WPR16LA088 Turbocharger Examination Findings

Report Date: May 21, 2016	Accident Number: WPR16LA088	Occurrence Date and Time: March 10, 2016	Location: Prescott, AZ
	Aircraft Year and Model: Lancair ES	Aircraft Registration N44AZ	Aircraft Serial Number: ES-089-FB
	Aircraft Total Time Unknown	Aircraft Engine Model: Mazda Rotary Derivative	Engine Total Time: Unknown
	Aircraft Damages: Substantial	Injuries: None	Investigator In Charge: Tom Little – Western Region

Owner Information, Name and Address: (per FAA Registration Database)
Thomas Parkes
[redacted]
Prescott, AZ 86301

Narrative (synopsis of events leading up to accident): (from NTSB Preliminary Report)

On March 10, 2016, about 1522 mountain standard time, a Thomas D. Parkes Lancair ES, N44AZ, was substantially damaged following a forced landing due to a partial loss of power at Ernest A. Love Field (PRC), Prescott, Arizona. The airline transport rated pilot, the sole occupant of the airplane, was not injured. Visual meteorological conditions prevailed for the proposed local flight, which was being operated in accordance with 14 Code of Federal Regulations Part 91, and a flight plan was not filed. The flight was originating at the time of the accident.

In a telephone interview with the National Transportation Safety Board investigator-in-charge, the pilot reported that after taking off from Runway 21 and at an altitude of about 50 feet above ground level, he experienced a partial loss of engine power near taxiway C. The pilot stated that he attempted to land on the airport's north ramp at taxiway B, but during the descent the nose landing gear impacted a Precision Approach Path Indicator (PAPI) light standard before impacting terrain and coming to rest upright between Runway 12 and the terminal ramp. The airplane was recovered to a secured location for further examination.

A Federal Aviation Administration aviation safety inspector performed a postaccident examination of the airplane on March 24, 2016. As a result of the examination, the inspector reported that the engine mount had punctured through the composite firewall. Additionally, the engine mount was observed to have sustained multiple fractures.

Prelim. Released?	Yes	Factual Released?	No	Probable Released?	No

Location of Inspection: Hartzell Propeller Engineering Test Lab, Piqua, OH	
Date of Examination: May 20, 2016	
Turbo Exam Witnesses:	**Representing:**
Les Doud	Hartzell Engine Technologies
Bob Craig	FAA Cincinnati FSDO (Delegated by NTSB)

Turbocharger Teardown Report

DATA TAG INFO:

Photo #1



General Condition: (Before Disassembly)

Photo #2 – Turbocharger assembly

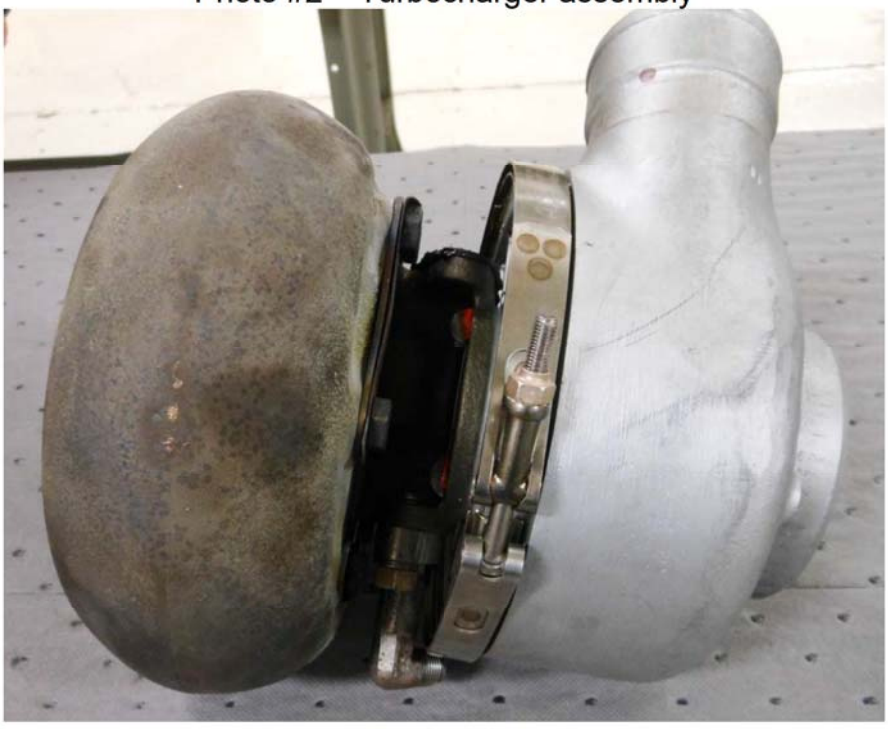


Photo #3 – Damaged turbine wheel and blades



Note any Additional Parts affixed to TC as received: There was an oil fitting attached to the oil inlet port. There was a stud, split lock washer and nut attached to one of the exhaust mounting flange holes

Are there any unusual discrepancies associated with any of these attaching parts? The oil fitting was attached with non-standard hardware. The mounting stud was also non-standard hardware. A portion of the oil drain port gasket was still attached and had evidence of RTV sealant being used as a gasket dressing.

There was no evidence of eroding, fretting, or damage to attachment/mounting surfaces.

The Turbine/Compressor Wheel/Shaft could be turned by hand but there was noted interference between the turbine wheel/blades and turbine housing during some segments of rotation. The measured resistance, axial or radial plays of the shaft were not measured.

Clearance Between T-Wheel blades and Housing Not for all blades

Clearance Between Impeller Blades and Housing Yes

Turbine Wheel Rub? Yes Witness Marks on T Hsg? Yes

Compressor Wheel Rub? Yes Witness Marks on C Hsg? Yes

V-Band(s)intact? Yes

- Safety wired? NA
- # of Threads from nut to end of shaft: 16.5
- Release Torque of nut: Tight but not measured

Clamps and Lockplates:
Number of **Clamps**: 1 Number of **Lockplates**: 3

- Are tabs on Lockplates folded over wrenching flats of bolt heads? Yes
- Condition of Compressor Housing: Intact with blade rub marks noted (see Photo #4).

Photo #4 – Compressor housing rub marks



There were no visible cracks or weld repairs on the turbine housing.

Markings on turbine housing: "LHK-30," "A/R1.58" and "5096A" on the exhaust mounting flange edge.

Foreign Object Damage / Bent Blades:

Turbine Wheel: None ____ Light ____ Moderate ____ Heavy **X** Extreme _____

Blade tips feather edged or torn? **Yes** ____ Less than 0.025? No _____

Compressor Wheel: None ____ Light X Moderate ____ Heavy ____ Extreme _____

Any Residual pieces? No

CHRA (Center Housing Rotating Assembly):

There was no evidence of oil sludge or coking in the center housing. The compressor wheel nut was tight but breakaway torque was not measured.

Heat Shield/Wheel Shroud: Height not measured

Compressor Wheel: Number Marking "Q51023"

Photo #5 – Compressor wheel



- Location of balance marks were noted on the bottom surface of the compressor wheel.

- There were no evident FOD impact marks, only blade tip rub and rubbing on compressor housing.

Turbine Wheel: The turbine wheel could not be removed from turbine housing due to blade creep increasing the wheel diameter larger than the opening (see Photo #6). The turbine wheel part number observed on the shaft assembly was "Q51018" and the wheel was "407579-2." The turbine wheel displayed a "reddish-white" discoloration indicative of excessive temperature.

Photo #6 – Turbine wheel blade tip damage and stretching

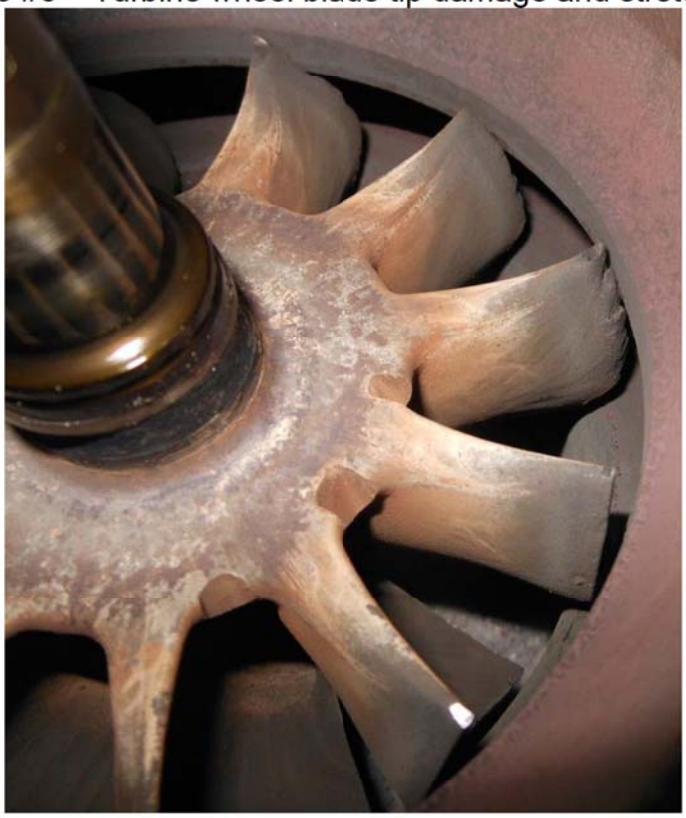
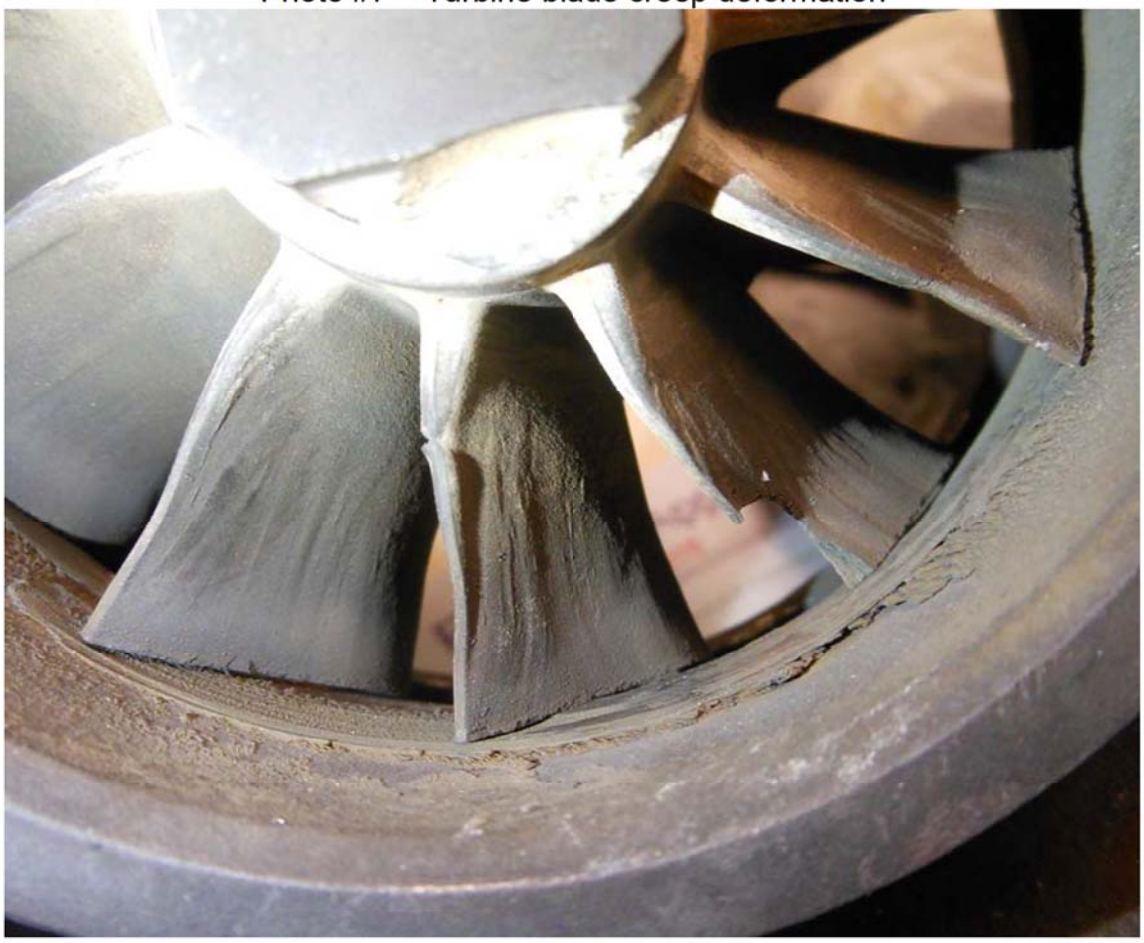


Photo #7 – Turbine blade creep deformation



Piston Rings: Placement and condition of the turbine side piston ring appeared normal. The turbine end shaft journal near the piston ring showed discoloration indicating high temperature. The compressor side piston rings appeared to be functional but showed scoring and debris impregnated into their surfaces and grooves.

Journal Bearings:

- Turbine Side: Circumferential scoring on ID
- Comp. Side: Circumferential scoring on ID
- Radial Holes: Clear
- Part Number Markings: (7134-0, H1212 PMA)

Thrust Collar: (see Photo #8)

- Radial Holes: Mostly clear, some blocked on the backplate side from seal bore lip debris.

- Some rotational scoring and wear on thrust bearing side with indications suggesting high temperature (black discoloring).
- There was evidence of rubbing against the backplate seal bore lip which fractured (see Photo#9) and generated debris/particles that appeared to be in the thrust collar, thrust spacer and piston rings.

Photo #8



Photo #9



Inboard Thrust Bearing:

- Some rotational scoring and wear on face area with indications suggesting high temperature (black discoloring).

Thrust Spacer: The OD of the thrust spacer showed rotational scoring and rubbing damage due to debris from the fractured backplate seal bore lip.

Back Plate: No part number was observed. The back plate had rotational scoring marks from contact with the bottom of the compressor wheel. The seal bore lip was fractured and the bore ID had rotational/circumferential scoring.

- Oil Squirt Holes: Clear

Center Bearing Housing: Part Number: 441320-0004 / 406294-3

- The cavity appeared clean and there was existence of residual oil.
- Oil Squirt Holes: Clear
- The oil outlet drain port was not restricted by coking.
- The outlet gasket was partially intact. The inlet gasket was intact. The outlet gasket had evidence of RTV used as gasket dressing.
- The oil inlet port had a 90° fitting with a restriction orifice; there was no evidence of a check valve being present.

Anti-Rotation Pins: All anti-rotation pins were present and appeared normal.

93 pictures were taken during the examination and are available in digital format.

Additional Comments:
The turbine wheel and blades had indications of being overtemped (EGTs greater than approximately 1650°F) and possibly oversped. The "reddish-white" discoloration of the turbine wheel suggests excessive exhaust gas temperature. Discoloration of the turbine end shaft journal is another indication of excessive temperature. Photo #7 shows how the turbine blade material deformed at high temperature and stress (creep). The combination of high exhaust temperature and wheel speed caused the blade material to creep (high temperature plastic deformation) and wheel diameter to increase until blades tips rubbed against the turbine housing. The blade tip rub and creep eventually caused blade tip failures (not determined if fatigue or overload), resulting in rotating imbalance that damaged the compressor bearing bore, compressor wheel rub and introducing debris/particles into the oil/bearings. The combination of imbalance and wheel rub likely resulted in the turbocharger rotation to slow or stop and thus loss of boost and engine power.

NASA Technical Memorandum 83699, "An Overview of the NASA Rotary Engine Research Program" implies that depending on mixture, a rotary engine exhaust gas temperature (turbo turbine inlet temperature) can exceed the material limit of 1650°F and that these "conditions over a period of time would cause failure of the turbine."

This turbocharger P/N (LW-12689) is used on the Piper PA-31 Navajo with the Lycoming TIO-540 with an exhaust gas temperature limit of 1650°F.

All evidence suggests that high exhaust gas temperature (turbo turbine inlet temperature) from the rotary engine exceeded the limits of the turbine wheel material, resulting in blade creep, blade rub, blade failures, rotating imbalance and eventual failure of the turbocharger.