



Rolls-Royce

Engine Investigation Report

**Rolls-Royce Corporation
Model T63-A-720
Engine CAE 405061**



**Jack Johnson
Air Safety Investigations**

**Accident date: 30 July 2020
Investigation date: 13 October 2020
Engine Exam date: 26 January 2021**

**A-Farmer Service Corp.
Bell OH-58A/Arrow OH-5
N901XV
Holtville, California**

Background

On 30 July 2020, a Bell OH-58A (converted by Arrow Falcon Exporters for agricultural applications), registered as N901XV, was substantially damaged following a loss of power and subsequent hard landing while conducting agricultural applications. The pilot, who was the sole occupant, was injured.

The helicopter was recovered by the operator to their own facility at the direction of the NTSB Investigator in Charge. The helicopter remained at this location until 13 October 2020, when the wreckage was examined by a Rolls-Royce Air Safety Investigator under the auspices of the local FAA FSDO.

Following the wreckage examination, the investigation party agreed to remove the engine and ship it to an Approved Maintenance Repair and Overhaul Center (AMROC) in Broussard, Louisiana for test running on that facility's test cell as well as a more-detailed examination.

This report presents the observations made during the investigation.

Accident Flight

According to information provided to the NTSB, on 30 July 2020, the subject aircraft was engaged in aerial application of agricultural product. The helicopter had completed the application of two loads of product, then reloaded the product hopper to continue the job. The pilot had completed three passes over the target field and had climbed to make a fourth pass, when the helicopter lost power. The pilot performed a run-on auto-rotative landing, resulting in a hard landing and collision with several large hay stacks. The pilot received minor injuries.

Aircraft Information

Model	Bell OH-58A (Arrow-Falcon Conversion)
Serial Number	69-16273
Registration Number	N901XV
Airframe Total Time	UNK

Engine Information

Engine Model	Allison T63-A-720
Rating:	420 HP
Serial Number	AE-405061

Initial Wreckage Examination

Due to the ongoing pandemic, immediate examination of the crash site or wreckage was not possible. The wreckage was recovered by the operator to their own facilities at the direction of the NTSB. On 13 October 2020, a Rolls-Royce Corporation Air Safety Investigator examined the wreckage at the operator's facility under the auspices of the FAA's local Flight Standards District Office.

The aircraft exhibited damage consistent with a hard landing and frontal impact. The tail boom had been severed aft of the horizontal stabilizer from an apparent main rotor strike. The landing skids and application equipment were extensively damaged. The cockpit area was destroyed and the entire length of the fuselage exhibited vertical buckling associated with a hard landing. Both main rotor blades had been cut near the grips for transporting the wreckage.

The fuel bladder remained intact with no apparent loss of fuel. An improvised dip stick was used to determine that several inches of fuel remained in the fuel bladder. The fuel supply line to the fuel spray nozzle was disconnected to check for the presence of fuel. Approximately 1 teaspoon of fuel drained from the line, which is typical. The fuel was clear/straw color with no unusual odor and no visible entrained water or particulate.

All engine B-nuts and fittings were checked by hand for torque. All were found to be at least hand tight.

Due to cockpit damage, control continuity from the cockpit to the engine could not be established.

The compressor could be manually rotated. Rotation was smooth with no unusual binding or noise. The power turbine was also manually rotated with similar results. Rotation of the power turbine resulted in the corresponding rotation of the main rotor and tail rotor drive shafts. There was no evidence of significant turbine or compressor blade damage.

The investigation party agreed that testing the engine on a test cell would be in order, and the engine was removed by the operator and placed in a rollover stand to facilitate preparing the engine for shipment.

The upper and lower Magnetic Chip Detectors (MCDs) were removed and the remaining oil drained from the accessory gearbox. The drained oil was bright amber and exhibited no unusual odor. The upper MCD exhibited some minor fuzz, while the lower MCD exhibited significantly more fuzz. The MCDs were replaced in the engine and the engine was secured in a shipping container. The engine was subsequently shipped to Arrow Aviation in Broussard, Louisiana for testing.

Engine Examination/Testing

The subject engine was shipped to Arrow Aviation where it remained in its sealed shipping container until 26 January 2021. Under the auspices of the FAA's local FSDO, the engine container was opened and the engine placed in a rollover stand for examination. Due to the ongoing pandemic, the NTSB Investigator in Charge and a representative from the operator observed the engine examination via a remote video feed.

The upper and lower MCDs were again removed for examination, in preparation for testing the engine on a test cell. At this time, a solid piece of ferrous metal (approximately 2mm across) was observed attached to the lower MCD.

50psi shop air was applied to the engine's pneumatic control system, in order to check the pneumatic system for leakage. A soapy solution was applied generously across all pneumatic lines and fittings. An air leak was detected on the Pc line where it is fitted to the Fuel Control Unit. Although the B-nut was found to be finger tight, putting a wrench on this B-nut revealed it to have no appreciable torque. Close examination of the Pc line's ferrule, revealed no evidence of misalignment or damage. When tightened, the B-nut threaded and tightened normally. The B-nut was returned to its original condition as closely as possible, in order to determine its effect on engine performance. However, later findings would render the engine un-runnable. It should be noted that if the subject B-nut had completely disengaged during operation, the engine would have gone to idle power (but not completely flame-out).

After the pneumatic examination, the mechanic performing the exam removed the N1 and N2 tach generators. He then inserted a speed handle into the N1 tach generator drive pad and turned the N1 drive train. Although the N1 drive train rotated smoothly, there was no corresponding rotation of the compressor. The same process was repeated on the N2 tach generator drive pad, which resulted in a corresponding rotation of the N2 power turbine.

This finding indicated a disconnect of the compressor rotor from the N1 drive train.

The investigation party agreed to abandon engine testing, with the new focus being the disassembly and detailed examination of the engine.

The engine accessories were removed and set aside, allowing the removal of the compressor module.

Removal of the compressor module revealed significant damage to the Compressor / Compressor-Turbine (CT) Shaft coupling area.

The aft end of the compressor, the Spur Adapter Gearshaft and the Splined Adapter were all found extensively damaged. The resultant damage had disconnected the compressor from the N1 drive train, which would have rendered the engine inoperable. Rolls-Royce Service Engineering was consulted at this time in order to compile a list of components to be retained for metallurgical examination.

Removal of the compressor also revealed an unusual number of shims present on the compressor-to-accessor gearbox mounts. Per the Rolls-Royce Maintenance Manual, a maximum of 0.020" of shimming is permissible on any single mount. One mount was found to have 0.036" shim, while another mount had 0.022" shim. There was no record of shimming in the engine's log book. (A

standard “shim card” is included in all Rolls-Royce M250 engine log books. It is standard practice to record the compressor’s shimming during module installation.)

It should be noted that, according to the engine log books and the operator, the compressor module had been replaced on 10 June 2020 by a third party maintenance provider (Del Rio Aviation).

The rest of the engine was then examined in detail.

The turbine module was removed from the accessory gearbox. The engine's Outer Combustion Case (OCC) was then removed to facilitate examination of the turbine module. The OCC exhibited no significant damage or deformation. Removal of the OCC exposed the Inner Combustion Liner, which was removed and examined. The Combustion Liner exhibited no evidence of abnormal combustion, thermal degradation, streaking or operational damage.

Removal of the Liner exposed the Gas Generator Turbine (Turbine Stages 1 and 2). The Turbine Nozzle Shield was removed and examined. It exhibited no evidence of operational damage. Some residual soot on the Combustion Liner and turbine blades and stator vanes was consistent with a small post-crash “stack fire” which is typical when unburnt fuel is allowed to pool in a hot engine.

The accessory gearbox was then opened and examined. It exhibited no evidence of operational failure or damage associated with the previously-noted damage. Rolls-Royce Service Engineering had requested the oil delivery tube (Piccolo Tube) be returned for examination. During the tube’s removal from the accessory gearbox, it was noted that its associated filter screen was significantly contaminated with a black substance. This screen was also retained with the hardware to be examined in the laboratory.

There were no other significant findings during the remainder of the examination.

The investigation party agreed to return the following parts to Rolls-Royce Failure Analysis Laboratory to detailed metallurgical examination: Compressor Rotor Assembly, Spur Adapter Gearshaft, Splined Adapter, Oil Delivery Tube, Compressor-Turbine Shaft, and both Magnetic Chip Detectors with their captured debris.