

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR24FA132

POWERPLANTS FACTUAL REPORT

January 27, 2026

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A. ACCIDENT

Location: Anaconda, Montana
Date: April 26, 2024
Time: 06:59 local time
Helicopter: Bell B206L-4, Registration Number N988B

B. POWERPLANTS GROUP

Group Chair	Harald Reichel National Transportation Safety Board Washington, D.C.
Party Coordinator	Nick Shepler Rolls-Royce Engines Indianapolis, Indiana
Party Coordinator	Matthew McLuckie Bell Helicopter Fort Worth, Texas

C. SUMMARY

On April 26, 2024, at 0659 mountain daylight time, a Bell 206-L4, N988B, powered by a single Rolls Royce (RR) M250-C30P turboshaft engine, was destroyed when it was involved in an accident near Anaconda, Montana. The pilot was fatally injured. The helicopter was operated as a Title 14 Code of Federal Regulations Part 137 aerial application flight.

The pilot had been conducting flights to distribute fertilizer from the same staging location for several days. The helicopter approached the load truck a third time that day, heading to the northwest, flying a similar approach as before. The helicopter appeared to hover over or near the load truck for 2-3 seconds and then turned and flew away in an easterly direction. The helicopter reapproached the load truck and appeared to complete a third onload of fertilizer. The helicopter then departed and climbed to the west and appeared to accelerate and climbed out normally to about 200 feet above the ground. About 20 seconds after departing the load truck the helicopter rotated about 180° to the left and descended rapidly in a nose-low attitude until it went out of view behind terrain. There were no known witnesses to the accident sequence.

The ground crew member, who was in regular communication with the pilot, attempted to contact him via radio when he did not return when expected, however, received no response. A company representative was conducting other work duties from his truck, which was positioned southwest of the load truck. He also thought it strange that he hadn't heard the helicopter for a while and drove to a different location behind where he was parked to see the area. During the drive, he saw the helicopter in a nearby gully. He drove back to pick up the ground crew member, responded to the accident site, and initiated an emergency call to 911.

Examination of the accident site revealed that the helicopter came to rest in a mostly upright position immediately adjacent to a flat and dry pond area in a gully about 855 feet southwest of the load truck. The fuselage came to rest oriented to a heading of about 060°. The bottom of the fuselage exhibited crushing deformation, and the left skid was splayed outward. The helicopter is equipped with two main rotor blades. One main rotor blade was fractured and separated about 3 feet from the rotor attachment point just outboard of the blade doubler and the fracture surfaces exhibited downward deformation. The remainder of the fractured blade was located about 15 feet forward of the helicopter. The second main rotor blade remained attached to the rotor mast and exhibited some bending opposite rotation. The spreader bucket and 25 foot long-line were located about 30 feet aft of the helicopter and were not attached to the helicopter, consistent with separation prior to impact. The long-line attachment shackle was undamaged. Fuel was observed leaking from the wreckage following the accident.

An external examination of the engine revealed no un-containment, or fire damage. The engine was removed from the airframe and shipped to the RR factory in Indianapolis, Indiana, where it was examined by the powerplant group on June 25 and 26, 2024. Several parts were retained for analysis by the RR laboratory.

The turbine-to-compressor coupling shaft was found rotationally distorted and fractured into three pieces. Heavy coke¹ buildup was observed in the forward and aft spline locations of the turbine-to-compressor coupling shaft. Coking was noted between the turbine-to-compressor coupling shaft and the power turbine (PT) outer and inner shafts. Extensive coking was noted upon removal of the power turbine-to-pinion gear coupling shaft.

Most of the surface of the oil screen in the piccolo tube was coated with oily coke deposits. One of the No. 3 bearing oil jets of the piccolo tube was restricted, and the other was blocked.

¹ Coke is a residue with a high carbon and low hydrogen content that is the final product of thermal decomposition of engine oil or fuel.

D. DETAILS OF THE EXAMINATION

1.0 Powerplant

1.1 Engine Description

The engine was a RR M250-C30P turbo-shaft engine (**Figure 1**), which features a gas generator which is composed of a single-entry centrifugal flow compressor directly coupled to a two-stage gas producer (GP) turbine. The compressed air from the compressor is diffused and then, via an external 180° compressor discharge tube system is directed into the combustor. The hot gases from the combustor drive the two-stage GP free turbine and subsequently a two-stage power turbine (PT) before being exhausted. The internal reduction gearbox has front and rear drive flanges to mate with the aircraft drives. The output shaft center line is located below the center line of the engine rotor. A hydro-mechanical fuel control unit (FCU) manages the engine power. The RR M250-C30P produces 650 shaft horsepower at takeoff.

The engine consists of four modules, three of which are serialized: the compressor module, the accessory gearbox (AGB) module, and the turbine module. The combustor assembly is not serialized.

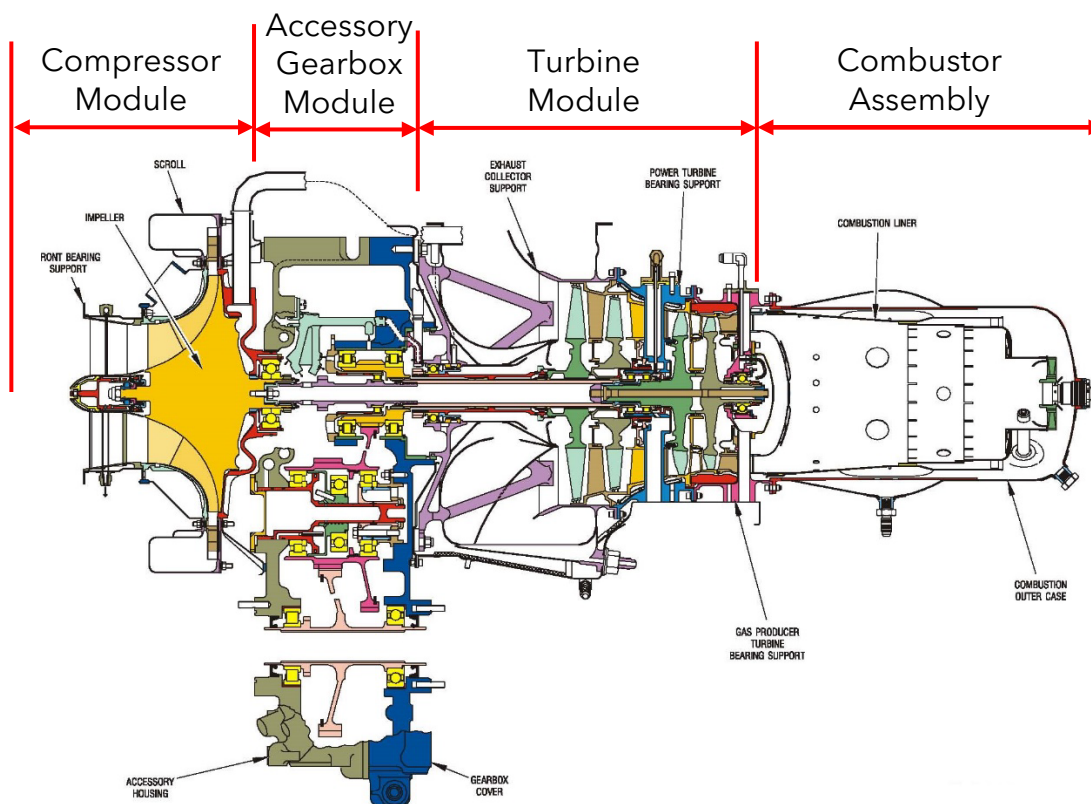


Figure 1 - Rolls Royce 250 Generic Cross Section - Courtesy Rolls-Royce

1.2 Engine Background

1.2.1 History

The engine was a RR 250-C30P, part number (P/N) 23004545, serial number (S/N) CAE-895785. The AGB assembly data plate identified it as P/N 23035178 and S/N CAG-95793. The turbine assembly data plate identified it as P/N 23035128 and S/N CAT-97719. The compressor assembly data plate identified it as P/N 23051643 and S/N CAC-91719.

A review of the logbooks revealed that the total time since new (TSN) of the engine was 7742.2 hours. The last 150-hour scheduled inspection occurred 49.2 hours before the event. The last major service was performed by Redding Air Service, Inc. Redding California in March 2019 with an engine total time of at 6328.1 hours.

1.2.2 Maintenance

According to the logbook, oil monitoring was done within the required 150-hour intervals ([Table 1](#)). The last four oil level inspections were:

Date of 150 Hour Inspection	Engine Oil Brand	Engine Hours
September 21, 2023	Mobil Jet 254	7515
October 8, 2023	Royco 560	7584
November 15, 2023	Mobil Jet 254	7610
October 8, 2023 ²	Royco 560	7693

Table 1 – 150-hour Oil Level Inspections

It is noted that two different oil brands were frequently mixed. The logbook entries state only that the MM requirements of the oil system were complied with, considering the short intervals (averaging 60 hours) between inspections, it is likely that the oil was topped up and not drained and filled. No record of oil consumption was made.

The RR M250-C30 Series Operation and Maintenance Manual (MM), Section 72-00-00, pages 43 to 45, lists the approved oils allowed for this engine and limitations of mixing oils. Both oils are synthetic turbine oils that conform to the same performance specification MIL-PRF-23699; however, manufacturers do not recommend mixing them because the proprietary additives packages may interact in unexpected ways that may affect the oils' thermal stability, oxidation resistance, or deposit control, potentially leading to undesirable effects or reducing their effectiveness. No significant study has been conducted on the performance or

² Suspected erroneous logbook date entry.

consequences of mixed oil. It is unknown if the mixing of oil brands influenced the carbon deposits found throughout the engine.

2.0 Engine Examination and Disassembly

2.1 General Condition

The engine was in a metal shipping container which was opened in the presence of the NTSB (**Photo 1**). It was externally clean and intact (**Photo 2**). There was no evidence of an un-containment or external impact or fire.



Photo 1 - RR M250-C30P S/N CAE-895742 - As Received

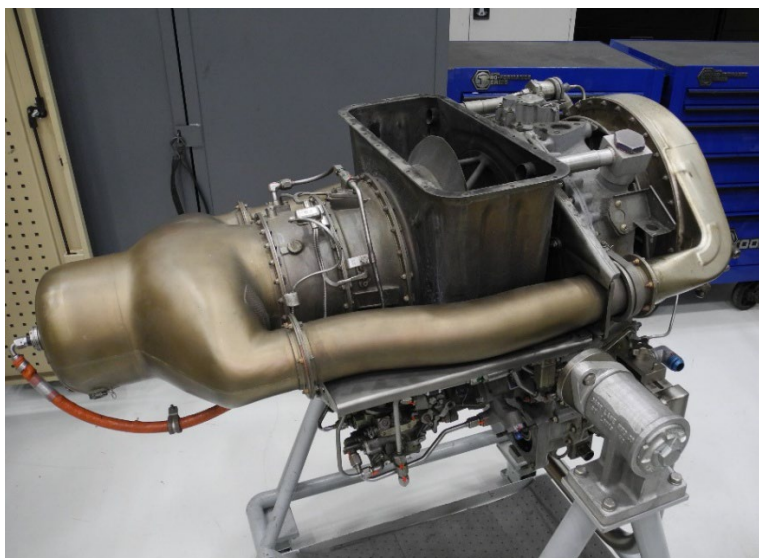


Photo 2 - Externally Generally Clean and Intact

The power takeoff (PTO) spline of the AGB (**Photo 3**) and starter/generator inner spline were intact and undamaged.

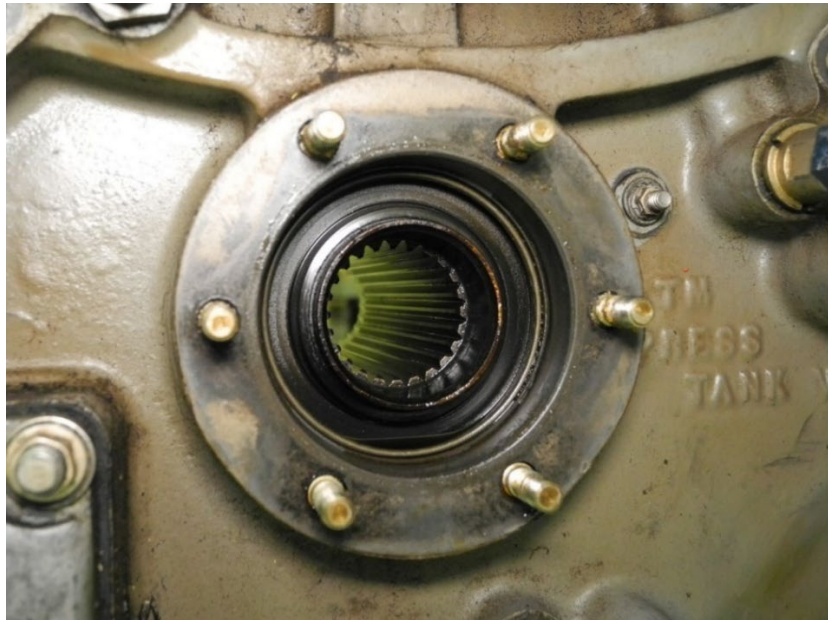


Photo 3 - AGB Power Takeoff (PTO) Spline - Undamaged

The FCU/fuel pump assembly (**Photo 4**) was intact, undamaged, and secured to the AGB. The power turbine governor (PTG) housing was fractured at the assembly split line, exposing the internal components; however, its mount flange was still attached to the AGB (**Photo 5**).

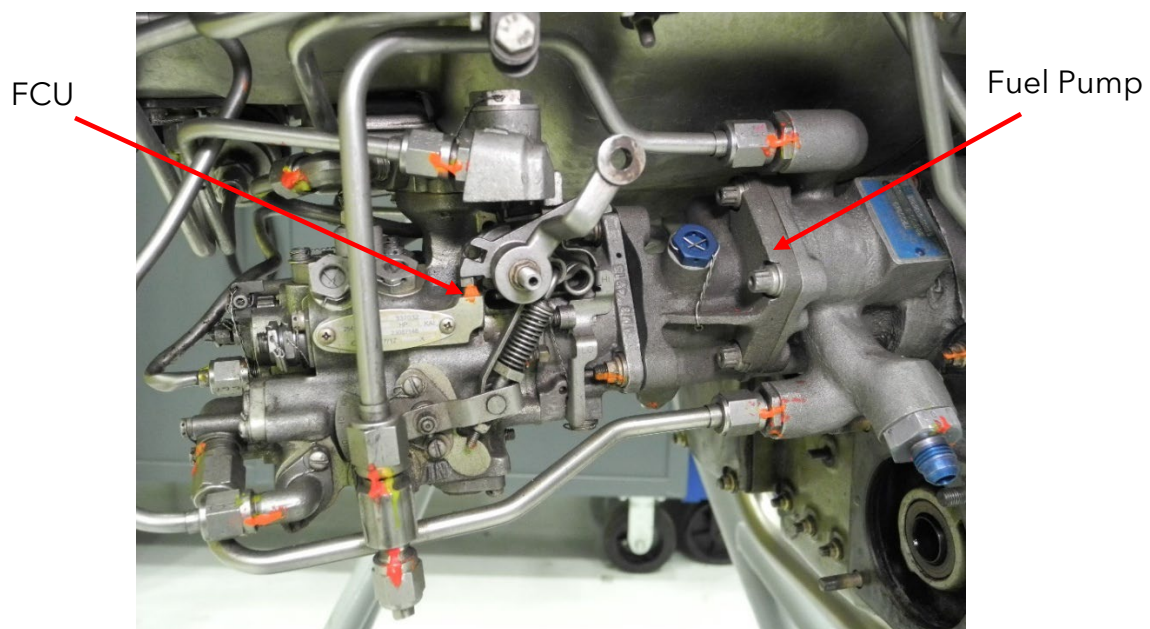


Photo 4 - FCU/Fuel Pump Assembly - Undamaged

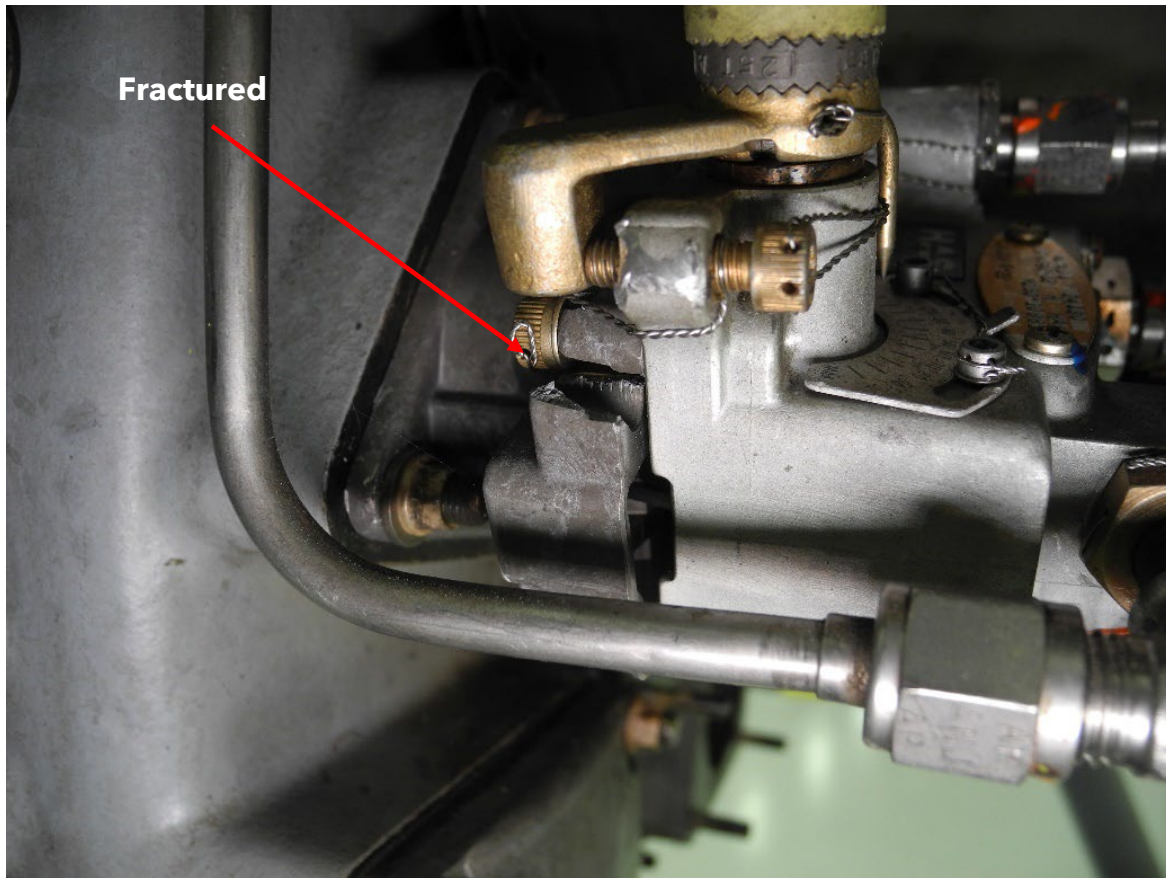


Photo 5 - PTG - Fractured Housing

Fuel Nozzle

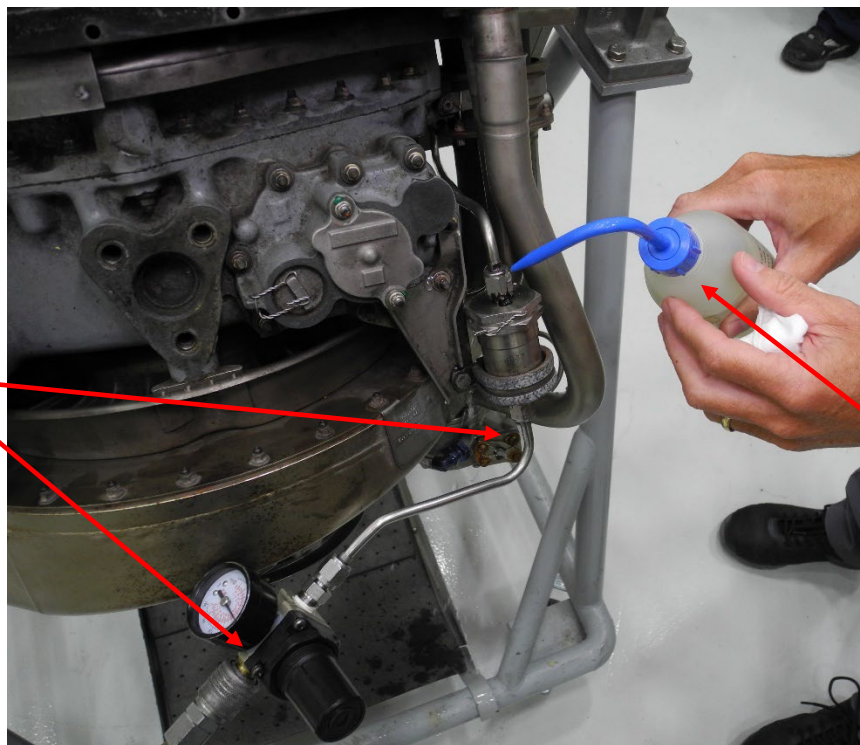
It was reported that during the wreckage review the fuel spray nozzle was removed and examined, revealing unobstructed fuel spray nozzle inlet and air distribution holes. It was noted that the spray face exhibited a uniform, black carbon layer. The nozzle body was safety-wired and was not disassembled further.

Pneumatic System

All the Pc³ tubes between the Pc filter, PTG, and FCU and the were intact; however, some tubes were deformed, consistent with impact. The Pc system tubes and fittings were tested for integrity and leaks by introducing an 80 pounds per square inch (psi) air source into the Pc filter and spraying a special leak detector fluid on all the tubes and fittings (**Photo 6**) and observing for the presence of air bubbles. No leaks were found.

³ Small external tubes relay air pressure from the compressor (Pc) to the FCU and PTG, which use the Pc pressure as feedback signal to determine power that is being produced by the engine. A loss of pressure due to a leak in the Pc system will cause the engine to roll back to idle.

80 psi Air
Pressure
Directed
into the Pc
Filter



Leak
Detector
Fluid

Photo 6 - Pc Leak Test Being Performed

The inlet was free of debris and the leading edges of the impeller vanes (**Photo 7**) were undamaged.



Photo 7 - Impeller - Undamaged

The exhaust collector was intact. All the blades of the 4th stage turbine wheel (2nd stage power turbine) were intact (**Photo 8**); however, most of the blade shrouds were rotationally scored, consistent with contact against 4th stage wheel seal. The outer rim was fractured in one location.

Outer
Shroud
Fractured
in One
Location



Photo 8 - 4th Stage Turbine Wheel

When the compressor impeller was turned, the starter generator, N1 tachometer generator and the FCU pad splines rotated in unison; however, there was no corresponding rotation of the GP (or N1) turbine, consistent with a discontinuity in the GP spool shaft. When the PT (or N2) rotor was turned, there was corresponding rotation of the accessory PTO spline and the N2 tachometer generator pad spline, consistent with an intact PT shaft.

Chip Detectors & Oil Content

It was reported that the AGB upper and lower chip detectors were inspected in the field and did not contain any magnetic debris. The AGB did not contain any oil; however, it was reported that two quarts of oil was drained from the AGB in the field, which is a normal oil quantity in the cavity.

2.2 Compressor Module

The compressor module (**Photo 9**) was intact and undamaged and the compressor impeller turned freely and smoothly, consistent with the No. 1 and No. 2 bearings being undamaged so the assembly was not further disassembled.



Photo 9 - Compressor Module - Undamaged

The spur adapter gearshaft (SAG) (**Photo 10**) was intact and undamaged. The No. 2-½ bearing inner race land of the SAG was intact and displayed minor witness marks, consistent with normal operation. The turbine-to-compressor coupling mating spline on the SAG was intact. The two O-ring grooves were undamaged; however, no visible evidence of either O-ring was found in the grooves (**Photo 11**). Small black granular particles were found still adhering to the SAG.

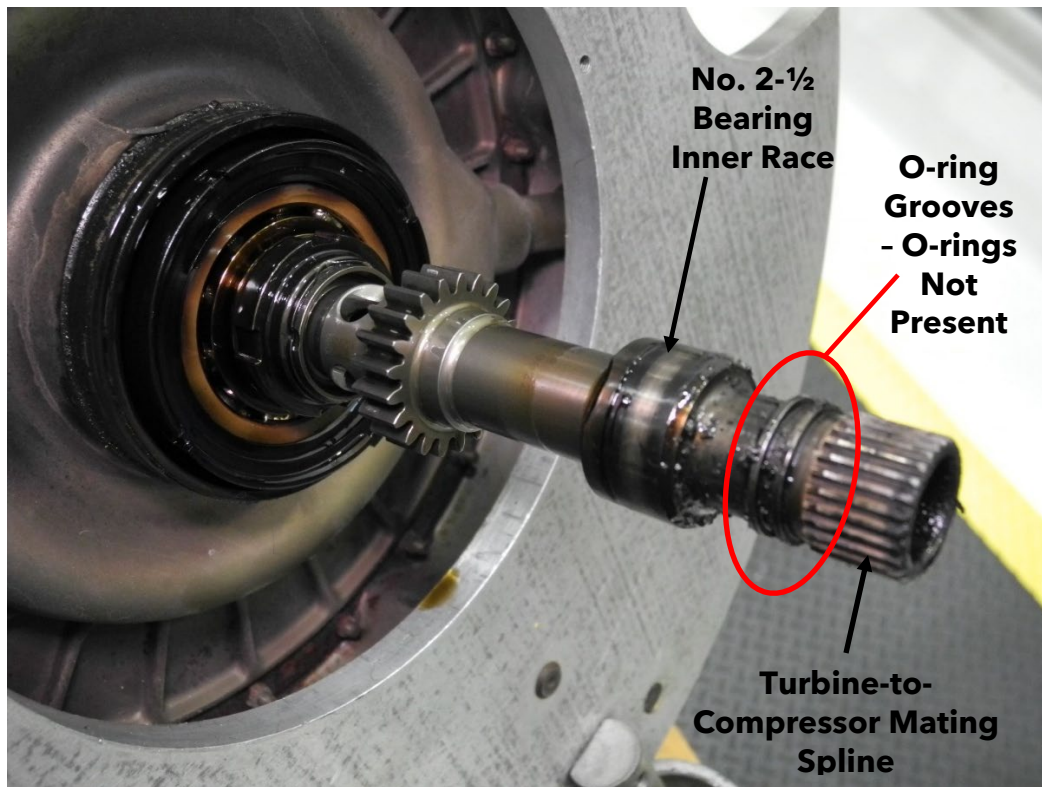


Photo 10 - Spur Adapter Gearshaft (SAG) - No O-rings Present

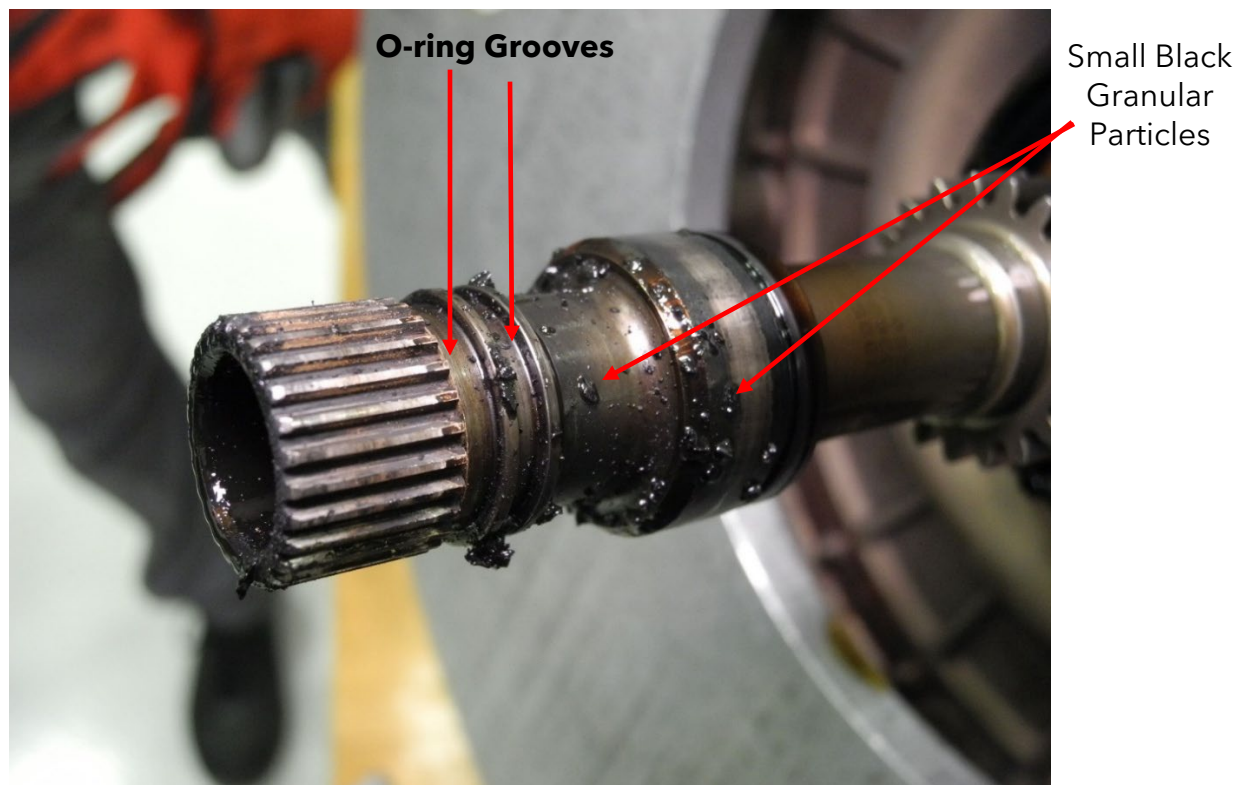


Photo 11 - SAG - Detail of O-ring Grooves - No O-rings Present

The SAG was sent to the RR materials laboratory which performed a microscopic examination of the O-ring grooves as well as a Fourier Transform Infrared Spectroscopy (FTIR) analysis of the black granular particles that were found adhered to the SAG (**Photo 12**). The findings were:

- 1) The axial span of deposited coked oil is indicated by the yellow dimension and was observed in the turbine-to-compressor spline roots, tooth tips, and just forward into the O-ring groove.
- 2) No evidence of coked oil was observed in the forward O-ring groove is indicated by the white dimension.
- 3) The FTIR analysis of the black granular particles collected from the SAG sleeve revealed minor fluorocarbon rubber signatures consistent with O-ring material.

This FTIR analysis and laboratory microscopic findings indicate that at least one O-ring was installed in a groove during the last assembly; however, it had completely disintegrated and no longer in the groove. According to RR technical representatives, the complete disintegration of an O-ring, leaving no remaining material within the grooves, has not previously been observed.

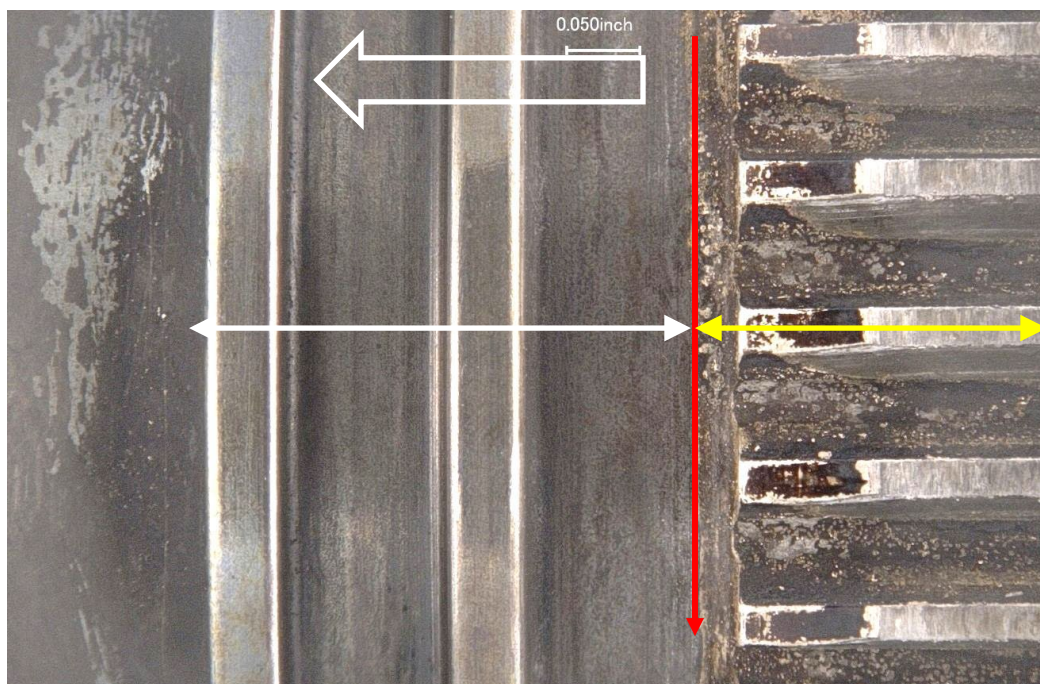


Photo 12 - Detailed view of the SAG O-ring Grooves and Turbine-to-Compressor Mating Spline - Image Taken After Cleaning - Courtesy RR

One possible cause of turbine-to-compressor coupling failure is linked to missing SAG O-rings. The importance of the SAG O-rings is depicted in **Figure 2**. See the reference numbers **1** to **5** on the figure.

1 Oil flows from the piccolo tube into the SAG. The oil from the piccolo tube lubricates the compressor and turbine ends of the SAG. The oil that is jetted into the SAG is pumped by centrifugal action due to the rapid rotation of the shafts.

2 Oil flows to the compressor adaptor coupling. An excess amount of oil is jetted to the compressor end of the SAG. The excess oil flows to the turbine end of the shaft via grooves in the oil dam.

3 Oil flows down the SAG to the turbine end of the engine.

4 Oil continues from the SAG to the turbine-to-compressor coupling. Some of the oil flows into the spline joint between the SAG and turbine-to-compressor coupling. The O-rings at this interface prevent excessive oil from flowing through the spline joint into the gearbox. Excess oil flows to the turbine-end of the shaft.

5 Oil flows through the spline joint at the turbine adaptor coupling and spills out at the end of the turbine-to-compressor coupling.

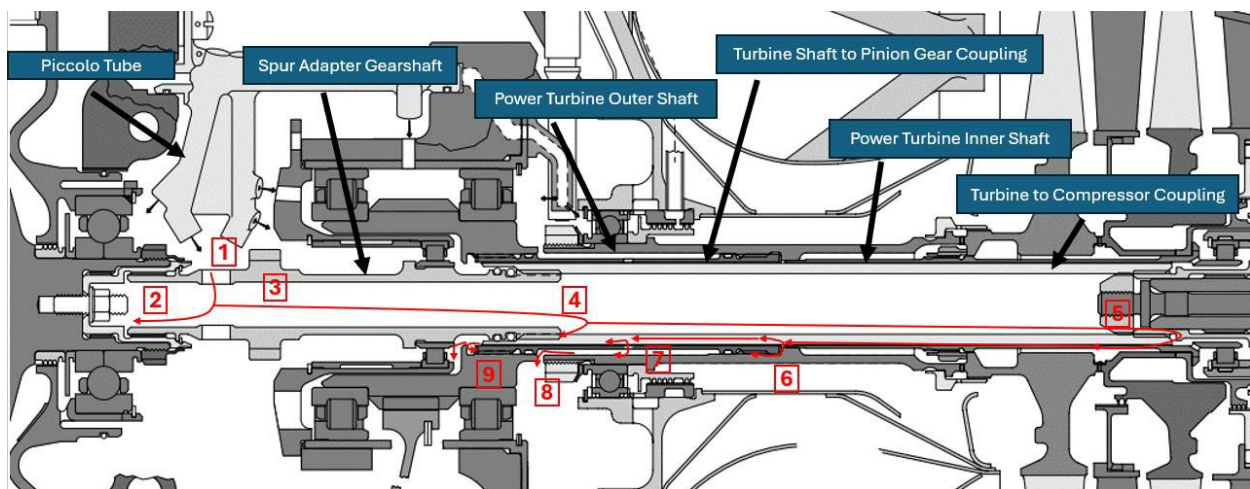


Figure 2 - Cooling Oil Flow Through Shafts - Courtesy Rolls Royce

The lower jets in the piccolo tube direct cooling oil flow through the SAG side openings and then along the inner wall to the turbine-to-compressor coupling. If the SAG O-rings are split or missing, the cooling oil flow will leak through the forward SAG splines, causing insufficient cooling oil flow to reach the turbine-to-compressor coupling, causing overheating and failure.

According to RR, there have been two failures of C30 model engines that were attributed to damaged or missing SAG O-rings. Because the previous engine failures occurred at less than 700 hours without the SAG O-rings being present, the question of when they escaped the O-ring grooves in this event was considered.

If the O-rings had disintegrated at some time before the turbine-to-compressor coupling failure, then the black granular particles that were found adhering to the SAG would have been centrifuged off the shaft because of the high rotational speed of the SAG during normal operation. It is therefore likely that the O-rings were still in the grooves at the time of the engine failure and that they were extruded due to the whirling of the non-parallel shafts after the turbine-to-compressor coupling failure.

2.3 Accessory Gearbox (AGB) Module

The AGB was externally intact and undamaged (**Photo 13**). The internal components were oil wetted and rotated normally.



Photo 13 - AGB - Undamaged

The oil filter was removed and found to be clear of debris, oil wetted; however, carbon or coke stained (**Photo 14**).

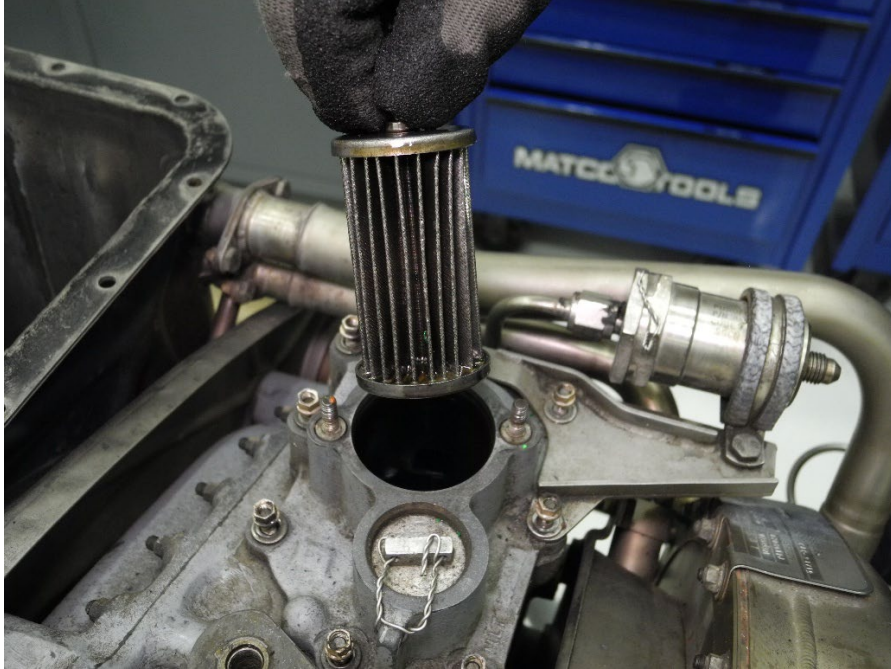


Photo 14 - Engine Oil Filter - Clean

The pressure oil filter housing was removed from the gearbox to visually assess the oil delivery (piccolo) tube and surrounding gear components. The engine gearbox was opened to facilitate inspection of the internal components, gears, bearings, torquemeter, & oil pump (**Photo 15**). All the components were in position and visually free of abnormal wear indications.

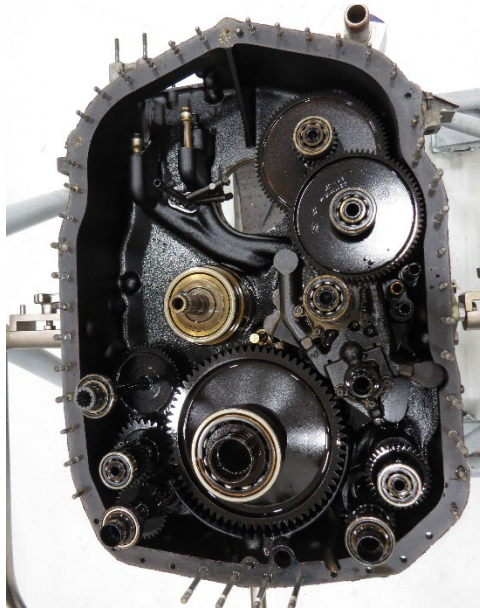


Photo 15 - Gearbox - Opened to Inspect Internal Components

The piccolo tube ([See Figure 3](#)) was installed correctly in the AGB ([Photo 16](#)) and the nozzles were externally clean. The piccolo tube features an inlet screen and five nozzles which direct oil to (1) No.2 bearing, (2) 1st stage N2 reduction gears (3) No. 3 bearing, (4) SAG holes which lubricate the turbine to compressor coupling splines and (5) No. 2-½ bearing.

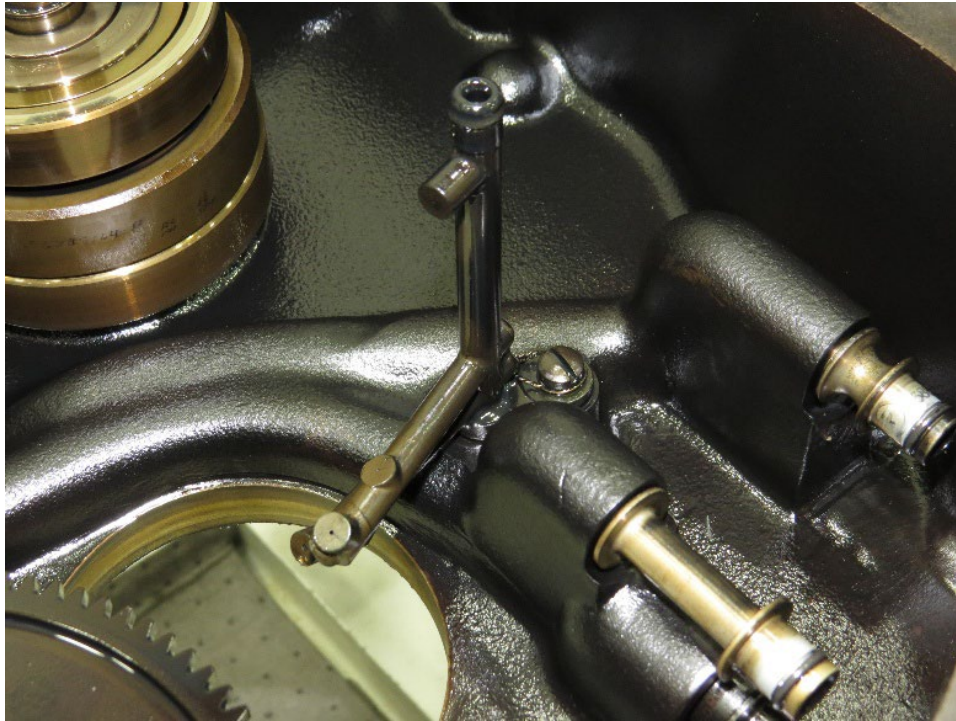


Photo 16 - Piccolo Tube - Installed Correctly

To test the flow from the piccolo tube oil jets, the gearbox housing was mounted in the engine stand and positioned vertically in the engine's normal operating configuration. The oil pump was rotated with an electric motor, and an oil supply was connected to the pump inlet ([Photo 17](#)). Oil flow through all oil supply and scavenge fittings on the gearbox that go to and from the compressor and turbine bearings were confirmed. Oil flowed through only three jets on the piccolo tube, with the oil streams aimed at the No. 3 bearing blocked ([Photo 18](#)).

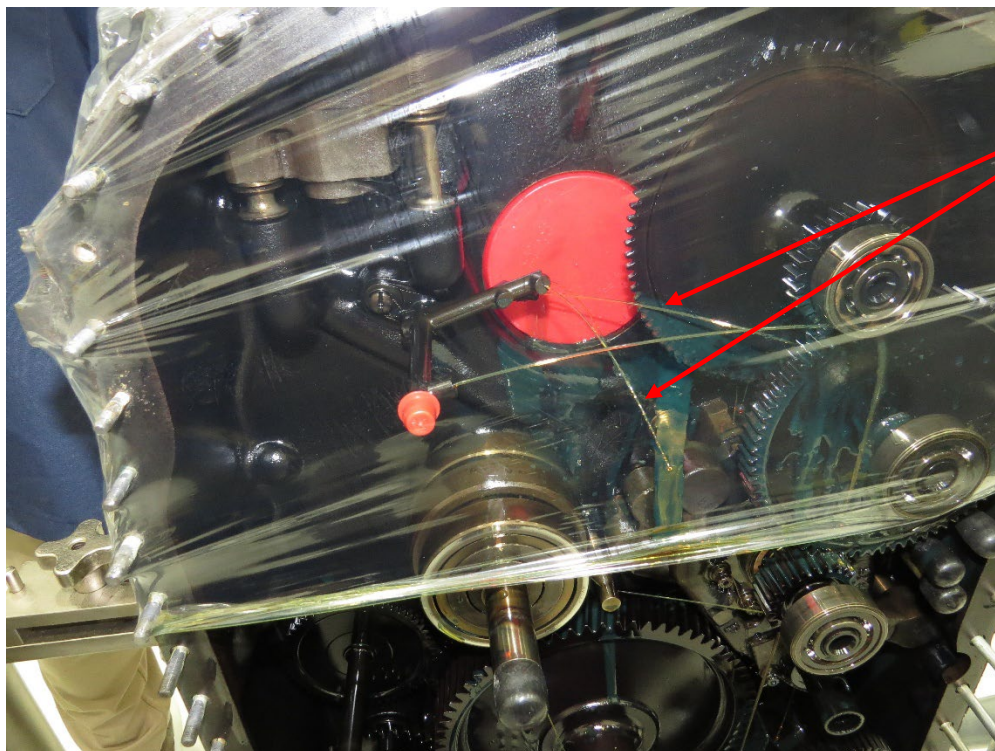


Photo 17 - Oil Distribution Flow Check

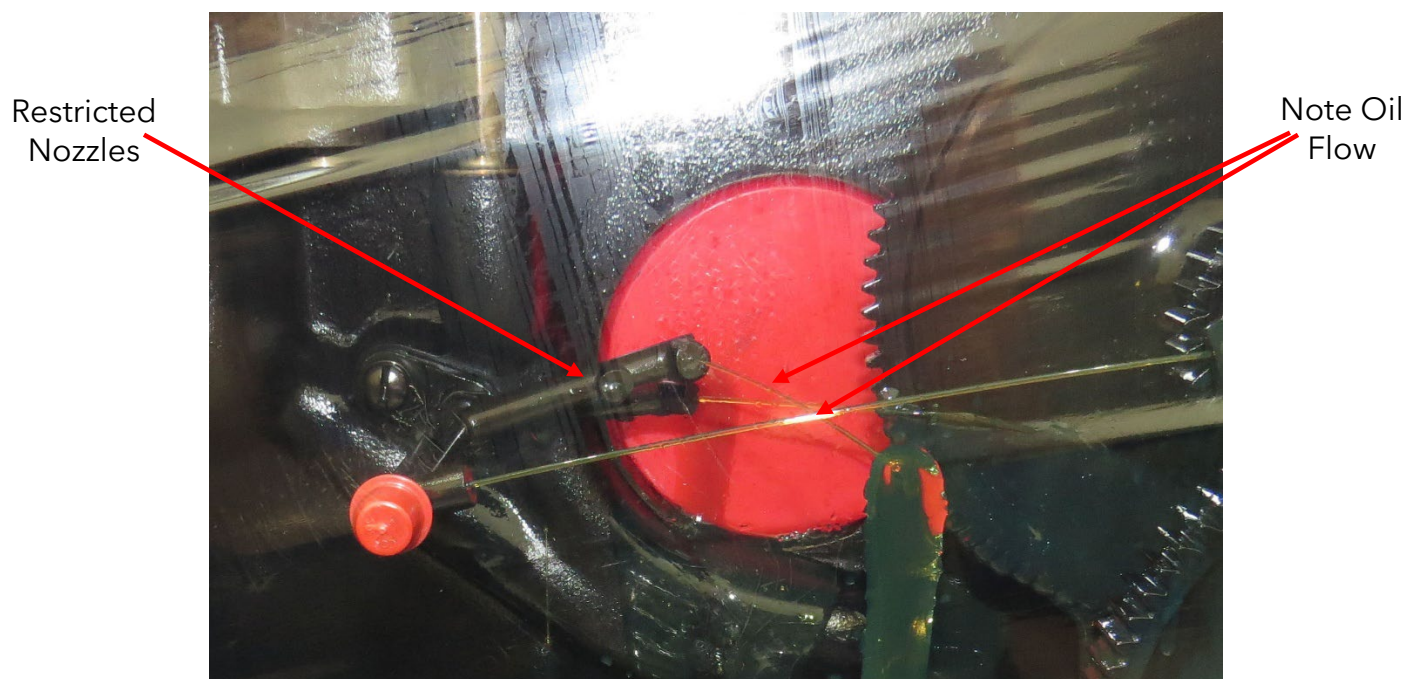


Photo 18 - Piccolo Tube - Nozzle Restrictions

The piccolo tube was therefore sent to the RR materials laboratory where a computer tomography (CT) scan of the part was made, revealing restricted orifices and a fully blocked No. 3 bearing oil jet (**Photo 19**, **Photo 20** and **Photo 21**).

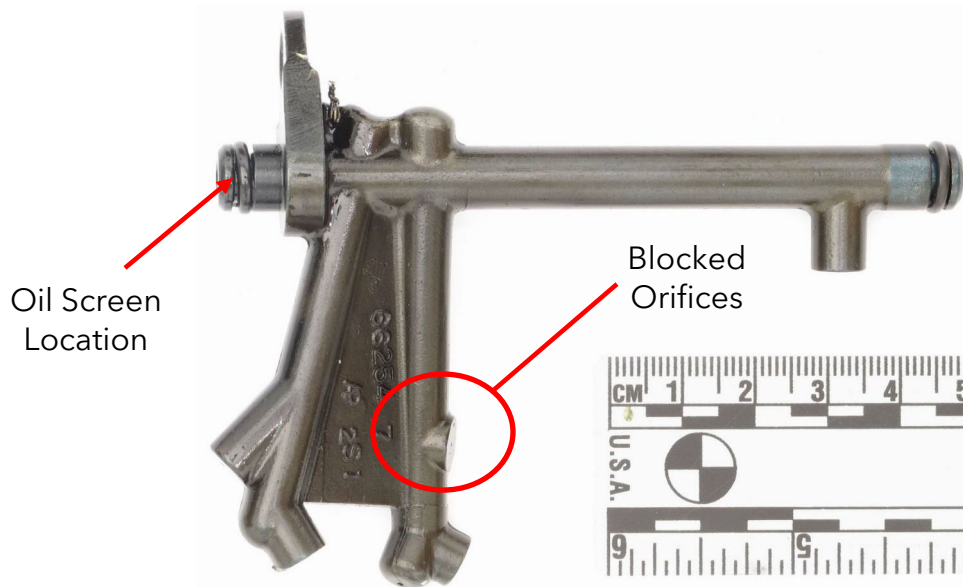


Photo 19 - Piccolo Tube - Courtesy RR

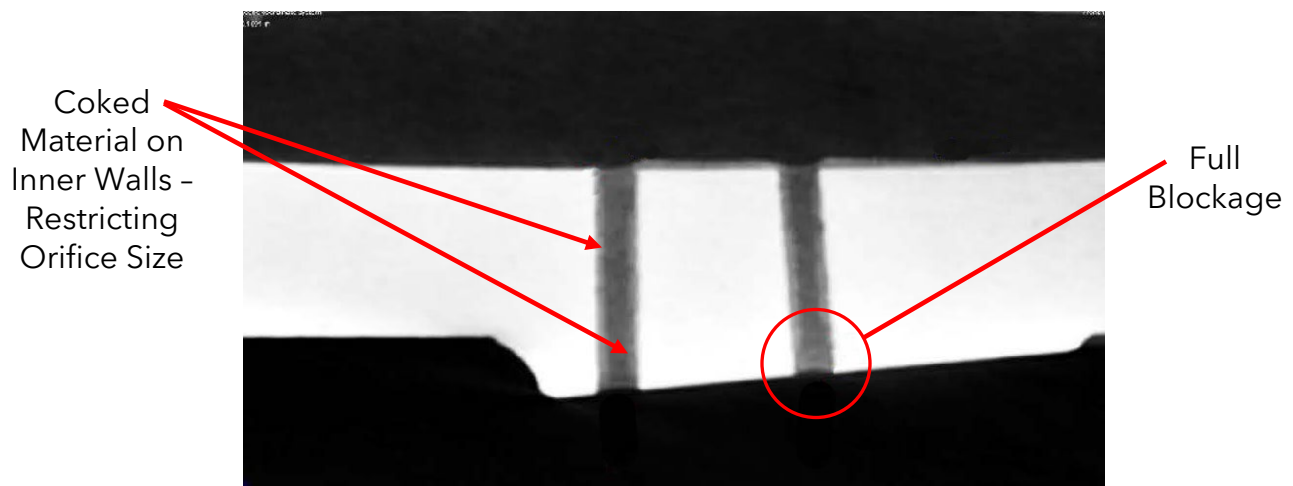


Photo 20 -Restricted Oil Jet Orifices in Piccolo Tube - Side View - Courtesy RR

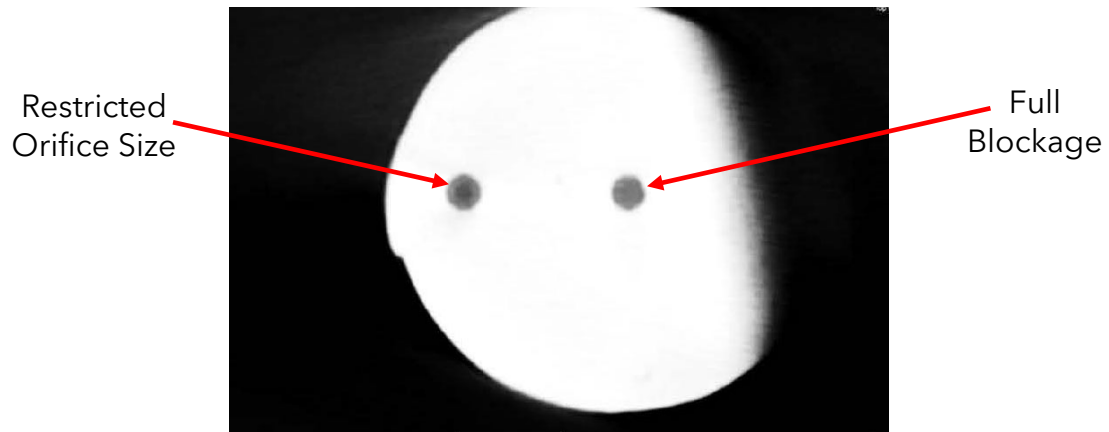


Photo 21 - Restricted Oil Jet Orifices in Piccolo Tube - Direct View - Courtesy RR

The oil screen at the piccolo inlet was removed and examined, revealing oily coke deposits that covered much of the surface (**Photo 23**). Although oil test confirmed that some oil flowed through the piccolo tube oil screen, the amount of restriction it presented to the oil flow could not be determined.



Photo 22 - Piccolo Tube Oil Screen - Courtesy RR

2.4 Turbine Module

2.4.1 Turbine Module General Arrangement

The arrangement of the shafts and couplings in the turbine module is shown on **Figure 3**.

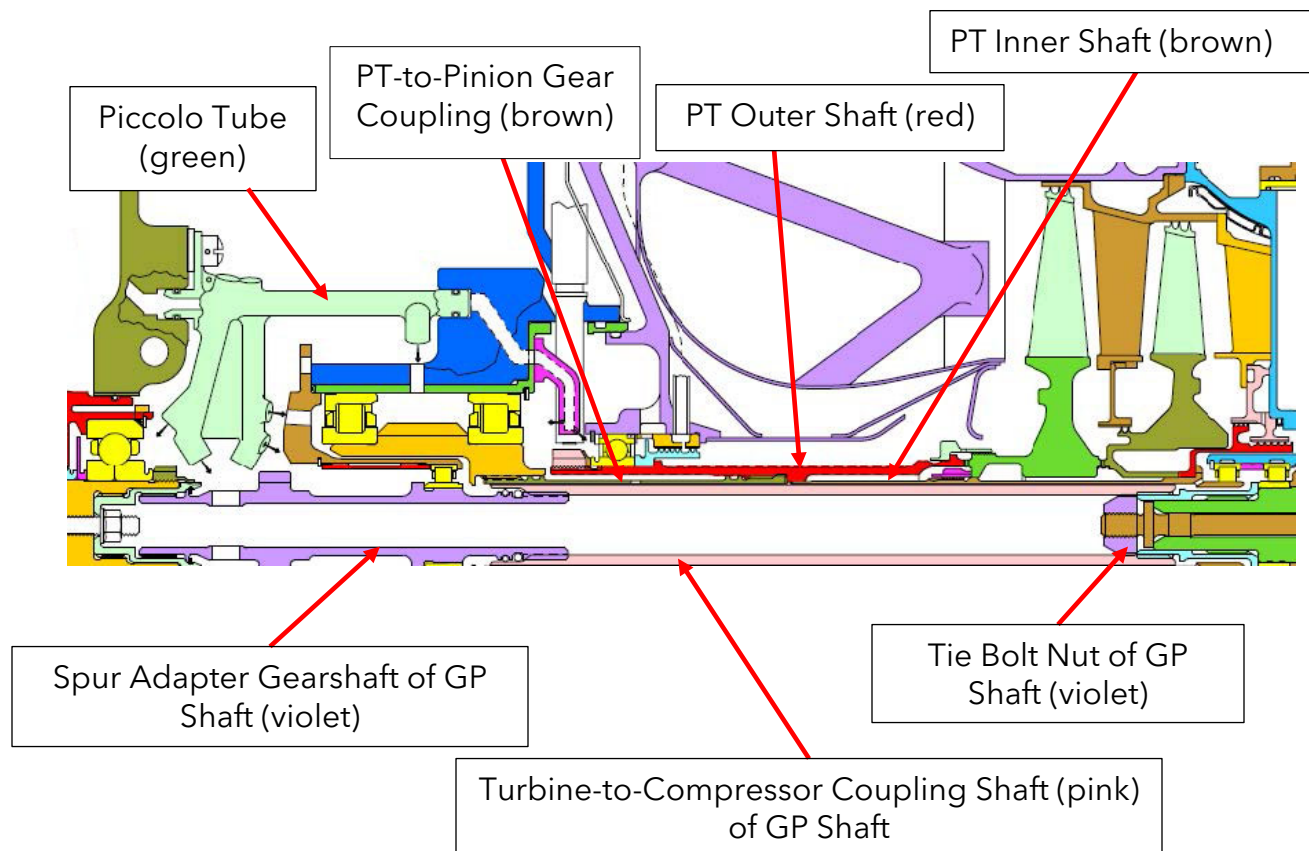


Figure 3 - Partial Schematic Showing Gearshaft Arrangement - Courtesy RR

2.4.2 Exhaust Collector Support Housing

The exhaust collector support housing was intact and undamaged (**Photo 20**).



Photo 23 - Exhaust Collector Support Housing - Intact

2.4.3 PT Shaft Assembly

2.4.3.2 PT Shafting

When AGB module was being separated from the exhaust collector support housing, the PT-to-pinion gear coupling remained attached to the PT outer shaft. As it was being separated from the PT outer shaft, a large amount of carbon deposits was drawn out of the mating spline (**Photo 21** & **Photo 22**).

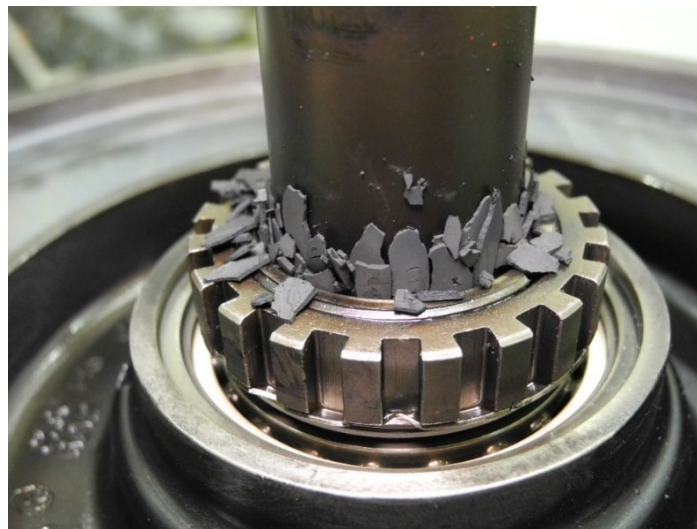


Photo 24 - PT-To-Pinion Gear Coupling - Note Grey Coke Flakes



Photo 25 - PT-To-Pinion Gear Coupling - Note Thermal Distress

The PT outer shaft could not be withdrawn from the assembly using normal procedures and was separated from the assembly in the RR materials lab.

The PT outer shaft was sectioned (**Photo 23**), revealing fractured and deformed material from the PT inner shaft, PT inner coupling nut, and turbine-to-compressor coupling on the inner diameter. Coke was present in the turbine-to-compressor coupling, PT inner shaft, PT outer shaft, spur adapter gearshaft, power turbine-to-pinion gear coupling, 4th stage turbine wheel, 3rd stage turbine wheel, turbine spline adapter, and No. 6 bearing.

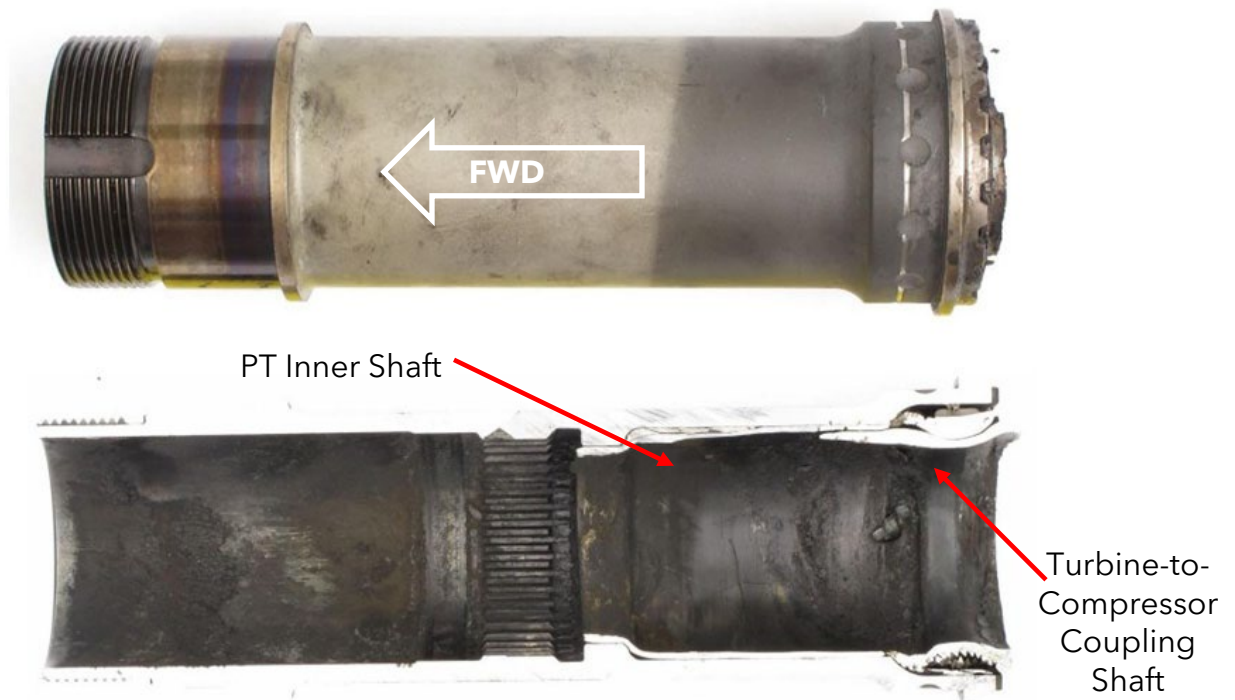


Photo 26 - PT Outer Shaft (Top) and Sectioned (Bottom) - Courtesy RR

2.4.3.2 PT Wheels

The 4th stage turbine wheel (2nd stage PT) (**Photo 24**) was intact; however, all the blade shrouds were rotationally scored, consistent with contact against the 4th stage wheel shroud. The rim was fractured in one location. The curvic coupling was rotationally sheared and smeared, consistent with rotation against the 3rd stage wheel curvic coupling.



Photo 27 - 4th Stage Turbine Wheel - Intact

The 3rd stage turbine wheel (1st stage PT) (**Photo 25**) was intact, however, the leading-edge platforms of the blades were rotationally scored. The aft end of the fractured PT inner shaft was seized in the bore. The rotating labyrinth seal could not be removed. The curvic coupling was rotationally sheared and smeared (**Photo 26**), consistent with contact against the 4th stage wheel curvic coupling. The No. 6 bearing was undamaged.



Photo 28 - 3rd Stage Turbine Wheel



Photo 29 - 3rd Stage Turbine Wheel Curvic Coupling - Rotationally Smeared

2.4.4 GP Shaft Assembly

2.4.4.2 Turbine to Compressor Coupling Shaft

The turbine-to-compressor coupling shaft ([See Figure 2](#)) was deformed, twisted, and fractured in three locations ([Photo 27](#)). One of the three fragments was lodged in the 4th stage PT wheel ([Photo 28](#)), the second was deformed over the end of the tie bolt ([Photo 29](#)), and the third, was seized in the PT outer shaft ([See Photo 23](#)).



Photo 30 - Turbine-to-Compressor Coupling Shaft - Fractured - Courtesy RR



Photo 31 - 4th Stage Wheel with Portion of the Deformed and Seized Turbine-to-Compressor Coupling Shaft



Photo 32 - Turbine-to-Compressor Coupling Shaft Was Deformed Over Tie Bolt Nut

The phenomenon of carbon build-up (coking) between the turbine-to-compressor coupling and turbine inner shaft (Refer to **Figure 2** and **Figure 3**) is due

to shaft temperatures higher than the carboning or coking limits of the oil. Generally, the two conditions leading to excessive temperatures in the shafting area are higher cavity temperatures or reduced oil flow through the shafting. The interference between the shafting caused by coke build-up results in localized heating, which can lead to weakened material properties of the components to the point of failure.

It is possible that the reduced oil flow from the piccolo tube screen and the nozzles reduced the cooling effect in the shafting and resulting in the carbon or coke buildup between the shafts.

2.4.4.2 Gas Producer (GP) Turbine Wheels

The 1st stage turbine wheel was intact and undamaged (**Photo 30**).



Photo 33 - 1st Stage Turbine Wheel - Undamaged

The 2nd stage turbine wheel was intact. The spline adapter was still secured to the 2nd stage wheel hub (**Photo 31**). The splines and the undercut area of the spline adapter were coated with thick layer of oily coke (**Photo 32**).

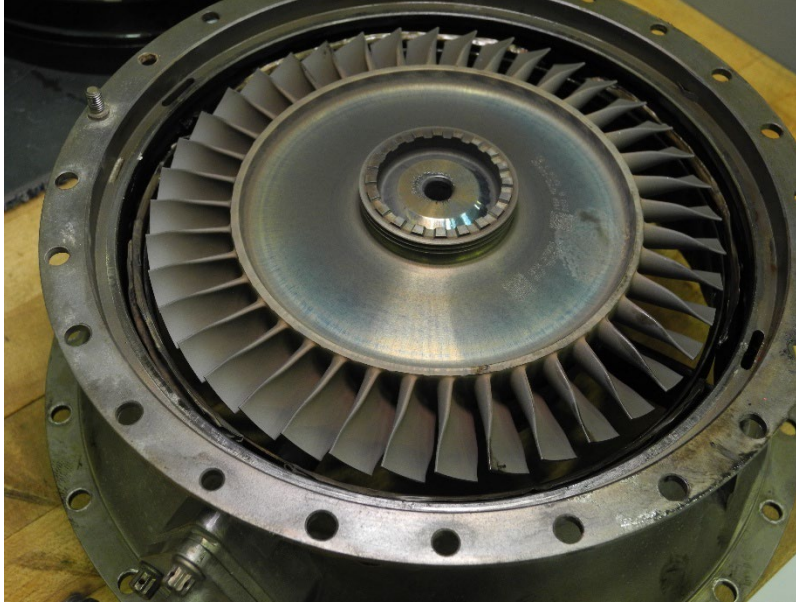


Photo 34 - 2nd Stage Turbine Wheel - Intact

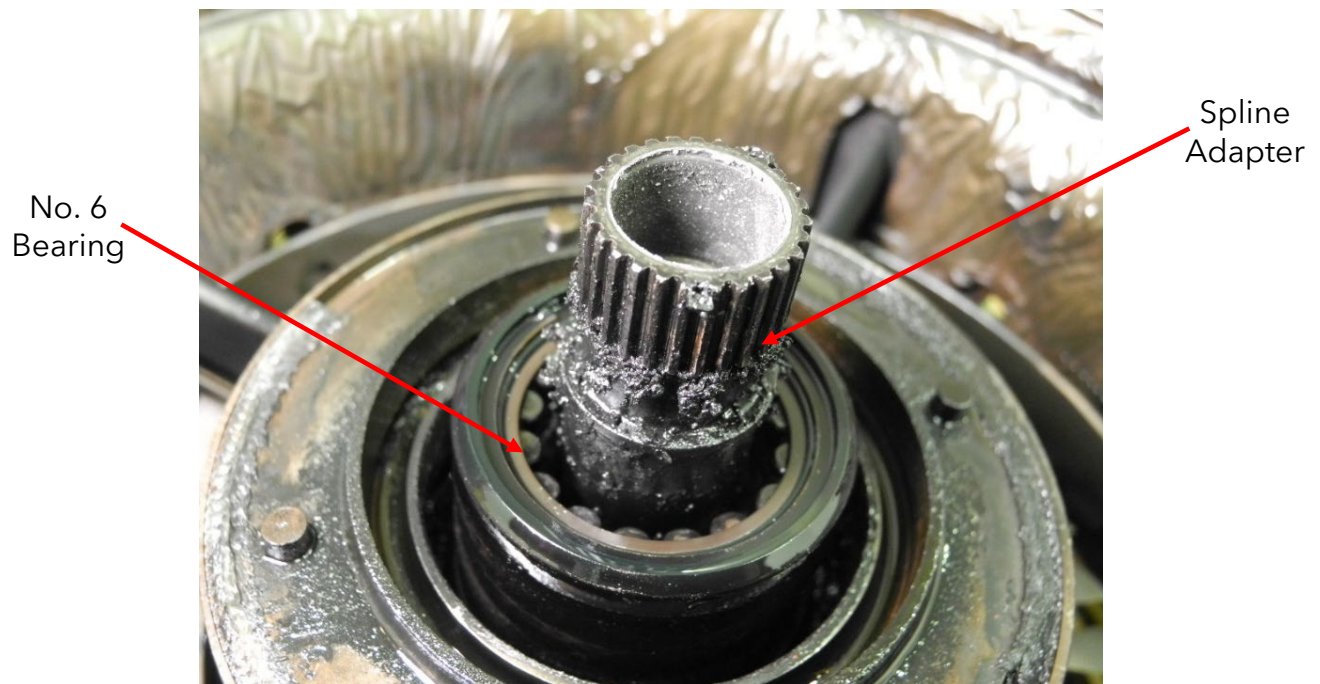


Photo 35 - Detail of 2nd Stage Turbine Spline Adapter - Heavy Carbon Deposits

2.4.5 Turbine Module Shafts Coking Issues

The GP and the PT shafts are concentric to each other. During engine operation of 100%, the rotational speed of the GP Shaft is 51,000 RPM⁴ while the PT is 30,650 RPM meaning the differential speed of the shafts is 20,350 RPM. The clearance between the outer diameter of the GP shaft and the inner diameter of the PT shaft is between 0.096 - 0.080 inches. In operation, an oil mist is present between the two shafts.

The GP and PT shafts operate in a high-heat environment and require cooling. Oil flow from the piccolo tube through the SAG is one of the important cooling systems to keep the shafting from reaching temperatures higher than the carboning or coking limits of the oil. If the shafting reaches these carboning temperatures, the oil that remains on the surface of the shafts can become coked and adhere on the shafts. If the thickness of the accumulated coke between the shafts approaches the clearance gap, then subsequent contact can occur between the shafts. The different rotational speed creates friction which can thermally distress the shafts, reduce their strength and lead to their ultimate failure, like what was observed in this event.

The shafts can also experience high heat soak temperatures and buildup of coke if engines are shut down too soon after a flight, without allowing the recommended cool down time at engine idle speed.

There is only one test specified for determining if there is sufficient oil flow from the power turbine support pressure oil nozzle flow. It is recommended that the PT pressure oil nozzle flow check be accomplished at 150-hour intervals or when an impending oil bypass indication has occurred or if carbon is found in the oil system. The inspection task on the RR250-C30. The RR M250-C30 Series Operation and Maintenance manual checklist task consists of opening a drain line under the scavenge oil strut, motoring the engine (N1) to 16-18 % RPM and measuring the quantity of oil that drains from the strut. The minimum flow for 15 seconds is 90 cc. RR recommends that the amount of oil collected from this test be recorded and a trend be established so that any sudden changes in oil quantity can be noted and acted upon. In an interview with the director of maintenance, this test had recently been done on this engine and the quantity of oil collected was within the RR limit; however, the operator did not record the trend data.

The PT pressure oil nozzle flow check does not give any indication of the condition of the other areas of the oil system, such as the piccolo tube. There is no procedure available for testing the condition of the piccolo tube oil supply to the SAG and shafting.

⁴ RPM revolutions per minute

The N1 rotor RPM coast-down time of the engine may be indicative of an impending engine difficulty. A coast-down from idle to stop of approximately 4 to 5 seconds can be indicative of binding in the N1 rotor system. The manual recommends that the cause should be investigated to determine the required corrective action; however, this is not a regular maintenance activity, but rather an observation that is made by the pilot. It is unknown if any pilots experienced this engine behavior prior to the event.

2.4.6 GP Support

The No. 8 bearing cavity and bearing were oil wetted (**Photo 33**). The No. 8 bearing was intact and undamaged.

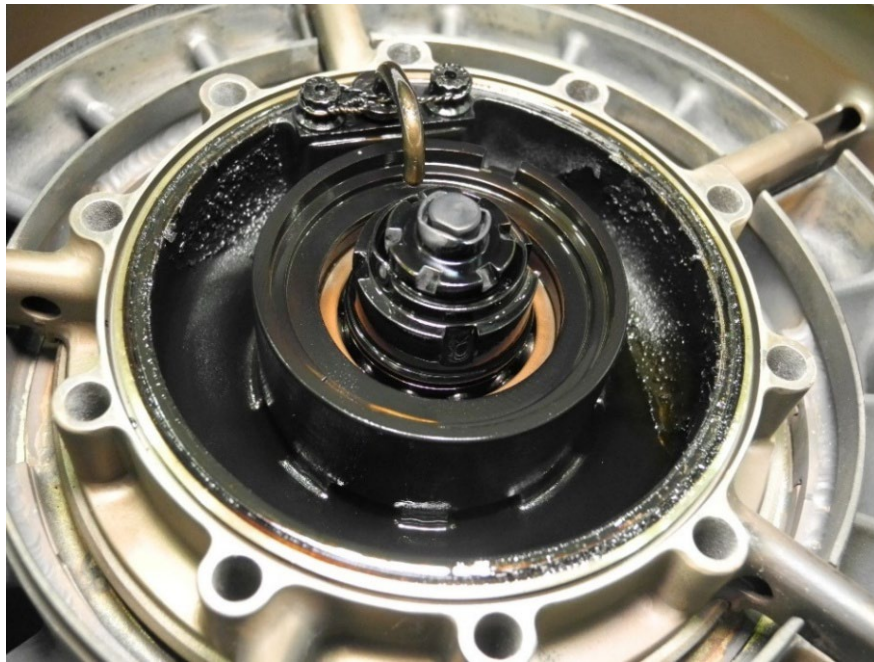


Photo 36 - No. 8 Bearing Cavity

2.5 Combustor Module

The outer combustor case (OCC) was intact and undamaged. The combustor liner was intact and undamaged. The fuel nozzle was intact and undamaged (**Photo 34**).

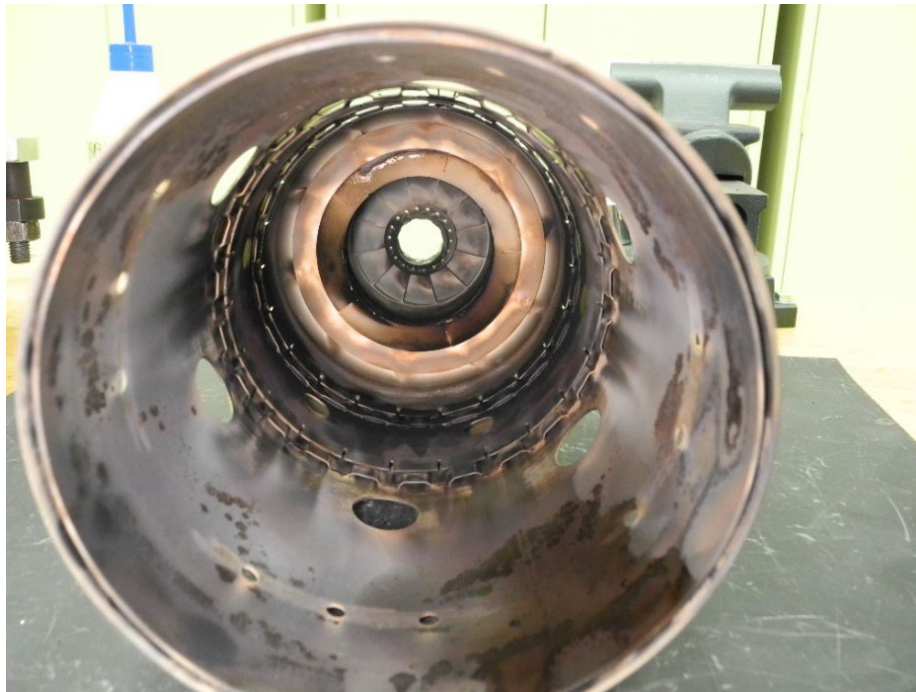


Photo 37 - Combustor Liner - Undamaged