

Pilot's Operating Handbook and
FAA Approved Airplane Flight Manual
Supplement
for

Tornado Alley Turbonormalizing System

When Tornado Alley Turbonormalizing System is installed in the Cirrus Design SR22 in accordance with Supplemental Type Certificate Numbers SA10588SC and SE10589SC, this Supplement is applicable and must be inserted in the Supplements Section (Section 9) of the Cirrus Design SR22 Pilot's Operating Handbook. This document must be carried in the airplane at all times. Information in this supplement adds to, supersedes, or deletes information in the basic SR22 Pilot's Operating Handbook.

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• Note •

Noted effectivity "*Serials before G3 Wing*" indicates aircraft serials 1602, 1821, 1840, 1863 thru 2333, 2335 thru 2419, and 2421 thru 2437.

Noted effectivity "*Serials with G3 Wing*" indicates aircraft serials 2334, 2420, 2438 and subsequent.

Noted effectivity "*Serials with TKS Flight Into Know Ice (FIKI) Anti-Ice System*" indicates aircraft serials equipped with approved TKS Anti-Ice System and operated in accordance with Cirrus Design AFM Supplement 13772-134 Revision 1 or later.

This POH Supplement Change, dated Reissue 3: Nov 15, 2008, supersedes and replaces Reissue 2 of this POH Supplement dated May 7, 2008. Dates of original issue and reissue are:

Issued	Nov, 8 2006	Reissue 2	May 7, 2008
Reissue 1	Apr 3, 2007	Reissue 3	Nov 15, 2008

FAA Approved

Date NOV 15 2008


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Section 1 - 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.

Propeller

Hartzell

Propeller TypeConstant Speed, Three Blade
Model Number..... PHC-J3YF-1N/N7605
Diameter.....78.0"

Propeller TypeConstant Speed, Three Blade
Model Number..... PHC-J3YF-1RF/F7693DF(B)
Diameter.....78.0" (75.0" Minimum)

Propeller TypeConstant Speed, Three Blade
Model Number.....PHC-J3Y1F-1N/N7605(B)
Diameter.....78.0"

MT-Propeller

Propeller TypeConstant Speed, Three Blade
Model Number..... MTV-9-D/210-58 MTV-9-D/205-58
Diameter..... 210 cm (max) 200 cm (min)
Placards none

Symbols, Abbreviations and Terminology

Engine Power Terminology

TIT **Turbine Inlet Temperature** is the temperature measured in front of the first stage turbine nozzle valves.

Power Plant Limitations

Engine

Do not reduce manifold pressure below 15 inches when above 18,000 ft MSL.

Propeller

Hartzell

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

Model Number PHC-J3YF-1N/N7605

Diameter78.0" (76.5" Minimum)

Hartzell

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

Model Number PHC-J3YF-1RF/F7693DF(B)

Diameter78.0" (75.0" Minimum)

Instrument Markings

Instrument (Range)	Red Line	Green Arc	Yellow Arc	Red Line
	Minimum	Normal	Caution	Maximum
Turbocharger Inlet Temperature (TIT) (200 - 1800°F)	—	—	—	1750°F
Fuel Flow (0 – 40 U.S. Gal./Hr.)	—	10 - 36 GPH	36 - 39 GPH	39 GPH
Manifold Pressure (10 – 30 Inches Hg)	—	15.0 - 29.6 in.Hg	29.6 - 32.0 in.Hg	32.0 in.Hg

Section 3 - 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.

IMMEDIATE ACTION

Regardless of the cause, in the event (see “FURTHER INFORMATION”, below) of an unexpected loss of manifold pressure the pilot should immediately:

1. Power ADJUST
Adjust the power to the minimum power setting required for continued flight to a suitable landing location.
2. Mixture ADJUST
Adjust mixture so that EGTs are between 1300 and 1400 °F. Depending on the circumstances, this may require substantial re-adjustment (either richer or leaner) of the mixture after loss of manifold pressure.

• 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.

3. 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.
4. Declare an emergency when time and workload permit.
5. Land as soon as practical.

Continued on the following page.

FURTHER INFORMATION

The four most likely causes of a loss of manifold pressure are:

1. A leak or rupture at an induction system coupling or a loose or failed induction coupling hose clamp.

This condition does not usually present a significant hazard and can usually be repaired promptly at most repair facilities.

While this first condition is, by far, the most common cause of unexpected loss of manifold pressure, **any of the next three conditions may present an immediate hazard to continued safe flight.**

Because it is difficult for the pilot to distinguish between a simple induction system leak and any of the following three possible causes of an unexpected loss of manifold pressure, all unexpected losses of manifold pressure should be assumed to be one of the three following causes until proven otherwise.

2. A significant leak in the exhaust system.

An exhaust leak may present a possible fire hazard. Reducing power and adjusting the mixture as described reduces the possibility of an engine compartment fire.

3. A loss of oil pressure to the wastegate actuator due to a general loss of engine oil pressure.

Typically, this is caused by a failed oil line, oil line fitting, or oil pump. It takes 15 PSI of oil pressure to begin to close the wastegate and the wastegate will not be capable of fully closing and making rated manifold pressure at altitude unless there is approximately 45 PSI of engine oil pressure.

Unexpected loss of manifold pressure or failure to maintain normal full manifold pressure at altitude may be an early indication of an oil leak and impending further loss of oil pressure. Monitor oil pressure closely.

4. A failure of an internal component in the turbocharger.

If the pilot experiences a sudden loss of manifold pressure and later observes declining oil pressure, it is most likely due to a failure of an internal turbocharger component. If there is a loss of

oil pressure due to a failure of the turbocharger, engine oil may be vented through the tail pipe overboard. Over a period of a few minutes, the pilot may then see a reduction in oil pressure with the oil pressure eventually dropping into the 10 to 15 PSI range.

There is a check valve at the oil flow inlet to the turbocharger set at approximately 10 PSI. Thus, if engine oil pressure drops into this range, the oil flow overboard through the turbocharger should cease and the engine should be able to maintain minimal oil pressure which will allow the engine to operate as a normally aspirated engine for a limited period of time.

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.

Section 3A - Abnormal Procedures

Inadvertent Icing Encounter

I *Aircraft serial numbers not equipped with TKS Anti-Ice System (FIKI):* Flight into known icing conditions is prohibited. However, If icing is inadvertently encountered:

1. Pitot Heat ON
2. Exit icing conditions..... Turn back or change altitude.
3. Cabin Heat MAXIMUM
4. Windshield Defrost FULL OPEN

• Note •

Alternate induction air door will automatically open if required.

| *Serials with TKS Anti-Ice System (FIKI):* Dependant on duration and severity of icing conditions, induction air filter icing is possible. Alternate induction air door will open automatically if required; if open alternate induction door is annunciated, exit icing conditions as soon as possible.

Engine Failure In Flight-retarding Power Lever To Idle

Below 18,000 Feet

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 Feet

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:

1. Electric Fuel Pump..... LOW BOOST
2. Power Lever ½ OPEN
3. Mixture Control FULL RICH, then LEAN until engine starts
then slowly advance to FULL RICH
4. Power Lever AS REQUIRED
5. Mixture AS REQUIRED
6. Electric Fuel Pump..... AS REQUIRED

Section 4 - Normal Procedures

Airspeeds for Normal Operation

Enroute Climb, Flaps Up:

- Normal, Full Power, Full Rich Climb 120 KIAS

Preflight Inspection

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

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

• Note •

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.

After engine starts:

Mixture LEAN

until RPM rises to a maximum value,

Leave the mixture in this position during taxi and until run-up.

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.

• Note •

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

1. Oxygen AS REQUIRED
2. Power Lever FULL FORWARD
3. Mixture FULL RICH
4. Airspeed..... V_y

After reaching altitude, for noise abatement considerations

- Below 7,500 feet..... 120 KIAS
- Above 7,500 feet 130 KIAS

5. Electric Fuel Pump..... LOW BOOST
6. 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.

7. 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 Set at 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.

1. Power LeverFULL FORWARD
2. Mixture 17.0 to 17.6 GPH
3. Minimum Airspeed 130 KIAS
4. 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.*

• Note •

Serials with TKS Anti-Ice System (FIKI):

- 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

1. Oxygen AS REQUIRED
 - Check masks and/or cannulas for proper flow.

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.

Desired Cruise Setting	Configuration
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 to 14.5 GPH* (~63% to 69% Power) High CHT below 380°F

* If provided by integrated avionics, target fuel flow indicator may be used as an aid to set mixture (target fuel flow is a cyan mark on the fuel flow indicator and indicates fuel flow for ideal LOP air-fuel ratio).

• Caution •

For engine break-in, cruise at a minimum of 75% power until the engine has been operated for at least 25 hours or until oil consumption has stabilized. Operation at this higher power will ensure proper seating of the rings and is applicable to new engines, and engines in service following cylinder replacement or top overhaul of one or more cylinders. Engines may be operated LOP at 75% to 85% power during break-in, provided the CHTs remain below 380°F.

Avoid continuous operation with the fuel flow set between 18 GPH and 30 GPH with MAP above 26" Hg. This will cause unacceptably high CHTs. Intermittent or transient operation only is permitted in this fuel flow range at high MAP settings, and then only when all CHTs remain below 420°F (216°C)

• Note •

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

1. Cruise Altitude ESTABLISHED
2. Power Lever 2700 RPM
3. Mixture FULL RICH for 1 to 2 minutes
4. Highest CHT VERIFY LESS THAN 380°F
5. Power Lever 2500 RPM at max available MAP (29.0" to 29.6")

• Note •

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.

6. Electric Fuel Pump..... LOW BOOST
7. Mixture FULL RICH
smoothly reduce fuel flow over a period of 3 to 6 seconds to approximately 16.0 to 17.6 GPH at 2500 RPM at maximum available MAP (29.0" to 29.6")

Continued on the following page.

• Note •

During fuel flow reduction, a slight deceleration of the aircraft will occur as the mixture passes from rich of peak TIT to lean of peak TIT.

8. Engine Parameters MONITOR

If any CHT persistently exceeds 380° F, LEAN mixture further in 0.3 GPH increments until all CHT's are under 380°F. If, over time, all CHT's are consistently under 380° F, mixture may be increased in approximately 0.1 to 0.2 GPH increments for increased speed. During Lean of Peak cruise operation, fuel flow should not exceed 18.0 GPH under any conditions

• Note •

Generally, each 0.5 GPH change in fuel flow when lean of peak 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 CHT to stabilize after a change in fuel flow.

9. Electric Fuel Pump AS REQUIRED

After 30 minutes of cruise, note fuel flow, then turn electric fuel pump OFF and reset fuel flow to noted value. If fuel flow is not stable, set electric fuel pump to LOW BOOST, and reset fuel flow to noted value.

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

Section 6 - Weight and Balance

See basic POH, Section 6 - Weight and Balance for list of equipment.

Section 7 - 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.

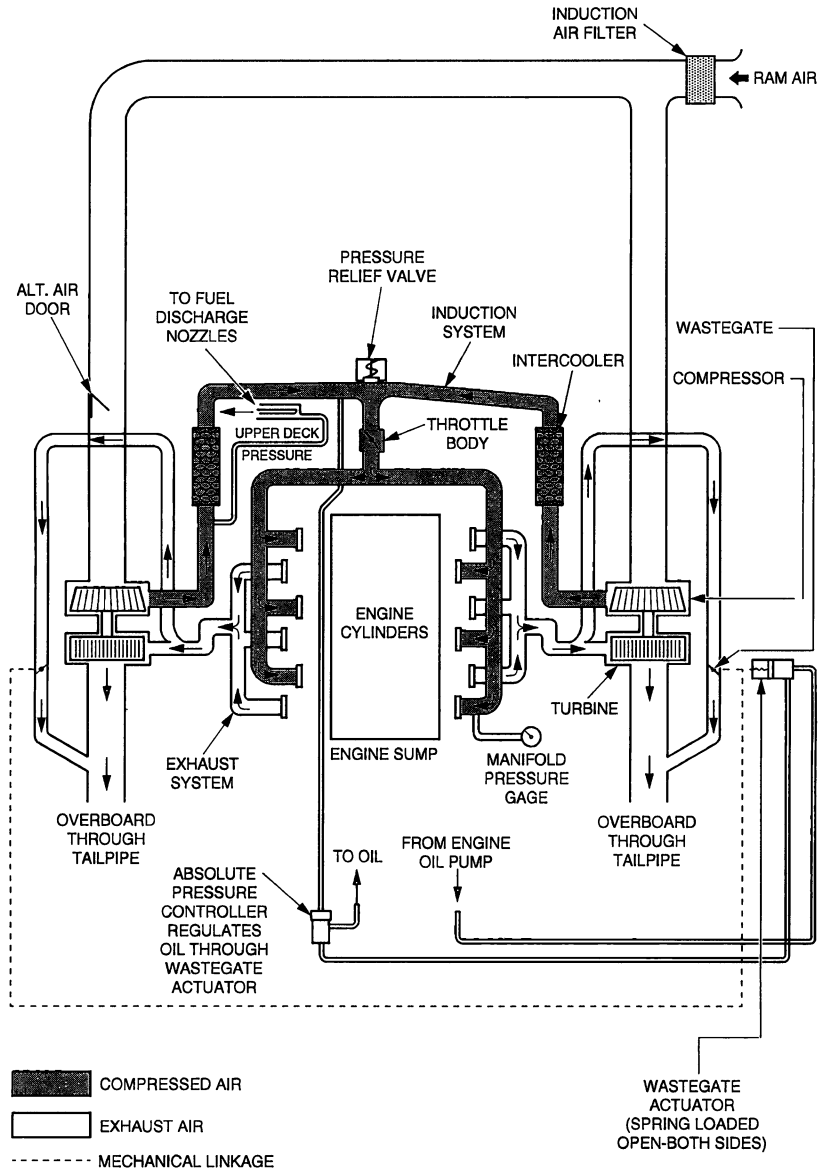
As compressor outlet pressure increases, the bellows are forced down, opening the normally closed oil control valve. When open, the valve allows metered oil to bypass the wastegate which, in turn, is spring loaded to the open position. Oil passing through the absolute controller is returned to the engine 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.



SR22_FM09_2484