TorqueSim
SR22/SR22TN

Revision A
18 July 2020

X AVIATION

# SR22 Series
## for X-Plane 11

TORQUESIM
AIRCRAFT DEVELOPMENT

REALSIM GEAR

# AIRPLANE INFORMATION MANUAL

NOT FOR FLIGHT - FOR SIMULATION USE ONLY

Revision A
18 July 2020



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# Acknowledgments


## Special Thank You

Saso Kiselkov for libacfutils (https://github.com/skiselkov/libacfutils), and for help all along the development process!

Our Customers: Thank you for supporting us – We look forward to integrating your feedback and making this plane even better!

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X AVIATION

**The SR22 Series is Proudly Sold Exclusively through X-Aviation**

# Section 1

# General

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# Introduction

The X-Aviation Take Command! brand of products represents the very best of flight simulation immersion, and assures you this TorqueSim product is one of the most sophisticated, study sim level aircraft available for X-Plane! Real world pilots test and assist in the development of these products, and real world procedures are followed. It tells you these products are unlike any other product you've seen outside of the ever growing X-Aviation catalog! Want to feel like a real captain? Take Command!

The TorqueSim SR22 Series is the product of thousands of hours of work to craft the most accurate rendition of the SR22 for X-Plane. With the most in-depth systems and unparalleled accuracy, we are excited to share this product with you and hope you enjoy it. If you run into any issues, please be sure to contact us, you can find us by following the links below.

This manual is **not** comprehensive to the depth of the aircraft model. We highly recommend using the real manual and supplements instead of this manual when able. This manual, and product is solely **for personal, simulation use only** and does not represent the real aircraft.

**Customer Support Information**

X-Aviation (Sales, Installation, Activation): torques.im/xasupport

X-Pilot Forum (Support, Discussion, Help): torques.im/forum

TorqueSim (Aircraft Problems, Comments): torques.im/support

Bug Reporter (Discovered Issues): torques.im/bugs

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# The Airplane

## Engine

Number of Engines ........ 1

Number of Cylinders ........ 6

Engine Manufacturer ........ Teledyne Continental

Engine Model ........ IO-550-N

Fuel Metering ........ Fuel Injected

Engine Cooling ........ Air Cooled

Engine Type ........ Horizontally Opposed, Direct Drive

Horsepower Rating ........ 310 hp @ 2700 rpm

## Propeller

Propeller Manufacturer ........ Hartzell

Propeller Type ........ Constant Speed, Three Blade

Model Number ........ PHC-J3YF-1RF/F7694(B)

Diameter ........ 79.0" (76.0" Minimum)

## Fuel

Total Capacity ........ 94.5 U.S. Gallons (358.0 L)

Total Usable ........ 92.0 U.S. Gallons (348.0 L)

Approved Fuel Grades:

100 LL Grade Aviation Fuel (Blue)

100 (Form. 100/130) Grade Aviation Fuel (Green)

Maximum Allowable Fuel Imbalance ........ 10.0 U.S. Gallons (1/4 tank)

> The fuel pump must be set to BOOST for takeoff, climb, landing, and when switching fuel tanks.

## Oil

Oil Capacity (Sump) ........ 8 U.S. Quarts (7.6 L)

Oil Grades:

All Temperatures ........ SAE 15W-50, 20W-50, or 20W-60

Below 40°F (4°C) ........ SAE 30

Above 40°F (4°C) ........ SAE 50

## Maximum Certificated Weights

Maximum Gross for Takeoff.......... 3400 lbs (1542 kg)

Maximum Baggage for Compartment Loading.......... 130 lbs (59 kg)

Standard Empty Weight .......... 2250 lbs (1021 kg)

Maximum Useful Load .......... 1150 lbs (522 kg)

Full Fuel Payload .......... 610 lbs (277 kg)

## Specific Loadings

Wing Loading.......... 23.5 lbs/ft²

Power Loading .......... 11.0 lbs/hp

## Altitude Limits

Maximum Takeoff Altitude.......... 10,000 ft MSL

Maximum Operating Altitude.......... 17,500 ft MSL

## Maneuver Limits

Aerobatic maneuvers and spins are prohibited

This airplane is certified in the normal category and is not designed for aerobatic operations. Only those operations incidental to normal flight are approved. These operations include normal stalls, chandelles, lazy eights, and turns in which the angle of bank is limited to 60°.

Note
Because the aircraft has not been certified for spin recovery, the Cirrus Airframe Parachute System (CAPS) must be deployed if the airplane departs controlled flight.

## Flight Load Factor Limits

Flaps UP (0%), 3400 lbs. .......... +3.8g, -1.9g

Flaps 50%.......... +1.9g, -0g

Flaps 100%, 3400 lbs .......... +1.9g, -0g

## Minimum Flight Crew

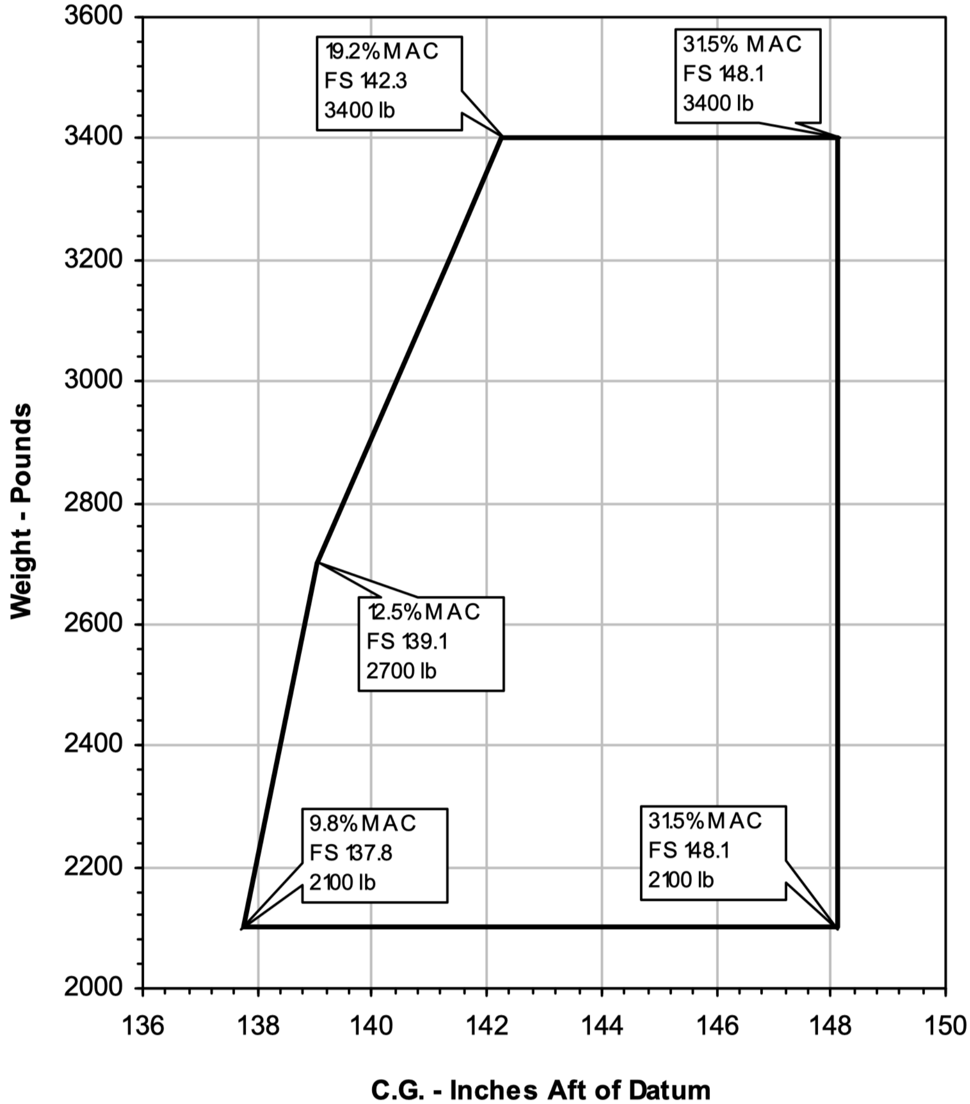
The minimum flight crew is one pilot.

## Center of Gravity Limits

Reference Datum ........................................ 100” forward of firewall

Forward limit........................................ Refer to figure below

Aft limit ........................................ Refer to figure below

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# Section 2

# Design Information

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# Electrical System

The electrical system on the SR22 consists of 2 lead-acid batteries, 2 alternators, 3 distribution busses, and 9 individual busses, powering approximately 50 independent electrical items through circuit breakers. The individual busses are connected to their distribution busses either through a circuit breaker or a fuse. Controlling the behavior of the batteries, alternators, and distributions is the Master Control Unit which regulates the behavior.

Two batteries (battery 1 and battery 2) and two alternators (alternator 1 and alternator 2) are used in the power generation system on this airplane. Both batteries are used for power storage. The two alternators are very similar in design to each other.

The alternators and the batteries are designed to function in parallel or independently. Both alternators are self-exciting which means the alternators become energized as soon as either battery switch is moved to the "on" position. If an alternator becomes disconnected, the remaining alternator will still function properly, as long as the opposing alternator received initial excitation. If the alternators were initially excited from the batteries, they will continue to generate electrical power if either battery should fail. Because the alternators are self-exciting (not self-starting), the battery switches should never be turned off during flight.

## Power Generation

During normal operation, the alternators feed their respective distribution bus independently (ALT 1 feeds Main Distribution Bus 1 and ALT 2 feeds Main Distribution Bus 2). The main distribution buses are interconnected by an 80-amp fuse and diode. The diode prevents ALT 2 from feeding Main Distribution Bus 1. Additionally, since ALT 2 voltage is slightly higher than ALT 1 voltage, bus voltage is further assured.

The alternators are three-phase AC generator type; each alternator has an internal rectifier. Each alternator uses two diodes for each phase to rectify the output. In addition, these diodes will block reverse current. If a single output diode were to fail, the winding junction will be held to the output potential, reducing the quantity of current the alternator can produce.

The alternators are regulated by the MCU and power the MCU. Alternator 1 is protected by an 100-amp fuse within the MCU while alternator 2 is protected by a 80 amp fuse within the MCU. ALT 1 is connected to the Main Distribution Bus 1 and ALT 2 is connected to the Main Distribution Bus 2. Each alternator system has its own 5-amp alternator circuit breaker located in the circuit breaker panel. Each alternator is individually protected against over-voltage generation by the field control module, located within the MCU. ALT 1 is regulated to 28 volts and ALT 2 is regulated to 28.75 volts.

Voltage output of each alternator is a function of engine RPM, alternator design, and load on the alternator. During low RPM operation, the alternator will require higher engine RPM to provide the same voltage to increased electrical loads.

The drop off RPM for each alternator will change whenever the electrical system loads are altered from nominal. When an alternator drops off line, a message will appear on the MFD. If an alternator drops off line due to low engine RPM, the alternator can be restarted by simply increasing engine RPM. When alternator 2 drops off line, alternator 1 will power the Essential Bus through the Main Distribution Bus 1 in the MCU. When alternator 1 drops off line, alternator 2 will power the Essential Bus through the Main Distribution Bus 2 in the MCU.

## Alternator 1

The front alternator (alternator 1) is mounted directly to the front of the engine on the co-pilots' side. Alternator 1 is a 100-amp engine-driven alternator.

Alternator 1 is controlled by the ALT 1 master switch located in the bolster panel. Battery 1 and alternator 1 are independently controlled and can be alternately connected to Main Bus 2. Failure or malfunction of alternator 1 will not impair the capability of the main battery to provide power to Main Bus 2.

Failure or malfunction of either or both alternators will not impair the capability of either battery to power the essential load circuits, because each of these power sources feed into the Essential Bus. If either alternator is lost, the other alternator and both batteries are still capable of feeding the Essential Bus. In addition, each alternator or battery can be manually disconnected by switching the appropriate master bolster switch located on the pilot's bolster switch panel.

## Alternator 2

Alternator 2 is a 70-amp belt-driven alternator mounted to the left front of the engine. Alternator 2 supplies electrical power to Essential Bus 2 through a 5-amp circuit breaker located in the circuit breaker panel. Alternator 2 is controlled by the ALT 2 switch located in the bolster panel. If alternator 2 fails while in operation, the Essential Bus will then get electrical power from alternator 1, battery 1, and/or battery 2.

## Battery 1

Battery 1 is a 24-volt, valve regulated, lead-acid aviation-grade type battery. The battery is mounted in the engine compartment. The battery is used for engine starting and can also be used as an emergency power source in the event Battery 2 or either alternator fails. Battery 1 provides all the electrical power for starting the aircraft. Battery 1 also supplies the electrical power to the landing light in the event Alternator 1 fails. Battery 1 is independently controlled by the BAT 1 switch, located in the pilot's bolster panel. The BAT 1 switch energizes a relay in the MCU which will connect BAT 1 to the Main Distribution Bus.

## Battery 2

Battery 2 is a maintenance free rechargeable sealed lead acid battery. The battery consists of two 12-volt, 6-cell, 18-amp-hour batteries connected in series to provide 24VDC to the Essential Bus. There is no need to check the specific gravity of the electrolyte or add water to these batteries during their service life.

Battery 2 is independently controlled by using the BAT 2 switch, located in the pilot's bolster panel. The BAT 2 switch energizes a relay located just aft of bulkhead 222 in the MCU which will connect BAT 2 to the Essential Bus. The electrical power from BAT 2 reaches the Essential Bus through the circuit breaker panel. Battery 2 is mounted directly behind bulkhead 222 in an acid resistant battery container.

Battery 2 is primarily used to power the Essential Bus. The Essential Bus delivers electrical power to the annunciator lights, turn coordinator, attitude indicator, horizontal situation indicator (HSI), stall warning system, and alternator 2.

Failure of the BAT 1 will not affect the ability of BAT 2 to provide necessary power to the Essential Bus. Because of diode protection, a failure or malfunction of the BAT 1 will not affect BAT 2 or either alternator output.

> Prior to engine start-up, the pilot must activate only the BAT 2 switch to verify that BAT 2 properly energizes the electrical loads powered by the Essential Bus and that BAT 2 has proper voltage.

## Distribution Busses

| | |
|---|---|
| Essential Distribution Bus | Essential Bus 1 |
| | Essential Bus 2 |
| Main Distribution Bus 1 | A/C Bus 1 |
| | A/C Bus 2 |
| | Main Bus 3 |
| Main Distribution Bus 2 | Non-Essential Bus |
| | Main Bus 1 |
| | Main Bus 2 |

# Engine

The airplane is powered by a Teledyne Continental IO-550-N, six-cylinder, normally aspirated, fuel-injected engine rated to 310 hp at 2700 RPM. The engine has a 2000-hour Time Between Overhaul (TBO). Dual, conventional magnetos provide ignition.

The engine is attached to the firewall by a six-point steel engine mount. The firewall attach points are structurally reinforced with gusset-type attachments that transfer thrust and bending loads into the fuselage shell.

## Engine Controls

The single-lever throttle control, labeled MAX-POWER-IDLE, on the console adjusts the engine throttle setting in addition to automatically adjusting propeller speed. The lever is mechanically linked by cables to the air throttle body/fuel-metering valve and to the propeller governor. Moving the lever towards MAX opens the air throttle butterfly and meters more fuel to the fuel manifold. A separate cable to the propeller governor adjusts the governor oil pressure to increase propeller pitch to maintain engine RPM. The system is set to maintain approximately 2500 RPM throughout the cruise power settings and 2700 RPM at full power.

The mixture control lever, labeled RICH-MIXTURE-CUTOFF, on the console adjusts the proportion of fuel to air for combustion. The Mixture Control Lever is mechanically linked to the mixture control valve in the engine-driven fuel pump. Moving the lever forward (towards RICH) repositions the valve allowing greater proportions of fuel and moving the lever aft (towards CUTOFF) reduces (leans) the proportion of fuel. The full aft position (CUTOFF) closes the control valve.

An Alternate Induction Air Control knob, labeled ALT AIR – PULL, is installed on the left console near the pilot's right knee. To operate the control, depress the center lock button, pull the knob to the open position, and then release the lock button. Pulling the knob opens the alternate air induction door on the engine induction air manifold, bypasses the air filter, and allows warm unfiltered air to enter the engine. Alternate induction air should be used if blocking of the normal air source is suspected. Operation using alternate induction air should be minimized and the cause of filter blocking corrected as soon as practical.

## Engine Lubrication

The engine is provided with a wet-sump, high-pressure oil system for engine lubrication and cooling. Oil for engine lubrication is drawn from an eight-quart capacity sump through an oil suction strainer screen and directed through the oil filter to the engine-mounted oil cooler by a positive displacement oil pump. The oil pump is equipped with a pressure relief valve at the pump output end to bypass oil back to the pump inlet should the pump exceed limits. The oil cooler is equipped with a temperature control valve set to bypass oil if the temperature is below approximately 180°F (82°C). Bypass or cooled oil is then directed through oil galleries to the engine rotating parts and piston inner domes. Oil is also directed to the propeller governor to regulate propeller pitch. The complete oil system is contained in the engine. An oil filler cap and dipstick are located at the left rear of the engine. The filler cap and dipstick are accessed through a door on the top left side of the engine cowling.

### Ignition and Starter

Two engine-driven magnetos and two spark plugs in each cylinder provide engine fuel ignition. The right magneto fires the lower right and upper left spark plugs, and the left magneto fires the lower left an upper right spark plugs. Normal operation is conducted with both magnetos, as more complete burning of the fuel-air mixture occurs with dual ignition. A rotary-type key switch, located on the instrument panel, controls ignition and starter operation. The switch is labeled OFF-R-L- BOTH-START. In the OFF position, the starter is electrically isolated, the magnetos are grounded and will not operate. Normally, the engine is operated on both magnetos (switch in BOTH position) except for magneto checks and emergency operations. The R and L positions are used for individual magneto checks and for single magneto operation when required. When the battery master switch is ON, rotating the switch to the spring loaded START position energizes the starter and activates both magnetos. The switch automatically returns to the BOTH position when released.

28 VDC for Starter operation is supplied through the 2-amp STARTER circuit breaker on NON-ESSENTIAL BUS.

### Fuel Injection

The multi-nozzle, continuous-flow fuel injection system supplies fuel for engine operation. An engine driven fuel pump draws fuel from the selected wing tank and passes it to the mixture control valve integral to the pump. The mixture control valve proportions fuel in response to the pilot operated mixture control lever position. From the mixture control, fuel is routed to the fuel-metering valve on the air-induction system throttle body. The fuel-metering valve adjusts fuel flow in response to the pilot controlled Power Lever position. From the metering valve, fuel is directed to the fuel manifold valve (spider) and then to the individual injector nozzles. The system meters fuel flow in proportion to engine RPM, mixture setting, and throttle angle. Manual mixture control and idle cut-off are provided. An electric fuel pump provides fuel boost for vapor suppression and for priming.

### Cooling

Engine cooling is accomplished by discharging heat to the oil and then to the air passing through the oil cooler, and by discharging heat directly to the air flowing past the engine. Cooling air enters the engine compartment through the two inlets in the cowling. Aluminum baffles direct the incoming air to the engine and over the engine cylinder cooling fins where the heat transfer takes place. The heated air exits the engine compartment through two vents in the aft portion of the cowling. No movable cowl flaps are used.

# Propeller

The airplane is equipped with a constant-speed, aluminum-alloy propeller with a three-blade (78" diameter) propeller and governor.

The propeller governor automatically adjusts propeller pitch to regulate propeller and engine RPM. The propeller governor senses engine speed by means of flyweights and senses throttle setting through a cable connected to the power (throttle) control lever in the cockpit. The propeller governor boosts oil pressure in order to regulate propeller pitch position. Moving the throttle lever forward causes the governor to meter less high-pressure oil to the propeller hub allowing centrifugal force acting on the blades to lower the propeller pitch for higher RPM operation. Reducing the power (throttle) lever position causes the governor to meter more high-pressure oil to the propeller hub forcing the blades to a higher pitch, lower RPM, position. During stabilized flight, the governor automatically adjusts propeller pitch in order to maintain an RPM setting (throttle position). Any change in airspeed or load on the propeller results in a change in propeller pitch.

# Fuel System

An 92-gallon usable wet-wing fuel storage system provides fuel for engine operation. The system consists of a 47.25-gallon capacity (46gallon usable) vented integral fuel tank and a fuel collector/sump in each wing, a three position selector valve, an electric fuel pump, and an engine-driven fuel pump. Fuel is gravity fed from each tank to the associated collector sumps where the engine-driven fuel pump draws fuel through a filter and selector valve to pressure feed the engine fuel injection system. The electric fuel pump is provided for engine priming and vapor suppression.

Float-type fuel quantity sensors in each wing tank supply fuel level information to the fuel quantity gages. Positive pressure in the tank is maintained through a vent line from each wing tank. Fuel, from each wing tank, gravity feeds through strainers and a flapper valve to the associated collector tank in each wing. Each collector tank/sump incorporates a flush mounted fuel drain and a vent to the associated fuel tank.

The engine-driven fuel pump pulls filtered fuel from the two collector tanks through a three-position (LEFT-RIGHT-OFF) selector valve. The selector valve allows tank selection. From the fuel pump, the fuel is metered to a flow divider, and delivered to the individual cylinders. Excess fuel is returned to the selected tank.

A dual-reading fuel-quantity gauge is located in the center console next to the fuel selector in plain view of the pilot.

The airplane may be serviced to a reduced capacity to permit heavier cabin loadings. This is accomplished by filling each tank to a tab visible below the fuel filler, giving a reduced fuel load of 30.0 gallons usable in each tank (60 gallons total usable in all flight conditions).

## Fuel Pump

Fuel pump operation and engine prime is controlled through the Fuel Pump switch located adjacent to the fuel selector valve. The PRIME position is momentary and the BOOST position is selectable. A two-speed prime allows the fuel pressure to rapidly achieve proper starting pressure.

An oil pressure based system is used to control fuel pump operation. The oil pressure/oil temperature sensor provides a signal to the starting circuit to generate a ground for the oil annunciator and the fuel system. This system allows the fuel pump to run at high speed (PRIME) when the engine oil pressure is less than 10 PSI. Whenever the engine oil pressure exceeds 10 PSI, pressing PRIME will have no effect. Selecting BOOST energizes the fuel pump in low-speed mode regardless of oil pressure to deliver a continuous 4-6 psi boost to the fuel flow for vapor suppression in a hot fuel condition.

The fuel pump operates on 28 VDC supplied through the 5-amp FUEL PUMP circuit breaker on MAIN BUS 2.

# Flight Controls

## Elevator

The two-piece elevator provides airplane pitch control. The elevator is of conventional design with skin, spar and ribs manufactured of aluminum. Each elevator half is attached to the horizontal stabilizer at two hinge points and to the fuselage tailcone at the elevator control sector. Elevator motion is generated through the pilot's control yokes by sliding the yoke tubes forward or aft in a bearing carriage. A push-pull linkage is connected to a cable sector mounted on a torque tube. A single cable system runs from the forward elevator sector under the cabin floor to the aft elevator sector pulley. A push-pull tube connected to the aft elevator sector pulley transmits motion to the elevator bellcrank attached to the elevators.

## Pitch Trim System

Pitch trim is provided by adjusting the neutral position of the compression spring cartridge in the elevator control system by means of an electric motor. It is possible to easily override full trim or autopilot inputs by using normal control inputs. A ground adjustable trim tab is installed on the elevator to provide small adjustments in neutral trim. This tab is factory set and does not normally require adjustment. An electric motor changes the neutral position of the spring cartridge attached to the elevator control horn. A conical trim button located on top of each control yoke controls the motor. Moving the switch forward will initiate nose-down trim and moving the switch aft will initiate nose-up trim. Neutral (takeoff) trim is indicated by the alignment of a reference mark on the yoke tube with a tab attached to the instrument panel bolster. The elevator trim also provides a secondary means of airplane pitch control in the event of a failure in the primary pitch control system not involving a jammed elevator.

Elevator (pitch) trim operates on 28 VDC supplied through the 2-amp PITCH TRIM circuit breaker on ESS BUS 2.

## Aileron System

The ailerons provide airplane roll control. The ailerons are of conventional design with skin, spar and ribs manufactured of aluminum. Each aileron is attached to the wing shear web at two hinge points.

Aileron control motion is generated through the pilot's control yokes by rotating the yokes in pivoting bearing carriages. Push rods link the pivoting carriages to a centrally located pulley sector. A single cable system runs from the sector to beneath the cabin floor and aft of the rear spar. From there, the cables are routed in each wing to a vertical sector/crank arm that rotates the aileron through a right angle conical drive arm.

## Roll Trim System

Roll trim is provided by adjusting the neutral position of a compression spring cartridge in the aileron control system by means of an electric motor. The electric roll trim is also used by the autopilot to position the ailerons. It is possible to easily override full trim or autopilot inputs by using normal control inputs.

An electric motor changes the neutral position of a spring cartridge attached to the left actuation pulley in the wing. A conical trim button located on top of each control yoke controls the motor. Moving the switch left will initiate left-wing-down trim and moving the switch right will initiate right-wing-down trim. Neutral trim is indicated by the alignment of the line etched on the control yoke with the centering indication marked on the instrument panel. The aileron trim also provides a secondary means of airplane roll control in the event of a failure in the primary roll control system not involving jammed ailerons.

Aileron trim operates on 28 VDC supplied through the 2-amp ROLL TRIM circuit breaker on ESS BUS 2.

### Rudder System

The rudder provides airplane directional (yaw) control. The rudder is of conventional design with skin, spar and ribs manufactured of aluminum. The rudder is attached to the aft vertical stabilizer shear web at three hinge points and to the fuselage tailcone at the rudder control bell crank.

Rudder motion is transferred from the rudder pedals to the rudder by a single cable system under the cabin floor to a sector next to the elevator sector pulley in the aft fuselage. A push-pull tube from the sector to the rudder bell crank translates cable motion to the rudder. Springs and a ground adjustable spring cartridge connected to the rudder pedal assembly tension the cables and provide centering force.

# TKS Anti-Ice System

This system, when compliant with the Kinds of Operation Equipment List and Minimum Dispatch Fluid Quantity, allows flight in icing conditions.

In icing conditions the airplane must be operated as described in the operating procedures section of this manual. Where specific operational speeds and performance information have been established for such conditions, this information must be used.

At the first sign of Anti-Ice System malfunction, the aircraft must immediately exit icing conditions.

Flight into freezing rain or freezing drizzle is prohibited.

Inadvertent operation in freezing rain, freezing drizzle, mixed conditions, or conditions defined as severe may be detected by:

- Visible rain at temperatures below 41°F (5°C) OAT.
- Droplets that splash or splatter on impact at temperatures below below 41°F (5°C) OAT.
- Ice on or behind the wing or horizontal tail panels that cannot be removed with Anti-Ice System HIGH flow.
- Unusually extensive ice accreted on the airframe in areas not normally observed to collect ice.
- Accumulation of ice on the upper surface or lower surface of the wing aft of the protected area.
- Accumulation of ice on the propeller spinner farther back than normally observed.

If the airplane encounters conditions that are determined to contain freezing rain, freezing drizzle, or severe icing, immediately exit condition by changing altitude, turning back, or if clear air is known to be immediately ahead, continue on course.

## Anti-Ice Limitations

Minimum Airspeed for flight into known icing conditions.................................................. 95 KIAS

Maximum Airspeed with Anti-Ice System operation....................................177 KIAS / 204 KTAS

Recommended holding airspeed ................................................................................. 120 KIAS

Maximum weight for flight into known icing conditions.....................................................3400 lbs

Takeoff is prohibited with any ice, snow, frost, or slush adhering to the wing, stabilizers, control surfaces, propeller blades, or engine inlet.

Minimum Operating Temperature .................................................................... -30°F (-34°C)

## Minimum Dispatch Fluid Quantity

Dispatch into known icing conditions with less than 5 gallons (19 liters) of deicing fluid is prohibited. The pilot must ensure adequate fluid quantity before each flight. If dispatching without the minimum 5 gallons and icing conditions are encountered, exit icing conditions as soon as possible.

Duration Times for 5 Gallon Minimum Dispatch Fluid Quantity:

NORM....................90 Minutes

HIGH....................45 Minutes

MAX....................22.5 Minutes

### Deice Fluid Limits

Usable Tank Capacity....................8 gallons (30 L)

Tank Capacity....................8.5 gallons (32 L)

### Maximum Operating Time

Normal Flow....................150 Minutes (3.2 gph)

High Flow....................75 Minutes (6.4 gph)

Maximum Flow....................37.5 Minutes (12.8 gph)

### Flap Usage

Unless required for Emergency operations (i.e. Forced Landing), Flaps are limited to a maximum deflection of 50% when the aircraft has encountered icing conditions and/or has accumulated ice on the airframe

When holding in icing conditions the flaps must be UP (0%).

### System Description

The TKS Anti-Ice System can prevent and remove ice accumulation on the flight surfaces by distributing a thin film of ice protection fluid on the wing, horizontal stabilizer, vertical stabilizer, elevator tips, and propeller. The presence of this fluid lowers the freezing temperature on the flight surface below that of the ambient precipitation preventing the formation and adhesion of ice.

The system consists of nine porous panels, propeller slinger ring, windshield spray nozzles, heated stall warning system, ice inspection lights, two proportioning units, two metering pumps, windshield/ priming pump, 3-way control valve, filter assembly, in-line strainer, outlet strainers, two fluid tanks with fluid level sensors and low level switches, filler caps and necks, test port assembly, electrical switching, and system plumbing. The system operates on 28 VDC supplied through the 7.5-amp ICE PROTECT A circuit breaker on Main Bus 1 and 5-amp ICE PROTECT B circuit breaker on Essential Bus 2.

Two separate and symmetrical 4.25 gallon (16.1L) deicing fluid tanks are serviced through filler caps located on the upper LH and RH wings. Each tank provides a capacity of 4.0 gallons (15.1L) usable and 0.25 gallons (1.0L) unusable, which provides a total system capacity of 8.0 gallons (30.2L) usable. The tanks are sealed wet bays, integral to the wing structure, bounded by the upper and lower wing skins, main spar web, and the inboard, outboard, and lateral tank ribs. The tanks are vented from the outboard ribs to a NACA style ducts attached to access panels on the lower wing skin, just outboard of the tanks. Course-mesh outlet strainers mounted internal to the tanks prevent large objects from obstructing the tank outlets, while a fine-mesh in- line strainer protects the metering pump and windshield/priming pump from damage by contaminates

Upon activation, two single-speed metering pumps, mounted below the LH passenger seat, draw fluid from the tank and provide fluid pressure to the system at a constant-volume flow rate. The pumps operate both singularly and in parallel according to system mode selection.

If the system is ON and PUMP BKUP is selected, #1 pump will operate (if not failed) based on the mode setting (NORM or HIGH) while #2 pump operates continuously (PUMP BKUP), causing the range and endurance to decrease from the published values, e.g. selection of HIGH and PUMP BKUP will reduce range and endurance as if MAX were selected.

The manifolds of both metering pumps are connected in series and primed by an integral windshield/priming pump which draws fluid from the tank, through both metering pump manifolds, forcing the fluid to the windshield spray nozzles. In the event the metering pumps cannot prime themselves, the windshield/priming pump can be activated to draw fluid from the tank to prime the metering pump manifolds and to remove any entrapped air between the metering pumps and the fluid tank(s). A normally-closed solenoid located between the windshield pump and spray nozzles prevents fluid back flow to the metering pumps. From the metering pumps, deicing fluid is pushed through a filter assembly, mounted adjacent to the pumps, and then carried through nylon tubing to the proportioning units located in the cabin floor- forward and empennage.

• The cabin floor-forward proportioning unit distributes fluid to the LH and RH Wing Inboard and Outboard panels and propeller slinger ring assembly.

• The empennage proportioning unit distributes fluid to the horizontal and vertical stabilizer panels and the elevator tip panels.

In addition to distributing fluid to the porous panels and propeller slinger ring, the proportioning units provide an additional, distinct pressure drop to the supply lines such that a specific flow rate is provided to each protected surface.

## System Control

The system is controlled from both switches on the bolster panel, and the "Engine" page on the G1000 MFD using the MFD soft-keys.

The bolster panel switches control flow rate (NORM, HIGH, and MAX), as well as windshield anti-ice. Pump Backup can be selected in the case of failures.

The G1000 MFD controls tank selection (AUTO, Left, and Right).

## Modes

- NORM: Both pumps at quarter time (30 seconds on, 90 seconds off) (100% Flow Rate).
- HIGH: Pump #1 continuously (200% Flow Rate).

- MAX: Both pumps continuously for 2 minutes (400% Flow Rate). After two minutes, the mode reverts to the switch selection.
- WINDSHLD: Triggers the windshield pump to operate for 3 seconds.
- PUMP BKUP: Pump #2 continuously (200% Flow Rate).

### Indication

System Indicating is displayed as bar graphs and text in the lower left corner of the MFD ENGINE page. The bar graphs, marked from 0 to 4 U.S. gallons in 1-gallon increments, indicate LH and RH tank fluid quantity. Fluid quantity is also displayed numerically below the bar graphs in 0.1-gallon increments. When the system is operating in the default, automatic tank selection mode (AUTO), a white box is centered around the "L" and "R" located above each bar graph and a cyan box is displayed around the selected Anti-Ice System mode. During normal operation, the white box will switch between the left and right tank as the fluid level changes. Manual tank selection mode is selected by pressing the ANTI-ICE softkey to access control of the LEFT and RIGHT tanks. In manual mode, a cyan box is displayed around the selected tank, gallons remaining in that tank, and the selected Anti-Ice System mode. Pressing AUTO returns the system to automatic tank selection mode.

System Endurance is displayed on the MFD ENGINE Page for the different system modes based on the total sensed fluid quantity and published system flow rates. A cyan box depicts the user selected system mode. System Range is displayed on the MFD ENGINE Page for the selected system mode based on the calculated system endurance and the current ground speed.

If tanks are selected manually, system range and endurance calculations use only the sensed fluid quantity of the selected tank. While in PUMP BKUP, system range and endurance calculations use the sensed system flow rate of the flow meter.

# Oxygen System

The system consists of a 77 ft³ oxygen bottle with pressure regulator assembly located in the aft fuselage, a distribution manifold in the headliner, a control panel on the center console, a filler port with oxygen gauge on the aft wall of the baggage compartment, , and up to five (5) flow devices consisting of either constant flow meters, or demand regulators, with either a cannula or face mask for each user. The A4/A5 flowmeters are adjustable for altitude to supply oxygen to either oxygen conserving cannulas, standard cannula, up to 18,000ft, or masks for altitudes up to the maximum operating altitude of the Cirrus SR22 /SR22TN.

The cockpit control electrically actuates the regulator allowing oxygen flow into the aircraft cabin. The cockpit control will annunciate O2 REQ'D if the System is not selected ON and the aircraft is above approx. 12,000ft PA to alert the requirement of oxygen in the cabin. Once the oxygen is selected ON, the quantity display illuminates indicating the presence of oxygen in the cabin. Quantity and system status is both visible on the oxygen control panel and G1000 MFD.

In the event of an electrical failure on Main Bus 2, oxygen will remain on in the cabin. Aircraft electrical power is required ONLY to turn the System ON and OFF. The System is designed to remain ON during an electrical failure, but oxygen quantity indication will be lost. Disconnecting the lines from the manifold will prevent the free flow of oxygen in the cabin.

WARNING

The Cirrus Perspective Aircraft Alerts are considered Secondary Annunciation and the primary warning and advisory annunciation is provided on the Oxygen System Display.

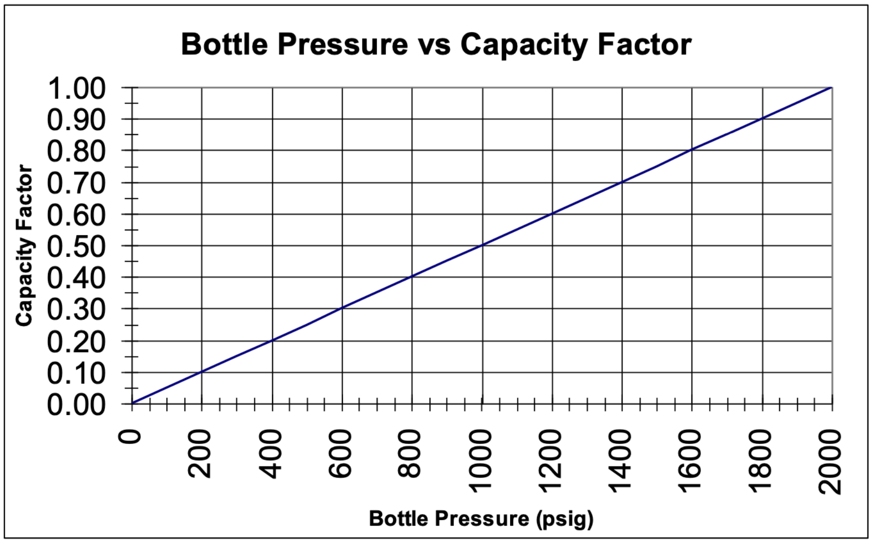
## Flowmeters

The constant flowmeters are calibrated and adjustable for altitude to supply oxygen to either oxygen conserving, or standard, cannulas up to a maximum altitude of 18,000ft MSL, or masks for altitudes up to a maximum of altitude of 25,000ft MSL , or the maximum operating altitude of the aircraft whichever is lower. The flowmeters provide the means to distribute the appropriate amount of oxygen for the pressure altitude of flight and indicate the presence of oxygen flowing to the pilot and/or passengers. The flowmeter should be checked periodically (recommended intervals of less than 10 min) as well as the oxygen quantity gauge. The flowmeter should be readjusted with each change in pressure altitude or physiological requirement.

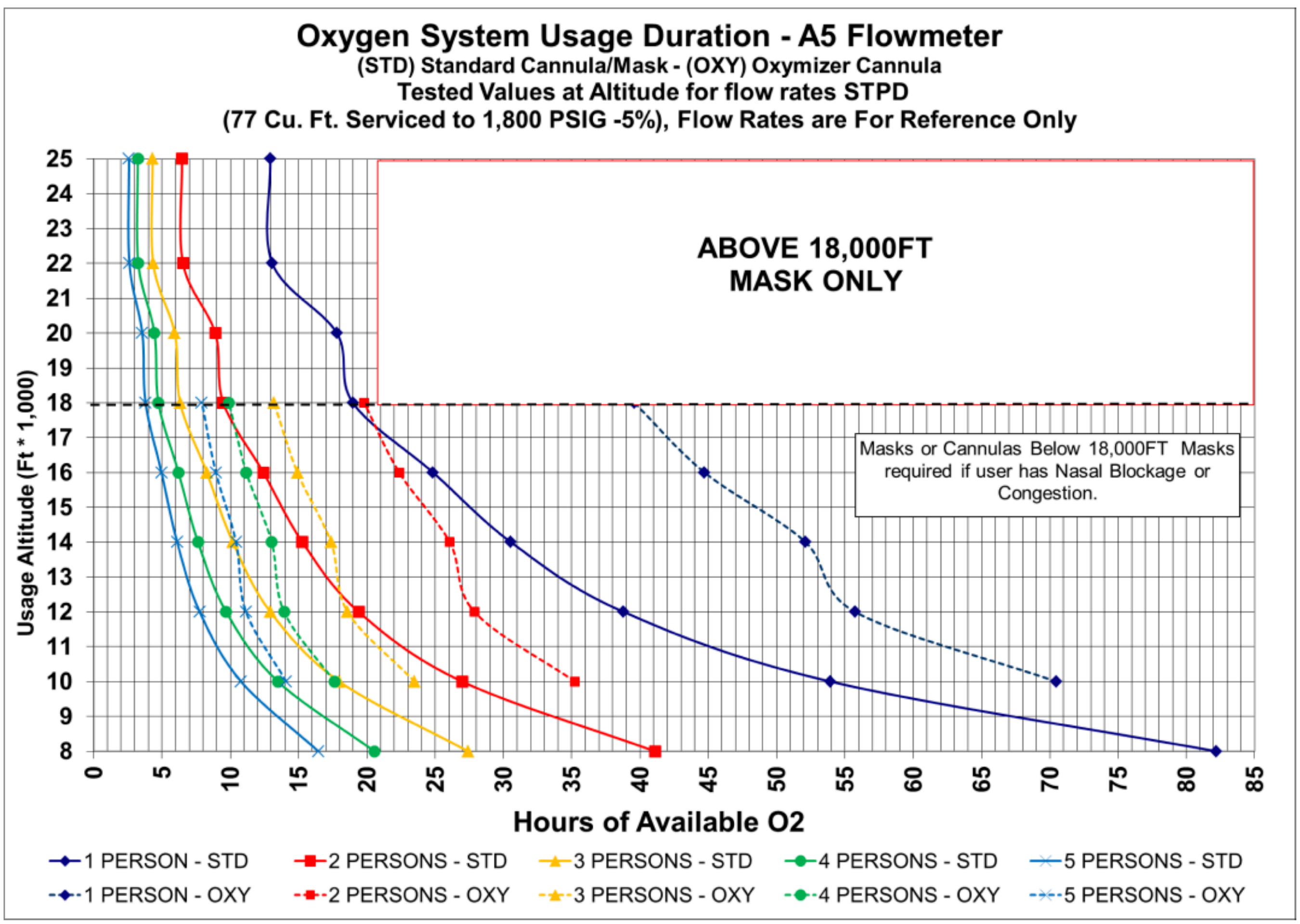
WARNING

Do not use oxygen while utilizing lipstick, Chapstick, petroleum jelly or any other product containing oil or grease. Smoking is not permitted while using the Oxygen System.

## Bottle Pressure vs Capacity




## A5 Flow Meter Duration




NOT FOR FLIGHT - FOR SIMULATION USE ONLY

# Section 3

# Normal Procedures

## Table of Contents

# Preflight Checks

## Walkaround

Before starting the walk around inspection remove the pitot head cover, control locks, and battery vent plug. During the external inspection, perform a general check of airframe condition and the security of all fasteners and control hinges and attachments.

## Cabin

Required Documents ........ On Board
Avionics Power Switch ........ Off
Battery 2 Master Switch ........ On
PFD ........ Verify On
Essential Bus Voltage ........ 23-25 Volts
Flap Position Light ........ Out
Battery 1 Master Switch ........ On
Avionics Cooling Fan ........ Audible
Lights ........ Check Operation
Stall Warning ........ Test

> Test stall warning system by applying suction to the stall warning system inlet and noting the warning horn sounds

Fuel Quantity ........ Check
Fuel Selector ........ Select Fullest Tank
Flaps ........ 100%, Check Light On
Oil Annunciator ........ On
Battery 1 and 2 Master Switches ........ Off
Alternate Static Source ........ Normal
Circuit Breakers ........ In
Fire Extinguisher ........ Charged and Available
Emergency Egress Hammer ........ Available
CAPS Handle ........ Pin Removed

## Left Fuselage

Door Lock ........ Unlock
COM 1 Antenna ........ Condition and Attachment

Transponder Antenna ........ Condition and Attachment

Wing/Fuselage Fairing ........ Check

COM 2 Antenna ........ Condition and Attachment

Baggage Door ........ Closed and Secure

Static Button ........ Check for Blockage

Parachute Cover ........ Sealed and Secure

## Empennage

Tiedown Rope ........ Remove

Horizontal and Vertical Stabilizers ........ Condition

> Note
>
> Verify tape covering the front and aft inspection holes located on outboard ends of horizontal stabilizer is installed and securely attached

Elevator and Tab ........ Condition and Movement

Rudder ........ Freedom of Movement

Rudder Trim Tab ........ Condition and Security

Attachment hinges, bolts, and cotter pins ........ Secure

## Right Fuselage

Static Button ........ Check for Blockage

Wing/Fuselage Fairings ........ Check

Door Lock ........ Unlock

## Right Wing Trailing Edge

Leading Edge and Stall Strips ........ Condition

Fuel Cap ........ Check Quantity and Secure

Fuel Drains (2) ........ Drain and Sample

Wheel Fairings ........ Security, Accumulation of Debris

Tire ........ Condition, Inflation, Wear

> CAUTION
>
> Clean and inspect temperature indicator attached to piston housing. If indicator center is black, the brake assembly has been overheated. The brake linings must be inspected and O-rings replaced

Wheels and Brakes........................Fluid Leaks, Evidence of Overheating, General Condition, Security

Chocks and Tiedown ropes........................................................................................Remove

Cabin Air Vent....................................................................................................Unobstructed

## Nose, Right Side

Vortex Generator...........................................................................................................Condition

Cowling..........................................................................................................Attachments Secure

Exhaust Pipe................................................................................Condition, Security, and Clearance

Gascolator.........................................................................................Drain for 3 seconds, sample

## Nose gear, Propeller, Spinner

> WARNING
>
> KEEP CLEAR OF PROPELLER ROTATION PLANE. DO NOT ALLOW OTHERS TO APPROACH PROPELLER.

Tow Bar...............................................................................................................Remove and Stow

Strut.................................................................................................................................Condition

Wheel Fairing.......................................................................................Security, Accumulation of Debris

Wheel and Tire.......................................................................................Condition, Inflation, and Wear

Propeller.....................................................................................Condition (indentations, nicks, etc.)

Spinner..........................................................................................Condition, Security, and Oil Leaks

Air Inlets........................................................................................................................Unobstructed

Alternator..........................................................................................................................Condition

## Nose, Left Side

Landing Light.....................................................................................................................Condition

Engine Oil.....................................................................Check 6-8 quarts, Leaks, Cap and Door Secure

Cowling..........................................................................................................Attachments Secure

External Power...............................................................................................................Door Secure

Vortex Generator...........................................................................................................Condition

Exhaust Pipes...............................................................................Condition, Security, and Clearance

## Left Main Gear and Forward Wing

Wheel fairings.......................................................................................Security, Accumulation of Debris

Tire...........................................................................................................Condition, Inflation, and Wear

> CAUTION
>
> Clean and inspect temperature indicator attached to piston housing. If indicator center is black, the brake assembly has been overheated. The brake linings must be inspected and O-rings replaced

Wheel and Brakes.................... Fluid Leaks, Evidence of Overheating General Condition, and Security

Chocks and Tiedown Ropes .................... Remove

Fuel Drains (2) .................... Drain and Sample

Cabin Air Vent .................... Unobstructed

Fuel Cap .................... Check Quantity and Secure

Leading Edge and Stall Strips .................... Condition

### Left Wing Tip

Fuel Vent (underside).................... Unobstructed

Pitot Mast (underside) .................... Cover Removed, Tube Clear

Strobe, Nav Light, and Lens.................... Condition and Security

Tip .................... Attachment

### Left Wing Trailing Edge

Flap and Rub Strips .................... Condition and Security

Aileron.................... Freedom of movement

Aileron Gap Seal .................... Security

Hinges, actuation arm, bolts, and cotter pins ....................Secure

## Before Starting Engine

Preflight Inspection .................... COMPLETED

> WARNING
>
> Ensure that the airplane is properly loaded and within the weight and balance limitations prior to takeoff

Weight and Balance .................... Verify within limits

Emergency Equipment .................... ON BOARD

Passengers.................... BRIEFED

Ensure all passengers have been fully briefed on smoking, use of seat belts, doors, emergency exits, egress hammer, and CAPS prior to engine start

CAPS Handle Safety Pin .......... REMOVED

Seats, Seat Belts, and Harnesses.......... ADJUST and SECURE

CAUTION

Crew seats must be locked in position and control handles fully down before flight. Ensure seat belt harnesses are not twisted

# Starting Engine

If the engine is warm, no priming is required. For the first start of the day and in cold conditions, prime will be necessary.

Weak intermittent firing followed by puffs of black smoke from the exhaust stack indicates over-priming or flooding. Excess fuel can be cleared from the combustion chambers by the following procedure:

- Turn fuel pump off.
- Allow fuel to drain from intake tubes.
- Set the mixture control full lean and the power lever full open.
- Crank the engine through several revolutions with the starter.
- When engine starts, release ignition switch, retard power lever, and slowly advance the mixture control to FULL RICH position.

If the engine is under-primed, especially with a cold soaked engine, it will not fire, and additional priming will be necessary. As soon as the cylinders begin to fire, open the power lever slightly to keep it running. Refer to Cold Weather Operation in this section or additional information regarding cold weather operations.

WARNING

If airplane will be started using external power, keep all personnel and power unit cables well clear of the propeller rotation plane.

CAUTION

Alternators should be left OFF during engine starting to avoid high electrical loads.

After starting, if the oil gage does not begin to show pressure within 30 seconds in warm weather and about 60 seconds in very cold weather, shut down engine and investigate cause. Lack of oil pressure indicates loss of lubrication, which can cause severe engine damage.

Brakes .......... HOLD
Bat Master Switches .......... ON (Check Volts)
Strobe Lights .......... ON
Mixture .......... FULL RICH
Power Lever .......... FULL FORWARD
Fuel Pump .......... PRIME, then BOOST

On first start of the day, especially under cool ambient conditions, holding Fuel Pump switch to PRIME for 2 seconds will improve starting.

Propeller Area .......... CLEAR
Power Lever .......... Open ¼ INCH
Ignition Switch .......... START (Release after engine starts)

CAUTION

Limit cranking to intervals of 20 seconds with a 20 second cooling period between cranks. This will improve battery and contactor life.

Power Lever .......... RETARD (to maintain 1000 RPM)
Oil Pressure .......... CHECK
Alt Master Switches .......... ON
Avionics Power Switch .......... ON
Engine Parameters .......... MONITOR
Amp Meter/Indication .......... CHECK

## Hot Engine Start

Apply this procedure when the engine has been shut down at operating temperatures and not restarted after more than 10 minutes. Fuel vapor will likely have formed in the fuel lines between the engine-driven fuel pump and the fuel nozzles, prohibiting a normal start. At very high engine temperatures and longer shutdown periods vapor formation may even propagate beyond the engine-driven fuel pump and the boost pump.

Brakes .......... HOLD

Bat Master Switches .......... ON (Check Volts)

Strobe Lights .......... ON

Mixture .......... CUT OFF

Fuel Pump .......... BOOST for 30-60 seconds

> Switching the fuel pump to BOOST with the mixture cut-off serves to cool down the fuel line leading to the engine-driven fuel pump and the pump itself. Hot fuel and vapor are routed through the fuel return line to the tanks without being pushed to the cylinders. Afterwards a normal start can be conducted.

Mixture .......... FULL RICH

Power Lever .......... FULL FORWARD

Fuel Pump .......... PRIME, then BOOST

Propeller Area .......... CLEAR

Power Lever .......... OPEN ¼ INCH

Ignition Switch .......... START (Release after engine starts)

Power Lever .......... RETARD (to maintain 1000 RPM)

Oil Pressure .......... CHECK

Alt Master Switches .......... ON

Avionics Power Switch .......... ON

Engine Parameters .......... MONITOR

External Power (If applicable) .......... DISCONNECT

Amp Meter/Indication .......... CHECK

## Flooded Engine Start

Apply this procedure when a high amount of fuel has been introduced into the cylinders by excessive priming and the engine does not start. This might be indicated by a positive fuel flow indication with intermittent cylinder firing and visible exhaust smoke puffs during cranking.

Mixture .......... CUT OFF

Power Lever ........ FULL FORWARD

Propeller Area ........ CLEAR

Ignition Switch ........ START (Release after engine starts)

Power Lever ........ RETARD (to maintain 1000 RPM)

Mixture ........ FULL RICH

Fuel Pump ........ BOOST

Oil Pressure ........ CHECK

Alt Master Switches ........ ON

Avionics Power Switch ........ ON

Engine Parameters ........ MONITOR

Amp Meter/Indication ........ CHECK

### False Engine Start

Apply this procedure when the engine fires but immediately quits after start. Most likely the cylinders are primed, but fuel vapor has formed in front of the injection nozzles causing combustion to cease after a few seconds. Additional priming may lead to flooding the cylinders.

Mixture ........ FULL RICH

Power Lever ........ FULL FORWARD

Fuel Pump ........ BOOST

Propeller Area ........ CLEAR

Power Lever ........ OPEN ¼ INCH

Ignition Switch ........ START (Release after engine starts)

Power Lever ........ RETARD (to maintain 1000 RPM)

Oil Pressure ........ CHECK

Alt Master Switches ........ ON

Avionics Power Switch ........ ON

Engine Parameters ........ MONITOR

External Power (If applicable) ........ DISCONNECT

Amp Meter/Indication ........ CHECK

# Before Taxiing

Flaps ........ UP (0%)

Radios/Avionics ........ AS REQUIRED

Cabin Heat/Defrost ........ AS REQUIRED

Fuel Selector ........ SWITCH TANK

# Taxiing

When taxiing, directional control is accomplished with rudder deflection and intermittent braking (toe taps) as necessary. Use only as much power as is necessary to achieve forward movement. Deceleration or taxi speed control using brakes but without a reduction in power will result in increased brake temperature. Taxi over loose gravel at low engine speed to avoid damage to the propeller tips.

> WARNING
>
> Maximum continuous engine speed for taxiing is 1000 RPM on flat, smooth, hard surfaces. Power settings slightly above 1000 RPM are permissible to start motion, for turf, soft surfaces, and on inclines. Use minimum power to maintain taxi speed.
>
> If the 1000 RPM taxi power limit and proper braking procedures are not observed, the brake system may overheat and result in brake damage or brake fire.

Parking Brake .......... DISENGAGE

Brakes .......... CHECK

HSI Orientation .......... CHECK

Attitude Gyro .......... CHECK

Turn Coordinator .......... CHECK

# Before Takeoff

During cold weather operations, the engine should be properly warmed up before takeoff. In most cases this is accomplished when the oil temperature has reached at least 100°F (38°C). In warm or hot weather, precautions should be taken to avoid overheating during prolonged ground engine operation. Additionally, long periods of idling may cause fouled spark plugs.

> WARNING
>
> Do NOT take off with frost, ice, snow, or other contamination on the fuselage, wing, stabilizers, and control surfaces

Doors .......... LATCHED

CAPS Handle .......... Verify Pin Removed

Seat Belts and Shoulder Harness .......... SECURE

Air Conditioner .......... AS DESIRED

> If Air Conditioner is ON for takeoff, there will be a performance impact. Make sure to perform takeoff performance calculations based upon air conditioning setting.

Fuel Quantity ........ CONFIRM
Fuel Selector ........ FULLEST TANK
Fuel Pump ........ BOOST
Mixture ........ AS REQUIRED
Flaps ........ SET 50%; CHECK
Transponder ........ SET
Autopilot ........ CHECK
Navigation Radios/GPS ........ SET for Takeoff
Cabin Heat/Defrost ........ AS REQUIRED
Brakes ........ HOLD
Power Lever ........ 1700 RPM
Alternator ........ CHECK
Pitot Heat ........ ON
Navigation Lights ........ ON
Landing Light ........ ON
Annunciator Lights ........ CHECK

Verify both ALT 1 and ALT 2 caution lights out and positive amps indication for both

Voltage ........ CHECK
Pitot Heat ........ AS REQUIRED

> Pitot Heat should be turned ON for flight into IMC, visible moisture, or whenever ambient temperatures are 41°F (5° C) or less.

Navigation Lights ........ AS REQUIRED
Landing Light ........ AS REQUIRED
Magnetos ........ CHECK Left and Right
- Ignition Switch ........ R, note RPM, then BOTH
- Ignition Switch ........ L, note RPM, then BOTH

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> RPM drop must not exceed 150 RPM for either magneto. RPM differential must not exceed 75 RPM between magnetos. If there is a doubt concerning operation of the ignition system, RPM checks at higher engine speeds will usually confirm whether a deficiency exists.
>
> An absence of RPM drop may indicate faulty grounding of one side of the ignition system or magneto timing set in advance of the specified setting.

Engine Parameters .......... CHECK

Power Lever .......... 1000 RPM

Flight Instruments, HSI, and Altimeter .......... CHECK and SET

Flight Controls .......... FREE and CORRECT

Trim .......... SET Takeoff

Autopilot .......... DISCONNECT

# Takeoff

**Power Check:** Check full-throttle engine operation early in takeoff run. The engine should run smoothly and turn approximately 2700 RPM. All engine parameters should read in the green. Discontinue takeoff at any sign of rough operation or sluggish acceleration. Make a thorough full-throttle static run-up before attempting another takeoff.

For takeoff over a gravel surface, advance Power Lever slowly. This allows the airplane to start rolling before high RPM is developed, and gravel will be blown behind the propeller rather than pulled into it.

**Flap Settings:** Normal and short field takeoffs are accomplished with flaps set at 50%. Takeoffs using 0% are permissible, however, no performance data is available for takeoffs in the flaps up configuration. Takeoffs with 100% flaps are not approved.

Soft or rough field takeoffs are performed with 50% flaps by lifting the airplane off the ground as soon as practical in a tail-low attitude. If no obstacles are ahead, the airplane should be leveled off immediately to accelerate to a higher climb speed.

Takeoffs into strong crosswinds are normally performed with the flaps set at 50% to minimize the drift angle immediately after takeoff. With the ailerons fully deflected into the wind, accelerate the airplane to a speed slightly higher than normal while decreasing the aileron deflection as speed increases then - with authority - rotate to prevent possibly settling back to the runway while drifting. When clear of the ground, make a coordinated turn into the wind to correct for drift.

> Fuel BOOST should be left ON during takeoff and for climb as required for vapor suppression with hot or warm fuel

### Normal Takeoff

Brakes ........ RELEASE (Steer with Rudder ONLY)

Power Lever ........ FULL FORWARD

Engine Parameters ........ CHECK

Elevator Control ........ ROTATE Smoothly at 70-73 KIAS

At 80 KIAS, Flaps ........ UP

### Short Field Takeoff

Flaps ........ 50%

Brakes ........ HOLD

Power Lever ........ FULL FORWARD

Mixture ........ SET

Engine Parameters ........ CHECK

Brakes ........ RELEASE (Steer with Rudder Only)

Elevator Control ........ ROTATE Smoothly at 70 KIAS

Airspeed at Obstacle ........ 78 KIAS

# Climb

Normal climbs are performed flaps UP (0%) and full power at speeds 5 to 10 knots higher than best rate-of-climb speeds. These higher speeds give the best combination of performance, visibility and engine cooling.

For maximum rate of climb, use the best rate-of-climb speeds shown in the rate-of-climb chart in Section 5. If an obstruction dictates the use of a steep climb angle, the best angle-of-climb speed should be used. Climbs at speeds lower than the best rate-of-climb speed should be of short duration to avoid engine-cooling problems.

Climb Power ........ SET

Flaps ........ Verify UP

Mixture ........ LEAN as required for altitude

Engine Parameters ........ CHECK

Fuel Pump ........ BOOST

> The fuel pump is used for vapor suppression during climb. It is also recommended that the fuel pump be left on after leveling off for 30 minutes following a climb and anytime fuel flow or EGT anomalies occur.

# Cruise

Normal cruising is performed between 55% and 85% power. The engine power setting and corresponding fuel consumption for various altitudes and temperatures can be determined by using the cruise data.

The selection of cruise altitude is made based on the most favorable wind conditions and the desired power settings. These significant factors should be considered on every trip to reduce fuel consumption.

Fuel Pump .......... AS REQUIRED

Cruise Power .......... SET

Mixture .......... LEAN as required

Engine Parameters .......... MONITOR

> Fuel BOOST must be used for switching from one tank to another. Failures to activate the Fuel Pump before transfer could result in delayed restart if the engine should quit due to fuel starvation.

Fuel Flow and Balance .......... MONITOR

## Cruise Leaning

| Mixture Description | Exhaust Gas Temperature |
|---|---|
| Best Power | 75°F Rich Of Peak EGT |
| Best Economy | 50°F Lean Of Peak EGT |

or st the y the

Under some conditions, engine roughness may occur while operating at best economy. If this occurs, enrich mixture as required to smooth engine operation. Any change in altitude or Power Lever position will require a recheck of EGT indication.

# Descent

Altimeter .......... SET

Cabin Heat/Defrost .......... AS REQUIRED

Landing Light .......... ON

Fuel System .......... CHECK

Mixture .......... AS REQUIRED

Brake Pressure .......... CHECK

# Before Landing

Seat Belt and Shoulder Harness .......... SECURE

Fuel Pump .......... BOOST

Mixture .......... AS REQUIRED

Flaps .......... AS REQUIRED

Autopilot .......... AS REQUIRED

# Landing

CAUTION

Landings should be made with full flaps. Landings with less than full flaps are recommended only if the flaps fail to deploy or to extend the aircraft's glide distance due to engine malfunction. Landings with flaps at 50% or 0%; power should be used to achieve a normal glide path and low descent rate. Flare should be minimized.

### Normal Landing

Normal landings are made with full flaps with power on or off. Surface winds and air turbulence are usually the primary factors in determining the most comfortable approach speeds.

Actual touchdown should be made with power off and on the main wheels first to reduce the landing speed and subsequent need for braking. Gently lower the nose wheel to the runway after airplane speed has diminished. This is especially important for rough or soft field landings.

### Short Field Landing

For a short field landing in smooth air conditions, make an approach at 77 KIAS with full flaps using enough power to control the glide path (slightly higher approach speeds should be used under turbulent air conditions). After all approach obstacles are cleared, progressively reduce power to reach idle just before touchdown and maintain the approach speed by lowering the nose of the airplane. Touchdown should be made power-off and on the main wheels first. Immediately after touchdown, lower the nose wheel and apply braking as required. For maximum brake effectiveness, retract the flaps, hold the control yoke full back, and apply maximum brake pressure without skidding.

### Crosswind Landing

Normal crosswind landings are made with full flaps. Avoid prolonged slips. After touchdown, hold a straight course with rudder and brakes as required.

The maximum allowable crosswind velocity is dependent upon pilot capability as well as aircraft limitations. Operation in direct crosswinds of 20 knots has been demonstrated.

### Balked Landing/Go-Around

In a balked landing (go around) climb, disengage autopilot, apply full power, then reduce the flap setting to 50%. If obstacles must be cleared during the go around, climb at 75-80 KIAS with 50% flaps. After clearing any obstacles, retract the flaps and accelerate to the normal flaps up climb speed.

Autopilot.......... DISENGAGE

Power Lever .......... FULL FORWARD

Flaps .......... 50%

Airspeed .......... 75-80 KIAS

After clear of obstacles:

Flaps .......... UP

## After Landing

Power Lever .......... 1000 RPM

Fuel Pump .......... OFF

Flaps .......... UP

Transponder .......... STBY

Lights.......... AS REQUIRED

Pitot Heat .......... OFF

As the airplane slows, the rudder becomes less effective and taxiing is accomplished using differential braking.

# Shutdown

Fuel Pump .................................................... OFF

Throttle .................................................... IDLE

CAUTION

Note that the engine hesitates as the switch cycles through the "OFF" position. If the engine does not hesitate, one or both magnetos are not grounded. Prominently mark the propeller as being "Hot," and contact maintenance personnel immediately.

Ignition Switch .................................................... CYCLE

Mixture .................................................... CUTOFF

All Switches .................................................... OFF

Magnetos .................................................... OFF

ELT .................................................... TRANSMIT LIGHT OUT

Chocks, Tie-downs, Pitot Covers .................................................... AS REQUIRED

# Section 4

# Emergency Procedures

## Table of Contents

# Flight Environment

## Inadvertent Icing Encounter

Pitot Heat .......... ON

Exit Icing Conditions. Turn back or change altitude

Cabin Heat.......... MAXIMUM

Windshield Defrost..........FULL OPEN

Alternate Induction Air.......... ON

## Inadvertent IMC Encounter

Airplane Control..........ESTABLISH straight and level flight

Autopilot.......... ENGAGE to hold heading and altitude

Autopilot.......... RESET to initiate 180° turn

## Door Open In Flight

The doors on the airplane will remain 1-3 inches open in flight if not latched. If this is discovered on takeoff roll, abort takeoff if practical. If already airborne do not allow efforts to close the door interfere with the primary task of maintaining control of the airplane. Do not attempt to hold door closed. Upon landing flare door may swing open - do not attempt to close door.

Airplane Control.......... MAINTAIN

# Abnormal Landings

## Landing With Failed Brakes

### One brake inoperative

1. Land on the side of runway corresponding to the inoperative brake
2. Maintain directional control using rudder and working brake

### Both brakes inoperative

1. Divert to the longest, widest runway with the most direct headwind
2. Land on the downwind side of the runway
3. Use the rudder for obstacle avoidance

## Landing With Flat Tire

Main Gear

1. Land on the side of the runway corresponding to the good tire.
2. Maintain directional control with the brakes and rudder.
3. Do not taxi. Stop the airplane and perform a normal engine shutdown.

Nose Gear

1. Land in the center of the runway
2. Hold the nosewheel off the ground as long as possible
3. Do not taxi. Stop the airplane and perform a normal engine shutdown

# Engine System

## Low Idle Oil Pressure

If In-Flight ........ LAND as soon as practical

## Starter Engaged Annunciation

### On-Ground

Ignition Switch ........ DISENGAGE prior to 20 seconds

Battery Switches ........ Wait 20 seconds before next start attempt

Bat 1 Switch ........ OFF

Engine ........ SHUTDOWN

STARTER Circuit Breaker ........ PULL

### In-Flight

Ignition Switch ........ Ensure not stuck in START

STARTER Circuit Breaker ........ PULL

Flight ........ CONTINUE

Engine start will not be available at destination

WARNING

Use extreme caution after shutdown if STARTER circuit breaker required pull (failed relay or solenoid). If breaker is unknowingly or unintentionally reset, starter will instantly engage if Battery 1 power is supplied; creating a hazard for ground personnel.

# Fuel System

### Low Fuel Quantity

Fuel Quantity Gauges....CHECK

*If fuel quantity indicates less than or equal to 14 gallons:*

Land as soon as practical

*If fuel quantity indicates greater than 14 gallons:*

Flight....CONTINUE, MONITOR

### Left Fuel Tank Quantity

Left Fuel Quantity Gauge....CHECK

*If left fuel quantity indicates less than or equal to 14 gallons:*

If On-Ground....REFUEL PRIOR TO FLIGHT

If In-Flight....CONTINUE, MONITOR

*If left fuel quantity indicates greater than 14 gallons:*

If On-Ground....CORRECT PRIOR TO FLIGHT

If In-Flight....CONTINUE, MONITOR

### Right Fuel Tank Quantity

Right Fuel Quantity Gauge....CHECK

*If right fuel quantity indicates less than or equal to 14 gallons:*

If On-Ground....REFUEL PRIOR TO FLIGHT

If In-Flight....CONTINUE, MONITOR

*If right fuel quantity indicates greater than 14 gallons:*

If On-Ground....CORRECT PRIOR TO FLIGHT

If In-Flight....CONTINUE, MONITOR

### Fuel Filter in Bypass Mode

If In-Flight....LAND AS SOON AS PRACTICAL

Replace fuel filter element prior to next flight

## Electrical System

### Low Voltage on Main Bus 1

1. Perform Alt 1 Caution (Failure) Checklist

### Low Voltage on Main Bus 2

1. Perform Alt 1 and Alt 2 Caution (Failure) checklists.

### Battery 1 Current Sensor

Main Bus 1, 2, and Non-Essential Bus Loads ........ REDUCE

Main Bus 1, 2, and Essential Bus Voltages ........ MONITOR

Land as soon as practical

### Low Alternator 1 Output

ALT 1 Circuit Breaker ........ CHECK and SET

ALT 1 Master Switch ........ CYCLE

*If alternator does not reset (low A1 current and voltage)*

ALT 1 Master Switch ........ OFF

Non-Essential Bus Loads ........ REDUCE

Consider shedding air condition, landing light, yaw servo, and convenience power

Continue Flight, avoiding IMC or night flight as able

### Low Alternator 2 Output

ALT 2 Circuit Breaker ........ CHECK and SET

ALT 2 Master Switch ........ CYCLE

*If alternator does not reset (low A2 current and M2 voltage less than M2 voltage)*

ALT 2 Master Switch ........ OFF

Continue Flight, avoiding IMC or night flight as able

## Avionics

### Avionics Switch Off

AVIONICS Switch ........ ON, AS REQUIRED

### PFD Cooling Fan Failure

AVIONICS FAN 2 Circuit Breaker ........ CYCLE

*If annunciation does not extinguish:*

Hot cabin temperatures ........ LAND AS SOON AS PRACTICAL

Cool cabin temperatures ........ CONTINUE, MONITOR

### MFD Cooling Fan Failure

AVIONICS FAN 1 Circuit Breaker ........ CYCLE

*If annunciation does not extinguish:*

Hot cabin temperatures ........ LAND AS SOON AS PRACTICAL

Cool cabin temperatures ........ CONTINUE, MONITOR

## Pitot Static System

### Static Source Blocked

Pitot Heat ........ ON

Alternate Static Source ........ OPEN

If erroneous readings of the static source instruments (airspeed, altimeter and vertical speed) are suspected, the alternate static source valve, on side of console near pilot's right ankle, should be opened to supply static pressure from the cabin to these instruments. With the alternate static source on, adjust indicated airspeed slightly during climb or approach according to the Airspeed Calibration (Alternate Static Source) table in Section 5 as appropriate for vent/ heater configuration.

### Pitot Tube Blocked

Pitot Heat ........ ON

If only the airspeed indicator is providing erroneous information, and in icing conditions, the most probable cause is Pitot ice. If setting Pitot Heat ON does not correct the problem, descend to warmer air. If an approach must be made with a blocked Pitot tube, use known pitch and power settings and the GPS groundspeed indicator, taking surface winds into account.

### Pitot Heat Current Sensor Annunciation

Pitot Heat Circuit Breaker ........ CYCLE

Pitot Heat ........ CYCLE OFF, ON

*If inadvertent icing encounter, perform Inadvertent Icing Encounter checklist and:*

Airspeed ........ EXPECT NO RELIABLE INDICATION

EXIT ICING CONDITIONS USING ATTITUDE, ALTITUDE, and POWER instruments

### Pitot Heat Required Annunciation

Pitot Heat ........ ON

# Flight Control System

### Electric Trim/Autopilot Failure

Airplane Control ........ MAINTAIN MANUALLY

Autopilot (if engaged) ........ DISENGAGE

*If problem is not corrected:*

Circuit Breakers ........ PULL AS REQUIRED

PITCH TRIM, ROLL TRIM, YAW SERVO, and AP SERVOS

Power Lever ........ AS REQUIRED

Control Yoke ........ MANUALLY HOLD PRESSURE

Land as soon as practical

### Flap System Exceedance

Airspeed ........ REDUCE

*or*

Flaps .......... RETRACT

# Landing Gear System

## Brake Failure During Taxi

Engine Power .......... AS REQUIRED

Directional Control .......... MAINTAIN WITH RUDDER

Brake Pedals .......... PUMP

Ignition Switch .......... OFF

## Left/Right Brake Over-Temperature

Stop aircraft and allow brakes to cool

# Other Conditions

## Aborted Takeoff

Power Lever .......... IDLE

Brakes .......... AS REQUIRED

CAUTION

For maximum brake effectiveness, retract flaps, hold control yoke full back, and bring the airplane to a stop by smooth, even application of the brakes.

After a high-speed aborted takeoff, brake temperatures will be elevated; subsequent aborted takeoffs or other high-energy use of the brakes may cause brake overheat, failure and possibly even fire. A 25-minute cooling time is recommended following high-energy use of the brake system before attempting to conduct operations that may require further high-energy braking. Brake temperature indicator should be inspected prior to flight following a high-energy brake event (refer to Preflight Walk-Around Checklist for detail).

## Parking Brake Engaged Annunciation

Parking Brake .......... RELEASE

Monitor CAS for BRAKE TEMP caution. Stop aircraft and allow the brakes to cool if necessary.

## Communications Failure

Switches, Controls ........ CHECK
Frequency ........ CHANGE
Circuit Breakers ........ SET
Headset ........ CHANGE
Hand Held Microphone ........ CONNECT

> In the event of an audio panel power failure the audio panel connects COM 1 to the pilot's headset and speakers. Setting the audio panel 'Off' will also connect COM 1 to the pilot's headsets and speakers.

# *Section 5*

# *Performance Data*

## Table of Contents

# Stall Speeds

Weight ........................................................ 3400 Lbs

CG ........................................................ On Table

Power ........................................................ Idle

Bank Angle ........................................................ On Table

KIAS values may not be accurate at stall

| Weight | Bank Angle | STALL SPEEDS | | | | | |
|---|---|---|---|---|---|---|---|
| | | Flaps 0% | | Flaps 50% | | Flaps 100% | |
| *Lbs* | *Deg* | *KIAS* | *KCAS* | *KIAS* | *KCAS* | *KIAS* | *KCAS* |
| 3400 / FWD CG | 0 | 73 | 70 | 66 | 64 | 62 | 60 |
| | 15 | 74 | 71 | 67 | 65 | 64 | 61 |
| | 30 | 76 | 75 | 71 | 69 | 66 | 64 |
| | 45 | 83 | 83 | 77 | 76 | 72 | 71 |
| | 60 | 99 | 99 | 90 | 90 | 84 | 84 |
| 3400 / AFT CG | 0 | 72 | 69 | 65 | 63 | 60 | 58 |
| | 15 | 73 | 70 | 66 | 64 | 61 | 59 |
| | 30 | 76 | 74 | 69 | 67 | 63 | 62 |
| | 45 | 82 | 82 | 76 | 75 | 69 | 69 |
| | 60 | 98 | 98 | 89 | 89 | 82 | 82 |

# Takeoff Distance

Winds ........................................................ 0 kts

Runway ........................................................ Dry, Level, Paved

Flaps ........................................................ 50%

Air Conditioner ........................................................ Off

Throttle ........................................................ Full Open

Mixture ........................................................ Set

Corrections:

- Headwind - Subtract 10% from computed distance for each 12 knots headwind.
- Tailwind - Add 10% for each 2 knots tailwind up to 10 knots.
- Grass Runway, Dry - Add 20% to ground roll distance.
- Grass Runway, Wet - Add 30% to ground roll distance.
- Sloped Runway - Increase table distances by 22% of the ground roll distance at Sea Level, 30% of the ground roll distance at 5000 ft, 43% of the ground roll distance at 10,000 ft for each 1% of upslope. Decrease table distances by 7% of the ground roll distance at Sea Level, 10% of the ground roll distance at 5000 ft, and 14% of the ground roll distance at 10,000 ft for each 1% of downslope.

- Aircraft with optional Air Conditioning System; Add 100 feet to ground roll distance and 150 feet to distance over 50' obstacle if Air Conditioner is ON during takeoff.
- For operation in outside air temperatures colder than this table provides, use coldest data shown.
- For operation in outside air temperatures warmer than this table provides, use extreme caution.
- If brakes are not held while applying power, distances apply from point where full throttle and mixture setting is complete.

## Takeoff Distance - 3400 lbs

| PRESS ALT FT | DISTANCE FT | TEMPERATURE ~°C | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 10 | 20 | 30 | 40 | ISA |
| SL | Grnd Roll | 917 | 990 | 1067 | 1146 | 1229 | 1028 |
| | 50 ft | 1432 | 1539 | 1650 | 1764 | 1883 | 1594 |
| 1000 | Grnd Roll | 1011 | 1092 | 1176 | 1264 | 1355 | 1117 |
| | 50 ft | 1574 | 1691 | 1813 | 1939 | 2069 | 1728 |
| 2000 | Grnd Roll | 1116 | 1206 | 1299 | 1395 | 1496 | 1215 |
| | 50 ft | 1732 | 1861 | 1995 | 2133 | 2276 | 1874 |
| 3000 | Grnd Roll | 1234 | 1332 | 1435 | 1542 | 1653 | 1323 |
| | 50 ft | 1907 | 2049 | 2196 | 2349 | 2507 | 2035 |
| 4000 | Grnd Roll | 1365 | 1474 | 1588 | 1706 | 1829 | 1441 |
| | 50 ft | 2102 | 2259 | 2422 | 2590 | 2764 | 2212 |
| 5000 | Grnd Roll | 1512 | 1633 | 1758 | 1889 | 2025 | 1572 |
| | 50 ft | 2320 | 2493 | 2673 | 2858 | 3051 | 2407 |
| 6000 | Grnd Roll | 1676 | 1810 | 1950 | 2095 | 2245 | 1717 |
| | 50 ft | 2564 | 2755 | 2953 | 3159 | 3371 | 2622 |
| 7000 | Grnd Roll | 1861 | 2009 | 2164 | 2325 | 2492 | 1877 |
| | 50 ft | 2837 | 3048 | 3267 | 3494 | 3729 | 2859 |
| 8000 | Grnd Roll | 2068 | 2233 | 2405 | 2584 | 2770 | 2054 |
| | 50 ft | 3142 | 3376 | 3619 | 3871 | 4131 | 3122 |
| 9000 | Grnd Roll | 2302 | 2485 | 2677 | 2875 | 3082 | 2250 |
| | 50 ft | 3485 | 3744 | 4014 | 4293 | 4581 | 3412 |
| 10000 | Grnd Roll | 2564 | 2769 | 2982 | 3204 | 3434 | 2468 |
| | 50 ft | 3870 | 4158 | 4457 | 4767 | 5088 | 3733 |

# Takeoff Distance - 2900 lbs

| PRESS ALT FT | DISTANCE FT | TEMPERATURE ~°C 0 | 10 | 20 | 30 | 40 | ISA |
|---|---|---|---|---|---|---|---|
| SL | Grnd Roll | 610 | 659 | 710 | 763 | 818 | 684 |
| | 50 ft | 971 | 1043 | 1118 | 1195 | 1275 | 1080 |
| 1000 | Grnd Roll | 673 | 727 | 783 | 841 | 902 | 743 |
| | 50 ft | 1066 | 1146 | 1228 | 1313 | 1401 | 1170 |
| 2000 | Grnd Roll | 743 | 802 | 864 | 929 | 995 | 809 |
| | 50 ft | 1173 | 1260 | 1351 | 1444 | 1541 | 1269 |
| 3000 | Grnd Roll | 821 | 887 | 955 | 1026 | 1100 | 880 |
| | 50 ft | 1292 | 1388 | 1487 | 1590 | 1697 | 1378 |
| 4000 | Grnd Roll | 908 | 981 | 1057 | 1135 | 1217 | 959 |
| | 50 ft | 1424 | 1530 | 1639 | 1753 | 1871 | 1498 |
| 5000 | Grnd Roll | 1006 | 1086 | 1170 | 1257 | 1348 | 1046 |
| | 50 ft | 1571 | 1688 | 1809 | 1935 | 2065 | 1630 |
| 6000 | Grnd Roll | 1116 | 1205 | 1298 | 1394 | 1494 | 1143 |
| | 50 ft | 1736 | 1865 | 1999 | 2138 | 2281 | 1775 |
| 7000 | Grnd Roll | 1238 | 1337 | 1440 | 1547 | 1659 | 1249 |
| | 50 ft | 1920 | 2063 | 2211 | 2365 | 2523 | 1936 |
| 8000 | Grnd Roll | 1376 | 1486 | 1601 | 1720 | 1843 | 1367 |
| | 50 ft | 2127 | 2285 | 2449 | 2619 | 2795 | 2113 |
| 9000 | Grnd Roll | 1532 | 1654 | 1781 | 1914 | 2051 | 1498 |
| | 50 ft | 2359 | 2534 | 2716 | 2904 | 3099 | 2309 |
| 10000 | Grnd Roll | 1707 | 1843 | 1985 | 2132 | 2285 | 1643 |
| | 50 ft | 2619 | 2814 | 3016 | 3225 | 3441 | 2527 |

# Takeoff Rate of Climb

Power....................Full Throttle

Mixture....................Set per Placard

Flaps....................50%

Airspeed....................Best Rate of Climb

For operation in air colder than this table provides, use coldest data shown.

For operation in air warmer than this table provides, use extreme caution.

| Weight | Pressure Altitude | Climb Speed | RATE OF CLIMB (FPM) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature °C | | | | |
| Lbs | Ft | KIAS | -20 | 0 | 20 | 40 | ISA |
| 3400 | Sea Level | 91 | 1326 | 1317 | 1300 | 1277 | 1304 |
| | 2000 | 90 | 1214 | 1200 | 1179 | 1153 | 1189 |
| | 4000 | 89 | 1100 | 1082 | 1057 | 1028 | 1074 |
| | 6000 | 88 | 985 | 962 | 934 | 901 | 958 |
| | 8000 | 88 | 869 | 842 | 809 | 774 | 843 |
| | 10000 | 87 | 851 | 719 | 683 | 644 | 727 |
| 2900 | Sea Level | 91 | 1646 | 1638 | 1621 | 1598 | 1626 |
| | 2000 | 90 | 1518 | 1505 | 1484 | 1457 | 1794 |
| | 4000 | 89 | 1389 | 1371 | 1346 | 1316 | 1363 |
| | 6000 | 88 | 1259 | 1236 | 1207 | 1172 | 1232 |
| | 8000 | 88 | 1128 | 1100 | 1066 | 1028 | 1101 |
| | 10000 | 87 | 995 | 962 | 924 | 883 | 971 |

# Enroute Rate of Climb

Power....................Full Throttle

Mixture....................Set per Placard

Flaps....................0%

Airspeed....................Best Rate of Climb

For operation in air colder than this table provides, use coldest data shown.

For operation in air warmer than this table provides, use extreme caution.

| Weight | Pressure Altitude | Climb Speed | RATE OF CLIMB (FPM) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature °C | | | | |
| Lbs | Ft | KIAS | -20 | 0 | 20 | 40 | ISA |
| 3400 | Sea Level | 101 | 1428 | 1414 | 1392 | 1366 | 1398 |
| | 2000 | 100 | 1311 | 1292 | 1267 | 1238 | 1279 |
| | 4000 | 99 | 1193 | 1170 | 1141 | 1108 | 1160 |
| | 6000 | 98 | 1074 | 1046 | 1013 | 977 | 1041 |
| | 8000 | 97 | 953 | 921 | 884 | 845 | 922 |
| | 10000 | 96 | 830 | 794 | 754 | 712 | 803 |
| | 12000 | 95 | 706 | 666 | 623 | 577 | 684 |
| | 14000 | 94 | 581 | 537 | 490 | 441 | 565 |
| | 16000 | 93 | 454 | 406 | 355 | 303 | 446 |
| 2900 | Sea Level | 101 | 1761 | 1748 | 1726 | 1698 | 1732 |
| | 2000 | 100 | 1629 | 1610 | 1584 | 1552 | 1596 |
| | 4000 | 99 | 1494 | 1471 | 1441 | 1405 | 1461 |
| | 6000 | 98 | 1359 | 1331 | 1296 | 1257 | 1326 |
| | 8000 | 97 | 1222 | 1189 | 1151 | 1108 | 1191 |
| | 10000 | 95 | 1084 | 1046 | 1004 | 958 | 1056 |
| | 12000 | 95 | 945 | 902 | 855 | 806 | 921 |
| | 14000 | 93 | 804 | 757 | 706 | 653 | 787 |
| | 16000 | 92 | 662 | 610 | 556 | 499 | 653 |

# Cruise Performance

Cruise Weight ........................................ 2900 lbs

Winds ........................................ 0 kts

Shaded Cells: Cruise power above 85% not recommended.

> Aircraft with optional Air Conditioning System - Cruise performance is reduced by 2 knots. For maximum performance, the air-conditioner should be off.

| Press Alt | | | ISA - 30°C | | | ISA | | | ISA + 30°C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | RPM | MAP | PWR | KTAS | GPH | PWR | KTAS | GPH | PWR | KTAS | GPH |
| 2000 | 2700 | 27.4 | 103% | 186 | 24.6 | 98% | 186 | 23.3 | 93% | 181 | 22.0 |
| | 2600 | 27.4 | 99% | 183 | 23.5 | 94% | 183 | 22.2 | 89% | 178 | 21.5 |
| | 2500 | 27.4 | 93% | 179 | 22.1 | 88% | 179 | 20.9 | 84% | 174 | 20.8 |
| | 2500 | 26.4 | 89% | 176 | 21.1 | 84% | 176 | 19.9 | 80% | 171 | 20.2 |
| | 2500 | 25.4 | 84% | 173 | 20.0 | 80% | 173 | 19.0 | 76% | 168 | 19.5 |
| | 2500 | 24.4 | 80% | 170 | 19.0 | 76% | 170 | 18.0 | 72% | 165 | 18.8 |
| | 2500 | 23.4 | 76% | 167 | 18.0 | 72% | 167 | 17.0 | 68% | 162 | 18.1 |
| 4000 | 2700 | 25.4 | 96% | 185 | 22.9 | 91% | 185 | 21.6 | 87% | 180 | 20.8 |
| | 2600 | 25.4 | 92% | 182 | 21.9 | 87% | 182 | 20.7 | 83% | 177 | 20.6 |
| | 2500 | 25.4 | 87% | 178 | 20.6 | 82% | 178 | 19.5 | 78% | 173 | 19.9 |
| | 2500 | 24.4 | 82% | 175 | 19.5 | 78% | 175 | 18.5 | 74% | 170 | 19.2 |
| | 2500 | 23.4 | 78% | 172 | 18.5 | 74% | 172 | 17.5 | 70% | 167 | 18.5 |
| | 2500 | 22.4 | 73% | 169 | 17.4 | 69% | 169 | 16.5 | 66% | 163 | 17.7 |
| | 2500 | 21.4 | 69% | 165 | 16.4 | 65% | 165 | 15.5 | 62% | 159 | 16.9 |
| 6000 | 2700 | 23.5 | 89% | 184 | 21.2 | 85% | 184 | 20.1 | 81% | 179 | 19.6 |
| | 2600 | 23.5 | 85% | 181 | 20.3 | 81% | 181 | 19.2 | 77% | 176 | 19.1 |
| | 2500 | 23.5 | 80% | 177 | 19.1 | 76% | 177 | 18.1 | 72% | 172 | 18.3 |
| | 2500 | 22.5 | 76% | 174 | 18.1 | 72% | 174 | 17.1 | 68% | 169 | 17.6 |
| | 2500 | 21.5 | 72% | 170 | 17.0 | 68% | 170 | 16.1 | 64% | 165 | 16.9 |
| | 2500 | 20.5 | 67% | 166 | 15.9 | 64% | 166 | 15.1 | 60% | 161 | 16.1 |
| | 2500 | 19.5 | 63% | 162 | 14.9 | 59% | 162 | 14.1 | 56% | 157 | 15.3 |

| Press Alt | | | ISA - 30°C | | | ISA | | | ISA + 30°C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | RPM | MAP | PWR | KTAS | GPH | PWR | KTAS | GPH | PWR | KTAS | GPH |
| 8000 | 2700 | 21.7 | 83% | 183 | 19.7 | 78% | 183 | 18.6 | 75% | 178 | 17.7 |
| | 2600 | 21.7 | 79% | 180 | 18.8 | 75% | 180 | 17.8 | 71% | 175 | 17.0 |
| | 2500 | 21.7 | 75% | 176 | 17.7 | 71% | 176 | 16.8 | 67% | 171 | 16.0 |
| | 2500 | 20.7 | 70% | 172 | 16.7 | 66% | 172 | 15.8 | 63% | 167 | 15.0 |
| | 2500 | 19.7 | 66% | 168 | 15.6 | 62% | 168 | 14.8 | 59% | 163 | 14.0 |
| | 2500 | 18.7 | 61% | 163 | 14.5 | 58% | 163 | 13.8 | 55% | 158 | 13.1 |
| | 2500 | 17.7 | 57% | 159 | 13.5 | 54% | 159 | 12.8 | 51% | 153 | 12.1 |
| 10000 | 2700 | 20.0 | 77% | 182 | 18.2 | 73% | 182 | 17.3 | 69% | 176 | 16.4 |
| | 2600 | 20.0 | 71% | 177 | 17.0 | 68% | 177 | 16.1 | 64% | 172 | 15.3 |
| | 2500 | 20.0 | 67% | 173 | 16.0 | 64% | 173 | 15.1 | 61% | 167 | 14.4 |
| | 2500 | 19.0 | 63% | 168 | 14.9 | 59% | 168 | 14.1 | 56% | 163 | 13.4 |
| | 2500 | 18.0 | 58% | 163 | 13.8 | 55% | 163 | 13.1 | 52% | 158 | 12.5 |
| | 2500 | 17.0 | 54% | 158 | 12.8 | 51% | 158 | 12.1 | 48% | 153 | 11.5 |
| 12000 | 2700 | 18.5 | 71% | 180 | 16.9 | 67% | 180 | 16.0 | 64% | 175 | 15.2 |
| | 2600 | 18.5 | 68% | 177 | 16.2 | 64% | 177 | 15.3 | 61% | 172 | 14.5 |
| | 2500 | 18.5 | 64% | 173 | 15.2 | 60% | 173 | 14.4 | 58% | 167 | 13.7 |
| | 2500 | 17.5 | 59% | 168 | 14.1 | 56% | 168 | 13.4 | 53% | 162 | 12.7 |
| | 2500 | 16.5 | 55% | 162 | 13.0 | 52% | 162 | 12.3 | 49% | 157 | 11.7 |
| | 2500 | 15.5 | 50% | 156 | 12.0 | 48% | 156 | 11.3 | 45% | 151 | 10.8 |
| 14000 | 2700 | 17.1 | 66% | 178 | 15.6 | 62% | 178 | 14.8 | 59% | 173 | 14.1 |
| | 2600 | 17.1 | 63% | 175 | 14.9 | 60% | 175 | 14.1 | 57% | 170 | 13.5 |
| | 2500 | 17.1 | 59% | 171 | 14.1 | 56% | 171 | 13.3 | 53% | 165 | 12.7 |
| | 2500 | 16.1 | 55% | 165 | 13.0 | 52% | 165 | 12.3 | 49% | 159 | 11.7 |
| | 2500 | 15.1 | 50% | 159 | 11.9 | 47% | 159 | 11.2 | 45% | 153 | 10.7 |
| 16000 | 2700 | 15.8 | 61% | 176 | 14.5 | 58% | 176 | 13.7 | 55% | 171 | 13.0 |
| | 2600 | 15.8 | 58% | 173 | 13.8 | 55% | 173 | 13.1 | 52% | 167 | 12.5 |
| | 2500 | 15.8 | 55% | 168 | 13.0 | 52% | 168 | 12.3 | 49% | 163 | 11.7 |
| | 2500 | 14.8 | 50% | 162 | 11.9 | 47% | 162 | 11.3 | 45% | 156 | 10.7 |
| 17000 | 2700 | 15.2 | 59% | 175 | 13.9 | 55% | 175 | 13.2 | 53% | 169 | 12.5 |
| | 2600 | 15.2 | 56% | 171 | 13.3 | 53% | 171 | 12.6 | 50% | 166 | 12.0 |
| | 2500 | 15.2 | 53% | 167 | 12.5 | 50% | 167 | 11.9 | 47% | 162 | 11.3 |
| | 2500 | 14.2 | 48% | 160 | 11.4 | 45% | 160 | 10.8 | 43% | 155 | 10.3 |

# Range / Endurance Profile

Weight ............ 3400 lbs

Winds ............ 0 kts

Temperature ............ Standard Day

Mixture ............ Best Economy

Total Fuel ............ 92 Gallons

Fuel Remaining For Cruise is equal to 92.0 gallons usable, less climb fuel, less 9.8 gallons for 45 minutes IFR reserve fuel at 47% power (ISA @ 10,000 ft PA), less descent fuel, less fuel used prior to takeoff.

Range and endurance shown includes descent to final destination at approximately 178 KIAS and 500 fpm.

Aircraft with optional air-conditioning system - Range is decreased by 1%. For maximum range the air-conditioner should be off.

Aircraft with optional Air Conditioning System - Cruise performance is reduced by 2 knots. For maximum performance, the air-conditioner should be off.

| 75% POWER | | | | | | | Mixture: Best Power |
|---|---|---|---|---|---|---|---|
| Press Alt FT | Climb Fuel Gal | Fuel Remaining For Cruise Gal | Airspeed KTAS | Fuel Flow GPH | Endurance Hours | Range NM | Specific Range Nm/Gal |
| **SL** | **0.0** | 81.3 | 166 | 17.8 | 4.6 | 763 | 9.3 |
| **2000** | **0.7** | 81.1 | 170 | 17.8 | 4.6 | 775 | 9.6 |
| **4000** | **1.3** | 80.4 | 173 | 17.8 | 4.5 | 786 | 9.8 |
| **6000** | **2.0** | 79.7 | 177 | 17.8 | 4.5 | 797 | 10.0 |
| **8000** | **2.7** | 79.0 | 180 | 17.8 | 4.4 | 811 | 10.3 |

| 65% POWER | | | | | | | Mixture: Best Power |
|---|---|---|---|---|---|---|---|
| Press Alt FT | Climb Fuel Gal | Fuel Remaining For Cruise Gal | Airspeed KTAS | Fuel Flow GPH | Endurance Hours | Range NM | Specific Range Nm/Gal |
| **SL** | **0.0** | 81.3 | 158 | 15.4 | 5.3 | 838 | 10.3 |
| **2000** | **0.7** | 81.1 | 161 | 15.4 | 5.3 | 850 | 10.5 |
| **4000** | **1.3** | 80.4 | 165 | 15.4 | 5.2 | 862 | 10.7 |
| **6000** | **2.0** | 79.7 | 168 | 15.4 | 5.2 | 874 | 11.0 |
| **8000** | **2.7** | 79.0 | 171 | 15.4 | 5.1 | 887 | 11.2 |
| **10000** | **3.5** | 78.2 | 174 | 15.4 | 5.1 | 899 | 11.5 |
| **12000** | **4.4** | 77.1 | 178 | 15.4 | 5.0 | 912 | 11.8 |

| 55% POWER | | | | | | | Mixture: Best Power |
|---|---|---|---|---|---|---|---|
| Press Alt<br>FT | Climb Fuel<br>Gal | Fuel Remaining For Cruise<br>Gal | Airspeed<br>KTAS | Fuel Flow<br>GPH | Endurance<br>Hours | Range<br>NM | Specific Range<br>Nm/Gal |
| SL | 0.0 | 81.8 | 149 | 13.1 | 6.3 | 931 | 11.4 |
| 2000 | 0.7 | 81.1 | 152 | 13.1 | 6.2 | 943 | 11.6 |
| 4000 | 1.3 | 80.4 | 154 | 13.1 | 6.2 | 955 | 11.9 |
| 6000 | 2.0 | 79.7 | 157 | 13.1 | 6.1 | 968 | 12.2 |
| 8000 | 2.7 | 79.0 | 160 | 13.1 | 6.0 | 980 | 12.4 |
| 10000 | 3.5 | 78.3 | 163 | 13.1 | 6.0 | 993 | 12.7 |
| 12000 | 4.4 | 77.4 | 166 | 13.1 | 5.9 | 1005 | 13.0 |
| 14000 | 5.3 | 76.5 | 169 | 13.1 | 5.8 | 1018 | 13.4 |

| 55% POWER | | | | | | | Mixture: Best Economy |
|---|---|---|---|---|---|---|---|
| Press Alt<br>FT | Climb Fuel<br>Gal | Fuel Remaining For Cruise<br>Gal | Airspeed<br>KTAS | Fuel Flow<br>GPH | Endurance<br>Hours | Range<br>NM | Specific Range<br>Nm/Gal |
| SL | 0.0 | 81.8 | 149 | 11.3 | 7.2 | 1074 | 13.1 |
| 2000 | 0.7 | 81.1 | 152 | 11.3 | 7.2 | 1088 | 13.4 |
| 4000 | 1.3 | 80.4 | 154 | 11.3 | 7.1 | 1108 | 13.7 |
| 6000 | 2.0 | 79.7 | 157 | 11.3 | 7.0 | 1115 | 14.0 |
| 8000 | 2.7 | 79.0 | 160 | 11.3 | 7.0 | 1129 | 14.3 |
| 10000 | 3.5 | 78.3 | 163 | 11.3 | 6.9 | 1143 | 14.6 |
| 12000 | 4.4 | 77.4 | 166 | 11.3 | 6.8 | 1156 | 15.0 |
| 14000 | 5.3 | 76.5 | 169 | 11.3 | 6.7 | 1170 | 15.4 |

# Landing Distance

Winds ........................................ 0 kts

Runway ........................................ Dry, Level, Paved

Flaps ........................................ 100%

Power ........................................ 3° Power Approach

(with smooth reduction to idle prior to touchdown)

- Headwind - Subtract 10% from table distances for each 13 knots headwind.
- Tailwind - Add 10% to table distances for each 2 knots tailwind up to 10 knots.
- Grass Runway, Dry - Add 20% to ground roll distance.
- Grass Runway, Wet - Add 60% to ground roll distance.

- Sloped Runway - Increase table distances by 27% of the ground roll distance for each 1% of downslope. Decrease table distances by 9% of the ground roll distance for each 1% of upslope.

CAUTION

• For operation in outside air temperatures colder than this table provides, use coldest data shown.

• For operation in outside air temperatures warmer than this table provides, use extreme caution.

| PRESS ALT FT | DISTANCE FT | TEMPERATURE ~°C | | | | | ISA |
|---|---|---|---|---|---|---|---|
| | | 0 | 10 | 20 | 30 | 40 | |
| SL | Grnd Roll | 1082 | 1121 | 1161 | 1200 | 1240 | 1141 |
| | Total | 2262 | 2316 | 2372 | 2428 | 2485 | 2344 |
| 1000 | Grnd Roll | 1122 | 1163 | 1204 | 1245 | 1286 | 1175 |
| | Total | 2317 | 2374 | 2433 | 2492 | 2551 | 2391 |
| 2000 | Grnd Roll | 1163 | 1206 | 1248 | 1291 | 1334 | 1210 |
| | Total | 2375 | 2436 | 2497 | 2559 | 2621 | 2441 |
| 3000 | Grnd Roll | 1207 | 1251 | 1295 | 1339 | 1384 | 1247 |
| | Total | 2437 | 2501 | 2565 | 2630 | 2696 | 2493 |
| 4000 | Grnd Roll | 1252 | 1298 | 1344 | 1390 | 1436 | 1285 |
| | Total | 2503 | 2569 | 2637 | 2705 | 2774 | 2548 |
| 5000 | Grnd Roll | 1300 | 1348 | 1395 | 1443 | 1490 | 1324 |
| | Total | 2572 | 2642 | 2713 | 2785 | 2857 | 2605 |
| 6000 | Grnd Roll | 1350 | 1399 | 1449 | 1498 | 1547 | 1365 |
| | Total | 2645 | 2719 | 2794 | 2869 | 2945 | 2665 |
| 7000 | Grnd Roll | 1402 | 1453 | 1504 | 1556 | 1607 | 1408 |
| | Total | 2723 | 2800 | 2879 | 2958 | 3038 | 2728 |
| 8000 | Grnd Roll | 1456 | 1509 | 1563 | 1616 | 1669 | 1452 |
| | Total | 2805 | 2887 | 2969 | 3052 | 3136 | 2794 |
| 9000 | Grnd Roll | 1513 | 1569 | 1624 | 1679 | 1735 | 1497 |
| | Total | 2892 | 2978 | 3064 | 3152 | 3240 | 2863 |
| 10000 | Grnd Roll | 1573 | 1630 | 1688 | 1746 | 1803 | 1545 |
| | Total | 2984 | 3074 | 3165 | 3257 | 3350 | 2936 |

# *Section 6*

# *Weight and Balance*

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# Loading Data

Use the following table to determine the moment/1000 for fuel and payload items to complete the Loading Form.

| Weight<br>LB | Fwd Pass<br>FS 143.5 | Aft Pass<br>FS 180.0 | Baggage<br>FS 208.0 | Fuel<br>FS 154.9 | Weight<br>LB | Fwd Pass<br>FS 143.5 | Aft Pass<br>FS 180.0 | Fuel<br>FS 154.9 |
|---|---|---|---|---|---|---|---|---|
| 20 | 2.9 | 3.6 | 4.2 | 3.1 | 300 | 43.1 | 54.0 | 46.5 |
| 40 | 5.7 | 7.2 | 8.3 | 6.2 | 320 | 45.9 | 57.6 | 49.6 |
| 60 | 8.6 | 10.8 | 12.5 | 9.3 | 340 | 48.8 | 61.2 | 52.7 |
| 80 | 11.5 | 14.4 | 16.6 | 12.4 | 360 | 51.7 | 64.8 | 55.8 |
| 100 | 14.4 | 18.0 | 20.8 | 15.5 | 380 | 54.5 | 68.4 | 58.9 |
| 120 | 17.2 | 21.6 | 25.0 | 18.6 | 400 | 57.4 | 72.0 | 62.0 |
| 140 | 20.1 | 25.2 | 27.04* | 21.7 | 420 | 60.3 | 75.6 | 65.1 |
| 160 | 23.0 | 28.8 | | 24.8 | 440 | 63.1 | 79.2 | 68.2 |
| 180 | 25.8 | 32.4 | | 27.9 | 460 | | | 71.3 |
| 200 | 28.7 | 36.0 | | 31.0 | 480 | | | 74.4 |
| 220 | 31.6 | 39.6 | | 34.1 | 500 | | | 77.5 |
| 240 | 34.4 | 43.2 | | 37.2 | 520 | | | 80.5 |
| 260 | 37.3 | 46.8 | | 40.3 | 552** | | | 85.5 |
| 280 | 40.2 | 50.4 | | 43.4 | | | | |

*130 lb Maximum

**92 U.S. Gallons Usable

NOT FOR FLIGHT - FOR SIMULATION USE ONLY

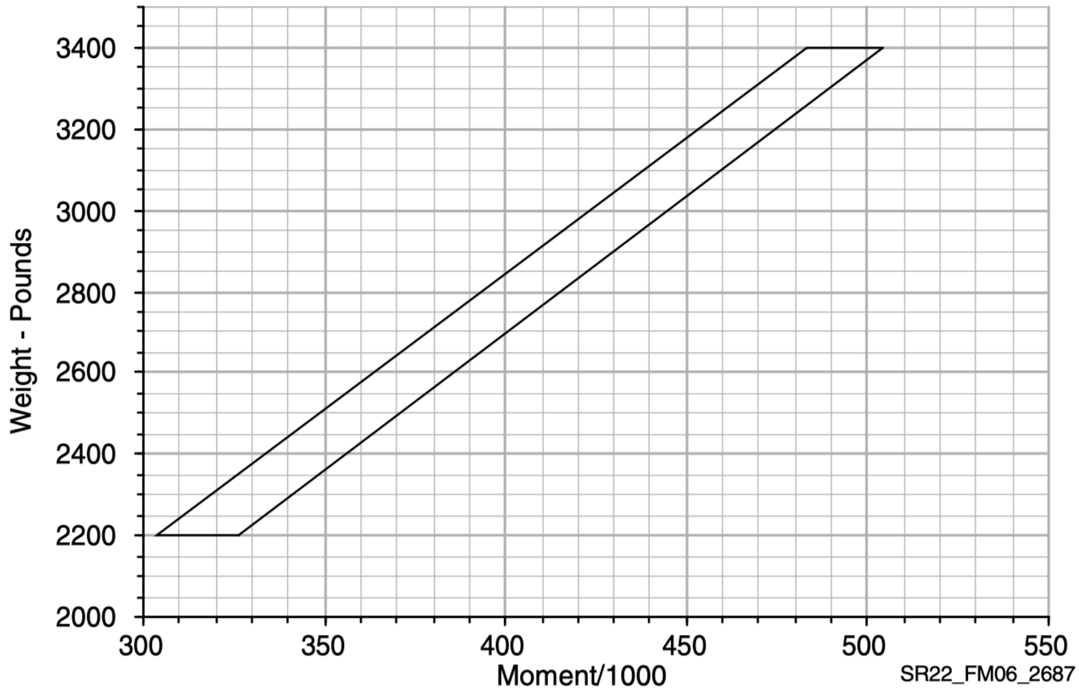
# Loading Form

Use the following form to determine the takeoff weight and moment.

| Item | Description | Weight LB | Moment/ 1000 |
|---|---|---|---|
| 1. | Basic Empty Weight<br>*Includes unusable fuel & full oil* | | |
| 2. | Front Seat Occupants<br>*Pilot & Passenger (total)* | | |
| 3. | Rear Seat Occupants | | |
| 4. | Baggage Area<br>*130 lb maximum* | | |
| 5. | Zero Fuel Condition Weight<br>*Sub total item 1 thru 4* | | |
| 6. | Fuel Loading<br>*92 Gallon @ 6.0 lb/gal. Maximum* | | |
| 7. | Ramp Condition Weight<br>*Sub total item 5 and 6* | | |
| 8. | Fuel for start, taxi, and run-up<br>*Normally 9 lb at average moment of 1394.* | – | – |
| 9. | Takeoff Condition Weight<br>*Subtract item 8 from item 7* | | |

# Moment Limits

Use the following chart or table to determine if the weight and moment from the completed Weight and Balance Loading Form are within limits.




| Weight | Moment/1000 | | Weight | Moment/1000 | |
|---|---|---|---|---|---|
| LB | Minimum | Maximum | LB | Minimum | Maximum |
| 2200 | 304 | 326 | 2850 | 398 | 422 |
| 2250 | 311 | 333 | 2900 | 406 | 430 |
| 2300 | 318 | 341 | 2950 | 414 | 437 |
| 2350 | 326 | 348 | 3000 | 421 | 444 |
| 2400 | 333 | 355 | 3050 | 429 | 452 |
| 2450 | 340 | 363 | 3100 | 437 | 459 |
| 2500 | 347 | 370 | 3150 | 444 | 467 |
| 2550 | 354 | 378 | 3200 | 452 | 474 |
| 2600 | 362 | 385 | 3250 | 460 | 481 |
| 2650 | 369 | 392 | 3300 | 467 | 489 |
| 2700 | 375 | 400 | 3350 | 475 | 496 |
| 2750 | 383 | 407 | 3400 | 483 | 504 |
| 2800 | 390 | 415 | | | |

# Section 7

# Tornado Alley Turbonormalizing System

## Table of Contents

# General

## Engine

The airplane is powered by Teledyne Continental Motors engine model IO-550-N, fuel-injected, direct drive, air-cooled, horizontally opposed, 6-cylinder, 550 cubic inch displacement, rated at 310 horsepower. The engine has been modified by the addition of the Tornado Alley Turbonormalizing System which provides 29 inches of manifold pressure to 25,000 feet.

## Airspeed Limitations

$V_{NE}$ up to 17,500 ft MSL ............ 200 KIAS / 204 KCAS

$V_{NE}$ at 25,000 ft MSL ............ 170 KIAS / 173 KCAS

$V_{NO}$ up to 17,500 ft MSL ............ 177 KIAS / 180 KCAS

$V_{NO}$ at 25,000 ft MSL ............ 151 KIAS / 153 KCAS

## Power Plant Limitations

> CAUTION
>
> Above FL200, do not reduce manifold pressure below FL/10 (ex. FL 250, 25" MP minimum) to avoid compressor surge.

Turbocharger Inlet Temperature (TIT) Max ............ 1750° F

Fuel Flow Max ............ 39 GPH

Manifold Pressure Max ............ 32.0 inHg

## Altitude Limits

Maximum Takeoff Altitude ............ 10,000 ft MSL

Maximum Operating Altitude ............ 25,000 ft MSL

# Normal Procedures

## Airspeeds for Normal Operation

Enroute Climb, Flaps Up ........ 120 KIAS

## Preflight Inspection

Perform Preflight Inspection per basic POH. Additionally, perform the following inspection:

Nose, Right and Left Sides: Grasp the end of each tailpipe where it exits the lower cowl area and confirm each is secure. If there is any indication that the tailpipe is not fully secure, repair before further flight. Do not fly the aircraft with a loose tailpipe.

## Starting Engine

*(Add to procedure)*

Electric Fuel Pump ........ LOW BOOST

> If the engine is warm priming is not required. On the first start of the day, especially under cool ambient conditions, holding the Fuel Pump switch to the HIGH BOOST/PRIME position for 2 seconds will improve starting.

Mixture ........ LEAN until RPM rises to a maximum

## Before Takeoff

*(Add to procedure)*

Electric Fuel Pump ........ LOW BOOST

> CAUTION
>
> Because this aircraft has a turbonormalizing system that maintains near sea level manifold pressure for all takeoffs, The mixture should normally be full rich for takeoff, even at high elevation airports. Leaning for takeoff and during maximum performance climb may cause excessive cylinder head temperatures.
>
> For maximum power operations (Power Lever full forward 2700 RPM, 29.6 in. Hg manifold pressure) fuel flow should be 35 to 36 GPH. On hot days takeoff performance will be improved slightly with the fuel flow at 34 GPH until clear of obstructions, then the fuel flow should be returned to the 35 to 36 GPH range.

## Takeoff

*(Add to procedure)*

Power Check:

- Check full-throttle engine operation early in takeoff run
- The engine should run smoothly and turn approximately 2700 rpm
- All engine parameters should read in the green

> MP may temporarily increase to 31 - 32 in Hg on first flight of the day due to cooler oil temperatures and associated higher oil pressures. This is acceptable under these conditions but normal full throttle should be 29.6 in. Hg. The fuel flow will normally also increase in proportion to the increase in manifold pressure. If manifold pressure exceeds 32 inches on takeoff or during full power climbs, reduce power to maintain no more than 32.0 in Hg.
>
> As the oil temperature increases during the climb the full power manifold pressure will steadily decline to a level near the normal 29.6 inches manifold pressure value at the top of the green arc. If the engine operates above 31.0 inches for more than two minutes after takeoff, then the system needs to be readjusted. During full power climbs or high power cruise with the oil temperature above 190° F, if the manifold pressure consistently exceeds 29.6 inches, then the system should be adjusted to reduce manifold pressure under these conditions.
>
> The electric Fuel Pump should be in the LOW BOOST position during takeoff and for climb. Leave the Fuel Pump in the LOW BOOST position for 30 minutes after leveling off after the climb to allow the temperature of the fuel in the tanks to stabilize. Above 18,000 feet, HIGH BOOST / PRIME may be required on hot days for vapor suppression.

## Climb

Oxygen .................................................. AS REQUIRED

Power Lever .................................................. FULL FORWARD

Mixture .................................................. FULL RICH

Airspeed .................................................. Vy

After reaching altitude, for noise abatement considerations

Below 7,500 ft .................................................. 120 KIAS

Above 7,500 ft .................................................. 130 KIAS

Electric Fuel Pump .................................................. LOW BOOST

Fuel Flow .................................................. MONITOR

During full power climb full, rich fuel flow may slowly decline from the normal sea level range of 35 to 36 GPH down to 33 GPH. This is acceptable, but will usually be corrected by use of LOW BOOST

(below 18,000 feet) or HIGH BOOST/PRIME (above 18,000 feet). If cylinder head temperatures consistently exceed 380°F, use higher airspeeds for better cooling.

Engine Parameters ........................................................................................................ MONITOR

To avoid excessive CHTs, verify electric Fuel Pump is in the LOW BOOST position. For increased engine life do not allow CHTs to continuously exceed 380°F. If any CHT consistently exceeds 380°F during the climb, lower the nose and increase airspeed as required to maintain the hottest CHT at or below 380°F whenever practical. Intermittent CHTs up to 410°F are not a concern. Maximum CHT value remains 460 °F.

## Cruise Climb - Mixture Lean of Peak

Cruise climb with the mixture lever set to a lean mixture setting (LOP) is acceptable provided CHTs remain under 380°F. This climb procedure may not be possible in very hot weather, but in moderate temperature conditions, LOP cruise climbs are sometimes useful, especially at altitudes up to 18,000 feet. Depending on aircraft weight and OAT, LOP cruise climbs will result in 600 to 700 FPM rates of climb at 130-140 KIAS. Above 18,000 feet, climbs should be made at full rich mixture as described in Climb Checklist.

Power Lever ........................................................................................................ FULL FORWARD

Mixture ........................................................................................................ 17.0 to 17.6 GPH

Minimum Airspeed ........................................................................................................ 130 KIAS

Electric Fuel Pump ........................................................................................................ LOW BOOST

If cylinder head temperatures consistently exceed 380°F, use higher airspeeds for better cooling, and/or make further reductions in fuel flow. If for any reasons, CHTs exceed 410°F, climbs should be made at full rich mixture as described in Climb Checklist.

> In icing conditions, lean of peak climb is prohibited; climb at full rich/full power and 120 KIAS until free of icing conditions. If climb performance is inadequate, higher climb rate will be observed at 100 KIAS. If performance necessitates a climb at less 120 KIAS, monitor cylinder head and oil temperatures.
>
> After exiting conditions, continued climb performance may be decreased due to accumulated ice, rich of peak/130 KIAS climb is recommended to cruise altitude if ice contamination is present; if climb performance is found inadequate, maintain airspeed above 100 KIAS and monitor Cylinder Head Temperatures.

## Use of High Boost / Prime

Under some extreme environmental conditions, the use of the electric fuel pump in the HIGH BOOST / PRIME position may be required in flight above 18,000 feet to adequately suppress vapor formation. This condition is most likely to occur during climbs above 18,000 feet on hot days with warm or hot fuel in the tanks. Except for aid in starting the engine, do not use HIGH BOOST / PRIME below 18,000 feet. Above 18,000 feet, if there is a loss of fuel flow or vapor locking is suspected, turn the electric fuel pump to HIGH BOOST /PRIME POSITION and reset the mixture as required to maintain adequate stable fuel flow. Vapor locking is most often indicated by any or a combination of the following:

- Fluctuations in normal fuel flow possibly coupled with abnormal engine operation;
- Rising EGTs and TIT coupled with falling fuel flow
- Rising CHTs (late in the process)

After the aircraft is in cruise flight for 30 minutes or more, the electric fuel pump should be returned to the LOW BOOST position or OFF, as conditions permit.

## During Climb, Cruise, and Descent

Oxygen ........................................................................................................................ AS REQUIRED

## Cruise Leaning

Normal cruise flight is accomplished with engine power settings between 65% and 85% power. The engine power setting and corresponding fuel consumption for various altitudes and temperatures can be determined by using the cruise performance data in Section 5.

Normal cruise power settings will be conducted with the mixture lever positioned to operate the engine with the mixture set lean of peak EGT or TIT.

- Maximum Cruise Power
  - Power Lever: Max available MAP at 2500 RPM
  - Mixture: 17.6 GPH (~85% Power)
  - High CHT below 380° F
- Economy Cruise Power
  - Power Lever - 24" MAP at 2500 RPM
  - Mixture 13.0 - 14.5 GPH (~63% - 69% Power)
  - High CHT below 380° F

> During colder weather, fuel flows towards the upper end of the cruise fuel flow ranges will be appropriate. If mixture set at 18.0 GPH (max allowable LOP cruise fuel flow) still creates rough running engine in cold weather conditions, reduce MAP as required to provide smooth running engine and readjust mixture as required. During hotter weather, fuel flows nearer to the middle or lower end of the cruise fuel flow ranges will be appropriate.

> Position the electric Fuel Pump to the LOW BOOST position when switching from one tank to another. Failure to activate the electric Fuel Pump before transfer could result in delayed restart if the engine should quit due to fuel starvation.

## Maximum Cruise Power

Cruise Altitude........ESTABLISHED

Power Lever........2700 RPM

Mixture........FULL RICH for 1 to 2 minutes

Highest CHT........VERIFY LESS THAN 380° F

Power Lever........2500 RPM at max available MAP (29.0” to 29.6”)

> After initial setting of the power lever to approximately 2500 RPM, some additional MAP may be obtained by slightly increasing the power lever until the RPM increases by 10 to 20 RPM.

Electric Fuel Pump........LOW BOOST

Mixture........FULL RICH, slowly REDUCE to 16.0 to 17.6 GPH

Engine Parameters........MONITOR

Electric Fuel Pump........AS REQUIRED

## Economy Cruise Power

Set power lever and mixture to high power cruise as described above. After the engine temperatures and power are stable, further reduce power lever until the MAP is approximately 24 to 26". This should result in a fuel flow in the 13 to 14.5 GPH range. While typically not required, provided that the engine continues to operate smoothly, the mixture may be further leaned for improved economy.

## Descent

*(add to procedure)*

Power........AS REQUIRED

- Avoid prolonged idle settings. Maintain a CHT of 240°F (116°C) or greater. Typically, no adjustment in the cruise mixture setting is required or appropriate.

## Rapid Descent

*(add to procedure)*

Power Lever........Smoothly REDUCE MAP 17 to 20 in.Hg

Mixture........Maintain CHTs above 240°F

## Before Landing

*(add to procedure)*

Electric Fuel Pump .................................... LOW BOOST

Mixture .................................... FULL RICH

## After Landing

*(add to procedure)*

Electric Fuel Pump .................................... OFF or LOW BOOST

Mixture .................................... LEAN to obtain maximum idle RPM

## Shutdown

*(add to procedure)*

Electric Fuel Pump (if used) .................................... OFF

# Emergency Procedures

## Unexpected Loss of Manifold Pressure

If for any reason the aircraft experiences an unexpected loss of normal manifold pressure the aircraft will typically revert to operation similar to a normally aspirated aircraft at approximately the same altitude. However, continued flight should only be conducted to the nearest suitable landing place in order to investigate the cause of the unexpected loss of normal manifold pressure.

Power....................................................Adjust

Mixture....................................................Adjust

> WARNING
>
> Remain alert for the possibility of a fire in the engine compartment. In the event of a fire in the engine compartment, perform the Engine Fire In Flight checklist.

Descend, to the minimum safe altitude from which a landing may be most safely and expeditiously accomplished, but leaving adequate altitude for a possible forced landing in the event of fire or complete loss of engine power.

Emergency....................................................Declare

Land....................................................As soon as practical

## Engine Failure In-Flight with Idle Power

Below 18,000 ft:

Retarding the power lever to idle at or near a full rich mixture setting may cause engine combustion to cease, depending on the position of the fuel pump and altitude. At altitudes below 18,000 feet, advancing the throttle should cause resumption of normal engine operation.

Retarding the power lever to idle at or near a very lean mixture setting may cause engine combustion to cease. This is most likely to occur when the RPM falls with decreasing airspeed on landing or roll out after landing. Using the boost pump in the LOW BOOST position during approach and landing will prevent this condition.

> WARNING
>
> Inadvertent use of the HIGH BOOST / PRIME position of the electric Fuel Pump, with the Power Lever near or in the idle position may prevent the engine from regaining power when the Power Lever is advanced

Above 18,000 ft:

The manifold pressure should be maintained at or above 15" Hg (bottom of the green arc on the manifold pressure gage) when the aircraft is operating above 18,000 feet. If the manifold pressure is reduced below 15" Hg and the Power Lever positioned close to or at idle, the engine may cease combustion. Upon advancing the Power Lever, if the wind milling engine does not immediately regain power, the following procedure should be used:

Electric Fuel Pump ........ LOW BOOST

Power Lever ........ ½ OPEN

Mixture Control ........ FULL RICH, then LEAN until engine starts, then FULL RICH

Power Lever ........ AS REQUIRED

Mixture ........ AS REQUIRED

Electric Fuel Pump ........ AS REQUIRED

## CAPS Deployment at High Altitudes

For any indicated airspeed, as altitudes increase the true air speed of the deployment increases. Higher true air speeds increase the parachute inflation loads. This makes it all the more important for the operator to take all reasonable efforts to slow to the minimum possible airspeed prior to deploying the CAPS.

# Performance

Performance of the airplane with the Tornado Alley Turbonormalizing System is equal to or better than the performance as listed in the basic manual. Except for the following tables refer to the basic manual.

## Cruise Performance

Power ........ As Noted

Mixture ........ As Noted

Cruise Weight ........ 3200 lbs

Winds ........ 0 kts

Monitor Cylinder Heat Temperatures, if any persistently exceeds 380°F, then LEAN the mixture further in 0.3 gph increments until all CHT's are under 380°F. As a rule of thumb, each 0.5 gph change in fuel flow when LOP, and near 380°F, will result in approximately a 15° F change in CHT. Increasing fuel flow will make the CHT hotter. Decreasing fuel flow will make the CHT cooler. It may take several minutes for the CHTs to fully stabilize after a change in fuel flow.

**2000 Feet Pressure Altitude**

| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-19° C) KTAS | ISA (11° C) KTAS | ISA + 30° C (41° C) KTAS |
|---|---|---|---|---|---|---|
| **29.0-29.5** | **2500** | 17.6 | 85% | 162 | 168 | 174 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 155 | 161 | 166 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 147 | 153 | 158 |

**4000 Feet Pressure Altitude**

| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-23° C) KTAS | ISA (7° C) KTAS | ISA + 30° C (37° C) KTAS |
|---|---|---|---|---|---|---|
| **29.0-29.5** | **2500** | 17.6 | 85% | 165 | 171 | 177 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 158 | 164 | 169 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 150 | 156 | 161 |

**6000 Feet Pressure Altitude**

| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-27° C) KTAS | ISA (3° C) KTAS | ISA + 30° C (33° C) KTAS |
|---|---|---|---|---|---|---|
| **29.0-29.5** | **2500** | 17.6 | 85% | 168 | 175 | 181 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 161 | 167 | 173 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 153 | 159 | 164 |

| 8000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-31° C) KTAS | ISA (-1° C) KTAS | ISA + 30° C (29° C) KTAS |
| **29.0-29.5** | **2500** | 17.6 | 85% | 172 | 178 | 184 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 164 | 170 | 176 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 156 | 162 | 167 |

| 10000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-35° C) KTAS | ISA (-5° C) KTAS | ISA + 30° C (25° C) KTAS |
| **29.0-29.5** | **2500** | 17.6 | 85% | 175 | 182 | 188 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 167 | 174 | 180 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 159 | 165 | 171 |

| 12000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-39° C) KTAS | ISA (-9° C) KTAS | ISA + 30° C (21° C) KTAS |
| **29.0-29.5** | **2500** | 17.6 | 85% | 178 | 186 | 194 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 171 | 177 | 184 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 162 | 168 | 174 |

| 14000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-43° C) KTAS | ISA (-13° C) KTAS | ISA + 30° C (17° C) KTAS |
| **29.0-29.5** | **2500** | 17.6 | 85% | 182 | 189 | 196 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 174 | 181 | 187 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 165 | 172 | 178 |

| 16000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-47° C) KTAS | ISA (-17° C) KTAS | ISA + 30° C (13° C) KTAS |
| **29.0-29.5** | **2500** | 17.6 | 85% | 186 | 193 | 200 |
| **26.0-28.0** | **2500** | 16.0 | 75% | 178 | 185 | 191 |
| **22.0-25.0** | **2500** | 14.0 | 65% | 169 | 175 | 182 |

| 18000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-51° C) KTAS | ISA (-21° C) KTAS | ISA + 30° C (9° C) KTAS |
| 29.0-29.5 | 2500 | 17.6 | 85% | 190 | 198 | 205 |
| 26.0-28.0 | 2500 | 16.0 | 75% | 181 | 189 | 196 |
| 22.0-25.0 | 2500 | 14.0 | 65% | 172 | 179 | 185 |

| 20000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-55° C) KTAS | ISA (-25° C) KTAS | ISA + 30° C (5° C) KTAS |
| 29.0-29.5 | 2500 | 17.6 | 85% | 193 | 201 | 209 |
| 29.0-29.5 | 2500 | 16.8 | 80% | 189 | 197 | 204 |
| 26.0-28.0 | 2500 | 16.0 | 75% | 185 | 192 | 199 |
| 22.0-25.0 | 2500 | 14.0 | 65% | 175 | 182 | 189 |

| 22000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-59° C) KTAS | ISA (-29° C) KTAS | ISA + 30° C (1° C) KTAS |
| 29.0-29.5 | 2500 | 17.6 | 85% | 197 | 205 | 213 |
| 29.0-29.5 | 2500 | 16.8 | 80% | 193 | 201 | 208 |
| 26.0-28.0 | 2500 | 16.0 | 75% | 188 | 196 | 203 |
| 22.0-25.0 | 2500 | 14.0 | 65% | 178 | 186 | 193 |

| 24000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-63° C) KTAS | ISA (-33° C) KTAS | ISA + 30° C (-3° C) KTAS |
| 29.0-29.5 | 2500 | 17.6 | 85% | 201 | 209 | 217 |
| 29.0-29.5 | 2500 | 16.8 | 80% | 196 | 205 | 212 |
| 26.0-28.0 | 2500 | 16.0 | 75% | 192 | 200 | 207 |
| 22.0-25.0 | 2500 | 14.0 | 65% | 182 | 189 | 196 |

| 25000 Feet Pressure Altitude | | | | | | |
|---|---|---|---|---|---|---|
| Manifold Pressure MAP | Engine Speed RPM | Fuel Flow GPH | Percent Power PWR | ISA - 30° C (-65° C) KTAS | ISA (-35° C) KTAS | ISA + 30° C (-5° C) KTAS |
| 29.0-29.5 | 2500 | 17.6 | 85% | 203 | 211 | 219 |
| 29.0-29.5 | 2500 | 16.8 | 80% | 198 | 207 | 215 |
| 26.0-28.0 | 2500 | 16.0 | 75% | 193 | 202 | 209 |
| 22.0-25.0 | 2500 | 14.0 | 65% | 183 | 191 | 198 |

## Range / Endurance Profile - LOP

Power........................................................ As Noted

Climb Technique ........................................................ Lean of Peak

Takeoff Weight ........................................................ 3400 lbs

Winds ........................................................ 0 kts

Total Fuel........................................................ 92 gal

Fuel Remaining for Cruise is equal to 92.0 gallons usable, less 1.5 gallons for taxi, less climb fuel, less 10.5 gallons for 45 minutes IFR reserve fuel at 60% Power.

| **85% POWER** (Lean of Peak Cruise Fuel Flow, LOP Climb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Press Alt FT** | **Climb Fuel Gal** | **Fuel Remaining For Cruise Gal** | **Airspeed KTAS** | **Fuel Flow GPH** | **Endurance Hours** | **Range NM** | **Specific Range Nm/Gal** |
| **2,000** | **0.8** | 79.2 | 168 | 17.6 | 4.5 | 763 | 9.6 |
| **4,000** | **1.7** | 78.3 | 171 | 17.6 | 4.5 | 776 | 9.7 |
| **6,000** | **2.5** | 77.5 | 175 | 17.6 | 4.4 | 789 | 9.9 |
| **8,000** | **3.5** | 76.5 | 178 | 17.6 | 4.3 | 803 | 10.1 |
| **10,000** | **4.4** | 75.6 | 182 | 17.6 | 4.3 | 817 | 10.3 |
| **12,000** | **5.4** | 74.6 | 186 | 17.6 | 4.2 | 831 | 10.5 |
| **14,000** | **6.5** | 73.5 | 189 | 17.6 | 4.2 | 846 | 10.8 |
| **16,000** | **7.6** | 72.4 | 193 | 17.6 | 4.1 | 861 | 11.0 |
| **18,000** | **8.8** | 71.2 | 198 | 17.6 | 4.0 | 876 | 11.2 |
| **20,000** | **10.6** | 69.4 | 201 | 17.6 | 3.9 | 880 | 11.4 |
| **22,000** | **12.5** | 67.5 | 205 | 17.6 | 3.8 | 883 | 11.7 |
| **24,000** | **14.6** | 65.4 | 209 | 17.6 | 3.7 | 885 | 11.9 |
| **25,000** | **15.7** | 64.3 | 211 | 17.6 | 3.7 | 886 | 12.0 |

| **75% POWER** (Lean of Peak Cruise Fuel Flow, LOP Climb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Press Alt FT** | **Climb Fuel Gal** | **Fuel Remaining For Cruise Gal** | **Airspeed KTAS** | **Fuel Flow GPH** | **Endurance Hours** | **Range NM** | **Specific Range Nm/Gal** |
| **2,000** | **0.8** | 79.2 | 161 | 16.0 | 4.9 | 802 | 10.0 |
| **4,000** | **1.7** | 78.3 | 164 | 16.0 | 4.9 | 815 | 10.2 |
| **6,000** | **2.5** | 77.5 | 167 | 16.0 | 4.8 | 829 | 10.4 |
| **8,000** | **3.5** | 76.5 | 170 | 16.0 | 4.8 | 843 | 10.7 |
| **10,000** | **4.4** | 75.6 | 174 | 16.0 | 4.7 | 857 | 10.9 |
| **12,000** | **5.4** | 74.6 | 177 | 16.0 | 4.7 | 872 | 11.1 |
| **14,000** | **6.5** | 73.5 | 181 | 16.0 | 4.6 | 887 | 11.3 |
| **16,000** | **7.6** | 72.4 | 185 | 16.0 | 4.5 | 902 | 11.6 |
| **18,000** | **8.8** | 71.2 | 189 | 16.0 | 4.4 | 917 | 11.8 |
| **20,000** | **10.6** | 69.4 | 192 | 16.0 | 4.3 | 921 | 12.0 |
| **22,000** | **12.5** | 67.5 | 196 | 16.0 | 4.2 | 923 | 12.3 |
| **24,000** | **14.6** | 65.4 | 200 | 16.0 | 4.1 | 925 | 12.5 |
| **25,000** | **15.7** | 64.3 | 202 | 16.0 | 4.0 | 925 | 12.6 |

| **65% POWER** (Lean of Peak Cruise Fuel Flow, LOP Climb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Press Alt FT** | **Climb Fuel Gal** | **Fuel Remaining For Cruise Gal** | **Airspeed KTAS** | **Fuel Flow GPH** | **Endurance Hours** | **Range NM** | **Specific Range Nm/Gal** |
| **2,000** | **0.8** | 79.2 | 153 | 14.0 | 5.7 | 870 | 10.9 |
| **4,000** | **1.7** | 78.3 | 156 | 14.0 | 5.6 | 884 | 11.1 |
| **6,000** | **2.5** | 77.5 | 159 | 14.0 | 5.5 | 898 | 11.3 |
| **8,000** | **3.5** | 76.5 | 162 | 14.0 | 5.5 | 913 | 11.6 |
| **10,000** | **4.4** | 75.6 | 165 | 14.0 | 5.4 | 927 | 11.8 |
| **12,000** | **5.4** | 74.6 | 168 | 14.0 | 5.3 | 942 | 12.0 |
| **14,000** | **6.5** | 73.5 | 172 | 14.0 | 5.2 | 957 | 12.3 |
| **16,000** | **7.6** | 72.4 | 175 | 14.0 | 5.2 | 972 | 12.5 |
| **18,000** | **8.8** | 71.2 | 179 | 14.0 | 5.1 | 988 | 12.8 |
| **20,000** | **10.6** | 69.4 | 182 | 14.0 | 5.0 | 990 | 13.0 |
| **22,000** | **12.5** | 67.5 | 186 | 14.0 | 4.8 | 992 | 13.3 |
| **24,000** | **14.6** | 65.4 | 189 | 14.0 | 4.7 | 992 | 13.5 |
| **25,000** | **15.7** | 64.3 | 191 | 14.0 | 4.6 | 992 | 13.6 |

## Range / Endurance Profile - ROP

Power ........ As Noted

Climb Technique ........ Rich of Peak

Takeoff Weight ........ 3400 lbs

Winds ........ 0 kts

Total Fuel ........ 92 gal

Fuel Remaining for Cruise is equal to 92.0 gallons usable, less 1.5 gallons for taxi, less climb fuel, less 10.5 gallons for 45 minutes IFR reserve fuel at 60% Power.

**85% POWER (Lean of Peak Cruise Fuel Flow, ROP Climb)**

| Press Alt FT | Climb Fuel Gal | Fuel Remaining For Cruise Gal | Airspeed KTAS | Fuel Flow GPH | Endurance Hours | Range NM | Specific Range Nm/Gal |
|---|---|---|---|---|---|---|---|
| 2,000 | 1.1 | 78.9 | 168 | 17.6 | 4.5 | 758 | 9.6 |
| 4,000 | 2.2 | 77.8 | 171 | 17.6 | 4.4 | 765 | 9.7 |
| 6,000 | 3.2 | 76.8 | 175 | 17.6 | 4.4 | 774 | 9.9 |
| 8,000 | 4.4 | 75.6 | 178 | 17.6 | 4.3 | 781 | 10.1 |
| 10,000 | 5.8 | 74.2 | 182 | 17.6 | 4.2 | 789 | 10.3 |
| 12,000 | 7.2 | 72.8 | 186 | 17.6 | 4.1 | 795 | 10.5 |
| 14,000 | 8.8 | 71.2 | 189 | 17.6 | 4.0 | 802 | 10.8 |
| 16,000 | 10.4 | 69.6 | 193 | 17.6 | 4.0 | 808 | 11.0 |
| 18,000 | 12.1 | 67.9 | 198 | 17.6 | 3.9 | 813 | 11.2 |
| 20,000 | 13.9 | 66.1 | 201 | 17.6 | 3.8 | 816 | 11.4 |
| 22,000 | 15.8 | 64.2 | 205 | 17.6 | 3.7 | 819 | 11.7 |
| 24,000 | 17.8 | 62.2 | 209 | 17.6 | 3.5 | 820 | 11.9 |
| 25,000 | 18.9 | 61.1 | 211 | 17.6 | 3.5 | 820 | 12.0 |

| **75% POWER** (Lean of Peak Cruise Fuel Flow, ROP Climb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Press Alt FT | Climb Fuel Gal | Fuel Remaining For Cruise Gal | Airspeed KTAS | Fuel Flow GPH | Endurance Hours | Range NM | Specific Range Nm/Gal |
| 2,000 | 1.1 | 78.9 | 161 | 16.0 | 4.9 | 797 | 10.0 |
| 4,000 | 2.2 | 77.8 | 164 | 16.0 | 4.9 | 805 | 10.2 |
| 6,000 | 3.2 | 76.8 | 167 | 16.0 | 4.8 | 813 | 10.4 |
| 8,000 | 4.4 | 75.6 | 170 | 16.0 | 4.7 | 821 | 10.7 |
| 10,000 | 5.8 | 74.2 | 174 | 16.0 | 4.6 | 828 | 10.9 |
| 12,000 | 7.2 | 72.8 | 177 | 16.0 | 4.5 | 835 | 11.1 |
| 14,000 | 8.8 | 71.2 | 181 | 16.0 | 4.5 | 841 | 11.3 |
| 16,000 | 10.4 | 69.6 | 185 | 16.0 | 4.4 | 847 | 11.6 |
| 18,000 | 12.1 | 67.9 | 189 | 16.0 | 4.2 | 852 | 11.8 |
| 20,000 | 13.9 | 66.1 | 192 | 16.0 | 4.1 | 855 | 12.0 |
| 22,000 | 15.8 | 64.2 | 196 | 16.0 | 4.0 | 857 | 12.3 |
| 24,000 | 17.8 | 62.2 | 200 | 16.0 | 3.9 | 857 | 12.5 |
| 25,000 | 18.9 | 61.1 | 202 | 16.0 | 3.8 | 857 | 12.6 |

| **65% POWER** (Lean of Peak Cruise Fuel Flow, ROP Climb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Press Alt FT | Climb Fuel Gal | Fuel Remaining For Cruise Gal | Airspeed KTAS | Fuel Flow GPH | Endurance Hours | Range NM | Specific Range Nm/Gal |
| 2,000 | 1.1 | 78.9 | 153 | 14.0 | 5.6 | 865 | 10.9 |
| 4,000 | 2.2 | 77.8 | 156 | 14.0 | 5.6 | 873 | 11.1 |
| 6,000 | 3.2 | 76.8 | 159 | 14.0 | 5.5 | 882 | 11.3 |
| 8,000 | 4.4 | 75.6 | 162 | 14.0 | 5.4 | 890 | 11.6 |
| 10,000 | 5.8 | 74.2 | 165 | 14.0 | 5.3 | 897 | 11.8 |
| 12,000 | 7.2 | 72.8 | 168 | 14.0 | 5.2 | 903 | 12.0 |
| 14,000 | 8.8 | 71.2 | 172 | 14.0 | 5.1 | 909 | 12.3 |
| 16,000 | 10.4 | 69.6 | 175 | 14.0 | 5.0 | 915 | 12.5 |
| 18,000 | 12.1 | 67.9 | 179 | 14.0 | 4.9 | 919 | 12.8 |
| 20,000 | 13.9 | 66.1 | 182 | 14.0 | 4.7 | 921 | 13.0 |
| 22,000 | 15.8 | 64.2 | 186 | 14.0 | 4.6 | 922 | 13.3 |
| 24,000 | 17.8 | 62.2 | 189 | 14.0 | 4.4 | 921 | 13.5 |
| 25,000 | 18.9 | 61.1 | 191 | 14.0 | 4.4 | 921 | 13.6 |

# System Description

## Turbonormalizing System

The Tornado Alley Turbonormalizing System utilizes two Kelly Aerospace (Formerly Garrett) turbochargers with a Kelly absolute manifold pressure controller, and a Kelly pressure relief valve. The turbochargers are new generation turbochargers designed to provide the same boost as older design turbochargers but with lower compressor discharge temperatures. This increase in efficiency is due to the improved design of the compressor blades and compressor housing. However, to further reduce engine induction temperatures, two side baffle mounted intercoolers are also installed in the system.

The absolute controller and wastegates work in conjunction with each other to provide proper boost pressure to the engine. The wastegate is actuated using engine oil pressure to actuate a small hydraulic cylinder which redirects the engine by-pass exhaust flow around the turbochargers. The absolute pressure controller utilizes an aneroid bellows and spring connected to a valve that regulates the amount of oil flowing out of the wastegate actuator hydraulic control cylinder. The aneroid bellows are located inside a housing that is connected to the output air produced by the compressors.

As compressor outlet pressure increases, the bellows are forced down, opening the normally closed oil control valve. When open, the valve allows metered oil to bypass the wastegate which, in turn, is spring loaded to the open position. Oil passing through the absolute controller is returned to the engine oil sump. The left hand wastegate is a master wastegate connected to a slave wastegate on the right side of the engine. The right hand wastegate is the same as the left hand wastegate, but is slaved to the hydraulic actuator on the left hand wastegate. The two wastegates are mechanically synchronized and move in parallel with each other.

Each wastegate incorporates a typical butterfly exhaust bypass valve. It is operated by a hydraulic actuator utilizing engine oil for operation. The wastegate is spring loaded to the open position. Increasing oil pressure from the engine causes the actuator to work against the spring to close the butterfly valve. The wastegate is located in the exhaust system ahead of the turbocharger turbine. As the butterfly valve opens, it allows exhaust gasses to bypass the turbocharger turbine, thereby controlling the speed and output of the turbocharger. The wastegate helps provide even control of the turbocharger speed and output so that the engine can maintain sea level manifold pressure well into the flight levels.

As turbocharger compressor outlet pressure rises, the aneroid bellows in the absolute pressure controller senses the increase in pressure. When at high engine speed and load and the proper absolute pressure is reached, the force on the aneroid bellows opens the normally closed metering valve. When the oil pressure in the waste gate actuator cylinder is lowered sufficiently, the waste gate actuator spring forces the mechanical linkage to open the waste gates. A portion of the exhaust gases then bypasses the turbocharger turbines, thus preventing further increase of turbocharger speed and holding the compressor outlet absolute pressure to the desired value. Conversely, at engine idle, the turbocharger runs slowly with low compressor pressure output; therefore, the low pressure applied to the aneroid bellows is not sufficient to affect the unseating of the normally closed metering valve. Consequently, engine oil pressure keeps the waste gates closed and all of the exhaust flows through the turbocharger turbine sections.

The system is equipped with a magnet latched ALTERNATE AIR DOOR on the left side of the induction system. When any restriction of the air filter is encountered, such as from ice or ice crystal formation, this door will open automatically. The MFD and PFD will provide a message alerting the pilot that the door is open. The door provides an alternate path for warm air from the lower side of the engine compartment to go to both turbochargers when the air filter becomes blocked. After the air filter blockage is removed, the alternate air door may be closed by simply retarding the power lever momentarily and the door will re-latch automatically. In some instances, if there is an unusual surge in engine power, especially at high altitude, the alternate air door may become unlatched. In that event, again, simply retarding the throttle momentarily will re-latch the alternate air door.