



Rolls-Royce

Engine Investigation Report

**Rolls-Royce Corporation
Model T63-A720
Engine AE-405936**

**Model: Bell OH-58C
Registration: N942SC
Serial: 68-16872**



Model T63-A720

**Nick Shepler
Air Safety Investigations**

**Spalding County Sheriff Dept.
Griffin, Georgia**

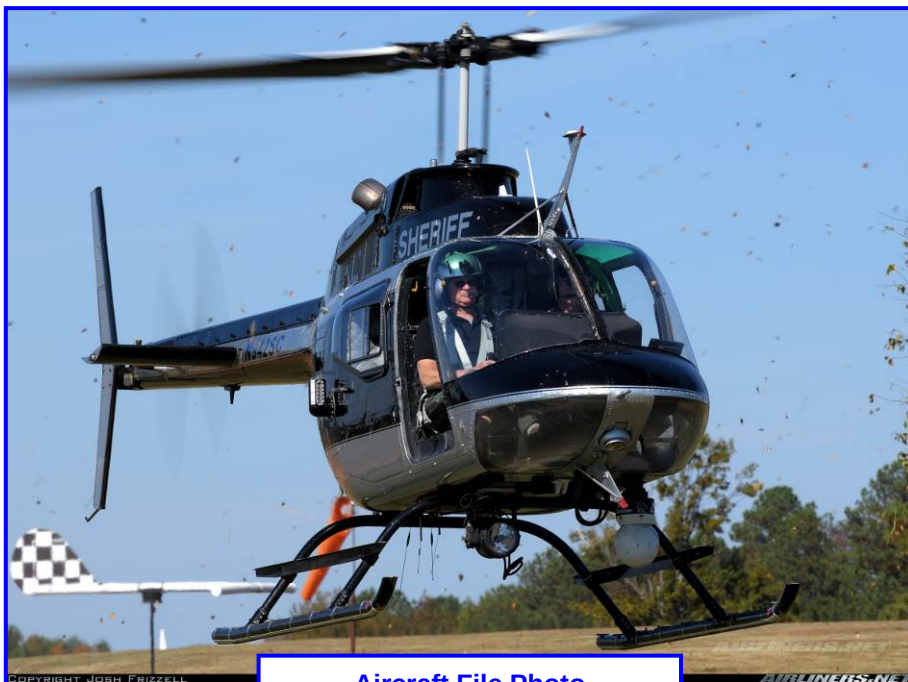
**Accident Date: 29 January 2018
Investigation Date: 22 February 2018
Engine Test Date: 6 March 2018
Report date: 21 March 2018**

Background

On 29 January 2018, a Bell OH-58C operated by the Spalding County, GA Sheriff Department, registration number N942SC, was damaged following a reported power loss while conducting auto-rotation training, in Zebulon (Pike County), Georgia.

The pilot (instructor) and passenger (student) were not injured. Daytime visual meteorological conditions prevailed and no flight plan was filed for the local flight.

The aircraft was subsequently recovered to Atlanta Aircraft Salvage in Griffin, GA.



Aircraft File Photo

This report presents the observations made during the investigation.

Aircraft Information

Model	Bell OH-58C
Serial Number	68-16872
Registration Number	N942SC
Airframe Total Time	8707.2 Hours
Hobbs	1150.7 Hours
Last Inspection	14-Jul-2017 (100 hour inspection)
Time since last inspection	110.9 hours

Engine Information

Engine Model	Rolls-Royce T63-A720
Rating:	420 HP
Serial Number	AE-405936
Engine total hours/cycles	8707.2 Hours / (2067 Cycles at last inspection)
Last inspection	110.9 Hours (100-300 hour inspection)

Accident Flight

NOTE: The author of this report did not attend the accident site examination but was provided photographs and related documentation by the NTSB-IIC.

The flight crew was conducting power recovery auto-rotation training operations. They had successfully performed 4 autos when on the 5th attempt they experienced a reported power loss on climb out. The instructor pilot was on the controls at the time of the event. At about 200' AGL, recovery commenced to complete the maneuver. On the main rotor RPM/N2 engine tachometer, the needles were joined by rolling up the throttle. The collective pitch lever was raised and the helicopter gained altitude in a climb out.

The pilot stated that within 4-5 seconds power was lost while at about 125' and 25 knots. He checked to verify that the throttle was fully open. Feeling no changes in the decelerating engine, he glanced at the N2 RPM and proceeded to lower the collective to maintain main rotor RPM. The needles were split with the N2 RPM needle pointing down at approximately 65-70%. At that point the pilot cycled the throttle from full open to idle and back to full open. No discernible change in engine response was noted. He does not recall hearing the engine out alarm during the event.

By this time the helicopter was in a nose low attitude at approximately 100-125'. The pilot rolled the throttle to the idle detent to prevent any surge on deceleration should the engine respond. Around 15-20', deceleration with an aggressive flair was initiated to help recover the decaying main rotor RPM. Ground contact was smooth while leveling the skids. During the ensuing ground run-on, the helicopter traveled over a 6-8" terrace. The tail boom kicked up as the helicopter slid over the raised ground. The subsequent drooping main rotor RPM allowed for main rotor blade contact with the tail boom. The tail boom also suffered buckling damage aft of its attachment to the fuselage structure.

Following the 5' ground run the aircraft came to a stop, and the fuel - battery switches were switched off. The pilot reported a smoke odor and gray smoke coming from engine exhaust ducts. There was no report of fire. Neither of the 2 crew members was injured as a result of the accident.



Aircraft at Accident Site

Aircraft Examination

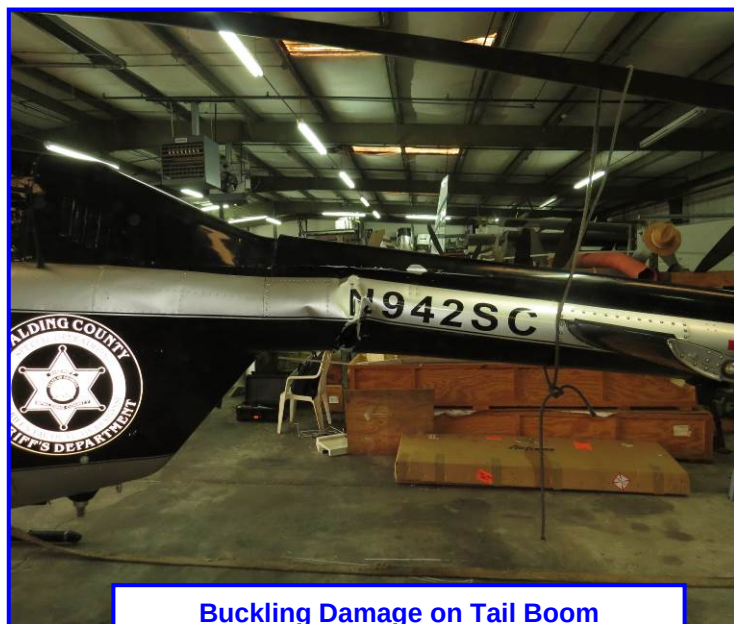
The aircraft was recovered back to Atlanta Air Salvage in Griffin, GA. Recovery examination was conducted 22-Feb-2018 at Atlanta Air Salvage under the auspices of the NTSB. Representatives from the NTSB and Rolls-Royce Air Safety participated in the investigation examination.



As-Recovered Condition of Helicopter

The aircraft exhibited damage consistent with the pilot's statement of a run on landing while traversing slightly undulating terrain. The tail boom was buckled and partially fractured approximately 12-18" aft of its attachment point with the fuselage. The top of the tail rotor drive shaft cover was damaged from contact with a main rotor blade tip. Neither of the main rotor blades exhibited visually extensive damage indicating the blade strike was relatively light.

Both the main and tail rotor drive shafting systems were intact and continuous. The skids did not appear to be spread and there was no readily visible damage to the fuselage structure other than that noted in this report.

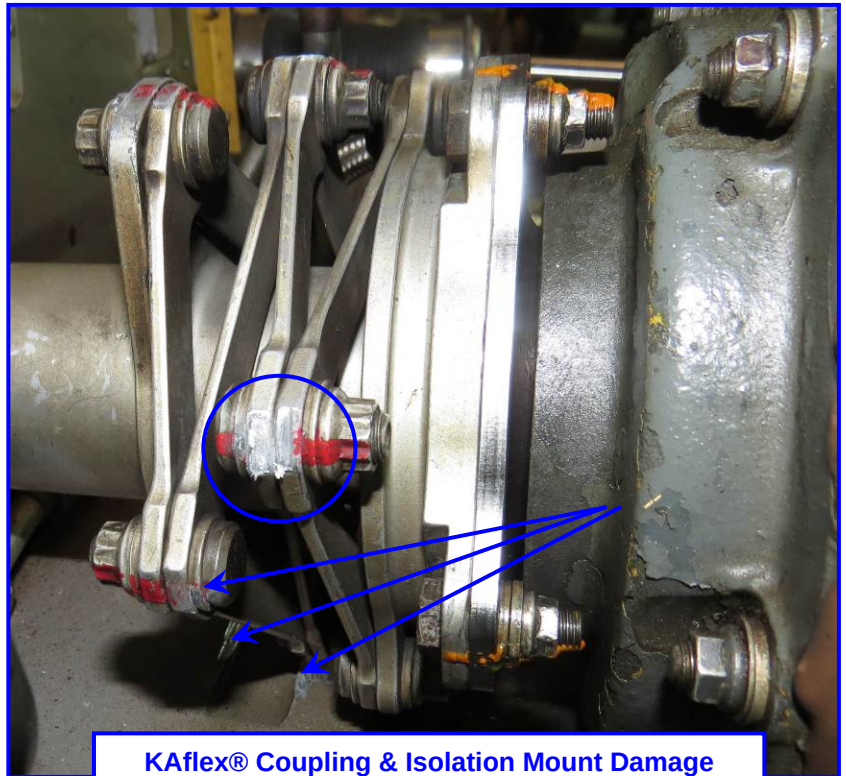


Buckling Damage on Tail Boom

The engine to transmission drive shafting (KAflex® style) was completely intact. There was contact between the forward flex coupling at the transmission and the isolation mount. The rotating portion of the swash plate contacted the shroud around the main rotor mast.



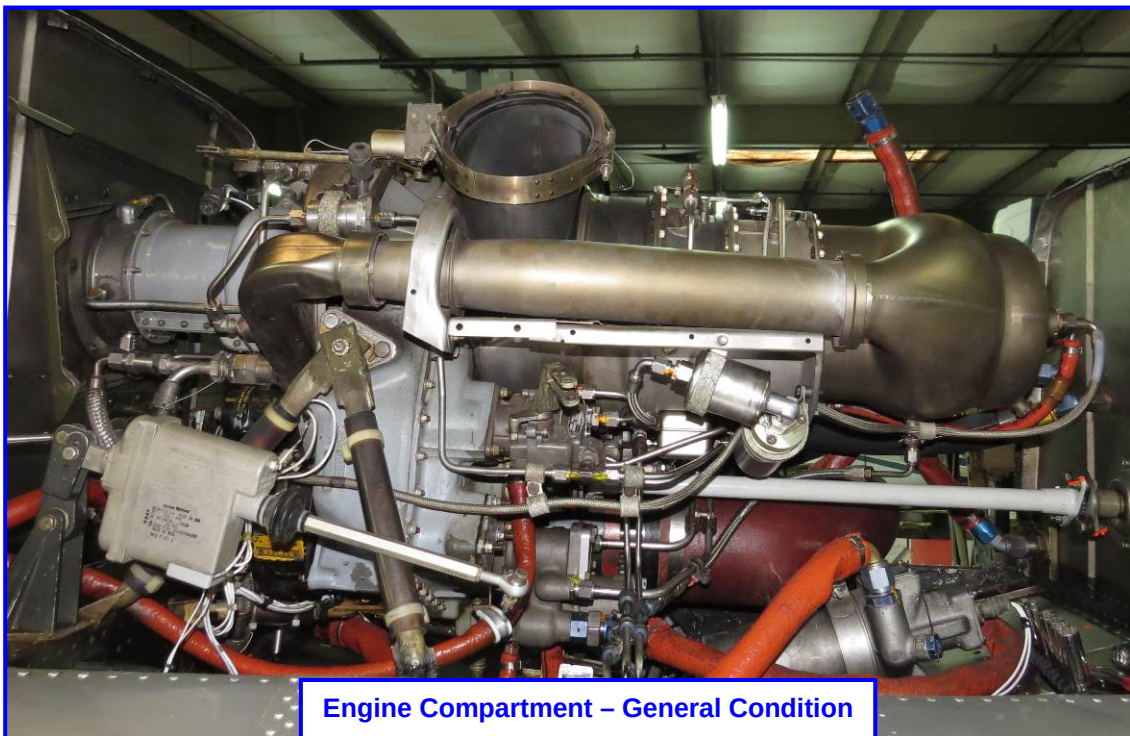
Fuel Quantity Gauge



KAflex® Coupling & Isolation Mount Damage

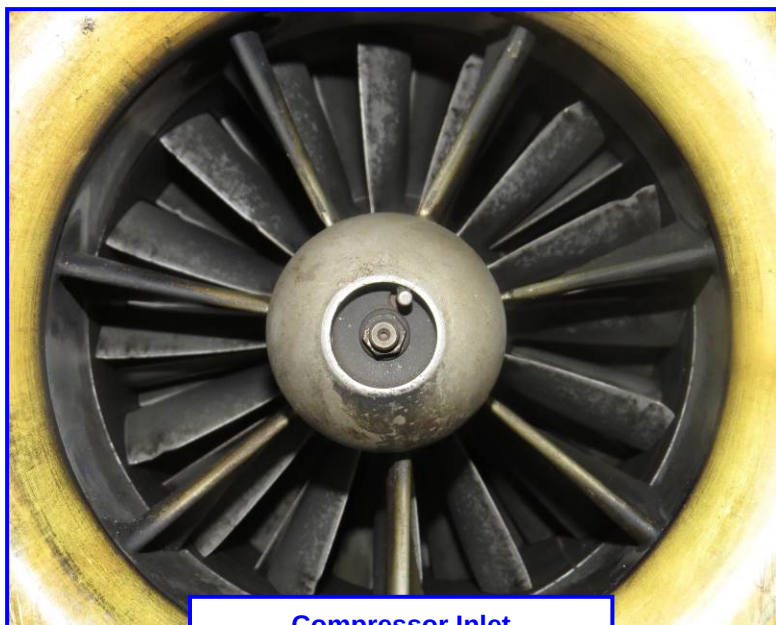
When aircraft power was applied the fuel quantity gauge read 240 lbs. The airframe fuel shutoff valve was in the ON position and the boost pump circuit breaker was pushed in. Power was applied and the boost pump functioned properly as indicated by fuel flowing out of the discharge side of the aircraft fuel filter housing. The fuel appeared clean and clear. The aircraft fuel filter was not removed and inspected.

The engine remained within the engine compartment and the engine mounts showed no immediate signs of damage. Initial inspection of the engine exterior did not reveal any obvious signs of damage from impact forces, internal engine failure, or evidence of fire. All B-nuts were found to be at least hand tight and torque stripe painted.

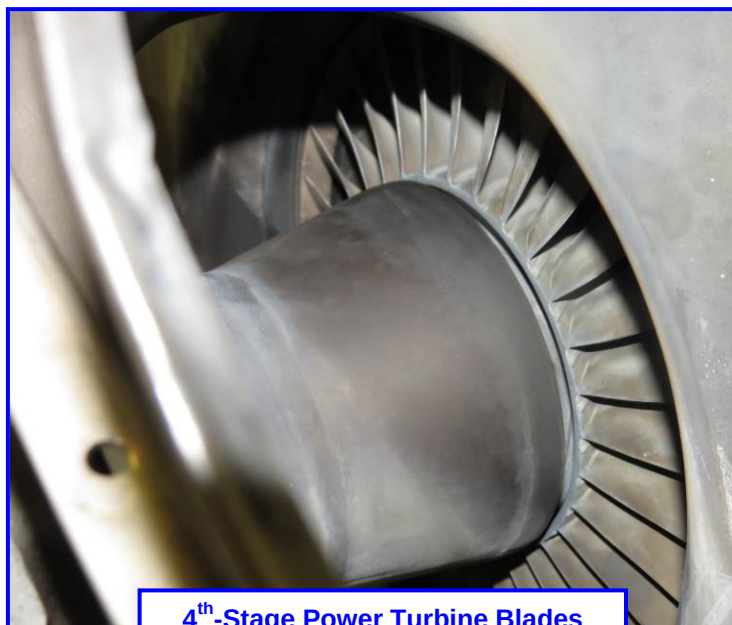


Engine Compartment – General Condition

The compressor inlet guide vanes, struts, and 1st-stage airfoils were noticeably dirty with random blacken color throughout. The 1st-stage blades were void of any noticeable impact damage or FOD but did contain a number of blades with leading edge blends. The 4th-stage turbine blades appeared undamaged as did the surrounding turbine sections and exhaust plenum.



Compressor Inlet



4th-Stage Power Turbine Blades

Control continuity was established from the collective twist grip to the engine FCU & PTG. Both N1 and N2 rotors could be rotated by hand and were smooth and quiet. Continuity from the power turbine to the power output and tail rotor output shafts was established. Continuity was confirmed throughout the N1 rotor system from the impeller to the starter-generator cooling fan.

Fuel was detected up to the fuel spray nozzle. Approximately ½ teaspoon of fuel was drained from the flex line between the turbine fire shield check valve and the fuel spray nozzle. The magnetic chip detectors were not pulled and inspected during the recovery examination. The oil supply and scavenge lines to and from the engine were full and exhibited no sign of obstruction or blockage. The oil appeared clean and clear.

Based on the initial findings and circumstances of the event, the NTSB-IIC recommended the engine be removed and prepared for test run at Keystone Turbine Services.



Engine Removal Process



Engine Ready to Ship

On 6 March 2018, the subject engine was removed from the shipping container at Keystone Turbine Services, in Coatesville, PA with NTSB-IIC oversight. Prior to prepping the engine for test a number of additional investigative actions were performed.

The fuel spray nozzle was removed and examined. There was no evidence of obstruction in the fuel spray nozzle inlet. The spray face exhibited a heavy carbon and soot appearance. There did not appear to be any blockage within the air distribution holes. The nozzle was not disassembled further.

Both the upper and lower Magnetic Chip Detectors (MCDs) were removed and examined. No evidence of flakes or related metallic debris was noted on either MCD. The lower magnetic chip detector plug was removed to facilitate oil drainage and an appropriate amount of oil (~1/2 liter) was drained from the gearbox. The engine pressure oil filter was not removed and inspected.

The bleed valve was operated by hand. The poppet valve smoothly travelled its full stroke and exhibited no radial play. A functional check of the bleed valve using shop air pressure was not performed.

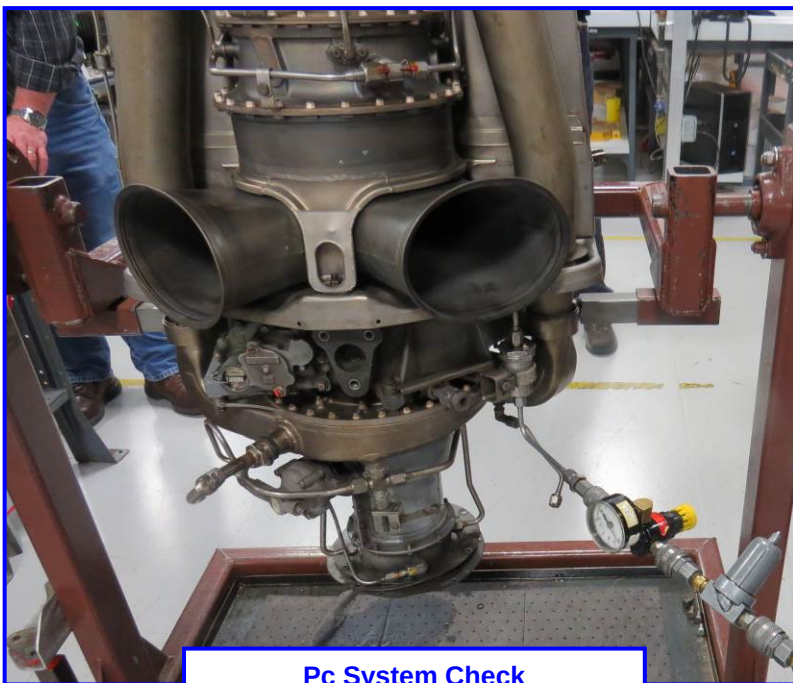
A check of the Pc system was performed using shop air at the inlet side of the Pc air filter at 80 psi. A soapy water solution was applied to the Pc system B-nuts and rigid tubing. Pressure was then reduced to 20 psi to check for leakage at the governor diaphragm. No leaks were detected anywhere throughout the system.



Fuel Spray Nozzle Condition

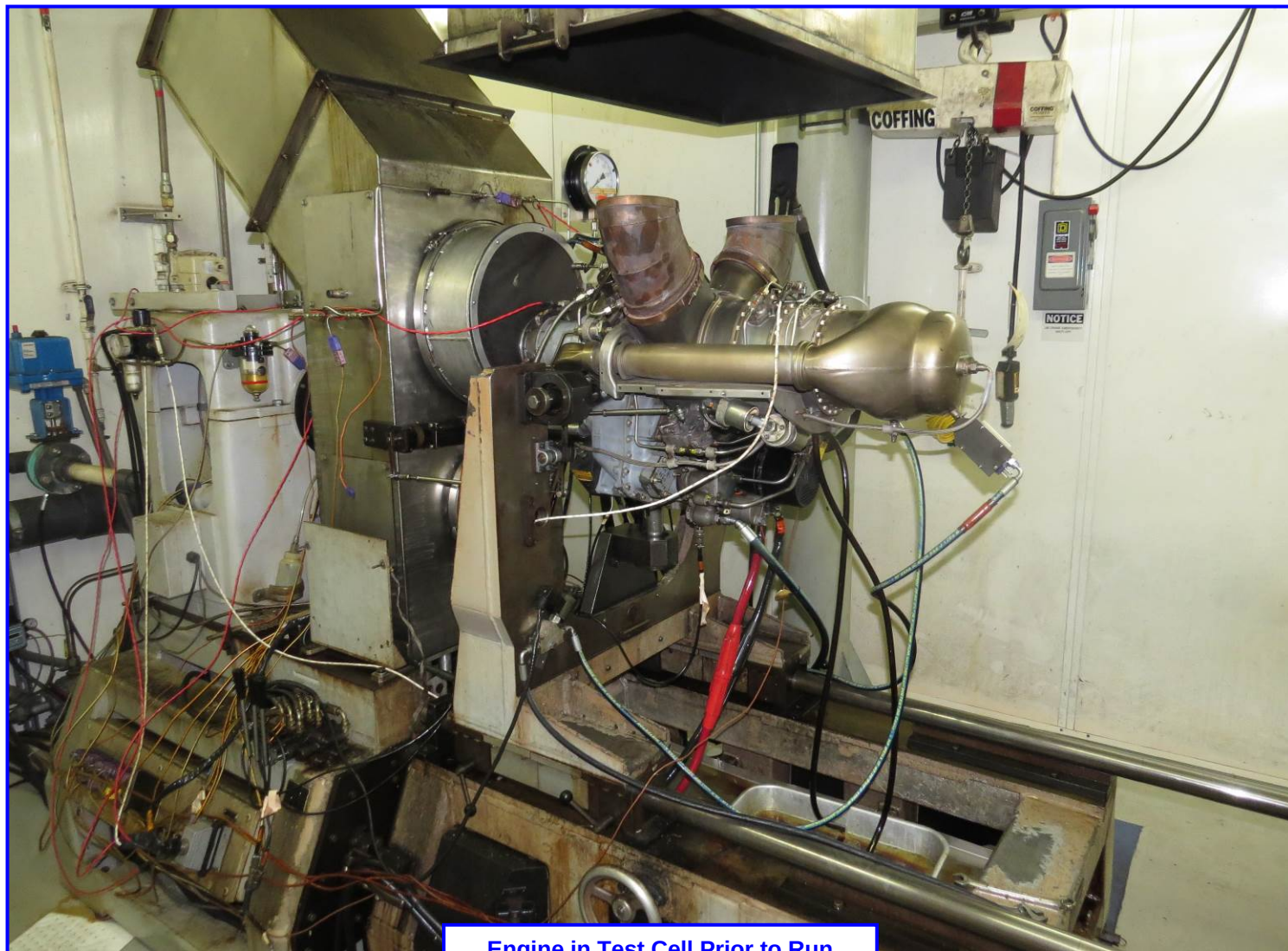


Engine Bleed Valve



Pc System Check

Upon completion of standard test cell preparedness tasks by Keystone technicians, the engine was considered acceptable to run on the test cell. The engine was installed on a test cell and a 6-point performance test was conducted to new engine production (model M250-C20B) standards, in accordance with Rolls-Royce M250-C20 Overhaul Manual (Publication ref. 10W3) revision 13 dated 15 August 2017.



Engine in Test Cell Prior to Run

The engine successfully started, ran and shut down. The engine successfully completed ground idle, flight-idle, max-continuous-power, and take-off power runs. When corrected for standard atmospheric conditions, the engine yielded performance 6.3% above new-production standards at "low cruise" (300 horsepower), 4.9% above new-production standards at normal cruise (370 horsepower), and 10.5% above new-production standards at maximum (Take-Off) power (420 horsepower). The engine then completed "wave-off" max-power transients where the power was reduced to flight idle and then rapidly increased to take-off power. The engine responded normally and responded with maximum power without surging or hesitation.

The testing was terminated following successful completion of the wave-off test and power calibration activities. The engine was removed from the test stand and delivered back to the inspection and preparation area at which point the engine was placed in the turnover stand, redressed with its originally shipped components and placed back into the shipping container.

Engine Maintenance and Records

Component	Serial Number	Part Number	TSO	Total Time
Engine	AE-405936	6887191	2838.1	8707.2
Gearbox	AE-405936	6879863	N/A	Unknown
Compressor	AC-18466	6890570	Unknown	Unknown
Turbine	AT18299	23038244	2838.1	Unknown
Governor	87141525	23030648	Unknown	Unknown
Fuel Control	BR53402H	23065105	Unknown	Unknown
Bleed Valve	FF46214	23053176	Unknown	Unknown
Fuel Pump	T108191	6899253	Unknown	Unknown
Fuel Nozzle	1WF00350	23077068	527.2	Unknown

Summary of Findings

- There was no evidence of pre-impact fire, damage, or malfunction of the engine.
- The engine performed satisfactorily on the test cell.
- All available evidence suggests the engine was capable of producing sufficient power and responding to throttle inputs.