CHANGE No. 4

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *3 April 1970*

Operator's Manual

ARMY MODELS U-21A AND RU-21A AIRCRAFT

TM 55-1510-209-10/1, 17 March 1969, is changed as follows:

1. Remove and insert pages as indicated below.

	Remove pages	Insert pages
Chapter 2, section II	2-21 thru 2-26	2-21 thru 2-26
	2-31 thru 2-34	2-31 thru 2-34
	2-39 and 2-40	2-39 and 2-40
Chapter 3, section II	3-5 thru 3-12	3-5 thru 3-12B
	3-13 and 3-14	3-13 and 3-14
	3-17 thru 3-20	3-17 thru 3-20
Chapter 4, section II - IV	4-3 thru 4-8	4-3 thru 4-8A/4-8B
section X	4-17	4-17
Chapter 8, section II - III	8-3	8-3
Chapter 9, section II	9-5 and 9-6	9-5 and 9-6
Chapter 10, section II - III	10-3 and 10-4	10-3 and 10-4
Chapter 14, section I - II	14-1 thru 14-10	14-1 thru 14-10A/14-10B
	14-11 thru 14-22	14-11 thru 14-22
	14-29 and 14-30	14-29 and 14-30
	14-33 and 14-34	14-33 and 14-34
	14-45 thru 14-54	14-45 thru 14-54

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:
KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31 (qty rqr block no. 89) requirements for Operator and Crew Maintenance Instructions for U-21 aircraft.

cockpit gage registers the temperature present between the compressor turbine and power turbine for the corresponding engine.

2-62. OIL PRESSURE INDICATORS.

2-63. Two oil pressure gages (18, figure 2-13 or 19, figure 2-14) located on the instrument panel register oil pressure in PSI as taken from the delivery side of the main oil pressure pump. Each gage is paired to a pressure transmitter installed on the respective engine. Both instruments are protected by a single 1-ampere fuse, placarded OIL PRESS, located on the copilot's circuit breaker and fuse panel (figure 2-20 or 2-21).

2-64. OIL TEMPERATURE INDICATORS.

2-65. One oil temperature gage (17, figure 2-13 or 18, figure 2-14) located on the instrument panel is provided for each engine. These instruments are paired with a thermal sensor unit attached to the respective engines. Each gage registers oil temperature in °C as it leaves the delivery side of the oil pressure pump. Both gages are protected by a single 5-ampere circuit breaker, placarded OIL TEMP IND, located on the right subpanel (figure 2-20 or 2-21).

2-66. FUEL PRESSURE INDICATORS.

2-67. Two gages located on the instrument panel (16, figure 2-13 or 17, figure 2-14) register fuel boost pump pressure sensed by the pressure transmitters. The fuel pressure gages and transmitters are protected by 1-ampere fuses, placarded FUEL PRESS, on the copilot's circuit breaker panel (figure 2-20 or 2-21).

2-68. FUEL FLOW INDICATORS.

2-69. Two gages (15, figure 2-13 or 16, figure 2-14) located on the instrument panel register the rate of flow for consumed fuel as measured by sensing units coupled into the fuel supply lines of the respective engines. Flow indicators are calibrated to show the flow of fuel by increments of hundreds of pounds per hour. Both circuits are protected by a single 1-ampere fuse, placarded FUEL FLOW, located on the copilot's circuit breaker and fuse panel (figure 2-20 or 2-21).

2-70. ENGINE FIRE DETECTION SYSTEM.

2-71. This aircraft incorporates a flame-surveillance system to detect external engine fire and provide alarm to the pilot. Both nacelles are monitored, each having a control amplifier and three detectors. Wiring links all sensors anc control amplifiers to DC power and to cockpit audio and visual alarm units. In each nacelle, one detector monitors both exhaust stacks, one the upper accessory area, and one the lower accessory area.

2-72. Fire emits an infrared radiation that will be sensed by the detector which monitors the area of origin. Radiation exposure activates the relay circuit of a control amplifier which causes signal power to be sent to cockpit alarms. An activated surveillance system will return to the standby state after the fire is out. The system includes a functional test switch and has circuit breaker protection.

2-73. Warning of internal nacelle fire is provided as follows: A warning horn sounds in the cockpit; simultaneously the red FAULT WARN light on the annunciator panel starts flashing, and these alarms are accompanied by the continuous illumination of a red LH FIRE WARNING or RH FIRE WARNING light also on the annunciator panel (10, figure 2-13 or 11, figure 2-14). Fire detector circuits are protected by a single 3-ampere circuit breaker, placarded FIRE WARN POWER, located on the right subpanel (figure 2-20 or 2-21).

2-74. FIRE DETECTION SYSTEM TEST SWITCH.

2-75. A single rotary switch (1, figure 2-9 or 2-10), placarded TEST SWITCH FIRE DETECTION - OFF, 1, 2, 3, located on the pilot's control pedestal, is provided to test the engine fire detection system. Before checkout, battery power must be on and the FIRE WARN POWER circuit breaker must be pressed in. Switch position 1, checks the detector for the air intake of each engine, including circuits to the cockpit alarm and indication devices. Switch position 2, checks the detector and circuits from the accessory area of each engine. Switch position 3, checks the exhaust stack detector and circuits from each engine. Each numbered switch position will initiate the cockpit alarm and indications described in paragraph 2-78 if the subcircuits checked are in good operating condition.

2-76. ENGINE CHIP DETECTION SYSTEM.

2-77. A magnetic chip detector is installed in the bottom of each engine nose gear box to warn the pilot of oil contamination and possible engine failure. The sensor is an electrically insulated gap immersed in the oil functioning as a normally-open switch. If a large metal chip or a mass of small particles bridges the detector gap an output circuit is completed, sending a signal to illuminate a fault light, CHIP DETECTED LEFT ENGINE or CHIP DETECTED RIGHT ENGINE, on the annunciator panel (10, figure 2-13 or 11, figure 2-14). Chip detector circuits are protected by a single 5-ampere circuit breaker, placarded CHIP DETECTOR, on the right subpanel (figure 2-20 or 2-21).

NOTE

The fault warning light will not come on with the chip detector light.

2-78. ANNUNCIATOR PANEL.

2-79. The annunciator panel (10, figure 2-13 or 11, figure 2-14) is positioned across the glareshield of the instrument panel in direct view of the pilot. This panel provides for monitoring critical functions of the aircraft and indicates conditions for which the pilot must take appropriate action. In frontal view this panel presents two rows of small, rectangular windows, some colored yellow and some colored red. Word-printing on individual windows identifies the monitored function or fault condition. Active elements of the panel include a FAULT WARN light, individual function and fault lights, and DIM and PRESS TO TEST controls. A function indication is displayed by illumination of an appropriate yellow window. Fault indications, except for the yellow CHIP DETECTED warning, are shown by illumination of a specific red colored window simultaneously with flashing of the FAULT WARN light.

2-80. If a fault should occur, (example: LH GEN OUT) a signal from the fault sensor is sent to its respective light (in this case: red) in the annunciator panel. A parallel signal is also directed to activate the flashing FAULT WARN light. This light will continue to flash after fault correction unless reset by pressing its face. Reset will extinguish the light, however, a second fault will cause it to illuminate again.

2-81. If an indicating function should occur, (example: LH IGN IND), a signal from the indicator sensor is sent to its respective channel (in this case: yellow) in the same manner as a fault signal. However, an indicating function will not cause the FAULT WARN light to illuminate.

2-82. The intensity of all lights in the annunciator panel are dimmed by a common DIM control (20, figure 2-13 or 21, figure 2-14). When a signal is sent to the panel, the affected light illuminates at maximum brightness. When the FAULT WARN light is reset, all light will dim to the level set by the DIM control. Dimming cannot be accomplished until after reset. Circuits of the annunciator are protected by a 5-ampere circuit breaker, placarded ANN PANEL, located on the right subpanel (figure 2-20 or 2-21).

2-83. PROPELLERS.

2-84. A 3-blade aluminum propeller assembly is installed on each engine. These propellers have hydraulically controlled constant speed regulation and possess both full-feathering and reversing capability. Each assembly is controlled by engine oil through a single-acting, engine-driven propeller governor. Centrifugal counterweights assist a feathering spring to move the blades toward the low RPM (high pitch) setting and into the feathered position. Oil pressure moves the propeller blades to the high RPM (low pitch) hydraulic stop and to the reverse setting.

2-85. Low pitch propeller position is determined by a mechanically monitored hydraulic stop. A back-up system, referred to as the Secondary Idle Stop, protects against propeller reversing in the event of failure of the low pitch stop. In the event of loss of oil pressure, the prop will go toward the feather position.

2-86. FEATHERING PROVISIONS.

2-87. The aircraft is equipped with both manual and automatic propeller feathering. Manual feathering is accomplished by pulling the corresponding propeller lever aft past a friction detent. To unfeather, the propeller lever is pushed forward into the governing range. An automatic system will sense loss of torque oil pressure and will feather an unpowered propeller.

2-88. AUTOMATIC FEATHERING. Automatic feathering can occur only with both engines operating and may be initiated from either the ARM or TEST control mode. A safety restraint limits autofeather to only one propeller (either). The autofeather system has a cross-interlocking safety feature designed into the control circuits to prevent feathering of both propellers by automatic means. When either propeller automatically feathers, the interlock event removes power from the corresponding circuit of the opposite propeller - which limits autofeather capability to one propeller only. After autofeathering has occured, feathering control for the opposite propeller reverts to manual control only.

2-89. PROPELLER AUTO-FEATHER SWITCH. Auto-feathering is controlled by a single, PROP AUTO FEATHER toggle switch located on the left subpanel (10, figure 2-11 or 15, figure 2-12). The 3-position switch is placarded ARM, OFF and TEST, and is spring-loaded from TEST to OFF. The ARM position is used for flight operation only. At ARM, if an engine develops loss of power, two torque-sensing switches of the affected engine are actuated by pressure drop. Switch actuations apply current through an autofeather relay to a corresponding dump valve, causing the release of oil pressure which held an established pitch angle on the blades of the affected propeller. Following the release of oil pressure, actual feathering movement is accomplished by centrifugal force applied by counterweights attached to the blade roots. TEST position of the switch, enables the pilot to check readiness of the auto-feather systems, at a minimum power setting, and is for ground checkout purposes only. See Chapter 3, Normal Procedures.

2-90. AUTO-FEATHER LIGHTS. Two amber lights located on the pilot's instrument panel, placarded AUTO FEATHER LEFT and AUTO FEATHER RIGHT, (8, figure 2-13 or 9, figure 2-14), when illuminated indicate that the autofeather system has attained a readiness state. When the system is ARMed, both lights will be extinguished if either propeller has been autofeathered or if the system is disarmed by retarding a power lever. Auto-feather circuits are protected by one 5-ampere circuit breaker, placarded PROP FEATHER, located on the right subpanel (figure 2-20 or 2-21).

2-91. PROPELLER GOVERNORS.

2-92. Each propeller system utilizes three governors, one "primary" and two "backup", to control propeller RPM. Each propeller lever establishes RPM for the respective propeller by altering the setting of a primary governor attached to the engine gear reduction housing. It is the primary governor which controls RPM through the entire range. Should a primary governor malfunction (exceeding 2200 RPM) an overspeed governor cuts-in (2266 ± 40 RPM), dumping oil from the affected propeller to stop RPM from exceeding safe limits. A solenoid actuated by the PROP GOV TEST switch enables the overspeed governor to be reset at approximately 2000 RPM for test purposes. If a propeller should stick or move too slow during a transient condition, the corresponding governor would be unable to prevent an overspeed condition. To provide for this contingency, the engine power turbine governor acts as a fuel topping governor. Thus, when the propeller RPM reaches 2332 RPM, this governor limits the fuel flow into the engine and prevents the propeller RPM from exceeding approximately 2332 RPM. During propeller operation in the reverse range, the engine power turbine governor will automatically be reset to allow a maximum of 2040 RPM, which prevents propeller overspeed in this mode.

2-93. PROPELLER TEST SWITCHES. Two 3-position toggle switches (11, figure 2-11 or 12, figure 2-12) on the left subpanel, placarded LEFT and RIGHT, are provided for operational test of the propeller systems. Each switch is a double unit, controlling two different test circuits for the corresponding propeller. In the PROP GOV TEST (up) position, each switch is used to test the function of the overspeed governor. In the SECONDARY IDLE STOP TEST position, each switch is used to test function of the secondary idle stop. Each switch is spring loaded to the OFF (center) position. Refer to Chapter 3, Normal Porcedures for steps of the test. Propeller test circuits are protected by one 10-ampere circuit breaker, placarded PROP GOV IDLE STOP, located on the right subpanel (figure 2-20 or 2-21).

2-94. PROPELLER LEVERS.

2-95. Two propeller levers (20, figure 2-9 or 26, figure 2-10), located on the pilot's control pedestal, are used to regulate propeller speeds. Each lever controls a primary governor, which acts to regulate propeller speeds within the normal operating range. The levers are placarded: HIGH RPM, TAKEOFF, LANDING, REVERSE, and FEATHER. When a lever is placed at HIGH RPM (full feather), the propeller will attain a maximum static RPM of 2050 to 2200 RPM, depending upon ambient temperature and field elevation. As a lever is moved aft, passing through the propeller governing range, but stopping at the feathering detent, propeller RPM will correspondingly decrease to the lowest limit. Moving a propeller lever aft past the detent into FEATHER, will feather the propeller.

2-96. PROPELLER REVERSING.

2-97. The propeller blade angle may be reversed to shorten landing roll. To reverse, propeller levers are positioned at HIGH RPM (full forward), and the power levers are lifted up to pass over an IDLE detent, then pulled aft into REVERSE setting. In REVERSE position, each power lever achieves override of the corresponding secondary idle stop, taking over control of engine power for the Beta and reverse ranges. Power levers must be pulled back through normal idle speed range before being positioned in REVERSE.

NOTE

Propeller levers must be in HIGH RPM position prior to propeller reversing.

2-98. PROPELLER REVERSE NOT-READY LIGHT. One yellow caution light, placarded PROP REV NOT READY, located on the annunciator panel (10, figure 2-13 or 11, figure 2-14) alerts the pilot when it is not appropriate to reverse propellers. This light illuminates only when the landing gear handle is down, and if propeller levers are not at HIGH RPM (full forward). This circuit is protected by a 5-ampere circuit breaker, placarded LDG GR RELAY, located on the left subpanel (figure 2-20 or 2-21).

2-99. PROPELLER SECONDARY LOW-PITCH STOP LIGHTS. Two red fault lights, placarded LH SECONDARY LOW PITCH STOP and RH SECONDARY LOW PITCH STOP, are located on the annunciator panel (10, figure 2-13 or 11, figure 2-14). Illumination of a light indicates malfunction of the normal propeller low-pitch stop, and that a backup system designated the Secondary Idle Stop has started to function for the affected propeller. Propeller is reverse pitch operation must not be attempted while either of these lights are illuminated.

NOTE

A rapid movement of the power levers may cause a false illumination of a light or lights. In this event, press the secondary idle stop test switches to reset the circuit.

2-100. OIL SUPPLY SYSTEM.

2-101. The engine oil tank is integral with the air-inlet casting located forward of the accessory gear box. Oil for propeller operation and lubrication of the reduction gear box is supplied by an external line from the high pressure pump. Two scavange lines return oil to the tank from the propeller reduction gear box. A non-congealing external oil radiator keeps the engine oil temperature within the operating limits. The capacity of each tank is 2.3 U.S. gallons of which 1.5 gallons are usable. This provides an expansion space of 0.70 gallons. The oil level is indicated by a dipstick attached to the oil filler cap. For oil grade, specification and servicing stations, refer to the Servicing Diagram (figure 2-23).

2-102. FUEL SUPPLY SYSTEM.

2-103. The engine fuel supply system (figure 2-15) consists of two separate systems sharing a common fuel management panel and fuel crossfeed system. Fuel for each system is contained in a 57 gallon nacelle tank located in the respective engine nacelle, and four inter-connected wing tanks which have a total of 128 gallons. An automatic crossfeed system enables either engine to use fuel from either system. Fuel level in each nacelle tank is automatically maintained by gravity-fed fuel from the wing tanks. However, approximately 28 gallons in each of the center wing tanks will not gravity feed. This fuel is moved by a submerged transfer pump in each center wing tank. These transfer pumps are energized and de-energized by a fuel quantity sensor in each nacelle tank. The crossfeed of fuel from either nacelle tank to the opposite engine may be manually controlled by the pilot.

NOTE

With a firewall valve closed, the indications of the BOOST PUMP FAIL warning lights will be unreliable.

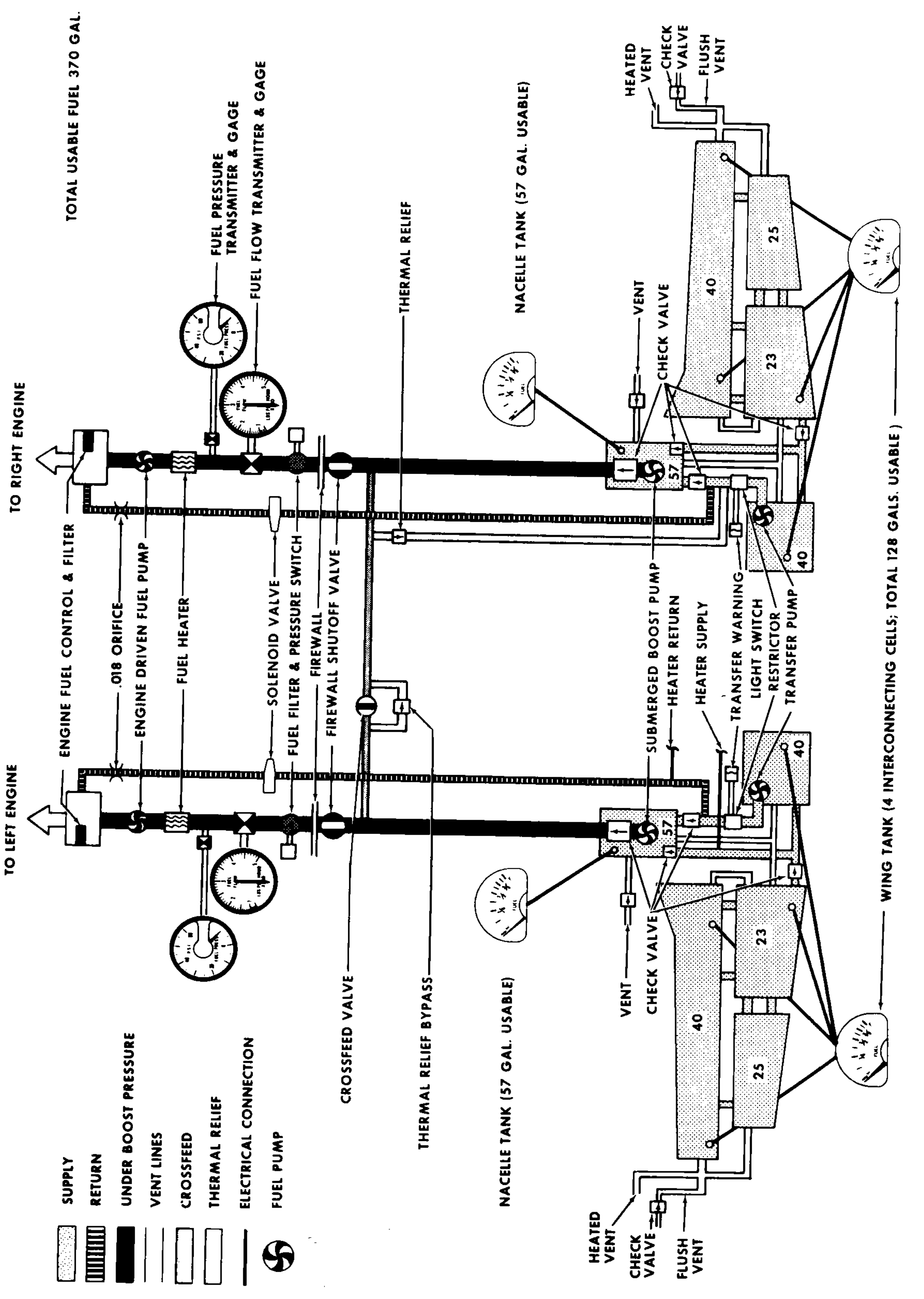


Figure 2-15. Typical fuel system schematic

2-104. Fuel under pressure is supplied to each engine by a submerged boost pump in each nacelle tank. Fuel vents for both the nacelle and wing tanks are protected against icing conditions by electric heating elements. In addition to external heated vents, each fuel system has a flush vent in the underside of its wing. Five tank drains are provided at low points in each fuel system.

2-105. It is the function of the nacelle tank boost pump to deliver pressurized fuel at the suction inlet of a gear-driven, high-pressure fuel pump mounted on the respective engine. Engine operation will quickly terminate if the engine mounted pump fails. However, if a boost pump fails, engine operation can be sustained by the engine-mounted pump alone for a limited time.

CAUTION

Engine-mounted fuel pump operation, without boost pump pressure, is time-limited to 10 hours during the pump TBO. All time in this category will be logged for the attention of maintenance personnel.

NOTE

The pilot is informed of boost pump failure by two lights on the annunciator panel which are active simultaneously. One light is the flashing FAULT WARN button, and the other gives steady illumination of a red fault window displaying words which identify the failed unit (LH BOOST FAIL or RH BOOST FAIL). When alerted to boost pump failure, the pilot can confirm activation of the automatic crossfeed system by the steady glow of a yellow function window having the words FUEL CROSSFEED.

2-106. Engine fuel is supplied from the nacelle tank under pressure from a submerged boost pump. However, fuel supply into the nacelle tank is gravity fed until approximately 28 gallons remain in the center wing stub cell. In the left wing tank system, when fuel level drops to 28 gallons, supply within the gravity feed line falls below the suction inlet tap to the cabin heater pump, terminating combustion of that unit due to fuel starvation. When supply in the nacelle tank is depleted to 10 gallons, the fuel quantity sensor in the nacelle tank activates the submerged transfer pump in the center wing stub cell transfering 14 gallons of fuel into the nacelle tank. This transfer action repeats each time fuel level within the nacelle tank is lowered to 10 gallons, until all remaining fuel in the respective wing tank system has transfered to the nacelle tank.

WARNING

All flight time remaining after fuel in the left wing tanks is depleted below 28 gallons will be conducted without operation of the windshield defroster or the cabin heater. This hazard can be averted, if a sufficient fuel load is carried to satisfy the flight duration without allowing the quantity of fuel available in the left wing tanks to be lowered to 28 gallons.

2-107. Fuel delivered to the engine inlet is preheated to a temperature substantially above freezing. This temperature range is thermostatically regulated between ±21°C to ±32°C an engine oil heater exchanger unit. Volume expansion in the fuel system is relieved by a thermal pressure relief valve. Normally, thermal expansion occurs only during hot weather when the aircraft is in static condition.

2-108. The fuel crossfeed system, which permits the use of fuel from all tanks by either engine, is controlled by an electrically operated solenoid valve in the crossfeed line. The variations in crossfeed system operational procedures required by specific operating conditions are covered in Chapter 4, Emergency Procedures and Chapter 9, Systems Operation. Cockpit control of the fuel system is directed from the Fuel Management Panel (5, figure 2-16) located on the left side of the pilot's compartment. This panel contains the switches for the firewall shutoff valves (left and right), switches for the boost pumps (left and right), switches for the fuel transfer pumps (left and right), a fuel transfer test switch (L and R), a switch for the crossfeed system, and the fuel system circuit breaker panel. Fuel quantity indicators are also included on the panel. For fuel grade, specifications, and servicing stations, refer to the Servicing Diagram, (figure 2-23). The use of alternate fuel grades is permissible, see Chapter 9, Systems Operation.

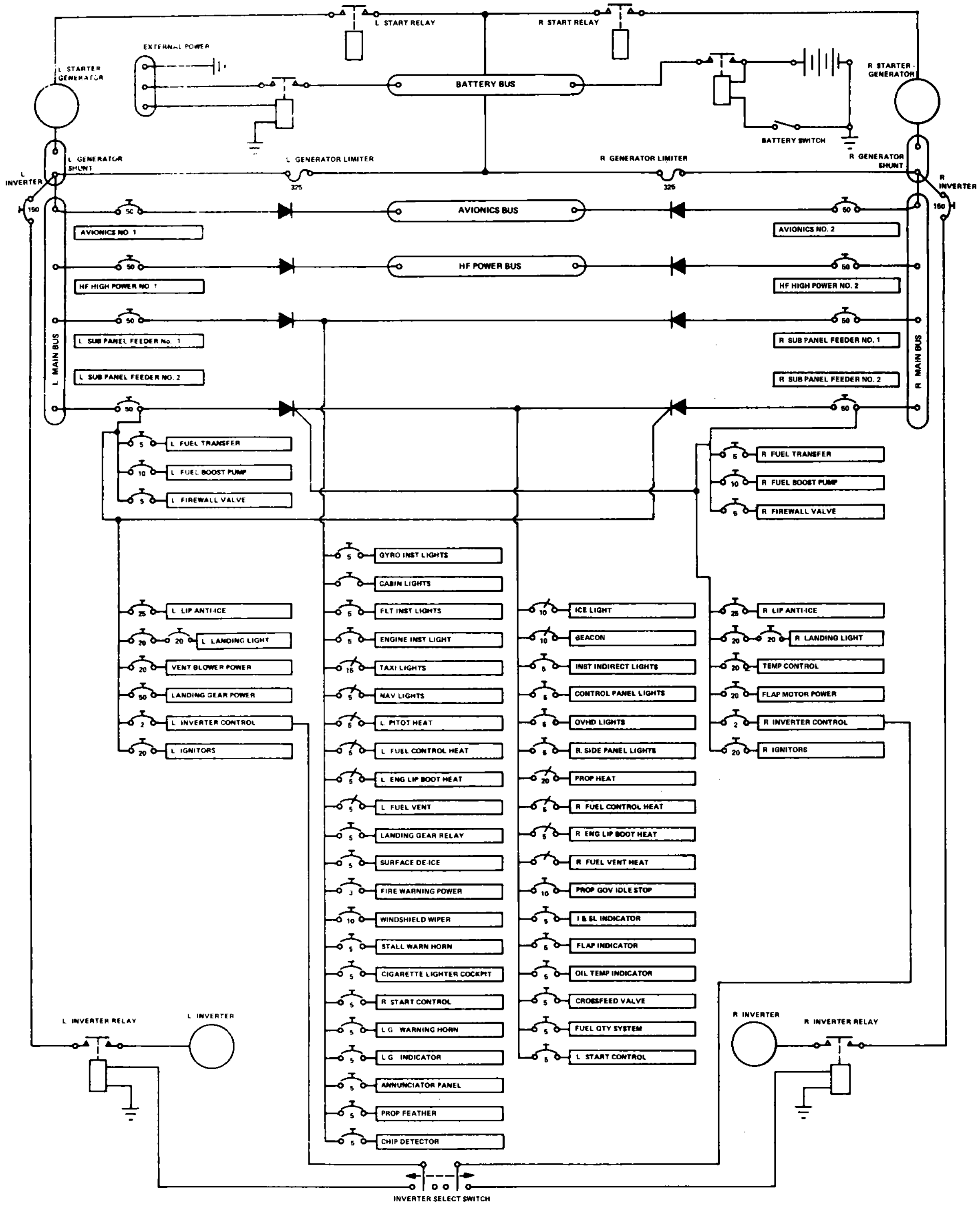


Figure 2-18. Electrical system schematic ***U-21A***

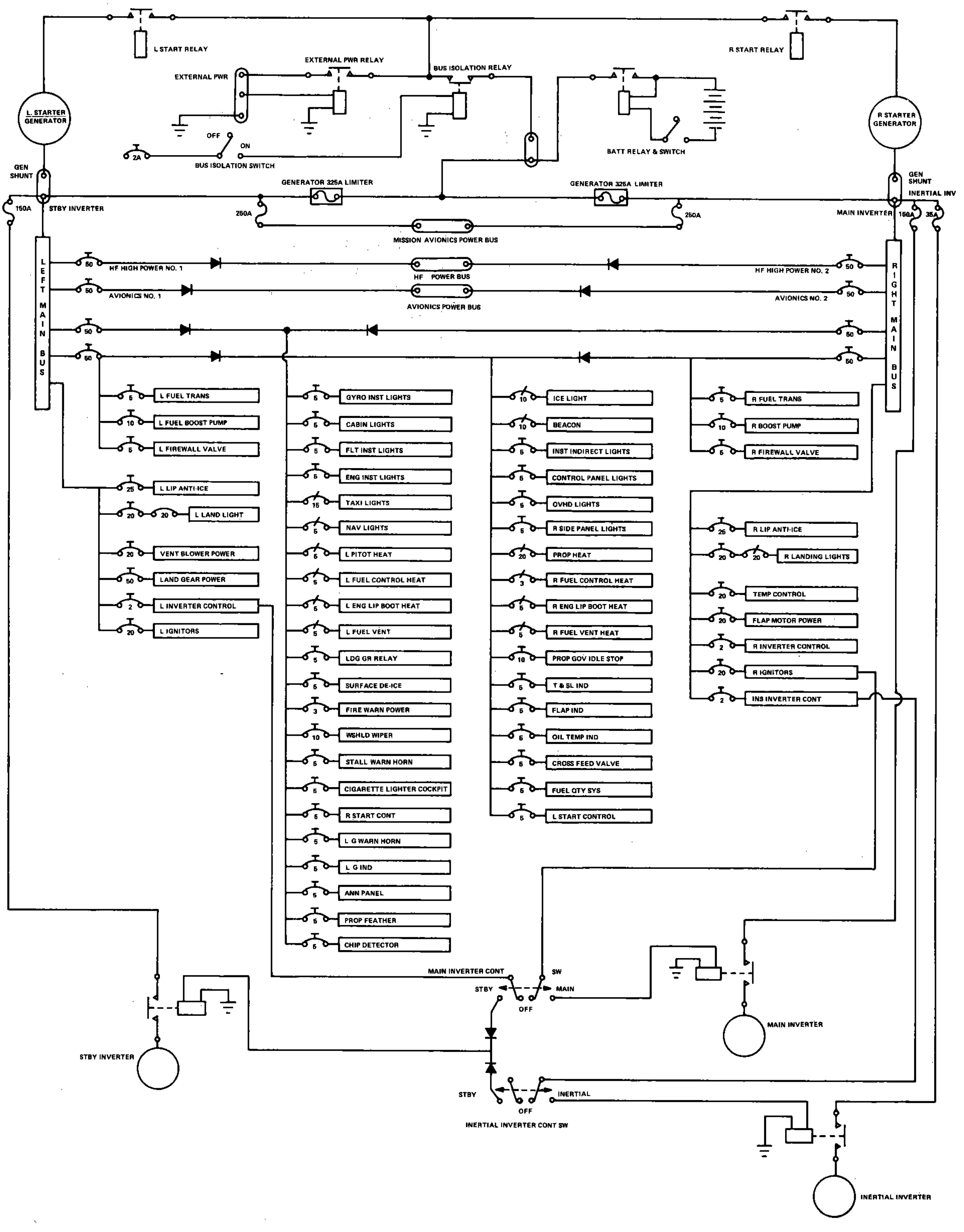


Figure 2-19. Electrical system schematic ***RU-21A***

2-139. GENERATOR OUT WARNING LIGHTS. Two red fault windows, LH GEN OUT and RH GEN OUT, on the annunciator panel (10, figure 2-13 or 11, figure 2-14), inform the pilot when either generator is not contributing current to the aircraft DC bus system. When either fault window illuminates and the flashing FAULT WARN light is active, either the identified generator has completely stopped current production, or voltage is insufficient to keep it coupled with the bus distribution system.

2-140. AC POWER SUPPLY.

2-141. GENERAL DESCRIPTION. (U-21A) Aircraft AC electrical power is supplied by two 2500 volt-ampere, single-phase inverters. These are designated as LEFT and RIGHT units which receive operating current from the DC power system. Aircraft equipment using inverter produced AC includes the following: attitude indicators, TACAN receiver/transmitter, course indicator-selectors, gyro magnetic compass, HF - SSB - AM receiver/transmitter, RMI indicators, flight instrument lights, engine instruments for fuel and oil pressure, fuel flow and torquemeters, and weather radar. Controls and indicators for the AC power system are in the pilot's compartment (figure 2-5), located on the main instrument panel, the annunciator panel, and on the left subpanel. The pilot selects an AC source using the inverter selector switch located on the left subpanel.

2-142. GENERAL DESCRIPTION. (RU-21A) AC power for the aircraft is supplied by three inverter units which obtain operating current from the DC power system. Two inverters, rated at 2500 volt-amperes, are placarded MAIN and STBY. The MAIN inverter provides single-phase output only. The STBY inverter produces either single-phase or three-phase output. The third inverter, rated at 250 volt-amperes, provides three-phase output only, and is placarded INERTIAL. The heaters of the Inertial Navigation System have the only aircraft requirement for three-phase AC. Aircraft equipment operating from single-phase AC include the following: one attitude indicator, the OMNI receiver, ADF receiver, TACAN receiver/transmitter, course indicator-selectors, gyro magnetic compass, HF - SSB - AM receiver/transmitter, RMI indicators, UHF - DF radio group, flight instrument lights, engine instruments for fuel and oil pressure, fuel flow and torquemeters and weather radar. Controls and indicators of the AC power system are in the pilot's compartment (figure 2-5), located on the main instrument panel, the annunciator panel, and on the left subpanel. The pilot selects AC sources using the two inverter select switches located on the left subpanel.

2-143. AC POWER WARNING LIGHTS. All aircraft have one warning and three fault identification windows on the annunciator panel (10, figure 2-13 or 11, figure 2-14), to inform the pilot of circuits which lack AC power. The pilot is warned of AC fault by the flashing red FAULT WARN button on the annunciator panel. Identity of the faulted circuit on the U-21A is given by an illuminated fault window reading: RADIO AC OUT, GYRO AC OUT or ENG AC INST OUT. The RU-21A identity fault windows read: MAIN INV OUT, STBY INV OUT, or INS INV OUT. Failure of either inverter during service will cause illumination of the lights.

2-144. INVERTER CONTROL SWITCH. (U-21A) Inverter selection is controlled by a single three-position INVERTER switch (2, figure 2-11) located on the left subpanel. Switch positions are LEFT, OFF and RIGHT. Neither inverter is a preferred unit allowing the pilot free choice to select either unit. If an inverter fails in service, power may be restored by selecting the alternate unit.

NOTE

When inverters are switched, the standby compass may be affected.

2-145. INVERTER CONTROL SWITCHES. (RU-21A) Two toggle switches, placarded MAIN INVERTER and INERTIAL INVERTER (2 and 4, figure 2-12) located on the left subpanel, are provided to give the pilot a choice of inverters to serve as sources for single-phase and three-phase AC power. Three inverters are involved in this selection (refer to paragraph 2-142) although switch placarding would seem to indicate only two units.

2-146. The MAIN INVERTER switch provides a choice between two 2500 volt-ampere units for single-phase power. At MAIN INVERTER position, the unit selected is capable of single-phase output only, and is intended to provide single-phase power during normal flight operation. STBY position activates the alternate inverter for the single-phase power source, although this unit is intended as a two-way standby and is capable of providing either single-phase or three-phase output, depending upon the mode selected.

NOTE

When the MAIN INVERTER switch is OFF, the aircraft is deprived of all single-phase power regardless of the position of the INERTIAL INVERTER switch.

2-147. The INERTIAL INVERTER switch selects only for three-phase power choosing between a small inverter unit rated at 250 volt-amperes and the large 2500 volt-ampere unit in its three-phase standby mode. At INERTIAL INVERTER (up) setting, either both inverters or the small unit will be selected. When the inertial navigation set is first turned on, automatic switching in the inverter select circuitry will energize the large standby inverter in addition to the small inverter. The three-phase output of the large inverter will be used for initial warm up of the heaters in the gyro-stabilized platform. When the initial warmup period is completed, automatic switching will turn off the large inverter and apply the output of the small inverter to the gyro-stabilized platform. If the inertial navigation set is not turned on, or if the initial warmup has been completed, the INERTIAL INVERTER (up) setting will select only the small inverter. The small inverter produces three-phase AC output only and is intended to serve as the three-phase source during normal flight operations, following the warmup period of the inertial gyros. OFF (center) setting, deprives the aircraft of all three-phase power. At STBY setting, the large two-way inverter is activated in the three-phase output mode.

NOTE

When the INERTIAL INVERTER switch is OFF, the aircraft is deprived of all three-phase power, regardless of the position of the MAIN INVERTER switch.

2-148. INVERTER CONTROL CIRCUIT BREAKERS. ***U-21A*** Both inverter units are protected by two 2-ampere circuit breakers, placarded INVERTER CONTROL, LEFT and RIGHT, located on the copilot's circuit breaker and fuse panel (figure 2-20). Each circuit breaker controls current to a holding coil within the corresponding inverter power relay. Further protection consists of a temperature-actuated switch capable of stopping DC flow to the power relay.

2-149. INVERTER CONTROL CIRCUIT BREAKERS. ***RU-21A*** All inverter units are protected by circuit breakers located on the copilot's circuit breaker and fuse panel (figure 2-21). The INERTIAL INVERTER breaker is a 2-ampere unit placarded INRTL NAV INVERTER CONTROL. Two INVERTER CONTROL breakers rated at 2-amperes each, placarded LH (main) and RH (standby), protect the large inverters. LH circuit breaker is for the MAIN INVERTER, capable of single-phase only. Added protection consists of a temperature-actuated switch capable of stopping DC flow to the power relay.

2-150. DC EXTERNAL POWER SOURCE.

2-151. External DC power can be applied to the aircraft through an external power receptacle (7, figure 2-23), accessible at the underside of the right wing leading edge adjacent to the nacelle outboard side. This receptacle is installed inside of the wing structure and is accessible through a hinged access panel. DC power is supplied through the DC external plug and applied directly to the battery bus after passing through the external power relay. The holding coil circuit of the relay is energized by the external power source. The use of external power is independent of battery master switch control.

2-152. AC EXTERNAL POWER SOURCE. ***RU-21A***

2-153. Single-phase AC power may be applied to the aircraft through an external receptacle. This receptacle is located on the underside of the left wing near the leading edge outboard of the nacelle, and is accessible through a hinged access panel. Power introduced at the receptacle is applied to the input terminal of the switching relay through which it must pass to reach aircraft circuits. The relay is controlled by an EXTERNAL POWER switch (7, figure 2-12) on the left subpanel.

(Deleted)

2-183. LANDING GEAR SYSTEM.

2-184. The landing gear is a retractable, tricycle type, electrically operated by a single DC motor. This motor drives the main landing gear actuators through a gear box and torque tubes arrangement, and powers a chain drive mechanism to control position of the nose gear. Three spring-loaded locks secure the gear in the extended position, whilethe jackscrew in each actuator holds the gear in the retracted position. A friction clutch between the gearbox and the torque shafts protects the motor from overloads in the event of systems mechanical malfunction. A 50-ampere push-to-reset type circuit breaker, placarded LANDING GEAR POWER, and located on the copilot's circuit breaker and fuse panel (figure 2-20 or 2-21) protects against electrical overloads. Gear doors are opened and closed mechanically through a linkage with the landing gear. Nose wheel steering mechanism design is such that when the landing gear is retracted, the nose wheel is automatically centered and the rudder pedals relieved of the steering load. Air-oil type shock struts, filled with compressed air and hydraulic fluid, are incorporated with the landing gear. Direct linkage from the rudder pedals turns the nose wheel 12° to the left of center and 14° to the right. When the rudder control is augmented by the brake, the nose wheel can be deflected up to 48° to either side of center.

2-185. LANDING GEAR CONTROL SWITCH.

2-186. Landing gear system operation is controlled by a single, manually actuated wheel-shaped switch (25, figure 2-11 or 28, figure 2-12), placarded LDG GEAR CONT, located on the right subpanel. This switch has two position settings, placarded UP or DOWN.

2-187. LANDING GEAR POSITION INDICATION LIGHTS.

2-188. Indication of landing gear position is provided by three green indicator lights (3, figure 2-9 or 2-10). These lights have a press-to-test feature, are placarded GEAR DOWN, and are located on the pilot's control pedestal. The circuit is protected by one 5-ampere fuse, placarded LG IND, located on the right subpanel.

2-189. LANDING GEAR POSITION WARNING LIGHTS.

2-190. Two red bulbs, wired in parallel, are positioned inside the clear plastic grip on the landing gear control handle (33, figure 2-11 or 36, figure 2-12). These lights illuminate whenever the landing gear handle is in either the UP or DOWN position and the gear is intransit. The lights will illuminate when one or both power levers are retarded past the horn and light microswitch and all gears are not down and locked. To turn the handle lights OFF, during single-engine operation, the power lever for the inoperative engine must be advanced to a position which is higher than the setting of the warning horn microswitch. Lowering the gear will also turn the lights off. Both red lights indicate the same warning conditions, but two are provided for a failsafe indication in the event one bulb burns out. For circuit test, see paragraph 2-194. The circuit is protected by a 5-ampere circuit breaker, placarded LDG GR RELAY, located on the right subpanel (figure 2-20 or 2-21).

2-191. LANDING GEAR WARNING HORN.

2-192. When either power lever is retarded past a warning horn and light microswitch, with the gear not down and locked, a warning horn located behind the instrument panel on the left side will sound intermittently. The circuit is protected by a 5-ampere circuit breaker, placarded LG WARN HORN, located on the right subpanel (figure 2-20 or 2-21).

2-193. LANDING GEAR WARNING HORN SILENCER BUTTON. The landing gear horn can be deactivated during operation with the power retarded, gear and flaps up, by pressing the button placarded WARN HORN SILENCER (35, figure 2-11 or 38, figure 2-21) located on the right subpanel. After silencing the warning horn, it will remain silent until either the flaps are lowered or the power levers are advanced, then retarded again. During single-engine operation, the warning horn may be silenced by either pressing the warning horn silencing button (flaps UP) or advancing the power lever of the inoperative engine to a position above the warning horn microswitch. If the warning horn has been silenced by pressing the silencer button, the power lever of the inoperative engine must again be advanced past the warning horn microswitch to reset the circuit. The circuit is protected by a 5-ampere circuit breaker, placarded LG WARN HORN (figure 2-20 or 2-21).

2-194. LANDING GEAR WARNING LIGHT TEST BUTTON. A landing gear warning light test button, placarded HDL LT TEST (32, figure 2-11 or 35, figure 2-12), is located on the right subpanel. Failure of the landing gear handle to illuminate red, when the test button is pressed, indicates two defective bulbs or a circuit fault. The circuit is protected by a 5-ampere circuit breaker, placarded LDG GR RELAY, located on the right subpanel (figure 2-20 or 2-21).

2-195. LANDING GEAR SAFETY SWITCH.

2-196. When the right main strut is compressed, a safety switch on that strut deactivates the landing gear control circuit. This safety switch also actuates a solenoid-operated downlock hook, preventing the landing gear handle from being raised while the aircraft is on the ground. The hook unlocks automatically when the aircraft leaves the ground, but can be manually overridden by pressing down on the red button, placarded DN LK REL (34, figure 2-11 or 37, figure 2-12), located adjacent to the gear handle.

2-197. EMERGENCY LANDING GEAR EXTENSION HANDLE.

2-198. The landing gear emergency extension handle (14, figure 2-9 or 16, figure 2-10), located on the floorboard right of the pilot's seat, is used for manual extension of all landing gear, after the landing gear clutch has been disengaged. (Reference paragraph 2-199.) The handle is actuated by pumping up and down, which operates a ratcheted gear attached to the actuating torque tube, enabling the gear to be extended but not retracted. Refer to Chapter 4, Section VIII, for emergency gear extension procedures.

NOTE

Approximately 50 full travel cycles of the handle are required to extend and lock the landing gear.

2-199. EMERGENCY LANDING GEAR CLUTCH DISENGAGE LEVER.

2-200. During manual landing gear extension, the landing gear motor must be disengaged from the landing gear drive mechanism. This is accomplished with a manually operated clutch disengage lever located adjacent to the emergency landing gear extension handle, (12, figure 2-9 or 14, figure 2-10). To disengage the clutch, pull up the clutch lever and turn clockwise. To engage the clutch, turn the clutch lever counterclockwise and release.

2-201. STEERABLE NOSE WHEEL.

2-202. The aircraft can be maneuvered on the ground by the steerable nose wheel system. The system is manually controlled by direct mechanical linkage from the rudder pedals to the steerable nose wheel. Shock loads, which would normally be transmitted to the rudder pedals are absorbed by a spring mechanism in the steering linkage. Retraction of the landing gear automatically centers the nose gear and disengages the steering linkage from the rudder pedals.

2-203. WHEEL BRAKE SYSTEM.

2-204. The main landing wheels are equipped with multiple-disc type hydraulic brakes actuated by master cylinders at the rudder pedals of either the pilot's or copilot's position. A shuttle valve adjacent to each set of pedals permits changing braking action from one set of pedals to the other. Brake fluid is supplied to the system from the reservoir in the nose compartment. The toe brake sections of the rudder pedals are connected to the master cylinders which actuate the system for the corresponding wheels. No emergency brake system is provided. Refer to paragraph 2-205 for parking brake operation.

2-205. PARKING BRAKE HANDLE.

2-206. Dual parking brake valves are installed adjacent to the rudder pedals between the master cylinders of the pilot's rudder pedals and the wheel brakes. After the pilot's brake pedals have been pressed to build up pressure in the brake lines, both valves can be closed simultaneously by pulling out the parking brake handle (1, figure 2-11 or 2-12), placarded PARKING

14. Right compartment access panel - CHECK.

(O) 15. Drift sight window - CHECK.

16. Battery compartment access panel - CHECK.

f. Right engine and prop.

1. Left cowl locks - LOCKED.

2. Left exhaust port - CHECK. Check free of obstructions.

* 3. Nacelle air intake - CHECK. Check free of obstructions.

4. Nacelle lip ice boot - CHECK. Check condition and security.

* 5. Oil cooler air intake - CHECK. Check free of obstructions and leakage.

* 6. Propeller blades and spinner - CHECK. Check blades for nicks, security of spinner, and free rotation.

7. Right cowl locks - LOCKED.

8. Right exhaust port - CHECK. Check free of obstructions.

9. Engine compartment and oil - CHECK. Check for fuel and oil leaks, oil level and positively secure oil cap.

NOTE

If engine has set idle for more than 12 hours, the engine must be motored approximately 20-30 seconds before an oil level check is reliable.

10. Engine compartment access door - LOCKED.

* 11. Nacelle tank fuel and cap - CHECK. Check fuel level visually. Check seal is installed and cap is tight.

g. Right main landing gear.

* 1. Tire - CHECK. Check for cuts, bruises, wear, and proper inflation.

2. Brake assembly - CHECK. Check brake lines for damage or signs of leakage, and brake pucks for wear.

* 3. Shock strut - CHECK. Check for leakage and a 3 inch extension.

4. Torque knee - CHECK.

5. Safety switch - CHECK.

6. Wheel well condition - CHECK. Check for fuel and oil leaks.

* 7. Doors and linkage - CHECK.

h. Right wing.

1. Inverter air intake and exhaust screens - CHECK. Check free of obstructions.

2. Wing ice light - CHECK.

* 3. Wing tanks fuel and cap - CHECK. Check fuel level visually. Check seal is installed and cap is tight.

4. Deicer boot - CHECK. Check bonding secure and free of cuts and cracks.

* 5. Tiedown - RELEASED.

6. Landing lights - CHECK.

7. Wing tip and navigation lights - CHECK.

8. Static wicks - CHECK.

9. Controls and trim tabs - CHECK. Check hinge attachment and trim tap rig.

10. Skin conditions - CHECK. Check for skin damage, such as buckling, cracking, splitting, distortion or dents.

i. Fuselage right side.

1. Skin condition - CHECK. Check for skin damage, such as buckling, cracking, splitting, distortion or dents.

2. Cabin air exhaust vent - CHECK. Check free of obstructions.

* 3. Antennas - CHECK. Check for security.

4. Static ports - CHECK. Check for freedom from dirt or obstructions.

* 5. Tiedown - RELEASED.

j. Empennage.

1. Deicer boots (right side) - CHECK. Check bonding secure and free of cuts and cracks.

2. Controls and trim tabs - CHECK. Check hinge attachment and trim tab rig.

3. Static wicks - CHECK.

4. Navigation and rotating beacon lights-CHECK.

5. Skin condition - CHECK. Check for skin damage, such as buckling, cracking, splitting, distortion or dents.

6. Deicer boots (left side) - CHECK. Check bonding secure and free of cuts and cracks.

k. Fuselage left side.

1. Cabin air exhaust vent - CHECK. Check free of obstructions.

2. Static port - CHECK. Check for freedom from dirt or obstructions.

(O) 3. INS air intake and exhaust ports - CHECK. Check free of obstructions.

4. Skin condition - CHECK. Check for skin damage, such as buckling, cracking, splitting, distortion or dents.

5. Cabin doors - CHECK.

NOTE

If desired, fuel and oil quantity and fuel drain checks may be performed prior to exterior check to preclude carrying drain bottle or ladder around during the inspection.

3-16. *INTERIOR CHECK.

1. Ladder - STOWED.

* 2. Cargo door - LOCKED.

* 3. Cabin door - LOCKED, chain secured.

4. Escape hatch - SECURED, safety seal intact.

* 5. Cargo and loose equipment - SECURED.

* 6. Personnel briefing - COMPLETED. This will include but not be limited to the following: Emergency exit procedures, bail out procedures, location of emergency equipment, and use of oxygen equipment.

3-17. BEFORE STARTING ENGINES.

* 1. Seats, pedals, belts, harnesses - AD-

(O) 2. Pilot's, copilot's and passenger's/crewmembers oxygen equipment - CHECK.

NOTE

During night operation, battery switch may be turned ON if interior lighting is desired.

3. Overhead panel switches - SET.

4. Magnetic compass - CHECK. Check for fluid and heading.

5. Free air temperature gage - NOTE CURRENT READING.

6. Fire detection switch - OFF.

* 7. Power levers - IDLE.

CAUTION

Do not position the power levers into the REVERSE range while the engines are shut down. Reverse pitch linkage damage will result.

* 8. Propeller levers - HIGH RPM.

* 9. Condition levers - FUEL CUTOFF.

10. Flap switch - CHECK UP.

11. INS switch - OFF.

12. UHF radio - OFF.

13. Emergency gear extension clutch handle - STOWED.

14. Emergency gear extension handle - STOWED.

15. Fuel system circuit breakers - CHECK. Check circuit breakers set.

16. Boost pump switches - OFF.

17. Transfer pump switches - OFF.

18. Crossfeed valve switch - CLOSED.

19. Pilot's audio control panel - SET.

20. Marker beacon/glideslope receiver - OFF.

21. Pilot's flight instruments - CHECK. Check for correct readings.

22. Compass slave switch - MAG.

* 23. Engine instrumentst - CHECK. Check readings, placards, and slippage marks.

24. Navigation radios and radar equipment - OFF.

(O) 25. MD-1 and MC-1 gyro select switches - SET on No. 1 POSITION.

26. Copilot's flight instruments - CHECK.

27. Emergency static air source - NORMAL OFF.

28. Copilot's audio control panel - SET.

29. Copilot's circuit breaker and fuse panel - CHECK. Check circuit breakers in.

30. Right subpanel circuit breakers - CHECK. Check circuit breakers in.

31. Vent blower switch - OFF.

32. Heater control switch - OFF.

33. Landing gear handle - DOWN.

34. Left subpanel light switches - OFF.

35. Deice cycle switch - OFF.

36. Auto feather switch - OFF.

37. Heat switches - OFF.

(O) 38. External power switch - OFF.

39. Landing light switches - OFF.

40. Engine ice vanes - AS REQUIRED.

41. Igniter power switches - OFF.

42. Ignition and starter switches - STOP (center).

* 43. Inverter switches - OFF.

3-18. *STARTING ENGINES — INS MISSION *RU-21A*

NOTE

In an emergency, engine starts may be made with battery power, provided all electric equipment is off.

3-19. Starting procedure is identical for both engines. Start the left engine first, as the APU receptacle is located on the right engine nacelle.

WARNING

Exposure to exhaust gases should be avoided since some exhaust gases are an irritant to eyes, skin and respiratory system.

CAUTION

Even through the intake velocity is relatively low, the immediate area of the engine intake must be free of loose objects, sand, grit, rags, and spilled fluids to prevent contamination and foreign object damage to the engine. Inertial separator vanes should be extended before operating on loose surfaces.

CAUTION

Occasionally, during starting, excess fuel accumulation in the combustion chamber causes flames to be blown from the exhausts. The area should be clear of inflammable materials.

1. DC APU - CONNECT.

2. Battery switch - ON

(N) 3. Navigation lights switch - ON.

4. Main inverter switch - STBY check. Check MAIN INV OUT light is ON and STBY INV OUT light is OFF.

5. Main inverter switch - MAIN check. Check MAIN INV OUT light is OFF.

6. Inertial inverter switch - STBY check. Check STBY INV OUT light is OFF.

7. Inertial inverter switch - INERTIAL check. Check INRTL INV OUT light is OFF.

8. INS switch - ON. Perform required alignment procedure described in Chapter 5.

NOTE

Step "8" must be accomplished before proceeding to other steps.

9. Annunciator panel lights - TEST.

10. Landing gear handle lights - TEST.

11. Fire detection system - TEST.

12. Fuel control HEAT SWITCHES - ON.

13. Generator switches - OFF.

14. Boost pumps switches - ON.

15. Propellers - CLEAR. (See figure 3-2, Exhaust danger area).

3-19a. *FIRST ENGINE START.

1. Ignition/start switch - ON (up). Check ignition light.

CAUTION

If the N_1 tachometer immediately indicates about 20%, abort the start.

NOTE

If starter does not operate, check the generator RESET and the battery fault light.

2. N_1 tachometer - CHECK. Check above 12% (4500 rpm) and stabilized for approximately 5 seconds.

3. Condition lever - LO IDLE. Monitor ITT.

CAUTION

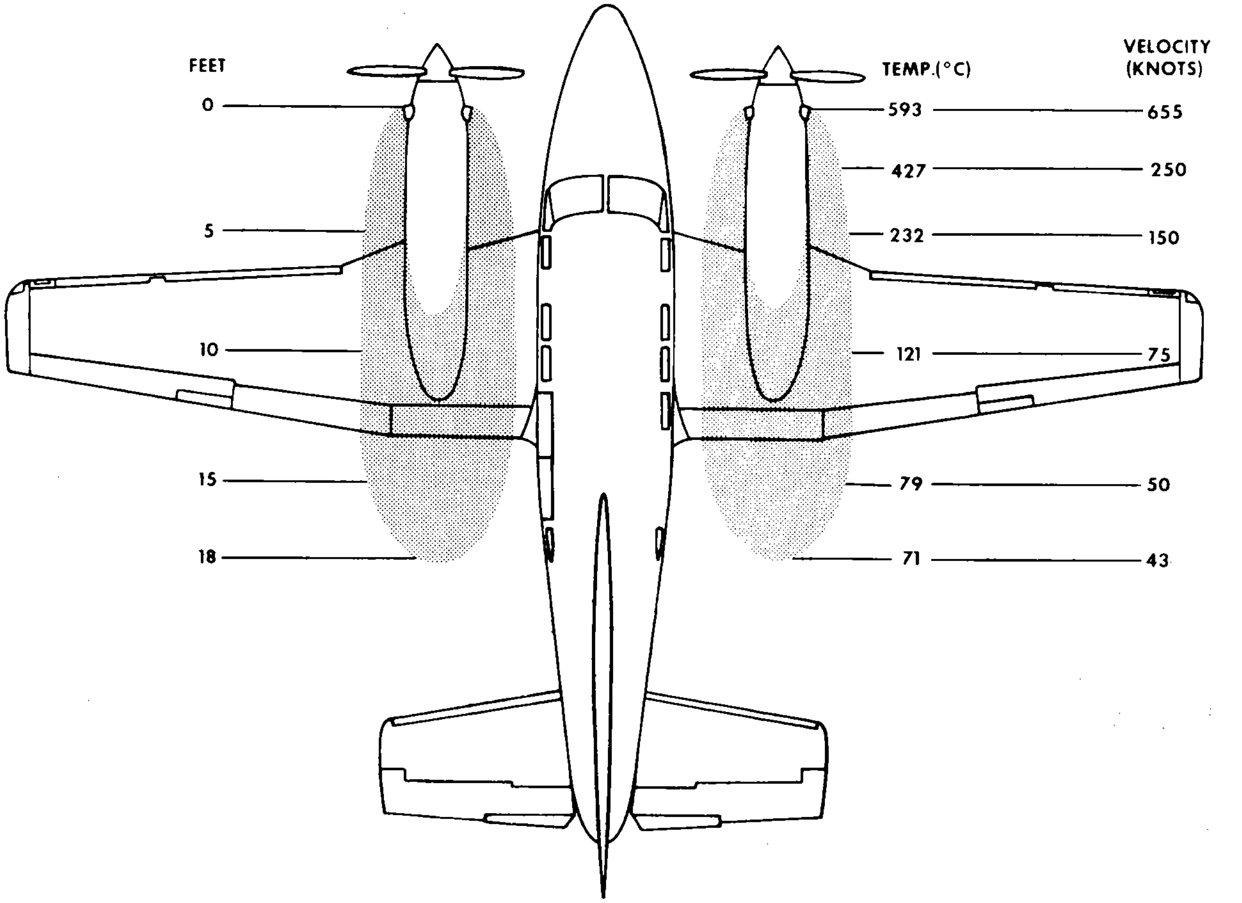
Monitor ITT to avoid a hot start. If there is a rapid rise in ITT, be prepared to abort the start before limits are exceeded. During starting, the maximum allowable ITT is 1090°C for two seconds. If this limit is exceeded, discontinue start and record the peak temperature and duration on DA Form 2408-13.

CAUTION

Whenever the gas generator fails to ignite properly within 10 seconds after moving the condition lever to LOW IDLE, position the condition lever to FUEL CUTOFF and the ignition/start switch to OFF. Allow a 30 second delay to drain fuel, then motor the engine by placing the ignition/start switch in the STARTER ONLY position. If for any reason a starting attempt is discontinued, the entire sequence must be repeated after allowing the engine to come to a complete stop.

4. Ignition/start switch - STOP (center), after ITT has stabilized.

5. Condition lever - HIGH IDLE. Monitor engine temperature limits.



EXHAUST DANGER AREA AT TAKE-OFF POWER (NO PROPELLER BLAST)

NOTES

THE EXHAUST DANGER AREA DOES NOT INCLUDE PROPELLER WAKE WHICH INCREASES VELOCITY, AND SIGNIFICANTLY REDUCES TEMPERATURE.

EXHAUST GAS TEMPERATURE AND VELOCITY AT GROUND IDLE IS VERY LOW, HOWEVER, THE IMMEDIATE AREA OF EXHAUST DISCHARGE SHOULD BE AVOIDED.

Figure 3-2. Exhaust danger area

6. Generator switch - ON.

7. Oil pressure - CHECK (40 PSI minimum).

8. Fuel pressure - CHECK (15 PSI minimum).

9. DC APU - DISCONNECT.

3-19b. *SECOND ENGINE START.

1. Ignition/start switch - ON (up). Check ignition light.

CAUTION

If the N_1 tachometer immediately indicates about 20%, abort the start.

2. N_1 tachometer - CHECK. Check above 12% (4500 rpm) and stabilized for approximately 5 seconds.

3. ITT operating engine - CHECK. Check that temperature does not exceed operating limit.

CAUTION

Monitor ITT to avoid a hot start. If there is a rapid rise in ITT, be prepared to abort the start before limits are exceeded. During starting, the maximum allowable ITT is 1090°C for two seconds. If this limit is exceeded, discontinue start and record the peak temperature and duration on DA Form 2408-13.

NOTE

Overtemperature condition may occur on the operating engine if battery or generator output is low during the second engine start. If overtemperature occurs, discontinue starter operation.

4. Condition lever - LO IDLE. Monitor ITT.

CAUTION

Whenever the gas generator fails to ignite properly within 10 seconds after moving the condition lever to LOW IDLE, position the condition lever to FUEL CUTOFF and the ignition/start switch to OFF. Allow a 30 second delay to drain fuel, then motor the engine by placing the ignition/start switch in the STARTER ONLY position. If for any reason a starting attempt is discontinued, the entire sequence must be repeated after allowing the engine to come to a complete stop.

5. Ignition/start switch - STOP (center), after ITT has stabilized.

6. Generator switch - ON.

7. Oil pressure - CHECK (40 PSI min - mum).

8. Fuel pressure - CHECK (15 PSI minimum).

9. Instrument air pressure - CHECK.

10. Pneumatic pressure - CHECK.

11. Condition levers - LO IDLE.

3-20. *STARTING ENGINES — NO INS MISSION *U-21A, RU-21A,*

3-21. Starting procedure is identical for both engines. Start the right engine first, as this will provide higher voltage to the starter.

NOTE

For APU start, start left engine first as the APU receptacle is located on the right engine nacelle. Use normal start procedure, disconnect APU after N_1 and ITT stabilize.

WARNING

Exposure to exhaust gases should be avoided since some exhaust gases are an irritant to eyes, skin and respiratory system.

CAUTION

Even through the intake velocity is relatively low, the immediate area of the engine intake must be free of loose objects, sand, grit, rags and spilled fluids to prevent contamination and foreign object damage to the engine. Inertial separator vanes should be extended before operating on loose surfaces.

CAUTION

Occasionally, during starting, excess fuel accumulation in the combustion chamber causes flames to be blown from the exhausts. The area should be clear of inflamable materials.

1. Battery switch - ON.

(N) 2. Navigation lights switch - ON.

3. Annunciator panel lights - TEST.

4. Landing gear handle lights - TEST.

5. Fire detection system - TEST.

6. Fuel control heat switches - ON.

7. Generators switches - OFF.

8. Boost pumps switches - ON.

9. Propellers - CLEAR. (See figure 3-2, Exhaust danger area).

3-21a. *FIRST ENGINE START.

1. Ignition/start switch - ON (up). Check ignition light.

CAUTION

If the N_1 tachometer immediately indicates above 20%, above the start.

2. N_1 tachometer - CHECK. Check above 12% (4500 RPM) and stabilized for approximately 5-seconds.

3. Condition lever - LO IDLE. Monitor ITT.

CAUTION

Monitor ITT to avoid a hot start. If there is a rapid rise in ITT, be prepared to abort the start before limits are exceeded. During starting, the maximum allowable ITT is 1090°C for two seconds. If this limit is exceeded, discontinue start and record the peak temperature and duration on DA Form 2408-13.

CAUTION

Whenever the gas generator fails to ignite properly within 10 seconds after moving the condition lever to LOW IDLE, position the condition lever to FUEL CUT-OFF and the ignition/start switch to OFF. Allow a 30 second delay to drain fuel, then motor the engine by placing the igntion/start switch in the STARTER ONLY position. If for any reason a starting attempt is discontinued, the entire sequence must be repeated after allowing the engine to come to a complete stop.

4. Ignition/start switch - STOP (Center), after ITT has stabilized.

5. Condition lever - HIGH IDLE. Monitor engine temperature limits.

6. Generator switch - ON.

(O) 7. Inverter switch - RIGHT, CHECK. Check for absence of AC OUT lights on annunciator panel.

(O) 8. Main Inverter switch - STBY check. Check MAIN INV OUT light is ON and STBY INV OUT light is OFF.

9. Oil pressure - CHECK (40 PSI minimum).

10. Fuel pressure - CHECK (15 PSI minimum).

CAUTION

Current limiter failure (due to low battery charge) may be avoided if start of the second engine is delayed until the electrical load, as registered by the volt loadmeter of the operating engine, is dropp ped to a level of 1/2 full scale load (or approximately 125-amperes).

3-21b. *SECOND ENGINE START.

1. Ignition/start switch - ON (up). Check ignition light.

CAUTION

If the N_1 tachometer immediately indicates above 20%, abort the start.

2. N_1 tachometer - CHECK. Check above 12% (4500 rpm) and stabilized for approximately 5 seconds.

3. ITT operating engine - CHECK. Check that temperature does not exceed operating limit.

CAUTION

Monitor ITT to avoid a hot start. If there is a rapid rise in ITT, be prepared to abort the start before limits are exceeded. During starting, the maximum allowable ITT is 1090°C for two seconds. If this limit is exceeded, discontinue start and record the peak temperature and duration on DA Form 2408-13.

NOTE

Overtemperature condition may occur on the operating engine if battery or generator output is low during the second engine start. If overtemperature occurs, discontinue starter operation.

4. Condition lever - LO IDLE. Monitor ITT.

CAUTION

Whenever the gas generator fails to ignite properly within 10 seconds after moving the condition lever to LOW IDLE, position the condition lever to FUEL CUTOFF and the ignition/start switch to OFF. Allow a 30 second delay to drain fuel, then motor the engine by placing the ignition/start switch in the STARTER ONLY position. If for any reason a starting attempt is discontinued, the entire sequence must be repeated after allowing the engine to come to a complete stop.

5. Ignition/start switch - STOP (center), after ITT has stabilized.

6. Generator switch - ON.

(O) 7. Inverter switch - LEFT, CHECK. Check for absence of AC OUT lights on annunciator panel.

(O) 8. Main inverter switch - MAIN check. Check MAIN INV OUT light is OFF.

9. Oil pressure - CHECK (40 PSI minimum).

10. Fuel pressure - CHECK (15 PSI minimum).

11. Instrument air pressure - CHECK.

12. Pneumatic pressure - CHECK.

13. Condition levers - LO IDLE.

3-22. ABORT START

1. Condition lever - FUEL CUTOFF.

2. Ignition/start switch - STARTER ONLY.

3. ITT - MONITOR. Monitor for drop in temperature.

4. Ignition/start switch - STOP (Center).

3-23. ENGINE CLEARING PROCEDURE.

1. Condition lever - FUEL CUTOFF.

2. Ignition/start switch - STOP (Center).

3. Ignition/start switch - STARTER ONLY for 30 to 45 seconds.

CAUTION

Observe starter limits of 2 minutes ON, 3 minutes OFF, 2 minutes ON, 30 minutes OFF.

4. Ignition/start switch - STOP (center).

3-24. *BEFORE TAXIING.

1. Radios - ON. Communication and navigation radios ON, radar and XPDR STBY.

2. Vent blower switch - AS REQUIRED.

3. Heater switch - AS REQUIRED.

4. Radios - CHECK. Check operation as required.

(O) 5. Autopilot system - CHECK. Check as follows:

NOTE

In the RU-21A, the autopilot shares gyro references derived from the Inertial Navigation System, and will not function except during INS operation.

(1) Aircraft and autopilot controls - CENTER.

(2) Autopilot ENGAGE switch - ON. (Accomplish per Chapter 5, Section VI.)

(3) Move TURN control to the left (l), then to the right (R) - check that aircraft control wheel follows movement.

NOTE

Intermediate positions of the control wheel are hard to obtain since there is no balance signal from the servos or control surfaces when the aircraft is not in flight.

(4) Rotate PITCH trim control wheel forward (down) - CHECK. Check that control column and trim tab control wheel follows movement.

(5) Press autopilot ALT switch ON - check switch remains ON.

(6) Rotate the PITCH trim control wheel - check ALT switch goes OFF.

(7) ILS frequency - SET.

(8) Pilot's course indicator switch - VOR.

(9) ILS/VOR switch - ON.

(10) Control wheel and course deviation indicator on the same side - check.

(11) Move the TURN control out of detent - check ILS/VOR switch is OFF.

(12) Autopilot ENGAGE switch (pilot's control wheel) - OFF, check autopilot is disengaged.

6. Taxi clearance - CHECK.

7. Clock - SET.

8. Altimeter - SET.

9. Chocks - REMOVED.

10. Parking brake - RELEASED.

3-25. *TAXIING.

3-26. Normal taxi operations are started from a slow straight-ahead roll using engine power as required to initiate movement. Normally 70% N_1 is effective on smooth level surfaces. Taxi speed can be effectively controlled by the use of power application and the use of the variable pitch propellers in the Beta range. Normal turns may be made with the steerable nosewheel, however, a turn may be tightened by using full rudder and inside brake as necessary. Turns should not be started with brakes alone, nor should the aircraft be pivoted sharply on one main gear. The turning range of the nosewheel provides a reasonably tight turn, with a 9 foot 4 inch turning radius of the inside wheel (figure 2-4). Observe gyro instruments during turns for proper response. While taxiing perform the following checks:

1. Brakes - CHECK.

2. Flight instruments - CHECK. Check settings and operation.

3-27. ENGINE RUNUP

3-28. Stop aircraft headed into wind if possible with nose wheels centered and perform the following checks:

* 1. Nose wheel - CENTERED.

NOTE

The nose wheel cannot be straightened with rudder pedals when the aircraft is stopped.

* 2. Parking brake - SET (keep feet on rudder pedals).

NOTE

Parking brake can be set from pilot's seat only.

* 3. Power levers - IDLE.

4. Condition levers - LOW IDLE.

★ * 5. Crossfeed - CHECK. Check by setting switch to OPEN. Check that crossfeed light illuminates, then set switch to AUTO.

★ * 6. Boost pumps - CHECK. Check by turning off and checking for fuel pressure drop, boost pump fail/crossfeed light ON, then reset boost pump switches ON.

NOTE

Whenever the boost pump fail/crossfeed light illuminates due to the boost pump switch being turned OFF, the light will stay on after the boost pump is turned ON again, until the crossfeed switch is CLOSED, and then set to AUTO.

★★ 7. Fuel transfer pumps - CHECK. Check as follows:

(1) Transfer test switch - hold "R".

(2) Right transfer pump switch (while watching annunciator panel) - ON.

(3) RH NO FUEL TRANSFER light - CHECK. Check for momentary flash.

NOTE

Steady illumination indicates a transfer pump system fault.

(4) Repeat check procedure for left transfer pump system.

8. Flaps - CHECK. Check operation of 4 panels.

9. Propeller feathering - CHECK. Check by pulling prop lever through detent to FEATHER. Check that prop feathers, then advance prop lever to high RPM.

CAUTION

Avoid sustained ground operations above 60% power with the propeller(s) in feather. Possible heat damage to painted surfaces may otherwise result.

★10. Automatic feathering system - CHECK. Check as follows:

(1) Power levers - IDLE.

(2) Test switch - TEST. Check no lights and no feathering.

(3) Both power levers - ADVANCE (to 500 LB. FT. torque).

(4) Test switch - TEST. Hold in test position; retard one power lever. At 410-330 LB. FT. troque, check opposite arm light out. At 260-180 LB. FT. torque, check both arm lights out; check propeller starts to feather.

NOTE

At 260-180 LB. FT. torque setting, auto feather arm light may oscillate.

(5) Power lever - 500 LB. FT. TORQUE.

(6) Repeat above steps for other power lever.

(7) Auto feather switch - ARM.

(8) Both power levers - ADVANCE to 90% ±2% minimum N_1. Observe ITT and torque limits. Check both arm lights on. Retard power levers individually below 90% ±2% N_1. Check both arm lights out.

WARNING

If the aircraft must be flown with a defective autofeather system, the auto-feather circuit breaker should be pulled out.

★11. Overspeed governor - CHECK. Check by setting RPM to 2100. Hold test switches UP. RPM should decrease to 2020 ± 40. Release test switches. RPM should return to 2100.

★12. Engine ice vanes - CHECK. Check operation by observing drop in torque reading and verify that ice vane handles do not creep, but remain extended when released.

★13. Primary governor - CHECK. Check by setting power levers at 1900 RPM and prop levers at MIN RPM. Check for 1750 ± 25 RPM, then advance prop levers to HIGH RPM.

★★ 14. Secondary idle stop - CHECK. Check by placing condition levers in HIGH IDLE and power levers at IDLE, then while holding test switches down, move power levers slowly into REVERSE until appropriate SECONDARY LOW PITCH STOP light illuminates. RPM should rise 150-250 RPM higher than before with 50 RPM maximum differential. When cushion is felt on power levers, return to IDLE position, and release test switches.

CAUTION

Do not force power levers into FULL REVERSE with test switch ON or while engines are inoperative.

NOTE

Loosen friction knobs prior to cushion check to provide better feel.

15. Generators - CHECK. Check that loadmeter readings are approximately equal.

(I) 16. Anti-icing system - CHECK. Check pitot heat and prop heat by momentarily turning switches ON and checking loadmeter for indication.

(I) 17. Deice system - CHECK. Check by activating deicer switch to SINGLE and visually check expansion of boots and deicing pressure.

NOTE

The deicing system should be actuated on a daily basis to insure system function and to exercise the system distributor valve.

* 18. Condition levers - LOW IDLE.

3-29. *BEFORE TAKEOFF.

1. Mirror - RETRACTED.

2. Fuel management panel - CHECK. Check switches and circuit breakers set.

3. Annunciator panel - CHECK. Check lights OFF.

4. Engine and flight instruments - CHECK.

5. Flight controls - CHECK. Check for full travel and proper response.

6. Propeller levers - HIGH RPM (full forward).

7. Engine control friction locks - SET.

8. Flaps - AS REQUIRED (normally, takeoff is made with zero flaps).

9. Trim - SET.

10. Engine ice vanes - AS REQUIRED.

11. Fuel heat switches - ON.

12. Auto feather system - ARM.

(I) 13. Navigation radios - SET.

14. Takeoff clearance - AS REQUIRED.

15. Windows - SECURE.

16. Rotating beacon light - ON.

3-30. LINE UP.

(I) 1. Anti-icing switches - AS REQUIRED.

2. Transponder - AS REQUIRED.

3. Gyro heading - CHECK.

NOTE

Cross-check gyro magnetic compass indicator with standby magnetic compass.

4. Power levers - STABILIZED (70-80% N_1).

5. ITT and torque - CHECK.

3-31. TAKEOFF.

3-32. Plan the takeoff according to the following variables affecting takeoff techniques: field elevation, gross weight, wind, outside air temperature, type of runway, and height and distance of the nearest obstacles. To aid in planning the takeoff and to gain maximum aircraft performance, make full use of the information affecting takeoff which is furnished in the takeoff illustration and the performance information. Adhering to the following procedures will obtain the results set forth in Chapter 14, Performance Data.

NOTE

Refer to Engine Failure under Specific Conditions, Chapter 4, for takeoff emergency procedures.

4. Engine instruments - CHECK. Check that engine instruments are within limits.

5. Climb power - SET.

6. Auto feather switch - OFF.

(O) 7. Autopilot engagement (if required). Accomplish as follows:

NOTE

Autopilot operation is not satisfactory with pneumatic pressure below 12 PSI. This corresponds to an engine torque of approximately 150 LB. FT. continuous.

(1) Determine that altitude is above 300 feet - CHECK.

(2) Determine that minimum pneumatic pressure is 12 PSI and that engine torque is at least 150 LB. FT. continuous - CHECK.

(3) Manually trim the aircraft on all axes: Center the pitch trim indicator with the PITCH control wheel, place the TURN control in the center (detent) position, and press the ENGAGE switch ON. (This solenoid held switch should stay on.)

NOTE

If the autopilot is engaged with the TURN control out of the detent, the aircraft will immediately assume a bank angle proportional to the position of the TURN control.

3-43. CLIMB.

3-44. Normal climb is maintained at a speed of approximately 140 knots IAS, propellers at 2000 RPM and power levers set as required. (Refer to Chapter 14 for Performance Charts.) Monitor ITT and torque gages so as not to exceed limits.

3-45. CLIMB - MAX RATE.

3-46. The maximum rate of climb at sea level standard conditions is maintained at approximately 117 knots IAS with landing gear and wing flaps retracted. During climb, reduce airspeed approximately 1 knot for each 2000 feet of altitude for maximum climb performance. The climb technique and procedure set forth herein will produce the results in Chapter 14, Performance Data.

3-47. CRUISE.

3-48. In general, cruise power settings are entirely dependent upon the prevailing circumstances and the type of mission being flown. Refer to Chapter 14, Performance Data, for the necessary flight planning information. Refer to Chapter 9 for necessary fuel system management. The following procedures are applicable to all cruise requirements:

1. Propeller levers - SET. Set at 1800 to 2000 RPM.

2. Power - SET. Adjust power according to cruise power chart in Chapter 14.

CAUTION

Turbulent air penetration speed: 159 knots IAS.

3-49. FLIGHT CHARACTERISTICS.

3-50. Refer to Chapter 8 for information concerning flight characteristics.

3-51. DESCENT.

3-52. Descent from cruising altitude should normally be made by letting down at cruise airspeed with reduced power. The autopilot may be used during descent, but must be disengaged below 300 feet terrain clearance.

CAUTION

Airspeed picks up quickly when the nose is lowered. Use caution not to exceed the maximum allowable indicated airspeed (V_{mo} = 208 knots).

CAUTION

Large variations in power may exceed autopilot capability and can generate localizer deviation not to exceed 3°/sec.

3-53. DESCENT - MAX RATE (CLEAN).

3-54. Maximum rate of descent in clean configuration may be obtained by using the following procedure:

1. Propeller levers - HIGH RPM.

2. Power levers - IDLE.

3. Landing gear - UP.

4. Flaps - UP.

5. Airspeed - 208 KNOTS IAS.

3-55. DESCENT - MAX RATE (LANDING CONFIGURATION).

3-56. Maximum rate and also the maximum angle of descent in landing configuration may be obtained by using the following procedure:

1. Propeller levers - HIGH RPM.

2. Power levers - IDLE.

3. Flaps - APPROACH (174 knots IAS).

4. Landing gear - DOWN (156 knots IAS).

5. Flaps - DOWN (130 knots IAS).

6. Airspeed - 130 KNOTS IAS.

3-57. BEFORE LANDING.

NOTE

Do not use autopilot below 300 feet terrain clearance.

1. Personnel - ALERTED (face seats forward in RU-21A).

2. Seat belts and harnesses - FASTENED.

3. Fuel panel - CHECK.

4. Parking brake handle - IN.

5. Radar - OFF or STANDBY.

6. Flaps - APPROACH (below 174 knots IAS).

7. Landing gear - DOWN (below 156 knots IAS) - CHECK LIGHTS.

NOTE

If the landing gear is down and locked, the gear position indicator lights on the pilot's control pedestal will illuminate green and the internal red light in the gear handle will be off. The warning horn will be silent when power is reduced.

3-58. LANDING CHECK.

3-59. Perform the following check during the final leg of the traffic pattern:

1. Flaps - AS REQUIRED (normally full flaps are used for landing).

(N) 2. Landing lights - AS REQUIRED.

3. Landing gear - RECHECK DOWN.

4. Propellers - HIGH RPM.

3-60. LANDING.

3-61. NORMAL LANDING.

3-62. In order to obtain the results stated in the landing charts in Chapter 14, Performance Data, accomplish the approach and landing procedure given in the normal landing diagram. In addition, observe the following precautions and techniques: Start flareout, adjusting power so as to touch down with power OFF. As the aircraft touches down, apply light braking and normal propeller reversing techniques.

NOTE

For normal reverse thrust: Propeller levers at HIGH RPM (full forward), condition levers at low idle (50%), power levers through Beta range into reverse range. Return power levers to Beta range as airspeed drops below 40 knots to prevent propeller blade erosion.

NOTE

For normal landing, maximum reverse will probably not be needed. Propeller drag can readily be modulated with power levers positioned in Beta range.

3-63. MINIMUM RUN LANDING.

3-64. For minimum run landing, lower full flaps on final and maintain approach angle with power. At touch down use maximum reverse propeller thrust and apply brakes as required.

NOTE

For maximum reverse thrust plan the approach so as to have 70% or greater N_1 before touchdown. At touchdown, pull the power levers into full reverse. Return to Beta range when reverse is no longer required. Reverse operation at airspeeds below 40 knots IAS increases propeller tip erosion.

3-65. CROSSWIND LANDINGS.

3-66. Less flaps should be used generally. Use crab and upwind wing low attitude to correct for drift. Touchdown on the upwind main gear with the crab being eliminated just prior to runway contact. Allow the aircraft to settle to the other main gear, reduce power, and lower the nose gear onto the runway as soon as practicable to maintain directional control.

3-67. NIGHT LANDING.

3-68. Night landing technique is the same as daytime landing, except that judgement of distance may be somewhat affected in semidarkness. Do not use landing lights until at a low enough altitude for them to be of use. Avoid using them in thick haze, smoke, or fog, as reflected light from the particles in the air will reduce visibility and possibly affect depth perception.

3-69. LANDING ON UNPREPARED RUNWAY.

3-70. Landing procedure for unprepared strips is the same as normal landing on paved runways, except that if the surface is very rough, touch down as smoothly as possible to minimize shock loads on the landing gear. Use brakes with caution on soft or uncertain ground. To minimize foreign objects damage extend ice vanes prior to touchdown and use propeller reversing only as necessary.

3-71. GO-AROUND.

3-72. The decision to go-around should be made as early as possible, to provide a safe margin of airspeed and altitude. The go-around procedure is a normal maneuver unless it is started too late. Accuracy of judgement and early recognition of the need to go-around are important (see figure 3-4). In a go-around situation perform the following procedure:

1. Power levers - MAX ALLOWABLE (see power schedule charts).
2. Landing gear - UP.
3. Flaps - UP.
4. (N) Landing light switch - OFF.
5. Engine instruments - CHECK.
6. Climb power - SET.

3-73. AFTER LANDING.

3-74. Complete the following checks after the aircraft has cleared the runway:

1. (N) Landing and taxi lights - AS REQUIRED.
2. Flaps - UP.
3. Rotating beacon switch - OFF.
4. Pitot heat switch - OFF.
5. Engine ice vanes - AS REQUIRED.
6. Transponder - OFF or STANDBY.
7. Radios - AS REQUIRED.
8. Heater control switch - AS REQUIRED.

3-75. ENGINE SHUTDOWN.

1. Nosewheel - CENTERED.

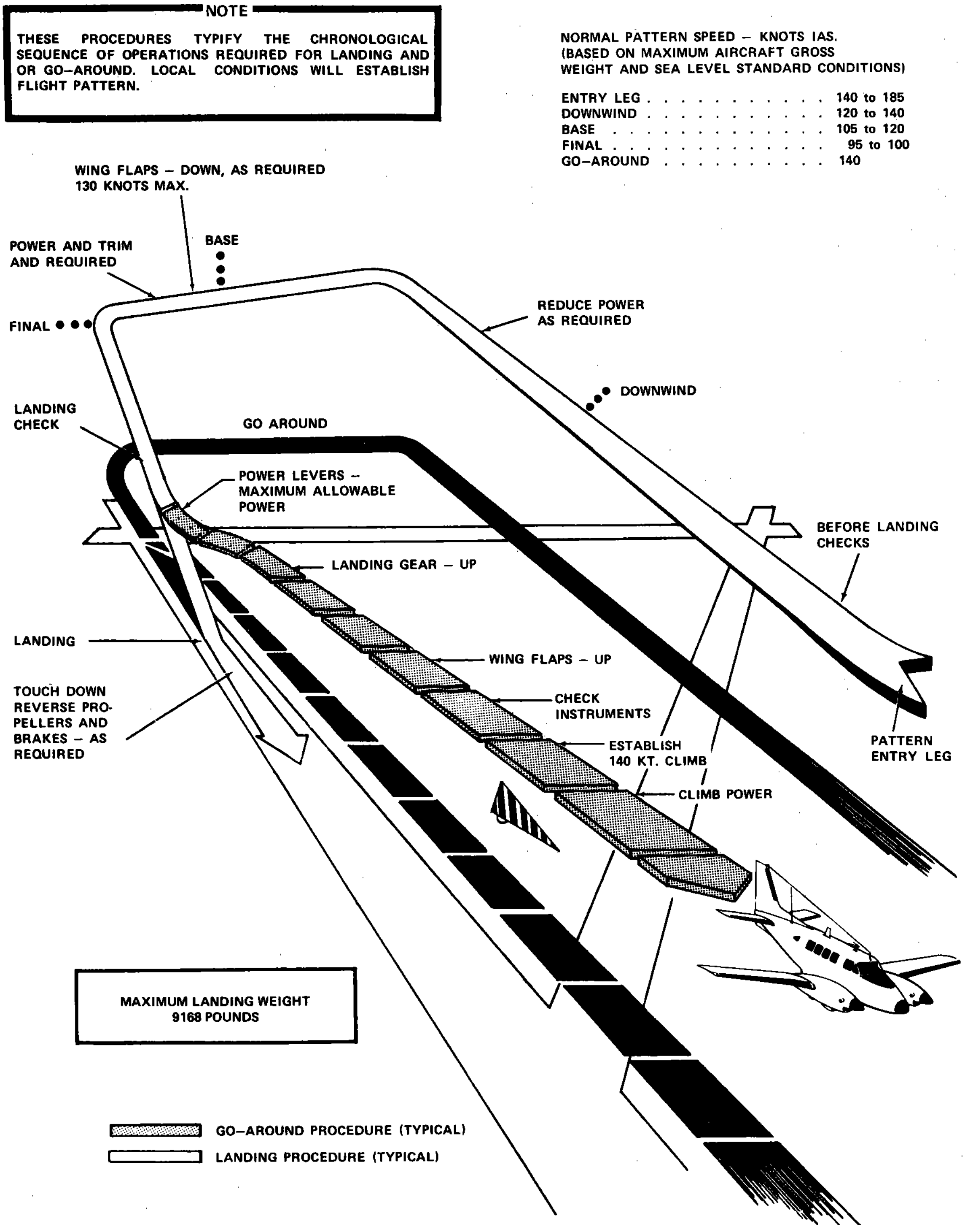


Figure 3-4. Landing and go-around (typical)

attained. In this event, the aircraft must be stopped on the remaining runway. The second condition is also an aborted takeoff. Ths time, lift-off has occurred before engine failure, but minimum single-engine climb speed has not been attained. Again the takeoff must be discontinued. The third condition is; takeoff speed has been attained before engine failure occurred, the landing gear may be retracted, the propeller feathered or auto-feathered on the inoperative engine, and the takeoff continued. Keep in mind that this discussion deals with generalitities and that special or individual circumstances will often dictate individual decisions. Refer to Chapter 14, Performance Data, for additional information on takeoff planning.

4-11. ENGINE FAILURE DURING TAKEOFF RUN (ABORT). In all cases regardless of speed, use the following procedures:

1. Power levers - IDLE.

2. Braking - AS REQUIRED.

NOTE

Reverse thrust may be used on operative engine if required.

NOTE

Braking action is impaired if wheels are allowed to slide.

4-12. ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF BELOW 110 KNOTS (SUFFICIENT RUNWAY REMAINING. If the aircraft has left the ground, but minimum single-engine climb speed has not been reached and there is sufficient runway available in which to stop, proceed as follows:

1. Power levers - IDLE.

2. Complete a normal landing.

4-13. ENGINE FAILURE IMMEDATELY AFTER TAKEOFF BELOW 110 KNOTS (INSUFFICIENT RUNWAY REMAINING. If sufficient runway is not available in which to land the aircraft and minimum single-engine climb speed has not been attained, avoid a stall and proceed as follows:

1. Power levers - IDLE.

2. Flaps - AS REQUIRED.

3. Land - STRAIGHT AHEAD turning slightly if necessary to avoid obstacles.

WARNING

A controlled crash landing straight ahead is preferable to the likelihood of stall or loss of control during a turn.

4-14. ENGINE FAILURE DURING TAKEOFF (TAKEOFF CONTINUED). Determine as early as possible whether conditions of airspeed and altitude make it possible to maintain flight. If the flight is to be continued, proceed as follows:

1. Gear - UP.

2. Flaps - UP.

3. Power - AS REQUIRED.

4. Airspeed - 110 KIAS.

4-15. ENGINE FAILURE DURING FLIGHT.

4-16. Refer to Chapter 14 for cruise information with one engine inoperative. If one engine fails during flight, proceed as follows:

1. Power - AS REQUIRED.

2. Dead engine - IDENTIFY.

3. Power lever (dead engine) - IDLE.

4. Propeller lever (dead engine) - FEATHER.

5. Gear - UP.

6. Flaps - UP.

7. Power - SET (for single-engine cruise).

8. Condition lever (dead engine) - FUEL CUT-OFF.

NOTE

If the situation permits, analyze the failure and take appropriate action to restore power.

4-17. ENGINE FAILURE DURING FINAL APPROACH. If an engine fails during the final approach of a normal traffic pattern, do not attempt to feather the propeller but continue approach using the following procedure:

1. Power - AS REQUIRED (to assure landing on required area).

2. Landing gear - RECHECK DOWN.

3. Flaps - AS REQUIRED.

4-18. ENGINE RESTART DURING FLIGHT.

4-19. If it appears reasonably safe to attempt an airstart after the cause of the failure has been determined, proceed as follows:

CAUTION

Before restarting the engine, allow at least 30 seconds for the fuel to drain and gas generator RPM to run down to stabilized windmill speed, approximately 3 to 5%. Be certain engine stoppage was not the result of a malfunction which might make it dangerous to attempt a restart. If in doubt, continue single-engine flight and land the aircraft as soon as practicable.

CAUTION

Do not allow propeller to windmill in HIGH RPM unless engine oil pressure is at least 15 PSI.

NOTE

With the propeller in HIGH RPM, windmilling gas generator RPM under certain conditions may be adequate for an air start without utilizing the starter. If windmilling gas generator RPM of 12% N_1 or above is experienced, a ram air start, without actuating the starter, may be carried out.

1. Condition lever - FUEL CUTOFF.

2. Propeller lever - FEATHER.

3. Power lever - IDLE.

4. Boost pump switch - ON.

5. Crossfeed valve switch - AUTO.

6. Fuel pressure indicator - CHECK (15 PSI MINIMUM.)

7. Power lever (live engine) - N_1 90% ±2% OR LESS.

8. Ignition start switch - ON.

9. N_1 tachometer - CHECK. Check over 12% and stabilized for approximately five seconds.

10. Condition lever - LOW IDLE (monitor ITT).

CAUTION

Whenever the gas generator fails to light within 10 seconds after injection of fuel, shut off ignition and place condition lever in FUEL CUTOFF.

11. Ignition start switch - OFF (after ITT stabilized).

12. Propeller lever - UNFEATHER (move forward to HIGH RPM, then pull back to match other lever).

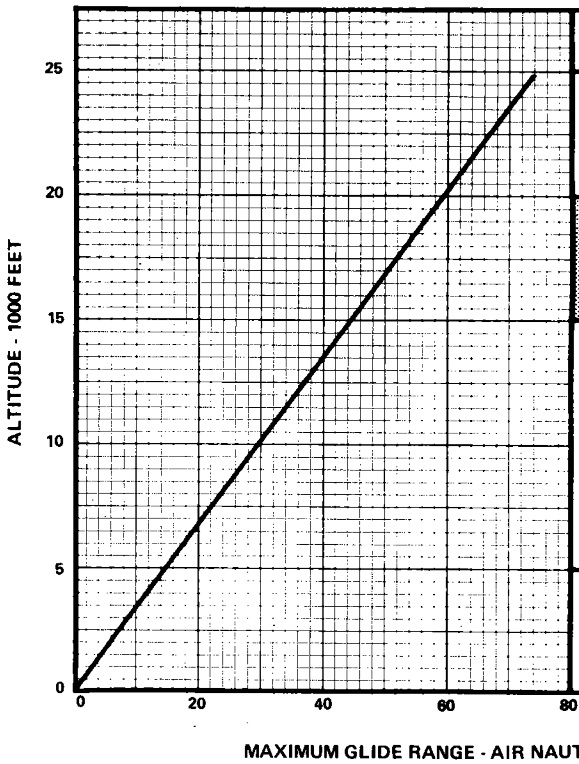
13. Power lever - AS REQUIRED (after engine stabilizes at idle).

CAUTION

Observe oil pressure. If oil pressure is not evident during the initial start attempt,shut down the engine.

4-20. MAXIMUM GLIDE.

4-21. In the event of failure of both engines, maximum gliding distance can be obtained by feathering both propellers to reduce propeller drag and by maintaining appropriate airspeed per figure 4-2, with landing gear and wing flaps up. Turn off all electrical equipment to conserve battery power for lowering landing gear and wing flaps, but leave the master switch ON. For approximate gliding distances in relation to altitude, see figure 4-2.



GROSS WEIGHT (POUNDS)	BEST GLIDE SPEED KNOTS IAS
9650	112
9000	108
8000	102
7000	94
6000	87

CONDITIONS

1. POWER-OFF (PROPELLERS FEATHERED)
2. GEAR AND FLAPS UP
3. NO WIND
4. AIRSPEED AND GROSS WEIGHT COMBINATIONS SHOWN PRODUCE MAXIMUM GLIDE RANGE

Figure 4-2. Maximum glide distance

4-22. LANDING WITH ONE OR MORE ENGINES INOPERATIVE.

4-23. SINGLE-ENGINE LANDING. Fly a normal pattern. Lower landing gear only after landing is assured. Do not lower flaps until the gear is down and locked and you are sure of making the field. Make a normal touchdown, easing power off during flare-out. Avoid making abrupt power correction to avoid excessive yaw (figure 4-3).

WARNING

With full flaps and gear down, level flight cannot be maintained on one engine.

NOTE

A feathered propeller will result in less drag and may cause a tendency for the aircraft to "float" during landing.

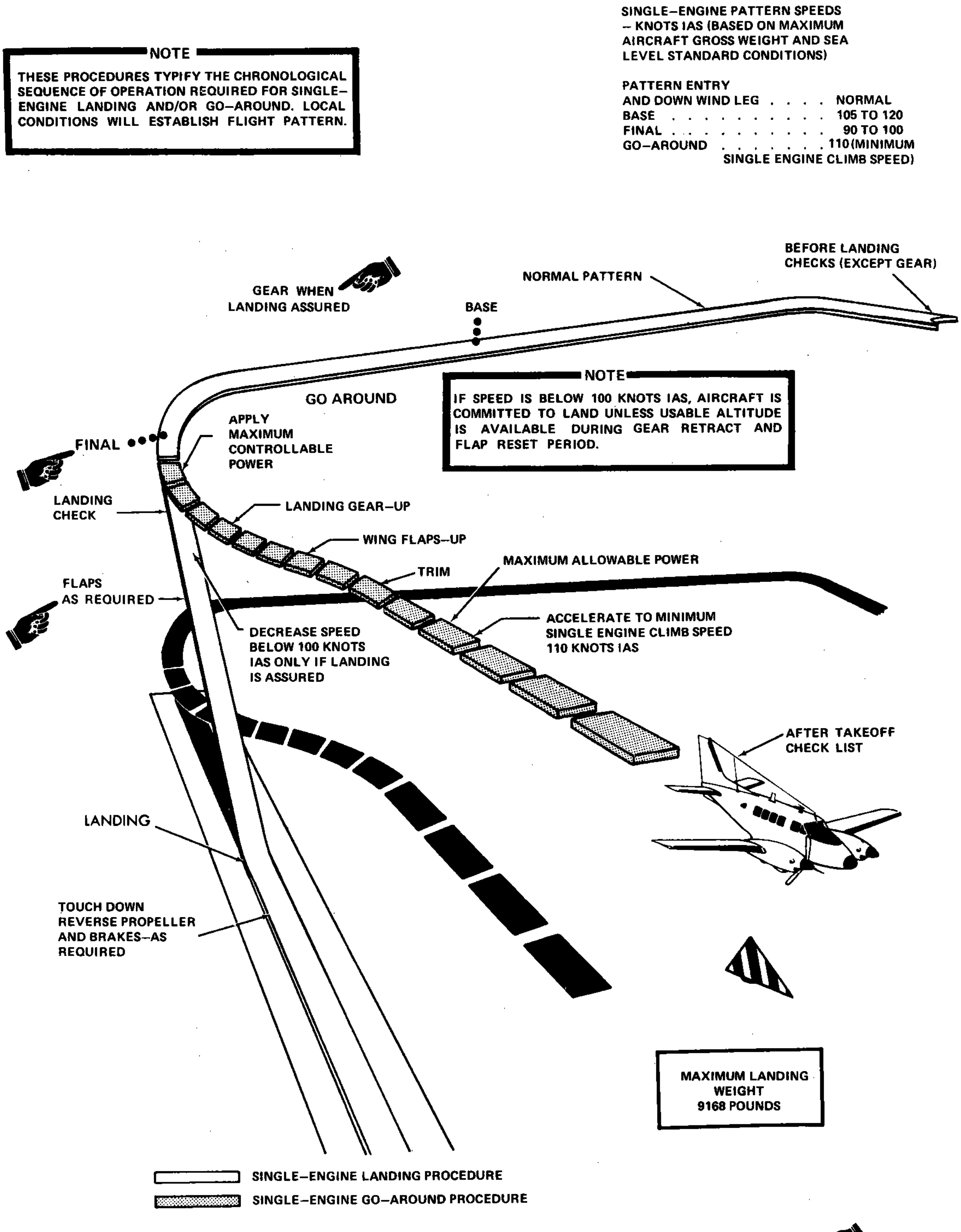


Figure 4-3. Single-engine landing and go-around (typical)

4-24. FORCE LANDING - NO POWER. If sufficient altitude remains after reaching a suitable landing area, a cirkcular descent over the field will provide best observation of ground conditions, wind velocity and wind direction. When the condition of the terrain has been noted and the landing area picked, set up a rectangular pattern and lower gear on the downwind leg. Fly the base leg as necessary to control point of touchdown. Plan to overshoot rather than undershoot, using flaps as necessary. Keep in mind that with both propellers feathered, the normal tendency is to overshoot due to less drag. In event a positive gear down and lock indication cannot be determined, prepare for a gear-up landing. Refer to paragraph 4-68 Landing Emergencies.

4-24a. LANDING WITH ONE ENGINE INOPERATIVE.

1. Personnel - ALERTED, SEATS FORWARD.

2. Seat belts and shoulder harnesses - FASTENED, personnel checked.

3. Fuel panel - CHECK. Check switch positions as required.

4. Brake handle - IN.

5. Radar - OFF or STBY.

6. Flaps - APPROACH

7. Gear - DOWN when landing assured.

4-24b. LANDING CHECK

1. Flaps - AS REQUIRED.

(N) 2. Landing Lights - AS REQUIRED.

3. Landing gear - RECHECK DOWN.

4. Propeller lever - HIGH RPM.

4-25. SINGLE-ENGINE GO-AROUND (ONE ENGINE INOPERATIVE).

WARNING

Once the flaps are fully extended on a single-engine final approach a go-around should not be attempted.

4-26. The decision to go-around must be made as early as possible. Gain airspeed before climbing. Climb out at or above 110 knots IAS using maximum allowable power. See figure 4-3. To perform a single-engine go-around, proceed as follows:

1. Power lever - MAXIMUM CONTROLLABLE POWER (correct for yaw as necessary).

WARNING

Elevator control forces at the start of a go-around are very high; retrim as time permits. Also, a considerable amount of rudder control will be required at low airspeeds and if insufficient or applied too slowly, directional control cannot be maintained.

2. Gear - UP.

3. Flaps - UP.

(N) 4. Landing lights - OFF.

5. Engine instruments - CHECK.

6. Climb power - SET.

4-27. CHIP DETECTOR WARNING LIGHT ON.

4-28. The illumination of either chip detector light on the annunciator panel will require the following immediate procedures:

1. Engine instruments - MONITOR.

2. Land as soon as practicable.

4-29. PRACTICE MANEUVERS WITH ONE ENGINE INOPERATIVE.

4-30. Single engine practice maneuvers should not be undertaken unless experienced personnel are present. They should be done with adequate altitude, speed, etc., to insure safe operation. Altitude cannot be maintained with landing gear and flaps extended. The engine shut down procedure is as follows:

1. Condition lever - FUEL CUTOFF.

2. Power lever - IDLE.

3. Propeller lever - FEATHER.

4. Electrical load - CHECK.

4-31. The procedure for restarting the engine during practice shutdown is the same as that described in paragraph 4-18.

SECTION III — PROPELLER

4-32. PROPELLER FAILURE.

4-33. Normally the primary governor controls the speed of the propeller within the range of 1750 to 2200 RPM. If the primary governor fails, the propeller will either feather or overspeed. Two additional governors control an overspeed condition. The first is the overspeed governor.

When the propeller speed reaches 2266 RPM, the overspeed governor cuts in and holds the propeller speed near 2266. If the primary and overspeed governors should fail, the power turbine governor will cut in at 2332 RPM and reduce the flow of fuel to the engine. The propeller is certified to 2420 RPM. If an overspeed condition occurs that cannot be controlled with the prop lever or by reducing power, feather the propeller. If the propeller feathers by itself, complete feathering procedure. The engine of the disabled propeller may be kept running to provide power for systems needed in flight.

4-34. The procedure to follow in the event of propeller failure is as follows:

1. Airspeed -- REDUCE (increase pitot attitude).

2. Power lever - IDLE.

3. Propeller lever (faulty prop) - FEATHER.

4-35. SECONDARY IDLE STOP SYSTEM FAILURE.

4-36. The procedure to follow in the event of illumination of the SECONDARY LOW PITCH STOP light is as follows:

1. Power lever (affected engine) - IDLE.

2. Propeller governor idle stop circuit breaker - PULL.

3. Power levers - AS REQUIRED.

NOTE

Propeller reversing, when the propeller idle stop circuit breaker is pulled, indicates failure of the mechanically monitored hydraulic stop. In this event, reset circuit breaker and secure the engine.

SECTION IV — FIRE

4-37. ENGINE FIRE.

4-38. The following paragraphs indicate the action to be taken in case of engine fire.

NOTE

Engine fire extinguisher systems are not installed.

4-39. ENGINE FIRE DURING START OR GROUND OPERATION.

4-40. The procedure for internal engine fire during start or ground operations is as follows:

1. Fuel firewall valve switches - CLOSED.
2. Master switch (gang bar) - OFF.
3. Propeller levers - FEATHER.
4. Abandon aircraft and use fire extinguishers.

CAUTION

If fire extinguishers are used on the engine, do not attempt to restart until the cause has been determined and corrected and all fire extinguishers agents removed.

4-41. ENGINE FIRE - DURING FLIGHT.

4-42. In the event of an engine fire during flight, shut down the affected engine in the following manner:

1. Fuel firewall valve switch - CLOSED.
2. Power lever - IDLE.
3. Propeller lever - FEATHER.
4. Condition lever - FUEL CUTOFF.
5. Boost pump switch - OFF.
6. Transfer pump switch - OFF.

1. Radio - DISTRESS PROCEDURE (If time permits).

2. Airspeed - REDUCE.

3. Flaps - DOWN.

4. Trim - AS REQUIRED.

5. Main entrance door - Unhook chain, pull pin, and OPEN.

6. Abandon the aircraft.

POWER-OFF STALL SPEEDS									
WING FLAP POSITION	GROSS WEIGHT								
	7500			8500			9650		
	DEGREES OF BANK AT CONSTANT ALTITUDE								
	0°	30°	45°	0°	30°	45°	0°	30°	45°
	KNOTS—IAS								
UP (0°)	80	86	95	85	91	101	91	98	108
35% (15°)	76	82	90	81	87	96	86	93	102
100% (43°)	69	74	82	73	79	87	78	84	93
POWER-ON STALLS WILL OCCUR APPROXIMATELY 10 TO 15 KNOTS BELOW THE SPEEDS LISTED.									

NOTE

LANDING GEAR POSITION (UP OR DOWN) HAS NO APPRECIABLE EFFECT ON STALL SPEEDS.

Figure 8-1. Stall power chart

SECTION III — CONTROL CHARACTERISTICS

8-24. FLIGHT CONTROLS.

8-25. The aircraft is stable under all normal flight conditions. Aileron, elevator, rudder, and trim tab controls function effectively throughout slow, cruising, and high speed flight. Controls become more sensitive as the speed increases; likewise, control forces become progressively greater.

8-26. FLIGHT CONTROL CHARACTERISTICS.

8-27. Elevator control forces are relatively light in the extreme aft CG (center-of-gravity) condition, progressing to moderately high with CG at the forward limit. Control feel at low airspeeds is enhanced by the use of anti-servo trim tabs, which also serve to increase elevator effectiveness at extreme positions. Extending and retracting the landing gear causes only slight changes in control pressure. Control pressures, resulting from changes in power settings or the repositioning of the wing flaps are not excessive in the landing configuration at the most forward CG, 96 knots IAS is the minimum speed at which the aircraft can be fully trimmed. Control forces produced by changes in speed, power setting, wing flap position, and landing gear position are light and can be overcome with one hand. Trim tabs permit the pilot to reduce these forces to zero.

8-28. LEVEL FLIGHT CHARACTERISTICS.

8-29. All flight characteristics are conventional throughout the level flight speed range.

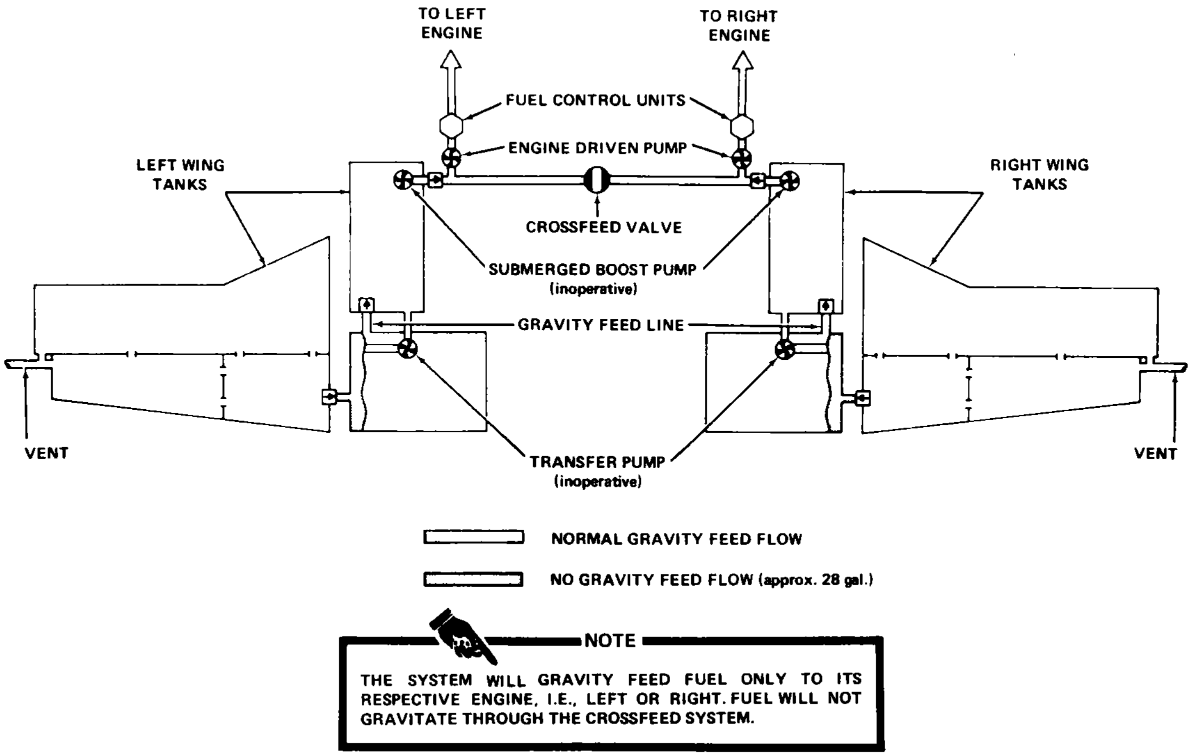


Figure 9-2. Gravity feed fuel flow (typical)

NOTE

It is best to select aviation gasoline with the lowest octane rating available to obtain the lowest lead content.

9-33. FLIGHT TIME REMAINING AT CABIN HEATER CUTOFF.

9-34. Flight time and range capability of the aircraft are affected by combustion requirements of the cabin heater, using fuel from the same left wing storage system which feeds the left engine. However, as fuel level drops within the left wing tanks to a near depletion quantity, a safety feature associated with gravity feed stops the supply of fuel to the heater. This action reserves the final quantity for propulsion only. Available flight time following cabin heater cutoff will vary due to the interaction of several factors. One factor is pilot technique in fuel management and others are associated with the operation of automatic components of the fuel system. This chapter will describe features of the fuel system which establish the amount of fuel reserve "on hand" at the time of cabin heater cutoff. Coverage will also include a technique of the fuel management by which the pilot may shorten the terminal period of flight after cabin heater cutoff, to maintain a maximum comfort period for occupants, although with some penalty to total range capability.

NOTE

If the left wing tanks contain less than 28 gallons, initially, the entire flight will be conducted without cabin heat.

9-35. FUEL SYSTEM FEATURES AFFECTING FLIGHT TIME AFTER HEATER CUTOFF.

9-36. The aircraft has a check valve in the gravity feed line to the nacelle tank which is downstream of the cabin heater tap into the line. This check valve isolates fuel within the nacelle tank from the cabin heater (i.e., fuel in the left nacelle tank is unavailable to the cabin heater).

When fuel level within the left wing tanks falls to a level with the main gravity feed interconnect line between the outboard wing and the center section cells, the cabin heater will cease to operate due to fuel starvation. At this point, approximately 28 gallons of fuel remain in the left wing tanks. Since fuel level in the wing tanks will lag behind the fuel level in the corresponding nacelle tanks, due to opposing head pressure and line losses, the actual level within the wing tanks is indeterminate at the time when the transfer pump starts to transfer fuel. However, float switches maintain fuel level within the left nacelle tank between two limits during transfer operation. These limits represent a maximum or minimum fuel level within the left nacelle tank between two limits during transfer operation. These limits represent a maximum or minimum fuel level which the left nacelle tank could hold at the time when fuel starvation stops the cabin heater. Actual "on hand" reserve of fuel is not computable, but would likely fall somewhere between these quantity limits at heater cutoff. Distribution of on board fuel for the maximum and minimum reserve limits at heater cutoff is as follows:

a. Maximum fuel on board when cabin heater stops - (per engine).

24 gallons - - nacelle tank

28 gallons - - wing tanks

52 gallons - - Total

b. Minimum fuel on board when cabin heater stops - (per engine)

10 gallons - - nacelle tank

28 gallons - - wing tanks

38 gallons - - Total

9-37. If no crossfeed operation has been accomplished or is intended, the pilot may estimate available flight time after cabin heater cutoff by using the graph on figure 14-45, entitled "Flight Time Remaining at Cabin Heater Cutoff". This graph has data for both military and commercial fuels usable by the engines.

NOTE

Information pertaining to available flight time after cabin heater cutoff is based on the condition that initial fuel quantity in the left wing tanks, external to the nacelle tank, must exceed 28 gallons.

9-38. FUEL MANAGEMENT TECHNIQUES AFFECTING FLIGHT TIME AFTER HEATER CUTOFF.

9-39. It is within the pilot's prerogative to shorten the time of flight which must be endured without heater operation. Flight time after heater cutoff can be decreased up to 50% by cross feeding from the right wing tanks to the left engine previous to heater cutoff. It is then possible to have all remaining wing fuel in the left wing tanks when the cabin heater stops. This should be accomplished as follows: When the remaining fuel within the left wing tanks is lowered to approximately one-quarter of gage capacity measure, commence crossfeed operation from the right wing fuel system. Continue feeding both engines from the right wing fuel system until the NO TRANSFER warning light is illuminated on the annunciator panel. At this point, there are between 10 and 25 gallons of fuel left in the right nacelle tank. Both engines may now be fed from the left wing fuel system. Total range capability of the aircraft is reduced by this fuel management technique.

9-40. ELECTRICAL SYSTEM.

9-41. For a description of electrical system operation, refer to Chapter 2, Aircraft Description.

9-42. LANDING WHEEL BRAKE SYSTEM.

9-43. For a description of the landing wheel brake system, refer to Chapter 2, Aircraft Description. The importance of proper braking techniques cannot be over-emphasized. The fundamental purpose of brakes is to retard motion, using friction to transform mechanical energy into heat energy. Repeated and excessive application of brakes, without allowing sufficient time for cooling to accumulate between applications, will cause loss of braking, efficiency, possible failure of brake or wheel structure, possible blowout of tires, and in flying should be used when flying at night. During preflight make certain that all lights function properly. Since the instrument panel lights are rheostat controlled, instrument lighting can be adjusted for comfortable vision. This will afford maximum visibility outside and at the same time allow the pilot to easily make the transition to instrument flying.

NOTE

Avoid using landing lights when in thick haze, smoke, or fog, as reflected light will reduce visibility and may affect depth preception.

SECTION III — COLD WEATHER OPERATION

10-31. GENERAL.

10-32. Difficulties encountered during operation in extreme cold weather result from not understanding the proper steps to be taken prior to and immediately after flight. It is important that all concerned with the operation be fully aware of the necessary procedures and precautions involved. Icing conditions are not considered here but are covered elsewhere in this chapter. The following cold weather operating instructions supplement the normal operating procedures in Chapter 3.

10-33. PREPARATION FOR FLIGHT.

10-34. Accumulations of snow and ice on the surface of the aircraft can seriously affect takeoff distance, climb performance and stall speeds to a dangerous degree. The ice and snow must be removed from the aircraft before flight to eliminate such effects in performance (Refer to TB-AVN-23-13, anti-icing, deicing and defrosting procedures of parked aircraft). In addition to the normal exterior check inspect the leading edge and move the control surfaces to be sure they are free from ice after removal of all ice and snow. Check tires for proper inflation and see that they are not frozen to the ground or wheel chocks. Use ground heaters to free frozen tires. In extreme emergencies, tires may be inflated to 1.5 times the normal pressure to free them, then reduced to normal pressure. Remove all covers and preheaters when possible. Use external power for starting engine. Due to the characteristics of the jet engine and the oil used, preheating of the oil is not necessary.

NOTE

For altitude limitations in visible moisture, see Chapter 7, Operating Limitations, Paragraph 7-43.

10-35. ENGINE STARTING.

10-36. Cold weather decreases the efficiency of batteries. When possible, use external power to start engines. Observe engine starter time limits. If there is no oil pressure after 30 seconds or pressure drops below minimum (40 PSI), shut down the engine.

10-37. WARM-UP AND GROUND TEST.

10-38. Warm-up procedures and ground test will follow those outlined in Chapter 3, Normal Procedures.

NOTE

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

10-39. TAXIING INSTRUCTIONS.

10-40. Avoid taxiing through slush and water if possible. Water and slush splashed on the wings and tail will freeze, increasing weight and drag and possibly limit control surface movement.

10-41. BEFORE TAKEOFF.

10-42. Turn on the propeller heat, anti-icing systems, and pitot heat just prior to takeoff and accomplish the before takeoff steps presented in Chapter 3.

WARNING

Takeoff is not recommended when both the temperature and the dew point are in the area of -1°C to +1°C and the runway is wet or precipitation (rain or snow) is present. When the above conditions exist, ice may accumulate on the empennage during runup and takeoff, and severe induction system icing may occur immediately after takeoff. Atmosphere containing free moisture is considered most favorable for system icing then temperatures are between -10°C and +15°C.

10-43. TAKEOFF.

10-44. Takeoff procedures for cold weather operations are the same as for normal takeoff. Follow the procedures presented in Chapter 3. Deep snow on runway may cause enough drag to prevent takeoff. Light snow or ice will decrease the traction of the tires. Use of brakes and nose wheel steering may be ineffective.

10-45. DURING FLIGHT.

10-46. It may be advisable to cycle the landing gear a few times after takeoff to dislodge ice accumulated from spray of slush or water on runway. Trim tabs and controls should also be exercised periodically to prevent freezing. Anti-icing systems should be activated when visible moisture is present.

10-47. DESCENT.

10-48. Use normal procedures presented in Chapter 3 for descent.

NOTE

When the defrost system is inoperative, the pilot's compartment side windows may be opened to aid visibility. Several factors may cause the windshield defrost system to become inoperative, such as a blown heater fuse, or when wing fuel has been depleted to the level which causes cutoff of fuel supply to the heater.

NOTE

During approach or when operating at low altitudes when heavy icing conditions are present, higher-than-normal airspeeds should be maintained in order to compensate for the additional weight imposed on the wing and tail surfaces due to ice formations.

10-49. LANDING.

10-50. Use procedures prescribed in Chapter 3 for landing. Use brakes sparingly or only when necessary during landing roll.

NOTE

In order not to impair pilot visibility, reverse thrust should be used with caution when landing on a runway covered with snow or standing water.

10-51. ENGINE SHUTDOWN.

10-52. Follow the normal engine shutdown procedures outlined in Chapter 3.

10-53. BEFORE LEAVING THE AIRCRAFT.

10-54. Park the aircraft in a warm area if possible. Should this be impossible; after wheel chocks are in place release the brakes to prevent freezing and lock the control surfaces. Condensation will be minimized if aircraft fuel tanks are filled. Clean the landing gear shock struts of dirt and ice. Install protective covers to guard against possible collection of snow and ice. If the aircraft is to remain outside in freezing temperatures for a period of more than 4 hours, have the battery removed and stowed in a heated area.

CHAPTER 14

PERFORMANCE DATA

SECTION I — SCOPE

14-1. GENERAL.

14-2. This chapter contains performance data necessary for preflight and inflight mission planning, and includes explanatory text on the use of the presented data.

14-3. EXTENT OF COVERAGE.

14-4. The information contained on the charts is based on, and is consistent with, the recommended operating procedures and techniques set forth in other chapters of this manual.

14-5. TERMS AND ABBREVIATIONS.

14-6. Terms and abbreviations used throughout this chapter are defined as follows:

AIRSPEED

IAS	Indicated airspeed assuming zero instrument error.
CAS	Calibrated airspeed; IAS corrected position error.
TAS	True airspeed; CAS corrected for relative density.
V_s	Stalling speed.
V_{mc}	Minimum control speed is the speed sufficient to enable the aircraft to fly a straight path over the ground: Takeoff configuration, dead engine propeller feathered, with maximum power and 5 degrees bank into live engine.
V_{TD}	Touchdown speed.
V_{TO}	Takeoff speed.
ISA	International Standard Atmosphere as defined by the ICAO. It assumes a temperature of +15°C (59°F) and a pressure of 29.92 in. H.G. at sea level. The temperature lapse rate with altitude is approximately -2°C per 1000 feet. Deviation from Standard Day temperature (i.e. ISA + 10°C) means to determine the Standard Day temperature at the altitude being considered and add 10°C to it.

ALTITUDE

PRESSURE ALTITUDE	The altitude that is read on an altimeter set to 29.92 in HG.
DENSITY ALTITUDE	The pressure altitude corrected for nonstandard temperature.
CRITICAL ALTITUDE	The maximum pressure altitude at which any specific power can be maintained for a specific engine rating.

CEILINGS

ABSOLUTE	The altitude at which the rate of climb is zero at stated weight and engine power.
CRUISE	The altitude at which the rate of climb is 300 ft/min at stated weight and engine power.

SERVICE	The altitude at which the rate of climb is 100 ft/min at stated weight and engine power.
GROSS WEIGHT	Total weight of the aircraft.
KTS	Knots
LANDING OVER 50-FOOT OBSTACLE	Distance required to clear a 50-foot obstacle at the approach end of the runway and come to a complete stop.
NAUT	Nautical.
OAT	Outside air temperature.

POWER (See figure 7-2)

TAKEOFF POWER	The maximum power available for the engine (5 minute limit).
MAXIMUM POWER	The maximum power available for the engine (intended for emergency use only).
NORMAL RATED POWER	The maximum power available for the engine for continuous operation.
NORMAL RATED POWER	The maximum power available for the engine for continuous operation (with lower ITT limit than Normal Rated Climb Power.)

MISCELLANEOUS

RPM	Propeller speed in revolutions per minute.
RUNWAY LENGTH	Usable length of runway in feet.
SHP	Shaft horsepower; the power output of engine delivered to the propeller shaft.
SL	Sea level.
TAKEOFF AIRSPEED	The indicated airspeed at which the main landing gear leaves the ground.

14-7. SYMBOLS AND DEFINITIONS.

14-8. Symbols and definitions used throughout this chapter are defined as follows:

ρ (rho)	Air density at some specific altitude.
ρ_o	Air density at sea level.
σ (sigma)	ρ/ρ_o - Density ratio.
°C	Degrees centigrade
°F	Degrees fahrenheit
$1/\sqrt{\sigma}$	Reciprocal of the square root of density ratio; used in converting CAS (calibrated air speed) to TAS (true air speed) at altitude.

NOTE

Fuel flow figures are given in pounds per/hour/engine.

SECTION II — CHARTS

14-9. EXPLANATION OF PERFORMANCE CHARTS.

14-10. A complete series of performance charts is provided for U-21A and RU-21A aircraft in this manual. These charts furnish the pilot with sufficient data to make an intelligent and safe flight plan. The charts include data on takeoff, climb, landing, and operating instructions for cruising flight from maximum endurance to normal rated power. Because the number of variables involved makes precise predictions impossible, the emphasis in these charts has been on conservatism. No allowance has been made for navigational error, formation flight, or other contingencies. Appropriate allowances for these items should be dictated by local regulations and should be accounted for when the fuel available for cruise is determined. The charts are arranged to give maximum facility of use in preflight and in-flight planning. All charts are based on operation in ICAO (ISA) standard atmosphere, except the takeoff, single engine climb and landing distance charts, which have colums for various temperatures. The flight operation instruction charts are also applicable in nonstandard atmosphere if the recommended CAS value is maintained.

14-11. STANDARD ATMOSPHERE TABLE.

14-12. The Standard Atmosphere Table (figure 14-2) is provided to show standard values of the atmosphere as defined by the International Civil Aviation Organization (ICAO). The ICAO assumes a temperature of ±15°C (59°F) and a pressure of 29.92 inches of mercury as standard sea level condition. The temperature variation (lapse rate) with altitude is approximately constant at -2°C per 1000 feet from sea level to 30,000 feet. The standard atmosphere table shows values for every 1000 foot increment in altitude and includes temperatures in both degrees Fahrenheit and degrees Centigrade.

14-13. DENSITY ALTITUDE CHART.

14-14. The Density Altitude Chart, (figure 14-3) is used to determine the density altitude from an existing pressure altitude and temperature. Along the right side of the density altitude chart, the reciprical square root of the density ratio is given to provide a means of computing true airspeed at any density altitude from the indicated airspeed read on the airspeed indicator.

Example:

Known:

OAT = 15°C
Pressure Altitude = 6000 Ft.
IAS = 160 knots

FIND:

Density Altitude = 4000 Ft.
$1\sqrt{\sigma}$ = 1.06
CAS = 161.6 knots
TAS = (161.6 x 1.06) = 171.3 knots

14-15. AIRSPEED CORRECTION.

14-16. Normal and Emergency Airspeed Correction tables (figures 14-5 and 14-6) respectively, show position error as a function of indicated airspeed for the clean approach and landing configurations. In using the tables, position error is added to indicated airspeed to obtain calibrated airspeed. IAS assumes zero instrument error.

Example:

Known:

Normal airspeed system

Clean configuration

IAS = 120 knots

Find:

CAS = 122.8 knots

14-17. ALTIMETER CORRECTION.

14-18. The Normal Altimeter Correction table (figure 14-7) shows altimeter error as a function of indicated airspeed and Altitude for the clean approach and landing configurations. In using the tables, the altimeter error is added to the indicated altimeter reading (corrected for instrument error) to obtain the true altimeter reading. Figure 14-8 shows the altimeter error for the emergency static system.

Example:

Known:

Normal static system

Clean configuration

Altimeter indication = 10,000 ft.

IAS = 120 knots

Find:

True altimeter indication = 10,042 ft.

14-19. POWER AVAILABLE FOR TAKE-OFF.

14-20. Power availalbe for takeoff (figure 14-9) shows torque available for takeoff versus outside air temperature for various runway pressure altitudes. These power settings were used to determine takeoff distances in figure 14-18.

Example:

Known:

OAT = 20°C

Altitude = 2,000 ft.

Find:

Torque available= 1215 FT. LB. engine at 2200 RPM

14-21. POWER CONVERSION CHART.

14-22. The Power Conversion chart (figure 14-10) presents in graphical form the relationship between torque, propeller speed and shaft horsepower.

14-23. POWER SCHEDULE AND FUEL FLOW.

14-24. Power schedule and Fuel Flow Charts (figures 14-11 to 14-16) present plots of torque and fuel flow versus calibrated airspeed with parameters of power setting (%) from maximum power to 20% Normal Rated Power. Separate charts are provided for standard day pressure altitudes of sea level, 5000, 10,000, 15,000, 20,000 and 25,000 feet. In level flight, determine CAS and read torque setting, prop RPM and altitude.

Example:

Known:

Torque setting = 1000 FT. LB.

Propeller = 1900 RPM

Airspeed = 183 knots CAS

Pressure altitude = 5000 feet

Temperature = 5°C

Find:

Power rating = 77% Normal Rated Power

Fuel flow = 267 LB/HR/ENGINE

Procedure:

Enter the chart for Power Schedule and Fuel Flow, 5000 Feet (figure 14-12) at 183 knots CAS and a torque setting of 1000 FT. LB. Read power rating and use it plus 183 knots CAS to determine fuel flow.

14-25. TAKEOFF AND LANDING DATA CARD.

14-26. The Takeoff and Landing Data Card (figure 14-1) is also included in TM 55-1510-209-CL/1. The data card provides readily available information for takeoff, landing immediately after takeoff, landing, and prevailing conditions. Pertinent data required to fill in the blanks on the card shall be computed from the performance charts and tables contained in this chapter, and from existing conditions at time of takeoff or landing. The takeoff and landing data shall be computed prior to takeoff, as a precaution against emergency conditions which could develop after takeoff.

14-27. TAKEOFF AND LANDING CROSSWIND CHART.

14-28. Figure 14-17 presents minimum touch down or nose wheel lift-off speeds for various crosswind conditions. These speeds are the lowest speeds at which sufficient rudder is available for adequate directional control under prevailing wind conditions. Use this chart also for determining the headwind component for takeoff distance (figure 14-18) and landing distance (figure 14-43).

Example:

Known:

Relative wind velocity = 25 knots

Relative wind direction (with respect to runway) = 85°

Find:

Crosswind component = 25 knots

Headwind component	= 2 knots
Safe minimum lift off or touchdown speed	= 95 knots CAS

14-29. TAKEOFF DISTANCE

14-30. Figure 14-18 presents takeoff performance. Distances assume a hard, level, dry surface runway, flaps up; lift-off and climb at 98 knots IAS (101 knots CAS); gear retraction after positive climb is established; and takeoff power set before brake release. (Reference figure 14-9). Distances are shown for various gross weights, obstacle heights, temperatures, altitudes and headwind components.

Example:

Known:

Runway air temperature	= 30°C
Pressure altitude	= 2000 feet
Gross weight	= 8190 pounds
Headwind	= 20 knots

Find:

Ground run	= 1300 feet
Total distance over a 100-foot obstacle	= 1800 feet

14-31. CLIMB CONTROL.

14-32. Climb Control Charts are presented for both two engine climbs (figure 14-19) and single-engine climbs (figure 14-20). Time, distance and fuel used to climb from sea level are provided for takeoff weights of 6000, 7000, 8000, 9000, and 9650 pounds. Two engine climb data are for a climb using Normal Rated Climb Power, gear up, flaps up and a sea level standard day take-off. Single engine climbs are for a climb using maximum power on operating engine, gear up, flaps up, inoperative propeller feathered and sea level standard day take-off on two engines. If the initial altitude is not sea level, read time, fuel used and distance for a take-off at sea level and climb to desired altitude. Then, read time, fuel used and distance for a take-off at sea level and climb to actual operating altitude. The difference between these two results will be the net climb performance. Allow 55 pounds for start, taxi and take-off. The weights shown are weights at lift-off from runway. Each 10°C above standard day temperature (for the altitude being considered) will have the same approximate effect on performance as adding 800 pounds to take-off weight.

Example:

Known:

(Two engine operation)

Ramp weight	= 9055 pounds
Takeoff weight	= 9000 pounds
Initial pressure altitude	= Sea level
Temperature at Sea Level	= 15°C
Final pressure altitude	= 20,000 feet
Temperature at 20,000 ft.	= 25°C (Std)

Find:

Time to climb	= 14 minutes
Distance to climb	= 37 N.M.
Fuel used	= 189 pounds

Procedure:
Enter table at 9000 pounds and 20,000 feet. Read time, distance, and fuel used.

14-33. SINGLE ENGINE CLIMB.

14-34. The single engine climb chart (figure 14-21) presents rate-of-climb versus outside air temperature, pressure altitude and gross weight. Performance is for gear up, flaps up, inoperative propeller feathered configuration and operating engine at maximum power. This chart should be used in conjunction with the climb speed chart (figure 14-22).

14-35. The Single Engine Best Rate-of-Climb speed chart (figure 14-22) presents climb speed versus density altitude and gross weight. These climb speeds should be used in order to obtain the rate-of-climb from figure 14-21). Non-standard temperature conditions can be handled by obtaining an equivalent density from the Density Altitude Chart (figure 14-3).

Example:

Known:

Outside air temperature	=	20°C
Pressure altitude	=	4000 feet
Gross weight	=	8400 pounds

Find:

Rate-of-climb	=	470 FT/MIN
Equivalent density altitude	=	5500 feet
Climb speed	=	105 knots CAS

Procedure:

Enter the single engine climb chart (figure 14-21) at 20°C and 4000 feet pressure altitude. Project horizontally 8400 pounds and read rate-of-climb. Enter Density Altitude chart (figure 14-3) at 20°C and 4000 feet pressure altitude to determine equivalent density altitude. Enter Single Engine Best Rate-of-Climb speed chart (figure 14-22) at 5500 feet density altitude and 8400 pounds to determine climb speed.

14-36. NAUTICAL MILES PER POUND OF FUEL (N.M./LB).

14-37. Detailed cruise performance is presented in the form of nautical miles per pound of fuel versus airspeed in knots. Two engine operation charts (figures 14-24 thru 14-29) are presented for standard day conditions at pressure altitudes of sea level, 5000, 10,000, 15,000, 20,000 and 25,000 feet. Single engine operation charts (figures 14-30 thru 14-33) are presented for standard day conditions at pressure altitudes of sea level, 5000, 10,000, and 15,000 feet.

14-38. Two engine operation charts vary from power required for maximum endurance to normal rated power. Single engine charts vary from power required for maximum endurance to maximum power. Each chart presents specific range and torque settings for various gross weights.

14-39. The curves are shown for the complete speed range of the aircraft from maximum airspeed down to the speed recommended for maximum endurance. Recommended airspeed lines are presented based on 99% of the maximum range.

14-40. The means for determining nautical miles per pound of fuel with headwind conditions is provided for the recommended airspeed line only. The effect of wind at all other airspeeds should be calculated as follows:

$$\text{N.M. / LB (with wind)} = \text{N.M. / LB (no wind)}\left(\frac{V_{ground}}{V_{air}}\right)$$

Where:

V_{ground} = Ground speed in knots.

V_{air} = True airspeed in knots.

14-41. Fuel flow can be determined as follows:

$$\text{Fuel flow (LB/HR)} = \left(\frac{V_{air}}{\text{N.M./LB}}\right)$$

14-42. Cruise performance for standard temperature conditions can be determined as follows:

Example: (Optimum range cruise data)

Known:

Two engine operation

Average gross weight	=	8500 pounds
Pressure altitude	=	5000 feet
Temperature	=	5°C (standard)
Headwind component	=	20 knots

Find:

Recommended airspeeds	=	155 knots CAS
	=	167 knots TAS
Torque setting per engine	=	675 FT. LB.
Propellers	=	1900 RPM

Nautical miles per pound of fuel (no wind) = .4005 N.M./LB.

Nautical miles per pound of fuel (20 knots headwind component) = .3530 N.M./LB.

Fuel Flow (total) $= \frac{167}{.4005}$

= 417 LB/HR

Fuel flow per engine $= \frac{417}{2}$

= 208 LB/HR

Procedure:

Enter the Two Engine Nautical Miles Per Pound of Fuel, 5000 Feet chart (figure 14-25) on the zero wind recommended airspeed line at 8500 pounds. This point of the chart is three-fourths the distance between 600 FT. LB. and 700 FT. LB. Both calibrated and true airspeeds are read directly off the chart. Read across to the base line, and follow guidelines to the 20 knot headwind. Fuel flow is calculated using the equation from paragraph 12-41.

14-43. Cruise performance for non-standard temperature conditions can be determined from standard day charts. Nautical miles per pound of fuel versus calibrated airspeed does not change with temperature. For a particular calibrated airspeed, the torque setting required increases 2% for each 10°C above standard day temperature at the pressure altitude being considered up to the maximum torque available. Inversely; the torque required decreases 2% per 10°C below standard day temperature.

Example: (Optimum range cruise data)

Known:

Two engine operation.

Average gross weight = 8500 pounds

Pressure altitude = 5000 feet

Indicated outside air temperature = 20°C (ISA + 15°C)

Headwind component = 20 knots

Find:

Recommended airspeed = 155 knots CAS

= 171 knots TAS

Torque setting per engine = 675 + (.03)(675)

= 695 FT. LB.

Propeller = 1900 RPM

Maximum allowable torque setting (normal rated power for 5000 FT and ISA + 15°C) = 1080 FT. LB.

Nautical miles per pound of fuel (no wind) = .4005 N.M./LB.

Nautical miles per pound of fuel (20 knot headwind component) $= .4005\left(\frac{171-20}{171}\right)$

= .3537 N.M./LB.

Fuel flow (total) $= \left(\frac{191}{.4005}\right)$

= 427 LB/HR

Fuel flow per engine $= \frac{427}{2}$

= 213 LB/HR

Procedure:

Enter the Two Engine Nautical Miles Per Pound of Fuel, 5000 Feet chart (figure 14-25) on the zero wind recommended airspeed line at 8500 pounds. Read calibrated airspeed, nautical miles per pound of fuel (no wind) and standard day torque. (Note: For non-standard temperatures, these three items are the only ones that can be read directly from the charts.) True airspeed was calculated by obtaining ($1/\sqrt{\sigma}$) from Density Altitude chart (figure 14-3). Torque setting is calculated by reading the standard day torque and adding 3% to it. The maximum allowable torque was determined by entering the maximum cruise chart, figure 14-34, at ISA + 15°C. Nautical miles per pound of fuel with a 20 knot headwind component is calculated using the equation from paragraph 14-40. Fuel flow is calculated using the equation from paragraph 14-41.

14-44. OPTIMUM RANGE SUMMARY.

14-45. Optimum range performance is presented for two engine operation (figure 14-35) and single engine operation (figure 14-36). These charts consist of crossplots of data derived from the zero wind recommended airspeed lines from nautical miles per pound of fuel charts. For some altitudes and weights, it is not possible to cruise at a speed for 99% of maximum range because speed is limited by the maximum available power. Where applicable, two engine operation charts utilize data at normal rated power and single engine operation charts utilize data at maximum power. These charts present calibrated airspeed, nautical miles per pound of fuel, and torque setting per engine versus gross weight and standard day pressure altitudes. In order to determine performance for non-standard temperatures, the explanation in pargraph 14-43 will apply. Calibrated airspeed and nautical miles per pound of fuel do not change with temperature. The torque setting required will change by the schedule previously explained.

Example:

Known:

Two engine operation

Average gross weight	= 8700 pounds
Pressure altitude	= 5000 feet
Temperature	= 5°C (standard)

Find:

Cruise airspeed	= 156 knots CAS
Nautical miles per pound of fuel (no wind)	= .398 N.M./LB.
Torque setting per engine	= 690 FT. LB.
Propeller	= 1900 RPM

Procedure:

Enter optimum Range Summary chart (figure 14-35) at 8700 pounds. Read calibrated airspeed, nautical miles per pound of fuel, and torque setting from the appropriate 5000 FT. parameter lines.

14-46. MAXIMUM CRUISE SUMMARY.

14-47. Torque settings and corresponding fuel flows (figure 14-34), two parts) are presented for normal rated power as a function of pressure altitude, ISA temperatures and indicated outside air temperature. Refer to chart, figure 14-4, for relationship between true and indicated outside air temperatures. ISA lines are provided for flight planning and indicated outside air temperatures are provided for setting power in flight.

Example:

Known:

Indicated outside air temperature	= 10°C
Pressure altitude	= 16,000 FT.

Find:

Torque setting per engine	= 964 FT. LB.
Fuel flow per engine	= 235 LB/HR

Procedure:

Enter both charts at indicated outside air temperature. Read torque setting and fuel flow at pressure altitude being considered. (The above known conditions correspond to approximately ISA + 1°C or -16°C true outside air temperature.)

14-48. MAXIMUM ENDURANCE SUMMARY.

14-49. A summary of Maximum Endurance performance is presented for two engine operation (figure 14-37) and single engine operation (figure 12-38). These charts are a crossplot of the maximum endurance airspeed data from the Nautical Miles Per Pound of Fuel charts. These charts present calibrated airspeed, fuel flow, and torque settings per engine versus gross weight and standard day pressure altitudes. In order to determine performance for non-standard temperatures, the explanation in paragraph 14-43 will apply. Calibrated airspeed does not change with temperature. The torque setting required will change by the schedule previously explained. For fuel flow, read the standard day value and correct it with the following explanation:

$$\text{Fuel flow} = \text{Fuel flow (STD)} \left(\frac{TAS}{TAS_{STD}} \right)$$

Where:

Fuel flow = Fuel flow for non-standard temperature

Fuel flow (STD)= Fuel flow read from chart

TAS = True airspeed at non-standard temperature.

TAS_{STD} = True airspeed for standard day temperature at the same altitude

Example:

Known:

Two engine operation

Average gross weight = 8700 pounds

Pressure altitude = 5000 feet

Temperature = 20°C (ISA + 15°C)

Find:

Endurance speed = 99 knots CAS

True airspeed (20°C at 5000 feet) = 109 knots TAS

True airspeed (5°C at 5000 feet) = 107 knots TAS

Fuel flow (standard) = 155.5 LB/HR/ENG

Fuel flow $= 155.5\left(\frac{109}{107}\right)$

= 158 LB/HR/ENG

Torque setting per engine = 377 +(.03) (377)

= 388 FT.LB.

Propeller = 1900 RPM

Procedure:

Enter maximum endurance chart (figure 14-37) at 8700 pounds. Read calibrated airspeed, fuel flow and torque setting per engine. True airspeeds for standard and nonstandard temperatures at 5000 feet are calculated by obtaining ($1/\sqrt{\sigma}$) for both temperatures from Density Altitude Chart (figure 14-3). Fuel flow is calculated by multiplying the fuel flow read from the chart by the ratio of the two true airspeeds. Torque setting is calculated by adding 3% to torque setting read from chart.

14-50. RANGE - DISTANCE PREDICTION.

14-51. Range prediction for distance is presented for two engine operation (figure 14-39) and single engine operation (figure 14-40). These charts were derived using the zero wind recommended airspeed data on the Nautical Miles Per Pound of Fuel charts. Each chart plots nautical miles versus gross weight and standard day pressure altitudes. Parameter lines assume that aircraft gross weight without fuel is 7248 pounds. This condition represents a full fuel load (370 gallons) and 9650 pounds takeoff weight. Allowance for taxi, runup, takeoff and climb have been made from climb control charts (figures 14-19 and 14-20). Distance prediction will apply for any temperature if the recommended airspeed can be maintained without exceeding the maximum available power.

Example:

Known:

Two engine operation

Gross weight (without fuel) = 8000 pounds

Fuel quantity (JP-4) = 1200 pounds (185 gallons)

Pressure altitude = 5000 feet

Temperature = 5°C (standard)

Find:

Range distance (no reserve) = 476 N.M.

Procedure:

Enter the Two Engine Range-Distance Prediction chart (figure 14-39) at 8000 pounds and zero range. Project parallel to the 5000 FT. parameter line to 9200 pounds (8000 ± 1200) read distance prediction.

14-52. RANGE - TIME PREDICTION

14-53. Range prediction for time is presented for two engine operation (figure 14-41) and single engine operation (figure 14-42). These charts were derived from the zero-wind-recommended airspeed data on the Nautical Miles Per Pound of Fuel charts. Each chart plots time versus gross weight and standard day pressure altitudes. Assumptions are the same as for range - distance preduction, and time prediction for a given set of conditions, and will correspond to the distances determined from range - distance prediction charts. Time on these charts apply only for standard temperatures since true airspeed changes with temperature.

Example:

Known:

Two engine operation	
Gross weight (without fuel)	= 8000 pounds
Fuel quantity (JP-4)	= 1200 pounds
	= (185 gallons)
Pressure altitude	= 5000 feet
Temperature	= 5°C (standard)

Find:

Range time (no reserve) = 2.92 hours

Procedure:

Enter the Range - Time Prediction chart (figure 14-41) at 8000 pounds and zero range. Project parallel to the 5000 FT. parameter line to 9200 pounds (8000 + 1200). Read time prediction.

14-54. LANDING.

14-55. Landing performance charts are presented for landing distance (figure 14-43) and landing speed (figure 14-44). Distances assume a hard, level, dry surface runway; flaps 100% (down); and gear down. The recommended approach speed and power, as required to maintain 800 FT/MIN descent. Touchdown at recommended touchdown speed, set power to idle and apply maximum braking. This chart presents ground roll and total distance over a 50-foot obstacle - versus outside air temperature, pressure altitude, gross weight and headwind.

Example:

Known:

Outside air temperature	= 30°C
Pressure altitude	= Sea level
Gross Weight	= 8500 pounds
Headwind component	= 20 knots

Find:

Ground roll	= 760 feet
Total distance over 50-foot obstacle	= 1660 feet
Approach speed	= 98 knots IAS
Touchdown speed	= 85 knots IAS

Procedure:

Enter the Landing Distance Chart (figure 14-43) at 30°C, and sea level pressure altitude. Project horizontally to 8500 pounds gross weight, then down to zero headwind. Follow wind guide lines to 20 knot headwind. Read ground roll distance. Project vertically downward to 20 knot headwind parameter and read total distance over 50-foot obstacle. Enter Landing Speed chart (figure 14-44) at 8500 pounds. Read approach and touchdown speeds.

14-56. EMERGENCY CEILING.

14-57. The Emergency Ceiling chart (figure 14-23) presents the pressure altitude on a standard day for which 100 FT/MIN rate-of-climb can be obtained versus gross weight. Data is furnished for both two engine and single engine operations.

Example:

Known:

Gross weight = 8500 pounds

Find:

Emergency ceilings-

Two engine operation = 28,400 feet

Single engine operation = 16,750 feet

Procedure:

Enter Emergency Ceiling chart (figure 14-23) at 8500 pounds. Read two engine and single engine emergency ceilings.

LIST OF PERFORMANCE GRAPHS AND TABLES

TM 55-1510-209-CL/1

TAKEOFF AND LANDING DATA CARD

TAKEOFF DATA

TAKEOFF POWER: TORQUE ________ RPM 2200
ROTATION SPEED ________ KN.
TAKEOFF SPEED ________ KN.
MINIMUM CONTROL SPEED (VMC) ________ KN.
TAKEOFF GROUND RUN ________ FT.
TAKEOFF OVER ________ FT. OBSTACLE ________ FT.
CLIMB POWER: TORQUE ________ RPM ________
INITIAL CLIMB AIRSPEED ________ KN.
SINGLE ENGINE CLIMB SPEED ________ KN.

LANDING IMMEDIATELY AFTER TAKEOFF

FINAL APPROACH SPEED ________ KN.
TOUCHDOWN SPEED ________ KN.
LANDING GROUND ROLL ________ FT.

P-1

TM 55-1510-209-CL/1

LANDING DATA

FINAL APPROACH SPEED ________ KN.
TOUCHDOWN SPEED ________ KN.
LANDING GROUND ROLL ________ FT.

CONDITIONS

DENSITY ALTITUDE ________ FT.
PRESSURE ALTITUDE ________ FT.
TEMPERATURE ________ °C
WIND DIRECTION ________ VELOCITY ________ KN.
RUNWAY LENGTH ________ FT. HEADING ________
GROSS WT. (TAKEOFF) ________ LB.
GROSS WT. (LANDING) ________ LB.

REMARKS: FOR U-21A ONLY

RECOMMENDED MAXIMUM WIND LIMITATIONS:
90° CROSSWIND ________ 21 KNOTS
60° CROSSWIND ________ 28 KNOTS
30° CROSSWIND ________ 60 KNOTS
MAXIMUM WIND — NO CROSSWIND ________ 60 KNOTS

P-2

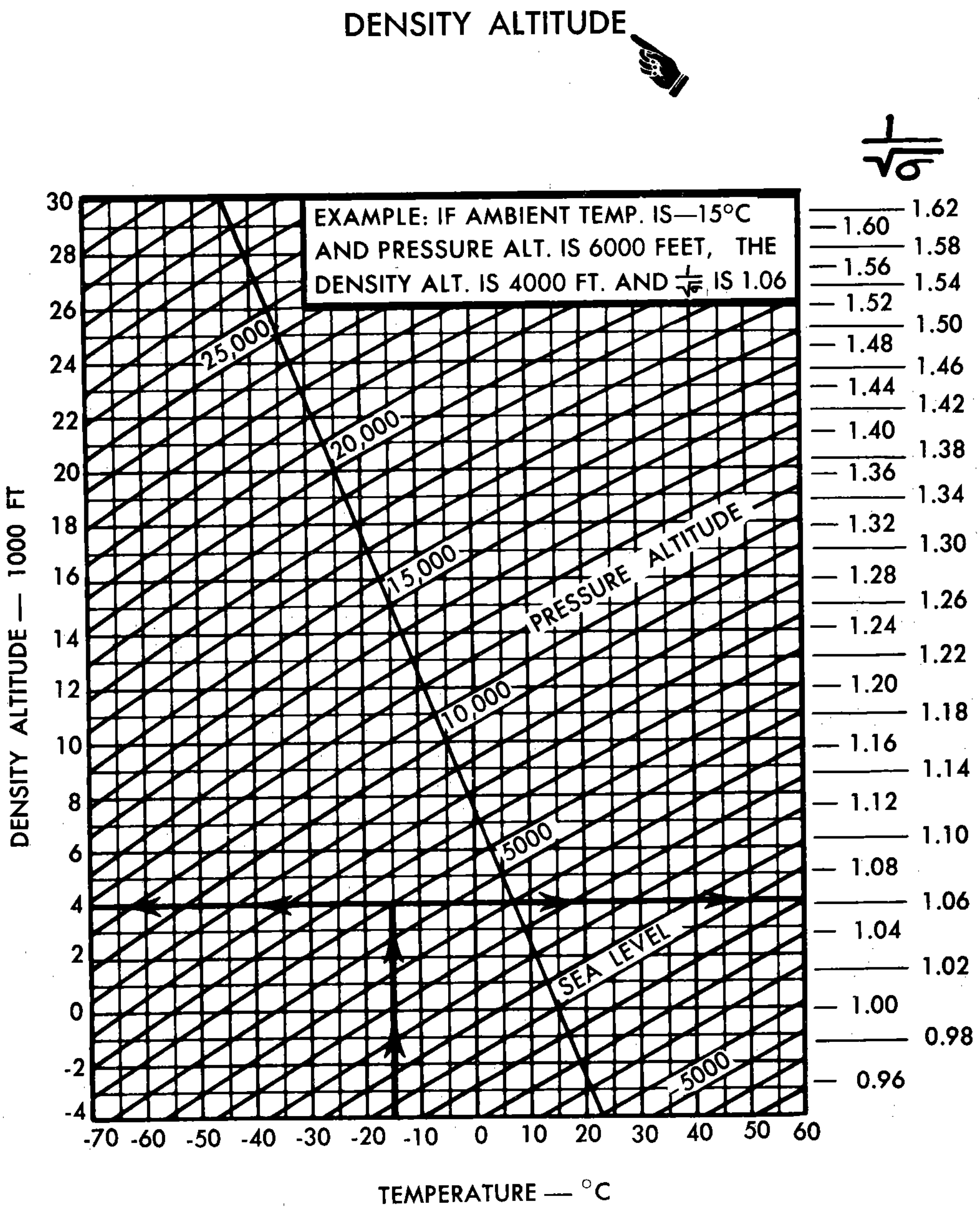
Figure 14-1. Take-off and landing data card

STANDARD SL CONDITIONS:
TEMP – 15 C (59 F)
PRESS. – 29.921 IN. Hg (2,116.216 LB/SQ FT)
DENSITY – 0.0023769 SLUGS/CU FT)
SPEED OF SOUND – 1,116.89 FT/SEC (661.7 KN)

CONVERSION FACTORS:
1 IN. Hg – 70.727 LB/SQ FT
1 IN. Hg – 0.49116 LB/SQ IN.
1 KN – 1.151 MPH
1 KN – 1.688 FT/SEC

PRESSURE ALTITUDE 1,000 FEET	DENSITY RATIO P/Po	$1\sqrt{\sigma}$	TEMPERATURE °C	TEMPERATURE °F	SPEED OF SOUND RATIO a/ao	PRESSURE IN. Hg	PRESSURE RATIO P/Po
SL	1.0000	1.0000	15.000	59.000	1.0000	29.92	1.0000
1	0.9710	1.0143	13.019	55.434	0.997	28.85	0.9644
2	0.9428	1.0299	11.038	51.868	0.993	27.82	0.9298
3	0.9151	1.0454	9.056	48.301	0.990	26.81	0.8962
4	0.8881	1.0611	7.075	44.735	0.986	25.84	0.8636
5	0.8616	1.0773	5.094	41.169	0.983	24.89	0.8320
6	0.8358	1.0938	3.113	37.603	0.979	23.98	0.8013
7	0.8106	1.1107	1.132	34.037	0.976	23.09	0.7716
8	0.7859	1.1280	-0.850	30.471	0.972	22.22	0.7427
9	0.7619	1.1456	-2.831	26.904	0.968	21.38	0.7147
10	0.7384	1.1637	-4.812	23.338	0.965	20.58	0.6876
11	0.7154	1.1822	-6.793	19.772	0.962	19.79	0.6614
12	0.6931	1.2012	-8.774	16.206	0.958	19.03	0.6359
13	0.6712	1.2206	-10.756	12.640	0.954	18.29	0.6112
14	0.6499	1.2404	-12.737	9.074	0.950	17.57	0.5873
15	0.6291	1.2608	-14.718	5.507	0.947	16.88	0.5642
16	0.6088	1.2816	-16.699	1.941	0.943	16.21	0.5418
17	0.5891	1.3029	-18.680	-1.625	0.940	15.56	0.5202
18	0.5698	1.3247	-20.662	-5.191	0.936	14.94	0.4992
19	0.5509	1.3473	-22.643	-8.757	0.932	14.33	0.4790
20	0.5327	1.3701	-24.624	-12.323	0.929	13.75	0.4594
21	0.5148	1.3937	-26.605	-15.890	0.925	13.18	0.4405
22	0.4974	1.4179	-28.586	-19.456	0.922	12.63	0.4222
23	0.4805	1.4426	-30.568	-23.022	0.917	12.10	0.4025
24	0.4840	1.4681	-32.549	-26.588	0.914	11.59	0.3874
25	0.4480	1.4940	-34.530	-30.154	0.910	11.10	0.3709
26	0.4323	1.5209	-36.511	-33.720	0.908	10.62	0.3550
27	0.4171	1.5484	-38.493	-37.287	0.903	10.16	0.3397
28	0.4023	1.5768	-40.474	-40.853	0.899	9.720	0.3248
29	0.3879	1.6056	-42.455	-44.419	0.895	9.293	0.3106
30	0.3740	1.6352	-44.435	-47.985	0.891	8.830	0.2968
31	0.3603	1.6659	-46.417	-51.651	0.887	8.483	0.2834
32	0.3472	1.6971	-48.399	-55.117	0.883	8.101	0.2707
33	0.3343	1.7296	-50.379	-58.684	0.879	7.732	0.2583
34	0.3218	1.7628	-52.361	-62.250	0.875	7.377	0.2465
35	0.3098	1.7966	-54.342	-65.816	0.871	7.036	0.2352
36	0.2962	1.8374	-55.000	-67.000	0.870	6.708	0.2242
37	0.2824	1.8818	-55.000	-67.000	0.870	6.395	0.2137
38	0.2692	1.9273	-55.000	-67.000	0.870	6.096	0.2037
39	0.2566	1.9738	-55.000	-67.000	0.870	5.812	0.1943
40	0.2447	2.0215	-55.000	-67.000	0.870	5.541	0.1852
41	0.2332	2.0707	-55.000	-67.000	0.870	5.283	0.1765
42	0.2224	2.1207	-55.000	-67.000	0.870	5.036	0.1683
43	0.2120	2.1719	-55.000	-67.000	0.870	4.802	0.1605
44	0.2021	2.2244	-55.000	-67.000	0.870	4.578	0.1530
45	0.1926	2.2785	-55.000	-67.000	0.870	4.364	0.1458
46	0.1837	2.3332	-55.000	-67.000	0.870	4.160	0.1391
47	0.1751	2.3093	-55.000	-67.000	0.870	3.965	0.1325
48	0.1669	2.4478	-55.000	-67.000	0.870	3.781	0.1264
49	0.1591	2.5071	-55.000	-67.000	0.870	3.604	0.1205
50	0.1517	2.5675	-55.000	-67.000	0.870	3.438	0.1149

Figure 14-2. Standard atmosphere table



REMARKS

1. SET ALTIMETER SETTING TO 29.92 INCHES Hg BEFORE READING INDICATED PRESSURE ALTITUDE.
2. CORRECT INDICATED OAT°C FOR COMPRESSIBILITY USING FIGURE 14-4 BEFORE ENTERING CHART.

Figure 14-3. Density altitude

TEMPERATURE CORRECTION

TOAT = INDICATED OAT — △ T

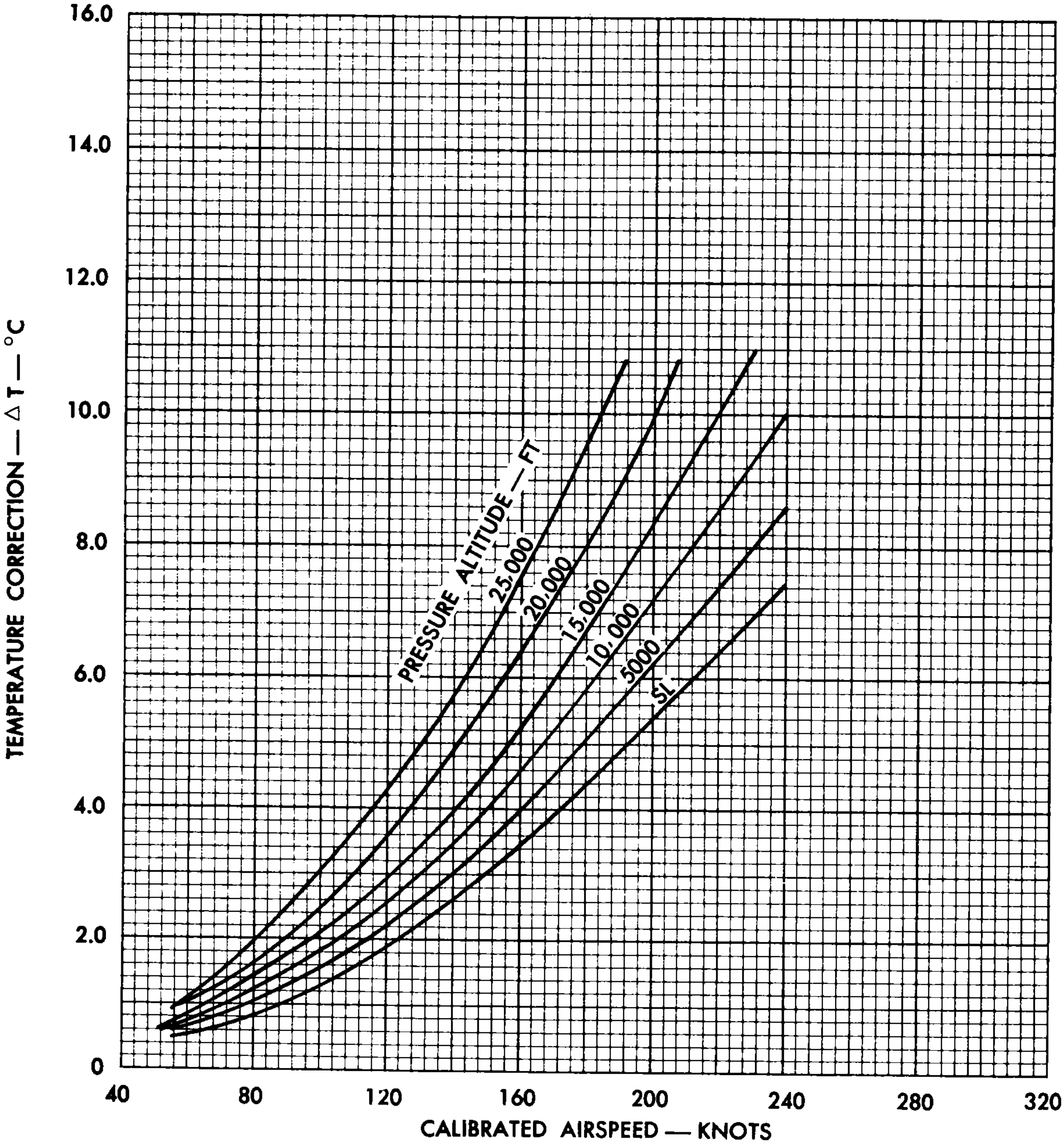


Figure 14-4. Temperature correction

MODEL: U-21A, RU-21A

AIRSPEED CORRECTION — NORMAL SYSTEM

ENGINES: T74-CP-700 (PT6A-20)

DATA BASIS: FLIGHT TEST

ADD CORRECTION TO IAS.

IAS ASSUMES ZERO INSTRUMENT ERROR.

DATE: JANUARY 24, 1967

WING FLAPS UP		WING FLAPS DOWN 35% APPROACH FLAPS		WING FLAPS DOWN 100% LANDING FLAPS	
IAS KTS	CORRECTION KTS	IAS KTS	CORRECTION KTS	IAS KTS	CORRECTION KTS
60	5.4	60	3.5	60	5.8
80	4.4	80	1.7	80	.7
100	3.6	100	.2	90	−1.5
120	2.8	120	−1.0	100	−3.5
140	2.2	140	−1.9	110	−5.3
160	1.6	160	−2.7	120	−7.0
180	1.1	174	−3.1	130	−8.6
200	.7				
208	.5				

REMARKS:

AIR STAIR DOOR INSTALLED OR REMOVED.

Figure 14-5. Airspeed correction - normal system

MODEL: U-21A, RU-21A

DATA: MARCH 3, 1967

DATA BASIS: FLIGHT TEST

AIRSPEED CORRECTION — EMERGENCY SYSTEM

ADD CORRECTION TO IAS.
IAS ASSUMES ZERO INSTRUMENT ERROR.

ENGINES: T74-CP-700 (PT6A-20)

ALL WINDOWS CLOSED, HEATER BLOWER ON OR OFF				LEFT STORM WINDOW OPEN, HEATER BLOWER ON OR OFF			
GEAR AND FLAPS UP		GEAR AND FLAPS DOWN 100%		GEAR AND FLAPS UP		GEAR AND FLAPS DOWN 100%	
IAS KTS	CORRECTION KTS	IAS KTS	CORRECTION KTS	IAS KTS	CORRECTION KTS	IAS KTS	CORRECTION KTS
60	1.0	60	3.5	60	−5.1	60	−1.8
80	0.0	70	0.8	80	−6.6	70	−4.8
100	−2.4	80	−1.7	100	−8.1	80	−6.3
120	−3.5	90	−3.7	120	−10.3	90	−9.5
140	−5.4	100	−5.3	140	−10.9	100	−11.6
160	−7.0	110	−6.1	160	−13.6	110	−12.5
180	−6.3	120	−6.5	180	−13.5	120	−13.5
200	−5.6	130	−7.5	200	−13.5	130	−14.4
208	−5.1			208	−13.0		

REMARKS:
STATIC SOURCE VENTED TO CABIN.

Figure 14-6. Airspeed corrections - emergency system

MODEL: U-21A, RU-21A
DATA BASIS: FLIGHT TEST
DATE: JANUARY 24, 1967

ALTIMETER CORRECTION — NORMAL SYSTEM
ADD CORRECTION TO ALTIMETER READING.
IAS ASSUMES ZERO INSTRUMENT ERROR.

ENGINES: T74-CP-700 (PT6A-20)

WING FLAPS UP			WING FLAPS DOWN 35% APPROACH			WING FLAPS DOWN 100% LANDING		
IAS KTS	ALT FT	CORRECTION FT	IAS KTS	ALT FT	CORRECTION FT	IAS KTS	ALT FT	CORRECTION FT
60	SL	32	60	SL	21	60	SL	35
	10,000	43		10,000	28		10,000	46
	20,000	54		20,000	37		20,000	81
	30,000	76		30,000	49		30,000	116
80	SL	35	80	SL	13	80	SL	5
	10,000	44		10,000	18		10,000	7
	20,000	62		20,000	24		20,000	10
	30,000	84		30,000	32		30,000	13
100	SL	34	100	SL	2	90	SL	-13
	10,000	45		10,000	3		10,000	-17
	20,000	61		20,000	3		20,000	-23
	30,000	86		30,000	5		30,000	-32
120	SL	31	120	SL	-11	100	SL	-33
	10,000	42		10,000	-15		10,000	-44
	20,000	59		20,000	-21		20,000	-60
	30,000	81		30,000	-29		30,000	-84
140	SL	29	140	SL	-25	110	SL	-53
	10,000	37		10,000	-32		10,000	-74
	20,000	53		20,000	-47		20,000	-100
	30,000	75		30,000	-65		30,000	-138
160	SL	23	160	SL	-39	120	SL	-77
	10,000	32		10,000	-54		10,000	-105
	20,000	43		20,000	-74		20,000	-144
	30,000	62		30,000	-105		30,000	-203
180	SL	18	174	SL	-48	130	SL	-103
	10,000	24		10,000	-67		10,000	-138
	20,000	34		20,000	-93		20,000	-194
	30,000	48		30,000	-132		30,000	-267
200	SL	13						
	10,000	18						
	20,000	24						
	30,000	35						
208	SL	10						
	10,000	13						
	20,000	18						
	30,000	26						

REMARKS:
AIR STAIR DOOR INSTALLED OR REMOVED.

Figure 14-7. Altimeter correction - normal system

MODEL: U-21A, RU-21A

DATE: MARCH 6, 1967

DATA BASIS: FLIGHT TEST

ALTIMETER CORRECTION — EMERGENCY SYSTEM

ADD CORRECTION TO ALTIMETER READING.
IAS ASSUMES ZERO INSTRUMENT ERROR.

ENGINES: T74-CP-700 (PT6A-20)

GEAR AND FLAPS UP						GEAR AND FLAPS DOWN 100%					
IAS KTS	ALT FT	CORREC-TION FT	IAS KTS	ALT FT	CORREC-TION FT	IAS KTS	ALT FT	CORREC-TION FT	IAS KTS	ALT FT	CORREC-TION FT
60	SL	6.0	160	SL	−101.5	60	SL	21.0	110	SL	−61.0
	10,000	8.0		10,000	−140.0		10,000	28.0		10,000	−85.4
	20,000	10.0		20,000	−189.0		20,000	49.0		20,000	−112.9
	30,000	14.0		30,000	−273.0		30,000	70.0		30,000	−158.6
80	SL	0.0	180	SL	−100.8	70	SL	5.6	120	SL	−71.5
	10,000	0.0		10,000	−138.6		10,000	7.2		10,000	−97.5
	20,000	0.0		20,000	−195.3		20,000	10.0		20,000	−133.3
	30,000	0.0		30,000	−308.0		30,000	13.2		30,000	−188.5
100	SL	−22.8	200	SL	−100.8	80	SL	−13.6	130	SL	−90.0
	10,000	−28.8		10,000	−140.0		10,000	−17.0		10,000	−120.0
	20,000	−40.8		20,000	−193.2		20,000	−23.8		20,000	−165.0
	30,000	−57.6		30,000	−274.4		30,000	−32.3		30,000	−232.5
120	SL	−38.5	208	SL	−96.9	90	SL	−31.5			
	10,000	−52.5		10,000	−132.6		10,000	−42.6			
	20,000	−71.8		20,000	−183.6		20,000	−57.4			
	30,000	−99.8		30,000	−262.7		30,000	−77.7			
140	SL	−70.2				100	SL	−50.4			
	10,000	−91.8					10,000	−66.3			
	20,000	−129.6					20,000	−90.1			
	30,000	−183.6					30,000	−127.2			

REMARKS:

ALL WINDOWS CLOSED, HEATER BLOWER ON OR OFF

Figure 14-8. Altimeter correction - emergency system (sheet 1 of 2)

MODEL: U-21A, RU-21A
DATE: MARCH 6, 1967
DATA BASIS: FLIGHT TEST

ALTIMETER CORRECTION — EMERGENCY SYSTEM
ADD CORRECTION TO ALTIMETER READING.
IAS ASSUMES ZERO INSTRUMENT ERROR.

ENGINES: T74-CP-700 (PT6A-20)

GEAR AND FLAPS UP						GEAR AND FLAPS DOWN 100%					
IAS KTS	ALT FT	CORRECTION FT	IAS KTS	ALT FT	CORRECTION FT	IAS KTS	ALT FT	CORRECTION FT	IAS KTS	ALT FT	CORRECTION FT
60	SL	−30.6	160	SL	−197.2	60	SL	−10.8	110	SL	−125.0
	10,000	−40.8		10,000	−272.0		10,000	−14.4		10,000	−175.0
	20,000	−51.0		20,000	−374.0		20,000	−25.2		20,000	−237.5
	30,000	−71.4		30,000	−530.4		30,000	−36.0		30,000	−331.3
80	SL	−52.8	180	SL	−216.0	70	SL	−33.6	120	SL	−148.5
	10,000	−66.0		10,000	−297.0		10,000	−42.2		10,000	−202.5
	20,000	−92.4		20,000	−418.5		20,000	−79.2		20,000	−276.8
	30,000	−125.4		30,000	−594.0		30,000	−117.6		30,000	−391.5
100	SL	−77.0	200	SL	−243.0	80	SL	−50.4	130	SL	−172.8
	10,000	−101.3		10,000	−337.5		10,000	−63.0		10,000	−230.4
	20,000	−137.7		20,000	−465.8		20,000	−88.2		20,000	−316.8
	30,000	−194.4		30,000	−661.5		30,000	−119.7		30,000	−446.4
120	SL	−118.5	208	SL	−247.0	90	SL	−80.8			
	10,000	−154.5		10,000	−338.0		10,000	−109.3			
	20,000	−211.2		20,000	−468.0		20,000	−147.3			
	30,000	−298.7		30,000	−669.5		30,000	−199.5			
140	SL	−141.7				100	SL	−110.2			
	10,000	−190.8					10,000	−145.0			
	20,000	−261.6					20,000	−197.2			
	30,000	−370.6					30,000	−278.4			

REMARKS:
LEFT STORM WINDOW OPEN, HEATER BLOWER ON

Figure 14-8. Altimeter correction - emergency system (sheet 2 of 2)

POWER AVAILABLE FOR TAKE-OFF

MODEL: U-21A, RU-21A
DATE: 30 JAN. 1967
DATA BASIS: FLIGHT TEST

ENGINES: T74-CP-700 (PT6A-20)
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB./GAL.

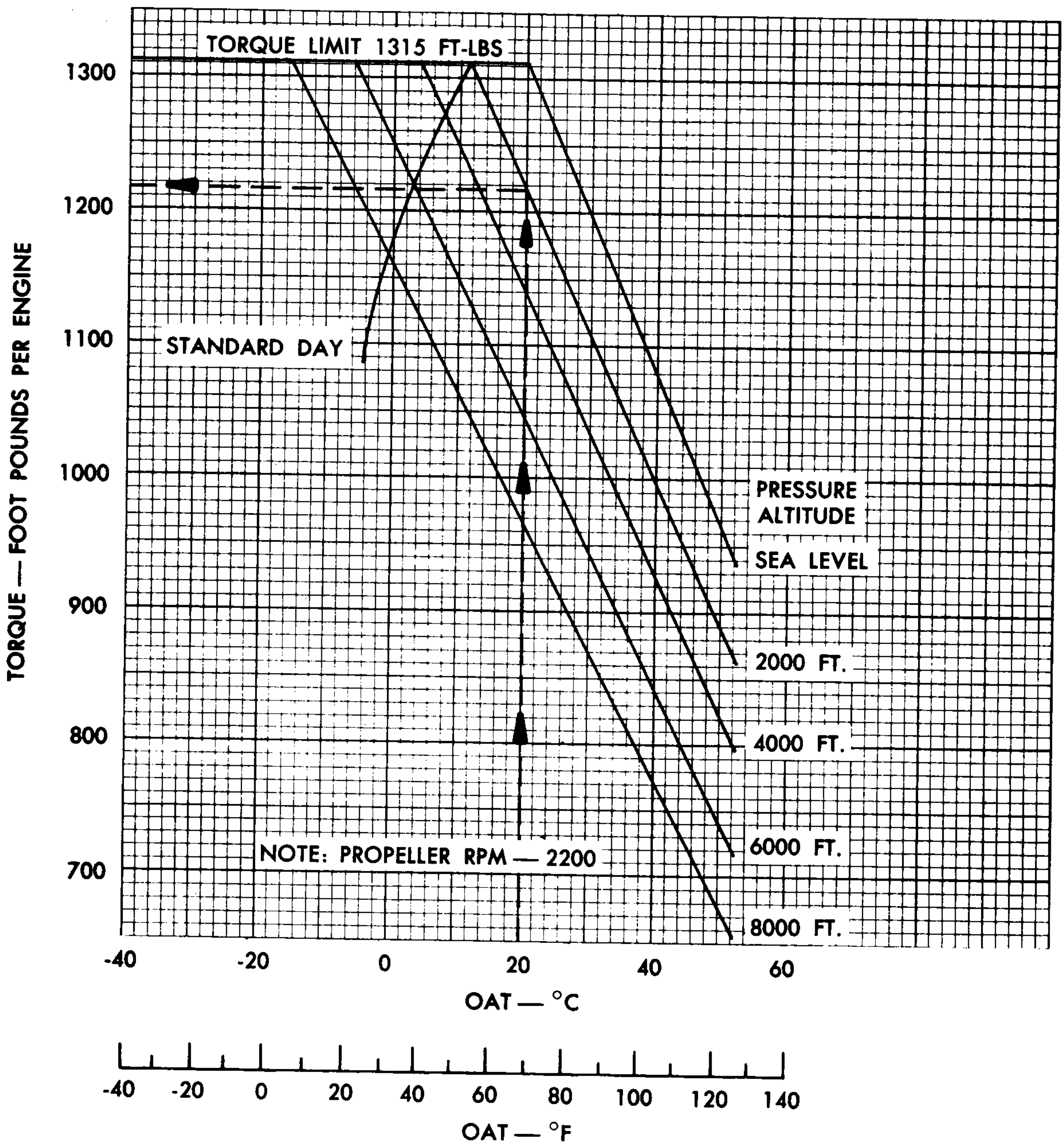


Figure 14-9. Power available for take-off

POWER CONVERSION

MODEL: U-21A, RU-21A
DATE: 31 JAN. 1967
DATA BASIS: FLIGHT TEST

ENGINES: T74-CP-700 (PT6A-20)
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

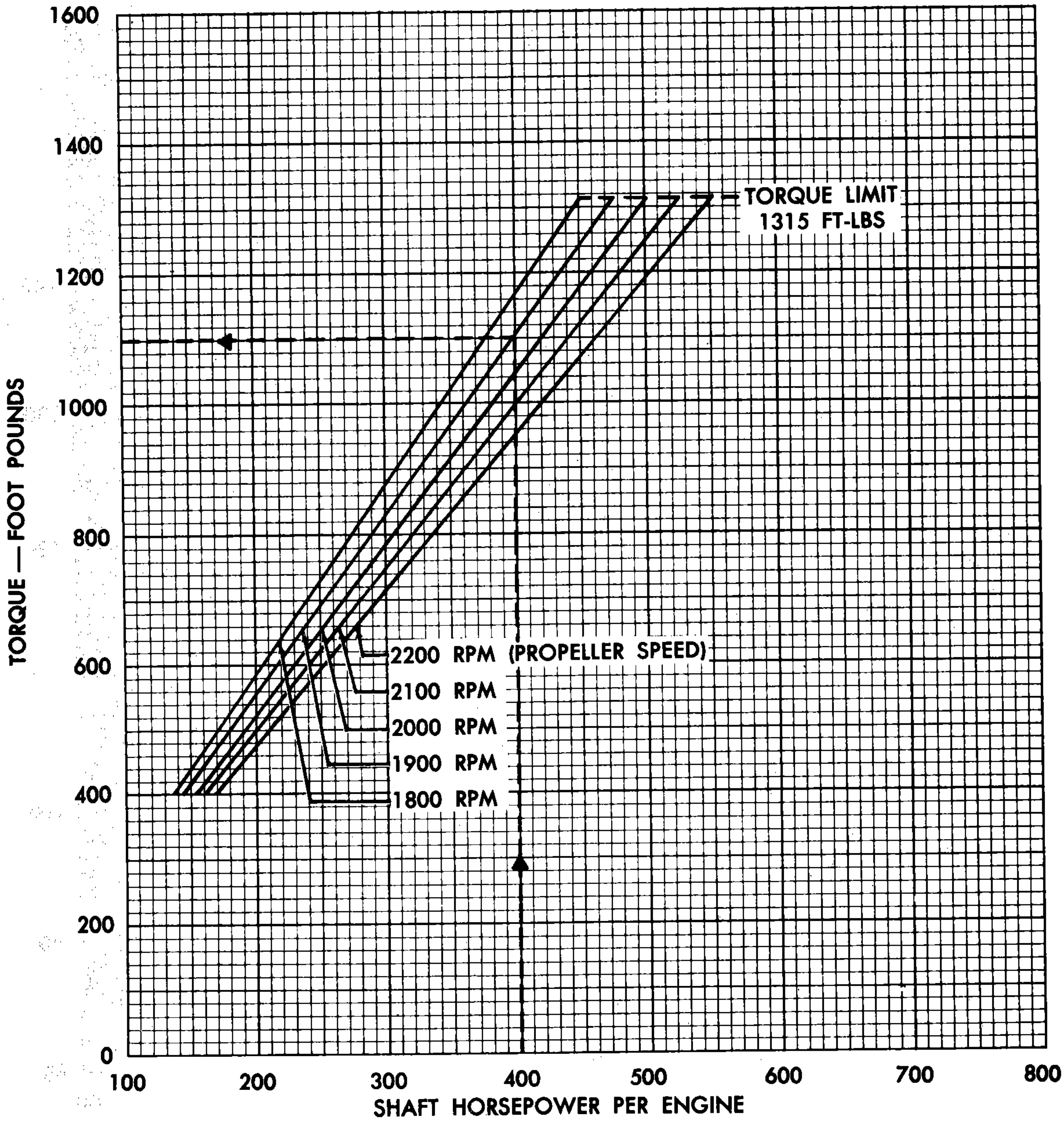


Figure 14-10. Power conversion

TAKE-OFF & LANDING CROSSWIND

MODEL: U-21A, RU-21A
DATE: 1 FEB. 1967
DATA BASIS: FLIGHT TEST

ENGINES: T74-CP-700 (PT6A-20)
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

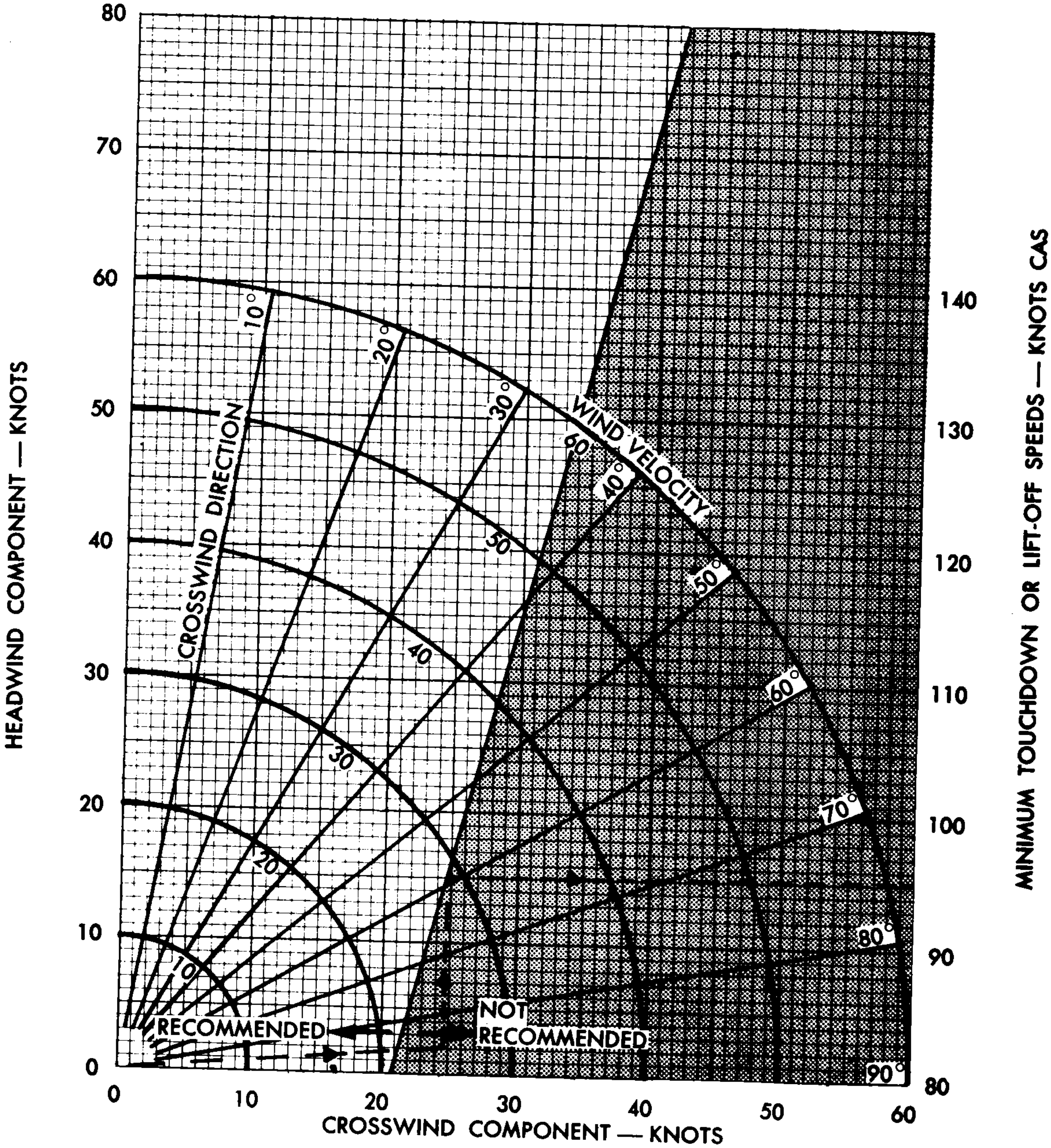


Figure 14-17. Takeoff and landing crosswind

TAKE-OFF DISTANCE

MODEL: U-21A, RU-21A
DATE: MARCH 8, 1967
DATA BASIS: FLIGHT TEST

TWO ENGINE OPERATION
FLAPS UP

TAKE OFF SPEED IS 101 KTS. CAS
FOR ALL GROSS WEIGHTS

ENGINES: T74-CP-700 (PT6A-20)
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS./GAL.
POWER: TAKE-OFF

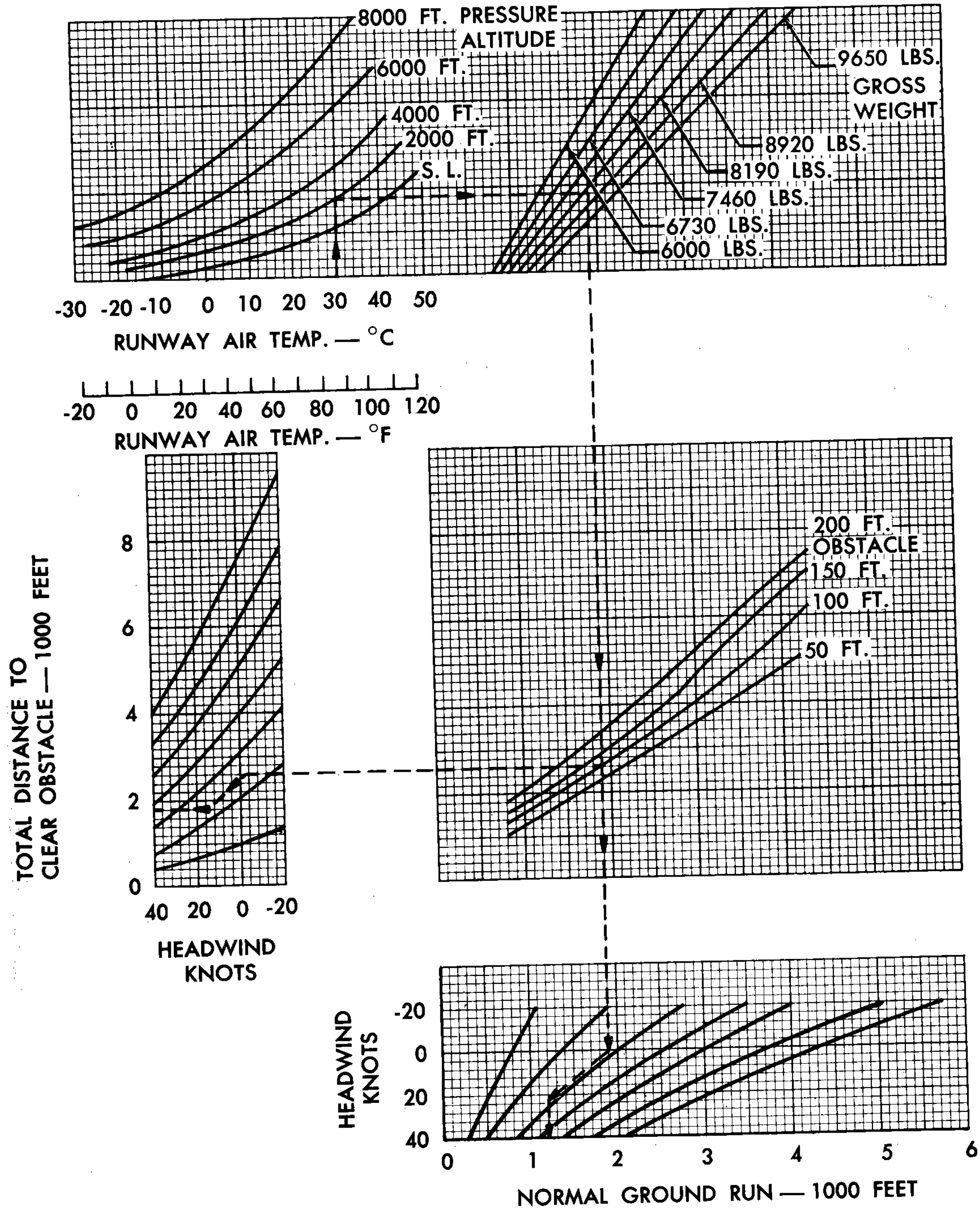


Figure 14-18. Takeoff distance

MODEL: U-21A, RU-21A
DATE: FEBRUARY 28, 1967
DATA BASIS: FLIGHT TEST

SINGLE ENGINE CLIMB

ENGINES: (2) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
CONDITIONS: 1. PROPELLER ON INOPERATIVE ENGINE FEATHERED
2. FLAPS AND GEAR UP
3. MAXIMUM POWER

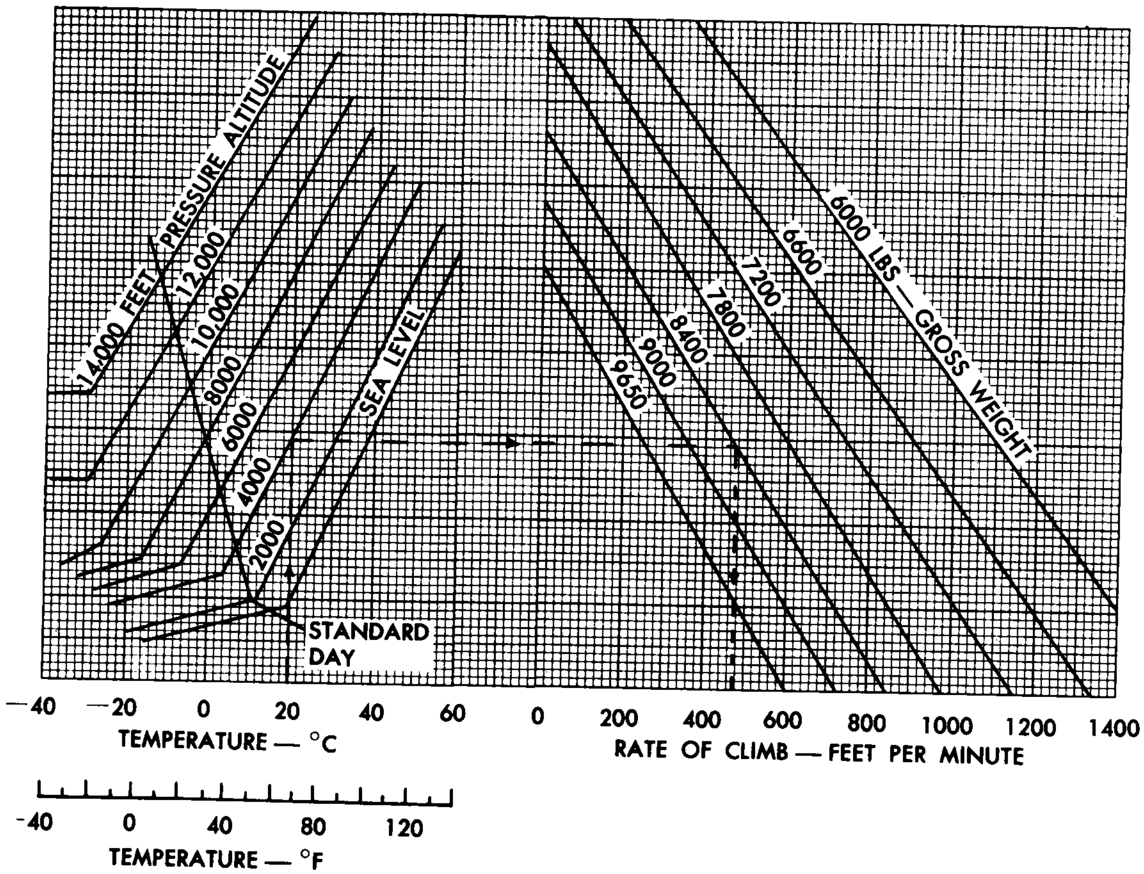


Figure 14-21. Single Engine Climb

SINGLE ENGINE BEST RATE-OF-CLIMB SPEEDS

STANDARD DAY

MODEL: U-21A, RU-21A
DATE: MARCH 7, 1967
DATA BASIS: FLIGHT TEST
CONFIGURATION: GEAR AND FLAPS UP

ENGINES: T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
POWER: MAXIMUM POWER

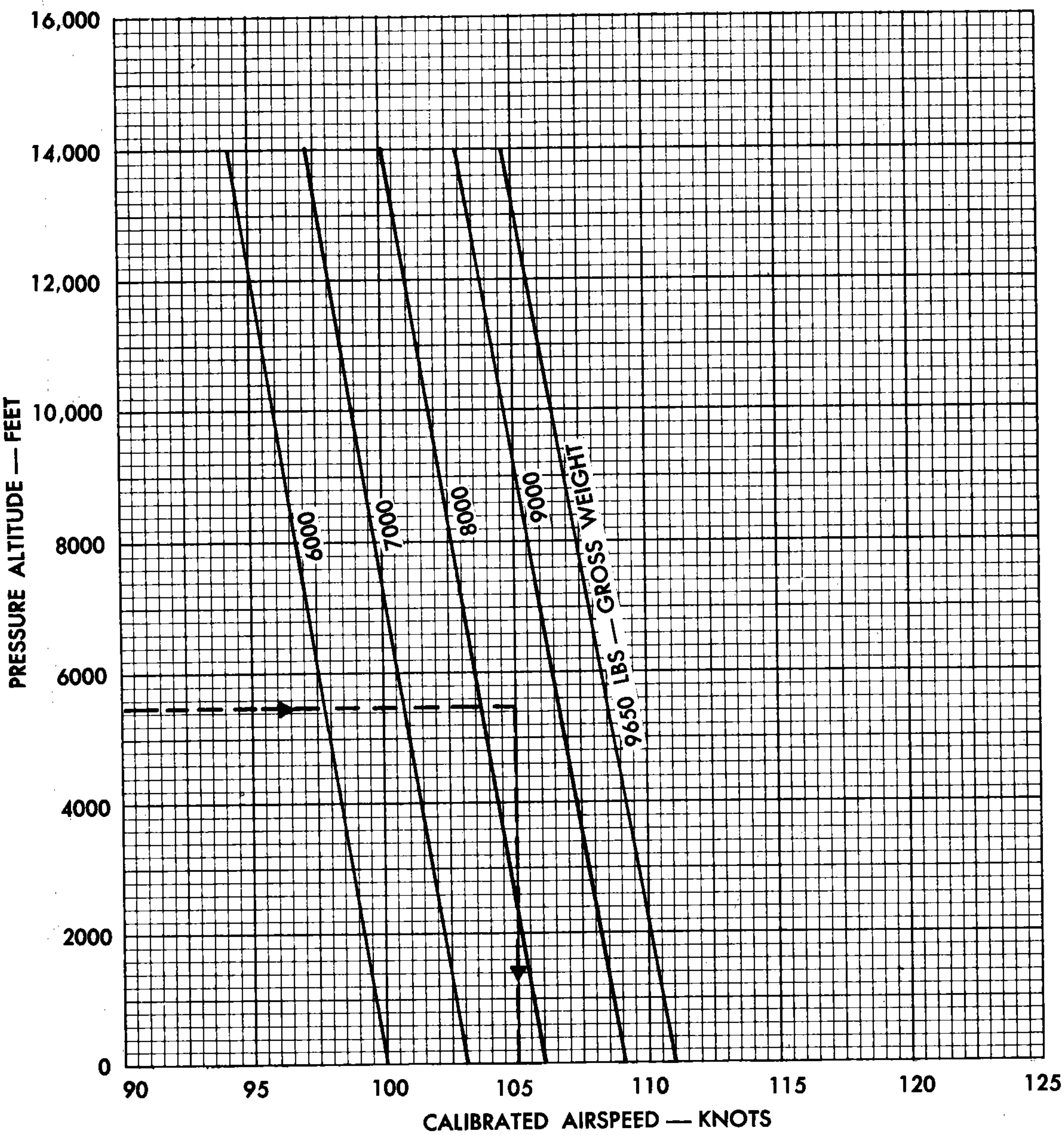


Figure 14-22. Single engine best rate-of-climb speeds

NAUTICAL MILES PER POUND OF FUEL

MODEL: U-21A, RU-21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

15,000 FEET
STANDARD DAY (—14.7°C)
CRUISE CONFIGURATION
CLEAN

ENGINES: (1) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
SINGLE ENGINE OPERATION

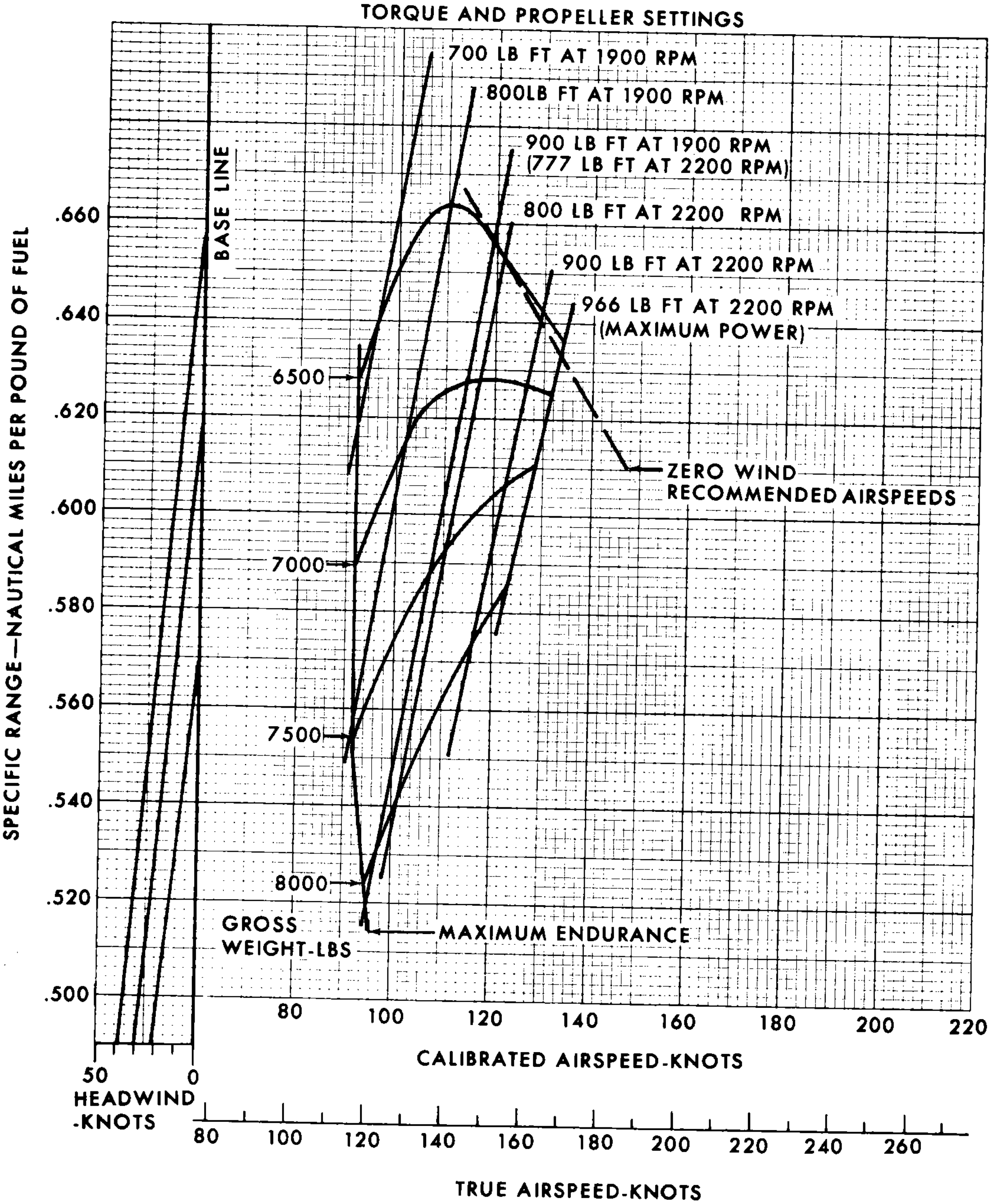


Figure 14-33. Single engine nautical miles per pound of fuel, 15,000 feet

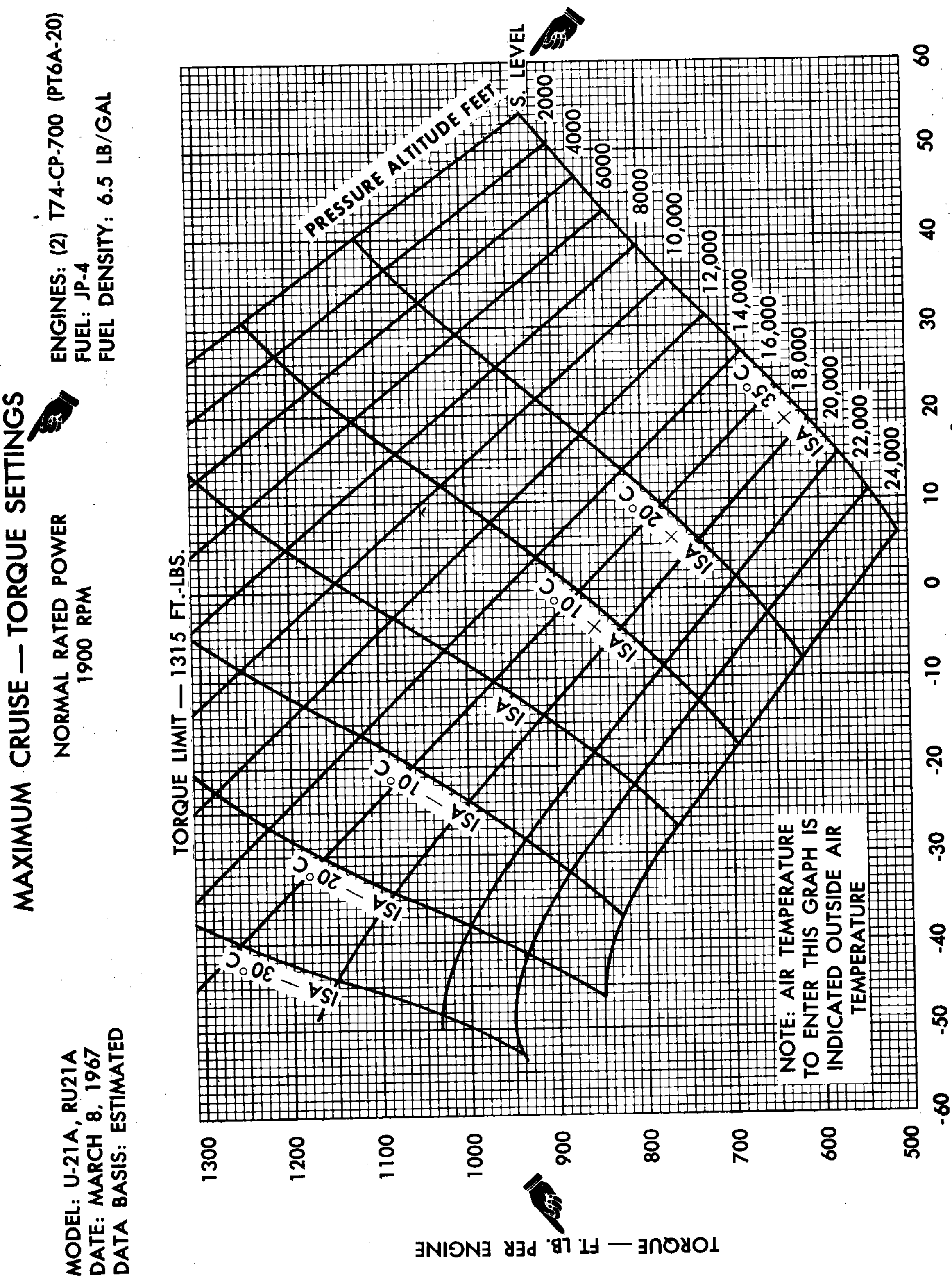


Figure 14-34. Maximum cruise - torque settings (sheet 1 of 2)

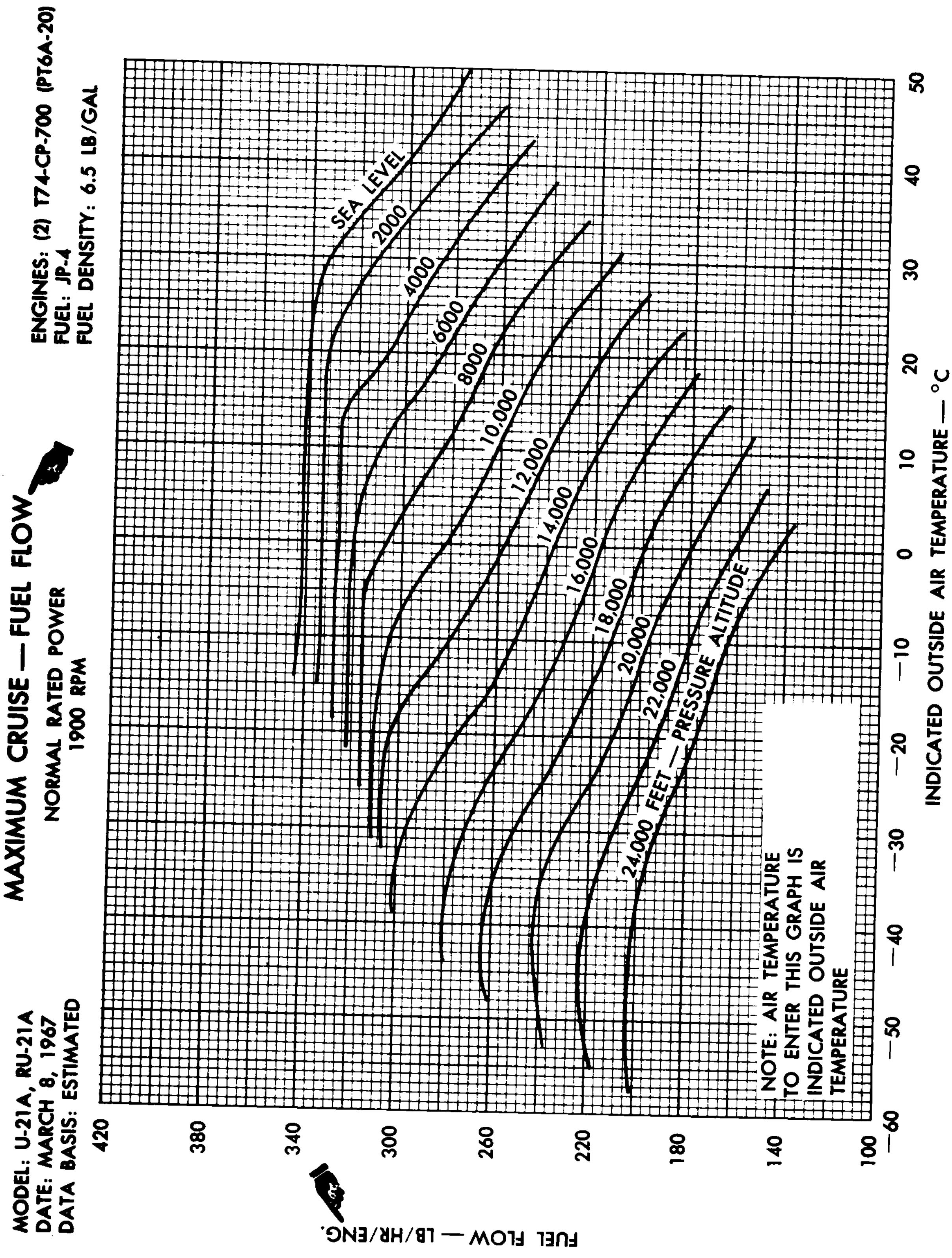


Figure 14-34. Maximum cruise - fuel flow (sheet 2 of 2)

OPTIMUM RANGE SUMMARY

MODEL: U-21A, RU-21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

STANDARD DAY

ENGINES: (2) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
2 ENGINE OPERATION AT
ZERO WIND RECOMMENDED AIRSPEED

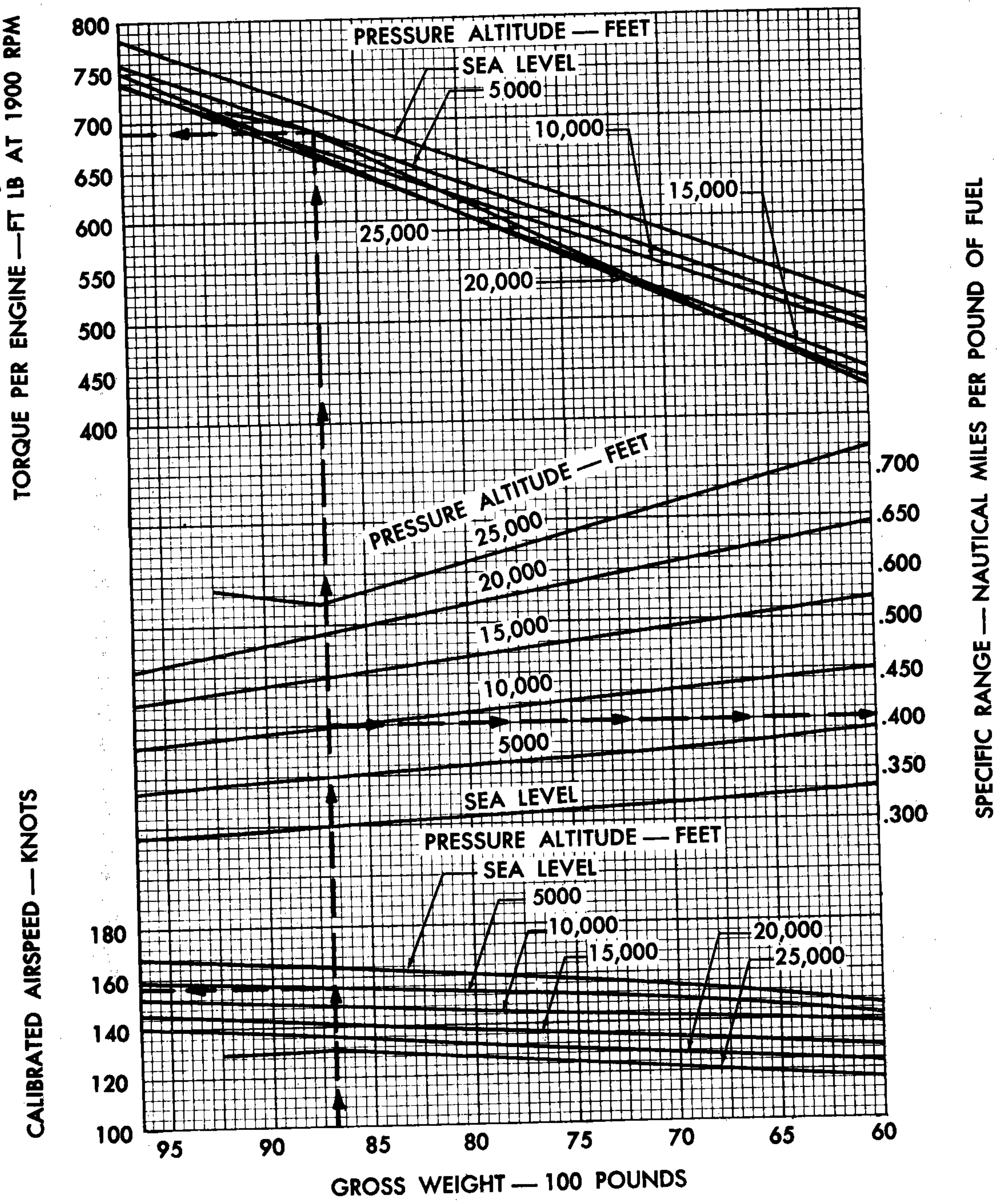


Figure 14-35. Two engine optimum range summary

OPTIMUM RANGE SUMMARY

MODEL: U-21A, RU-21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

STANDARD DAY

ENGINES: (2) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
SINGLE ENGINE OPERATION AT ZERO WIND RECOMMENDED AIRSPEED UNLESS LIMITED BY MAXIMUM POWER

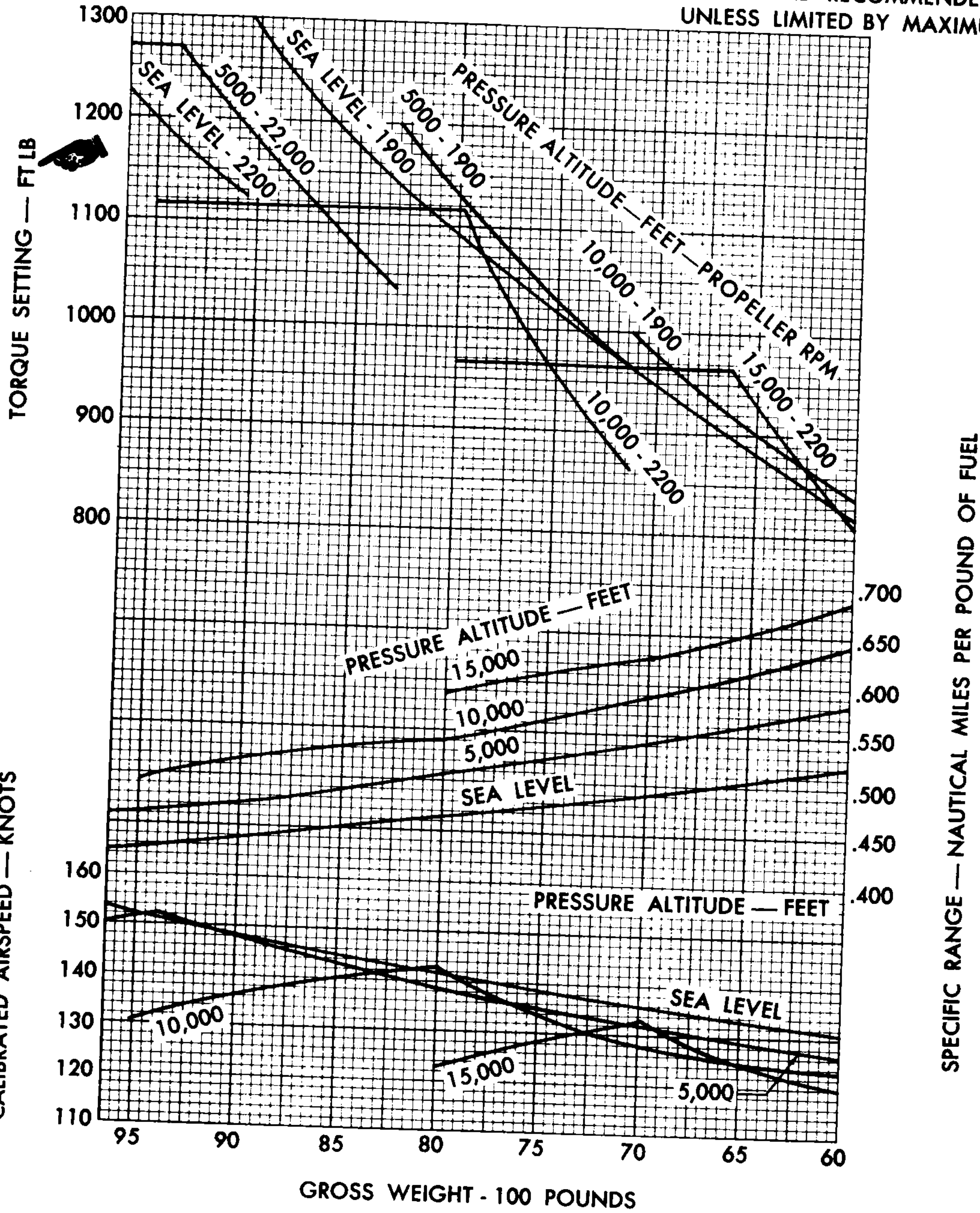


Figure 14-36. Single engine optimum range summary

MAXIMUM ENDURANCE SUMMARY

MODEL: U-21A, RU-21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

STANDARD DAY

ENGINES: (2) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
2 ENGINE OPERATION

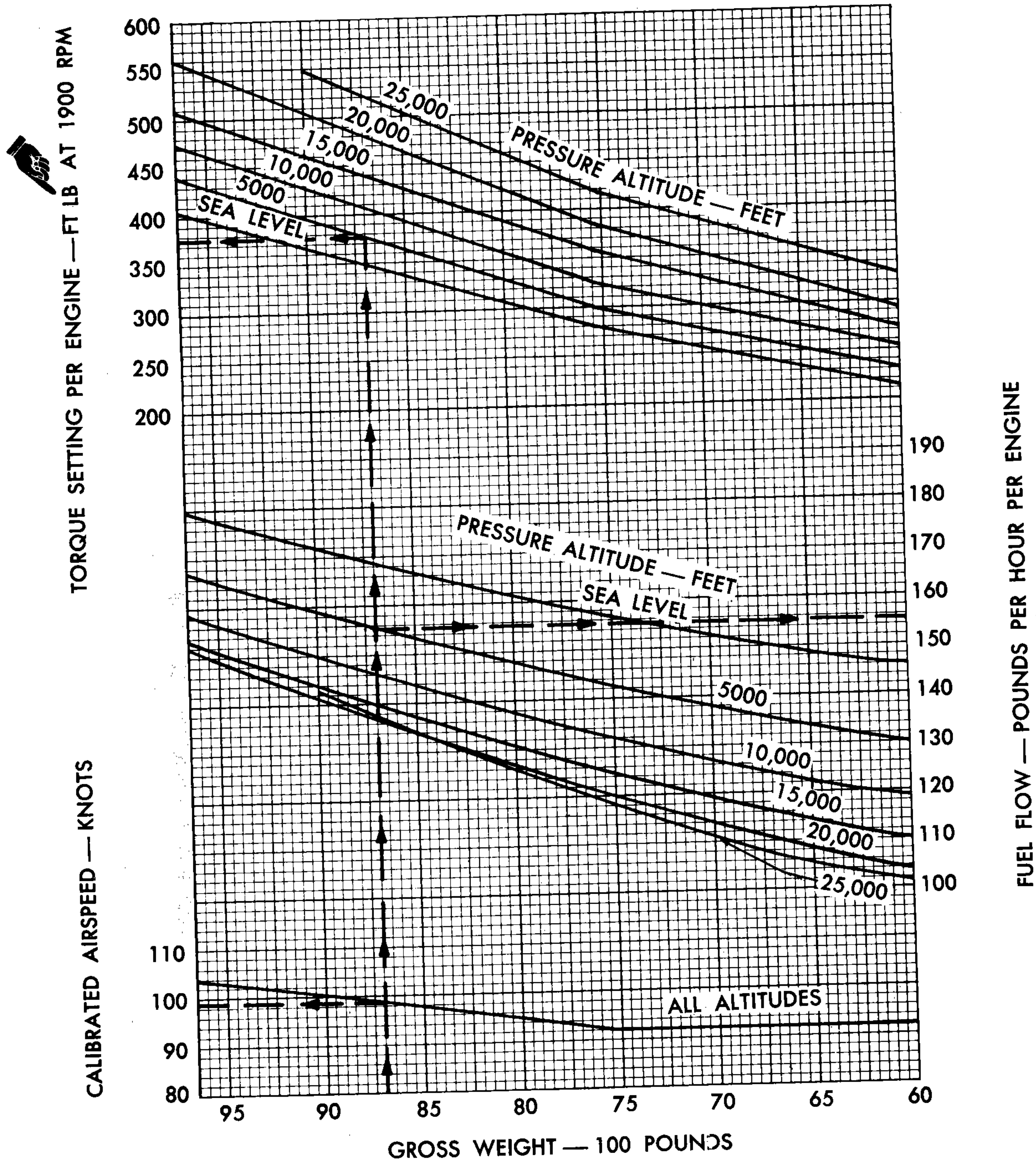


Figure 14-37. Two engine maximum endurance summary

MAXIMUM ENDURANCE SUMMARY

MODEL: U-21A, RU-21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

STANDARD DAY

ENGINES: (2) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
SINGLE ENGINE OPERATION

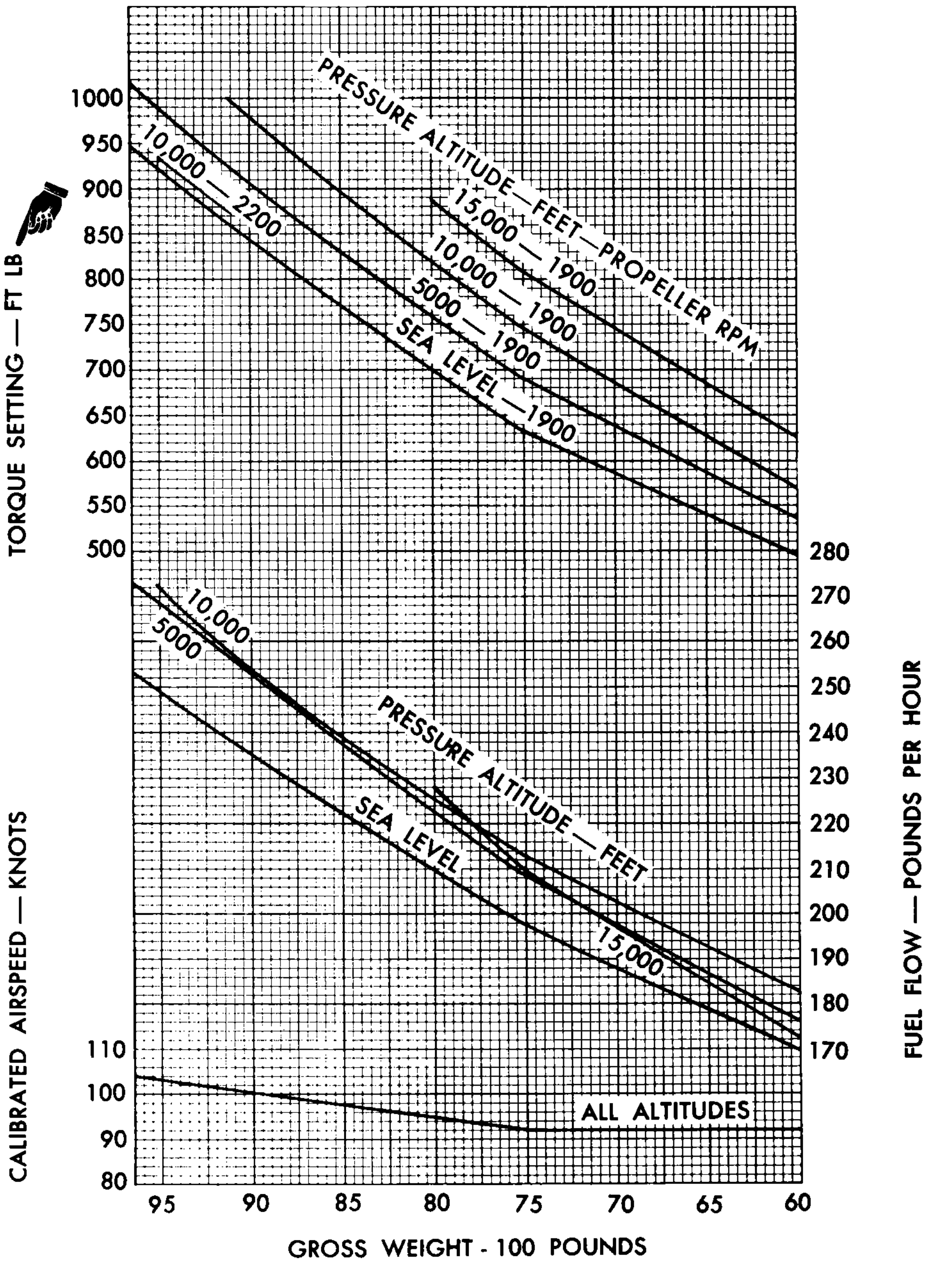


Figure 14-38. Single engine maximum endurance summary

RANGE — DISTANCE PREDICTION

STANDARD DAY

MODEL: U21A, RU21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

ENGINES: (2) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY — 6.5 LB/GAL
2 ENGINE OPERATION AT
ZERO WIND RECOMMENDED
AIRSPEED UNLESS LIMITED
BY NORMAL RATED POWER

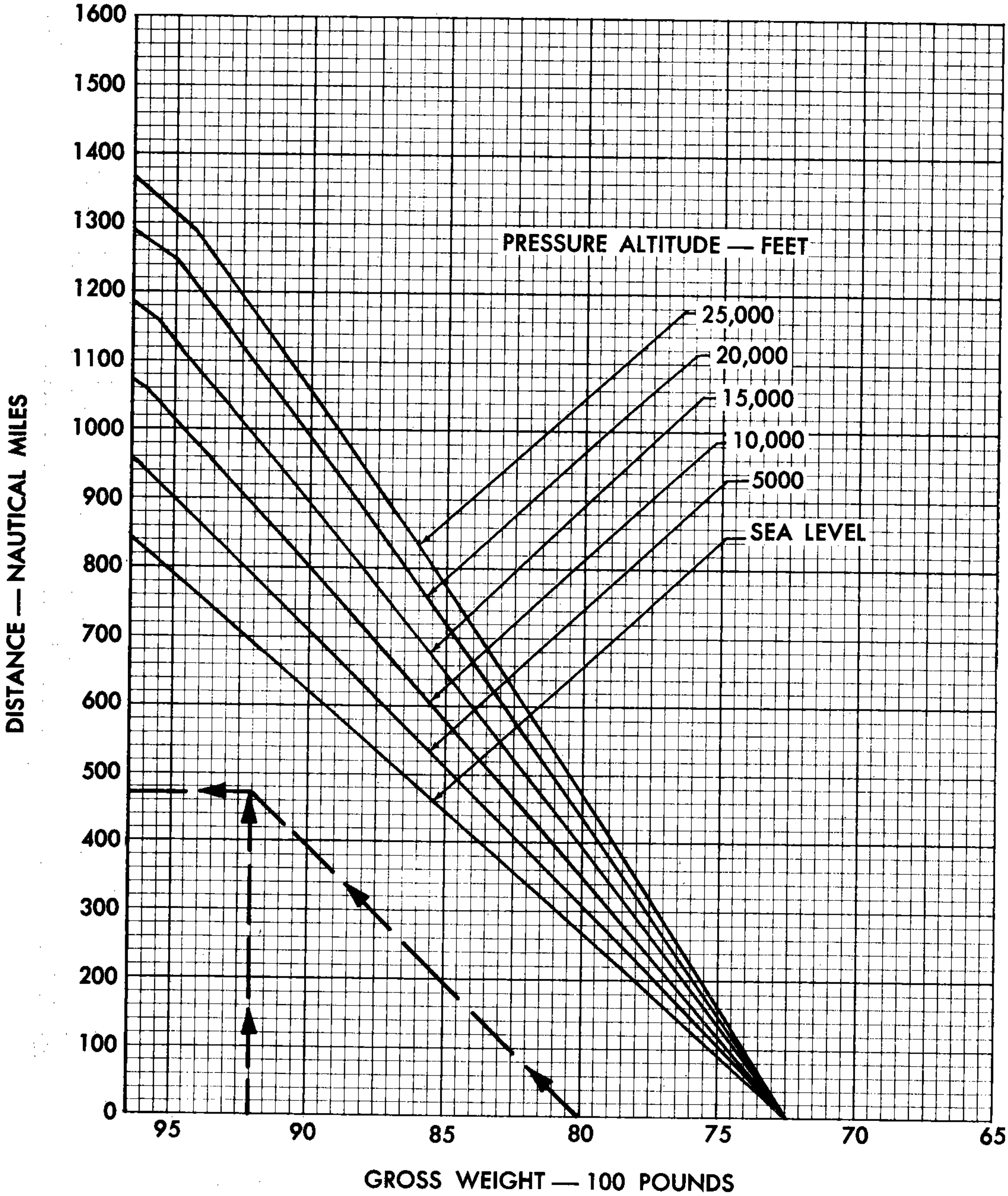


Figure 14-39. Two engine range-distance prediction

RANGE — DISTANCE PREDICTION

MODEL: U21A, RU21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

STANDARD DAY

ENGINES: (2) T74-CP-700 (PT6A-20)
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
SINGLE ENGINE OPERATION AT ZERO WIND RECOMMENDED AIRSPEED UNLESS LIMITED BY MAXIMUM POWER

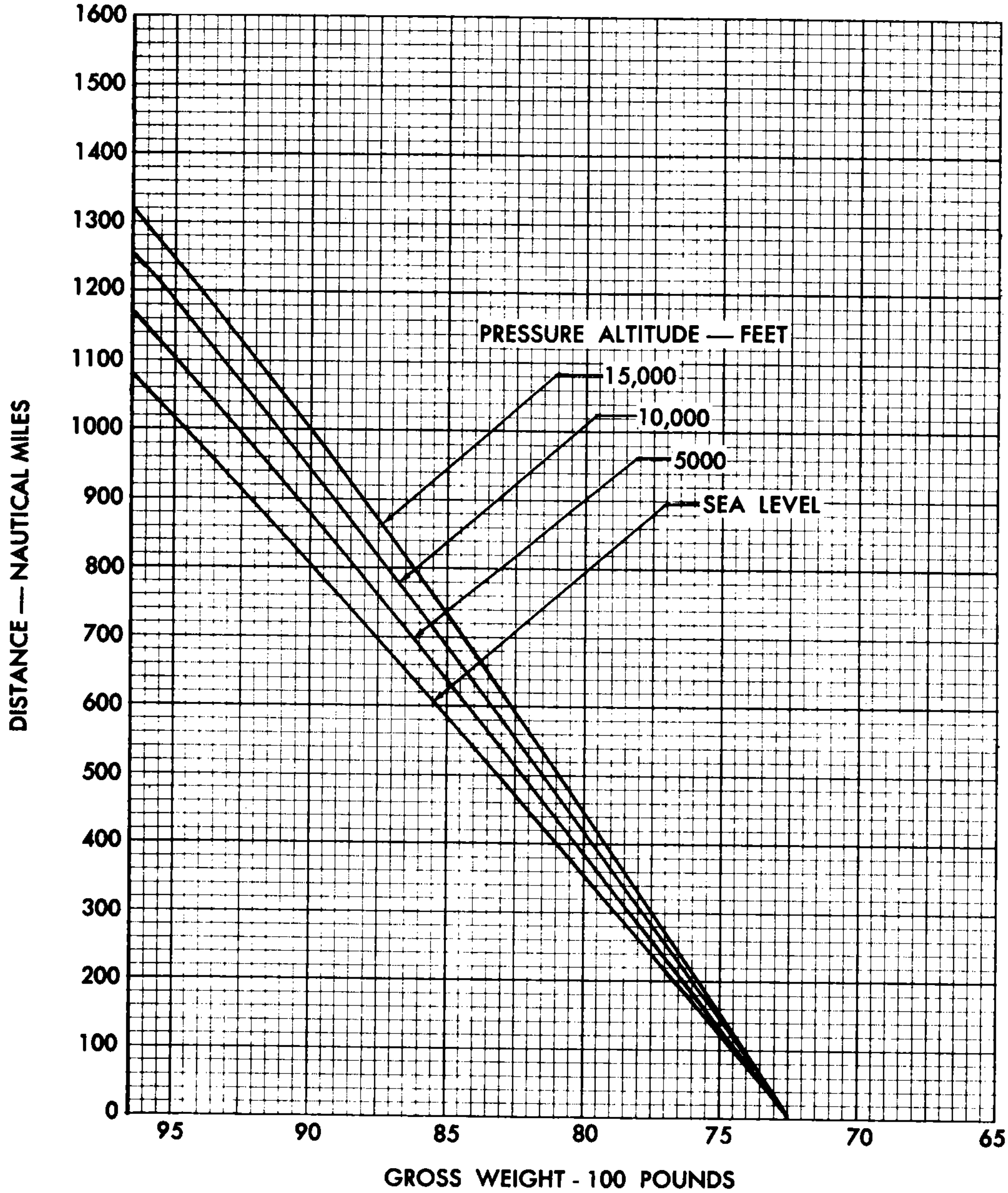


Figure 14-40. Single engine range-distance prediction

RANGE — TIME PREDICTION

MODEL: U21A, RU21A
DATE: SEPTEMBER 2, 1968
DATA BASIS: FLIGHT TEST

STANDARD DAY

ENGINES: (2) T74-CP-700
FUEL: JP-4
FUEL DENSITY: 6.5 LB/GAL
2 ENGINE OPERATION AT
ZERO WIND RECOMMENDED OR
NORMAL RATED POWER AIRSPEEDS

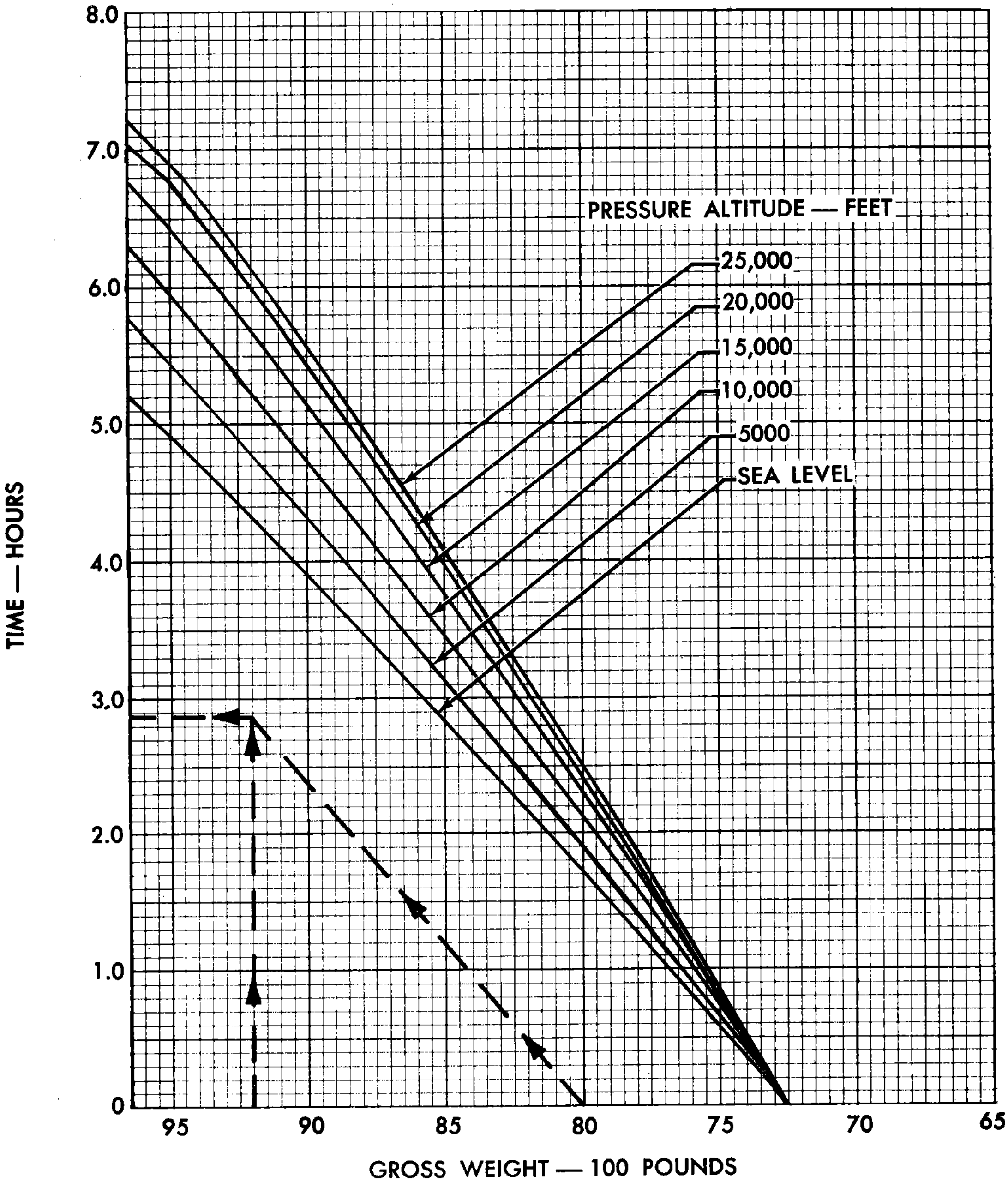


Figure 14-41. Two engine range-time prediction

☆ U.S. GOVERNMENT PRINTING OFFICE: 1970 — 397094/411