Cardinal Cruiser™ System

Maintenance and Troubleshooting Manual

for

Turbonormalized Cessna 177RG Aircraft

Modified per STC's SA4081NM and SE4082NM

Instructions for Continued Airworthiness

This report applies to General Aviation Modifications Inc Cardinal Cruiser™ turbonormalizing systems per STC's SA4081NM and SE4082NM.

LOG OF REVISIONS

Pages	Revision	Date	Remarks
1-41	A	14 Oct 09	Initial Release
5, 6, 8, 18	B	12 Oct 11	Changes due to TAT SB11-07

Revisions

Lettered revisions of this document will be issued periodically. Each revision will cover the entire document. Changes to data in the previous revisions will be identified by revision bars in the outer margins of the pages. Change bars will be shown only against the immediate prior revisions. Extensive changes will not be accompanied by change bars but will be identified on Log of Revisions page under the Remarks section.

Revision Distribution

The latest revision of this document in its entirety will be posted at www.taturbo.com/drawings/

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Referenced Instructions for Continued Airworthiness and other Publications

The latest revision to the following publications should be used in conjunction with this manual:

Vendor	Manual Title	Part Number
Hartzell Engine Technologies (formerly Kelly Aerospace)	Kelly Aerospace Troubleshooting Reference Guide	400888-0000
GAMI	GAMIjector Installation Procedure	IP-98-002
Lycoming	Direct Drive Engine Overhaul Manual	60294-7
Lycoming	Troubleshooting Guide	SSP-475
Cessna	Aircraft Service Manual 1971 - 1975	D991-3-13
Cessna	Aircraft Service Manual 1976 - 1978	D2009-4-13

GAMI and TATI service instructions are available at www.taturbo.com/drawings/

TATI Bulletin, Letter, or Instruction Number	Subject	Notes/Compliance
TAT SB09-02	Reflow Fuel Injection Servo	Mandatory
TAT SB11-07	Fine wire spark plugs	Mandatory

AIRWORTHINESS LIMITATIONS

The Airworthiness Limitations Section is FAA approved and specifies inspection and maintenance required under paragraphs 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.

All fluid transfer hoses and the V-band clamps are to be replaced per the schedule shown below:

Item		Replacement Interval	Notes
1.	Flexible Turbo System Fluid Carrying Lines	Every 10 years	Flexible fluid carrying lines used in the turbonormalizing system are Teflon lined with integral firesleeve per TSO C53a Type D. Replace with same style hoses.
2.	V-band clamp	Upon accumulating 400 hours time-in-service (TIS) after incorporating STC's SA4081NM and SE4082NM on the airplane and thereafter at intervals not to exceed 400 hours TIS	See AD 2001-08-08 for reference

A. There are no other limiting inspections and/or maintenance items.

FAA Approved_____________________________Date___________

TURBONORMALIZER SYSTEM DESCRIPTION AND OPERATION

The Tornado Alley Turbonormalizing System utilizes one Kelly Aerospace turbocharger with a Kelly Absolute Pressure Controller, and a Kelly pressure relief valve. The turbocharger is a new generation turbocharger 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, a firewall mounted intercooler is also installed in the system.

The Absolute Pressure Controller and wastegate 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 turbocharger. 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 turbocharger compressor outlet pressure increases, the normally closed oil control valve opens. 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 wastegate incorporates a typical butterfly exhaust bypass valve. 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 parallel with 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 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 wastegate actuator cylinder is lowered sufficiently, the wastegate actuator spring forces the mechanical linkage to open the wastegate. A portion of the exhaust gases then bypasses the turbocharger turbine, 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 wastegates closed and all of the exhaust flows through the turbocharger turbine section.

The system is equipped with a spring loaded alternate air door on the back side of the induction air box. When any restriction of the air filter is encountered, such as from ice or ice crystal formation, the alternate air door will open automatically. The alternate air door provides a path for warm air from the lower side of the engine compartment to go to the turbocharger when the air filter becomes blocked. After the air filter blockage is removed, the alternate air door will close automatically.

TROUBLESHOOTING

To facilitate troubleshooting, the following information provides an explanation of how the turbonormalizer system works and points out some of the items that are affected by turbonormalizing.

The information below follows the induction air as it enters and passes through the engine until it is expelled as exhaust gases.

- Engine induction air is taken in through an opening in the nose bowl, ducted through a filter and into the turbocharger compressor where it is compressed.
- The pressurized induction air then passes through an intercooler (if equipped with an intercooler), then the fuel injection servo, and finally, the induction manifold into the cylinders.
- The air and fuel are burned and exhausted to the turbocharger turbine.
- The exhaust gases drive the turbine which, in turn, drives the compressor, thus completing the cycle.

The compressor has the capability of producing manifold pressure in excess of 29.6 in. Hg. In order to maintain 29.6 inches of manifold pressure, a wastegate is used on the exhaust so that some of the exhaust from the cylinders will bypass the turbine and be vented into the tailpipe.

It can be seen from studying the bulleted items above that anything which affects the flow of induction air into the compressor or the flow of exhaust gases into the turbine will increase or decrease the speed of the turbine. A wastegate controller automatically maintains maximum allowable compressor discharge pressure anytime the turbine and compressor are capable of producing that pressure.

At high altitude, part throttle, or low RPM, the exhaust flow is not capable of turning the turbine and compressor fast enough to maintain maximum compressor discharge pressure, and the wastegate will close to force all of the exhaust flow through the turbine. In normal operation at full throttle the wastegate will seldom if ever be fully closed.

When the wastegate is fully closed, any change in turbocharger speed will mean a change in engine operation. Thus, any increase or decrease in turbine speed will cause an increase or decrease in manifold pressure and fuel flow. If turbine speed increases, the manifold pressure increases; if the turbine speed decreases, the manifold pressure decreases. Since the compression ratio approaches 3 to 1 at high altitude, any change in exhaust flow to the turbine or ram induction air pressure will be magnified proportionally by the compressor pressure ratio and the change in flow through the exhaust system.

A. Momentary Overshoot Of Manifold Pressure

Under some circumstances (such as rapid throttle movement especially with cold oil) it is possible that the engine can slightly overboost.

This would most likely be experienced during takeoff roll or during a change to full throttle operation in flight.

A slight overboost to 32.0 inches of manifold pressure is not considered detrimental to the engine as long as it’s duration is less than 2 minutes. No corrective action is required when momentary overboost corrects itself and is followed by normal engine operation as the engine warms up. However, if overboosting of this nature persists when oil temperature is normal or if the amount of overboost tends to exceed 3 inches or more, the throttle should be retarded to eliminate the overboost and the controller system including the wastegate and relief valve, should be checked for necessary adjustment or replacement of components.

This troubleshooting section primarily references items covered for the turbonormalizing system. If it is not covered in this chart see appropriate Cessna or Lycoming troubleshooting documents.

Trouble	Probable Cause	Remedy
Engine will not start.	No indication of fuel flow and no fuel to engine.	Check fuel controls for proper position, auxiliary fuel pump "BOOST" and operating, fuel valve open, mixture full rich, throttle open, fuel filters open and visually check fuel tank level.
	Positive indication of fuel flow and engine is flooded.	Perform a Flooded Engine Start.
	Positive indication of fuel flow, but no fuel to engine.	Check for bent or loose fuel lines. Check for fuel at a fuel nozzle. If no fuel present at nozzle consult Lycoming Direct Drive Engine Overhaul Manual.
Engine starts but dies or will not idle properly.	Vaporized fuel in system. (Most likely to occur in hot weather with a hot engine.)	Refer to Hot Start Procedure.
	Obstructed air intake.	Remove obstruction; service air filter.
	Inadequate fuel to fuel manifold valve.	Set fuel control in "FULL RICH" position, turn auxiliary fuel pump "BOOST" check to be sure feed lines and filters are not restricted. Clean or replace defective components.
	Upper deck air supply to fuel discharge nozzle restricted or defective.	Check for bent lines or loose connections. Tighten loose connections. Remove restrictions and replace defective components.
	Defective ignition system.	Check engine data and verify which cylinders are affected by drop in EGT during single magneto operation. Check the spark plug and ignition lead indicated by which cylinder EGT drops on the operating magneto.
	Defective engine.	Check compression and listen for unusual engine noises. Check oil filter for excessive metal. Repair engine as required.

Trouble	Probable Cause	Remedy
Engine Has Poor Acceleration.	Fouled spark plugs.	Check engine data and verify which cylinders are affected by drop in EGT during single magneto operation. Check the spark plug and ignition lead indicated by which cylinder EGT drops on the operating magneto.
	Idle mixture too lean.	Readjust idle setting per Lycoming Direct Drive Engines Overhaul Manual.
	Incorrect fuel-air mixture, worn control linkage, or restricted air filter.	Tighten loose connections, replace worn elements of linkage. Service air filter.
Engine lacks power, reduction in maximum manifold pressure or critical altitude.	Incorrectly adjusted throttle control, "sticky" linkage or dirty air filter.	Check movement of linkage by moving control from idle to full throttle. Make proper adjustments and replace worn components. Service air filter.
	Defective ignition system.	Replace the defective parts. Check engine data and verify which cylinders are affected by drop in EGT during single magneto operation. Check the spark plug and ignition lead indicated by which cylinder EGT drops on the operating magneto.
	Improperly adjusted wastegate.	Adjust wastegate.
	Wastegate capillary tube plugged.	Disconnect lines from controller to master wastegate and back flush Wastegate and lines with oil compatible solvent at 50 psi.
	Loose or damaged exhaust system.	Inspect entire exhaust system to turbonormalizer for cracks and leaking connections. Tighten connections and replace damaged parts.
	Loose or damaged intake manifolding.	Inspect entire manifolding system for possible leakage at connections. Replace damaged components, tighten all connections and clamps.
	Restricted fuel discharge nozzles.	Look at engine data and check fuel discharge nozzle that is indicated by higher than usual EGT and CHT at full power and full rich mixture.

Trouble	Probable Cause	Remedy
(Continued) Engine lacks power, reduction in maximum manifold pressure or critical altitude.	Malfunctioning turbocharger.	Check for unusual noise in turbocharger. If malfunction is suspected remove tailpipe and/or air inlet connections and check rotor assembly for possible rubbing in housing, damaged rotor blades or defective bearings. Replace turbocharger if damage is noted.
	Turbocharger inlet blocked.	Remove obstruction.
	Fuel discharge nozzle defective.	Inspect fuel discharge nozzle vent manifolding for leaking connections. Tighten and repair as required. Check for restricted nozzles and lines and clean and replace as necessary.
	Absolute Pressure Controller not getting enough oil pressure to close the wastegate.	Check oil pump outlet pressure, oil filter and external lines for obstructions. Clean lines and replace if defective. Replace oil filter.
	Absolute Pressure Controller out of adjustment or defective.	Adjust Absolute Pressure Controller or replace controller if defective.
	Defective Wastegate actuator.	Replace wastegate actuator.
Engine smokes (white smoke).	Defective scavenge pump.	Replace scavenge pump if defective.
	Master wastegate actuator leaking oil.	Replace Master wastegate actuator.
	Turbo drain line (oil return to scavenge pump) plugged.	Clean line and check valve. Replace either if defective.
	Turbocharger jammed.	Replace turbocharger.
	Turbocharger bearing seals leaking.	Replace turbocharger.
Engine smokes (black smoke).	Black smoke only below 1200 RPM idle rise too rich.	Adjust idle mixture rise.
	Black smoke only above 1200 RPM.	Adjust fuel servo.
Engine surges.	Defective Absolute Pressure Controller.	Replace Absolute Pressure Controller if defective.
	Wastegate actuator linkage binding.	Lubricate and adjust wastegate. Replace wastegate if defective.

Trouble	Probable Cause	Remedy
Engine Power Increases Slowly Or Severe Manifold Pressure Fluctuations When Throttle Advanced.	Pressure relief valve out of adjustment or defective.	Replace Pressure relief valve if defective.
	Wastegate operation is sluggish.	Lubricate and adjust wastegate. Correct cause of sluggish operation. Replace Wastegate if defective.
Engine Power Increases Rapidly And Manifold Pressure Overboosts When Throttle Advanced.	Oil temperature not to operating standards.	Warm up oil temperature and try again.
	Wastegate operation is sluggish.	Lubricate and adjust wastegate. Replace Wastegate if defective.
	Throttle advanced too rapidly.	Advance throttle smoothly.
	Verify oil pressure is in proper operating limits.	Adjust oil pressure to proper limits per Lycoming Direct Drive Engine Overhaul Manual.
	Pressure relief valve out of adjustment or defective.	Factory adjustments required or replace pressure relief valve if defective.
High Cylinder Head Temperature.	Defective cylinder head temperature indication.	Verify connections. If connected properly replace CHT probe.
	Engine timing incorrectly set.	Reset timing to correct setting.
	Restricted fuel discharge nozzle.	Perform GAMI lean test to identify problem nozzle and replace or clean as appropriate.
	Engine baffles loose, or heat shields bent or missing.	Install baffles or heat shields properly. Repair or replace if defective.
	LOP ops with insufficient manifold pressure or excessive fuel flow.	Review downloaded engine data to verify correct operating technique per the AFMS is being used.
	Debris accumulated on cylinder cooling fins.	Clean fins thoroughly.
Engine will not deliver rated power.	See "Low manifold pressure at take-off" below.	
	Turbocharger rotating assembly bearing seizure.	Free rotating assembly per Kelly Aerospace Troubleshooting Reference Guide.

Trouble	Probable Cause	Remedy
Engine Has Poor Acceleration, Runs Rough At Speeds Above Idle Or Lacks Power.	Improper fuel-air mixture.	Review downloaded engine data to verify correct operating technique per the AFMS is being used. Check intake manifold connections for leaks. Check fuel controls and linkage for setting and adjustment. Replace worn elements of control linkage. Service air filter.
	Loose hose connections.	Tighten loose connections.
	Turbocharger rotor rubbing.	Replace Turbocharger.
	Improperly adjusted or defective Absolute Pressure Controller.	Adjust or replace Absolute Pressure Controller as required.
	Leak in turbonormalizer induction system.	Correct cause of leaks. Repair or replace damaged parts.
	Engine oil viscosity too high for ambient air temperature.	Replace oil with proper grade of oil.
	Exhaust system leakage.	Inspect and repair excessive exhaust leaks.
	Ignition system defective.	Check engine data and verify which cylinders are affected by drop in EGT during single magneto operation. Check the spark plug and ignition lead indicated by which cylinder EGT drops on the operating magneto. Replace damaged or misfiring plugs.
	Restricted fuel discharge nozzles.	Look at engine data and check fuel discharge nozzle that is indicated by higher than usual EGT and CHT at full power and full rich mixture.
High manifold pressure.	Manifold pressure gage is not functioning properly.	Check that the manifold pressure gage reads the same as field barometric pressure with the engine not operating. (This is not the altimeter setting).
	Manifold pressure overshoot. (Most likely to occur when engine is accelerated too rapidly.)	Smoothly move throttle about two-thirds open. Let engine accelerate and stabilize. Smoothly move throttle to full open.

Trouble	Probable Cause	Remedy
Manifold pressure is high and stays high after engine is warm.	Absolute Pressure Controller sensing line broken or loose.	Check upper deck sense line is connected and tight or replace if needed.
	Absolute Pressure Controller out of adjustment or defective.	Adjust Absolute Pressure Controller or replace controller if defective.
	Wastegate not functioning.	Lubricate and adjust wastegate. Replace wastegate if defective.
	Absolute Pressure Controller sensing line blocked.	Remove blockage.
Low fuel flow.	Malfunctioning engine driven fuel pump.	Replace engine driven fuel pump.
	Restricted flow to fuel metering valve.	Check mixture control for full travel. Check for restrictions in fuel filters and lines, adjust control and clean filters. Replace damaged parts.
	Fuel control lever interference or out of adjustment.	Check operation of throttle and mixture control for possible interference with other components. Adjust as required to obtain correct operation.
	Incorrect fuel injection servo adjustment and operation.	Check and adjust fuel flow. Fuel injection servo may need to be sent to Tornado Alley Turbo Inc for proper flow bench adjustment per STC.
Fluctuating fuel flow.	Fuel flow transducer or wiring failing.	Verify this by determining if EGT's fluctuate with fuel flow. If EGT's do not fluctuate replace fuel flow transducer or repair wiring.
	Interference from ignition system.	Operate engine on single magneto and identify which magneto is causing the interference.
	Manifold pressure fluctuating.	Troubleshoot fluctuating manifold pressure.
Unsatisfactory engine idle cut-off.	Engine getting fuel with mixture in "IDLE CUT-OFF".	Adjust fuel control not in full "IDLE CUT-OFF" position. Check auxiliary fuel pump "OFF". Check for leaking fuel manifold valve. Replace defective components.

Trouble	Probable Cause	Remedy
Low engine oil pressure or high oil temperature.	Insufficient oil in oil sump or using improper grade oil for prevailing ambient temperature.	Add oil, or change oil to proper viscosity.
	Oil cooler restriction.	Clean oil cooler.
	Debris under oil pressure relief valve.	Check oil pressure adjuster seat for debris.
	Leaking, damaged, or loose oil line connection. Restricted screen or filter.	Check for restricted lines and loose connections and cut the oil filter and inspect for contaminates or for partially plugged oil filter. Clean parts, tighten connections and replace defective parts.
	Oil pressure adjusted too low.	Readjust oil pressure if necessary.
Malfunctioning Turbocharger.	Turbocharger rotor jammed or rubbing.	Replace turbocharger.
	Turbocharger inlet blocked.	Remove blockage.
	See section "Engine lacks power, reduction in maximum manifold pressure or critical altitude."	
Engine has low critical altitude.	See section "Engine lacks power, reduction in maximum manifold pressure or critical altitude."	
Manifold pressure surges at altitude.	Absolute Pressure Controller malfunctioning.	Replace Absolute Pressure Controller.
	Wastegate capillary tube plugged.	Disconnect lines from controller to wastegate and back flush wastegate and lines with oil compatible solvent at 50 psi.
	Absolute Pressure Controller sensing line blocked.	Remove sense line blockage.
	Induction system leaking.	Tighten all connections in induction system.
	Leak in exhaust system.	Adjust or repair exhaust system.
Oil leaking or dripping from wastegate actuator drain.	Acceptable drip.	Continue monitoring drip.
	Actuator piston seal ruptured or leaking.	Replace Actuator.
Low manifold pressure at take-off.	Absolute Pressure Controller out of adjustment or defective.	Adjust Absolute Pressure Controller or replace controller if defective.
	Induction system leaking.	Adjust or repair induction system.
	Wastegate capillary tube plugged.	Disconnect lines from controller to master wastegate and back flush wastegate and lines with oil compatible solvent at 50 psi.
	Leak in exhaust system.	Eliminate any leaks.

MAINTENANCE PRACTICES

TIME LIMITS AND MAINTENANCE CHECKS

A. Overhaul And Replacement Schedule

The following items must be overhauled or replaced at the following intervals unless otherwise noted. To ensure correct observation of these times, the date of removal, installation, or overhaul of such components as well as the airplane's flight hours must be entered into the Service Time Record filed in the Airplane Maintenance Log.

Item		Interval	Replc.	O'haul	Notes
1.	Flexible Turbo System Lines	On condition not to exceed 10 years	X		
2.	Turbocharger	See Note		X	Recommend overhaul turbocharger at 1000 hrs not to exceed 2000 hrs.
3.	Wastegate	See Note		X	Recommend overhaul Wastegate at 1000 hrs not to exceed 2000 hrs.
4.	Absolute Pressure Controller	See Note		X	Recommend overhaul Absolute Pressure Controller at 1000 hrs not to exceed 2000 hrs.
5.	V-band clamps	450 hrs time in service	X		After 350 hrs if clamp is removed or first annual after 350 hrs, whichever occurs first.
6.	Magneto Pressurization Filter	3 years or 300 hours.	X		

B. Scheduled Maintenance Checks

Airframe Group		Chap-Sect Reference	Interval		Initials
			100	Special	
1.	All external surfaces for signs of exhaust leaks: Flat gray, gray-white or light gray powdering, or a sooty appearance indicate exhaust leakage. Signs of deterioration include warping, deformation, thinning, collapse, dents, cracking, tears, separation, scaling, weld separation, discoloration, corrosion, metal pitting or burn-through.		X	1st 25 Hrs and every 50 Hrs after.	
2.	All external joints, clamps, and couplings for misalignment, warpage, broken, loose or missing fasteners, clamps, and abnormal wear.		X	1st 25 Hrs	
3.	Visually inspect tailpipe heat exchanger, and shields for condition.		X	1st 25 Hrs	
4.	Visually inspect exhaust stack to flange interface for cracks in welds or weld heat affected area, blown out or missing gaskets.		X	1st 25 Hrs	

Airframe Group		Chap-Sect Reference	Interval		Initials
			100	Special	
5.	Visually inspect all welds and area adjacent to the weld for cracks or weld separation.		X	1st 25 Hrs	
6.	Visually inspect tailpipes, for erosion, thinning, bulging or burn through.		X	1st 25 Hrs	
7.	Visually inspect bracing, supports and support attach lugs on other structures for security.		X	1st 25 Hrs	
8.	Visually inspect surrounding structures for discoloration, heat damage, or burning.		X	1st 25 Hrs	
9.	Cold and Hot Air Hoses Visually Inspect for leaks, security, and condition.			50 Hrs	
10.	Engine Baffling and Seals Visual Inspection for cracks, tears, and rips.			50 Hrs	
11.	Turbocharger Mounting Bracket Visually Inspect for security and condition.			50 Hrs	
12.	Engine Heat Shields Visually Inspect for security and condition.			50 Hrs	
13.	Engine Mount Isolators Visually Inspect for cracking, splitting, and general condition.		X		
14.	Turbonormalizer Visually Inspect turbine for oil deposits, and turbine impeller damage. Visually Inspect compressor wheel for damage, interference, and free rotation. (Inspection may be accomplished by flexible bore scope or by removal of tailpipe.)	Kelly Aerospace Troubleshooting Reference Guide 400888-0000	X		
15.	Turbonormalizer System Lines Visually Inspect for chafing, obstruction, security, and general condition.		X		
16.	Wastegate and Absolute Pressure Controller Visually Inspect for security and condition.		X		
17.	Exhaust Heat Exchanger Pressure test inspection of exhaust heat exchanger for signs of cracking. Repair or replace on condition.		X		
19.	Induction System Filter Clean filter at each inspection period or when filter is more than 50% covered by foreign material. (Due at annual or on condition, not less than each annual.)	Clean per Cessna 177RG Service Manual.	X		
20.	Alternate Air Door Visually Inspect for secure closing. Check for loose fasteners or rivets that may enter turbocharger. Clean area around alternate air door.		X		

All service interval times are to be referenced from initial installation of system or overhaul of turbonormalizing system, or after replacement of major exhaust components.

	Engine Group	Chap-Sect Reference	Interval		Initials
			100	Special	
1.	Engine Oil Drain and change every 50 hours or 6 months, whichever occurs first.			50 Hrs	
2.	Fuel Injection System Visually Inspect for leaks, security, and condition			50 Hrs	
3.	Vent Lines to Fuel Pump and Fuel Discharge Nozzles Visually Inspect for chafing, obstruction, security, and general condition.			50 Hrs	
4.	Fuel Discharge Nozzles Visually Inspect nozzles and manifold valve for fuel stains, security, and proper sealing of upper deck reference manifolds. Remove and clean injector nozzles every 5 years or 500 hours, whichever comes first. Remove, clean, and replace per GAMI Installation Procedure No. IP-98-002.	GAMI Installation Procedure No. IP-98-002	X	On Condition	
5.	Spark Plugs Replace RHB36S and RHB32S spark plugs, if equipped, with RHB29E or equivalent heat range massive electrode spark plugs per TAT SB11-07. If RHB29E spark plugs are not available RHB32E or equivalent heat range massive electrode spark plugs are acceptable.	TAT SB11-07		Initially per TAT SB11-07 Thereafter, On Condition	

C. **Progressive Inspection Program**
The following inspections are to be performed in addition to the Routine and detailed Inspection for the Engine Group of a typical Progressive Inspection Program.

Engine Group Routine Inspection Criteria		Chap-Sect Reference
1.	Induction System Hoses and Couplings Visually Inspect for security, leaks, and condition.	
2.	Turbocharger Visual inspection of turbine for carbonization, oil deposits, and turbine impeller damage. Visually Inspect compressor wheel for damage, interference, and free rotation.	
3.	Turbocharger Mounting Brackets Visually Inspect for security and condition.	
4.	Flexible Turbo System Lines Visually Inspect for chafing, obstruction, security, and general condition.	
5.	Wastegate and Absolute Pressure Controller Visually Inspect for security and condition.	
6.	Vent Lines to Fuel Pump and Discharge Nozzles Visually Inspect for chafing, obstruction, security, and general condition.	
7.	Engine Heat Shields Visually Inspect for security and condition.	
8.	Exhaust Muffler/Heat Exchanger Borescopic inspection of tailpipe sections adjacent to heat exchanger for signs of cracking. Repair or replace on condition.	

Engine Group Detailed Inspection Criteria		Chap-Sect Reference
1.	Induction System Hoses and Couplings Visually Inspect for security, leaks, and condition. Tighten hose clamps as required.	
2.	Turbocharger Visually Inspect turbine for carbonization, oil deposits, and turbine impeller damage. Visually Inspect compressor wheel for damage, interference, and free rotation.	Kelly Aerospace Troubleshooting Reference Guide 400888-0000
3.	Turbocharger Mounting Brackets Visually Inspect for security and condition. Replace any cracked or damaged brackets.	
4.	Flexible Turbo System Lines Visually Inspect for chafing, obstruction, security, and general condition.	
5.	Wastegate and Absolute Pressure Controller Visually Inspect for security and condition. Lubricate wastegate butterfly with Mouse Milk®	
6.	Vent Lines to Fuel Discharge Nozzles Visually Inspect for chafing, obstruction, security, and general condition.	
7.	Engine Heat Shields Visually Inspect for security and condition.	
8.	Exhaust Heat Exchanger Pressure test heat exchanger for signs of cracking. Repair or replace on condition.	

TURBOCHARGERS

The turbocharger is an exhaust gas driven compressor, or air pump, which provides high air mass flow to the engine intake manifold. The turbocharger is composed of a turbine wheel, compressor wheel, turbine housing and compressor housing. The turbine, compressor wheel, and interconnecting drive shaft comprise one complete assembly and are the only moving parts in the turbocharger. Turbocharger bearings are lubricated with filtered oil supplied from the engine oil system. Engine exhaust gas enters the turbine housing to drive the turbine wheel. The turbine wheel, in turn, drives the compressor wheel, producing high density air entering the engine induction manifold. Exhaust gas is then dumped overboard through the exhaust outlet of the turbine housing and exhaust tailpipe. Air is drawn into the compressor through the induction air filter and is forced out of the compressor housing through a tangential outlet to the intake manifold. The degree of compression is controlled by means of a wastegate valve, which varies the amount of exhaust gas allowed to bypass the turbine.

ABSOLUTE PRESSURE CONTROLLER (APC)

The Absolute Pressure Controller (APC) uses engine oil pressure to actuate the wastegate. The turbocharger is controlled by the wastegate, wastegate actuator, the absolute pressure controller and pressure relief valve (PRV). The wastegate bypasses engine exhaust gas around the turbonormalizer turbine inlet. The wastegate actuator, which is physically connected to the wastegate by mechanical linkage, controls the position of the wastegate butterfly valve. The absolute pressure controller controls the maximum turbonormalizer compressor discharge pressure. The pressure relief valve prevents an excessive pressure increase from the turbocharger compressor.

The wastegate actuator is spring-loaded to position the wastegate to the normally open position when there is not adequate oil pressure in the wastegate actuator power cylinder during engine shut down. When the engine is started, oil pressure is fed into the wastegate actuator power cylinder through an internal capillary tube. This automatically fills the wastegate actuator power cylinder and lines leading to the controller, blocking the flow of oil by normally closed metering and/or poppet valves. As oil pressure builds up in the wastegate actuator power cylinder, it overcomes the force of the wastegate open spring, closing the wastegate. When the wastegate begins to close, the exhaust gases causes the turbonormalizer to rotate faster, raising the turbonormalizer compressor outlet pressure. As the 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 wastegate actuator power cylinder is lowered sufficiently, the wastegate actuator opening spring forces the mechanical linkage to open the wastegate. A portion of the exhaust gases then bypasses the turbonormalizer turbine, thus preventing further increase of turbonormalizer speed and holding the compressor discharge absolute pressure to the desired value. Conversely, at engine idle, the turbonormalizer runs slowly with low compressor pressure output; therefore, the low pressure applied to aneroid bellows is not sufficient to affect the unseating of the normally closed metering valve. Consequently, engine oil pressure keeps the wastegate closed. The PRV will open to prevent any excessive pressure increase from the turbocharger compressor.

MAGNETOS

If the engine has two separate magnetos, then these magnetos may have been fitted with a magneto pressurization system to enable them to work at higher altitudes without cross firing due to the reduced resistivity of lower pressure atmosphere. This pressurization system consists of magneto housing gaskets, a calibrated bleed orifice, an inlet air filter, and tubing to rout pressurized air to the magnetos. The pressurization system gets the pressurized air from the induction system from just downstream of the turbochargers. In this application the timing is set at 20° BTDC ±0.5°. The inlet air filter will need to be changed periodically as shown in the Overhaul and Replacement Schedule listed under Maintenance Practices.

Ignition timing:

Engine	Magneto pressurization	Spark occurs, degrees BTC
IO-360-A1B6	Yes	20º ± .5º
IO-360-A1B6D	No	22º ± .5º

ABSOLUTE PRESSURE CONTROLLER (APC)

A. Removal and Installation -Absolute Pressure Controller

1) Disconnect and tag oil lines from controller and plug or cap open lines and fittings.
2) Disconnect compressor outlet pressure sensing lines from controller and plug or cap open lines and fittings.
3) Remove two bolts attaching controller to mounting bracket on firewall.
4) Remove controller from aircraft, being careful not to drop controller unit.
5) Installation of the controller may be accomplished by reversing the preceding steps.

B. Adjustment – Absolute Pressure Controller

Caution: With engine oil temperature at 170°F or greater, slowly open throttle and note maximum manifold pressure obtainable.

-5 Absolute Pressure Controller Adjustment Procedure

1) Adjust the Absolute Pressure Controller so that the engine maintains 29.6 in. Hg at full throttle in flight with the oil temperature greater than 170°F. Normal in flight oil pressure should be between 55 and 95 psi.

   Note: **Some aircraft have a different absolute pressure controller installed on them. This can be identified by a square head on the bottom of the controller instead of a hex head fitting. THIS IS THE ADJUSTER. DO NOT TURN MORE THAN IS NEEDED FOR THE ADJUSTMENT. See the procedure below for the -10 absolute pressure controller.**

2) Cut safety wire and remove plug from bottom of absolute controller. (It is normal for a small amount of oil to be encountered upon removal of the plug.)
3) Using a flat blade screw driver, rotate metering valve seat clockwise to increase manifold pressure and counterclockwise to decrease manifold pressure. Lightly tap the unit after each adjustment to seat internal parts.

Note: When adjusting, rotate in VERY small increments as this is extremely sensitive. Approximately 13 degrees rotation will change the manifold pressure reading about one inch Hg.

4) Install the bottom plug in absolute pressure controller, then operate engine as in step "1" above to ascertain that adjustment has not caused an unacceptable change in manifold pressure.

Note: When making adjustment on the ground, the hotter the engine gets, the lower the manifold pressure will be.

5) After each adjustment, the aircraft must be flight tested to check results.
6) Repeat this procedure until desired results are obtained.
7) Safety controller plug.

-10 Absolute Pressure Controller Adjustment Procedure

1) Adjust the Absolute Pressure Controller so that the engine maintains 29.6 in. Hg at full throttle in flight with the oil temperature greater than 170°F. Normal in flight oil pressure should be between 55 and 95 psi.
2) Cut safety wire.
3) Using a 1/2" wrench, rotate metering valve seat clockwise to increase manifold pressure and counterclockwise to decrease manifold pressure. Lightly tap the unit after each adjustment to seat internal parts.

Note: When adjusting, rotate in VERY small increments. Approximately ¼ turn will change the manifold pressure reading about one inch Hg.

4) Operate engine as in step "1" above to ascertain that adjustment has not caused an unacceptable change in manifold pressure.
5) After each adjustment, the aircraft must be flight tested to check results.
6) Repeat this procedure until desired results are obtained.
7) Safety wire adjuster.

Torque values are located in Appendix A.

TURBOCHARGER

A. Removal and Installation - Turbocharger

1) Loosen clamp and remove induction tubing from the front of the turbochargers.
2) Loosen clamp attaching tailpipe to turbine exhaust outlet and work tailpipe from exhaust system.
3) Disconnect and tag oil lines from turbochargers and plug or cap open lines and fittings.

4) Remove bolts, washers, and nuts from exhaust flange that connects the turbocharger to the exhaust manifold assembly.
5) Remove the turbocharger from aircraft being careful not to drop the unit.
6) Installation may be accomplished by reversing the preceding steps and alignment of support rods.

Caution: Pre-oil turbocharger before engine operation.

WASTEGATE ACTUATOR

A. Removal and Installation - Wastegate Actuator

1) Disconnect and tag oil lines from actuator and plug or cap open lines and fittings.
2) Loosen clamp attaching tailpipe to turbine exhaust outlet and work tailpipe from exhaust system.
3) Remove bolts holding wastegate manifold assembly to exhaust system.
4) Remove bolts, washers, and nuts attaching wastegate manifold assembly to the turbocharger.
5) Remove the assembly from aircraft being careful not to drop the unit.
6) Installation may be accomplished by reversing the preceding steps.

Note: When installing the assembly, be sure the gaskets at inlet and outlet of valve are installed and are in good condition. Replace gaskets if damaged.

B. Adjustment - Wastegate Actuator

If adjustment of wastegate actuator is required, remove wastegate actuator in accordance with "Removal and Installation of Wastegate Actuator" instructions and send to an approved facility for repair or overhaul of wastegate actuators.

PRESSURE RELIEF VALVE

A. Removal And Installation Of Pressure Relief Valve

1) Remove bolts, washers, and nuts holding pressure relief valve to induction manifold assembly.
2) Remove pressure relief valve from induction manifold assembly.
3) Check condition of O-ring on face of pressure relief valve before installation.
4) Clean surface of induction manifold assembly, verify that the surface is smooth and free from nicks, gouges, or burrs that may damage the O-ring or prevent proper seal of the pressure relief valve.
5) Install the pressure relief valve by lining up the holes in the pressure relief valve with the holes in the induction manifold assembly and installing bolts, washers, and nuts in the same orientation as when removed.

ENGINE

A. Removal and Overhaul - Engine

If the engine is to be removed, the turbocharger and its accessories should be removed in accordance with the following steps before removing engine mount bolts. All other procedures for engine removal listed in the Cessna 177RG service manual apply.

1) Disconnect hoses to the intercooler.
2) Remove wastegate in accordance with “Removal and Installation of Wastegate Actuator” instructions.
3) Remove turbocharger in accordance with “Turbocharger Removal and Installation” instructions.

Note: The replacement normally aspirated IO-360 engine must be modified before installation as a turbonormalized Cessna Cardinal RG engine. Therefore turbonormalized engines must be overhauled by a facility approved by Tornado Alley Turbo, Inc. (TATI) and in accordance with procedures established by TATI. Installation of new or overhauled engines in existing turbonormalized aircraft requires installation of components at TATI or a facility approved by TATI. Overhaul turbochargers, MPC, wastegates, PRV, and fuel injection servo at the same time as engine overhaul. Contact TATI for a current list of approved overhaul facilities for engine and components. Keep fuel injectors in proper cylinders.

B. Installation – Engine

Before installing the engine, the aft accessories should be installed prior to attaching the engine to the engine mounts per the Cessna service manual. The turbocharger and exhaust can then be installed on the engine.

1) Install the turbocharger in accordance with “Turbocharger Removal and Installation” instructions.
2) Install the wastegate per “Removal and Installation of Wastegate Actuator” instructions.
3) Connect all hoses and induction system.

C. Inspection - Post Engine Overhaul / Installation

After overhaul and reinstallation of the engine and turbonormalizing system a final inspection is required.

Inspect the following for security, signs of chaffing, leaking, and general condition:

1) All hose connections, routing, and security.
2) All clamps and couplings for proper engagement and alignment.
3) Induction tubing for current and possible chafe problems.
4) Tightness of all exhaust mounting hardware and v-band clamps.
5) Clearance of exhaust through cowling.
6) Wiring chafe and heat related problems.
7) Engine probe wiring to exhaust clearance.
8) Cylinder lower fuel drain plumbing clearance to exhaust and heat shields.
9) Heat shield clearance off of exhaust components.
10) Turbo supports for security and safety wire.

11) Turbo air inlet SCEET to front cowling clearance.
12) Throttle, propeller, and mixture control levers full travel.

D. Servicing - Post Engine Overhaul / Installation (Before First Engine Start)

After overhaul and reinstallation of the engine and turbonormalizing system, pre-oil the turbochargers as described below.

1) Remove one spark plug from each cylinder.
2) Ground all ignition leads to engine.
3) Fuel Selector to "OFF".
4) Clear engine and propeller area from obstacles.
5) Ensure proper oil level.
6) Turn on battery power.
7) With security person outside, crank engine and monitor indicated oil pressure. Crank engine for no more than 30 seconds at a time. When 12 psi or more is consistently indicated on the oil pressure indicator the turbo will be considered to be pre-oiled.
8) Turn off battery power.
9) Reinstall spark plugs and leads and visually inspect the engine compartment for any oil leaks.
10) Conduct a fuel prime operation check by putting the Fuel Selector to either tank, and mixture full rich.
11) Turn on battery.
12) Activate auxiliary fuel pump switch and observe fuel flow for brief positive indication of fuel flow.
13) Turn off battery.
14) Inspect engine area for any fuel leaks, paying careful attention to the fuel discharge nozzles and fuel lines.

E. Operational Inspection - First Flight Run-Up

Perform the following Run-Up Procedure prior to first flight after reinstallation of turbonormalizing system during overhaul or maintenance of turbonormalizing system components.

With upper and lower cowling removed, fireguard/observer present:

Note: Make sure turbocharger is pre-oiled under Servicing – Post Engine Overhaul/Installation.

1) Start engine using normal starting procedures.
2) Keeping RPM below 1700 rpm, monitor oil pressure, fuel flow, manifold pressure, and engine temperatures for normal operation.
3) Run engine for a short time, only long enough to check all indications and ensure no fuel or oil leakage.
4) Shut engine down, inspect engine and turbo system for any sign of leakage, chafing, or heat damage.
5) Install complete cowling.
6) Perform normal engine start and operation to achieve proper operating temperatures.
7) Perform magneto operational check.
8) Perform high power operation check.

9) Monitor engine operating parameters and make adjustments as described in section F.
10) After achieving the desired operating parameters, inspect the engine compartment for evidence of leaking, chafing, and heat damage.
11) Release aircraft for return to service flight.

F. Adjustments -Post Engine Overhaul / Installation

Make the following adjustments as required prior to first flight after reinstallation of turbonormalizing system during overhaul or maintenance of turbonormalizing system components.

1) Engine Setup
   a) RPM
   All adjustments need to be made at full operating RPM (2700). Fuel Flow, Manifold Pressure, Turbo Inlet Temperature, and Oil Pressure, to be measured at full RPM. If needed, make adjustments at the propeller governor. Ensure normal operating oil temperature before making RPM adjustments.

   Note: Every airplane may not make full RPM during static ground run. Make adjustments as close as possible, then fly and readjust after flight per pilot information.

   b) Fuel Flow
   For the IO-360 turbonormalized engine, the target full power (RPM and MAP) fuel flow is 21.5 GPH ± 0.5 GPH. Normally, full power fuel flow will be 21.5 GPH. To achieve these indicated target amounts adjustments may need to be made to the fuel injection servo.

   Note: Fuel flow is proportional to RPM, and Manifold Pressure. Given targets are set at engine operating oil temperature, engine operating RPM, and indicated 29.6 inches of manifold pressure. During the run-up, the oil temperature should be not less than 170° F; cooler oil will make higher manifold pressure which will make higher fuel flow.

   c) Manifold Pressure
   Maximum manifold pressure in cruise flight is 29.6 inches at full throttle with normal engine operating oil temperature. Make adjustments to manifold pressure according to "Absolute Controller Adjustments" section above.

   Note: The APC pressure set point will vary slightly with engine oil temperature and oil pressure. If the oil temperature is cooler, the manifold pressure may indicate higher. Be sure to make adjustments with the engine oil temperature at or above 170° F.

   d) Oil Pressure
   Normally, there should not be a need to make oil pressure adjustments, but if the oil pressure is below 25 PSI at idle, the oil pressure must be increased enough to keep adequate oil flow

through the turbo at idle speeds. The turbo inlet oil pressure check valve is preset to 10 PSI. If oil pressure is lower than this, the turbo will "starve" for oil.

Note: Make oil pressure adjustment according to Lycoming Direct Drive Engine Overhaul Manual.

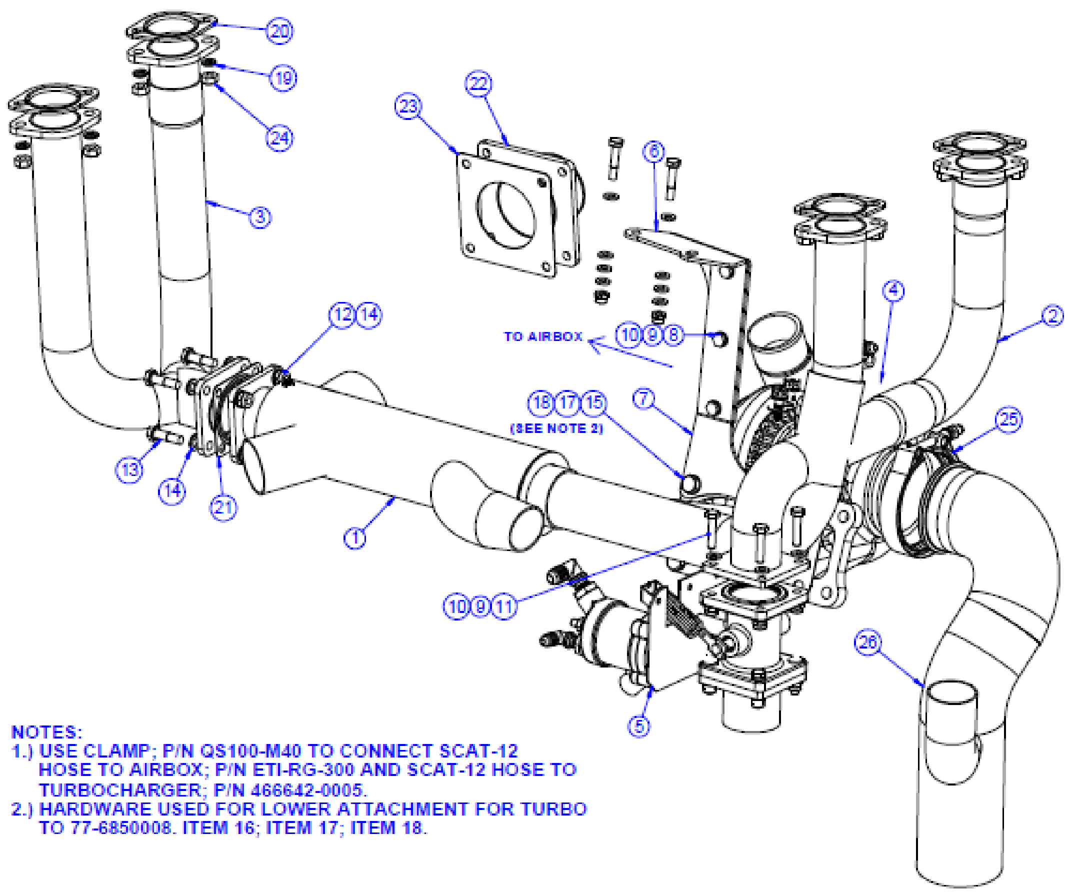
G. Functional Inspection - Return to Service Flight

Perform the following Return to Service Flight after reinstallation of turbonormalizing system during overhaul or maintenance of turbonormalizing system components.

1) Perform normal start up, taxi, engine parameter checks and any ground operational checks not related to the turbo system.
2) Utilizing normal Cessna before flight checklist perform additional full power performance operational check prior to releasing the brakes for take off. Take note of: engine RPM, fuel flow, TIT, manifold pressure, and oil temperature.
3) Depending on oil temperature the parameters may vary. Optimally, 2700 RPM, 29.6 inches MP, 21.5 GPH ± 0.5 GPH at normal operating oil temperature.
4) Because of a direct correlation between oil temperature and manifold pressure at lower than normal operating oil temperature, manifold pressure may indicate higher than redline.
5) Because of a direct correlation between manifold pressure and fuel flow higher manifold pressure will give higher fuel flow.
6) At full power and full rich mixture, the TIT will normally be between 1250-1330° F.
7) Utilize normal Lycoming engine break-in procedures. Keep in mind the turbo parameters and the added system components.

H. Post Return to Service Flight Inspections

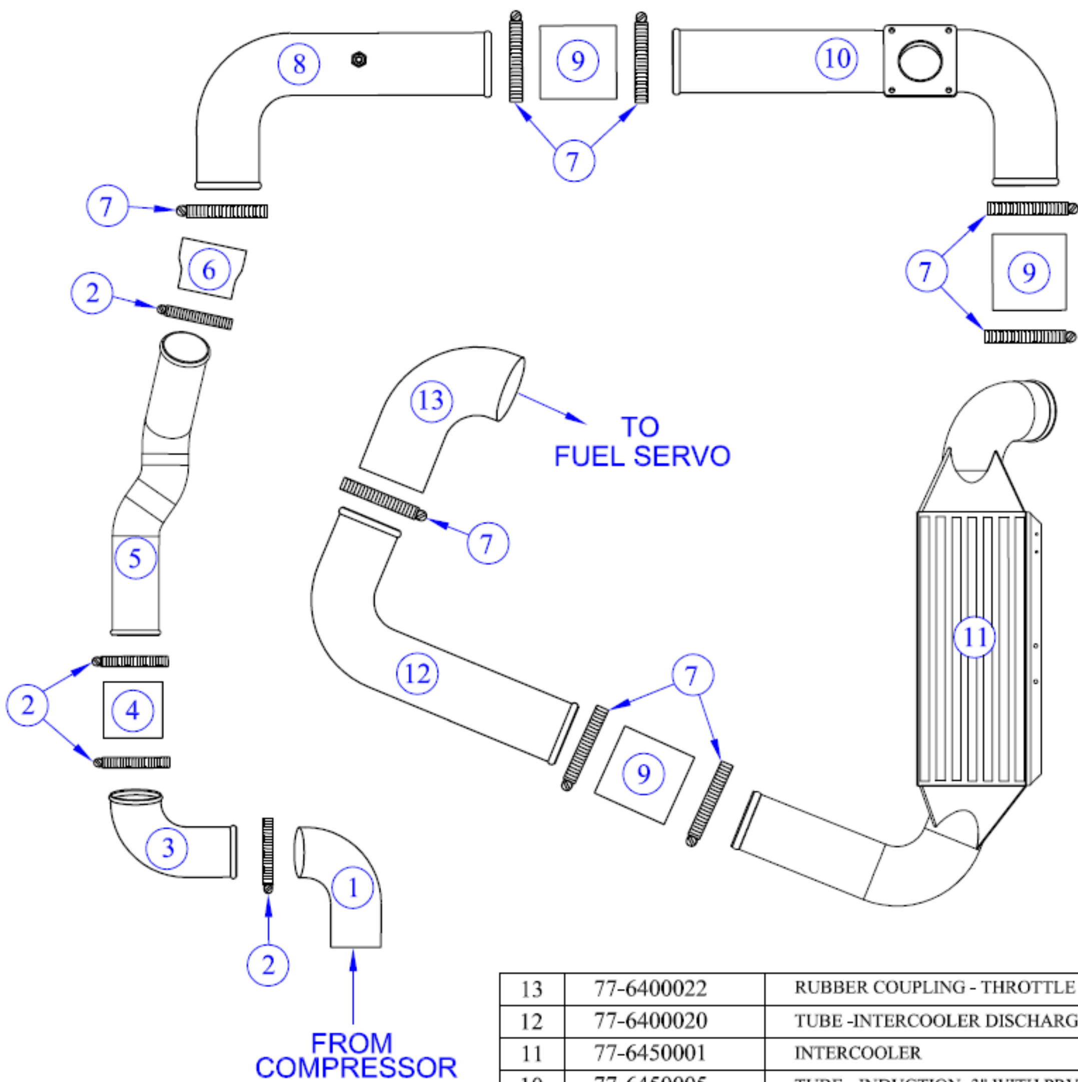
1) After first flight, recheck torque on V-band clamps. Use caution to not over torque the V-band clamps.
2) Inspect engine compartment for evidence of leaking, chafing, and heat damage.



NOTES:
1.) USE CLAMP; P/N QS100-M40 TO CONNECT SCAT-12 HOSE TO AIRBOX; P/N ETI-RG-300 AND SCAT-12 HOSE TO TURBOCHARGER; P/N 466642-0005.
2.) HARDWARE USED FOR LOWER ATTACHMENT FOR TURBO TO 77-6850008. ITEM 16; ITEM 17; ITEM 18.

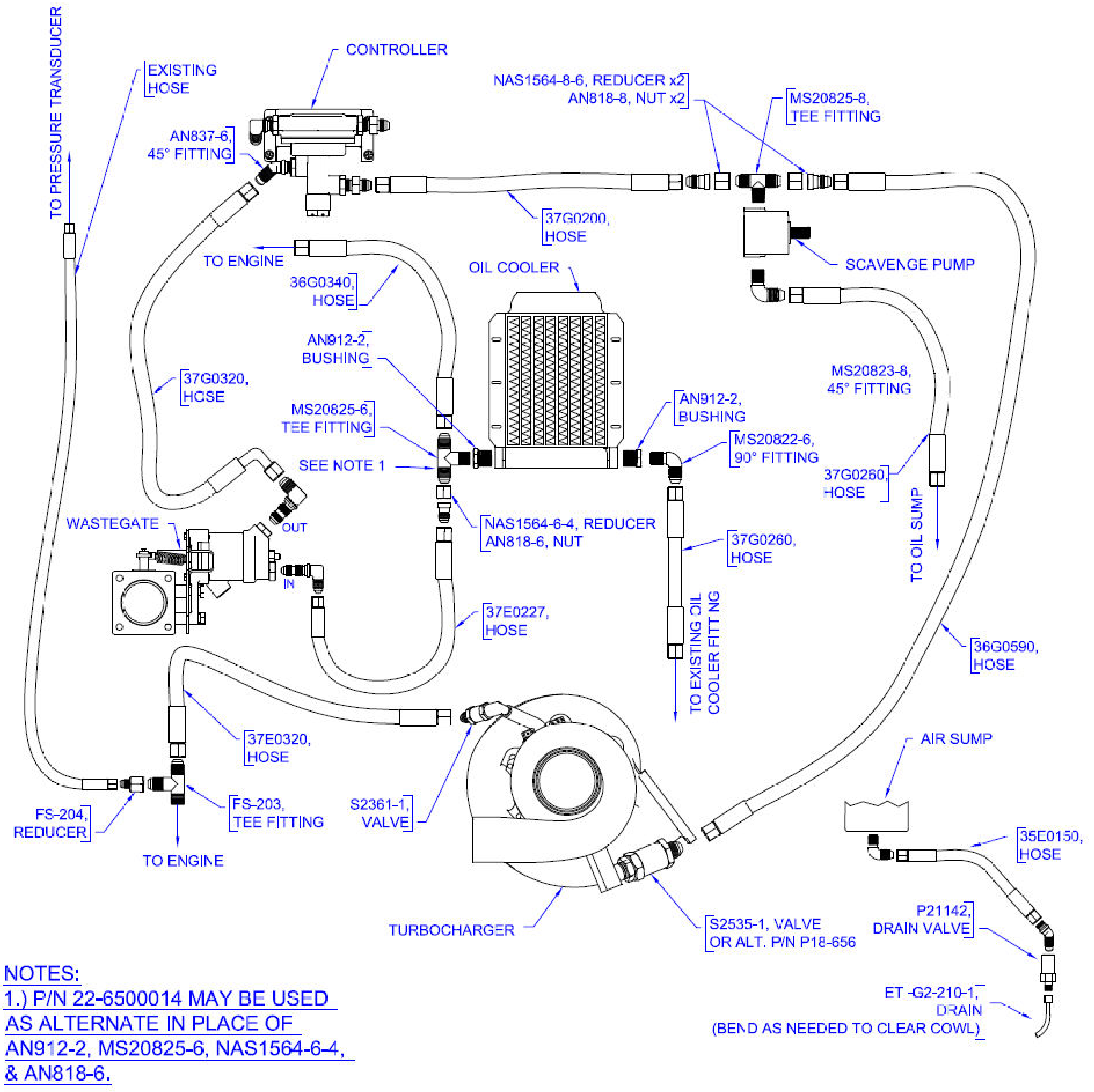
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	77-6850006	HEATER CABIN	1
2	77-6850008	EXHAUST - ASSEMBLY, R/H, COMPLETE	1
3	77-6850003	EXHAUST L/H	1
4	77-1050002	TURBOCHARGER INSTALLATION	1
5	77-1050004	WASTEGATE ASSEMBLY	1
6	ETI-RG-600-101	TURBO MOUNT BRACKET	1
7	ETI-RG-600-102	TURBO MOUNT BRACKET	1
8	AN4C6A	BOLT	3
9	NAS1149C0463R	WASHER	14
10	MS20500-428	NUT	7
11	AN4C11A	BOLT	4
12	MS21046C5	NUT, SELF-LOCKING	4
13	AN5C10A	BOLT	4
14	NAS1149C0563R	WASHER - FLAT	8
15	AN6C14A	BOLT	2
16	AN6C13A	BOLT	2
17	NAS1149C0663R	WASHER - FLAT	8
18	MS21046C6	NUT, SELF-LOCKING	4
19	MS35338-45	LOCKWASHER	8
20	77611	GASKET	4
21	642502	GASKET	1
22	77-6450009	TUBE ASSEMBLY THROTTLE BODY	1
23	77504	GASKET	1
24	1410	NUT	8
25	9956T-0339	CLAMP - V BAND	1
26	77-6850010	TAILPIPE ASSEMBLY	1
29	AN4-12A		2
30	MS21045-4	NUT	2
31	NAS1149F0463P	WASHER	8

Exhaust System

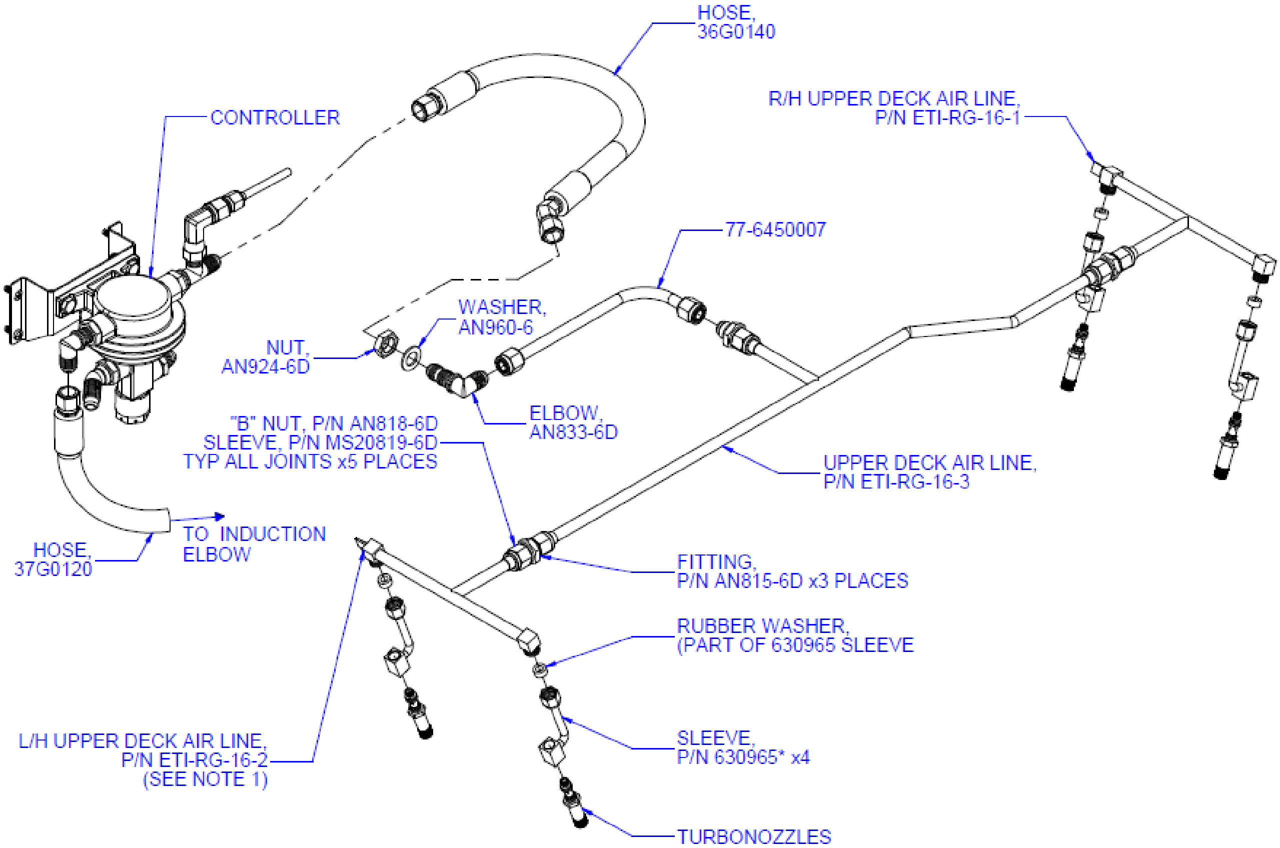


KEY	PART. NO.	DESCRIPTION	QTY
13	77-6400022	RUBBER COUPLING - THROTTLE BODY INLET, 3"	1
12	77-6400020	TUBE -INTERCOOLER DISCHARGE	1
11	77-6450001	INTERCOOLER	1
10	77-6450005	TUBE - INDUCTION, 3" WITH PRV ASSEMBLY	1
9	SLOOT 10-14	RUBBER COUPLING, 3"	3
8	77-6450014	TUBE - INDUCTION, 3", 90° WITH PRESSURE FITTING	1
7	100M-40H	CLAMP	8
6	ETI-SR22-15-6	RUBBER COUPLING - REDUCER, 3" TO 2"	1
5	77-6700001	TUBE - INDUCTION, R/H, 2",	1
4	04-6400002-8-12	RUBBER COUPLING, 2"	1
3	77-6400007	TUBE - INDUCTION, R/H, 2", 90°	1
2	100M-32H	CLAMP	4
1	77-6400021	RUBBER COUPLING - COMPRESSOR DISCHARGE, 2", 90°	1

Induction System



Lubrication System



NOTES:
1. " * " DENOTES TCM P/N.

Upper Deck Lines

Appendix A. Component Specific Torque Specifications				
		Torque Value		
SIZE	FASTENER	IN./LB.	FT./LB.	MODELS AFFECTED
Miscellaneous Hardware (see Note 5)				
10028H	Clamp	45 - 50	3.7 - 4.1	All Turbonormalized models
10040H	Clamp	45 - 50	3.7 - 4.1	All Turbonormalized models
10048H	Clamp	45 - 50	3.7 - 4.1	All Turbonormalized models
10016H	Clamp	45 - 50	3.7 - 4.1	All Turbonormalized models
Miscellaneous Fuel Injection (see Note 5)				
#3 (.38-24)	Nut- "B", Controller reference line	70 - 105	5.8 - 8.7	All Turbonormalized models
#6 (.5625-18)	Nut- "B", upper deck reference tube	150 - 195	12.5 - 16.2	All Turbonormalized models
.50-24	Nut- Air reference sleeve "B" nut to air reference line	Snug nut finger tight to set seal between nut and male connector, then tighten additional 3/4 to 1 turn.		All Turbonormalized models
.125-27	Nozzle- Fuel injector (with anti-seize compound)	55 - 65	4.6 - 5.4	All Turbonormalized models
.31-32	Nut- Fuel injection line	40 - 45	3.3 - 3.7	All Turbonormalized models
Exhaust (see Note 5)				
.3125-24	Nut- Exhaust manifold flange to cylinder	180 - 220	15.0 - 18.3	All engine models
.38-24	Nut- Turbocharger to exhaust flange	275 - 325	22.9 - 27.1	All Turbonormalized models
.250-28	Nut- All .250 bolts to attach support brackets	90 - 100	7.5 - 8.3	All Turbonormalized models
#10-32	Bolt- Turbo heatshield	36 - 50	3.0 - 4.2	All Turbonormalized models
#8-32	Screw- Turbo heatshield	17.5 - 22.5	1.5 - 4.2	All Turbonormalized models
.3125-24	Nut- All .312 nuts for turbo support	180 - 220	15.0 - 18.3	All Turbonormalized models
.25-28	Nut- Exhaust coupling "V" band clamp	60 - 65	5.0 - 5.4	All Turbonormalized models
Turbo (see Note 2)				
.3125-18	Bolt- Turbo oil inlet adapter	155 - 175	12.9 - 14.6	All Turbonormalized models
.376-15	Bolt- Turbo oil outlet adapter	220 - 260	18.3 - 21.7	All Turbonormalized models
.125-27	Valve- Turbo oil inlet	100 - 105	8.3 - 8.7	All Turbonormalized models
.3125-18	Bolt- Turbo compressor housing	130 - 140	10.8 - 11.6	All Turbonormalized models
Fitting and Hose connection (see Note 1 & 6)				
.125-27 pipe	Fitting- 1/8 Pipe thread	60 - 80	5.0 - 6.7	Plus alignment
.250-18 pipe	Fitting- 1/4 Pipe thread	130 - 150	10.8 - 12.5	Plus alignment
.375-18 pipe	Fitting- 3/8 pipe thread	185 - 215	15.4 - 18.0	Plus alignment

Appendix A. Component Specific Torque Specifications				
		Torque Value		
SIZE	FASTENER	IN./LB.	FT./LB.	MODELS AFFECTED
.44-20	#4 Aluminum	90 - 105	7.5 - 8.7	Bulkhead fitting (with o-ring)
.44-20	#4 Steel	110 - 130	9.1 - 10.8	Bulkhead fitting (with o-ring)
.56-18	#6 Aluminum	125 - 145	10.4 - 12.0	Bulkhead fitting (with o-ring)
.56 -18	#6 Steel	225 - 275	18.7 - 22.9	Bulkhead fitting (with o-ring)
.75-16	#8 Aluminum	240 - 280	20.0 - 23.3	Bulkhead fitting (with o-ring)
.75-16	#8 Steel	400 - 450	33.3 - 37.5	Bulkhead fitting (with o-ring)
.44-20	#4 Aluminum	90 - 105	7.5 - 8.7	Straight thread (with o-ring)
.44-20	#4 Steel	110 - 130	9.1 - 10.8	Straight thread (with o-ring)
.56-18	#6 Aluminum	125 - 145	10.4 - 12.0	Straight thread (with o-ring)
.56 -18	#6 Steel	225 - 275	18.7 - 22.9	Straight thread (with o-ring)
.75-16	#8 Aluminum	240 - 280	20.0 - 23.3	Straight thread (with o-ring)
.75-16	#8 Steel	400 - 450	33.3 - 37.5	Straight thread (with o-ring)
#3 (.38-24)	Brass / Aluminum fitting	70 - 105	5.8 - 8.75	Hose fitting "B" nut
#3 (.38-24)	Steel fitting	95 - 140	7.9 - 11.6	Hose fitting "B" nut
#4 (.4375-20)	Brass / Aluminum fitting	100 -140	8.3 - 11.6	Hose fitting "B" nut
#4 (.4375-20)	Steel fitting	135 - 190	11.2 - 15.8	Hose fitting "B" nut
#6 (.5625-18)	Brass / Aluminum fitting	150 - 195	12.5 - 16.2	Hose fitting "B" nut
#6 (.5625-18)	Steel fitting	215 - 280	17.9 - 23.3	Hose fitting "B" nut
#8 (.750-16)	Brass / Aluminum fitting	270 - 350	22.5 - 29.1	Hose fitting "B" nut
#8 (.750-16)	Steel fitting	470 - 550	39.1 - 45.3	Hose fitting "B" nut

NOTE	
1	Bulkhead fittings consist of fitting with o-ring and jam nut. To properly install the fitting, thread jam nut past first set of threads and to the end of the second set, slide o-ring over the long end to rest in the groove between threads. Thread the fitting into the receiving port until o-ring makes contact witht he port seat. Turn fitting for alignment while ensuring o-ring remains in the groove without contacting threads. Tighten jam nut to specified torque above.
2	Turbo compressor housing and hot section housing require the application of Locktite 545 be placed on the threads prior to installation of bolts.
3	Use locking devices as required after installation and applying the specified torque values.
4	The turbo oil inlet valve requires special torque of 105 inch lbs plus the application of Locktite 545 prior to installation.
5	Specific requirements as stated in Lycoming Service Table of Limits will take precedence over this document as it relates to Lycoming components.
6	Utilize accepted procedures and techniques for the installation of all hoses in reguards to alignment and support. Back up all fittings when tightening hoses.