITY LIMITATIONS

It is possible to exceed the CG limits if the helicopter is not properly loaded. To determine placement of load for anticipated mission refer to T.O. 1-1B-40 WEIGHT AND BALANCE DATA, HH52A AIRCRAFT. The CG limitations are 249 inches aft of datum for the most forward CG and 262 inches aft of datum for the most aft CG. Datum is 252 inches forward of the main rotor centroid. The takeoff and anticipated landing gross weight should be obtained prior to each mission and determined to be within specified limitations. If a weight and balance clearance form which shows the helicopter to be within limits is not on file, the weight and balance will be computed to determine that the helicopter is within limits.

WEIGHT LIMITATIONS

The maximum gross weight is 8300 pounds. Flight at gross weights above 8100 pounds shall be limited to operational situations which necessitate the higher gross weights.

LANDING GEAR LIMITATIONS

There are no structural limits affecting the extension or retraction of the landing gear in flight. The maximum run on speed is 43 knots (main landing gear limitation).

MINIMUM FLIGHT CREW

The minimum allowable crew for the operation of the helicopter is one pilot, but a copilot and crewmen may also be carried.

STARTER LIMITS

The starter is limited to 30 seconds at full engine load. Except for emergencies, do not attempt more than three starts in any 30-minute period, allowing a minimum of 3 minutes between each attempt.

SECTION VI

FLIGHT CHARACTERISTICS

TABLE OF CONTENTS

INTRODUCTION

The HH-52A is capable of flight over a speed range of 109 knots forward, 20 knots rearward, and 25 knots sideward. These are limited by the amount of control available with various center of gravity loadings and rotor speeds. While there may be no need for flight other than in the forward direction, it is frequently necessary to hover in crosswinds and tailwinds of the same velocities, as those mentioned above, for sideward and rearward flight. The helicopter is directionally stable in forward flight, but in sideward and rearward flight, directional control is more difficult to maintain, as the nose of the helicopter has a tendency to turn in direction of flight. This is due to the large flat plate area aft of the main rotor shaft. However, there is adequate tail rotor pitch available to accomplish any desired directional maneuvering within the above limits. The automatic stabilization equipment (ASE) improves the helicopter's basic flying qualities and in conjunction with the cyclic stick trim system, is capable of maintaining a desired attitude with minimal assistance from the pilot.

FLIGHT CHARACTERISTICS

The helicopter will always exhibit a tendency to return to trim following a disturbance in pitch, roll or yaw with ASE engaged. Without ASE, any oscillations can be stabilized by the pilot. Due to the forward tilt of the main rotor shaft and the sideward thrust of the anti-torque tail rotor, the HH-52A hovers slightly nose up and left "wing" down. In forward flight, small trim corrections are necessary to compensate for a change in collective pitch setting. As power is increased, the nose tends to rise and a slight right roll is observed. Conversely, as power is reduced, the nose falls slightly and the helo exhibits a slight amount of left roll. In high speed flight, the fixed horizontal stabilizer has a small negative pitch angle to offset the nose down pitching tendency of the helo, giving pitch axis stability and a more favorable nose attitude. After sudden power loss inflight, the rpm will decay rapidly, however it will be regained after lowering collective to minimum pitch providing it has not gone below 77% Nr. There is adequate autorotative rpm for landing, either from flight or a low hover.

FLIGHT CONTROLS

Both the primary servos at the rotor assembly and the auxiliary servos at the mixing unit are in operation at all times. Because of the damping and boost effects of the servo units, control forces are light and constant throughout their full range. This may cause a tendency to over-control, because there is very little feel in operating the cyclic stick unless the cyclic stick trim system is in operation. If either servo system should fail or malfunction, it may be turned off, provided there is hydraulic pressure in the other system. Either servo system may be turned off; however, the switching system prevents securing both systems simultaneously.

CAUTION

Securing primary servo system in flight is prohibited except for emergencies and maintenance testing.

If the primary servo system, which physically controls the lower swashplate, is turned off, movement of the lower controls and swashplate is accomplished through the auxiliary servo system which is in the broom closet near the cockpit controls. In this instance, the feel of control remains almost unchanged except for small differences due to increased friction and lost motion in the control system. A slight one-per-revolution beat may be felt with the primary servos secured. If the auxiliary servo system is turned off, the pilot physically moves the push-pull rods and bell cranks up to the primary servo system. In this instance, a friction augmentation through the ASE is lost. Hydraulic boost to the tail rotor control system is also lost when the auxiliary servo system is turned off. Control force required on the pedals is reduced however, because the pedal damper is depressurized when the auxiliary servo is turned off.

COLLECTIVE MANAGEMENT AFTER POWER OFF (EMERGENCY) LANDING

The aerodynamic characteristics of the main rotor blades are such that proper collective management upon completion of a successful power off landing can greatly reduce the possibility of the tail cone being struck by the main rotor blades after touchdown. The optimum technique calls for smoothly lowering the collective to the full down position after touchdown, while keeping the cyclic in a centered or slightly forward of centered position. If the collective is maintained in the full up position after touchdown, the rotor blades will lose the dynamic stiffness caused by centrifugal force as N_r decays. This will result in one or more of the blades flexing down to an extreme position and striking the tail cone. Conversely, if the collective is rapidly slammed down after touchdown, the blade tips may deflect low enough to strike the tail cone in spite of droop stop protection.

WATER HANDLING CHARACTERISTICS

Due to forward tilt of the main rotor shaft, the HH-52A will tend to taxi forward at a very slow speed. To maintain a position in the water, it is necessary to use aft cyclic and sufficient collective to keep main rotor blades from hitting the droop stops. The helicopter will respond to speed and directional controls in the conventional manner. Since there is less positive roll stability from the sponsons in the water, application of tail rotor control will cause the helicopter to roll in direction opposite the direction of the turn, and it may be necessary to maintain a level roll attitude by application of cyclic in direction of turn. This is primarily due to the roll-lateral coupling caused by the location of the tail rotor above the roll axis of the helicopter, and in part due to centrifugal force tending to roll helicopter to the outside of the turn. Under certain conditions, the HH-52A will experience a nose down or "Tucking" tendency. Tucking can be the result of excessive water speed or incorrect management of cyclic and collective pitch. As the helo is accelerated forward through the water, the drag of the hull provides a pivot point about which the nose will rotate as collective pitch is increased, causing the helo to tuck. For this reason, running maneuvers on the water are not practicable. Tucking may also be experienced with collective application while holding the cyclic forward even with little or no forward speed. As the collective is raised, before the aircraft can leave the surface, the nose sinks lower into the water creating a pivot point about which the helo rotates. In either case, positive lowering of the collective is the desired corrective action. If the tuck is caused by excessive water speed, lowering the collective may be only partially effective because the mass of the decelerating helicopter creates a pitch down force which is independent of collective. However, if the tuck is caused by incorrect management of cyclic and collective, lowering the collective will be totally effective because collective pitch directly controls the magnitude of the pitch down forces. Corrective action must be initiated as soon as the tuck is recognized to prevent blade contact with the water or engine flameout due to water ingestion. Rough water taxiing should be kept to a minimum. Due to wave action and effect of wind, the helicopter will pitch and roll excessively if collective is lowered to the full down position. This pitching and rolling results in the tail rotor coming into close proximity to the water and may result in damage to the tail rotor. Rough water taxiing should be accomplished by utilizing enough collective to keep the aircraft in light contact with the water and using cyclic to resist pitching and rolling tendencies. The helicopter's inherent stability limits may be exceeded in rough water in a power off condition. Use of auxiliary flotation equipment will aid materially in maintaining stability and should be employed as soon as possible after a power off landing. Although the power off helicopter can right itself from a roll up to approximately 16° without aid of auxiliary floatation, a wind of 15 knots or more (creating waves of 2 feet or higher) will probably drive it into the trough of a wave and possibly cause excessive roll. The helicopter is equipped with a sea drogue and a Danforth anchor. Either one should be utilized in maintaining heading in relation to waves. These help to keep the helicopter near the point of descent by minimizing drift.

FLIGHT WITH EXTERNAL LOADS

The helicopter has no unusual characteristics when carrying an external load except in tight turns and strong or gusty winds when cargo may tend to oscillate. External loads which have aerodynamic characteristics may cause oscillations to the extent that the load may strike the rotor blades and/or fuselage. The length of the hookup cable influences the feed back to the helicopter of oscillating forces, the better characteristic being achieved with shorter hookup cables. Oscillations can usually be controlled by slowing the forward speed of the helicopter. The center of gravity of the helo will not be affected adversely since the cargo hook hangs directly beneath the rotor centroid.

HOVERING OUT OF GROUND EFFECT

Careful evaluation of wind direction and consultation of performance charts are extremely important prior to this operation. To enter a hover out of ground effect, approach into the wind and gradually reduce airspeed, maintaining altitude. Control manipulation and power changes must be smooth and precise or the helicopter may inadvertently begin a rate of descent which may lead to power settling. To resume forward flight, slowly lower the nose to attain translation. The pilot must be thoroughly familiar with power settling and its recovery procedure prior to attempting this maneuver.

RETREATING BLADE STALL

Blade stall is most likely to occur when operating with high values of speed, gross weight, density altitude and torque, and with relatively low rotor RPM. Maneuvers, acceleration, or turbulent air which increase the G-load factor also contribute to blade stall, and reduce the airspeed at which blade stall will occur. When any one or a combination of the conditions which contribute to blade stall are present, it will most likely occur when excessive or abrupt control deflections are made. Blade stall occurs initially at the tip of the retreating blade on the left side of the helicopter. The only noticeable effect on the helicopter at this point is a slight increase in the power required. If retreating blade pitch is increased (as with forward cyclic stick), or the forward speed is increased, the stalled portion of the rotor disc is enlarged, and the stall progresses from the tip toward the hub of the retreating blade. Each main rotor blade tip will stall as it retreats through the 9 o'clock position and will create an increase in the general vibration level of the helicopter and possible "kicks" in the flight controls. The retreating blade reaches its lowest point 90° from the point at which lift decreases, thereby causing the tip-path plane of rotation of the main rotor blades to tilt downward toward the rear and causing the nose of the helicopter to pitch upward. This change in attitude greatly increases the angle of attack and accentuates blade stall. The normal control response to overcome pitching, forward application of the cyclic stick, may be ineffective. The uncontrolled pitch-up lasts only for a very short period. Then, full control is restored as airspeed decreases in the nose-high attitude and the excessively high angle of attack no longer exists. To stop the nose pitch-up, especially during turns at critical airspeeds and attitudes, reduce collective pitch, increase rotor speed and ease the nose of the helicopter down with a smooth forward application of the cyclic stick.

Vibrations of the helicopter during high speed flight or when maneuvering at lower speeds caused by blade stall may be reduced or eliminated by accomplishing one or any combination of the following:

1. Decrease collective pitch.
2. Increase rotor rpm.
3. Decrease the severity of the maneuver.
4. Gradually decrease airspeed.
5. Descend to lower altitude.

POWER SETTLING

Power settling is the uncontrollable settling of the helicopter when the main rotor is operating in the "Vortex ring state." In the vortex ring state, air flowing upward near the center of the rotor (due to the descent) and downward through the outer portion (as lift is produced) generates a giant recirculation of air around the rotor resulting in near zero total lift. Application of power which normally stops the descent is ineffective. Instead the rate of descent increases, vibration increases and the controls become ineffective as the vortex ring state is established. Power settling which can occur even though power is available to maintain level flight, is rare. The right combination of rate of descent, low airspeed, and collective pitch setting must be satisfied to induce the vortex ring state. Conditions likely to lead to power settling are typified by a helicopter in a vertical or near vertical descent with relatively low airspeed using power to control the descent. Actual critical conditions depend on rate of descent, gross weight, rotor RPM, density altitude and power applied. Confined area approaches at high elevations are an excellent example of this type of maneuver. In this situation development of power settling could be critical as low altitude may inhibit recovery. Maintaining translational lift during the descent will prevent establishing the vortex ring state. Power settling can be recognized by rotor roughness, loss of control effectiveness, and uncontrollable settling of the aircraft. To recover from power settling, the vortex ring state must be disestablished. Recovery procedures in Section III are listed in the order resulting in least loss of altitude. The vortex rings will be dissipated by abruptly increasing power if down flow can be made to exceed upflow. This may be ineffective if initiated late or if near maximum power is already being applied. An increase in forward speed allows the rotor to meet undisturbed air, breaking the vortex ring state. If those corrective measures are ineffective, the collective must be bottomed to allow all airflow to go upward through the rotor system, restoring controllability. Then forward speed can be increased and power reapplied as translational lift is gained. Power settling should not be confused with the settling which occurs when the helicopter is flown beyond its capabilities as when flying at high gross weight at high density altitude. In this case control response is positive but power required exceeds power available. Nor should power settling be confused with uncontrolled settling resulting from late or insufficient applications of power. In this case control response is positive but there is insufficient power available to stop the descent prior to ground contact. Pilot induced settling through power mismanagement, is likely to result from lack of planning in the approach and failure to maintain a rate of descent within the power available capability.

GROUND RESONANCE

Ground resonance is a self-excited vibration that occurs when a coupling interaction occurs between the movement of the blades and the helicopter. For ground resonance to occur, there must be some abnormal lead/lag blade condition which would dynamically unbalance the rotor, and a reaction between the helicopter and ground which could aggravate and further unbalance the rotor. Ground resonance can be caused by a blade being badly out-of-track, a faulty damper, or a peculiar set of landing conditions. When a wheel reaction occurs, such as a hard one-wheel landing that would cause out-of-phase blades to be aggravated to the point where maximum lead and lag blade displacement is realized, ground resonance may occur. This helicopter does not have a history of ground resonance. For corrective actions see Section III.

PILOT INDUCED COLLECTIVE BOUNCE

Since the flight control servo systems provide "force free" operation of the flight controls, a condition of collective bounce can occur if collective friction is not used. Collective bounce can occur in flight as well as on the ground. Rapid vertical displacement of the helicopter may cause a neutrally balanced, friction free collective pitch lever to move out of phase with the helicopter's vertical motion. The pilot, in an attempt to correct the condition by holding the collective, may inadvertently increase the amplitude of the collective bounce with a possibility of the helicopter's motion becoming divergent. This condition is sometimes referred to as "collective resonance." To preclude collective bounce, some collective friction should be used at all times.

HELICOPTER VIBRATIONS

The inherent vibrations in any helicopter are those created by the mechanical functions of the engines and transmission systems, dynamic action of the main and tail rotors, and aerodynamic effects on the fuselage. The overall vibration level is influenced by the many individual frequencies of vibration and combinations thereof. Many multiples of a basic frequency are felt, and often two or more different superimposed frequencies create beats. The overall magnitude is the resultant of the amplitudes of all the frequencies and it would be difficult for the pilot to completely separate all the types of vibrations encountered. Generally, these are divided into three categories; namely, low, medium, and high frequencies. Varying magnitudes of all three types of vibrations are often present in an individual helicopter. Only through experience will the pilot be able to judge what is normal and what is abnormal and correctable. Any unusual vibrations should be noted on the aircraft Flight Record (CG-4377).

LOW FREQUENCY VIBRATIONS

Vibrations, one, two, or three times the main rotor rpm, may be felt as a strong shake at a relatively low rate being transmitted through the fuselage and/or control stick. The majority of low frequency vibrations, however, are of a one-per-revolution nature.

One Times Main Rotor Speed (One-Per-Revolution)

This vibration emanates from the main rotor system and is generally caused by main rotor head or blade unbalances. It produces a rotary excitation of the fuselage which feels like a lateral oscillatory roll or wallow to the pilot. The most probable causes are:

1. Main rotor blades out-of-track. A blade track adjustment is not warranted even though the blades appear to be slightly out-of-track, if a one-per-revolution vibration is not present.

2. Worn or loose control rod end bearings.

3. Malfunctioning blade dampener.

Ground Roll

This is a one-per-revolution lateral roll of the helicopter which often occurs during rotor engagement, and is due to the in-plane misalignment of the main rotor blades causing an out-of-balance condition in the main rotor system. When the rotor attains flying speed, centrifugal force normally aligns the blades and the vibration disappears. If the vibration continues with the rotor up to speed at flat pitch, but disappears when the helicopter is lifted into a hover, then the cause could be:

1. Static balance of the main rotor blades.

2. Improper servicing of the landing gear struts.

Two Times Main Rotor Speed (Two-Per-Revolution)

This very uncommon vibration, which is recognized as a distinct two times the main rotor speed vibration, emanates from the main rotor system and the most probable causes are:

1. Main rotor blades out-of-track.

2. Worn or loose control rod end bearings.

3. Malfunctioning blade dampeners.

4. Damaged main rotor blades.

Three Times Main Rotor Speed (Three-Per-Revolution)

This most common inherent vibration is caused by the dynamic response of the main rotor blades to unsymmetrical aerodynamic blade loading. Its intensity is greatest at high forward speeds, at low gross weights, and during transition to a hover at high gross weight. It is felt in transition to a hover as a steady vertical shake caused by the main rotor blades traversing the downwash of preceding blades. This is normal to the helicopter when felt at the point where the collective pitch is increased to sustain the hover, or when hover taxiing the helicopter into and out of translational lift. The effect can be reduced during transition to a hover by leveling the helicopter just prior to applying collective pitch, and by planning the approach so that the hover can be attained with a slow rate of final pitch application. At high speeds, the difference in the lift distribution between the advancing and retreating main rotor blades results in heavy vibratory loads on the rotor head as the spanwise center of lift of each blade moves in and out. It is felt as a combination of vertical and lateral shake at the same frequency.

MEDIUM-FREQUENCY VIBRATIONS

These vibrations are easily detected by the pilot and are most often felt in the tail rotor pedals as a one times tail rotor speed vibration (1720 cycles-per-minute at 100% N_r). Generally these vibrations may be caused by an unbalanced tail rotor assembly, misaligned tail rotor drive shaft, improperly torqued intermediate or tail rotor gear box or bad bearings. However, the most frequent cause is lack of proper lubrication.

HIGH-FREQUENCY VIBRATIONS

These vibrations may be felt as a tingling sensation in the soles of the feet or a tickling in the nose. In extreme cases, the instrument pointers will appear to be fuzzy. High-frequency vibrations will normally emanate from the engine, or main gear box input sections, and are often equally apparent on the ground run and in flight. The most important cue, by far, to high-frequency vibration will be the associated sounds.

MAIN GEAR BOX VIBRATIONS

The main gear box contains many possible sources of high frequency vibrations such as the various gear box mounted accessories, the accessory gear train, the oil cooler blower, and the input bevel gear and free wheeling units. These vibrations are generally heard rather than felt. Combinations of these high frequency vibrations in extreme cases could result in the pilot sensing low- or medium-frequency vibrations. These would be detected as vibrations which are affected only by variation in main rotor speed, and may be just as apparent in a ground run as in flight. There are also numerous gear clash sounds that occur under various conditions, the acceptability of which can only be determined by experience or measurements with instrumentation.

ENGINE VIBRATIONS

The engine gas generator and power turbine will normally beat together at various N_g and N_f combinations, or with N_f split off from N_r. To the pilot, the only obvious evidence of excess vibrations will be greatly increased high pitch noise levels. If an excessive noise varies with N_g or N_f changes, then a bad engine bearing or rubbing compressor blades may be indicated. Listen carefully to the noisy engine during shutdown. Any unusual noises or a rapid coast-down time noted during engine coast-down should be entered on CG-4377.

SECTION VII

SYSTEMS OPERATION

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ENGINE FUEL CONTROL

The power available from the engine is proportional to the gas generator speed (N_g) and power turbine inlet temperature (T_5) relationship. The engine must be operated within the N_g and T_5 limits. The fuel control accomplishes this by maintaining certain scheduled acceleration, deceleration, and steady state limits. Acceleration due to increased power requirements or speed selector movement, is controlled by a maximum fuel flow schedule limit, or by the topping contour in the fuel control. Deceleration due to decreased power requirements or speed selector movement, is controlled by a minimum fuel flow schedule. Selected steady state conditions are maintained at optimum efficiency by a lead-lag servo system which dampens the effect of power transients, and the fuel control power turbine governor which maintains power turbine speed (N_f) within the specified droop limit at full speed selector position.

FUEL CONTROL SCHEDULING

The fuel control does not monitor power turbine inlet temperature (T_5) directly. It monitors compressor discharge pressure and adjusts fuel flow to maintain engine temperatures within safe, predetermined, scheduled limits. The amount of ratio of fuel to be burned, in proportion to the amount of compressor air available for both combustion and cooling, directly determines the temperature of the combustion gases at any point in a turboshaft engine. This ratio is known as weight flow of fuel (W_f) to compressor discharge pressure (P_3) and is used within the fuel control to determine the required fuel flow schedules. Maintenance of a continuous flame within the gas generator combustion system depends on a proper mixture of fuel and air. As performance-factors change, the values of both will change. The proportion between the two must be maintained or scheduled within limits or the flame will be lost (blowout or flameout). During deceleration, if fuel flow (which is decreasing) drops below a given amount, a lean blowout due to an insufficient amount of fuel for the air being used may occur. During acceleration, if fuel flow (which is increasing) rises above a given amount, an overtemperature due to an excessive amount of fuel for the air being used may be encountered.

Topping

The engine is considered at topping when operating at maximum gas generator speed. A contour on the 3D cam in the fuel control, acting through an adjustable linkage, prevents gas generator overspeed and overtemperature. There exists a relationship between the operating temperature (T_5) and the gas generator speed (N_g). This temperature/speed relationship is a function of ambient temperature (T_2). The topping contour limits the maximum attainable gas generator speed for various ambient temperatures, and in so doing limits the maximum operating temperature (T_5). The topping contour is therefore a speed control exclusively, indirectly controlling T_5. For operation at maximum power, the gas generator operates near or at the highest possible T_5, except when low ambient temperatures (T_2) are encountered; then the maximum gas generator speed limit is reached first. Since the T-58-8B is a derated engine, it is never operated at designed maximum power. Consequently, topping adjustment is not critical in the T-58-8B.

Bottoming

The engine is considered at BOTTOMING during deceleration whenever a minimum fuel (W_f) to compressor discharge pressure (P_3) ratio is attained. The bottoming schedule determines gas generator "IDLE" speed and the minimum W_f/P_3 ratio to sustain normal combustion.

DROOP

Actual power turbine speed varies approximately 8.5% from minimum to maximum load at a given speed selector position in the N_f governing range. This droop characteristic is a design feature incorporated to ensure N_f stability and to provide better load sharing in multi-engine installations. A droop of only 3% to 4% is experienced in the HH-52A because the engine is never operated at designed maximum power.

TEMPERATURE LIMITS

The temperature which engine components (particularly turbine buckets and turbine nozzles) can withstand without structural damage, limits the amount of heat energy which should be released by burning fuel. Temperature is controlled by limiting the maximum fuel flow for the prevailing gas generator speed and inlet conditions.

COMPRESSOR STALLS

Stall designates reversals of flow within the compressor. The severity of stall depends upon the number of reversals which take place per second. Specific causes of stalls may be incorrect stator vane operation, fuel control malfunction, or FOD. Compressor stalls may be recognized by any one of a combination of the following: Compressor pulsations felt through the airframe, loud bang, rumbling, or increase in engine noise, inability of N_g to accelerate, N_g decreasing and T_5 increasing. Each compressor has a maximum pressure ratio for every speed at which it operates. The maximum pressure ratio sets a limit on the compressor discharge which can result from rotating the compressor at a particular speed. As long as the pressure at the compressor discharge equals, or is below this limit, the compressor will deliver air smoothly. However, if this limit is exceeded, flow will be reduced and there will be some reverse flow through the compressor. Compressor stall will occur when a number or all of its blades are subject to too high an angle of attack. If it were not for the engine fuel control system and the variable vanes, stall could occur during an attempt to accelerate or decelerate the engine. During acceleration; sudden and excessive increase in fuel flow might generate a volume of gas which would create an excessive back-pressure at the compressor discharge, and compressor stall would result. During deceleration, early closing of the variable vanes would effectively block the airflow through the engine. This could result in a deceleration stall. Stall is avoided automatically by the fuel control and the variable vanes.

FUEL CONTROL OPERATING CONDITIONS

The engine fuel control must schedule fuel flow and variable vane positioning during four general operating conditions. These general operating conditions are: STARTING, IDLE, TRANSITION RANGE, and GOVERNING RANGE. These conditions are related to the various engine speed selector settings.

Starting

During start, as the speed selector is advanced to the ground IDLE position, the stopcock opens and allows fuel to pass through the flow divider and to enter the number one (low pressure) manifold to the nozzles where it is mixed with compressor-discharge air. As the fuel-air mixture leaves the nozzles, it is ignited by the two igniter plugs in the combustion chamber and enters a sustained combustion process. The fuel temperature sensing portion of the flow divider operates in conjunction with an auxiliary metering valve in the fuel control. The auxiliary metering valve is arranged in tandem with the main metering valve in a manner that allows its orifice area to decrease as the orifice area of the main metering valve increases. The lower portion of the flow divider housing contains a bellows that senses fuel temperature to vary the area opening of an attached needle valve. The temperature compensated needle valve and the fuel control auxiliary metering valve are arranged in series with each other and in parallel with the main metering valve. Fuel flow past the auxiliary metering valve is routed to the flow divider needle valve where it is biased by fuel temperature and then ported back to the fuel control to be added to the main flow. As the engine accelerates and fuel flow increases, the auxiliary metering valve will move toward the closed position and will be fully closed at 250 LB/HR flow (Occurs at about Ground Idle). At this point the temperature compensating system is eliminated and total fuel is metered by the main system.

Light-Off

The instant that the fuel-air mixture in the combustion section ignites is termed light-off. Light-off should occur within 15 seconds after advancing the speed selector to ground idle. Observing T_5 and N_g at light-off enables the pilot to identify an abnormal start and take appropriate action if necessary. A normal start is characterized by T_5 remaining below 700°C accompanied by smooth, steady, acceleration of N_g to ground idle. If the fuel-air ratio during start is lean or rich, T_5 and N_g response will be abnormal. Too lean a fuel-air mixture will cause a cold hangup and too rich a mixture will cause a hot start. Hot starts and cold hangups are abnormal engine conditions. They provide an early indication that the engine and fuel control combination are not operating properly.

Cold Hangup

During a start, fuel flow scheduling malfunctions or other conditions, although not affecting engine light-off capabilities, may cause the engine gas generator speed (N_g) to accelerate to normal idle speed. Cold hangup can be identified by slow N_g acceleration, hanging up at approximately 30%-50% with T_5 between 350°-400°C. The emergency throttle may be utilized after light-off to bypass the automatic features of the fuel control and provide manual scheduling of fuel by the pilot for engine acceleration to the idle range. Possible causes of a cold hangup are:

1. Fuel boost pumps not on.
2. Fuel control malfunction.
3. Improper fuel density settings.
4. P_3 system leak or P_3 valve open.
5. Flow divider malfunction.

Hot Start

A hot start is defined as a temperature (T_5) that rises abnormally fast, or above that normally expected. If a hot start is evident, the start must be aborted before T_5 rises above 700°C. If a hot start has been experienced, record maximum T_5, OAT, N_g when S/S advanced to ground idle, and type of start on the aircraft maintenance form.

Hot start may be caused by one or a combinations of the following:

1. Weak battery.
2. Malfunction of fuel control system.
3. Hot ambient temperatures.
4. Hot engine.
5. Fuel change/fuel control/flow divider set wrong.
6. High density altitude.
7. Malfunctioning starter.
8. Wind blowing up the exhaust.
9. Clogged combustion drain.
10. Improper starting procedure.

Idle

Engine idle is a stable gas generator speed of 56 ±3%. This condition exists in either the GROUND IDLE or FLIGHT IDLE positions of the speed selector.

Transition Range

The transition range is that range of engine operation between idle and minimum governing range. As the speed selector is advanced from FLIGHT IDLE, T_5 will advance fairly rapidly as the fuel flow/compressor-discharge pressure (W_f/P_3) ratio increases until it is limited by the fuel control. At minimum N_f governing, the fuel control will decrease the fuel flow/compressor-discharge pressure (W_f/P_3) ratio, lowering T_5, until a new steady-state operation is attained. During this time, N_g should show a steady increase.

NOTE

Prolonged operation of the engine in the transition range is not recommended.

N_f Governing Range

At speed selector settings above 85% N_f, the N_f governor, which is driven by the power turbine flexible drive shaft, becomes the primary parameter affecting fuel flow. Accordingly, the N_f governor, by sensing power turbine speed, is able to maintain the power turbine/rotor speed selected by the pilot. The engine fuel control maintains selected power turbine speed by varying gas generator speed as power requirements change.

Increasing Engine Load Increasing collective pitch tends to slow the main rotor and the power turbine. The Nf governor senses an underspeed condition and causes the fuel control to increase gas generator output. During gas generator acceleration, maximum fuel flow is delivered to the engine, with the rate of increase limited by cam contours to avoid compressor stall, rich or lean blowout, or turbine overtemperature. When the gas generator output power has matched the new load, fuel flow decreases to the level necessary to maintain the new load at the selected speed.

Decreasing Engine Load Decreasing collective pitch tends to increase main rotor/power turbine speed. The Nf governor senses an overspeed condition and causes the fuel control to decrease gas generator output. During gas generator deceleration the engine fuel control supplies the minimum fuel flow which will maintain combustion until the gas generator approaches the speed which will match output power to the new load. The engine fuel control then supplies the fuel flow necessary to maintain selected Nf.

EMERGENCY THROTTLE

The main metering valve is normally positioned automatically by components of the fuel control to perform fuel flow scheduling and Nf governing functions. These functions can also be performed manually by the pilot using the emergency throttle. The emergency throttle is mechanically linked to the main metering valve in such a way that it can increase the main metering valve opening demanded by automatic components of the fuel control, but cannot reduce it. Therefore, the speed selector must be in flight idle before the pilot can exercise complete control of the engine with the emergency throttle. The stator vane actuating system continues to function but the automatic fuel scheduling parameters which prevent overtemps, lean blowouts and compressor stalls are bypassed when operating on emergency throttle.

FUEL SYSTEM

See figure 1-15.

FUEL SYSTEM MANAGEMENT

The operation of the fuel system is automatic. Fuel is supplied to the engine from the forward tank only and an ejector type fuel transfer system automatically transfers fuel from the aft tank to the forward tank whenever either or both fuel booster pumps are operating. Overflow of the forward tank is prevented by a float valve which interrupts the transfer of fuel from the aft tank when the forward tank is full. If both boost pumps fail, the system will not transfer fuel from the aft tank. Any fuel remaining in the aft tank will be unusable.

WARNING

If dual boost pump failure occurs, the engine-driven pump must draw fuel from the tank up to the engine. Use of high power settings will help prevent loss of suction. Since the fuel system is unable to transfer fuel from the aft tank to the forward tank, the engine will flame out when the forward tank is emptied. For this reason, the Fuel Quantity Gage is kept in the FWD position in flight so that the fuel quantity of the tank feeding the engine will be displayed.

MIXING OF FUELS

The mixing of fuels is not recommended because of problems encountered with starts. Figure 7-1 shows the types of starts that may be expected with various combinations of fuel, fuel control settings, and flow divider settings. After using JP-5 and refueling with JP-4, in the initial start with no changes to the fuel control or flow divider, a normal start will result because of JP-5 fuel in the lines. Subsequent starts may go hot unless the settings are changed. With a mix of JP-4 and JP-5 in the lines, the type of start to expect may be determined by interpolating the results listed in figure 7-1.

POWER TURBINE OVERSPEED SYSTEM

The power turbine overspeed system functions automatically, when the flex shaft is intact, to prevent destructive overspeed of the power turbine. Without this

Fuel	Fuel Control Setting	Flow Divider Setting	Type of Start to Expect
JP-4	4	4	Normal
JP-4	4	5	Hot Start
JP-4	5	4	Cold Hangup tendency
JP-4	5	5	Hot Start
JP-5	5	5	Normal
JP-5	4	5	Hot Start tendency
JP-5	5	4	Cold Hangup
JP-5	4	4	Cold Hangup

Figure 7-1. Fuel, Fuel Control, and Flow Divider Settings VS Start to Expect Chart

system the power turbine could disintegrate if the engine load were suddenly removed or reduced to a vary low level, such as, failure of power turbine drive shaft or failure of the transmission input section. A pilot-induced overspeed caused by misapplication of emergency throttle will also actuate the system. When the power turbine governor in the fuel control senses a power turbine speed of 122%, the overspeed shutoff valve closes, stopping all fuel flow to the engine. The engine then flames out. It may relight when power turbine speed falls below 122% if the combustion or turbine sections are hot enough to provide a source of ignition and if the fuel/air ratio is favorable.

ROTOR OVERSPEED SYSTEM

See figure 1-7.

The rotor overspeed system protects the main rotor from destructive overspeeds by an automatic power reduction when rotor speed reaches 110%. The power reduction is accomplished by bleeding to the atmosphere, the compressor discharge pressure (P_3) signal sensed by the fuel control. The fuel control immediately schedules a greatly reduced fuel flow appropriate to the false signal now received from the compressor and engine power is drastically reduced. Engine power is restored when rotor speed falls below 110%.

NOTE

The rotor overspeed system offers no protection against overspeeds resulting from mismanagement of emergency throttle.

NORMAL OPERATION

Rotor speed is sensed by the centrifugally actuated rotor speed switch mounted on the main transmission. At 110%, a set of electrical contacts in the rotor speed switch close, energizing the P_3 solenoid valve. The solenoid valve opens when energized, bleeding the compressor discharge pressure signal to atmosphere. The stator vane actuator switch, which responds to gas generator speed, breaks the circuit to the solenoid valve when the gas generator speed drops to 72% ±3%. If rotor speed remains above 110% for a sustained period, gas generator speed will oscillate about 72% ±3% due to the action of the stator vane actuator switch. When rotor speed falls below 110%, the electrical contacts in the rotor speed switch open, de-energizing the solenoid valve and restoring full engine power.

ROTOR OVERSPEED TEST

A switch marked ENG OVSPD TEST has been incorporated in the rotor overspeed system to permit a functional check of Test No. 1 by the pilot at rotor speeds within the normal operating range. The 110% overspeed contacts are tested by maintenance personnel.

Test No. 1

Placing the ENG OVSPD TEST switch in the No. 1 position allows the pilot to check the functioning of the stator vane actuator switch and the solenoid valve. When the speed selector is advanced from the flight idle position, gas generator speed increases until the stator vane actuator switch closes at the value obtained from figure 5-3 (normally 72% ±3%). Gas generator speed then drops, opening the stator vane actuator switch, which will stop bleeding P_3. Gas generator speed will oscillate with the upper end of speed range at the value obtained from figure 5-3 until the ENG OVSPD TEST switch is moved to NORMAL or the speed selector is retarded.

SECTION VIII

CREW DUTIES

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INTRODUCTION

Each flight crewmember has duties other than those covered in NORMAL PROCEDURES, Section II, and EMERGENCY PROCEDURES, Section III. These additional duties are contained in this section. The minimum allowable crew for the operation of the helicopter is one pilot. A copilot and/or a flight mechanic may also be carried.

PILOT IN COMMAND

The pilot in command is responsible for the safe and orderly conduct of the flight. His responsibility and authority exist from the time he enters the aircraft preparatory to flight until he leaves it upon completion of the flight or mission. He shall be responsible for insuring that his crew and passengers are properly briefed. Responsibility for all phases of the flight rests with the pilot in command. The pilot in command shall perform the duties of copilot in flight while not operating the flight controls.

COPILOT

The copilot's duty is to assist the pilot. His general duties are:

1. Act as safety pilot.

2. Monitor aircraft instruments.

3. Operate communication and navigation equipment.

4. Navigate.

5. Make required reports in normal and emergency situations.

6. Ensure that he receives an adequate briefing from the pilot for and during the flight and to question anything he fails to understand.

FLIGHT MECHANIC

The aircrewman is designated as a Flight Mechanic (FM). The Air Operations Manual (CG 333) contains the crew requirements for SAR as well as the training requirements to become a Flight Mechanic.

PREFLIGHT

1. Perform the preflight inspection as listed in Section II.

2. Brief passengers on aircraft emergency procedures, emergency exits, and survival equipment as directed by the pilot.

INFLIGHT

1. Check the helicopter for fumes and leaks.

2. Perform lookout duties as directed.

3. Monitor communications radios.

4. Insure the safety and comfort of the passengers.

INSTRUMENT APPROACH OPERATIONS

PILOT DUTIES

Prior to commencing an instrument approach the pilot will brief the copilot and the flight mechanic on the particulars of the approach. The brief will include as a minimum the following items when they apply:

1. The type of approach and the frequencies of the navigation aids to be used during the approach.

2. The courses to be set in the course display windows.

3. Approach minimums.

4. Minimum altitudes for each phase of the approach.

5. Missed approach timing.

6. Missed approach procedures.

7. Designation of the pilot to handle communications.

8. Designation of the pilot to monitor the navigation aid used for the approach.

9. Procedures to be followed after the safety pilot is visual.

10. Type of subsequent approach and intentions.

COPILOT DUTIES

1. Perform general copilot's duties.

2. Provide the pilot with heading and altitude information from the approach plate.

3. Start and stop the clock.

4. Advise the pilot 100 feet prior to, and reaching all minimum altitudes.

5. Report when visual reference is established.

FLIGHT MECHANIC DUTIES

1. Look out for other aircraft during periods of visual meteorological conditions.

BEEP TO A HOVER

PILOT DUTIES

The following is a minimum list of items on which the pilot must brief the crew prior to commencing a BEEP TO A HOVER.

1. Procedures to be used (full pattern or straight-in).

2. Beep heading.

3. Time from rollout on heading to the gate.

4. Special instructions to copilot and aircrewman.

COPILOT DUTIES

1. Perform general copilot's duties.

2. Perform safety pilot duties (SECTION IX, Beep To A Hover).

CREWMEN DUTIES

1. As briefed by the pilot.

PASSENGER BRIEFING

The pilot in command shall insure that all passengers embarked receive an adequate briefing. This briefing shall encompass at least the following:

1. Use of parachutes (if carried).

2. Use of lifejackets (if flight over water).

3. Applicable alerting signals in event of an emergency.

4. Action required in case of ditching or crash landing.

5. Emergency exits.
6. Use of other emergency equipment.
7. No smoking and seat belt rules.

SAFETY DEVICES

The safety belt and shoulder harness (if provided) of each occupant shall be fastened properly from prior to takeoff until subsequent to landing, except when necessary activities require temporary removal. This removal shall not be made below 1,000 feet absolute altitude without authorization by the pilot in command. Crew members engaged in activity near an open hatch while airborne shall wear a properly attached safety harness.

SECTION IX

ALL WEATHER OPERATION

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INTRODUCTION

This section contains only those procedures that differ from or are in addition to the normal operating procedures outlined in Section II except where repetition is necessary for emphasis, clarity, or continuity of thought.

NIGHT PROCEDURES

Night flying procedures do not differ from daylight procedures in the HH52A. However, additional considerations include preflighting all lights, use of a taxi director with lighted wands, and knowledge of operating areas, etc. For HH52A aircraft an operative ASE system and an operative radalt are required for night flight. Only in matters of life or death may Commanding Officers waive this provision. This is not intended to prevent pilots from practicing basic maneuvers at night with the ASE intentionally secured. The use of trim release at night is a matter of pilot technique, however, the trim release should be used only when the pilot has good visual reference.

Pilot requirements are found in CG-333.

INSTRUMENT FLIGHT PROCEDURES

The HH52A exhibits excellent basic instrument flight characteristics with ASE operating. However, backup capability in the communications-navigation equipment is lacking, and only engine anti-icing equipment is provided. Compliance with the following rules is therefore mandatory:

1. An operating ASE system and radalt are required for instrument flight. Only in matters of life or death may a commanding officer waive this provision.

2. Flight into known icing conditions is prohibited.

3. Pilot requirements are listed in CG-333.

4. The VGI horizon bar is adjusted during the NORMAL PROCEDURES INSTRUMENT CHECK, and is not readjusted during flight.

5. The Trim Release will not be used during instrument flight.

INSTRUMENT TAKEOFF

Prior to commencing an instrument takeoff (ITO), accomplish the following:

1. Before Take-off Checklist.

2. Feet on the deck.

Initiate a smooth application of collective to 95% torque, maintain a nose on the horizon, wings level attitude by overriding cyclic trim as necessary. Once a positive rate-of-climb has been established and when passing through 40 to 60 feet on the RADALT, override pitch and lateral trim to lower the nose and attain an accelerating attitude (do not exceed 3° nose down), keeping the wings level. Approaching 55 knots, relax this pressure and trim to maintain a 55 knot climb.

CAUTION

The yaw heading retention feature of the ASE may not hold. Close monitoring of the heading during the initial phase of the takeoff is required.

This maneuver is the same from the land, water, or from a hover.

INSTRUMENT CLIMB

Climb from takeoff to 1000 feet above the terrain will be at 100% Nf/Nr, 95% torque, and 55 knots. Above 1000 feet, increase climb speed to 70 knots. If the time to climb to altitude exceeds 5 minutes, reduce torque to 90%. Continue climb at 70 knots.

INSTRUMENT CRUISE

Cruise speed is at the discretion of the pilot.

HOLDING

Holding for short periods will be at cruise RPM. Holding for long periods or when fuel is critical will be at 96% Nf/Nr and 55 knots.

DESCENT

Descents are made at cruise airspeeds.

INSTRUMENT APPROACHES

Use standard instrument approach procedures. Approach airspeeds are at the discretion of the pilot.

The BEFORE LANDING CHECK will be accomplished as follows:

1. on GCA and ASR—when directed to "PERFORM COCKPIT CHECK".

2. on ILS, VOR, TACAN, ADF and LF—prior to final approach fix.

MISSED APPROACH PROCEDURE

At any time the approach appears unsafe or if the field is not in sight at approach minimums, the pilot should announce GO AROUND on the ICS, increase torque to 95% and establish a climb at 55 to 70 knots.

BEEP TO A HOVER APPROACH

See figure 9-1.

GENERAL

A Beep to a Hover will be used to transition to a hover over water under the following conditions: at night, during day glassy water conditions, during IFR.

CAUTION

A beep should not be attempted if the aircraft is too heavy to hover out of ground effect, as determined by performance data.

PROCEDURE

When stabilized in level flight at 55 knots and prior to crossing datum:

1. Conduct the BEFORE LANDING CHECK.

2. Conduct instrument crosscheck:

   a. Nf/Nr—RECHECKED.

   b. Airspeed 55 knots—RECHECKED.

   c. VGI—CHECKED.

   d. Radalt—CHECK AND SET BOTH BUGS TO 40 FEET.

   e. Torque—CHECKED AND NOTED.

   f. Flight director—SET CG TRIM HORIZONTAL BAR BETWEEN CENTER INDEX AND TWO UNITS BELOW CENTER INDEX.

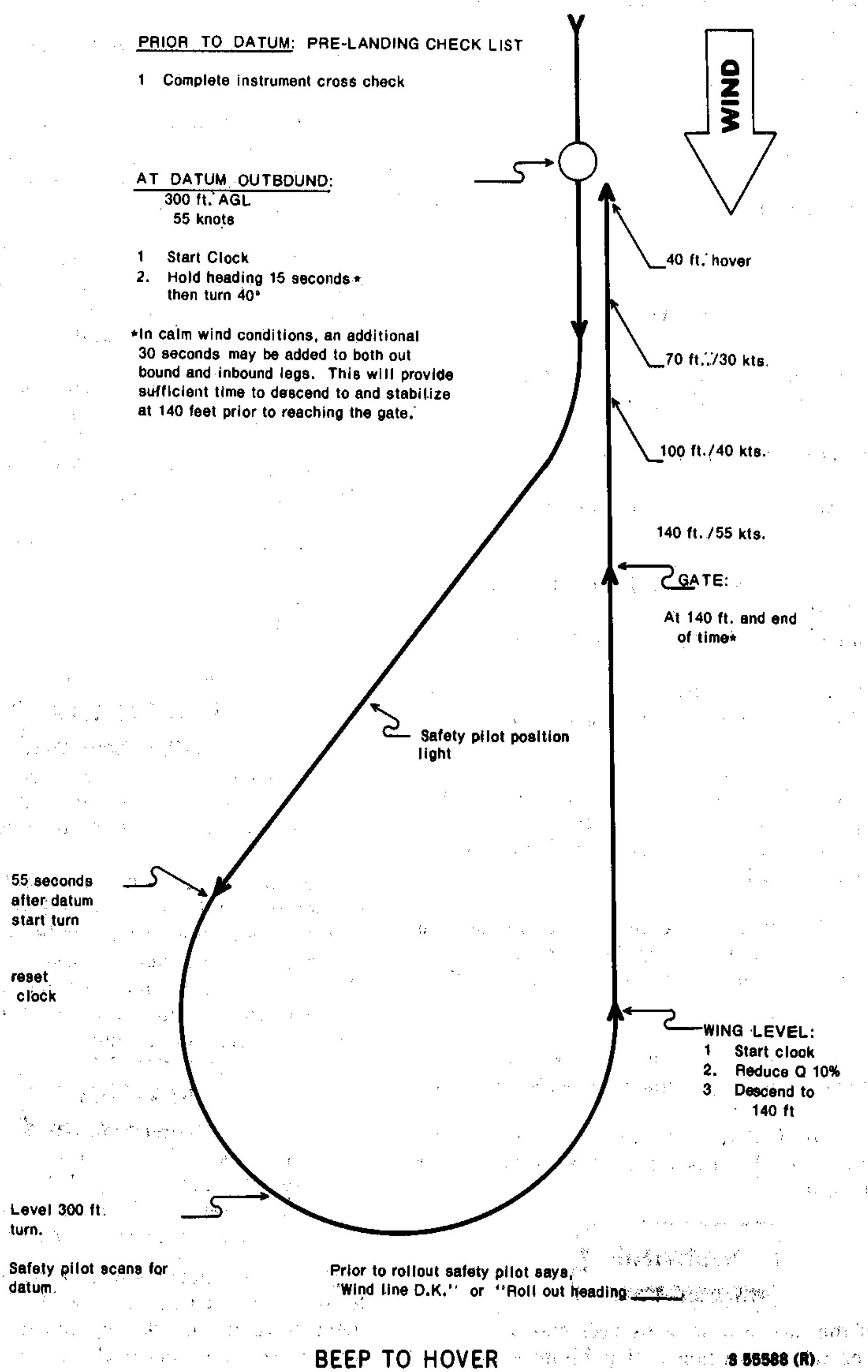

Figure 9-1. Beep to Hover

g. MA-1 compass—CROSSCHECK WITH WET COMPASS.

h. Altimeter—CHECK AND COMPARE WITH RADALT.

i. Clock—RESET.

j. VSI—CHECKED.

BEEP PATTERN

NOTE

The pilot in control is called the pilot. The other pilot is the safety pilot.

1. Establish 300 feet and 55 knots.

2. Passing over datum on a downwind heading start the clock.

3. 15 seconds (45 seconds if using the calm wind option) past datum, initiate a standard rate turn of 40°—normally toward the pilot's side of the aircraft.

4. Safety pilot, with the acquiescence of the pilot, positions the controllable landing light for use by the safety pilot.

5. 55 seconds (1 minute, 25 seconds if using the calm-wind option) after passing datum, initiate a standard rate turn in the opposite direction from the initial turn. Reset the clock.

6. The safety pilot scans to the inside of the turn and estimates the heading to bring the helicopter back to datum. He advises the pilot "Wind line okay" or "Roll out heading ______."

7. After roll out on heading place feet flat on deck, restart clock and make an immediate torque reduction.

8. Start immediate descent to 140 feet using approximately 10% less torque than required for 55 knot cruise.

WARNING

If the rate of descent exceeds 400 feet-per- minute any time during this maneuver, execute a go around.

9. Turn on lights at pilot's discretion.

10. Safety pilot monitors descent and warns pilot when passing 180 feet.

11. Level off and stabilize at 140 feet.

12. Safety pilot continues to monitor radar altitude while scanning outside.

13. The gate for commencing the Beep to Hover is reached 30 seconds after restarting the clock in calm winds (60 seconds if using calm wind option). An additional 15 seconds must be added for each 5 knots of wind.

14. Arriving at the gate, commence the beep to hover. Begin decreasing torque to approximately 10%-15% less than that required for 55 knots cruise and begin to beep the nose up toward 6°. Vary the rate of beep to arrive at these check points.

Altitude	Airspeed (KIAS)
140	55
100	40
70	30

WARNING

Do not lower collective to correct errors in altitude/airspeed relationships as dangerous rates of descent can develop.

This attitude power combination will cause a gradual deceleration and a descent of 100 to 150 feet-per-minute. After commencing the beep to a hover from the gate, control inputs are made with the BEEPER TRIM button, using short beeps and very small collective changes. Heading control is left entirely with the ASE heading retention feature.

WARNING

If during the beep to a hover the helicopter attitude exceeds 12° nose-up, 5° nose-down, or 6° roll, level the helicopter and execute an instrument takeoff.

15. At approximately 60 feet, begin increasing collective, predicated on rate of RADALT needle movement, to control the descent and establish a hover of 40 feet. The nose will pitch up proportionate to the amount and rate of collective application. In wind

conditions less than 10 knots, the flight characteristics of the helicopter will cause it to assume a hover attitude when hovering airspeed is reached. In winds greater than 10 knots, the pilot should assume a hover attitude when airspeed drops to a value equal to existing wind velocity.

16. The safety pilot scans outside to gain visual reference for hovering. If he acquires sufficient visual references he calls "I'm visual."

17. The pilot passes control to the safety pilot.

18. When the safety pilot acknowledges control, the pilot shifts his scan outside and acquires visual reference. When he has visual reference well established the pilot states "I'm visual" and control is returned to the pilot.

CAUTION

> Before transitioning to visual flight, pilots must be absolutely sure that they do not merely see the surface but rather that they see enough to give them good reference for control of the helicopter.

19. In event the safety pilot does not acquire satisfactory visual contact within 10 seconds of establishing a hover, the pilot may start a very gradual descent to 30 feet radar altitude (after advising the safety pilot of his intention).

20. If visual reference is not established at 30 feet, execute an instrument takeoff.

CAUTION

> Once the safety pilot has established a hover, the pilot should not move the landing light to light his side of the aircraft until he has adequate references for hovering.

STRAIGHT-IN BEEP PATTERN

During periods of good visibility the pilot may elect to abbreviate the Beep to a Hover approach by flying a straight-in pattern.

Procedure

1. Conduct Before Landing Check and Instrument crosscheck no lower than 300 feet AGL.

2. Position aircraft directly downwind from datum at 300 feet AGL and 55 knots.

3. Commence descent to 140 feet AGL as outlined in steps 8. through 12. of the beep pattern.

4. Safety pilot visually estimates gate position and directs the pilot to commence the beep.

5. Complete the maneuver as outlined in steps 14. through 20. of the beep pattern.

COLD WEATHER OPERATIONS

GENERAL

Helicopter operations in cold weather present various problems depending on: The base of operation, temperature, wind, precipitation, and surface condition. Maintenance work that is easily accomplished in warm conditions becomes extremely difficult to perform in remote areas with limited equipment and cold temperatures.

Cold is the real enemy. As the temperature drops more precautions are required. Cold brings physical hazards to the crew and limits their abilities. Extremely cold fluids such as fuel and oil may cause frostbite if spilled on exposed flesh. Static electricity builds very rapidly in cold, dry air. The parts of the helicopter that seem to be most susceptible to failure in cold weather are lubricated shafts and bearings, e.g. ground inverter and electronics equipment, and rubber seals, e.g. in the auxiliary servos. Moisture, usually from condensation or melted ice, may freeze in critical areas. Pressures of the tire, landing gear strut, fire extinguisher bottle, and accumulators will decrease as the temperature decreases.

When deploying to a remote area, a battery that has recently been deep cycled will provide maximum performance. An extra battery connected in parallel with the installed battery may also be carried. Anticipate hot starts and cold hangups. A spare igniter plug may be carried for the heater. If a spare is not available, the crewman can remove and clean the plug if it fouls. At low temperatures, at least 15 minutes will be required to adequately warm up the systems. Wind may be the result of rotor wash or natural forces but in either case it increases the rate of heat losses. Consequently, the time that personnel are exposed must be kept to a minimum. The exact effects of wind chill to helicopter components can not be predicted but it will cause cooling at a more rapid rate. Wind may also cause restricted visibility by blowing snow.

When hovering in loose or powdery conditions all ground references may be lost. Therefore, when possible, avoid areas of loose or powdery snow for takeoffs and landings. When this is not possible and conditions permit, a no-hover takeoff or landing will keep the blowing snow aft of the cockpit. If a no-hover takeoff is not practical, an instrument takeoff may be warranted. If a no-hover landing is not advisable it may be possible to sweep the landing area with rotor wash. To do this, air taxi over area at a speed just fast enough to keep the blowing snow aft of the cockpit, continue until the loose snow has been blown away.

Precipitation adversely affects both flight and ground operations. Flight into known icing conditions is prohibited. Ice and snow accumulations on the windshield and canopy may be ingested into the engine causing engine failure. Any precautions that protect the helicopter from accumulating ice or snow after shutdown will greatly simplify preparations for the next flight.

Although other surface conditions may be encountered, ice and snow covered surfaces are generally associated with cold weather operations. Ice chocks are recommended for operation on ice or snow covered surfaces. During ground operations involving torque changes, ensure that personnel and equipment are well clear as slewing of the helicopter may occur. If conditions are extremely slippery, the pilot may delay the over speed system checks. Loose powdery snow and crusts (surface or hidden) should be anticipated on all landings on snow. Snow depth is less in clear areas where there is little or no drift effect. Landings should be made only to surfaces of known characteristics. If it is necessary to land on an unfamiliar snow covered surface, competent personnel should physically check snow depth, hardness, and hidden obstructions before landing. After contacting the surface, slowly reduce collective pitch until the wheels come to rest on a level plane or the bottom of the fuselage comes to rest on the surface. This will prevent any serious consequences if one wheel should hang up or break through a crust of snow. Make smooth power changes when the fuselage is resting on the surface. Providing there are no obstructions, the tail rotor will be clear when the fuselage rests on a level surface or a nose low attitude is maintained. **Except in an emergency, never reduce rpm** until it is positively determined that the helicopter will not settle. Be alert for a warm fuselage melting the snow adjacent to it and subsequently refreezing to the surface.

WARNING

Main and tail rotor ground clearances are reduced with the helicopter resting on the fuselage. Therefore, personnel entering or leaving the helicopter should exercise extreme caution to preclude being struck by the blades.

PREPARATION FOR FLIGHT

In addition to accomplishing a normal exterior inspection, engine inlets, rotor head, main rotor blades, tail rotor, and flight controls should be thoroughly inspected and should be free of all ice and snow. Check **that fuel tank vents, heater vents, and pitot tube** (including static ports) are free of snow and ice; that landing gear struts and tires are properly inflated; and that a well charged battery has been installed. Check the engine for ice and snow. If ice and snow is found, the engine must be thawed out with hot air prior to attempting a start.

CAUTION

Conduct a thorough inspection of rubber boots on rotor head and primary servo pilot valves to insure no moisture is present which may freeze in flight and cause control malfunctions.

MAIN ROTOR BLADES DE-ICING

To remove ice from rotor blades, use anti-icing and defrosting fluid MIL-D-8243 heated to 180°F and applied in a small stream under pressure. Be particularly alert for ice frozen in blade tip caps, which could create a lateral imbalance.

CAUTION

Ice should not be chipped from blade surfaces due to danger of damage to blades. Even minor scratches are stress risers and could lead to cracks. Portable ground heaters or de-icing fluid may be used to remove an accumulation that cannot be swept off. Do not de-ice windows with de-icing fluid, alcohol, or other materials that can soften plastic.

PREHEAT INSTRUCTIONS

If main transmission oil temperature is below −15°C it must be preheated prior to engagement to prevent damage. No preheat is required for the intermediate and tail rotor gear boxes.

NOTE

In an emergency situation, when no preheat equipment is available, engagement may be accomplished in temperatures down to −28°C.

To preheat proceed as follows:

1. Install a heavy canvas cloth or equivalent over the main transmission area. A 24-foot cargo chute, split at 120° intervals with Velcro tape sewn to the splits makes an excellent barrier. When draped over main rotor head, the chute will cover the engine compartment, transmission and oil cooler.

2. Lower the left transmission service platform, keeping all other transmission service platform and access panels closed.

3. Utilizing a 200,000 BTU heater or equivalent, with 7-inch ducts, direct heat to the main gear box input section to insure lubrication of the input sleeve bearings and heat to the oil cooler.

NOTE

The transmission oil temperature gage operates on 28 volts D.C. from the D.C. essential bus.

4. The following table is representative of preheat time utilizing the 24-foot cargo chute cover and 200,000 BTU preheat source.

Ambient Temperature	Time Duration	Preheated Temperature
−30°C	20 minutes	+15°C
−40°C	30 minutes	+ 8°C

TABLE OF MAIN GEAR BOX WARMUP AND COOLING RATES

Warmup data is based on the time required at 100% Nf/Nr and flat pitch to raise the transmission oil temperature to +40°C.

Ambient Temperature	Preheated MGB	Time
−30°C	0°C	10 minutes
−15°C	−15°C	10 minutes
−30°C	+15°C	6 minutes
−40°C	+ 8°C	9 minutes

Cool down data is based on time required for transmission oil temperature to cool from 79° to 0°C.

Ambient Temperature	25 kt Wind/No Wind
−15°C	3.0 hours/5.5 hours
−23°C	1.8 hours/3.0 hours
−32°C	1.3 hours/2.5 hours
−40°C	1.1 hours/1.8 hours

NOTE

Engine cooling is more rapid and a temperature drop from +40° to −32°C in one hour at −40°C ambient with a 25 knot wind may be expected. When engine oil temperature is below −25°C a successful start without preheat application is doubtful, even with use of parallel batteries.

ENGINE STARTING

After the above preheat is accomplished and ground heater ducts have been removed, accomplish a normal engine start. At extremely low temperatures it is possible that the engine oil pressure will go to maximum value during an engine start. If engine oil pressure does not drop to operating limits within 30 seconds after the engine has reached idle rpm, stopcock the engine and investigate. When oil pressure stabilizes and the transmission oil temperature gage maintains an indication of −15°C or warmer, rotor speed may be slowly increased to 100% Nr, being careful not to exceed transmission oil pressure limitations.

NOTE

Be alert for hot starts or cold hangups. It may take as long as 5 minutes of emergency throttle operation before the fuel control will perform satisfactorily.

If the battery voltage is so low that a battery start cannot be accomplished, an additional source of battery power may be connected in parallel with the installed battery or through the D.C. external power receptacle.

GROUND CHECK OF SYSTEMS

Accomplish normal check of systems as in Section II. In cold weather make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

NOTE

A T_5 increase of approximately 10° can be anticipated when using engine anti-ice.

CAUTION

Possible erratic operation of relays, and inability to change radio frequencies may be experienced until some degree of cockpit/cabin heat is attained.

DURING FLIGHT

During flight use the cabin heater, engine inlet anti-icing, and windshield defrost systems as required. The horizon may be lost when flying over large unbroken expanses of snow. If such a situation exists, the helicopter should be flown entirely by instruments at a safe altitude. Colored glasses should be worn in snow areas to prevent snow blindness. At the first indication of icing turn and fly from the icing conditions. Some significant locations to observe for ice or snow accumulation are the windshield wipers, pitot tube and sponsons. Rotor rotation amplifies ice accumulation and the ice accretion on parts of the fuselage will not provide the pilot with a direct indication of ice accretion on the rotor system. Increased indicated torque accompanies ice accumulation on the main rotor and is a useful indication of ice accretion. Continued flight may cause ice ingestion in the engine from areas forward of the inlet. Icing of the air inlet area is an ever present possibility when operating in weather with temperatures of 10°C and below with visible moisture with the exception of dry snow. Snow below a temperature of −4°C can be assumed to be dry if there is no accumulation on the helicopter, in which case the engine anti-ice should be turned off. Takeoffs into fog or low clouds when the temperature is at or near freezing result in engine inlet icing. Climbs should be made at higher than normal rates under such conditions. Engine inlet icing does not necessarily occur with blade icing.

WARNING

This helicopter is restricted from flying in known icing conditions when visible moisture, except dry snow, is present. When icing conditions, except dry snow, are inadvertently encountered immediately turn on the engine inlet anti-icing system if not previously accomplished. With dry snow present, use of the anti-icing system may result in melting of the snow on the intake ducts with subsequent re-freezing and ice accumulation at the engine front frame. Under such conditions use of the inlet anti-icing system is not recommended.

NOTE

The ENG INLET ANTI-ICE caution light will remain on if the capability of the system is exceeded. At low temperatures where this occurs, icing is usually not encountered due to the lack of moisture in the air.

CAUTION

Autorotation at low gross weights in low density altitude conditions may result in loss of generators. If flight at low gross weights is required in night or IFR conditions autorotation rpm should be reset. See CGTP 1H- 52A-2 for amplifying details.

WARNING

Do not attempt to shed accumulated ice from the rotor systems by rapidly pumping the collective or rapid cyclic control pulse inputs, as assymetrical shedding may occur resulting in severe vibrations. The most effective means to induce shedding is by rotor speed variation.

If snow or ice accumulates during flight a precautionary landing should be made to remove the accumulation. If a landing is not possible, change altitude to leave the icing environment.

WARNING

With excessive ice accumulation on the inboard portion of the main rotor, it may not be possible to maintain autorotational rotor speed to provide sufficient rotor kinetic energy to ensure a safe autorotational landing in the event of an engine failure.

SECURING

A little effort by the flight crew following the days flight operations will greatly simplify operations the following day. As soon as the helicopter is parked, chock the wheels and release the brakes. Fuel the helicopter to prevent moisture from entering the fuel system. Drain the following items of condensation while the component temperature is still above freezing.

WARNING

The use of Fuel System Icing Inhibitor in the jet fuel is mandatory. Fuels obtained from military facilities contain ice inhibitor. Aviation units and flight crews shall ensure its presence in any commercial fuel procured. Icing inhibitor shall be used in a ratio of 0.08%-0.20% by volume (approximately 1 pint per 100 gallons of jet fuel). Additive should meet requirements of MIL-I-27686E (commercial name PRIST).

Item	Special Instructions
Fuel Filter	Lower platform on the left hand side of the transmission fairing. Momentarily depress valve to eliminate any water.
Fuel Tank Sumps	Momentarily depress valves at bottom of the fuselage to eliminate any water
Engine Oil Tank Sump	Momentarily depress the drain valve plunger at the bottom of the oil tank.

Remove ice from vents, drains and breathers. Clean landing gear oleo struts of dirt, snow, and ice with a clean cloth soaked in hydraulic fluid. Remove the battery and store in a heated room if the temperature will go below −25°C (−13°F) or if the temperature will remain below freezing for 4 hours or more. Check and refill the windshield washer reservoir as necessary. A solution of 60% ethylene glycol and 40% water prepared according to Specification O-A-548 is effective for temperatures as low as −53.9°C (−65°F). Close doors, windows, and work platforms. Install protective engine covers.

CAUTION

To prevent melted snow from accumulating in the bottom of the compressor case and freezing, thereby causing subsequent locking of the compressor blades, take the following precautions: When parking or mooring in snow conditions with temperatures below freezing, install the engine inlet duct plug immediately after the compressor blades have stopped turning. Leave the exhaust duct plug out until the engine has cooled sufficiently, then install.

Cover the rotor head to minimize ice and snow buildups in this critical area. Closing the engine compartment shutter doors will help minimize snow buildups on the engine deck. A plastic tarpaulin draped across the engine and out under the engine cowling doors will provide added protection from snow buildups. Snow accumulations in this area will melt after the engine is started, run into the engine and transmission deck drains, refreeze, and stop up the drain lines. Charts, rags, newspapers or some similar material should be placed under the tires if parking outside overnight to prevent the wheels from freezing to the ground. To prevent icing of rotor blades with helicopter parked in freezing rain, light weight blade covers (S14-50-4093-11) are recommended. Anti-icing and de-frosting fluid MIL-D-8243 should be applied to the blades before installing covers to prevent freezing of covers to blades; however, if covers are not available anti-icing and de-frosting fluid MIL-D-8243 can be used to prevent icing. Reapplication of the fluid will be required as rain washes fluid away.

CAUTION

Anti-icing materials are inflammable and toxic. They should not be applied around heater or engine exhausts. Avoid contact with skin or eyes.

HOT WEATHER PROCEDURES

Hot weather operation, as distinguished from desert operation, generally means operation in a hot, humid atmosphere. High humidity usually results in the condensation of moisture throughout the helicopter. Possible results include malfunctioning of electrical equipment, fogging of instruments, rusting of metal parts, and the growth of fungi in vital areas of the helicopter. Further results may be pollution of lubricants and fluids, and deterioration of nonmetallic materials. Normal procedures, outlined in Section II, will be followed for all phases of operation with emphasis placed on the data contained herein. More power will be required to hover during hot weather than on a standard day. Hovering ceilings will be lower for the same gross weight and power settings on a hot day. The flight should be thoroughly planned to compensate for existing conditions by using the charts in Appendix I. Check for the presence of corrosion or fungus at joints, hinge points, and similar locations. Any fungus or corrosion found must be removed. If instruments, equipment, and controls are moisture coated, wipe them dry with a clean soft cloth.

NOTE

As fuel density decreases with a rise in ambient temperature, total usable fuel quantities will be reduced, thus resulting in a decrease in normal operating range. When the helicopter is parked, the cabin door should be opened if weather permits. The cockpit windows should remain closed to prevent unexpected rain showers from pooling water on control panels which could possibly create short circuits.

DESERT PROCEDURES

Desert operation generally means operation in a very hot, dry, dusty, often-windy atmosphere. Under such conditions sand and dust will often be found in vital areas of the helicopter. Severe damage to the affected parts may be caused by sand and dust. The helicopter should be towed into takeoff position, which if at all possible should be on a hard, clear surface, free from sand and dust. Plan the flight thoroughly to compensate for existing conditions by using the charts in Appendix I. Check for the presence of sand and dust in control hinges and actuating linkages, and inspect the tires for proper inflation. High temperatures may cause over inflation. The oleo struts should be checked for sand and dust, especially in the area next to the cylinder seal, and any accumulation removed with a clean dry cloth. Inspect for, and remove, any sand or dust deposits on instrument panel and switches, and on and around flight and engine controls.

ENGINE START

If possible, engine starting and ground operation should be accomplished from a hard, clean surface. Accomplish the normal engine start and ground checks as outlined in Section II but limit ground operations to minimize the sand being blown up around the main rotor and engines.

TAXI AND TAKEOFF

When it is absolutely necessary to taxi in sand and dust, get the helicopter airborne as quickly as possible in order to minimize sand and dust intake by the engine. A no-hover takeoff is recommended.

IN-FLIGHT

Avoid flying through sand or dust storms. Excessive dust and grit in the air will cause considerable damage to internal engine parts.

LANDING

The best procedure to minimize blowing sand and dust is a running landing. If the terrain does not permit a running landing, an approach should be made to a no-hover landing.

CAUTION

If operation in sand cannot be avoided, landings should be made using an approach angle that is greater than the angle used for normal approaches. The approach angle should be compatible with available power. Touchdown roll should be kept to a minimum to preclude the possibility of overloading the landing gear. No-hover takeoffs should be used. All doors and windows should be kept closed during landings and takeoffs to help prevent sand from entering the cockpit and cabin. These procedures will lessen sand clouds and insure greater visibility. Hovering and prolonged operation in sand is not recommended because unpredictable foreign object damage can result.

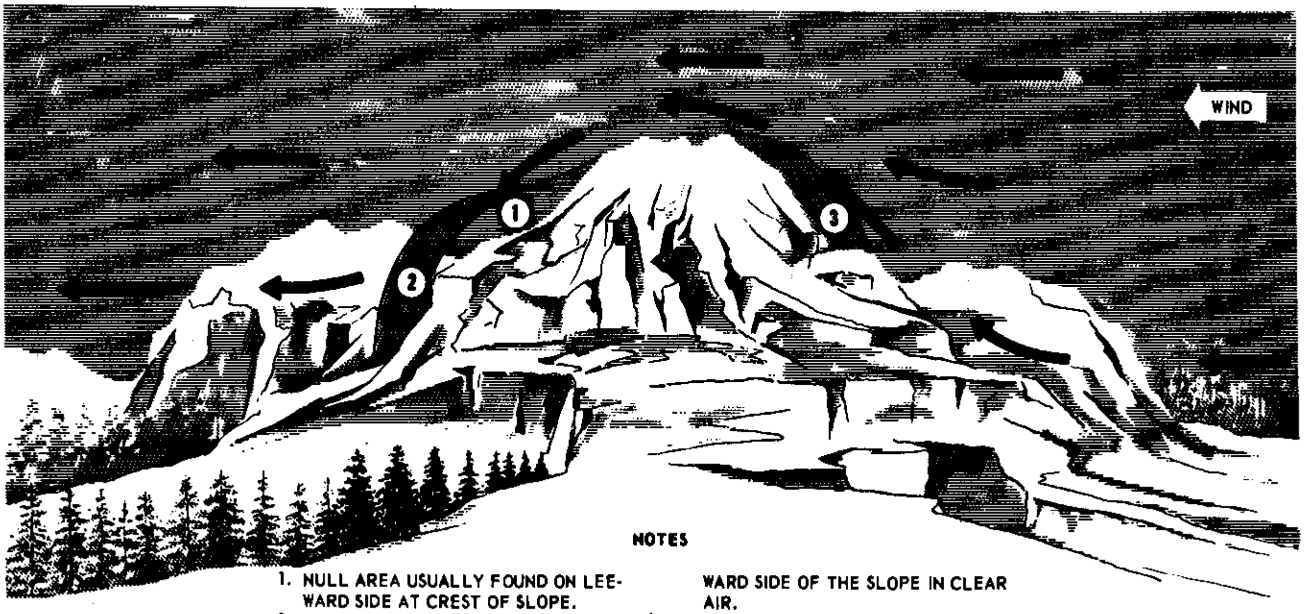

Figure 9-2. Wind Flow Over and Around Peaks

Figure 9-3. Wind Flow Over Gorge or Canyon

SHUTDOWN

The engine should be shut down as soon as practical after landing to minimize the ingestion of sand and dust. Install all protective covers and shields. Leave windows and doors open to ventilate the helicopter except when sand and dust are blowing.

MOUNTAIN AND ROUGH TERRAIN FLYING

See figures 9-2 to 9-6.

Many helicopter missions require flight and landings in rough and mountainous terrain. Refined flying techniques along with complete and precise knowledge of

Figure 9-4. Wind Flow in a Valley or Canyon

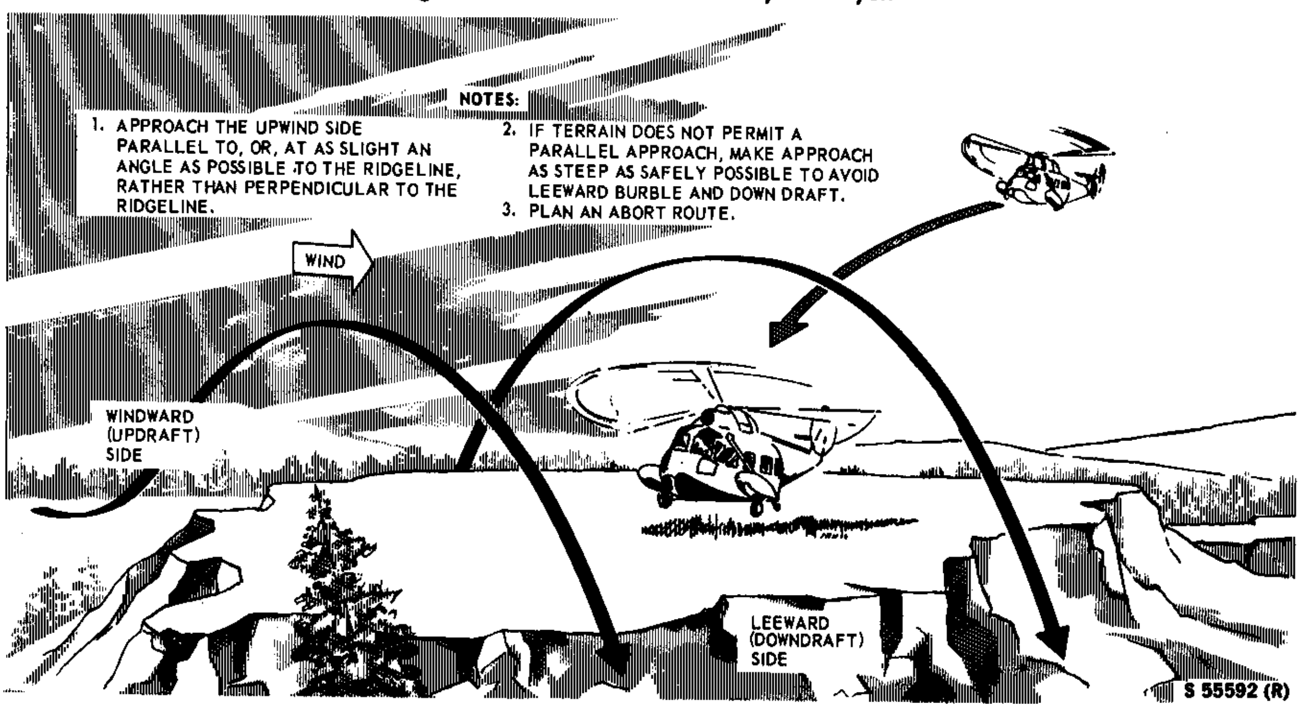

Figure 9-5. Wind Effect on Ridgeline Approach

the individual problems to be encountered is required. Landing site condition, wind direction and velocity, gross weight limitations, and effects of obstacles are but a few of the considerations for each landing or takeoff. In a great many cases, meteorology facilities and information are not available at the site of intended operation. The effects of mountains and vegetation can greatly vary wind conditions and temperatures. Each landing site must be evaluated at the time of intended operation. Altitude and temperature are major factors in determining helicopter performance. Gross weight limitations under specific conditions can be computed from the performance data in Appendix I. A major factor improving helicopter lifting performance is

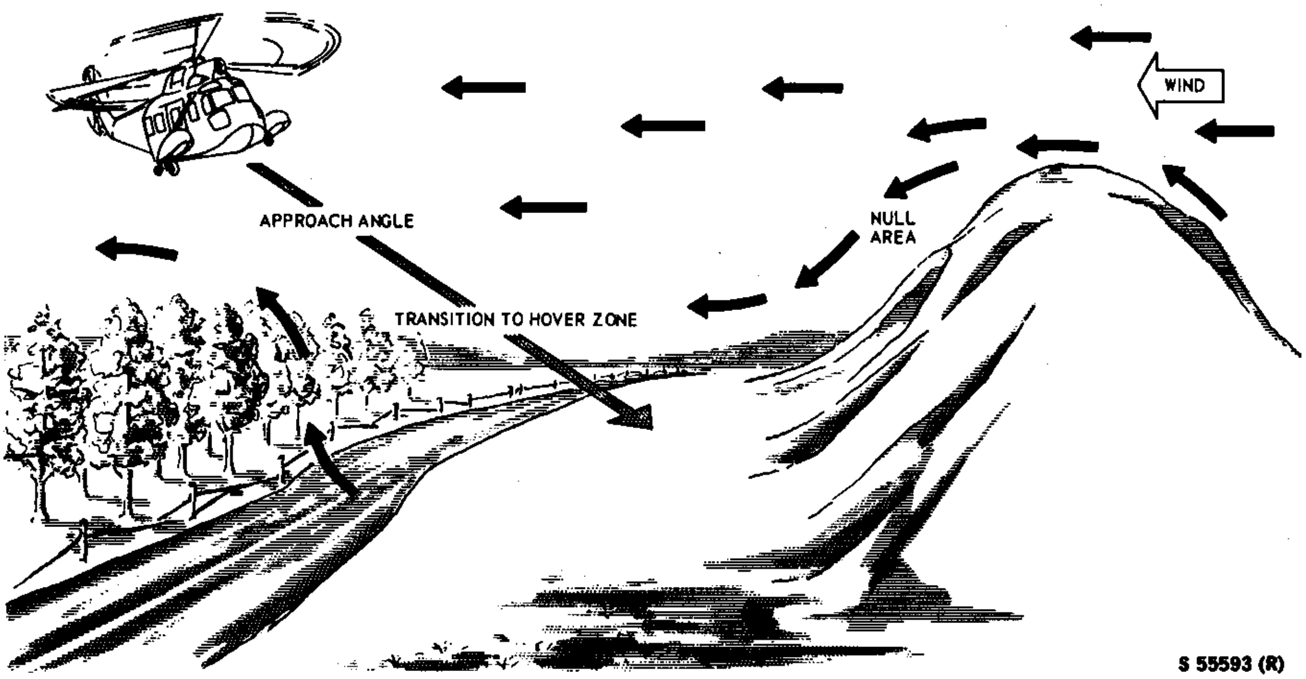

Figure 9-6. Wind Effect in a Confined Area

wind. Weight carrying capability increases rapidly with increases in wind velocity relative to rotor system. However, accurate wind information is more difficult to obtain and more variable than other planning data. It is therefore not advisable to include wind in advanced planning data except to note that any wind encountered in the operating area may serve to improve helicopter performance. In a few cases, operational necessity will require landing on a prepared surface at an altitude above the hovering capability of the helicopter. In these cases a no hover landing or a running landing and takeoff will be necessary to accomplish the mission. Data for these conditions can be computed from the charts in Appendix I.

EFFECTS OF HIGH ALTITUDE

Helicopter performance at altitude decreases and operations can easily be in a situation of limited hovering ability. High gross weight at altitude increases the susceptibility of the helicopter to blade stall. Conditions that contribute to blade stall are high forward speed, high gross weight, high altitude, low rpm, induced G-loading and turbulence. Shallower turns at slower airspeeds are required to avoid blade stall. A permissible maneuver at sea level must be tempered at a higher altitude. Smooth and timely control application and anticipation of power requirements will do more than anything else to improve altitude performance.

TURBULENT AIR FLIGHT TECHNIQUES

Helicopter pilots must be constantly alert to evaluate and avoid areas of severe turbulence; however, if encountered, immediate steps must be taken to avoid continued flight through it to preclude the structural limits of the helicopter being exceeded. The most frequently encountered type of turbulence is orographic turbulence. It can be dangerous if severe and is normally associated with updrafts and downdrafts. It is created by moving air being lifted by natural, or man-made obstructions. It is most prevalent in mountainous regions and is always present in mountains if there is a surface wind. Orographic turbulence is directly proportional to the wind velocity. It is found on the upwind side of slopes and ridges near the tops and extending down the downwind slope. It will always be found on the tops of ridges associated with updrafts on the upwind side and downdrafts on the downwind side. Its extent on the downwind slope depends on the strength of the wind and the steepness of the slope. If the wind is fairly strong (15 to 20 knots) and the slope is steep, the wind will have a tendency to blow off the slope and not follow it down; however, there will be some tendency to follow the slope.

In this situation there will probably be severe turbulence several hundred yards downwind of the ridge at a level just below the top. Under certain atmospheric conditions a cloud may be observed at this point. On more gentle slopes the turbulence will follow down the slope, but will be more severe near the top. Orographic turbulence will be affected by other factors. The intensity will not be as great when climbing a smooth surface as when climbing a rough surface. It will not follow sharp contours as readily as gentle contours.

Man-made obstructions and vegetation will also cause turbulence. The best method to overfly ridge lines from any direction is to acquire sufficient altitude prior to crossing to avoid leeside downdrafts. If landing on ridge lines, the approach should be made along the ridge in the updraft, or select an approach angle into the wind that is above the leeside turbulence. When the wind blows across a narrow canyon or gorge it will often veer down into the canyon. Turbulence will be found near the middle and downwind side of the canyon or gorge. When a helicopter is being operated at or near its service ceiling and a downdraft of more than 1.6 feet per second is encountered, the helicopter will descend. Although the downdraft does not continue to the ground, a rate-of-descent may be established of such magnitude that the helicopter will continue descending and crash even though the helicopter is no longer affected by the downdraft. Therefore, the procedure for transiting a mountain pass shall be to fly close aboard that side of the pass or canyon which affords an upslope wind. This procedure not only provides additional lift but also provides a readily available means of exit in case of emergency. Maximum turning space is available and a turn into the wind is also a turn to lower terrain. The often used procedure of flying through the middle of a pass to avoid mountains invites disaster. This is frequently the area of greatest turbulence and in case of emergency, the pilot has little or no opportunity to turn back due to insufficient turning space. Rising air currents created by surface heating causes convective turbulence. This is more prevalent over bare areas. Convective turbulence is normally found at a relatively low height above the terrain, generally below 2000 feet. It may however, under certain conditions and in certain areas, reach as high as 8000 feet above the terrain. Attempting to fly over convective turbulence should be carefully considered, depending on the mission assigned. The best method is to fly at the lowest altitude consistent with safety. Attempt to keep your flight path over areas covered with vegetation. Turbulence can be anticipated when transitioning from bare areas to areas covered by vegetation or snow. Convective turbulence seldom gets severe enough to cause structural damage.

ADVERSE WEATHER CONDITIONS

When flying in and around mountainous terrain under adverse weather conditions, it should be remembered that the possibility of inadvertent entry into clouds is ever present. Air currents are unpredictable and may cause cloud formations to shift rapidly. Since depth perception is poor with relation to distance from cloud formation and to cloud movement, low hanging clouds and scud should be given a wide berth at all times. In addition to being well briefed the pilot should carefully study the route to be flown.

SUMMARY

The following guidelines are considered to be most important for mountain and rough terrain flying:

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

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

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

4. When evaluating a landing site, execute as many fly-bys as necessary with at least one high and low pass before conducting operations into a strange landing area.

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

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

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

8. Watch for rpm surges during turbulent conditions. Strong updrafts will cause rpm to increase, whereas downdrafts will cause rpm to decrease.

9. Avoid flight in or near thunderstorms.

10. Give all cloud formations a wide berth.

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

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

13. Avoid downdrafts prevalent on leeward slopes.

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

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

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

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

18. The surface of the water may give valuable information as to wind currents and downdrafts in areas of orographic turbulence.