

NTSB File No. ERA19LA057
Cirrus SR22T, N597CP, Kennesaw, GA 11/29/18

Hartzell Engine Technologies
Turbocharger Examination Report

Turbocharger Examination

Location: Hartzell Engine Technologies
 2900 Selma Hwy
 Montgomery, AL 36108

Date: June 24, 2019

Participants: Les Doud – Hartzell Engine Technologies Air Safety Investigator
 Anna Williams – FAA Birmingham FSDO Inspector
 Judd Hough – Hartzell Engine Technologies, Director of Engineering
 John Mincey – Hartzell Engine Technologies, Quality Assurance Manager

Turbocharger Description

Left Turbocharger

Black, Kelly Aerospace factory new data plate
P/N: 466304-0003
S/N: LGL00028 (Manufactured July 2008)

Right Turbocharger

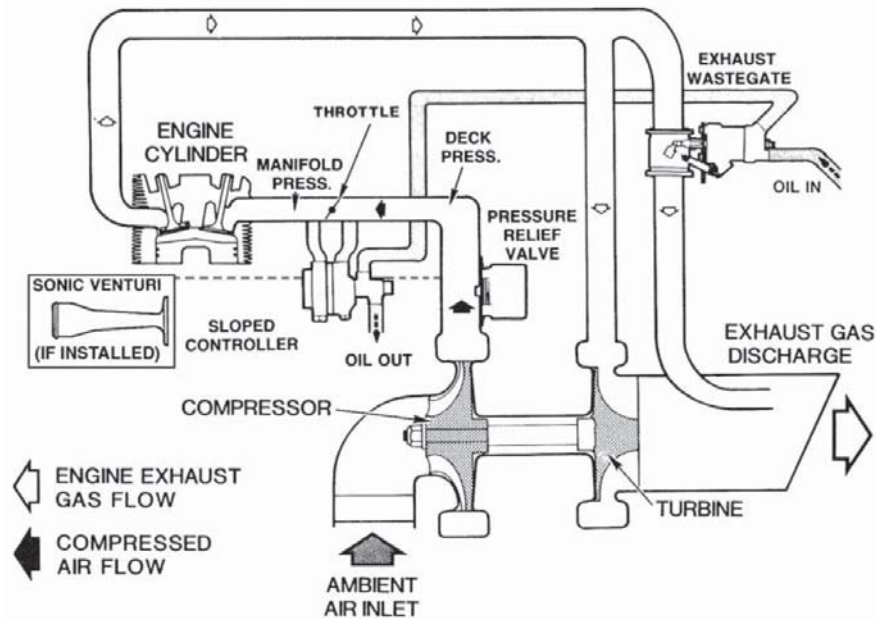
Black, Kelly Aerospace factory new data plate
P/N: 466304-0003
S/N: LHL00161 (Manufactured August 2008)

The engine logbooks were not available at the time of this examination, therefore the time-in-service of both turbochargers are unknown to the participants.

SR-22/Tornado Alley Turbocharger System Description

The TSIO-550-K1B engine on the Cirrus SR22T uses a Slope Control Turbocharger System with two, low-mounted turbochargers and a scavenged oil system. The sloped controller is designed to maintain the rated deck pressure at wide open throttle, and to maintain a reduced deck pressure at part-throttle settings. The controller senses both deck and manifold pressure and monitors the differential between them. If either the deck pressure or differential pressure rises above predetermined values for a given throttle setting, the controller opens the exhaust bypass valve, thus lowering compressor speed and output. A system schematic is shown in Figure 1.

Figure 1: Sloped Control Turbocharger System



Accident Background

The following excerpts are from the NTSB Preliminary Report:

“The pilot reported that during the descent that originated from 17,500 ft mean sea level (msl), about 7,000 ft msl and 20 nautical miles from PDK, he felt the engine “jolt” and subsequently received a low oil pressure warning message. Prior to the notification, all engine instruments had been in the “normal” range. The pilot reduced the throttle and notified Cobb County International Airport (RYY), Kennesaw, Georgia, of his intentions to divert. While on an extended base leg for runway 27 at RYY, about 2,000 ft msl, the pilot experienced another “jolt” and observed sparks emanating from the engine cowling area. Shortly thereafter, the engine jolted a third time, and the pilot pulled the mixture to idle-cut-off and turned the ignition key off to shut down the engine. He reported that with no clear landing area in-sight, he pulled the CAPS and prepared for impact.

and

“The engine crankcase at the number 6 cylinder displayed a fracture hole and the connecting rod had sheared from the upper crankshaft bearing. There was no other damage observed on the engine, nor evidence of oil spraying observed. Fragments of the upper cowling were located about 720 ft northwest of the main wreckage.”

and

“According to FAA airworthiness records, the low-wing airplane was powered by a Continental Motors IO-550-N engine equipped with a Tornado Alley Turbo turbonormalizing system. The most recent annual inspection was completed in October 2018.”

As Received Condition

The left and right turbochargers from the accident aircraft were removed during the engine examination at Continental Aerospace. The left turbocharger rotating group could not be rotated by finger/hand force. The left and right turbochargers were then boxed and shipped on June 11, 2019 to Hartzell Engine Technologies (HET) on RMA 2640 and examined on June 24, 2019.

The left turbo assembly as-presented is shown Photo #1. The left turbocharger had no hoses, ducts, or oil lines attached to the turbocharger. There was an “L-shaped” tube fitting attached to the oil drain port with a check valve attached to the fitting as shown in Photo #1. The rotating group could not be turned by finger/hand force.

Photo #1 – Left turbo assembly



Turbocharger Examination Findings

There was no remarkable external damage to the left turbocharger. All bolts and lock plates were secured in position.

The following observations were noted during a disassembly of the left turbocharger;

1. The rotor group was frozen/locked in position and could not be turned by finger/hand force. No attempt was made to turn the rotor group with any tools. The compressor wheel nut was present and securely holding the compressor wheel in place but the torque stripes were not aligned (Photo #8). Removal torque of the compressor nut was measured to be 15 in-lbs. Balance cuts were

observed on the turbine wheel nose but none were observed on the compressor wheel nose. Balance cuts were later observed on the base of the compressor wheel after removal from the shaft.

2. There appeared to be positive blade clearance between the turbine wheel blades and housing but evident rub marks in the turbine housing (Photo #2). There was no oil wetting in the turbine exhaust port and no other indications that oil escaped from the center housing into the turbine area. There was no excessive exhaust buildup in the turbine exhaust port.
3. There was evident blade contact between the compressor wheel and compressor housing. The compressor wheel appeared displaced to one side with clearance on one side vs. contact on the other (Photo #3). There were evident rub marks on the compressor housing and evident compressor blade damage with deformation opposite rotation (Photo #8). There was no oil wetting in the compressor inlet or discharge ports and no other indications that oil escaped from the center housing into the compressor area.
4. After removal of the turbine housing, Foreign Objects (FO) were observed in the volute area of the housing with other miscellaneous small debris. One piece FO appeared to be similar to engine bearing material (Photo #4). There did not appear to be any remarkable Foreign Object Damage (FOD) on the leading edges of either the compressor or turbine blades. Also after removal of the turbine housing, the rotating group (compressor wheel, turbine wheel and shaft) could be rotated together by hand/finger force but with some tactile roughness detectable in the bearings. The rotation by hand was video-recorded and is available in the collection of photos from the examination.
5. The turbine housing exhibited remarkable rub marks (Photo #5) with corresponding blade tip damage on the turbine wheel (Photo #6 and #13) indicating contact while rotating.
6. The compressor housing was removed and there were remarkable rub marks in two areas of the housing sidewalls (Photo #7). There were also rub/contact marks between the base of the compressor wheel and also the bottom hub area of the wheel and the compressor backplate (Photo #8).
7. There were relatively clean, "fresh" small aluminum particles/dust in the space between compressor backplate and Center Housing (Photo #9). These particles did not appear to have been "flushed" into the drain area of the Center Housing suggesting they formed after oil interruption to the turbocharger.
8. The thrust collar and thrust bearing separated from the Center Housing during the compressor backplate removal and were then removed from the backplate. The piston ring on the thrust collar was intact and free in the ring groove. The thrust bearing had similar small aluminum particles on the side of backplate and some residual oil on both sides (Photo #10). A small lip on the backplate that engages with the thrust collar was fractured, fretted and likely the source of these aluminum particles. Remnants of the fractured lip were lodged in the thrust collar.

(Photo #11). There were small, but evident rotational score marks on both sides of the thrust bearing as well as the thrust collar.

9. The "L fitting" was removed from the drain port of Center Housing. The Center Housing internal cavity was observed through this oil drain port. The internal Center Housing walls appeared wet with oil. The rotating group shaft appeared black in color and dry, not wet with oil. Despite the shaft appearing black in color, there was no indication of long-term, excessive coking or indication of excessive heat (Photo #12). The oil galleys in the Center Housing appeared open with no restrictions.
10. The shaft could not be removed from the assembly by hand force and had to be pressed through the compressor wheel and Center Housing for removal. The bearing journals on the shaft had rotational scoring marks and bearing material transfer signatures on both the turbine end and compressor ends (Photos #13 through #15). The piston ring on the turbine end was free to move in the groove.
11. Both the turbine end and compressor end bearings had some residual oil coating when initially removed. Both bearings also rotational score marks on the OD and ID surfaces. The radial holes appeared mostly clear but there was evidence of rotational galling and bearing material wiping that partially closed some holes (Photos #16 and #17).
12. Dimensional measurements of the components were not deemed necessary due to the damage indicating oil interruption.
13. There was no remarkable external damage to the right turbocharger. The right turbocharger rotating group rotated freely and smoothly as-received. The rotation by hand was video-recorded and is available in the collection of photos from the examination. Disassembly and examination of the right turbocharger was not deemed necessary.
14. Parts from the left turbocharger were bagged and/or placed in a box with the right turbocharger for return to Atlanta Air Salvage.

Conclusions

The left turbocharger exhibited characteristics of oil interruption. Oil interruption caused loss of oil to the bearings resulting in rotational scoring damage and loss of rotational stability which resulted in rotor group contact with the compressor and turbine housings. The damage suggested the oil interruption occurred during the last engine operation and was short in duration. There were no pre-impact functional discrepancies noted that would prevent or degrade normal turbocharger operation.

Les Doud
Air Safety Investigator
Hartzell Engine Technologies Inc.



Photo #2 –Left turbine exit/wheel damage



Photo #3 – Left compressor inlet/wheel damage



Photo #4 – FOD/debris from left turbine housing



Photo #5 – Left turbine housing rub marks and FOD in volute

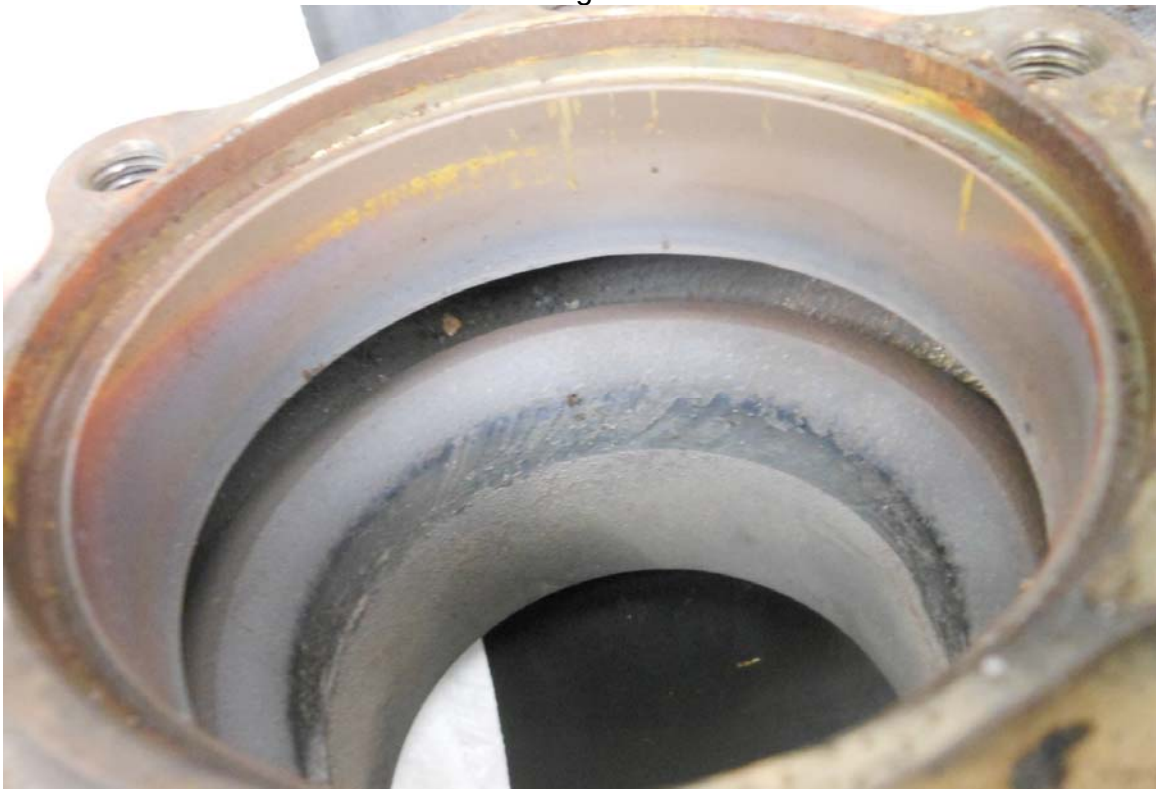


Photo #6 – Left turbine wheel and blade damage



Photo #7 – Left compressor housing rub marks



Photo #8 – Left compressor wheel blade damage

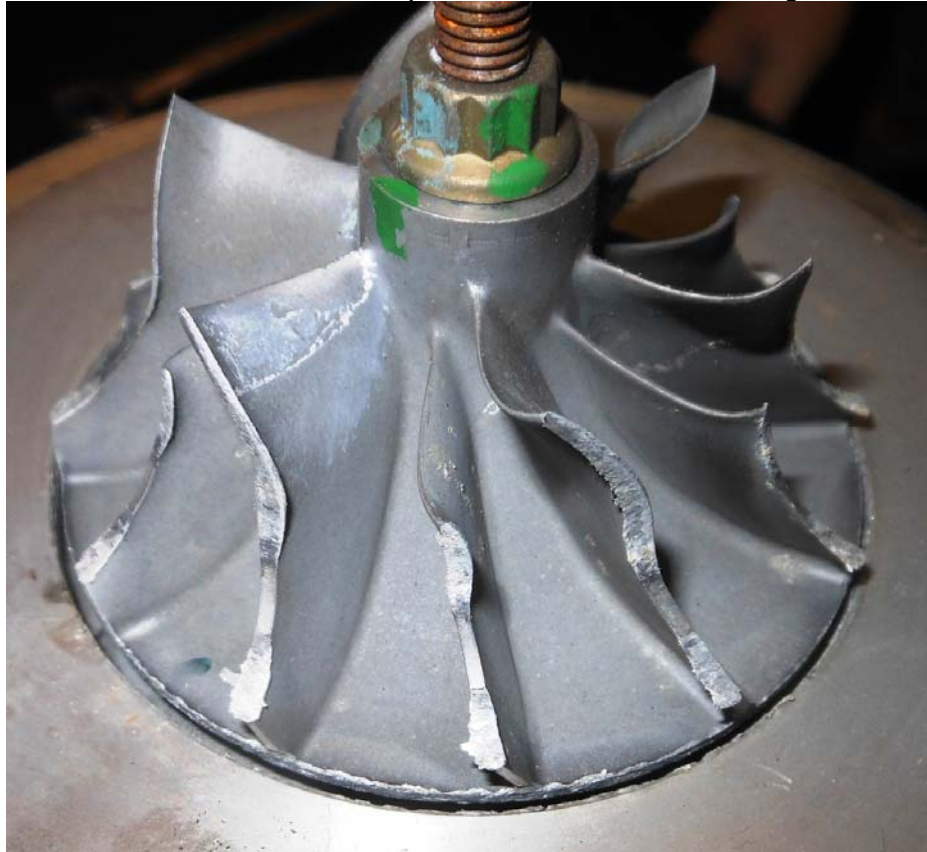


Photo #9 – Left backplate (area between backplate and Center Housing)



Photo #10 – Left thrust bearing with residual oil and aluminum particles



Photo #11 – Left thrust collar and piston ring



Photo #12 – Left Center Housing internal cavity

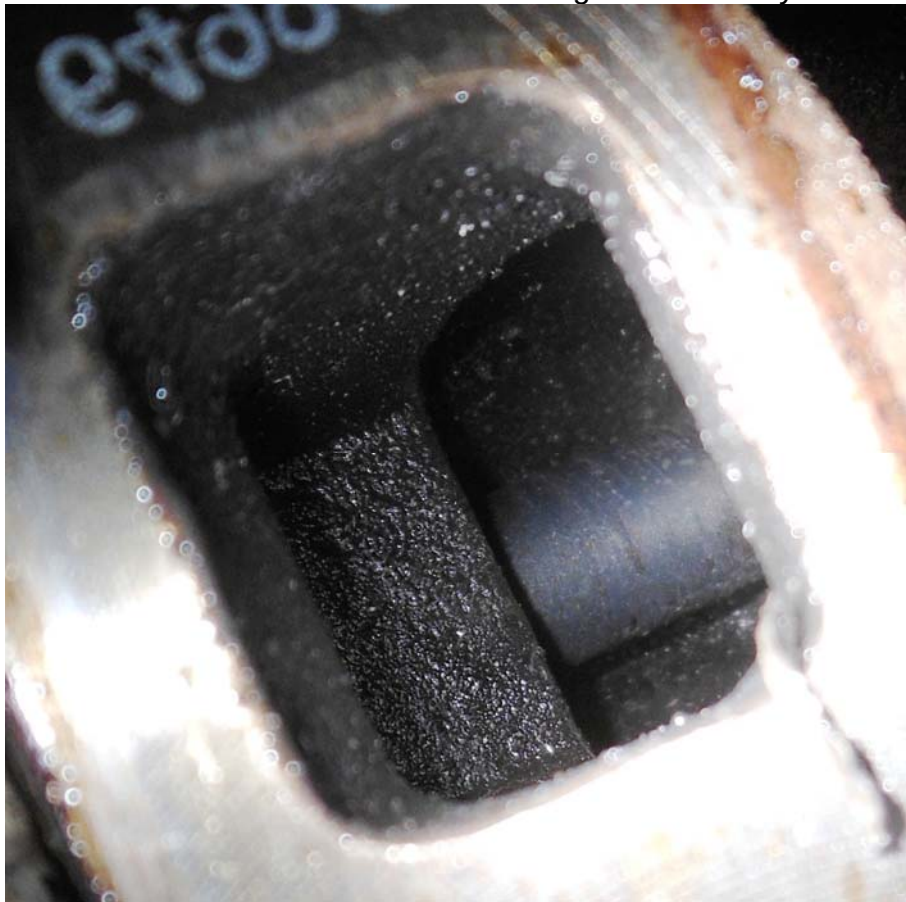


Photo #13 – Left turbine wheel assembly



Photo #14 – Left shaft compressor-end bearing journal



Photo #15 – Left shaft turbine-end bearing journal and piston ring



Photo #16 – Left compressor-end bearing



Photo #17 – Left turbine-end bearing

