SECTION IX

ALL WEATHER OPERATION

This section provides information relative to operation under conditions of instrument flight and approach including snow, ice, rain, turbulent air, extreme heat or cold, desert operations, and whatever adverse condition the helicopter may operate in.

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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.

INSTRUMENT FLIGHT PROCEDURES.

Flight in this helicopter during instrument conditions is possible and is comparable to fixed wing instrument flight. The ASE provides stable flight characteristics which are desirable for instrument flight. An instrument qualified helicopter pilot can safely perform instrument flight and approaches.

CAUTION

To preclude the possibility of ice ingestion failure, the helicopter will not be flown in known icing conditions or in visible moisture when temperatures are at or below 5°C.

PREPARATION FOR INSTRUMENT FLIGHT.

Complete the normal inspection outlined in Section II of this manual. Particular attention should be given to anti-icing system, pitot heat, windshield wipers, lighting, instrument systems, and navigational aids for proper operation.

WARNING

In cold weather make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

INSTRUMENT TAKEOFF.

If visibility will allow a normal hover, the safety checks of flight controls, engines, and ASE should be accomplished. When a normal hover is not possible, the helicopter may be flown and into a normal climb without any outside reference. In the case of full instrument takeoff (when outside visual reference cannot be maintained at hover altitudes) the doppler indicator must be used for stability of vertical position. The collective should be increased steadily as the helicopter leaves the ground. The engine fuel control will maintain N_r at approximately 100% as collective pitch is increased. A level attitude must be maintained with reference to the attitude indicator. As altitude increases through 15 feet as indicated on the radar altimeter, the nose should be lowered to an attitude approximately 5 degrees nose-low. Simultaneously the collective should then be increased to an approximate torque value of 80 percent and the nose lowered to an attitude approximately 10 degrees nosedown. Until a normal climb airspeed of 70 knots is attained, climbout should be maintained by a combination of attitude and power. Airspeed indications are usually unreliable at speeds below 60 knots, and reliance on indications below 60 knots may result in premature leveloff airspeeds.

INSTRUMENT CLIMB.

Climb under instrument conditions is similar to the climb technique and procedure prescribed for normal climb. An airspeed of 70 knots results in best climb performance at all weights and altitudes. ASE will maintain the heading and attitude established by the pilot. Climbing turns should be limited to a maximum bank of 20 degrees.

INSTRUMENT CRUISING FLIGHT.

After leveling off and stabilizing airspeed and power, engage the BAR ALT channel of the ASE. Under smooth air conditions collective friction is not necessary. If operating in light turbulence with the BAR ALT channel of the ASE engaged, a slight amount of collective friction is required to reduce random movement of the collective caused by the turbulence.

Speed Range.

Performance data must be checked prior to flight for accurate airspeed limitations based on proposed cruising altitudes at various temperatures and gross weights. It is considered acceptable to reduce the maximum airspeed by 6 knots for each thousand feet of altitude. Airspeed limitations at altitude must be considered when accepting changes in cruising altitudes on instrument flight plans.

Level Turns.

Level turns during low-level instrument flying should normally be made by overcoming the stick trim pressure for the following reasons:

1. The pitch attitude, as referenced by a fixed fore-and-aft cyclic position, will be retained.
2. Level roll attitude will be preserved in the trimmed position of the cyclic.
3. An excessive rate-of-roll is retarded.
4. A quick recovery is provided.

Attitude Changes.

Attitude changes during the low-level night mission should be made with the beeper trim. Changes in airspeed are comparatively more permanent than changes in banks for turns. Therefore overcoming trim pressure is not recommended.

NOTE

In changes in either bank or pitch during the night instrument mission, the use of the trim release button should be avoided. If a pilot is distracted while the button is depressed, inadvertent and undesired cyclic movements may take place, resulting in changes in helicopter attitude. These changes may go undetected beyond a reasonable time if the pilot's attention is turned outside of the cockpit.

Barometric Altitude Control.

After leveling off and stabilizing airspeed and power, the BAR ALT channel may be engaged. Under smooth air conditions collective friction is not necessary. If operating in turbulence with the BAR ALT channel engaged, a slight amount of collective friction is required to reduce random movement of the collective caused by the turbulence.

INSTRUMENT FLIGHT WITH ASE INOPERATIVE.

Should the ASE malfunction during instrument flight, the pilot must decide whether the degree of failure necessitates complete disengagement or whether partial disengagement of the ASE makes it desirable to continue using ASE with the pilot flying the failed channel. Instrument flight at reduced airspeed (60 to 80 knots) and mildly banked turns (10 to 15 degrees) can be accomplished without ASE by good technique. If the ASE completely fails, the flight should be terminated as soon as practical.

Holding.

A maximum endurance airspeed of approximately 70 knots can be easily maintained during normal holding and presents no fuel problem. However, a navigational problem will be present while attempting to maintain a pattern in high winds. Drift correction angles of 30 degrees are common to the helicopter.

Descent.

Normal descents are made by reducing power until the desired rate-of-descent is accomplished. Enroute descents are normally made at cruising airspeed. Emergency or maximum rate-of-descent can be made by entering autorotation and maintaining 70 knots IAS.

INSTRUMENT APPROACHES.

Instrument approaches are performed using standard instrument approach procedures prescribed for fixed-wing aircraft. By utilizing cruising speed during the entire approach, the pilot can reduce the effect of wind on the course and groundspeed of the helicopter and be able to fly a more precise approach.

Radio Range Approach.

During the final approach it is important that the airspeed be held constant to control drift and groundspeed. Small changes in heading may be made by rotating the YAW TRIM knob of the ASE.

Radar Approaches.

A "short" pattern with a crosswind altitude of about 800 feet and a final approach of approximately 3 miles will reduce the total time required to complete a PAR/ASR. During the final approach small changes in heading may be made by rotating the YAW TRIM knob of the ASE.

ICE AND RAIN.

ICE.

WARNING

Some significant locations to observe for ice or snow accumulation are the windshield wipers, pitot tubes, and the wing stubs. If snow or ice accumulates during flight, a precautionary landing should be made to remove the accumulation. In the event a landing is not possible, change altitude to leave icing environment. Continued flight may cause ice ingestion in the engine from areas forward of the inlet. Icing of the engine air inlet area is an everpresent possibility when operating in weather with temperature of 10°C (50°F) and below with visible moisture with the exception of dry snow. Snow below a temperature of -4°C (25°F) can be assumed to be dry if there is no accumulation on the aircraft. Takeoff into fog or low clouds when the temperature is at or near freezing could result in engine air inlet icing. Climbs should be made at higher than normal rate-of-climb under such conditions. Engine air 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 and windshield anti-icing systems. With dry snow present, use of the anti-icing system may result in melting of the snow on the intake ducts and subsequent refreezing and ice accumulation at the engine front frame. Under such conditions, use of the inlet anti-icing system is not recommended. A loss of gas generator speed (no mechanical difficulties present) and a rise in power turbine inlet temperature may indicate engine icing. If power turbine inlet temperature increases, retard engine speed selector to maintain normal power turbine inlet temperatures. Engine failure may occur rapidly because of overheating of turbine and exhaust area.

Exterior Inspection.

Check the lower section of the engine air inlet for evidence of ice. Moisture collected on the previous flight can accumulate in the lower section and freeze. An attempted engine start could cause damage. If ice is suspected, check the engine to insure it is free to rotate. If the engine is not free to rotate, external heat must be applied to the forward engine section to permit thawing. Start the engine as soon as possible after thawing to remove all moisture before refreezing can occur. Check that the helicopter surfaces, controls, pitot tubes, static ports, ducts, blades, and oleo shock struts are free from ice.

WARNING

Remove all ice accumulations prior to flight.

Taxiing.

When it is necessary to taxi on ice-covered surfaces, use slow groundspeeds so that cyclic stick displacement may be used as the primary braking force.

Takeoff.

The pilot must ascertain that the helicopter wheels are not frozen to the surface. A slight yawing motion, induced by light tail rotor pedal motion, should break the wheels free when they are frozen to the surface. Takeoffs into fog or low clouds when the temperature is at or near freezing could result in engine inlet icing. Rate-of-climb speeds should be higher than normal under such conditions.

During Flight.

During icing conditions the main rotor assembly and rotor blades will collect ice. After a sufficient amount has collected, vibration may be noted in the controls and the airframe. Engine inlet icing may also be encountered, but not necessarily concurrent with rotor blade icing.

WARNING

When engine inlet icing is detected, change altitude immediately to leave the icing layer. Reduce power a necessary to maintain normal power turbine inlet temperatures.

When icing is present during low altitude flights or approach, additional power will be necessary to maintain safe flight. Also, do not lower the landing gear until in the landing pattern to avoid excessive ice accumulation on the landing gear and exposed components. Use the heater, as required.

Landing.

Accomplish a normal landing; if icing is present, increased power may be necessary to insure a safe landing. If power requirements become critical and

WARNING

FOR SINGLE ENGINE APPROACH MAINTAIN NORMAL CRUISE SPEED IF POSSIBLE. DO NOT LET AIRSPEED FALL BELOW 70 KTS. OPERATION AT LOWER SPEEDS CAN RESULT IN LOSS OF ALTITUDE AT HIGHER GROSS WEIGHTS AND MISSED APPROACHES MAY NOT BE POSSIBLE.

NOTE

- MAINTAIN NORMAL CRUISE AIRSPEED (110 KTS RECOMMENDED) AND 100% N_r THROUGHOUT APPROACH. USE STANDARD RATE TURNS
- WITH AUX SERVO OFF USE MAXIMUM OF 100 KTS AND 1/2 STANDARD RATE TURNS.
- THIS IS A TYPICAL DIAGRAM NOT MEANT TO SHOW INTENDED FLIGHT PATH, BUT DOES INDICATE A CHRONOLOGICAL ORDER FOR ITEMS TO BE PERFORMED. THESE ITEMS MAY BE PERFORMED BEFORE, BUT IN NO CASE LATER THAN WHERE INDICATED.

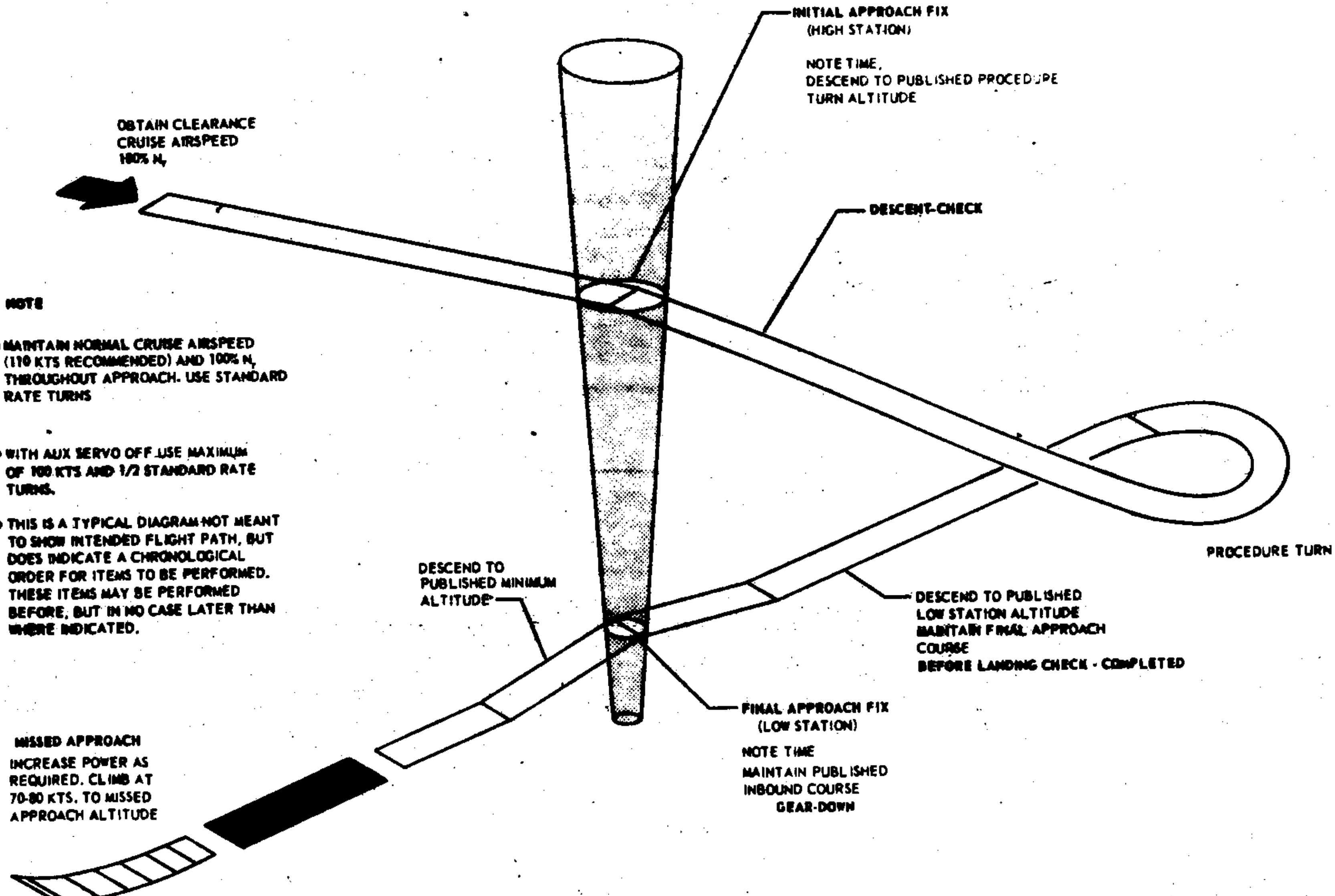
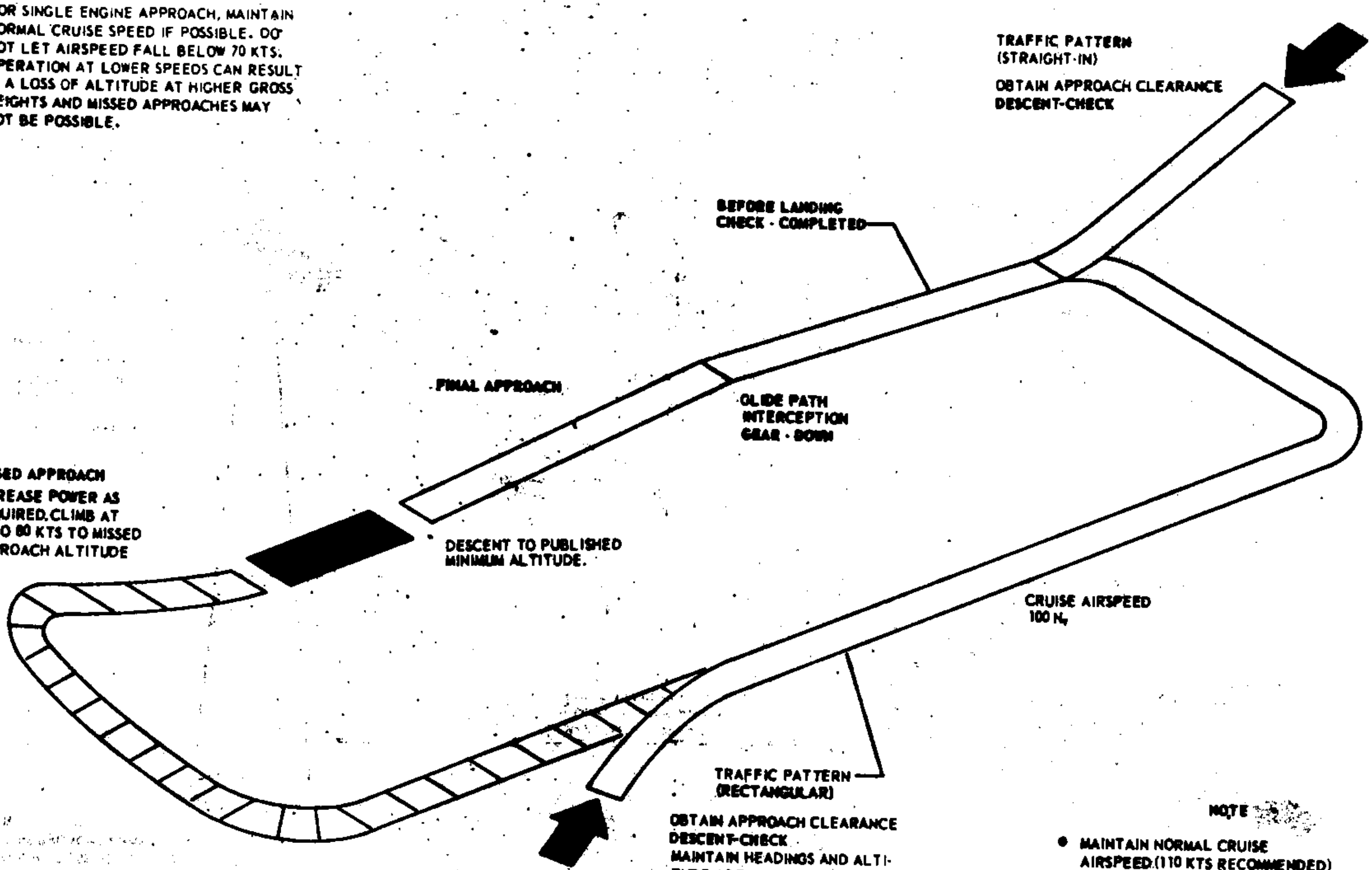


Figure 9-1. UHF/LF-ADF Approach (Typical) (Normal and Single Engine)

WARNING

FOR SINGLE ENGINE APPROACH, MAINTAIN NORMAL CRUISE SPEED IF POSSIBLE. DO NOT LET AIRSPEED FALL BELOW 70 KTS. OPERATION AT LOWER SPEEDS CAN RESULT IN A LOSS OF ALTITUDE AT HIGHER GROSS WEIGHTS AND MISSED APPROACHES MAY NOT BE POSSIBLE.



NOTE

- MAINTAIN NORMAL CRUISE AIRSPEED (110 KTS RECOMMENDED) AND 100% N_f THROUGHOUT APPROACH. USE STANDARD RATE TURNS.
- WITH AUX SERVO OFF USE MAXIMUM OF 100 KTS AND 1/2 STANDARD RATE TURNS.
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Figure 9-2. Radar Approach (Typical) (Normal and Single Engine)

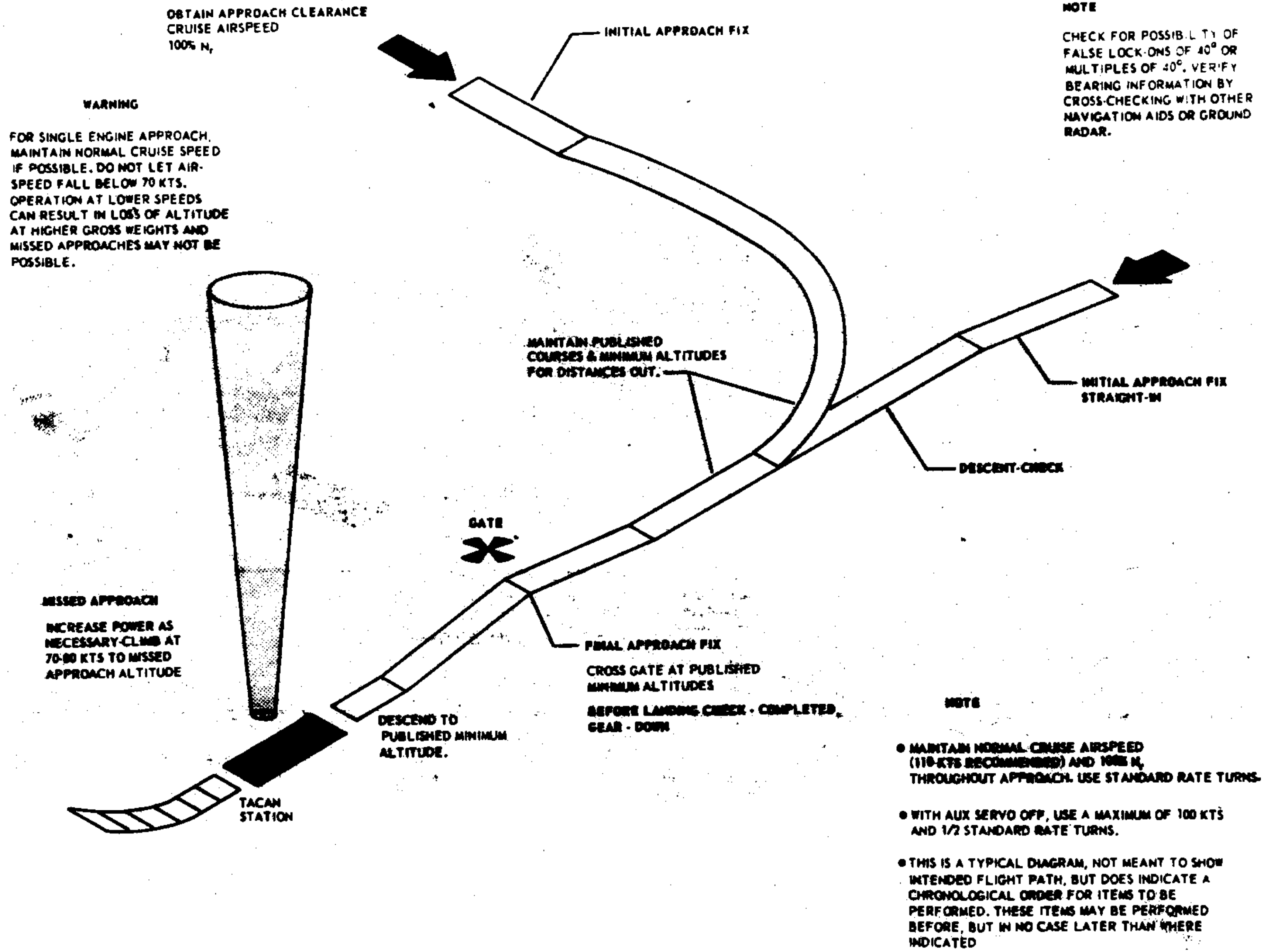

Figure 9-3. TACAN Approach (Typical) (Normal and Single Engine)

terrain permits, a running landing should be accomplished.

RAIN.

Rain has no adverse aerodynamic effects on the helicopter.

Heavy water ingestion into the engines will cause the steady state fuel requirements to increase appreciably. Gas generator speed will decrease, accompanied by a reduction in power output, when abnormally heavy water ingestion causes the engine steady state fuel requirements to exceed the fuel control's ability to maintain gas generator speed. Gas generator speed may or may not stabilize at some lower level, depending upon the amount of water being ingested. The emergency fuel control lever can be used to stabilize gas generator speed and restore power within the limits of the maximum fuel flow of the fuel control.

NOTE

Rain on the windshield will reduce visibility regardless of whether the windshield wipers are operating or not.

TURBULENCE AND THUNDERSTORMS.

TURBULENT AIR OPERATION.

The helicopter handles very well in light to moderate turbulence. As turbulence levels increase from trace to light buffeting, cruise airspeeds should be reduced for comfort, ease of control, and reduced blade stall effects. Flying under conditions of moderate or heavy turbulence should be avoided. Descents should be made at a low rate-of-descent and comfortable cruise speeds.

NOTE

The ASE barometric altitude channel should be disengaged to prevent possible damage to the barometric altitude controller if strong updrafts or downdrafts cause the helicopter to be displaced more than 200 feet from the engaged altitude.

THUNDERSTORMS.

Avoid flights through or near thunderstorms. If thunderstorms are encountered during flight, land as soon as practical and wait for the storm to pass. Violent turbulence and restricted visibility may be encountered in thunderstorms. When lightning is encountered at night, the dome light, spotlight, and instrument lights should be turned to full intensity to preclude temporary blindness. If a particular mission requires flight in a thunderstorm environment, the storms should be skirted at low altitudes in the trace to light turbulence areas while maintaining visual conditions, if possible.

LIGHTNING STRIKES.

WARNING

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

Although the possibility of lightning strike is remote, with increasing use of all-weather capabilities the helicopter could inadvertently be exposed to lightning damage. Therefore, static tests were conducted to determine lightning strike effects on rotors. Simulated lightning tests indicated that lightning strikes may damage helicopter rotors. The degree of damage will depend on the magnitude of the charge and the point of contact. Catastrophic structural failure is not anticipated. However, damage to hub bearings, blade pockets, and blade tips was demonstrated. Also adhesive bond separations occurred between the blade spar and pockets and between the spar and leading edge abrasion strip. Some blade pockets deformed to the extent that partial or complete separation of the damaged sections could be expected. Such damage can aerodynamically produce severe structural vibration and serious control problems which, if prolonged, could endanger the helicopter and crew. If lightning damage occurs, as indicated by control problems or vibration changes, especially abnormal noise, the pilot's assessment of the extent of damage, the mission requirements, and the demands of the current flight situation will determine the required action.

NOTE

Abnormal operating noises almost always accompany rotor damage, but loudness or pitch is not valid indication of damage sustained.

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

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

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

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

   d. Record suspected lightning strike in maintenance forms.

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

3. If lightning damage is moderately serious, an immediate emergency landing is recommended.

4. In the event severe lightning damage makes the helicopter difficult or impossible to control, make an emergency landing or bailout.

NIGHT FLYING.

Night flying does not present any additional instrument flight problems, but does add the physical problems of illumination of cockpit instruments and interior and exterior reflections. Exterior lights may reflect on surrounding clouds to hamper night adaptation and make instrument reading difficult.

TAKEOFF PROCEDURE.

There is basically little difference in the technique used on night takeoffs from that used in day operations. Care should be excercised to make a clean decisive break from the ground to a safe hovering altitude. The hover, flood, and/or spotlights should be used to illuminate the ground. The effectiveness of the landing light improves as the helicopter is brought to a hover. The use of hover, flood, and/or spotlights are discretionary with the pilot since he can best judge conditions. The spotlight should be positioned for immediate use in the event of an emergency. The spotlight provides good illumination and gives fewer reflections from a runway for takeoffs and landings.

LANDING PROCEDURE.

In poorly lighted or unlighted areas the spotlight can be used to clear the landing area prior to landing. Care should be exercised to correct for sidedrift prior to contacting the ground.

WARNING

Rotation of the spotlight while the helicopter is in a hover may cause the pilot to become spatially disorientated because the light does not rotate in a level plane.

WARNING

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

COLD WEATHER PROCEDURES.

The major problems in cold weather operations are the preparation for flight, restricted visibility from blowing snow, and the adverse effects on helicopter materials. Moisture, usually from condensation or melted ice, may freeze in critical areas. Tire, landing gear strut, fire extinguisher bottle, and accumulator air pressures will decrease as the temperatures decrease. Extreme diligence on the part of both ground and flight crews is required to insure successful cold weather operation. Icing conditions are not considered in this discussion since they are covered under ICE AND RAIN in this section. While still a factor for successful cold weather operation, cold weather postflight preparation is not generally as critical in turbine-powered helicopter operation as in reciprocating engine helicopter operation, since there is no need for oil dilution. The problems encountered when operating from snow-covered surfaces are compounded when operating from other than an operational air base. The restricted visibility, caused by blowing snow, can be partially overcome by utilizing smoke grenades or some other object distinguishable in color (such as pine boughs, painted jerry can, or emergency kit) placed or planted in the landing area for reference. The smoke grenade will reveal the wind direction and allow an estimate of its speed. The danger of breaking through snow crust is minimized by maintaining maximum rpm when resting on an unknown snow surface. Pilots should be cognizant of the fact that 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 instrument altitude.

NOTE

Hoist and sling operations are possible under loose or powdery snow conditions provided normal precautions for maintaining ground references under low visibility are followed.

WARNING

Static electricity, generated by the helicopter, should be dissipated prior to attempting a sling or hoist pickup, particularly in colder dry climatic conditions when static electricity buildups are large. To dissipate this static charge, allow the sling or hoist to touch the ground, or use a conductor to make contact between the helicopter and the ground.

NOTE

Human efficiency is reduced sharply as temperature drops below -18°C (0°F). In arctic and subarctic operations, rotor wash is known to have a super-cooling effect which may reduce the efficiency of exposed personnel as much as may be expected by a 11°C (20°F) drop in temperature. Consequently, exposure of survivors being evacuated or ground personnel to rotor wash should be held to a minimum.

PREPARATION FOR FLIGHT.

In addition to accomplishing a normal exterior inspection, the rotor head, main rotor blades, tail rotor, and flight controls should be thoroughly inspected and free of all ice and snow. Failure to remove snow and ice accumulations while on the ground can result in serious aerodynamic and structural effects when flight is attempted. It is recommended that ice chocks be used on the landing gear wheels due to the minimum traction afforded on snow and ice surfaces.

CAUTION

If the ambient temperature is below -29°C (-20°F), do not rotate the rotor head by hand as damage to the main transmission may result.

CAUTION

Do not attempt to chip or scrape snow and ice from any surfaces or controls. Portable ground heaters or de-icing fluid may be used to remove any accumulation that cannot be swept off. For de-icing fluid specification, refer to MAINTENANCE MANUAL.

Check that fuel tank vents, static ports, and pitot tubes are free of snow and ice; that landing gear struts, tires, and hydraulic accumulators are properly inflated; and that warm well-charged batteries have been installed. Manually check compressor rotors for freedom of rotation. If ice or snow is found, the engine should be thawed out with hot air prior to attempting to start.

WARMUP AND GROUND TESTS.

Immediately after starting No. 1 engine turn on the cabin heater, engine inlet anti-icing, pitot heat, and windshield anti-ice systems. Check the transmission oil pressure and temperature. When engaging the rotor head, be careful not to exceed the transmission oil pressure limitations.

ENGINE STARTING.

At extremely low temperatures it is possible that the engine oil pressure will go to a maximum value or actually peg out on the gage during an engine start. If oil pressure does not return to within operating limits within 30 seconds after reaching ground idle, shut down the engines and investigate. Insure that ground heater ducts have been removed then accomplish normal engine start as outlined in Section II. If there is no indication of oil pressure after 30 seconds of engine operation at ground idle or if oil pressure drops to zero after a few minutes of ground operation, stop engines and investigate.

COLD WEATHER EMERGENCY ENGINE STARTING PROCEDURE.

If the electrical portion of the accessory drive system is malfunctioning or if the No. 1 engine is inoperative, the No. 2 engine may be started and the rotor engaged. Refer to ENGAGING ROTORS WITH NO. 2 ENGINE in Section III. However, if the ambient temperature is -20°F (-29°C) or less, the following procedure is necessary:

1. Perform No. 2 engine emergency starting procedure and rotor engagement and stabilized main transmission oil temperature and pressures.

2. Shut down and perform the following main transmission serviceability check.

   a. Flush main gear box inspect oil screen filter and magnetic plugs for particles. Note the number of particles found.

b. Reservice the main gear box and again perform the starting and engagement procedure. Allow the main gear box to operate for one hour on the ground.

c. Reinspect the oil screen filter and magnetic plug for particles. If the number of particles has increased, replace the gear box. If the number of particles has decreased, keep the gear box in service.

NOTE

Emergency starting and rotor engagement in temperatures above -20°F (-29° C) does not require compliance with step 2 above.

3. Upon satisfactory completion of the main gear box serviceability check, the helicopter may be restarted and readied for flight.

TAXIING INSTRUCTIONS.

The helicopter can be taxied in soft snow. The deeper the snow, the more difficult taxiing and steering may become, and increased collective pitch may be necessary. Helicopters should not be taxied on a snow-covered surface that is suspected or known to contain hidden obstructions or hazards. Normally, the rotor wash at taxiing power will create a restriction to visibility from blowing snow. If this should occur, taxi the helicopter at a low pitch and higher groundspeed, if possible, to get ahead of the blowing snow, or have the helicopter towed to a takeoff position. Ground handling characteristics of the helicopter on loose or packed snow at temperatures below -18°C (0°F) are good, and wheel braking action is fair to good. However, as temperatures rise toward freezing, snow-covered surfaces become more slippery and increased caution must be exercised.

WARNING

In cold weather make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

TAKEOFF.

Select an area devoid of loose or powdery snow to minimize the restriction to visibility from blowing snow, and ascertain that the wheels are not frozen to the snow or ice.

WARNING

Remove all ice and snow accumulation prior to flight.

DURING FLIGHT.

During flight use the cabin heater, engine inlet anti-icing, and windshield anti-ice protective 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 instrument altitude. After takeoff from water, wet now, or slush-covered field, operate the landing gear through several complete cycles to preclude their freezing in the retracted position. (Expect slower operation of the landing gear in cold weather due to stiffening of all lubricants.)

NOTE

If FAT is extremely low, at higher airspeeds the engine anti-ice caution lights may illuminate in flight. This does not necessarily indicate an icing condition, but does indicate that sufficient heat is not being supplied to raise the inlet duct temperature to 4.5°C. At lower temperatures where this might occur, icing conditions are not usually encountered due to a lack of moisture in the air.

LANDING.

If possible, select an area clear of loose or powdery snow so that visibility will not be restricted by blowing snow. Loose powdery snow and crusts (surface and hidden) should be anticipated on all landings on snow. Snow depth is less in clear areas where there is little or no drift effect. The snow coverage in clear areas normally forms gentle swells similar to the swells present in a large body of water. The crests of these swells are usually crusted and are suitable for landings. Generally the heaviest crust will be present on the upwind side of the crest. Deep snow is prevalent in valleys and to the lee (due to the prevailing winds) of wooded areas and ridges. These are suitable for landings. Landings are accomplished in a normal manner except the approach must be accomplished with a minimum hover before touchdown to minimize the rotor wash on loose powdery snow. Limited visibility will result if hovering is attempted before touchdown. If possible, landings should always be made where visual ground reference can be maintained. After contacting the surface, maintain maximum rpm, while slowly reducing collective pitch to a minimum, 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 (in which case another landing site will have to be selected). Providing there are no obstructions, the tail rotor will be clear when the fuselage rests on the surface of a level 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. Competent personnel should physically check the snow depth and hardness and, if possible, evaluate the surface before reducing rpm. Make smooth power changes when the fuselage is resting on the surface.

WARNING

Main rotor and tail rotor blade 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.

STOPPING OF ENGINES.

Make a normal engine shutdown as outlined in Section II. As soon as the helicopter is parked, chock the wheels and release the brakes.

BEFORE LEAVING THE HELICOPTER.

When possible, leave helicopter parked with full fuel tanks. Every effort should be made during servicing to prevent moisture from entering the fuel system. Condensation should be drained from the fuel and oil sumps and drains and all ice removed from vents, drains, and breathers. Close the doors, hatch, and maintenance platform. Clean landing gear oleo struts of dirt, snow, and ice with a clean cloth soaked in hydraulic fluid. If the helicopter is to remain outside for a period more than 4 hours at below freezing temperatures or less than 4 hours at temperatures below -29°C, remove the batteries and store in a heated room. Check that protective covers have been installed. (Engine exhaust and air inlet protective covers should not be installed until after engine cools down.)

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 steel 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.

AFTER LANDING.

During hot weather operations preliminary engine cooling prior to shutdown may be accomplished by one of the following methods:

1. One minute of taxiing.
2. One minute of operation at or above the minimum governing range and with minimum collective pitch.
3. One minute at ground idle.

BEFORE LEAVING HELICOPTER.

If T_5 remains at or above 300°C during coastdown or suddenly rises to that point after lower coastdown cooling, a fire should be suspected. Have an observer check visually, and motor the engine as necessary without fuel or ignition to extinguish the fire if any. Slow buildup of T_5 to temperatures above 200°C after coastdown cooling to 150-100°C is not abnormal. When the helicopter is parked, the doors and windows except the pilot's window should be opened if weather permits. The pilot's window should remain closed to prevent unexpected rain showers from pooling water on the ASE channel monitor panel which could possibly create short circuits in the ASE.

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.

PREPARATION FOR FLIGHT.

Plan the flight thoroughly to compensate for existing conditions by using the charts in Appendix I. Check for the presence of sand and dust in control hinges and actuating linkages, and inspect the tires for proper inflation. High temperatures may cause overinflation. 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 have removed any sand or dust deposits on instrument panel and switches and on and around flight and engine controls.

ENGINE STARTING, WARMUP, AND GROUND TESTS.

If possible, engine starting and ground operation should be accomplished from a hard clean surface. Accomplish the normal engine start, warmup, and ground tests as outlined in Section II, but limit ground operation to a minimum since the downwash from the main rotor may stir up clouds of sand. Every effort should be made to minimize the sand from being blown up around the main rotor and engines.

TAXIING INSTRUCTIONS.

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 engines.

TAKEOFF.

Execute normal takeoff and climb as outlined in Section II. If the rotor should stir up sand and dust, take off, but do not hover, and climb out as rapidly as possible.

DURING FLIGHT AND DESCENT.

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

LANDING.

The best procedures for landing 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 high hover and then a vertical landing accomplished with a minimum of forward speed.

STOPPING ENGINES.

The engine should be shut down as soon as practical after landing to minimize the ingestion of sand and dust. During desert operations preliminary engine cooling prior to shutdown may be accomplished by one of the following methods:

1. One minute of taxiing.
2. One minute of operation at or above minimum governing range and with minimum collective pitch.
3. One minute at ground idle.

BEFORE LEAVING THE HELICOPTER.

Accomplish the normal procedures as outlined in Section II. Install all protective covers and shields and leave windows and doors open to ventilate the helicopter, except when sand and dust are blowing. If T_5 remains at or above 300°C during coastdown or suddenly rises to that point after lower coastdown cooling, a fire should be suspected. Have an observer check visually, and motor the engine as necessary without fuel or ignition to extinguish the fire if any. Slow buildup of T_5 to temperatures above 200°C after coastdown cooling to 150-100°C is not abnormal.

SALT WATER OPERATION.

POWER DETERIORATION.

Operational experience has shown that salt spray ingestion in the T58 engine may result in a loss in performance as well as a loss in compressor stall margin. This reduction in stall margin makes the engine susceptible to stalls during accelerations and more particularly under deceleration conditions. As the spray is ingested and strikes the compressor blades and stator vanes, salt is deposited. The resulting buildup gradually changes the airfoil sections which in turn affect performance. This deterioration will be noticed as a decrease in torque (Q) and an increase in T_5 for a given N_g. Should the deterioration reach the point where the compressor actually stalls, T_5 will increase while N_g and torque will decrease. The circumstances under which power deterioration may occur during salt water operation vary with a number of factors. The flight regime, gross weight, wind direction and velocity, pilot technique, duration of maneuver, salinity of the water, and the relative density of the salt spray all have a bearing on performance deterioration. Intermittent operation in moderate salt spray conditions (such as a series of landings and takeoffs) could expose the engines to enough salt spray to cause noticeable performance deterioration. During prolonged operations (such as low hovering or taxiing) in heavier spray conditions, power deterioration will be apparent and is more critical. Maneuvers such as hovering close to the water in light winds (under about 8 knots), taxiing with high power, or low flights at low speeds will generate maximum rotor downwash spray conditions. Careful operation following the procedures and limitations below in strict adherence to the prescribed maintenance procedures when operating in these conditions should result in the preservation of rated engine power. Power deterioration conditions may be forewarned. The best indication of performance and stall margin loss is found to be the relationship between T_5 and torque. Partial loss of stall margin may be indicated by a T_5 increase of 10° to 15°C for the same torque output. A T_5 increase of 30° to 40°C for the same torque output represents the maximum deterioration that can be accepted without complete loss of stall margin. In severe salt spray environments, the time for a deterioration of this magnitude to occur may be as little as three to four minutes.

WARNING

When the stall margin is entirely lost due to salt encrustation, relatively minor power reduction can cause the near simultaneous loss of power from both engines. In the event that maximum loss of stall margin is suspected, increase collective pitch and commence a climbout, insuring that the engines do not decelerate. Do not reduce power or retard speed selectors. Proceed to a point of intended landing and position the aircraft for an emergency landing. With the aircraft favorably positioned for an emergency landing, check the condition of each engine individually, reducing power by reduction of the appropriate speed selector. Be prepared for engine deceleration stall.

In the event of significant stall margin loss, the pilot should terminate the mission, return to a suitable location and have engines washed. Continued operation of engines in clean air may dissipate some of the salt build-up but this cannot be assured. Flight through rain may also be beneficial in reducing salt built-up but, again, this cannot be assured. In any event, pilots should be aware of any loss of stall margin and make an appropriate entry in aircraft forms so as to assure engine wash prior to subsequent flights.

TAKEOFFS.

Takeoffs from salt water are accomplished by accelerating as rapidly as practicle to climbout speed as the helicopter leaves the water. This procedure will minimize hovering within the spray caused by rotor downwash. Before takeoff from salt water following spray exposure, perform acceleration/deceleration check, covered in Section II.

LANDING.

Make water landings as outlined under EMERGENCY WATER OPERATIONS, Section II, while avoiding the generation and ingestion of salt spray.

TAXIING.

Taxi using a collective setting which minimizes salt spray. Spray on the windshield indicates a high degree of spray ingestion caused by the use of excessive collective pitch.

HOVERING.

Hovering over salt water at altitudes which cause concentrated spray into the engine inlets results in gradual power deterioration and eventual reduction of compressor stall margin. Operation in these conditions should be avoided or minimized.

NOTE

The following altitude time combinations are considered as maximums for conducting normal hovering operations. They should be used in conjunction with a performance deterioration check in Section VII and should not be exceeded when any loss in performance has been experienced.

40 feet	-	2 hours
30 feet	-	1 hour
20 feet	-	30 minutes
15 feet	-	15 minutes
10 feet	-	10 minutes
2-5 feet	-	5 minutes

CAUTION

Prolonged hovering over salt water which results in spray ingestion indicated by spray on the windshield must be avoided. The amount of spray observed on the windshield and the necessity to use windshield wipers to maintain visibility is usually the best indication of spray ingestion into the engine inlets.

The following procedures are grouped according to wind conditions:

No Wind.

Hovering in a no wind condition normally results in a relatively low spray concentration at all hovering altitudes.

Light Winds (Approximately 5 to 15 Knots).

Hovering in these conditions results in the heaviest or most critical spray concentrations. Spray can be minimized by hovering downwind at low altitudes (0 to 10 feet) and by hovering downwind or crosswind at higher altitudes (15 feet and above).

Moderate to Heavy Winds (15 Knots and Above).

Higher winds normally result in the lowest of spray concentrations at all hovering altitudes. In these conditions hovering can be accomplished into the wind.

POSTFLIGHT CHECK.

Following salt water operation the following should be accomplished:

1. Perform power check in accordance with Section II.
2. Appropriate entries should be made in Form 781 following salt water operation reflecting time hovering or on water, altitudes, power losses, etc.

APPENDIX I

PERFORMANCE DATA

This section contains performance data charts necessary for preflight and inflight mission planning with explanatory text on use of the data presented.

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INTRODUCTION.

NOTE

External stores of the Mark 44 type were included in the calculation of forward flight performance. However, the inclusion of these stores at the forward stations has a slight effect on the overall drag. The performance values given at the higher airspeeds are slightly conservative for the CH-3B. CG location effect on drag is negligible.

PURPOSE OF PERFORMANCE CHARTS.

The charts in this appendix are designed to aid the pilot in determining the capability of the helicopter for takeoff, climb, cruise, and endurance for a complete mission under any combination of conditions and circumstances. These charts also aid in enroute planning when a mission objective is changed or when an emergency situation develops. The prediction of helicopter performance is complicated by the fact that variations in operating technique from pilot to pilot can result in large variations in performance. These variations can be reduced by establishing preferred operating procedures and basing the calculation of performance data on the assumption that these procedures will be followed. These procedures must be followed, if efficient operation - the extra range or the additional payload that may mean the success of a mission - is to be realized. Certain charts contain corrections for wind and nonstandard temperatures. Charts for emergency operating (single engine) conditions have black diagonal striped corners for rapid identification.

CHART EXPLANATION.

Descriptive explanations are included at the beginning of the Appendix to illustrate the use of the performance charts. Guide lines are shown on the charts to illustrate the path to follow when using the chart.

DENSITY ALTITUDE CHART.

Many of the performance charts are based on density altitude to compensate for temperature variations at any altimeter reading. The Density Altitude Chart (figure A-1) provides a means of determining density altitude from a known pressure altitude and free air temperature. A standard day temperature line for the altitude range shown is marked on the curves as a convenient guide for this frequently referenced condition. Along the right side of the chart, the reciprocal square root of the density ratio is given to provide a means of computing true airspeed at any altitude from the calibrated airspeed. At the bottom of the chart there are two scales to facilitate the conversion of either Fahrenheit temperatures to Centigrade or of Centigrade temperatures to Fahrenheit. The Density Altitude Chart shows the density altitude for standard and nonstandard atmospheric conditions. Density altitude is an expression of the density of the air in terms of height above sea level; hence, the less dense the air, the higher the density altitude. For standard conditions of temperature and pressure, density altitude is the same as pressure altitude. As temperature increases above standard for any altitude, the density altitude will also increase to values higher than pressure altitude. Helicopter pilots are vitally concerned with density altitude and its relation to the performance of the helicopter. A high density altitude affects the performance of helicopters. When density altitude is high, less lift is developed by the rotor blades for any given power settings than standard conditions. As density altitude increases, useful load must be decreased. Each takeoff and landing must be separately evaluated as density altitude may change considerably in a short period of time. Figure A-1 expresses density altitude in terms of pressure altitude and temperature. An example of the use of the density altitude chart is contained on the chart.

EXAMPLE PROBLEM FOR USE OF DENSITY ALTITUDE CHART.

Determine the density altitude when the ambient temperature is 20°C (68°F) and the pressure altitude is 2000 feet.

1. Enter the chart at 20°C.
2. From the temperature line, move vertically to intersect the 2000 foot pressure altitude line.
3. From the 2000 foot pressure altitude line, move horizontally to the left to the density altitude line. Density altitude is 3000 feet.

AIRSPEED CALIBRATION CHART.

An airspeed calibration chart (figure A-2) is provided to supply the correction required to determine calibrated airspeed (CAS). Indicated airspeed (IAS), as read from the instrument and corrected for instrument error plus or minus installation correction, equals calibrated airspeed (CAS). Because of the speed range through which the helicopter operates, compressibility corrections to airspeed are negligible and were intentionally omitted.

TRUE AIRSPEED CORRECTION.

True airspeed (TAS) is obtained by multiplying CAS by the conversion factor $\sqrt{\frac{1}{\sigma}}$ shown in figure A-1 for the density altitude at which the CAS reading is taken.

EXAMPLE: The helicopter is cruising in level flight at 2000 feet pressure altitude at an IAS of 80 knots. The OAT is 40°C. Find CAS and TAS.

SOLUTION: Enter figure A-2 at the bottom of the 80 Kt line and move vertically until the line marked level flight is intersected. From this point move horizontally to the left to a CAS of 83 kts. Enter the density altitude chart (figure A-1) at the bottom at 40°C and move vertically until the line marked 2000 feet pressure altitude is reached. Project horizontally to the right and read $\sqrt{\frac{1}{\sigma}}$ equals 1.08. Multiply CAS x $\sqrt{\frac{1}{\sigma}}$ to obtain TAS, or 83 kts x 1.08 equals 89.6 kts TAS. This is the true airspeed.

POWER AVAILABLE CHARTS.

The power available charts (figures A-3 through A-5) are based on a specification engine. Each chart is based on a selected power. Figure A-3 is based on maximum power and figure A-4 on military power while figure A-5 is based on maximum continuous power. Various atmospheric factors, such as temperature and pressure altitude, have an effect on the capability of the engine to produce power. The power available charts define power and torque output as a function of pressure altitude and temperature.

CAUTION

The power output capability of the engine can exceed the structural limit of the transmission under certain conditions. Therefore, the power limitations in Section V should be observed to prevent exceeding the power limitations imposed by the transmission. These limitations are also shown on the charts.

EXAMPLE PROBLEM FOR USE OF POWER AVAILABLE CHARTS.

The power available charts are illustrated in the same manner; therefore, figure A-3, Power Available - Maximum Power - 5 Minute Limit-Estimated Torque Available, is used to illustrate the example problem.

Given:

OAT	15°C
Pressure Altitude	3000 feet
N_f/N_r	19,535 rpm N_f/103% N_r

Determine:

Torque available at maximum power.

Solution: (Refer to figure A-3.)

1. Enter chart at 15°C OAT.
2. Move vertically up 15°C OAT line to 3000 feet pressure altitude.
3. From this intersection, move horizontally to the 19,535 rpm N_f/103% N_r line.
4. From this point, move vertically downward to the indicated torque scale and read 93% torque.

HORSEPOWER VS TORQUE CHART.

The Horsepower Vs Torque Chart (figure A-6) defines the engine horsepower realized at an indicated torque and power turbine speed (N_f). To use the chart: enter the chart at the given indicated torque and move vertically to the selected power turbine speed (N_f) line. From this point move horizontally left to obtain the engine horsepower. It should be noted that at a constant torque, as power turbine speed (N_f) increases, engine horsepower also increases.

EXAMPLE PROBLEM FOR USE OF TORQUE VS HORSEPOWER CHART.

Given:

Torque	87.5% Q
Power Turbine Speed	100% N_f

Determine:

Horsepower per engine.

Solution: (Refer to figure A-6.)

1. Enter chart at 87.5% Q.
2. Move vertically up to intersection of 100% N_f curve.
3. From this intersection move horizontally to the horsepower scale and read 1060 horsepower.

TORQUE VS FUEL FLOW CHART.

The Torque Vs Fuel Flow Chart (figure A-7) provides the means for computing fuel consumption for a selected altitude and power rating. Data given is for specification engine. To find the fuel flow in pounds per hour for one engine, enter the chart at the indicated torque (or shaft horsepower) on the bottom scale and proceed vertically to the proper altitude line. From this point of intersection move horizontally left to the scale and read the fuel flow in pounds per hour.

EXAMPLE PROBLEM FOR USE OF TORQUE VS FUEL FLOW CHART.

Given:

Torque	87.5% Q
Pressure Altitude	Sea Level

Determine:

Fuel flow per engine.

Solution: (Refer to figure A-6.)

1. Enter chart at 87.5% Q.
2. Move vertically up to the intersection of the sea level altitude curve.
3. From this intersection move horizontally to the fuel flow curve and read a fuel flow of 680 pounds per hour per engine.

TAKEOFF CHARTS.

MAXIMUM GROSS WEIGHT FOR VERTICAL CLIMB-TAKEOFF OUT OF GROUND EFFECT.

The maximum gross weight for Vertical Climb Takeoff Out of Ground Effect (figure A-8) indicates the maximum takeoff gross weight for two engine operation at maximum power. The maximum takeoff gross weight may be determined for various combinations of pressure altitudes, temperatures and headwinds, as limited by rate-of-climb at maximum power (100% N_f) and transmission limits.

Example Problem For Use Of Maximum Gross Weight For Vertical Climb Takeoff Out of Ground Effect.

Given:

Pressure Altitude	5800 feet
Temperature	15°C
Vertical Rate-of-Climb	100 FT/MIN.
Headwind	10 knots

Determine:

Maximum takeoff gross weight out of ground effect.

Solution: (Refer to figure A-8.)

1. Enter the chart at 5800 feet pressure altitude. (Point A).
2. Move horizontally across the 5800 feet pressure altitude line to intersection of 15°C line. (Point B).
3. From this intersection move vertically downward to zero vertical rate-of-climb. (Point C). Then follow the slope of the vertical rate-of-climb influence lines to 100 feet per minute. (Point D).
4. From the 100 FT/MIN. point move vertically downward to zero headwind (Point E) and follow the slope of the headwind influence lines to a 10 knot headwind. (Point F).
5. From the 10 knot headwind move vertically downward to the gross weight scale and read 17750 pounds.

SINGLE ENGINE TAKEOFF AT VARIOUS AIRSPEEDS CHART.

The Single Engine Takeoff Chart (figure A-9) indicates the headwind necessary to take off with one engine operating for various combinations of gross weight and outside air temperature.

ABILITY TO MAINTAIN FLIGHT WITH ONE ENGINE FOR VARIOUS AIRSPEEDS.

The ability to maintain flight with one engine for various airspeeds chart (figure A-10) indicates the airspeed required to maintain flight with one engine operating for various combinations of gross weight and outside air temperature.

HEIGHT VELOCITY DIAGRAMS.

The height velocity diagrams (figures A-11, A-12, and A-13) are plots of minimum height and airspeed combinations required for continued flight and safe landing after single engine failure and safe landing after dual engine failure, respectively. The single engine height velocity capabilities in the low speed range are a function of power remaining in the operating engine, density altitude, and weight. In the high speed range, these height velocity capabilities are less affected by power remaining, density altitude, and weight.

MINIMUM HEIGHT FOR CONTINUED FLIGHT AFTER SINGLE ENGINE FAILURE DIAGRAM.

This diagram (figure A-11) provides a means of determining minimum height and airspeed combinations that will permit continued flight after failure of one engine. The factors governing this determination are airspeed, altitude, temperature, and weight. The following are different variations in use of this diagram.

Example Problem No. 1

Given:

Gross Weight	17000 pounds
Pressure Altitude	0 feet
Outside Air Temperature	40°C

Determine:

Whether or not flight can be continued.

Solution:

1. Enter diagram (figure A-11) at 0 feet pressure altitude.
2. Move horizontally to an OAT of 40°C.
3. From this point move down vertically to the maximum allowable gross weight of 15500 pounds.
4. The maximum allowable temperature for continued flight at 17000 pounds is 33°C; therefore, a landing is required.

Example Problem No. 2

Given:

Gross Weight	18000 pounds
Pressure Altitude	1000 feet
Outside Air Temperature	23°C

Determine:

Whether or not flight can be continued.

Solution:

1. Enter diagram (figure A-11) at 1000 feet pressure altitude.
2. Move horizontally to an OAT of 24°C.
3. At this point, move down vertically to the maximum allowable gross weight of 18000 pounds.
4. Since the maximum allowable gross weight equals the actual gross weight, continued flight is possible.
5. Move to the continued flight curve and pick up the line labeled ANY WEIGHT to find the minimum height and airspeed combinations at which flight may be continued.

Example Problem No. 3

Given:

Gross Weight	17000 pounds
Pressure Altitude	0 feet
Outside Air Temperature	22°C

Determine:

Whether or not flight can be continued.

Solution:

1. Enter the diagram (figure A-11) at 0 feet pressure altitude.
2. Move horizontally to an OAT of 22°C.
3. At this point, move down vertically to the maximum allowable gross weight of 19000 pounds. This indicates flight may be continued.
4. Since the maximum allowable gross weight is 2000 pounds more than the actual gross weight, move to the continued flight curve and use the line labeled-2000 pounds. The minimum height and airspeed combinations at which flight may be continued are determined from this curve.

Example Problem No. 4

Given:

Gross Weight	17000 pounds
Pressure Altitude	1000 feet
Outside Air Temperature	21°C
Height at which helicopter must be flown	50 feet

Determine:

Minimum airspeed required for continued flight at 50 feet.

Solution:

1. Enter diagram (figure A-11) at 1000 feet pressure altitude.
2. Move horizontally to an OAT of 21°C.
3. At this point, move down vertically to arrive at a maximum allowable gross weight of 18500 pounds. This indicates continued flight is possible.
4. Since the maximum allowable gross weight is 1500 pounds more than the actual gross weight, move to the continued flight curve and pick up the point at -1500 pounds and 50 feet.
5. From this point move down vertically to the minimum airspeed of 26 knots CAS for continued flight at 50 feet.

MINIMUM HEIGHT FOR SAFE LANDING AFTER SINGLE ENGINE FAILURE DIAGRAM.

The minimum height for safe landing after single engine failure diagram (figure A-12) should be used to determine the ability to safely land following single engine failure. The chart is based on flight test data acquired under the following conditions: A hard prepared surface runway was used for a landing area. The pilot reaction time for a collective pitch change was 0.5 seconds. The low speed avoid areas for either 17000 pounds at 40°C or 17000 pounds at 15°C are approximated areas. These areas should be recognized as regions where a recovery and landing after single engine failure could result in damage to the helicopter. When operating outside of the avoid areas, a landing is possible without damage to the helicopter. The high speed avoid area should be avoided as there is insufficient maneuvering altitude to establish single engine flight. Landings within this area should be avoided to prevent exceeding the structural limits.

MIMIMUM HEIGHT FOR SAFE LANDING AFTER DUAL ENGINE FAILURE DIAGRAM.

The minimum height for a safe landing after dual engine failure diagram (figure A-13) should be used to determine the ability to safely land following dual engine failure. The conditions upon which this information was compiled are as follows: A hard prepared surface runway was used as a landing area. The pilot reaction time for a collective pitch change was 1.5 seconds. The airspeed and altitude combinations above 135 knots are extrapolated based on flight test experience, allowing for recovery from blade stall and the ability to exchange airspeed for altitude before entering the approach path.

HOVERING CHARTS.

The Hovering Charts (figure A-14 through A-17) provide information to determine the maximum gross weights and torque required to hover in ground effect at 10 feet wheel clearance and to hover out of ground effect.

MAXIMUM GROSS WEIGHT TO HOVER CHARTS.

The Maximum Gross Weight To Hover Charts (figures A-14 and A-16) indicate the maximum gross weight at which the helicopter can be hovered at 10 feet wheel clearance and out of ground effect with various combinations of pressure altitude, temperature, and headwind. Wind velocities increase the maximum gross weight due to increased efficiency of the rotor in forward flight.

Example Problem For Use Of Maximum Gross Weight For Hovering Chart.

Both Maximum Gross Weight To Hover Charts are used in the same manner. For illustrative purposes, the Maximum Gross Weight To Hover Out of Ground Effect Chart (figure A-16) is used.

Given:

Pressure Altitude	4400 feet
Temperature	35°C
Headwind	11 knots

Determine:

Maximum Gross Weight to Hover at Military Power + Out of Ground Effect

Solution: (Refer to figure A-16.)

1. Enter chart at 4400 feet pressure altitude.
2. Move horizontally across 4400 foot pressure altitude line to intersection of 35°C line.
3. From this intersection move vertically downward to zero headwind line.
4. From zero headwind line follow the slope of the headwind influence lines to a 11 knot headwind.
5. From this point move vertically downward to the gross weight scale and read 16250 pounds.

INDICATED TORQUE REQUIRED TO HOVER CHARTS.

The Indicated Torque Required to Hover Charts (figures A-15 and A-17) indicate the torque required to hover within 10 feet wheel clearance and out of ground effect at various density altitude, gross weight, and headwind factors.

Example Problem For Use Of Indicated Torque Required To Hover Chart.

All Indicated Torque Required to Hover Charts are used in the same manner. For illustrative purposes, the Indicated Torque Required to Hover Out of Ground Effect Chart (figure A-17) is used.

Given:

Gross Weight	16500 pounds
Density Altitude	2000 feet
Headwind	5 knots

Determine:

Torque required to hover.

Solution: (Refer to figure A-17.)

1. Enter chart at 16500 gross weight.
2. Move horizontally to intersection of 2000 feet density altitude line.
3. From this intersection move vertically downward to zero headwind line.
4. From zero headwind line follow the slope of the headwind influence lines to a 5 knot headwind.
5. From this point move vertically to the torque scale and read 72.5% Q.

CLIMB CHARTS.

The climb charts for normal and military power (figures A-18 and A-19) are calculated for dual and single engine operation respectively. The charts provide climb performance with two external stores and include 45 pounds (22.5 pounds single engine) of fuel on a 15°C standard day consumed for warm-up and takeoff. The climb speed schedule indicated on the charts should be used in order to realize the values obtained from the charts. Rate-of-climb is based on normal and military power at certain temperatures for various gross weights and altitude conditions. Also shown are the time of climb and the fuel consumed in climbing from sea level to various altitudes at various temperatures. A standard temperature correction table is provided to show the variation in temperature from sea level to 12000 feet pressure altitude.

EXAMPLE PROBLEM FOR NORMAL POWER CLIMB CHART.

Given:

Gross Weight	17500 pounds
Sea Level Temperature	33°C
Temperature at 4000 feet	25°C

Climb from SL to 4000 feet pressure altitude.

Determine: (See figure A-18.)

Time

Distance

Fuel Consumed for Climbing

Rate-of-Climb at 4000 feet

Rate-of-Climb at SL

Solution:

1. Enter chart at 17500 pounds gross weight and proceed vertically to 4000 feet pressure altitude.
2. At this point, move horizontally to the left to the base line of the temperature deviation scale.
3. At 4000 feet the standard OAT equals +7°C (read from standard temperature correction table). The deviation from standard temperature is +25°C-(+7°C) = +18°C.
4. Follow the time influence line to +18°C. At this point move horizontally to the left and read 4.5 minutes.
5. Determine distance of 4.5 nautical miles by moving to the next scale and follow steps 1 thru 4.
6. Determine fuel consumed for climb of 130 pounds by moving to the next scale and follow steps 1 thru 4.
7. Determine rate-of-climb at 4000 feet of 840 fpm by moving to the next scale and follow steps 1 thru 4.
8. Determine rate-of-climb of 1070 fpm at SL in the same manner as for 4000 feet but use zero altitude (SL). The temperature deviation at SL is +33°C - (+15°C) = +18°C.

SERVICE CEILING CHARTS.

The Service Ceiling Charts (figures A-20 and A-21) show the highest altitudes at which the helicopter has a rate-of-climb of 100 feet per minute at best rate-of-climb speed at the specific gross weight, OAT, and power setting (Normal or Military). These ceilings are shown for both twin engine operation (figure A-20) and single engine operation (figure A-21). Since ceilings are affected by the power required by the rotor systems, which is a function of gross weight, altitude and temperature, as well as power available from the engine, which is a function of altitude and temperature, ceilings can be varied, either raised or lowered, for a given set of ambient conditions by controlling the gross weight to obtain reasonable enroute terrain clearances.

EXAMPLE PROBLEM FOR USE OF SERVICE CEILING CHART.

Given:

Gross Weight	17000 pounds
Outside Temperature	40^{o} C OAT

Determine:

Service ceilings.

Solution: (Refer to figure A-20.)

1. Enter chart at a gross weight of 17000 pounds.
2. Move vertically to intersect the outside temperature line of 40^{o} C.
3. Then move horizontally to the pressure altitude scale and read service ceilings of 8000 feet for normal power, and 11200 feet for military power two engines operating.

RANGE CHARTS.

The range charts (figures A-22, A-23, and A-24) graphically illustrate the cruise performance of the helicopter. The charts present fuel flow in pounds per hour at various pressure altitudes. The calibrated, indicated airspeeds, and approximate torque are presented at various density altitudes. Two separate charts are presented for dual engine operation. The maximum range chart provides fuel consumption, airspeed, and torque values that will yield the greatest range. The maximum continuous range chart provides the same data. However, with the higher airspeeds a corresponding decrease in range results. A maximum range chart for single engine operation is provided so that optimum range may be determined.

EXAMPLE PROBLEM FOR MAXIMUM RANGE TWO ENGINE OPERATION.

Given:

Gross Weight	17500 pounds
Cruise Altitude	2000 feet pressure altitude
OAT at Cruise Altitude	20^{o}C
Density Altitude (Density Altitude Chart Figure A-1)	3000 feet
Fuel Quantity	4400 pounds

Determine:

Maximum Range.

Solution: (Refer to figure A-22)

Initial Gross Weight	17500 pounds
Fuel for Warmup and Climb (From Climb Chart Figure A-18)	75 pounds
Initial Cruise Gross Weight	17500 lbs - 75 lbs = 17425 pounds
Initial Fuel	4400 pounds
Warmup and Takeoff	-75 pounds
Reserve	-440 pounds
Fuel for Cruise	3885 pounds
Landing Gross Weight	(17425 - 3885) lbs = 13450 lbs
Average Cruise Gross Weight	$17425 - \frac{3885}{2} = 15483$ pounds

1. Enter chart at 15483 pounds average gross weight. Proceed vertically to 2000 feet pressure altitude. At this point move horizontally to the left and read average fuel consumption of 1008 lbs/hr.
2. At this gross weight proceed vertically to 3000 feet density altitude on speed scale. At this point move horizontally to left and read 123 KN CAS. (122 KN IAS).
3. Again proceed vertically at this gross weight to 3000 feet density altitude on the torque scale. At this point move horizontally to the left and read approximate torque 59%.
4. From the density altitude chart figure A-1, obtain the airspeed correction factor at 3000 feet density altitude which is = 1.045.

$$\text{Mission Time} = \frac{\text{Cruise Fuel}}{\text{Average Fuel Consumption}} = \frac{3885}{1008} = 3.85 \text{ hours.}$$

TAS = 123 x 1.045 = 128.5 KN

Range = 128.5 x 3.85 = 495 Na. Mi.

5. To attain this range, an average speed of 122 knots IAS should be maintained with an approximate torque of 59 percent.
6. Following the same logic to obtain initial and final values of speed and torque using the initial gross weight of 17425 pounds and the landing gross weight of 13540 pounds.

MAXIMUM ENDURANCE CHARTS.

The endurance charts (figures A-25 and A-26) are presented in the same format as the range charts.

The charts graphically illustrate the maximum flight time allowable with a given amount of fuel. The charts present fuel flow in pounds per hour at various pressure altitudes. The calibrated airspeed, indicated airspeed, and approximate torque required are presented at various density altitudes. There are two charts, one for dual engine operation and one for single engine operation.

EXAMPLE PROBLEM FOR MAXIMUM ENDURANCE TWO ENGINE OPERATION.

Given:

Gross Weight	15500 pounds
Cruise Altitude	1000 feet pressure altitude
OAT at Cruise Altitude	17° C
Density Altitude	1500 feet
Fuel Remaining	2000 pounds

Determine:

Maximum time helicopter can remain in the air before the fuel low level warning light illuminates, if the landing is delayed upon return to carrier.

Solution: (Refer to figure A-25)

Fuel for Endurance = 2000 lbs - 600 lbs (Low Level 300 lbs/tank) = 1400 lbs.

G W End of
Endurance = (15500 - 1400) lbs = 14100 lbs

Average G W = $15500 - \frac{1400}{2} = 14800$ lbs

1. Enter chart at 14800 pounds average gross weight. Proceed vertically to 1000 feet pressure altitude.
2. At this point move horizontally to the left and read average fuel consumption of 750 lbs/hr.
3. Proceed vertically at the same gross weight to 1500 feet density altitude on the speed scale.
4. At this point, move horizontally to the left and read airspeed of 58 knots IAS (62 knots CAS).
5. Again proceed vertically to 1500 feet density altitude on the torque scale and read approximate torque of 36 percent.

Endurance

Time = $\frac{\text{Endurance Fuel}}{\text{Average Fuel Consumption}} = \frac{1400}{750} = 1.87$ hours

Average Airspeed = 58 knots IAS

Average Torque = 36 percent

HOVERING ENDURANCE CHART.

The hovering endurance chart (figure A-27) graphically illustrates the maximum time available for hovering at a given amount of fuel. The chart presents fuel consumption at various pressure altitudes; also the indicated airspeed, calibrated airspeed, and approximate torque required at various density altitudes.

EXAMPLE PROBLEM.

Given:

Gross Weight	17500 pounds
Pressure Altitude	Sea Level
OAT at Sea Level	30° C
Density Altitude	1800 feet

Determine:

Maximum time for hovering.

Solution: (Refer to figure A-27)

Initial G W	17500 pounds
Warm-up and Climb Fuel (From Climb Chart Figure A-18)	65 pounds

GW at Start of
Endurance = 17500 lbs - 65 lbs = 17435 pounds

Initial Fuel	4760 pounds
Warmup and Climb	-65 pounds
Reserve (10%)	-476 pounds

Fuel for Endurance = 4760 lbs - 541 lbs = 4219 pounds

G W at End of
Endurance = 17435 lbs - 4219 lbs = 13216 pounds

Average G W = $17435 - \frac{4219}{2} = 15326$ pounds

1. Enter chart at 15326 pounds average gross weight. Proceed vertically to sea level pressure altitude. At this point, move horizontally to the left and read average fuel consumption of 1120 lbs/hr.
2. Following the same gross weight, proceed vertically to 1800 feet density altitude on the torque scale and read 67.5 percent approximate torque.

Hovering Endurance

Time = $\frac{\text{Endurance Fuel}}{\text{Average Fuel Consumption}} = \frac{4219}{1120} = 3.76$ hours

Average Torque = 67.5%

Zero Airspeed

LANDING DISTANCE CHARTS.

The landing distance charts (figures A-28 and A-29) include the power-off total landing distance to clear a 50 foot obstacle and the power-off landing distance ground roll at various gross weight, altitude, headwind, and temperature conditions. Normal power-on landings will be approximately 10 to 15 percent less than the distance shown on the charts. With gross weight, altitude, and temperature conditions where hovering out of ground effect is possible, vertical descents can be made.

CAUTION

> Caution should be observed when operating at low altitude with zero or low forward airspeed as a satisfactory autorotative flare could not be accomplished before ground contact.

EXAMPLE PROBLEMS FOR THE USE OF LANDING DISTANCE CHARTS.

Example No. 1

Given:

Gross Weight	16000 pounds
Pressure Altitude	3000 feet
OAT	4.4°C
Headwind	10 knots

Determine:

Total landing distance required to land clearing a 50 foot obstacle.

Solution:

1. Enter the chart (figure A-28) at an OAT of 4.4°C (40°F) (point A).
2. From point A, proceed vertically to a pressure altitude of 3000 feet (point B).
3. From point B, proceed horizontally to a gross weight of 16000 pounds (point C).
4. From point C, proceed downward to the 0-knot headwind line (point D).
5. From point D, move parallel to the headwind influence line to 10 knots (point E).
6. From point E, move downward to the total distance at point E. For the conditions of the example, the total landing distance would be 325 feet as read at point F.

Example No. 2

Given:

Gross Weight	16000 pounds
Pressure Altitude	3000 feet
OAT	4.4°C
Headwind	10 knots

Determine:

Ground roll landing distance.

Solution:

1. Enter the chart (figure A-29) at an OAT of 4.4°C (40°F) (point A).
2. From point A, proceed vertically to a pressure altitude of 3000 feet (point B).
3. From point B, proceed horizontally to a gross weight of 16000 pounds (point C).
4. From point C, proceed downward to the 0-knot headwind line (point D).
5. From point D, move parallel to the headwind influence line to 10 knots (point E).
6. From point E, move downward to the ground roll distance (point F). For the conditions of the example, the ground roll distance would be 140 feet as read at point F.

INSTRUCTIONS FOR COMPLETING TAKEOFF AND LANDING DATA CARD.

The Takeoff and Landing Data Card should be completed by the pilot prior to takeoff and landing. It is accomplished as follows:

1. Fill in the elevation of the takeoff and landing fields.
2. Fill in the pressure altitude, the free air temperature, and wind of the fields of takeoff and landing.
3. Fill in the mission gross weight at takeoff, that is, the basic weight as carried in the helicopter records (T.O. 1H-1B-40), the actual oil and equipment weight, the crew weight, and the fuel weight.
4. Enter the maximum available torque as obtained from the power available chart (figure A-4).
5. Determine the torque required from the torque required to hover charts (figures A-15 and A-17).

EXAMPLE PROBLEM FOR USE OF THE TOLD CARD IN MISSION PLANNING.

Fly a maximum range mission at 2000 feet pressure altitude with three crewmembers and two observers.

Given:

Basic Weight	11870
Pilot, Copilot, and Flight Engineer	645
Oil	63
Two Observers	500
Miscellaneous	500
	13578

Takeoff -	Field Elevation	30
	Pressure Altitude	125
	FAT	26
	Wind	zero
Landing -	Field Elevation	1000
	Pressure Altitude	1300
	FAT	19
	Wind	20/20

Determine:

Power available for takeoff and landing.
Power required to hover in ground effect for takeoff and landing.

Solution:

For takeoff find the estimated torque available to be 94%. Use Military Power Chart (Figure A-4).

For takeoff find the torque required to hover in ground effect at 19100 pounds gross weight to be 80.5%. Use Hovering Chart (Figure A-15).

Use Climb Chart (Figure A-18) to find:

Time to climb	2 minutes
Distance covered	2.5 nautical miles
Climb fuel	100 pounds
Rate-of-climb	975 feet per minute
Climb speed	69 IAS

Normal Gross Weight	19100
Normal Gross Weight Less Fuel	-13578
Fuel	5622
Unusable Fuel	-63
Usable Fuel	5459
Reserve 10%	-546
Fuel Available for Mission	4913
Warmup, Takeoff, and Climb Fuel	-100
Fuel Available for Cruise	4813
One Half Cruise Fuel	2406

Normal Gross Weight Less Fuel	13578
Unusable Fuel	63
Reserve 10%	546
One Half Cruise Fuel	2406
Average Cruise Gross Weight	16593

Use Density Altitude Chart (Figure A-1) to convert a pressure altitude of 2000 feet with a temperature of 22°C to 3200 feet density altitude. Observe TAS conversion factor $(\frac{1}{\sqrt{\sigma}})$ 1.0475 on right side of chart.

Use the Range Chart (Figure A-22) and the average cruise gross weight of 16593 to find:

Fuel consumption	1020 pounds per hour
CAS	123
IAS	122
Torque	60.5

CAS x $\frac{1}{\sqrt{\sigma}}$	=	TAS
123 x 1.0475	=	128.8
Fuel for cruise	=	4813
Fuel consumption	=	1020
Cruise time	=	4 + 42
Cruise TAS	=	128.8
Range	=	608

Normal Gross Weight Less Fuel	13578
Unusable Fuel	63
Reserve 10%	546
Landing Weight	14187

For landing find the estimated torque available to be 96.5%. Use Military Power Chart (Figure A-4).

For landing find the torque required to hover in ground effect at 14187 pounds gross weight to be 47%. Use Hovering Chart (Figure A-15).

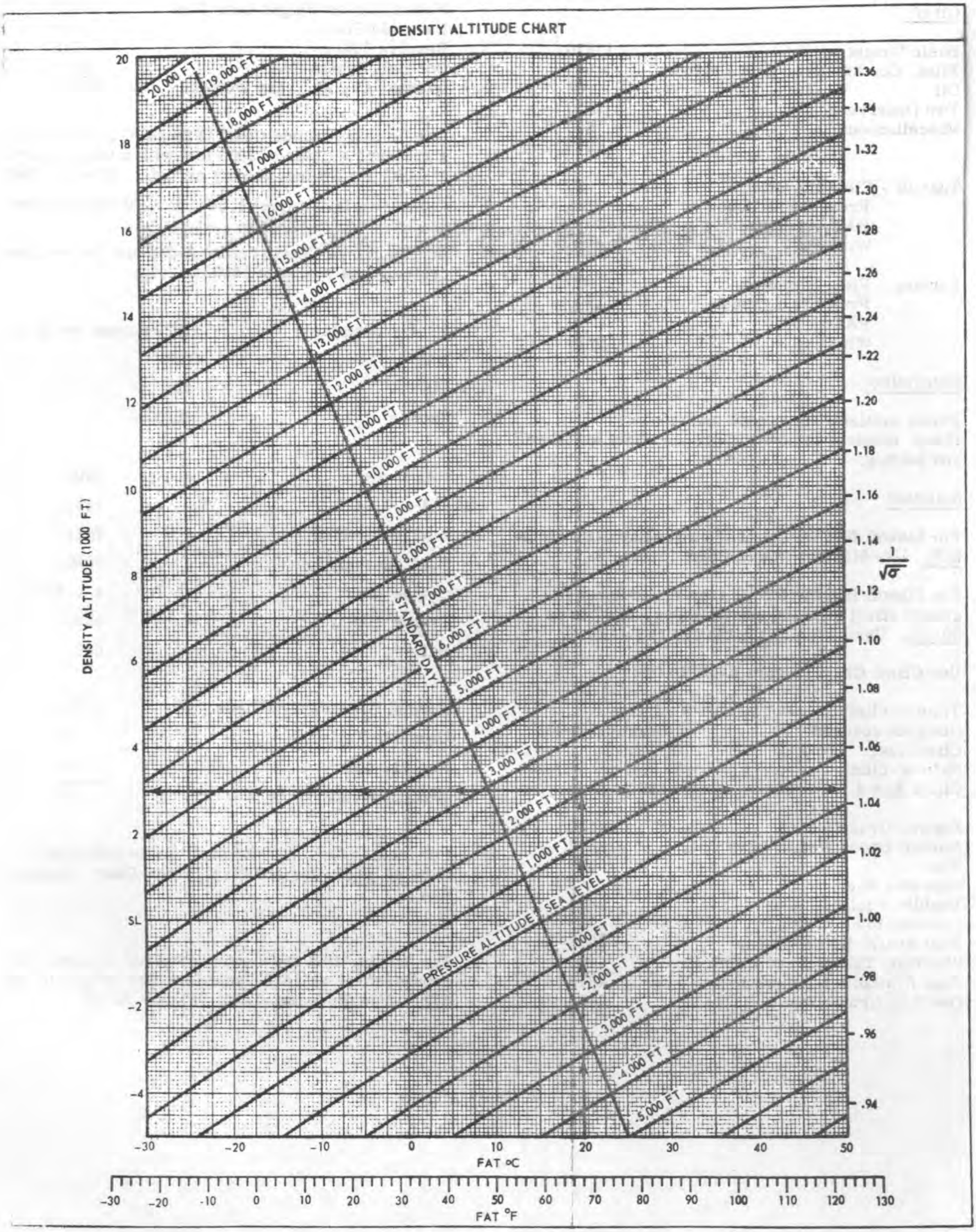


Figure A-1. Density Altitude Chart

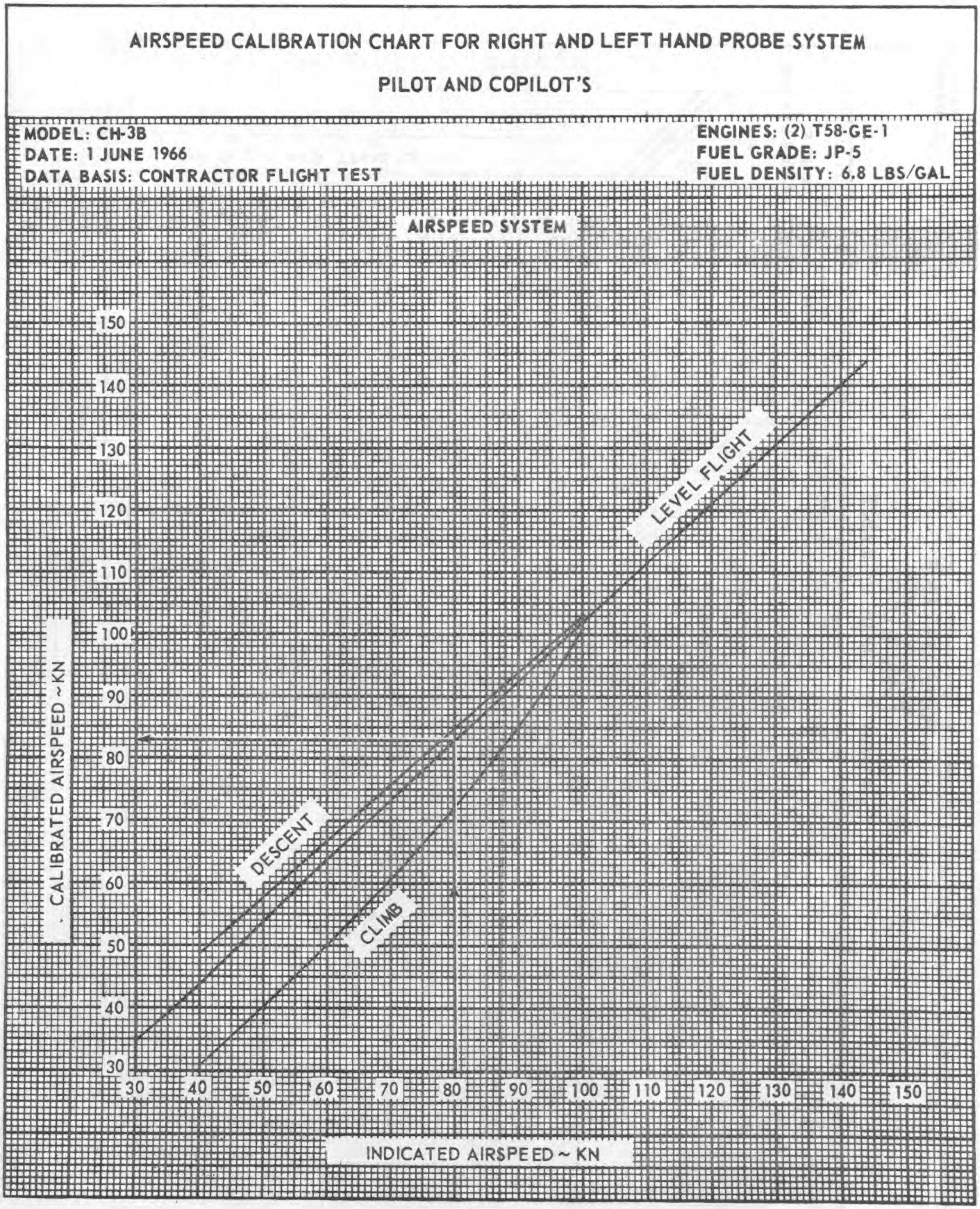


Figure A-2. Airspeed Calibration for Right and Left-Hand Probe System Chart

S 2074 (R2)

POWER AVAILABLE
MAXIMUM POWER
5 MINUTE LIMIT
ESTIMATED TORQUE AVAILABLE

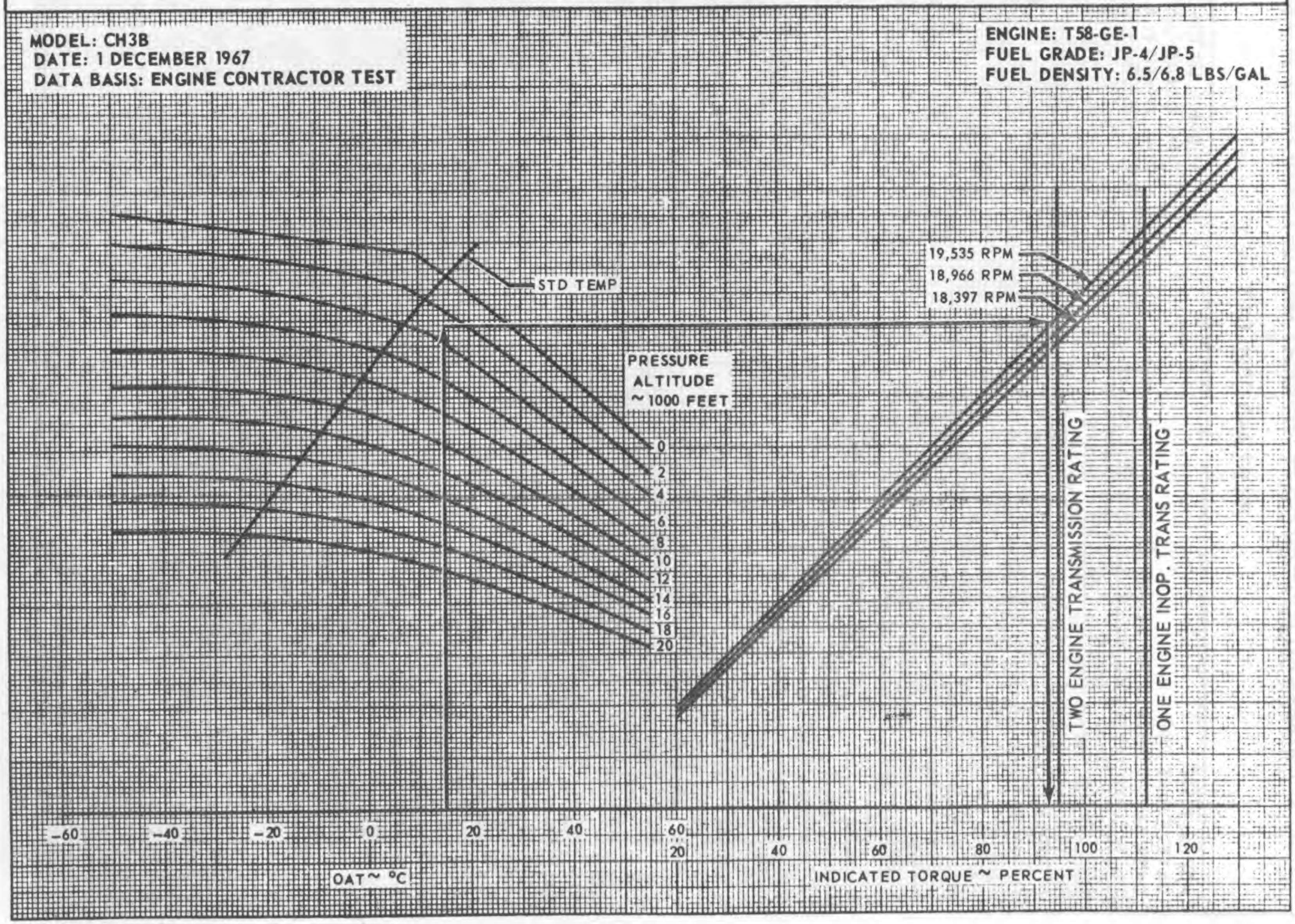


Figure A-3. Power Available - Maximum Power - 5 Minute Limit - Estimated Torque Available

S 2075 (R2)

POWER AVAILABLE
MILITARY POWER
30 MINUTE LIMIT
ESTIMATED TORQUE AVAILABLE

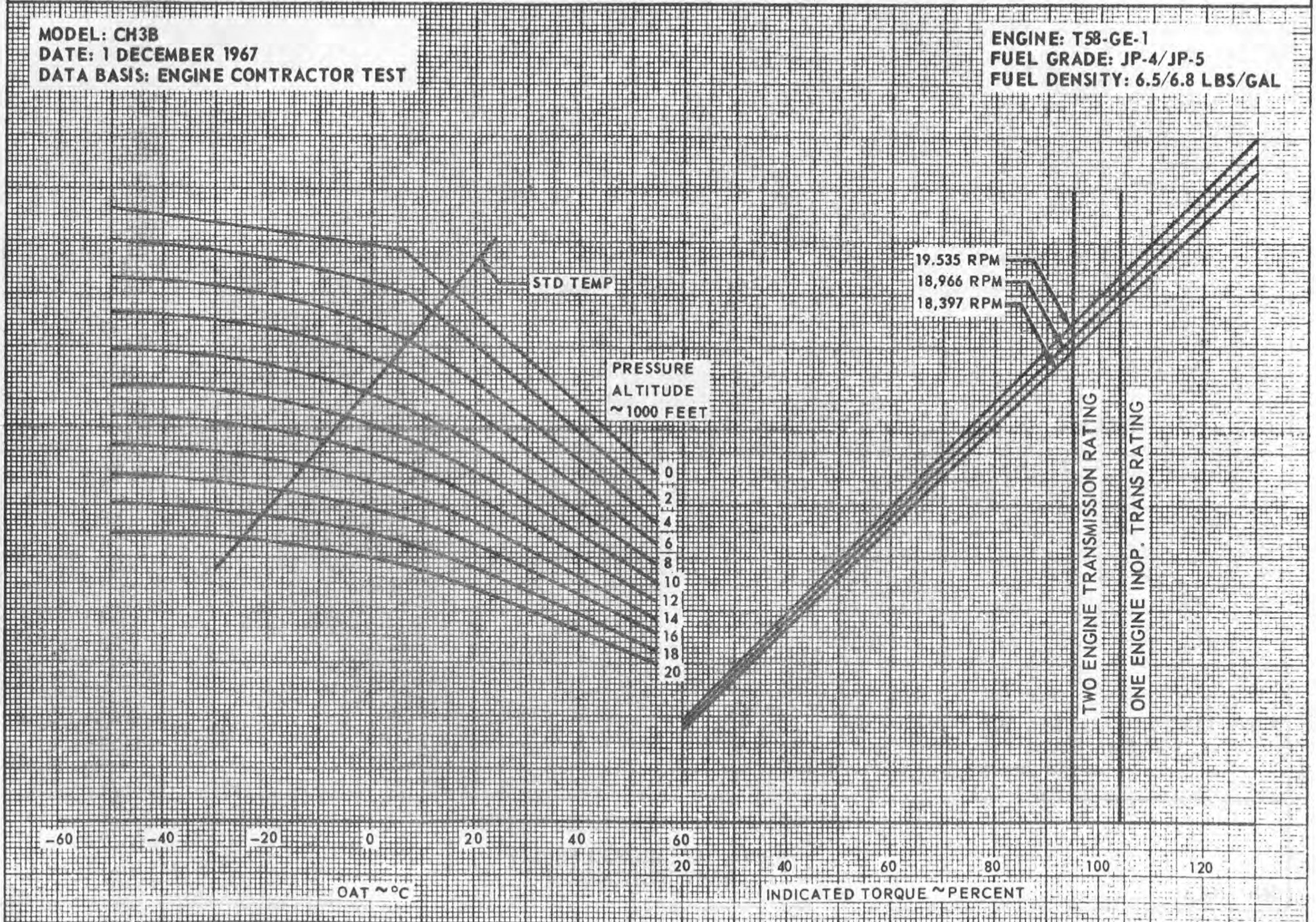


Figure A-4. Power Available - Military Power - 30 Minute Limit - Estimated Torque Available

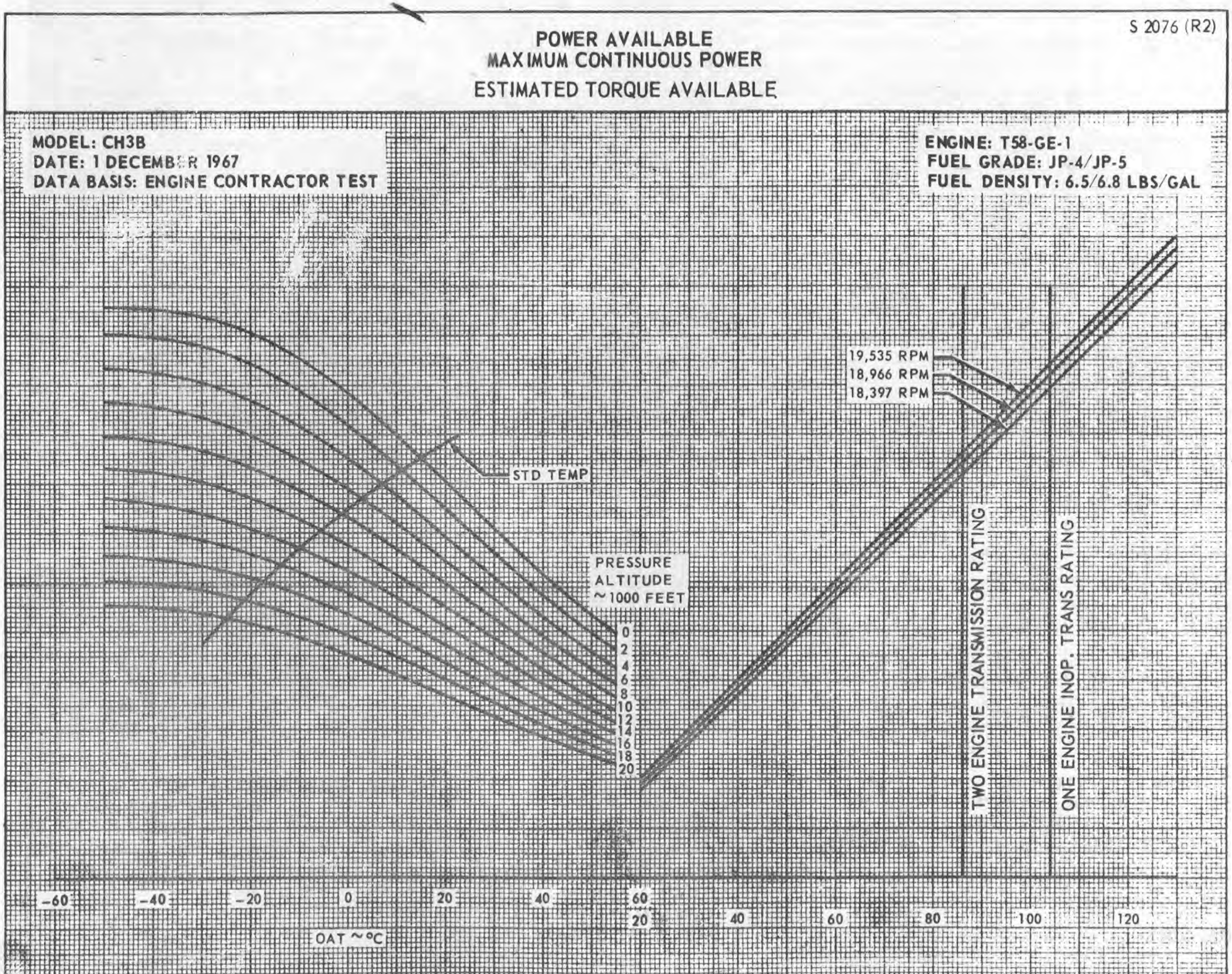


Figure A-5. Power Available - Maximum Continuous Power - Estimated Torque Available

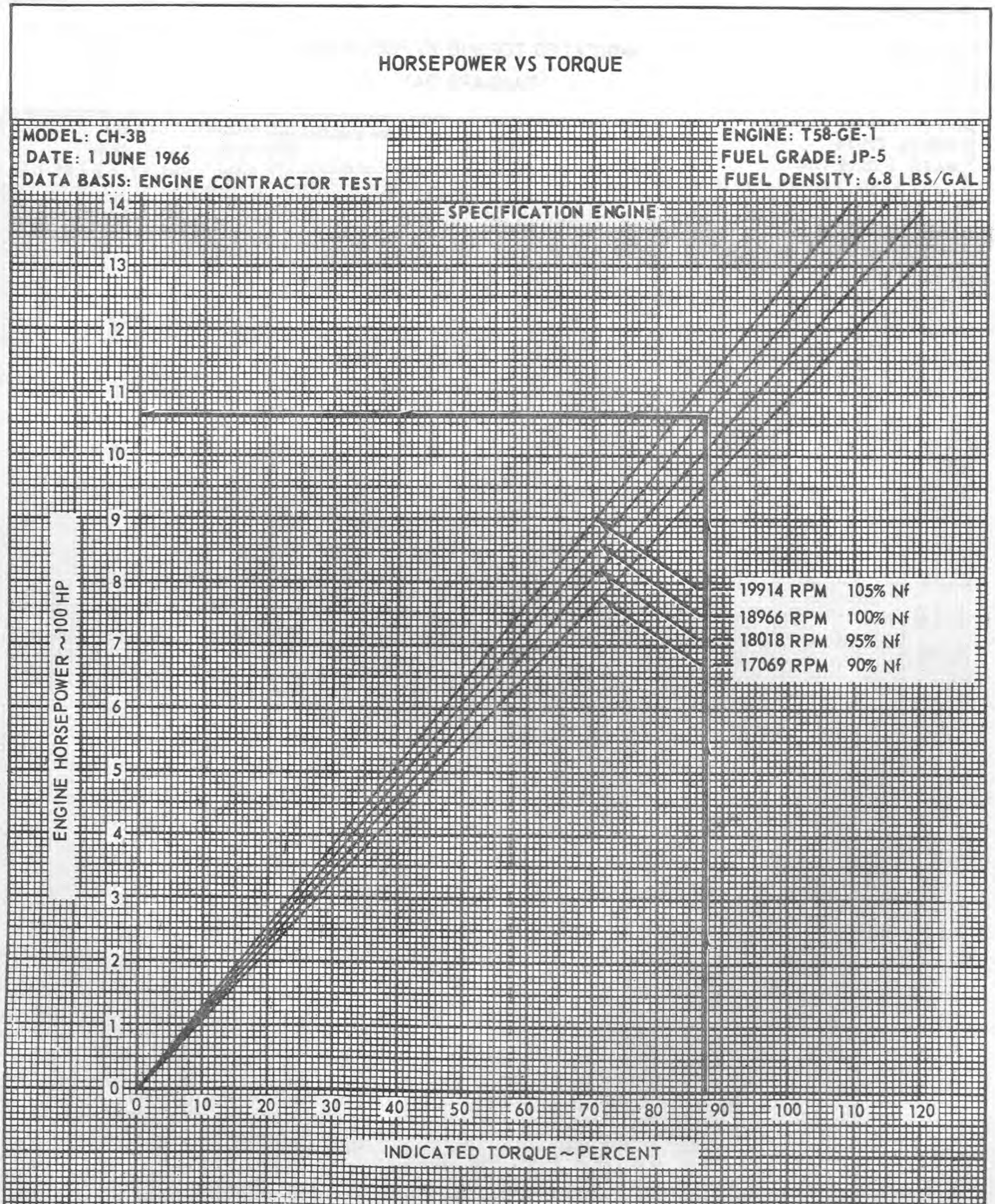


Figure A-6. Horsepower vs Torque

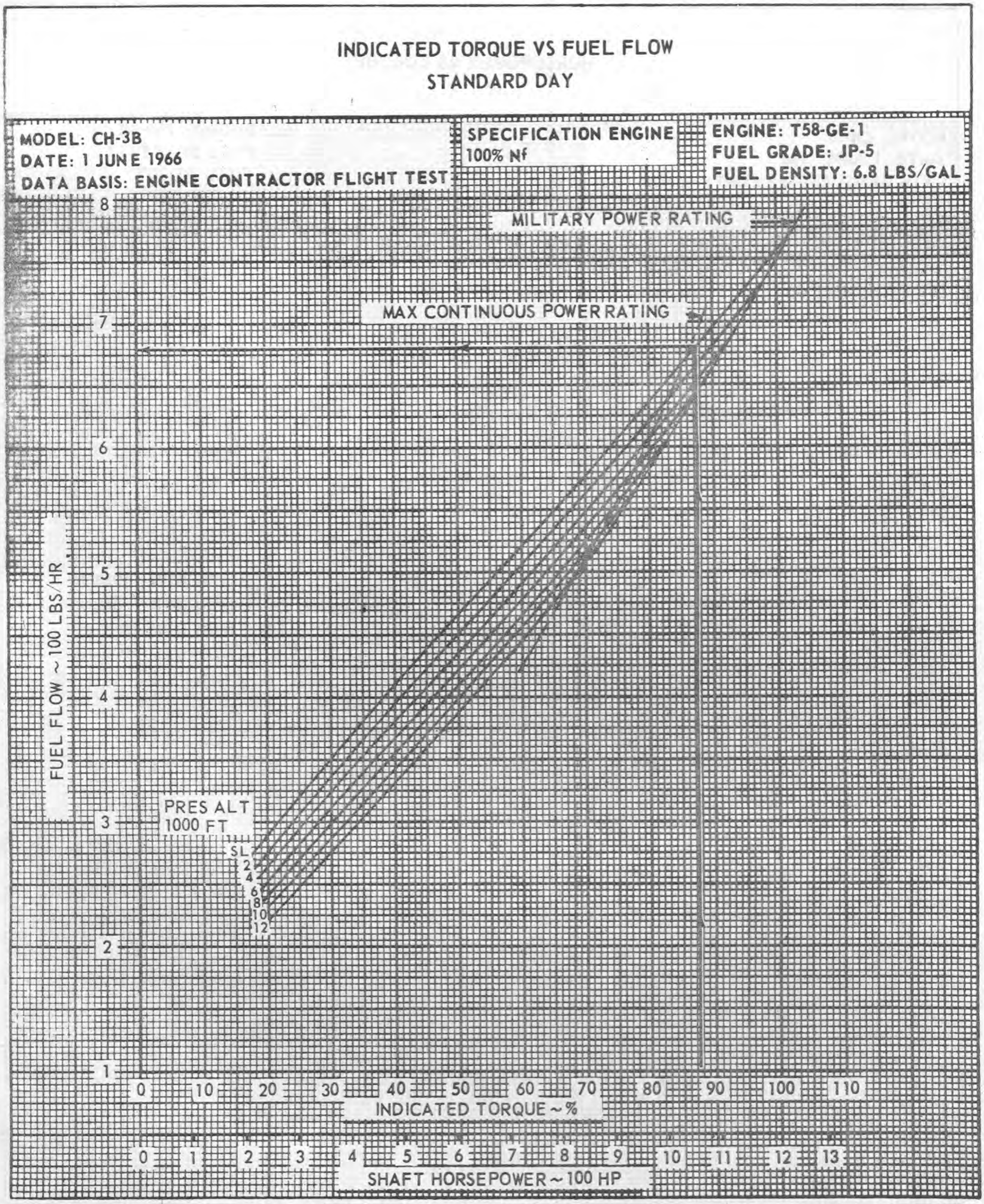


Figure A-7. Torque vs Fuel Flow

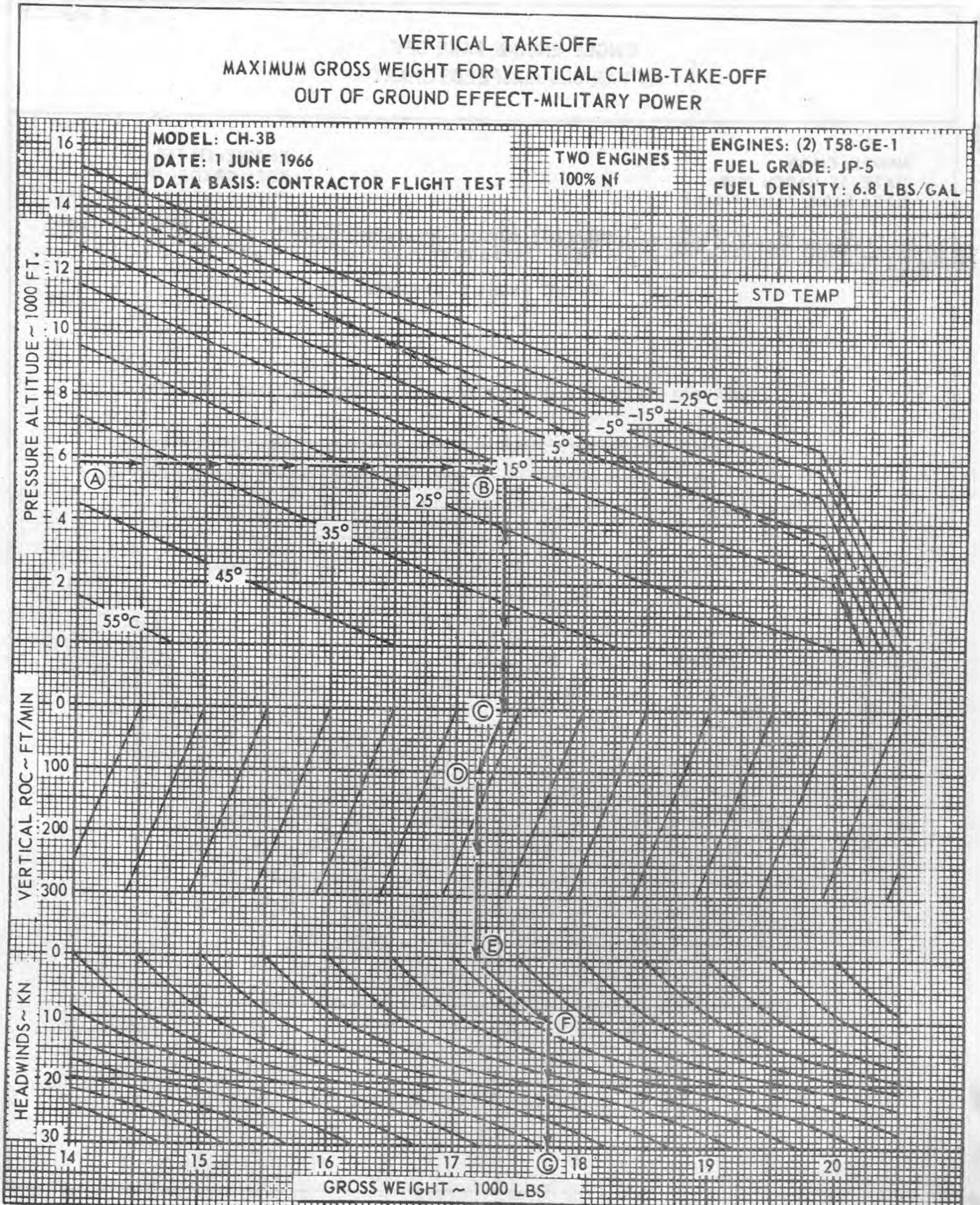


Figure A-8. Vertical Takeoff - Maximum Gross Weight for Vertical Climb - Takeoff Out of Ground Effect

S 2080 (R2)

SINGLE ENGINE TAKE-OFF AT VARIOUS AIRSPEEDS CHART

MODEL: CH-3B
DATE: 12 MARCH 1969
DATA BASIS: FLIGHT TEST

ENGINE: (1) T58-GE-1
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

MILITARY POWER * 19535 RPM
SEA LEVEL

10 FOOT WHEEL CLEARANCE

*MAXIMUM ALLOWABLE HORSEPOWER WAS CONSIDERED TO BE 1287 SHP.

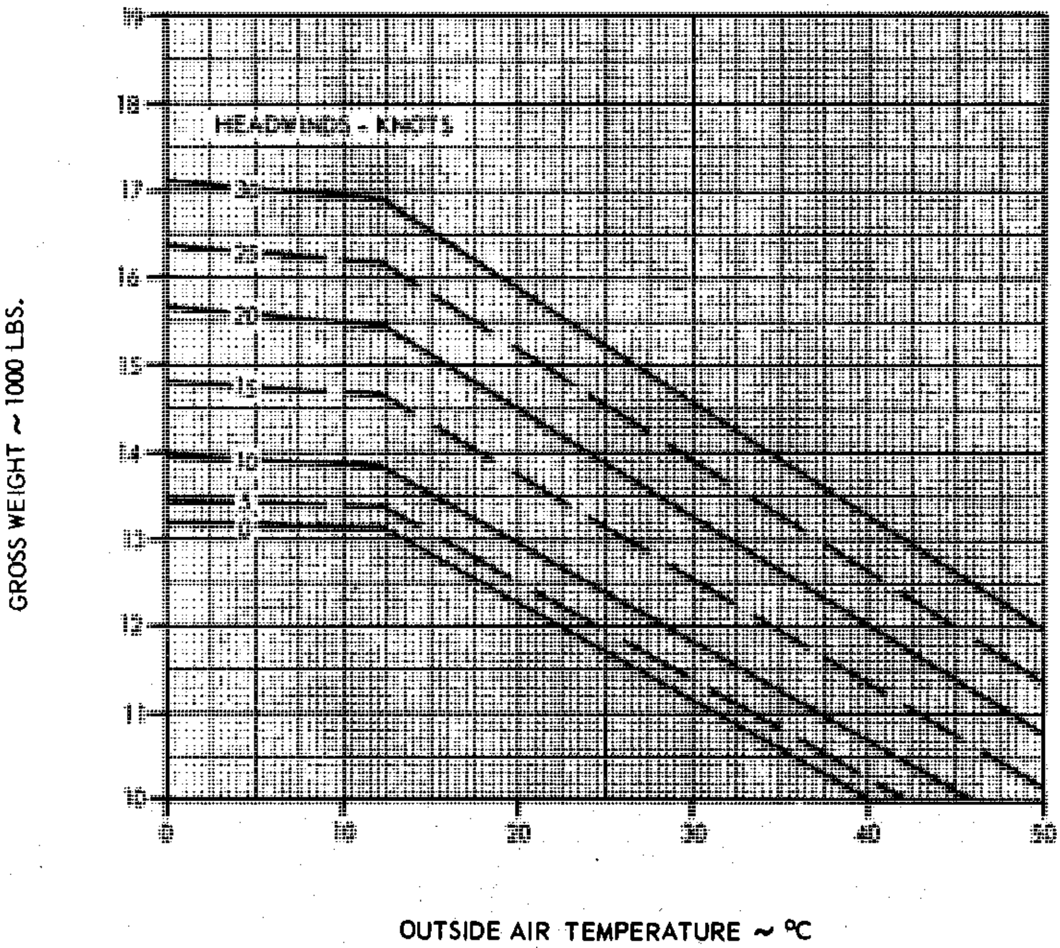


Figure A-9. Single Engine Takeoff at Various Airspeeds

S 2081 (R2)

ABILITY TO MAINTAIN FLIGHT WITH ONE ENGINE FOR VARIOUS AIRSPEEDS

MODEL: CH-3B
DATE: 12 MARCH 1969
DATA BASIS: FLIGHT TEST

ENGINES: (1) T58-GE-1
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

NO GROUND EFFECT
MILITARY POWER*

SEA LEVEL ONLY
19535 RPM

*MAXIMUM ALLOWABLE HORSEPOWER WAS CONSIDERED TO BE 1287 SHP.

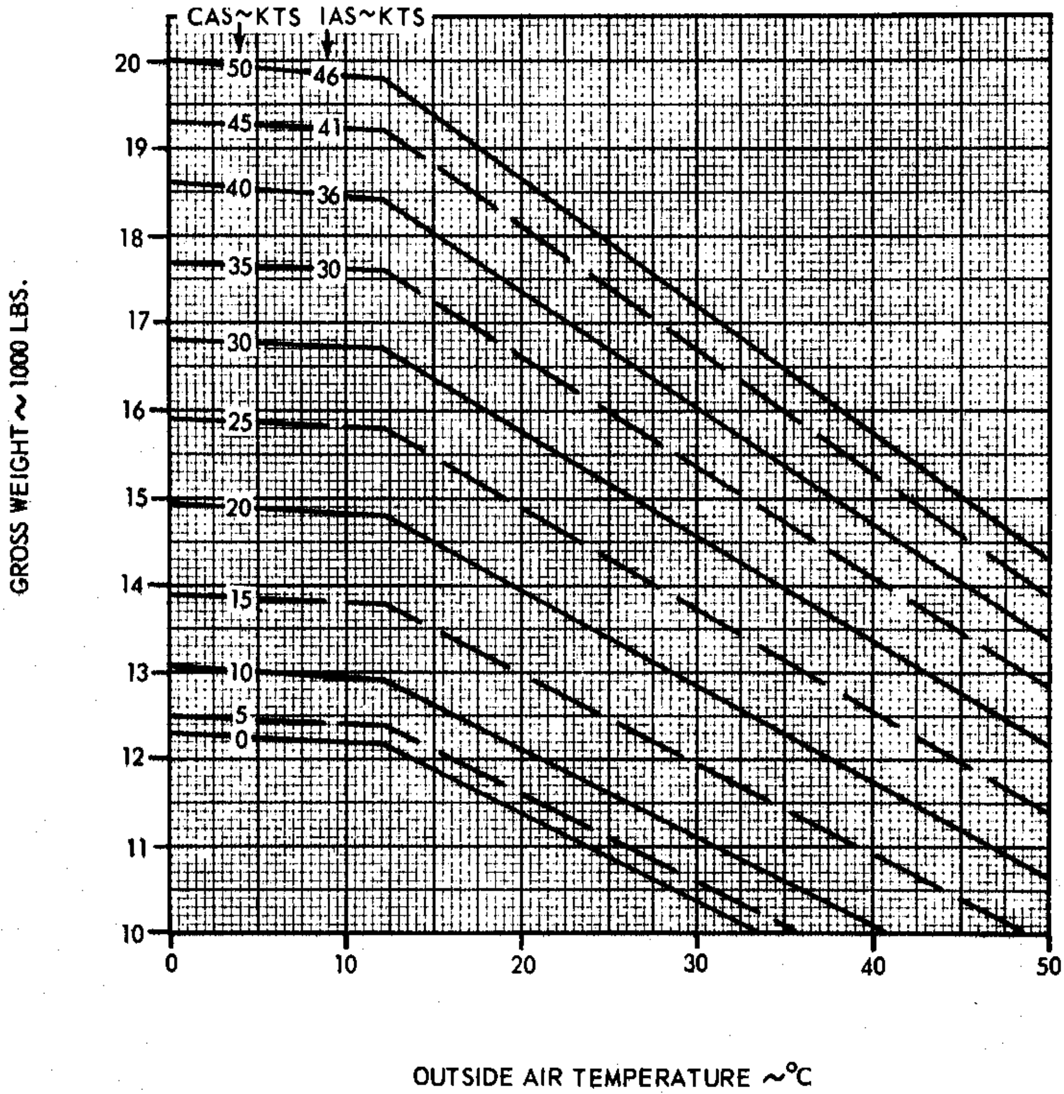


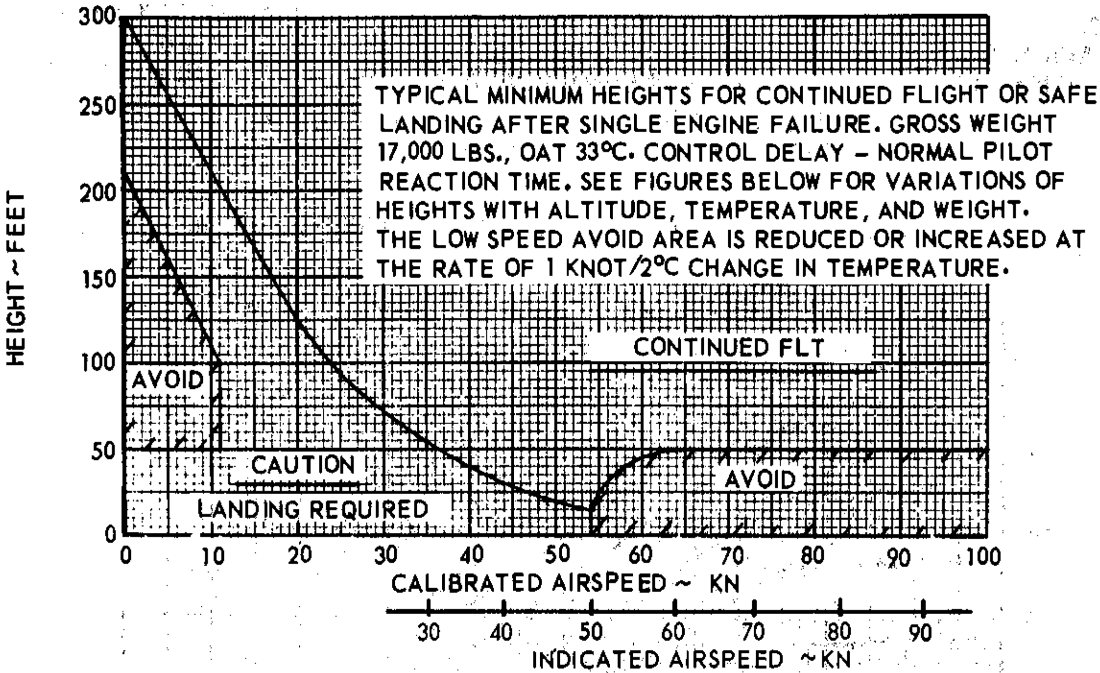
Figure A-10. Ability to Maintain Flight with One Engine for Various Airspeeds

S 2082 (R2)

MINIMUM HEIGHT FOR CONTINUED FLIGHT AFTER SINGLE ENGINE FAILURE

MODEL: CH-3B
DATE: 7 MAY 1964
DATA BASIS: CONTRACTOR FLIGHT TEST

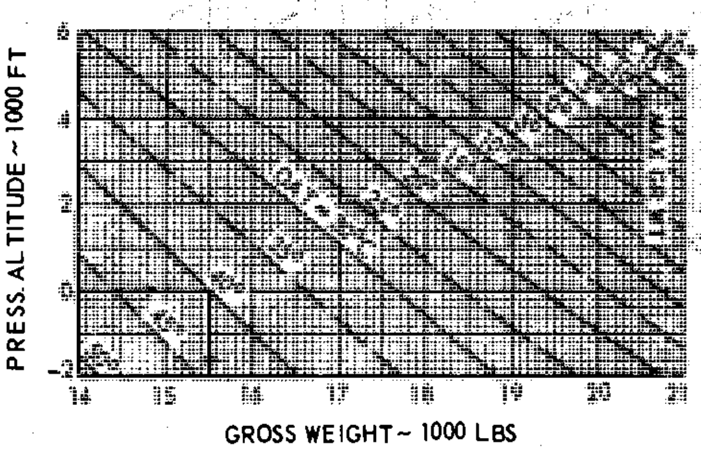
ENGINE: (1) T58-GE-1
FUEL GRADE JP-5
FUEL DENSITY 6.8 LBS/GAL



TO DETERMINE MINIMUM HEIGHTS FOR CONTINUED FLIGHT, ENTER WITH AMBIENT CONDITIONS. DETERMINE MAXIMUM GROSS WEIGHT FOR CONTINUED FLIGHT. MINIMUM HEIGHTS FOR THIS WEIGHT ARE SHOWN IN THE CONTINUED FLIGHT CURVE BELOW (UPPERMOST LINE). IF THE HELICOPTER WEIGHT IS LESS THAN THE DETERMINED MAXIMUM GROSS WEIGHT, DECREASE MINIMUM HEIGHTS TO THE LINE SHOWING THE WEIGHT DIFFERENCE.

MINIMUM CONDITIONS FOR CONTINUED FLT.

MAX TAKE-OFF POWER 1250 HP
100 FT/MIN RATE OF CLIMB AT BROC SPEED



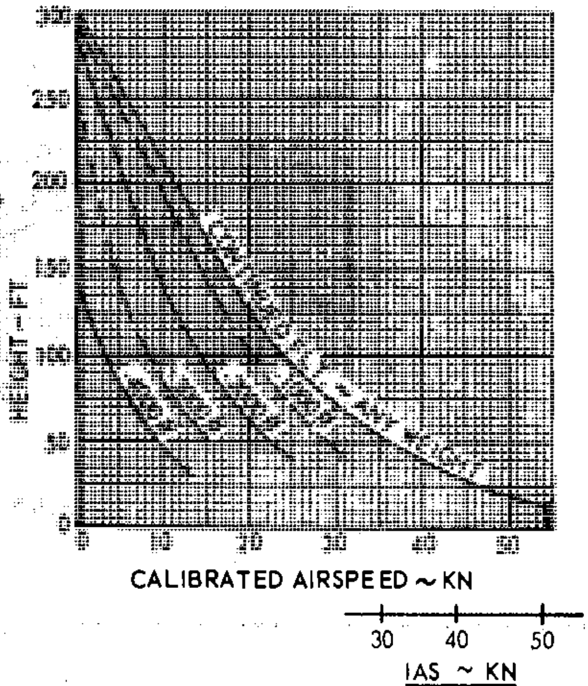


Figure A-11. Minimum Height for Continued Flight After Single Engine Failure

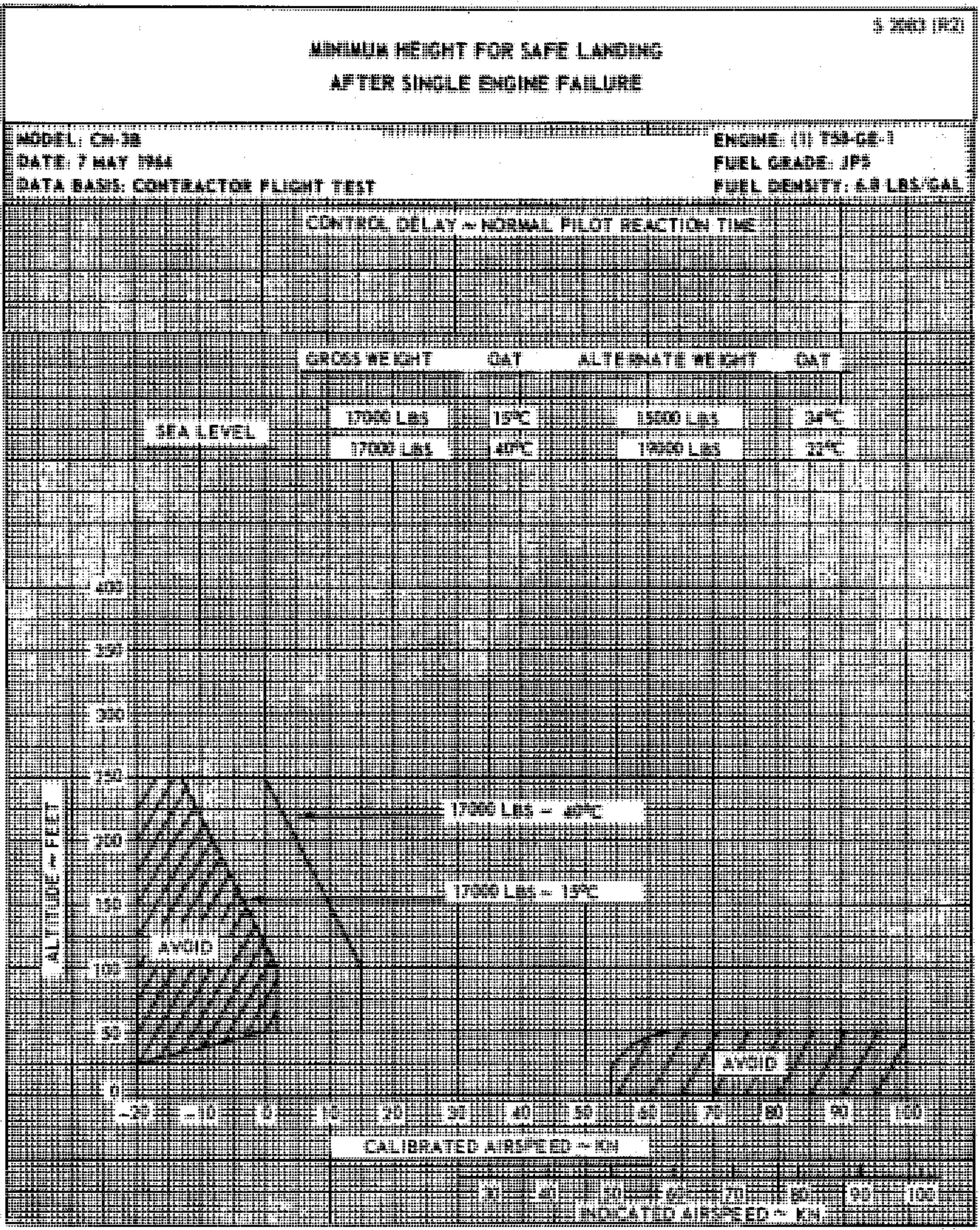


Figure A-12. Minimum Height for Safe Landing After Single Engine Failure

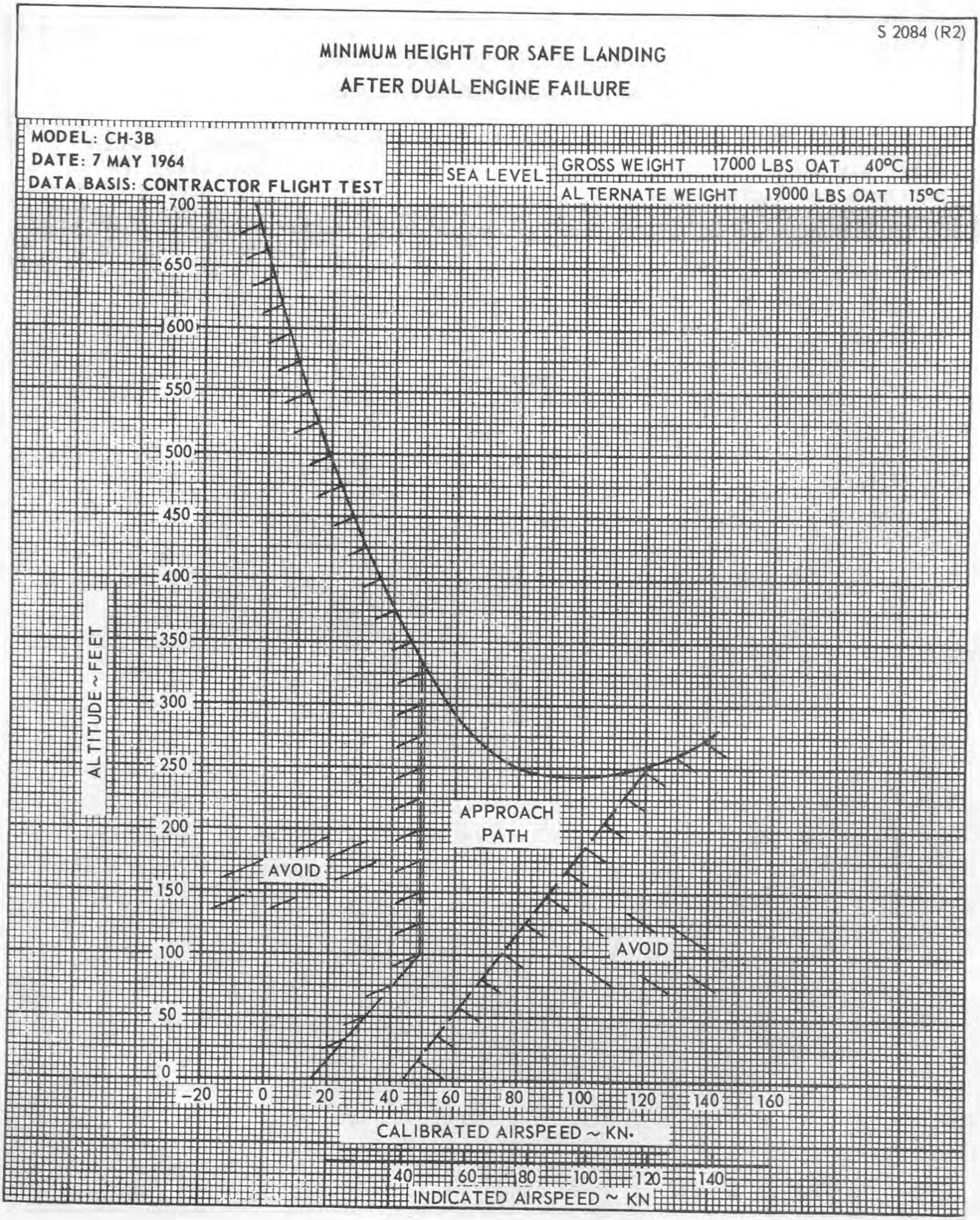


Figure A-13. Minimum Height for Safe Landing After Two Engine Failure