



Rolls-Royce

Engine Investigation Report

**Rolls-Royce Corporation
Model 250-C30M
Engine CAE 900172**



**Jack Johnson
Air Safety Investigations**

**Puerto Rico Electric
Power Authority
Vega Baja, Puerto Rico**

**Accident date: 24 July 2015
Investigation date: 30 July 2015
Engine Examination date: 15 September 2015**

Aircraft Information

Model	MD-369FF
Serial Number	0137FF
Registration Number	N5842Z
Airframe Total Time	4,952.6 Hours

Engine Information

Engine Model	Rolls-Royce 250-C30M
Rating:	650 HP
Serial Number	CAE-900172
Engine Total Hours	4,961.2 Hours
Time Since Overhaul	956.8 Hours

Accident Flight

On 24 July 2015, an MD369FF helicopter, registered as N5842Z, was substantially damaged after making an emergency landing following a reported loss of power while in cruise flight from San Juan to Arecibo, Puerto Rico. The pilot successfully made an auto-rotative landing to the ocean shoreline; however, before the helicopter could be recovered, the incoming tide partially submerged the helicopter, resulting in substantial damage. The occupants were not injured.

The helicopter was operated by the Puerto Rico Electric Power Authority (PREPA), and was being used to transport two passengers at the time of the event.

History

Prior to the accident flight, on 22 July 2015, the operator reported that the helicopter had experienced an ENG CHIP caution light illumination while in flight. A precautionary landing was made and the engine's magnetic chip detectors (MCDs) were examined. A small amount of metallic paste was found on the lower MCD. The MCDs were cleaned and a 30-minute ground run was completed without additional ENG CHIP lights.

The helicopter was flown back to its base, where the MCDs were again checked and verified to be free of debris. An additional 30-minute ground run was completed, and then the engine oil was changed. A sample of this oil was sent for analysis. Analysis indicated the oil sample was "acceptable", and the aircraft was released for operation.

On the day of the accident, the helicopter had flown 30-45 minutes before landing to refuel. The helicopter then took off and flew an additional 15 minutes before the pilot reported hearing a loud 'bang' and subsequent loss of power.

Following the successful auto-rotation and landing, the pilot reported that the engine was no longer running.

Wreckage Examination

The helicopter was recovered by the operator to hangar facilities owned by the operator.

On 30 July 2015, representatives from Rolls-Royce, MD Helicopters, PREPA and the FAA examined the helicopter at PREPA's facility near San Juan, PR. (The engine was subsequently removed from the airframe and sent to Rolls-Royce's facility in Indianapolis, Indiana for detailed examination).

The wreckage was presented for examination in a hangar belonging to PREPA.

The tail boom and main rotor blades had been removed by recovery crews. The landing skids were not spread, and there was no evidence of a hard landing. Two main rotor blades exhibited evidence of low-energy impact, likely from contact with the tail boom. The tail rotor had been severed from the tail boom; the tail rotor drive shaft exhibited minor twisting, and had fractured in several locations.

When examined, the anti-torque pedals were found with the left pedal floored, the cyclic roughly centered, and the collective in the full-down position; the throttle was in the 'OFF' position.

Control continuity was established from the anti-torque pedals to the severed ends of their respective control tubes in the tail boom. Control continuity was also established from the collective and cyclic to the main rotor, and from collective and throttle twist-grip to the engine.

The engine cowlings were then removed to facilitate engine examination.

Initial Engine Examination

Inspection of the engine exterior revealed no evidence of fire or uncontained failure. Corrosion was beginning to take place on the engine's exterior, presumably exacerbated by saltwater emersion.

Engine oil was present in the oil sight glass. The oil level was at the mid-point between the high and low level marks. The engine oil was drained and collected in preparation for removing the engine. The oil was dark, opaque and contained entrained slivers and chips of ferrous metal. The oil exhibited no unusual odor. Examination of the airframe-mounted engine oil filter revealed similar conditions, with captured metallic debris in both the filter bowl and filter element. The engine-mounted oil filter's bypass indicator did not indicate a bypass condition.

The engine was then removed from the airframe by PREPA mechanics to facilitate examination.

The Fuel Spray Nozzle (FSN) was removed to facilitate examination of the Gas Generator Turbine. The FSN exhibited normal carbon coating of the spray face, as well as corrosion on the FSN body. A boroscope was then inserted into the FSN port. Boroscope examination revealed corrosion throughout the combustion liner and thermal erosion of the 1st Stage Turbine Blades.

The Power Turbine was visually inspected; no evidence of operational failure or foreign object damage was noted.

The Exhaust Collector exhibited no evidence of high-energy debris or damage.

The compressor was visually examined. A light grey powder was noted around the compressor inlet, which was consistent with a compressor surge. The compressor could not be rotated by hand.

Given the findings from the initial engine examination, the parties agreed to ship the engine to Rolls-Royce's Indianapolis facility for disassembly and detailed examination. The engine was placed in an engine shipping container and delivered to Rolls-Royce's secure investigations room.

Engine Detailed Examination

The engine was shipped to the Rolls-Royce facility in Indianapolis, Indiana for disassembly and detailed examination. The engine was delivered to the secure Rolls-Royce accident investigation facility and remained in its unopened shipping container until 15 September 2015, when the engine was examined under the auspices of the Federal Aviation Administration.

The engine was removed from the shipping container and placed in a rollover stand for examination. The initial examination revealed evidence of excessively high temperatures on the compressor scroll. This evidence was consistent with the compressor rotor contacting the scroll during engine operation.

Given the initial findings from the compressor, the investigation party agreed to remove the engine oil filter assembly in order to inspect the #2 Bearing and its oil supply tube (Piccolo Tube) prior to engine disassembly. Removal of the filter exposed the #2 Bearing, and it was evident the #2 Bearing was damaged. The Piccolo Tube was found installed correctly and undamaged.

The compressor module was then removed from the engine, disassembled and examined.

Examination revealed the #2 Bearing (part number 23009670) to have a fractured ball separator, as well as evidence of thermal distress, and spalling of the balls and races. The bearing was removed for detailed examination by Rolls-Royce's Failure Analysis Laboratory.

Metallurgical Examination Summary

Metallurgical examination of the #2 Bearing revealed a thermal distress pattern consistent with the bearing operating with a forward thrust load and possible reduction in oil flow to the bearing. The composition of the #2 Bearing components were consistent with the material types specified by design.

X-ray examination of the #2 Bearing's Oil Delivery Tube (commonly referred to as the "piccolo tube"), revealed no evidence of obstruction or restrictions, and the inlet screen was free of debris.

Engine Maintenance and Records

Component	Serial Number	Part Number	TSO	Total Time
Engine	CAE-900172	23062052	956.8	4961.2
Gearbox	CAG-97692	23053333	New	4961.2
Compressor	CAC-98503	23065557	New	4961.2
Turbine	CAT-98502	23066662	956.8	4961.2
PT Governor	BR42223	23065125	2957.2	4961.2
Fuel Control Unit	BR50770	23087146	UNK	UNK
Bleed Valve	FF43926	23073353	UNK	UNK
Fuel Pump	JG01AKY0100	23070461	New	2957.2
Fuel Spray Nozzle	1MX03805	23077067	956.8	4961.2

Summary of Findings

Engine examination revealed #2 Bearing damage consistent with a thermal event associated with insufficient oil flow.

The oil delivery tube to the #2 Bearing was found free of obstruction.

Rolls-Royce has issued Commercial Engine Bulletin CEB-72-3299 to address this issue by calling for the replacement of the oil delivery tube with an improved design.