D. If the "remedy" of the chart in step C, above, is to consult the troubleshooting chart for a specific turbocharger system component condition, proceed to that chart and continue to trace the cause(s) and apply the remedy or remedies. For instance, troubleshooting the "Manifold Pressure Low" condition may eliminate other possible causes except "Turbocharger Output Low or Operates Sluggishly." Following the troubleshooting procedure for this condition may show that the turbocharger itself lacks deficiency but lead to the conclusion that the "Exhaust Bypass Valve Fails to Close or Operates Sluggishly," thus leading the investigating mechanic to the troubleshooting chart for that component malfunction. The troubleshooting chart for bypass valve failure to close may lead to the discovery of a clogged inlet port orifice, or it may conclude that the command to close never reaches the bypass valve from the controller. In this hypothetical case, the "Controller Fails to Close Oil Flow" troubleshooting chart may help discover a leak in a sensing line to the controller, or foreign particles in the oil in the controller, holding open an internal poppet valve. Simple flushing of the controller may be the only remedy required for the controller. However, further investigation to find the source of the foreign particles is now required.

Troubleshooting charts for valves and controls may be found in the Troubleshooting section of the Kelly Aerospace Power Systems Aircraft Valves & Controls Overhaul Manual #400999-0000.

LISTING ENGINE TROUBLES:

The following is a list of engine troubles, or symptoms of malfunctions, related to the supplying of air to the engine by the turbocharger. For each symptom there is a troubleshooting chart and a written troubleshooting procedure. For example:

A. Manifold pressure low or fluctuating, or aircraft cannot reach critical altitude.

B. Oil leakage into engine intake air or exhaust.

C. Engine overboosts.

D. Cabin loses pressure at altitude and partial power.

PRE-TROUBLESHOOTING INSPECTION:

The pre-troubleshooting inspection described below, and summarized in Table 3.1, constitutes a thorough visual inspection capable of detecting and eliminating many possible causes of malfunctions for which troubleshooting would otherwise be necessary. To prevent the entry of damaging foreign matter into the system it is essential to examine each disconnected, removed, or replacement part prior to reinstallation for cleanliness, foreign objects, and hardware security.

NOTE: Consult aircraft and engine manufacturer maintenance publications for procedures that use an outside source of air pressure, and soap solution, to detect leaks in the air induction system and exhaust system.

A. With the engine shut down, externally inspect all components of the air induction system for loose connections, cuts, cracks, punctures, and corrosion or other evidence of deterioration that could permit air leakage and the ingestion of damaging foreign matter. The components include the engine air cleaner, ducting from the air cleaner to the turbocharger compressor inlet, ducting from the compressor outlet to the engine intake manifold, and the intake manifold. Tighten loose connections and repair or replace parts, as needed, per the aircraft and/or engine manufacturer maintenance publications.

B. Inspect the air cleaner for a clogged element, and service per manufacturer instructions. If installed, inspect the engine alternate air device. Check actuating device and assure that the door seals correctly and unfiltered air does not leak into the induction system.

C. Check the engine crankcase breather for restrictions to air flow, and remove any restriction. Improper positioning of the breather will cause back pressure or low pressure in the crankcase, refer to the aircraft manufacturer's maintenance manual for the breather position, angle and scarf.

D. Inspect the exhaust system for leakage, especially at the exhaust manifold connection to the turbocharger turbine inlet and at the engine exhaust manifold gasket. Tighten connections as needed, and replace damaged components in accordance with the engine manufacturer maintenance publications.

NOTE: Exhaust gas leakage may be indicated by streaks of exhaust deposits at joints, and by inside scorching of nacelle.

E. Check for oil leakage at the connections to the turbocharger oil inlet and drain ports, and tighten connections or replace gaskets, fittings, etc., as needed. Inspect for faulty check valves which can allow oil to drain into the turbocharger center housing after shutdown, leading to turbocharger seal leakage.

F. Check the oil supply and drain lines to and from the exhaust bypass valve and controller(s), and any air pressure sensing lines, for leakage or vibration. Tighten connections and mounting bracket attachments as needed. Also look for damage which might cause restriction, and repair or replace as needed.

G. Check the oil drain line from the actuator drain port of the exhaust bypass valve for more than slight leakage, or constant leakage. Temporarily disconnect the line if necessary. If there is such leakage, disassemble the actuator and check for cylinder wall scoring. If there is no scoring, replace the actuator piston packing in accordance with the engine manufacturer's instructions for the specific valve. If there is scoring, overhaul or replace the exhaust bypass

All valve and control repairs must be performed in accordance with Kelly Aerospace Power Systems Aircraft Valves & Controls Overhaul Manual #400999-0000.

H. Check for oil leakage from the controller(s), past the seal of the controller internal poppet. Significant leakage is cause for overhaul or replacement of a controller. Such leakage may be detected at a compressor outlet sensing line to the controller, at a low-pressure sensing port, or for a duct-mounted controller without a cover, by removing the controller and inspecting the bellows area.

I. If the turbocharger system includes an absolute pressure relief valve, use a noncaustic cleaning solvent and compressed air to remove any accumulation of debris that may tend to restrict bellows or valve motion. Check the bolts and O-Ring on the mounting flange and tighten or replace as needed.

J. Use a non-caustic cleaning solvent and compressed air to remove any accumulated debris from the cooling fins of a poppet-type exhaust bypass valve, or from the linkage of a butterfly-type exhaust bypass valve. Clean the debris from any controller external linkage, but without solvent, to avoid loss of lubricant from self-lubricating bearings.

WARNING: Operation of the turbocharger without all normally installed inlet ducts and filters connected can result in injury to personnel and damage to equipment from foreign objects entering the turbocharger.

CAUTION: Operation of the engine at any speed faster than idle immediately after start-up can result in "oil lag" failure of turbocharger bearings, especially in cold weather or after a prolonged non-operative period.

K. If feasible, operate the engine at a low partial power setting and listen for unusual turbocharger noises. If a shrill whine is heard above the normal turbine whine, indicating imminent turbocharger bearing failure, shut down immediately. For such a turbocharger, perform the "Bearing Clearance Inspection" (page 2-190-01). If the turbocharger fails to pass this inspection, determine the cause of wear by performing the troubleshooting procedure, below, for the condition, "Turbocharger Shaft Bearings, Journals or Bearing Bores Worn" (page 3-230-01), and overhaul or replace the turbocharger.

L. Remove the air duct from the turbocharger compressor inlet and inspect the compressor wheel and compressor housing for damage to wheel blades, indicating rubbing on the compressor housing, erosion by ingestion of dirt and sand, or impact with foreign objects. Also look for a heavy buildup of oil and dirt, indicating seal leakage; remove any foreign matter. Rotate the wheel by hand while pressing the rotating assembly

toward the turbine end of the turbocharger. Rock shaft sideways and up and down. There should be no binding, rubbing, or other interference with free rotation. If none of the above defects is found, securely reconnect the air duct to the compressor inlet.

M. Disconnect the exhaust ducting from the turbine outlet and examine the turbine wheel blades for damage. Rotate the wheel by hand while pressing the rotating assembly toward the compressor end of the turbocharger; also rock shaft sideways. Look for oil in the turbine wheel and its housing indicative of seal leakage, and check for evidence of the wheel rubbing on the housing. Remove any foreign matter. If none of the above defects is found, securely reconnect the exhaust duct to the turbine outlet.

N. If any listed conditions were found in steps l and m, above, see the troubleshooting procedures for the conditions, as applicable, of "Turbocharger Seal Leakage at Compressor End" (page 3-250-01), or "Turbocharger Seal Leakage at Turbine End" (page 3-270-01), or "Turbocharger Rotating Assembly Binding or Dragging" (page 3-220-01). Also perform the "Bearing Clearance Inspection" (page 2-190-01). If the bearings do not pass this inspection, determine the cause of wear by performing the troubleshooting procedure "Turbocharger Shaft Bearings, Journals or Bearing Bores Worn" (page 2-230-01), as described below, and overhaul or replace the turbocharger.

O. If the compressor wheel or turbine wheel has suffered foreign object damage, clean or repair the air induction system or engine exhaust system, as needed, before installing a replacement or overhauled turbocharger.

P. If there was turbocharger seal leakage, troubleshooting the condition "Turbocharger Seal Leakage at Compressor End" (page 3-250-01), or "Turbocharger Seal Leakage at Turbine End" (page 3-270-01), as applicable.

Table 3.1 - Summary of Pre-Troubleshooting Inspection	
System / Location	**Problem to be Found and Corrected**
Air Induction System	Air leaks, loose connections, damage, deterioration.
Engine Air Cleaner	Clogging.
Alternate Air Device	Leaking air, door not fully closed.
Crankcase Breather	Restriction, position, angle, and scarf of breather.
Exhaust System	Leaks, especially at exhaust manifold connections to turbocharger and to engine (gasket).
Turbocharger Oil	Oil leaks, loose connections, bad gaskets, fittings, check valves.
Bypass Valve and Controller Oil Lines, Sensing Lines, and Their Brackets	Leaks, vibrations.
Bypass Valve Actuator	Oil leakage due to twisted or damaged piston packing due to cylinder scoring or dirt.
Controller	a. Oil leakage past seal of internal poppet. b. Air leaks at any place in signal lines. c. Oil pressure variations.
Exterior of Bypass Valve or Controller	Accumulated debris on cooling fins of poppet-type bypass valve, or on linkage of butterfly-type bypass valve, or on any external controller linkage.
Turbocharger	With engine running, shrill whine above normal whine - shut engine down and check turbocharger bearing clearance.
Compressor Wheel or Turbine Wheel.	Indication of seal leakage, wheel damage or rubbing, binding, or dragging. (For any of these defects, check turbocharger bearing clearance and troubleshoot as applicable. For foreign object damage, also clean and repair air system or exhaust system).