

Email from Larry Vitatoe describing the video recording of a static test run demonstration of a stuck wastegate

In the video we did a static demonstration of takeoff parameters of a 1979 P210N (N4789K) modified with the Vitatoe TN550 engine conversion i/a/w STC SA02918CH. Three cameras were used, one directed at the Auracle Engine Analyzer mounted in the instrument panel, one directed at the general instrument panel area, and the third on a tripod to observe the exterior of the aircraft. All three cameras were synchronized so the three different images all represent the same moment in time.

As I was getting into position to operate the aircraft and engine, I apparently bumped the camera recording the general instrument panel area and moved the field of view away from the engine control knobs. It was our intent to show positions of the mixture, propeller, and throttle. However, for most of the control positions, I announced what was happening so the information is still available.

Two normal takeoff runups were accomplished showing typical engine readings in takeoff mode after the engine was sufficiently warmed up. On the first takeoff of the day it is not unusual for the Manifold Pressure to slightly exceed the normal adjusted value of 31.0". If Manifold Pressure exceeds 33.0", the pilot should bring back the throttle until Manifold Pressure is within the desired limits. If the Manifold Pressure exceeds 34" of Manifold Pressure, the Pressure Relief Valve (PRV) in the induction system will start to open to relieve excessive pressure. If the PRV opens frequently, adjustment of the wastegate controller to control the Manifold Pressure should be made by a certified mechanic.

Normal climb out engine configuration is 31"MP, 2700 RPM, and 35-37 GPH fuel flow. This setting can be maintained until reaching the desired cruise altitude.

After the initial takeoff tests, the engine was shut down and the oil line from the wastegate to the wastegate controller was disconnected at the wastegate controller and blocked. This was to simulate a wastegate or wastegate controller stuck in the closed position. The turbocharger performance is regulated by the wastegate and wastegate controller. Oil from the engine is pumped

to the wastegate and enters a hydraulic cylinder with activation of the wastegate butterfly by a mechanical arm. The wastegate is spring loaded in the open position allowing some exhaust gas to be directed to the tail pipe avoiding the turbocharger. When additional turbo boost is desired, the wastegate controller restricts oil coming from the wastegate causing the wastegate butterfly to close diverting all or most of the exhaust gases to the turbocharger, increasing turbocharger speed and producing higher pressure in the induction system.

The engine was restarted and static takeoff runup initiated. The Manifold Pressure far exceeded the standard reading going as high as 37" MP. The Manifold Pressure or upper deck system influences the fuel pump output by way of an aneroid bellows. The higher MP causes a higher fuel flow output. Above 34" of MP, the Pressure Relief Valve opened to try to restrict engine output. The original equipment turbocharger has high enough output to be able to supply the engine with boosted induction pressures as well as inflate the aircraft cabin to 3.35 psi. With the wastegate or wastegate controller stuck in the closed position, the Manifold Pressure far exceeded the design criteria. When the Pressure Relief Valve opens with the throttle fully open, the air to the engine is somewhat reduced below what it would be if the PRV didn't open. The upper deck reference signal to the fuel pump is also reduced but not enough to balance the loss of compressed air causing a very rich mixture and loss of power. Sporadic black smoke was observed coming from the turbo exhaust during this portion of the test. The engine was rough and lost power as the mixture became richer while the throttle was held fully forward.

Reducing the throttle position to reduce Manifold Pressure back below 33" MP, allowed the PRV to close and more normal operation to resume. This also allowed the fuel flow to reduce to a less rich mixture. The engine resumed somewhat normal operating conditions except for the wastegate still being fully closed.

Attached is a reprint of the Pilot Operating Handbook Supplement supplied with every TN550 conversion. A copy was also emailed to Keith McRoberts, Arlyn's partner on June 7, 2018.

Please reference the SECTION 2 LIMITATIONS POWER PLANT LIMITATION on page 4 of 20 where the Maximum Manifold Pressure is listed as 33.0"Hg (31.0" Hg nominal). Also the Fuel Pressure, Maximum: is listed as 39 GPH (warm engine).

See also the POWER PLANT INSTRUMENT MARKINGS on page 5 of 20. The Red Line Maximum Limit is shown as 33.0 in. HG for Manifold Pressure and 39 GPH for Fuel Flow.

In the PLACARDS section, also on page 5 of 20, it states:

"Full rated horsepower is achieved at 31"Hg. MP. Cold oil may cause momentary overboost to 33"Hg. MP. Do not exceed 33"Hg. MP. Do not exceed 31" Hg.MP for prolong periods."

Please reference page 11 of 20 under TAKEOFF POWER CHECK.

"It is important to check takeoff power early in the takeoff roll. Any sign of rough engine operation or sluggish engine acceleration is good cause for discontinuing the takeoff"

On page 12 of 20, the first paragraph states:

“On the first flight of the day, when the throttle is advanced for takeoff, manifold pressure will normally exceed 31.0 inches of Hg and fuel flows will exceed 37 GPH if the throttle is opened fully. Momentary manifold pressures up to 33.0 inches HG are acceptable. If manifold pressure consistently exceeds 31.0 inches of HG, mechanical adjustment may be necessary. On any takeoff, the manifold pressure should be monitored and the throttle set to provide 31.0 inches Hg; then, for maximum engine power, a full rich mixture should provide at least 35 GPH (36-37 GPH preferred). With a heat-soaked engine on a hot day, it may be necessary to use the right half auxiliary fuel pump switch to LOW BOOST to obtain the recommended takeoff fuel flow of 35-37 GPH preferred.”