NTSB File No. CEN18LA363
Turbocharger System Component Exam Notes

Accident

Accident Date: September 1, 2018
Location: Crete, NE
Aircraft: Cessna P210N, N210PF
Engine: Continental TN-550-P (S/N: 1009768) Vitatoe Aviation STC SA02918CH

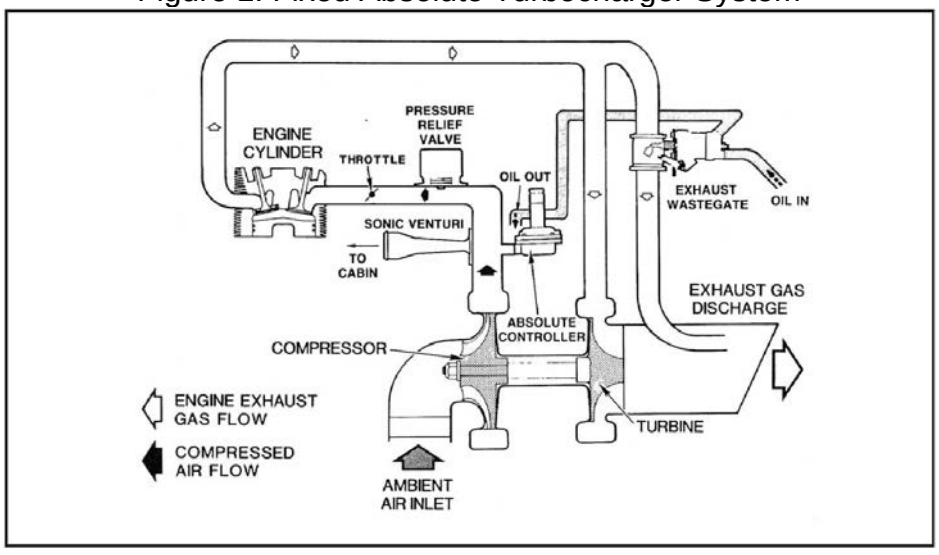
Examination Location and Participants

Location: Hartzell Engine Technologies (HET) in Montgomery, AL
Date: April 23, 2019
Participants: Les Doud – HET Air Safety Investigator
Anna Williams – FAA Birmingham FSDO, HET Principal Inspector
Judd Hough – HET Director of Engineering
John Mincey – HET Manager, Quality Assurance

Turbocharger System Description

Description: The Vitatoe Conversion STC (SA02918CH) engine on the P210N uses a Fixed Absolute turbocharger system to turbo-normalize a normally-aspirated IO-550-P engine with a maximum manifold pressure (downstream of throttle) limit of 33" Hg. The fixed absolute pressure controller hydraulically regulates the wastegate opening for high engine power settings from sea level to altitude. The controller senses deck pressure (upstream of throttle) compares it to a reference absolute pressure, and adjusts the wastegate butterfly (controlling turbocharger speed) to maintain sea-level horsepower at higher altitudes. A pressure relief valve, set slightly in excess of maximum deck pressure, is provided to prevent damaging overboost in the event of a system malfunction. The pressurized P210N uses a sonic venture to provide a constant source of compressed air to the cabin pressurization system. A system schematic is shown in Figure 1.

Figure 1: Fixed Absolute Turbocharger System



Components Received for Examination

Turbo Controller:
HET P/N: 470688-8
OEM P/N: C165004-0503
S/N: KKR0132
Data Tag: Red, Kelly Aerospace/Main Turbo Systems Inc. Field Overhaul

Wastegate Actuator
HET P/N: 470908-9020
OEM P/N: C165006-0114
S/N: PUR155N
Data Tag: Red, Kelly Aerospace/Main Turbo Systems Inc. Field Overhaul

Pressure Relief Valve (PRV)
HET P/N: 470930-1
OEM P/N: C482002-0101
S/N: CA0163
Data Tag: Red, Kelly Aerospace/Main Turbo Systems Inc. Field Overhaul

The turbocharger controller and wastegate were removed from the engine after the engine examination and test run at Continental Aerospace Technologies in Mobile, AL. They were shipped to HET in Montgomery, AL and presented for examination in the conditions shown in Photos #1 and #2. The Pressure Relief Valve was removed from the accident engine by JD Aviation in Crete, NE on approximately April 17, 2019 and shipped to HET in the condition as shown in Photo #3. The PRV was still attached to a segment of the upper deck ducting along with a hose coupling, clamps and a metal braided hose. The upper deck ducting had a small dent along one edge/sealing bead as shown in the lower portion of Photo #3.

All three turbocharger system components were in good condition considering time in service. The PRV had some minor chaffing on top of the cover due to contact with what appeared to be braided hose marks. All three components had red, field overhaul data plates indicating the last service was performed by Main Turbo Systems Inc.

Turbocharger Controller Functional Test

The airframe-specific fittings were removed from the controller and it was subjected to the factory test procedures defined in Process Instruction PI-477364. The controller with the cover installed was leak tested before removing the cover for additional tests; no leaks were detected.

The cover was removed and the controller was mounted to a test bench at HET as shown in Photo #4. The controller regulation test consisted of determining the as-received actuation pressure. The factory specification for the 470688-8 controller that is used on the TSIO-520-P engine in the P210N is 38.5” Hg deck pressure with a corresponding maximum manifold pressure of 36.5”, for an approximate 2” drop across the throttle valve. The Vitatoe Aviation STC for the TN-550-P requires adjusting the controller setting until an actuation pressure that results in a maximum manifold

pressure of 31” Hg is obtained. The deck actuation pressure for the tested controller was measured to be approximately 33.2” Hg, which is consistent with an approximate 2” drop across the throttle valve. The hysteresis checks determined hysteresis to be within factory specification of +/-0.2” Hg. The controller also passed the Stroke Test and Case Leakage Test requirements.

Wastegate Functional Test

The engine specific fittings were removed from the wastegate actuator and the wastegate assembly was mounted to a test bench at HET as shown in Photos #5 and #6. The wastegate was subjected to functional tests specified in the Overhaul Manual 400999-0000.

The wastegate actuator passed the leak tests and the butterfly valve open and closed position checks were performed. The closed position was visually verified and the open position was checked with a go/no-go gage. The wastegate was cycled several times with smooth actuator and valve movement noted, no binding or “stickiness.” The capillary check was deemed unnecessary and thus not performed.

Pressure Relief Valve (PRV) Functional Test

The PRV was removed from the engine duct and subjected to the factory test procedures defined in Process Instruction PI-477350. Before installation on the test bench a hand/finger force check of the valve head movement confirmed the bellows was still functional. The PRV was mounted to a test bench as shown in Photo #7. The PRV passed the Seat Leakage test and Hysteresis test and Regulation Pressure was determined to be approximately 34.75” Hg vs. a requirement of 34.4 +/-0.25” Hg.

A pressurized leak test of the pneumatic line provided with the PRV was conducted. The line was pressurized to 45” Hg and no pressure decay was detected over a period of one minute.

Conclusions

The turbocharger controller, wastegate and PRV exhibited normal operation with no discrepancies noted that would prevent or degrade operation. The PRV regulation pressure was determined to be approximately 0.1” Hg higher than maximum specification but that would not affect normal turbocharger system operation.

Les Doud
Hartzell Engine Technologies. - Air Safety Investigator
[redacted]

Photo #1 – Wastegate

Photo #2 – Turbocharger Controller

Photo #3 – Pressure Relief Valve (PRV) as-received

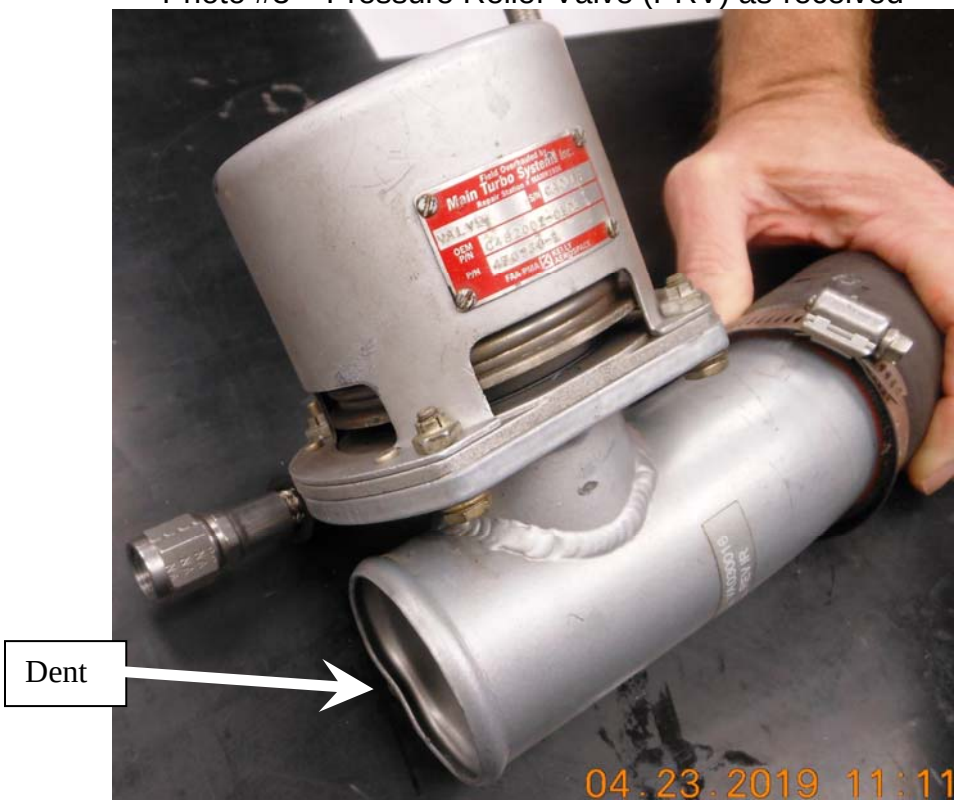


Photo #4 – Turbo Controller on test bench

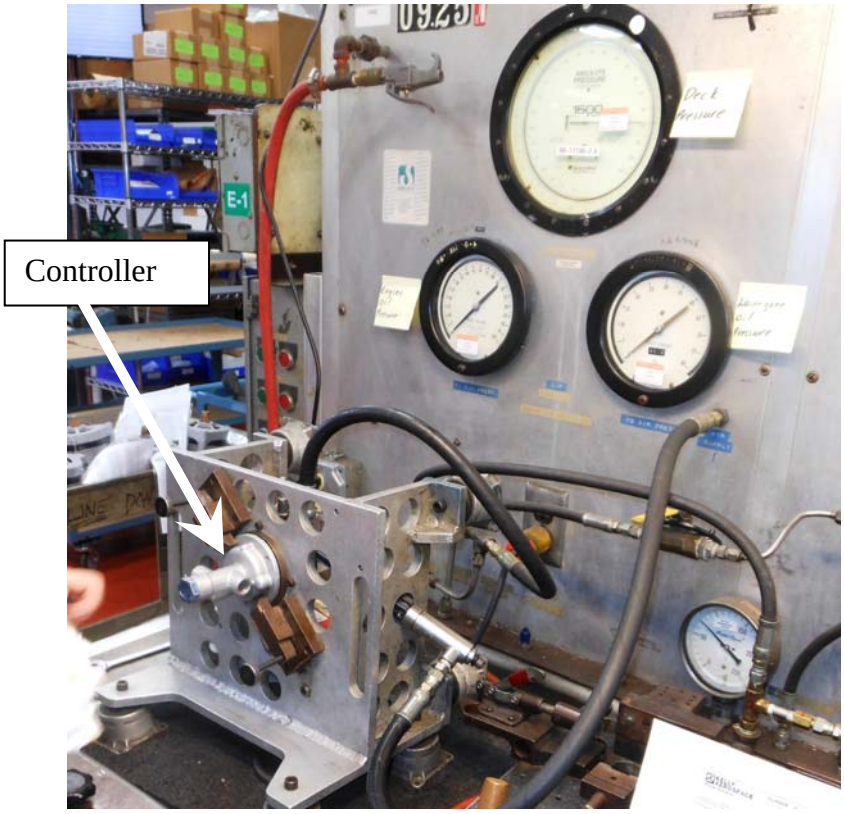


Photo #5 –Wastegate on test bench (valve open)

Photo #6 –Wastegate on test bench (valve closed)

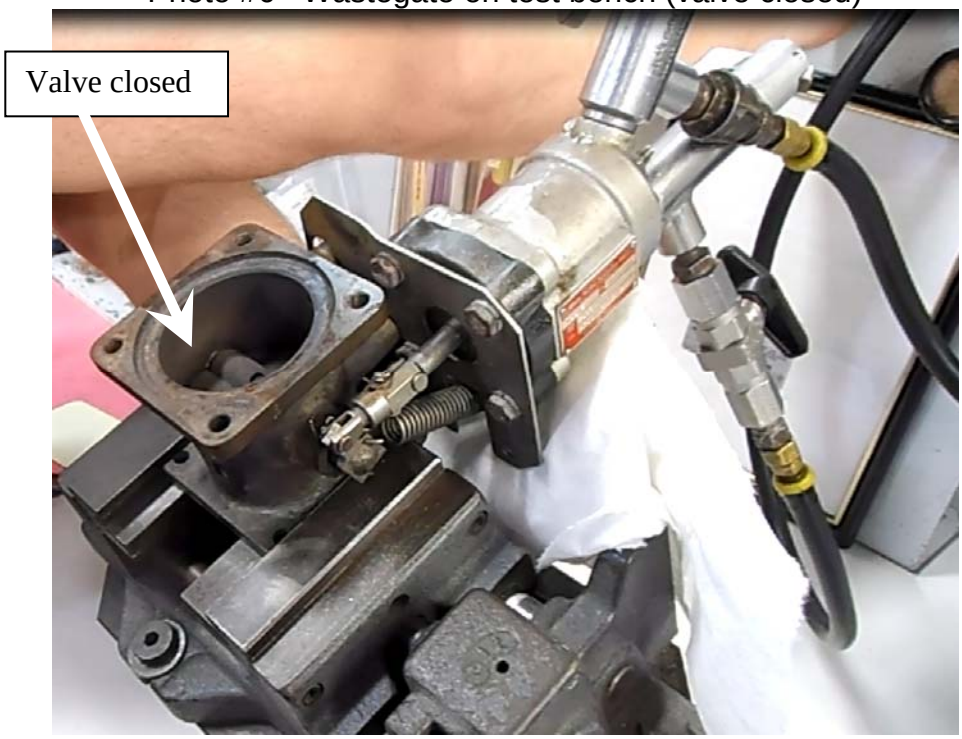


Photo #7 – Pressure Relief Valve (PRV) on test bench