



Metal Innovations Helps You **TURBOCHARGE** a **CESSNA 185**

By Dagmar Kinne

Many pilots enjoy a greater margin of safety, get out of high-mountain lakes, fly off the glaciers, and fly up and over obstructions with the manually controlled turbonormalizer manufactured by Metal Innovations.

Perfecting a Turbo System

Metal Innovations purchased the old Turbo Tech STC #SA1750NM in 2007. The original STC from Turbo Tech was first issued in 1983 and had been amended a couple times before Metal Innovations purchased it. Many customers have asked Metal Innovations to resurrect this turbo system, because it had a manual waste gate control. The vernier-style control allows smooth, small inputs, and the turbocharger can be turned on or off or set to anything in between at the pilot's discretion. This is very helpful for floatplane and amphibian oper-

ations; the turbo system gives a pilot the extra power needed to get out of the water at higher-altitude lakes or up on a glacier with a skiplane. After getting airborne and clearing all obstacles, one can often go without turbo. Going fast is not the objective. Using the turbo system to go high and fast is a little bit different story.

After studying the brittle and yellow paper drawings, Metal Innovations went to work and bought an IO-520D engine to acquire the pick-up points of the exhaust in three-dimensional space. All parts were modeled using 3-D software and assembled virtually before the company began manufacturing parts. A different design and relocation of the turbo assembly allowed parts to be made by using bending techniques for the pipes rather than welding the pipe sections together. This process resulted in less material, an in-

crease in exhaust flow and intake flow, more power, and more efficiency.

A completely revised drawing packet was submitted to the FAA in 2007, and the STC was amended in 2008.

Turbocharger Operation and Control

In principle, a turbocharged engine works and acts just like any normally aspirated engine, with some exceptions in behavior when the waste gate is closed and the turbocharger is engaged. So, why have a turbocharger?

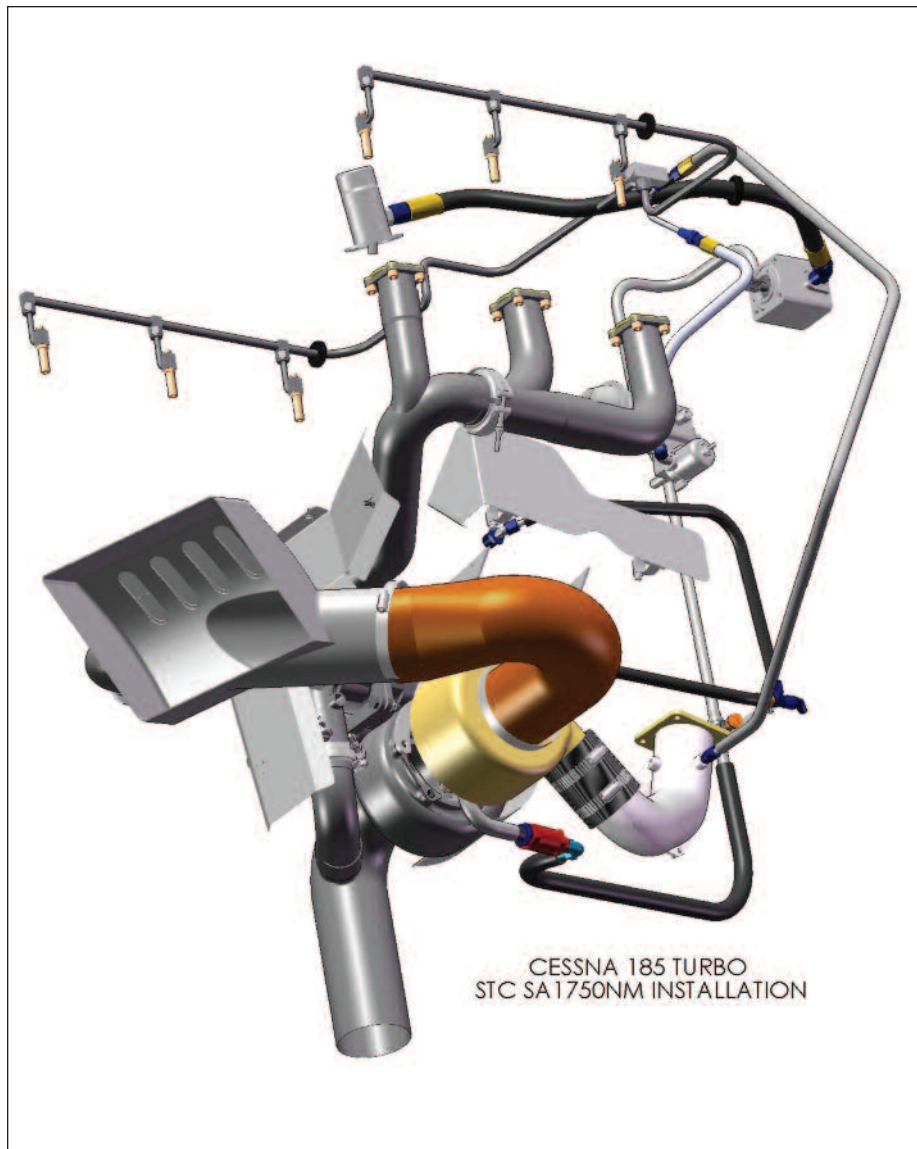
When climbing to altitude, the air becomes less dense and, therefore, less efficient; this means that, at higher altitude, one has less horsepower available. A turbocharger is an ideal way of increasing performance at altitude. For a better understanding of how it works, let's follow the airflow through the system.

The turbocharger consists of a turbine and a compressor linked by a shared axle. The turbine inlet receives exhaust gases from the engine, causing the turbine wheel to rotate. This rotation drives the compressor, compressing ambient air and delivering it to the air intake manifold of the engine at higher pressure, providing denser air (based on temperature). This results in a greater amount of air and fuel entering the cylinder.

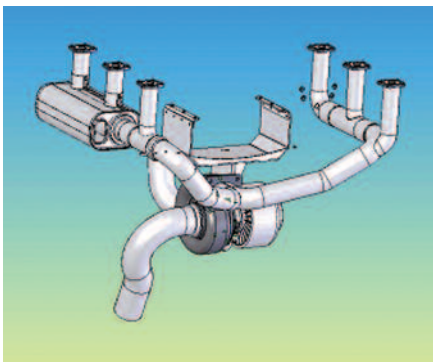
Because the turbocharger increases the pressure at the point where air is entering the cylinder, it provides the same density as air at sea level (based on temperature). Hence, it is providing sea-level performance at altitude. This is also referred to as a turbonormalizer system.

Just for clarification and comparison, a turbosupercharger (blower) is a gas compressor that forces more air and, thus, more oxygen into the combustion chambers of an internal combustion engine than is achievable with ambient atmospheric pressure. This means it can achieve higher-than-sea-level performance. “Boost” refers to the increase in manifold pressure that is generated by the turbocharger which exceeds normal atmospheric pressure. Often, the term boost is used for turbonormalizers, as well, which is not quite accurate.

A turbocharger can spin an engine far beyond what is needed, or what it is safely capable of. Hence, it can create too much pressure in the cylinders (“overboost”),



The controls for the turbo system.



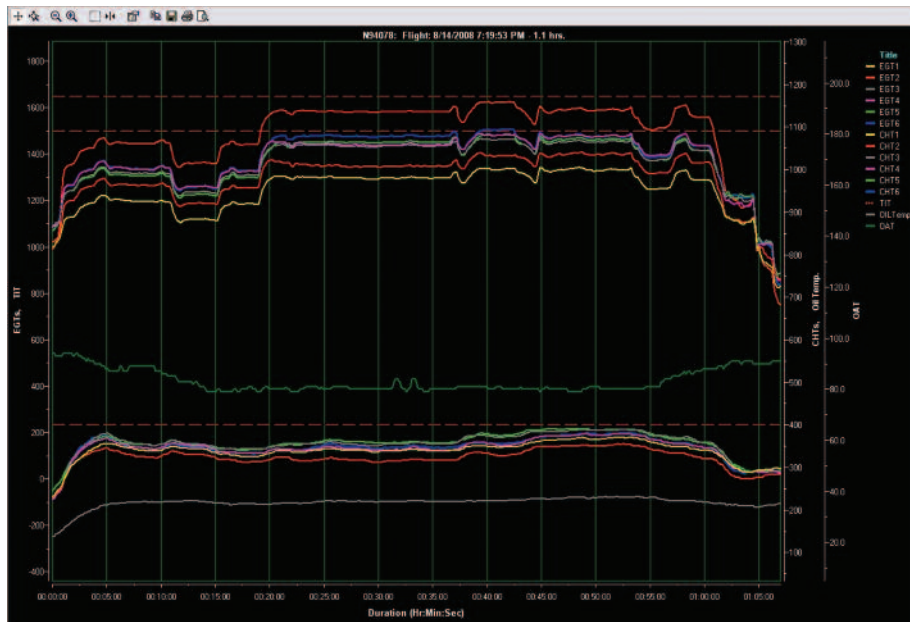
The clean design of the turbo system.

which causes detonation and physical damage. The intake pressure must be controlled, and this is done by a waste gate. A waste gate is the most common mechanical speed control system, and it allows some of the exhaust to bypass the turbine when the desired intake pressure is achieved. The Metal Innovations turbo system has a manually controlled waste gate. This means that you can turn the turbo system on or off at your discretion.

Because turbochargers use the output energy from the engine to achieve a net gain, a small amount of engine output energy is absorbed. However, the benefits far outweigh the loss of horsepower. Also, the pilot has to keep in mind that it takes time for the turbocharger to spool up to the appropriate engine speed, because it is driven by the exhaust flow, and the exhaust gas first has to travel through the system to take effect.

Most modern systems have an automatic waste gate controller where the manifold pressure is held constant to reduce the work load. In order to get good and long-lasting performance out of the Metal Innovations turbo system, the company recommends that pilots familiarize themselves with the performance around 25 inches MAP to provide a good safety margin. Many things have an effect on the MAP, such as engine speed, airspeed variations, rapid throttle movements, and differences in each cylinder performance with subsequent CHT monitoring. At high speeds and high altitudes with 30 inches MAP, things can happen fast to ruin your day. The basic rule is: Do not exceed any of the redlines or limits.

Because the turbo system has a manually controlled waste gate, the two most obvious ways of boosting the engine beyond its capability are by not adjusting the



An acceptable fuel distribution among cylinders.

waste gate lever correctly and by rapid throttle movements. If there is more compression created than what the engine and fuel system can handle, detonation will occur. If allowed to continue, a perfectly fine engine can be ruined in a matter of minutes. Metal Innovations added a pressure relief valve to reduce the risk. The pressure relief valve opens at 34.4 +/- 1 inches Hg to accommodate cold-weather flying. As a result, Metal Innovations redlined the

MAP gauge, and it is the pilot's responsibility to stay within the operating limitations and not exceed 30 inches MAP.

Installing a Turbonormalizer Kit

Photo-guided installation instructions assist installers through the process of installing the turbonormalizer kit on an IO-520D with this STC. The example illustrated here shows the installation of the oil pump.

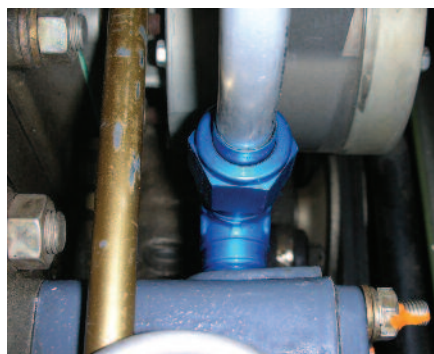


Photo-guided installation instructions assist the installer.



A turbo system really helps a 185 that's destined for high-altitude lakes.

The installation instructions show step by step how to:

- Prepare the aircraft
- Remove old components and install new components
- Install the turbocharger and its support bracket
- Install the oil line and check valves
- Install the intake tube and pressure relief valve
- Install the deck pressure lines and components
- Modify the cowl air induction system
- Install the new exhaust
- Install the temperature monitoring instrument
- Install heat shielding
- Run-up the engine
- Adjust fuel distribution of engine
- Conduct performance flights

Typical Installation Benefits, Notes, and Results

Utilizing tube-bend techniques and slip joints aid installation and maintenance, and they ultimately reduce the cost for a customer if a section of exhaust needs to be repaired or replaced.

More room in the lower engine compartment helps to provide a more efficient airflow to keep the compartment and engine cooler.

An engine is delivered from the manufacturer with some intake variations among the cylinders, and, based on wear and tear, the engine will even change during its service life. To put it simply, the air cannot be controlled to each cylinder individually. However, the fuel metering to each cylinder is adjustable.

The turbonormalizer magnifies any of those variations, and part of the installation requires fine tuning all of the cylinders to each other. This is accomplished by using different engine manufacturer injector dash numbers for fine tuning. With that method, one can directly control how rich or lean the engine will run from cylinder to cylinder. This fine tuning is not specifically related to the turbo system, but it is inherent to each engine's design/manufacturing process and can cause problems with fouled spark plugs when running the turbo system.

In one particular case, after some trial and error in finding a suitable combination of Teledyne Continental Motors injectors, Metal Innovations was able to achieve what the customer previously came to expect.

The accompanying graph shows an acceptable distribution among cylinders.^{CO}



METAL INNOVATIONS, INC.

CAPABILITIES

SHEET METAL REPAIR

MII employs highly qualified, licensed Airframe and Powerplant aircraft mechanics. Their years of experience combined with the extensive training they receive at MII has resulted in our team being one of the best in business.

COMPOSITE REPAIR

MII has a full service composite facility staffed with extensively trained personnel. Training has included Abaris Level 1, 2 and 3 Composite Repair and FlightSafety International training for key aircraft repair and extensive metal bonding training.

ENGINEERING

MII has a team of A&P licensed Engineers on staff utilizing Solidworks seats to accomplish unique project.

Our Engineers have many years of experience and receive regular training to stay current on new design techniques. They can assist you with a DER repair, or even completion of a fully designed model, taking your project from the screen to a working prototype or PMA/STC.

AOG SERVICES

When your aircraft is on the ground and you need immediate repairs, give us a call.

We can dispatch our highly skilled structural repair team to anywhere in the world. Repairs will be completed at your location. If you need finishing touches on your aircraft, we can do that on site, too – saving you time and money.

We deliver quality services at competitive prices. Call for a free quotation.

MANUFACTURING

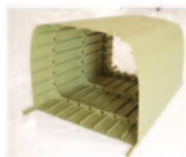
MII is setting a new standard in our manufacturing capability. Our multi-faceted design and manufacturing team can accomplish a single, unique one-off design or tackle a large assembly project with myriad part numbers and utilizing materials of differing specifications.

We offer extensive capabilities in both sheet metal and composite part manufacture. MII is a PMA authorized facility and our list of STC holdings is growing year by year.

3 & 5 AXIS MACHINING

Metal Innovations gets a new mill

The Haas 5 Axis GR-512 is a gantry-style mill with 145" x 61" x 35" travels and a powerful 40-taper milling head. Its 10,000-rpm spindle and powerful 15-hp vector drive system provide the power to cut aluminum and other metals. A 20-pocket automatic tool changer is standard. Featuring rigid steel construction, the GR-512 provides a very stable platform for heavy cutting. The machine's 5' x 12' fixed Vacuum table provides plenty of support for large and/or heavy work pieces, and the gantry assembly travels the full length of the table on heavy-duty linear guides for low friction and extreme accuracy. Powerful brushless servomotors and high-pitch ball screws combine to produce rapids up to 2100 ipm for reduced cycle times.



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