Aviation Investigation Final Report

Location:	BUCKEYE, Arizona	**Accident Number:**	LAX98LA129
Date & Time:	March 24, 1998, 18:45 Local	**Registration:**	N4010X
Aircraft:	Ayres S2RT-34RE	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 None
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

An Ayres S2R airplane lost power and crashed following a landing attempt to a field. The subsequent disassembly of the engine revealed that the compressor turbine disk was intact, but that all of the CT blades were fractured across the airfoils adjacent to the blade root platform. The Canadian Transportation Safety Board's engineering branch found that there were 55 blades of one part number and 3 blades of another part number which were not authorized for use in a PT6A-34AG engine. The three unapproved blades had a different heat code than was approved for this engine. One of the unapproved blades revealed a fatigue fracture on the surface as seen by the scanning electron microscope. The blades were manufactured by Doncaster, under a FAA Parts Manufacturing Approval as an alternate part for PWC CT blades. They were then packaged and shipped to Superior Air Parts. Superior Air parts would repackage the blades in Superior Air parts packaging prior to reshipping the blades. Doncaster's stated that Superior was the sole distributor of the Doncaster blades. Both the quality control standards at Superior Air Parts and Air Force Turbine Services did not notice the three incorrect CT blades, which were shipped from Superior Air Parts and subsequently, installed on the engine. Additionally, when the engine underwent repair work and these blades were installed, the new CT blades were installed and the radial tip clearance between the blades and segments was 0.0025 inches less than the minimum required by the PT6 engine manual.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The incorrect turbine blades installed on the engine, the fractured compressor turbine blades and separation of the blade, and the improper maintenance installation of the incorrect CT blades by the repair station. A factor in the accident was the inadequate quality control

procedures by both the shipper of the CT blades and the maintenance facility which installed the blades.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation: CRUISE

Findings
1. (C) TURBINE ASSEMBLY,TURBINE BLADE - INCORRECT
2. (C) MAINTENANCE,OVERHAUL - IMPROPER - OTHER MAINTENANCE PERSONNEL
3. (F) INADEQUATE QUALITY CONTROL - OTHER MAINTENANCE PERSONNEL
4. (C) TURBINE ASSEMBLY,TURBINE BLADE - FATIGUE
5. (C) TURBINE ASSEMBLY,TURBINE BLADE - SEPARATION

Occurrence #2: FORCED LANDING
Phase of Operation: DESCENT - EMERGENCY

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - EMERGENCY

Factual Information

On March 24, 1998, at 1845 hours mountain standard time, an Ayres S2RT-34RE, N4010X, collided with the ground following a complete loss of power at Buckeye, Arizona. The power loss was attributed to an unknown mechanical malfunction to the turbine engine. The aircraft sustained substantial damage. The commercial pilot was not injured. The aircraft was operated by Pierce Aviation for the positioning flight under 14 CFR Part 91. Visual meteorological conditions prevailed at the time of the accident, and a flight plan was not filed.

The pilot stated that he was ferrying the aircraft back to Buckeye, and was at cruise flight at 500 feet above ground level when he heard a "loud bang, followed by flames coming out of both exhaust stacks." He said he also heard a high pitched growling sound. He established a glide and attempted to land on a nearby roadway. He said he determined that he could not land on the roadway due to power lines and poles, so he elected to land parallel to the roadway in the desert. During the landing attempt, the airplane came into contact with a small wash and slid sideways approximately 200 feet before coming to rest.

The aircraft was recovered and placed in a hanger at Pierce Aviation, Buckeye. The aircraft was examined at the hanger under the direction of the National Transportation Safety Board. The aircraft engine, serial number PCE-56415, was split at the "C" flange to visually inspect for damage, reassembled, and placed in a sealed container and shipped to Pratt and Whitney, Canada, for complete disassembly and inspection.

ENGINE HISTORY

The engine, a PT6A-34AG engine, serial number PCE-56415, had 9747.8 hours since new. The engine had been installed in the Ayres S2R airplane, N4010X, on March 14, 1998, at 9,708.8 hours time since new. The engine was removed from S2R airplane N5696X for installation in N4010X. The engine's records did not state the reason for the engine change.

On September 12, 1997, at 9435 total hours, the engine was repaired by Air Force Turbine Services under work order (WO) 02071, for a power turbine blade fracture. At this time of repair, the engine had a TSN (time since new) of 9,435.0 hours. At this time, the compressor turbine (CT) disk was "trued" and balanced, and the compressor turbine shroud segments were replaced. The records showed that Airforce Turbine trued the outer diameter of the CT disk assembly to 8.537 inches, and that the CT segments ID were machined to 8.556 inches. The engine was then returned to Pierce Aviation.

A new compressor (turbine) segment kit PN 3018503CL20PR was also installed in the inner exit duct after the segments were preground to 8.556 inches. The components were returned to Pierce Aviation and the engine was reassembled on September 15, 1997. The records did

not have any indication that the compressor segments were ground further that resulted in a radial clearance of 0.0095 inches between the blade tips and compressor segments. (8.556-8.537=0.019/2-=0.0095) The Pratt and Whitney Canada (PWC) PT6 engine manual requires a radial clearance between the CT blade tips and compressor segments of 0.012 to 0.015 inches.

On August 20, 1994, at 7206.0 total hours, the engine was repaired for overtemperature distress by Air Force Turbine Services under work order 01300. The records indicate that 58 CT blades were installed during the repair. A copy of the logbook record for repair on August 20, 1994, is attached to this report. Included in the records that Airforce Turbine Service submitted regarding the repair of engine PCE-56415 on August 20, 1994, was a copy of a label that was marked PN T102401-792, QTY. 58, Turbine Blade, 894, although the label did not have any company letterhead or logo marked. Airforce Turbine also submitted copies of a two-page Superior Air Parts, Inc., Turbine Blade Heat Code Log, dated August 12, 1994, that lists the heat codes for 58 parts; 55 blades were 7CAN and 3 were 8ENH. Also included was an invoice with no letterhead, dated August 16, 1994, shipping 58 PN T-102401-792 CT blades to Airforce Turbine Services, and, an Airforce Turbine Services purchase order addressed to Turbines, Inc, but with a fax label to Pierce Aviation, dated August 16, 1994, listing 58 CT blades 792 series. Copies of the Turbine Blade Heat Code Log and invoices are attached to this report. The records also show that the CT disk assembly outer diameter was machined to 8.555 inches, and the CT segments inner diameter was machined to 8.580 inches. The PT6 Maintenance Manual Section 72-50-02, Reference 318, requires a CT blade radial tip clearance of 0.012 to 0.015 inches.

VISUAL EXAMINATION OF THE ENGINE

The powerplant investigation was performed on April 28, 1998, at the Pratt and Whitney Canada Service Investigation Facility at St. Hubert, Quebec, Canada. The Safety Board arranged to have an investigator from the Transportation Safety Board of Canada represent them at the teardown.

The engine was received without any airframe-related equipment. The engine related controls and accessories were still attached to the engine except for the fuel nozzles, forward oil transfer tubes, and the flow divider, which were received separately. The propeller overspeed governor was not received. The exhaust duct to gas generator case flange, or "C" flange, retaining bolts were missing except for a few bolts. The engine did not have any apparent impact or fire damage.

The reduction gearbox housing and propeller shaft was intact. The exhaust duct housing was dimpled around the upper surface of the left-hand exhaust port. The gas generator case and accessory gearbox were not damaged. The power control and reversing linkage was loose at the reduction gearbox to exhaust case flange, "A" flange. The linkage was intact and continuous.

The compressor discharge airline was continuous and intact. All of the fittings and safety wire were tight and intact. The power turbine control line was continuous and intact. The propeller governor fitting was loose, and the safety wire was not in place. The other fittings and safety wire was tight and intact.

The reduction gearbox chip detector was clean. The oil filter had three fine particles of metallic debris. The P3 filter was clean.

The disassembly revealed that the CT disk was intact, but all of the CT blades were fractured across the airfoils adjacent to the blade root platforms.

ENGINE TEARDOWN

The compressor was not disassembled. The first stage blade tips were rubbed and corresponded to the circumferential rub on the shroud. The first stage stator vanes were bent towards the direction of the compressor rotation. The first stage stator vane tips were circumferentially rubbed and corresponded to rubbing on the first stage spacer.

The No. 2 bearing was observed in-situ after the bearing cover was removed. The bearing's outer race retaining nuts were fractured. The cage was deformed radially, and the No. 2 bearing rollers were lying loose in the bearing compartment. The bearing inner race was deformed radially outward. The bearing's races and rollers were wet with oil and did not have any rotational damage. The case generator No. 2 bearing support web was slightly deformed radially.

The combustion chamber liner, large exit duct, and small exit duct had no apparent distress. The flame pattern indications on the large exit duct appeared to be normal.

The CT guide vane ring airfoil's leading edges had no apparent distress. The trailing edges and the downstream surfaces had extensive pockmarks and gouging. The right-hand side of the vane ring's inner drum was circumferentially rubbed, was discolored, and had material smearing that corresponded to the circumferential rub on the CT disk. The vane ring positioning lugs were fractured from the ring.

The CT shroud had severe gouging and circumferential scoring. The shroud segments at the 6:00 and 8:00 o'clock locations were gouged completely through the segment material. The shroud housing was deformed radially outward and torn at the 12:00 and 6:00 o'clock locations.

The CT blades were fractured across the airfoils adjacent to the blade root platforms. The airfoil's fracture surfaces were circumferentially rubbed and smeared. The upstream side of the CT disk outer rim was rubbed circumfrentially for half of the circumference that corresponded to a rub on the CT guide vane ring. The interturbine temperature (ITT) probes were fractured. The ITT harness appeared to be intact.

The power turbine (PT) housing had circumferential scoring and gouging. The PT guide vane ring airfoils were extensively pockmarked and gouged. The upstream side of the interstate baffle inner cup was radially deformed and circumferentially rubbed and corresponded to a circumferential rub on the CT disk hub spigot. The PT shroud had severe circumferential rubbing, scoring, and discoloration that corresponded to the rubs on the PT blade tips. The PT blade leading edges were extensively pockmarked and gouged. There were 15 PT blades in a 90-degree arc that were fractured about 1/4-inch above the blade root platforms. The PT disk was intact.

The PT shaft could be rotated freely by hand. The propeller shaft rotated with the PT shaft. The PT shaft housing was not disassembled.

METALLURGICAL EXAMINATION

The Transportation Safety Board of Canada (TSB) engineering laboratory performed the metallurgical examination of the CT disk and blades. The visual examination of the CT disk and blades showed that the disk was intact and the 58 blades were fractured transversely across the airfoil adjacent to the blade root platform. The blades were removed from the disk and it was noted that 55 of the blades were part number (PN) T-102401-792A with a heat code of 7CAN that corresponds to IN_792 and 3 of the blades were PN T-102401-01F with a heat code 8ENH that corresponds to IN-738 alloy. The TSB's report stated that the blade manufacturer, Doncaster, advised that the CT blades made of IN-738 are not approved for use in the PT6A-34AG engines. All of the CT blades except one had surface cracks on the convex side of the airfoil. Scanning electron microscope examination of the one blade that did not have surface cracks, which was one of the PN T-102401-01F with a IN-738 heat code, revealed a fatigue fracture. A copy of the complete Transportation Safety Board of Canada Engineering Report No. LP 56/98, dated July 23, 1998 is attached to this report.

Pilot Information

Certificate:	Commercial	**Age:**	36,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Center
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	June 24, 1997
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	5600 hours (Total, all aircraft), 2800 hours (Total, this make and model), 80 hours (Last 90 days, all aircraft), 20 hours (Last 30 days, all aircraft), 7 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Ayres	**Registration:**	N4010X
Model/Series:	S2RT-34RE S2RT-34RE	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Restricted (Special)	**Serial Number:**	6024
Landing Gear Type:	Tailwheel	**Seats:**	1
Date/Type of Last Inspection:	March 14, 1998 Annual	**Certified Max Gross Wt.:**	6000 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo prop
Airframe Total Time:	9708 Hrs	**Engine Manufacturer:**	P&W
ELT:		**Engine Model/Series:**	PT6A-34
Registered Owner:	PIERCE AVIATION	**Rated Power:**	780 Horsepower
Operator:		**Operating Certificate(s) Held:**	
Operator Does Business As:		**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KGY ,959 ft msl	**Distance from Accident Site:**	
Observation Time:	17:45 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	20 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	90°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29 inches Hg	**Temperature/Dew Point:**	-5°C / 32°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	BUCKEYE (BXK)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	16:45 Local	**Type of Airspace:**	Class E

Airport Information

Airport:		**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	0	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 None	**Latitude, Longitude:**	33.380538,-112.549308(est)

Administrative Information

Investigator In Charge (IIC):	Childress, Deborah
Additional Participating Persons:	DEAN HENNIES; SCOTTSDALE , AZ J. D. DUNSON; TYNAN , TX JIM PIERCE; BUCKEYE , AZ DAVID FRESIA; IVORYTON
Original Publish Date:	February 16, 2001
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=30061