



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

February 2, 2022

POWERPLANT GROUP CHAIRMAN'S FACTUAL REPORT

NTSB No: WPR19LA122

A. ACCIDENT

Location: Oakridge, Oregon

Date: April 26, 2019

Time: 0700 Pacific Daylight Time

Aircraft: Bell 206 Helicopter, Registration Number N206JH

B. POWERPLANTS GROUP

Investigator-In-Charge: Elliott Simpson
National Transportation Safety Board
Los Angeles, California

Powerplant Group Chairman: Harald Reichel
National Transportation Safety Board
Washington, District of Columbia

Member: Nick Shepler
Rolls-Royce
Indianapolis, Indiana

C. SUMMARY

On April 26, 2019, about 0700 Pacific daylight time, a Bell 206B, N206JH, struck trees during a forced landing in Oakridge, Oregon. The commercial pilot was not injured, and the helicopter sustained substantial damage. The helicopter was registered to and operated by Wilbur Ellis Company under the provisions of Title 14 Code of Federal Regulations Part 137 as an agricultural aerial application flight. Visual meteorological conditions prevailed, and no flight plan had been filed.

The local flight departed from a remote landing spot in Oakridge at 0642 local time. The pilot had just sprayed a load of herbicide on trees and was maneuvering the helicopter for a final pass to complete the dispersal, when he heard a faint buzzing sound that lasted about 1 to 2 seconds. The pilot reported that there were no accompanying annunciator light warnings, and he did not hear any alert horns, but noticed that the engine power turbine (N2) gauge was oscillating about the 11 to 12 o'clock position (50-65% range). The helicopter rotor tachometer (Nr) speed remained within the operating range, and he decided to perform an autorotation. With no landing spots close by, the helicopter landed on sloping tree-covered terrain and rolled over.

The airframe with the Rolls Royce M250-C20B turbo-shaft engine was recovered by Air Transport salvage recovery and transferred their facility in Phoenix, Arizona, where a preliminary external inspection was performed. The engine was then transferred to Dallas Airmotive for an engine teardown and examination. The team met on June 18 – 19, 2019 to perform the engine examination and document the condition.

Disassembly and examination of the engine revealed no un-containment. One blade of the 3rd stage turbine wheel was fractured near the inner platform at the blade root. Visual examination of the fracture surface revealed a high cycle fatigue zone from the trailing edge to approximately $\frac{2}{3}$ along the chord, at which point the fracture surface changed texture, becoming rough, consistent with overload failure. The 3rd stage turbine wheel was sent to the Rolls Royce materials laboratory for further evaluation. The Rolls Royce materials laboratory report stated that the fracture initiated in a low-cycle fatigue near the trailing edge radius of the blade to the inner platform which progressed to a high cycle fatigue process along the blade chord and final overload failure. The wheel was identified as part of a post-service bulletin (SB) commercial engine bulletin (CEB)-1365 or 'enhanced' turbine assembly design released in November 1999.

According to Rolls Royce records, the SB CEB-1365 wheel has been associated with 5 previous accidents and 2 previous incidents.

The Rolls Royce mitigation plan was to redesign the 3rd stage turbine wheel, featuring a modified fillet radius at the platform and improved manufacturing processes to reduce fillet variations, with production to begin in December 2020. An in-service replacement program was begun on July 30, 2021, via SB CEB A-1428, requiring removal of the SB CEB-1365 3rd stage turbine wheel and installation of the new SB CEB A-1428 3rd stage turbine wheel at the next scheduled replacement time. The new 3rd stage

turbine design is expected to increase low and high cycle fatigue resistance. An FAA AD is planned to mandate the incorporation of SB CEB A-1428; however, the release of the AD has not yet been established.

D. DETAILS OF THE INVESTIGATION

D.1 Engine Description

The incident engine was a Rolls-Royce (RR) M250-C20B turbo-shaft engine (Figure 1) which features a 6-stage axial and 1 stage centrifugal compressor section which directs the diffused air via an external 180-degree compressor discharge tube system to the combustor. The hot gases from the combustor are then directed against a two-stage gas producer turbine and subsequently a two-stage power turbine before being exhausted. The RR M250-C20B produces 420 shaft horsepower.

The engine is of a modular design and a complete engine consists of three serialized major assemblies: the compressor module, the gearbox module, the turbine module.

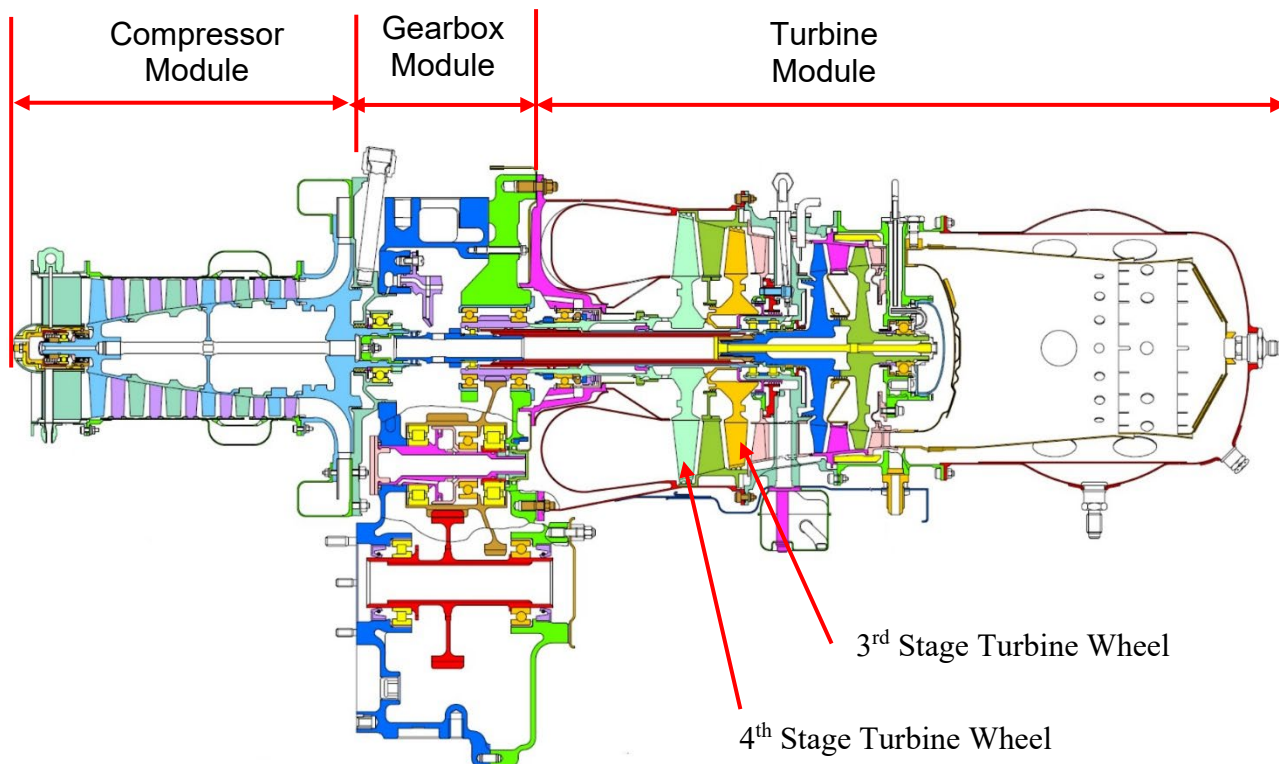


Figure 1 – Rolls Royce M250-C20B Cross Section

D.2 Engine History

The engine was a Rolls-Royce 250-C20B, serial number (S/N) CAE-832565. It was manufactured on October 26, 1979. The operators' engine logbook revealed the following recent history of the engine:

Total Time Since New (TSN)/Cycles	12902.1 Hours / Unknown Cycles
Date of Last Inspection (100/300-Hr)	April 11, 2019
Hours/Cycles at Last Inspection	12874.2 Hours / 13376 Cycles
Time Since Last Inspection	27.9 Hours (12902.1 – 12874.2)
Time Since Overhaul (TSO)*	1661.9 Hours (12902.1 – 11240.2)

* Overhaul is based on turbine module records

The turbine was overhauled on September 2015 at Engine Total Time = 11240.2 hours

The component maintenance records, and Rolls Royce limitations are listed on [Table 1](#).

Component	Serial Number	Part Number	TSO (Hours)	Total Time (Hours)	Overhaul Limit (Hours)
Engine	CAE-832565	6887190	1661.9	12902.1	Ref. Turbine
Gearbox	CAG-36471	6894171	N/A	3765.4	On Condition
Compressor	CAC-41196	6890550	904.9	4399.6	3500
Turbine	CAT-23412	23069745	1661.9	14869.1	1750
Governor	25992	M250-10844	68.5	Unknown	2000
Fuel Control	323263	M250-10816	143.2	Unknown	2500
Bleed Valve	FF16416	23053176	341.4	Unknown	1500
Fuel Pump	TT110354	6899253	2954.1	Unknown	4000
Fuel Nozzle	AG80937	M250-10603	2328.5	Unknown	2500

[Table 1](#) – Engine Maintenance Records & Limits

D.3 Examination of The Engine

D.3.1 General Condition Notes

The engine was in a metal engine container which was opened in the presence of the NTSB ([Photo 1](#)). It was externally generally clean and intact. There was no evidence of an un-containment. The starter-generator was not returned.

The internal surface of the exhaust collector duct exhibited numerous small indents, consistent with impact from high-speed particles ([Photo 2](#)). Additionally, the duct was fractured at the 12 o'clock¹ location near the upper mount strut ([Photo 3](#)).

Prior to dis-assembly, it was noted that the Gas Producer (N1) or (GP) rotor was free to rotate with hand effort and that the starter generator pad, fuel control unit (FCU) and the fuel pump splines rotated in unison, confirming gear drive continuity. The Power Turbine (N2) of (PT) rotor and associated drive train could not be rotated by hand.

The airframe oil transfer fittings were disconnected and uncovered. Approximately a pint of oil was collected from the gearbox case. The oil condition and smell were unremarkable.

Interstage compressor pressure (Pc) is sent via rigid tubes to the FCU which is used as a speed signal. A leak check was performed on the Pc pressure lines using 80 pounds per square inch (psi) shop air pressure and no leaks were detected.

D.3.2 Gearbox Module

The gearbox module, S/N CAG-36471, and was intact and appeared to be undamaged ([Photo 4](#)). An examination of the two chip detectors revealed fine particles on the upper chip detector and a small shiny flake in the lower chip detector ([Photo 5](#)). A rattling noise emanated from the No. 6 and No. 7 bearing oil sump can as it had been drained of approximately a ½ cup of oil, and upon further investigation revealed that it contained a damper from one of the No. 6 or No. 7 bearings ([Photo 6](#)). The oil supply nozzles for the Nos. 6, 7 and 8 nozzles were removed and found to be oil wetted and undamaged. The last-chance oil screen was clean ([Photo 7](#)). Alcohol was introduced into the feed tube and seen to exit the nozzles, indicating a clear flow path.

The oil filter was examined and found to be clean ([Photo 8](#)).

¹ All directional references to front and rear, right and left, top and bottom, and clockwise and counterclockwise are made aft looking forward (ALF) as is the convention. All numbering in the circumferential direction starts with the No. 1 position at the 12:00 o'clock position or immediately clockwise from the 12:00 o'clock position and progresses sequentially clockwise ALF.

When the N1 tach generator pad was rotated by hand, the output splines of the fuel control unit and the starter/generator rotated in unison, confirming continuity of the internal gear train. After the turbine module was removed, the N2 tach generator pad was rotated by hand and the power turbine output shaft rotated in unison, confirming continuity of the gearbox power gear train. Therefore, the gearbox was not disassembled further.

D.3.3 Gas Producer Module

D.3.3.1 Compressor

The compressor module, S/N CAC 41196 was removed from the gearbox with no unusual effort. Once removed, the compressor rotor could be rotated normally with light hand effort. The diffuser scroll case was intact and undamaged. The spur adapter gear shaft was intact, oil wetted and undamaged ([Photo 9](#)). Only the 1st stage compressor blades were visible ([Photo 10](#)), and they were intact, complete, and undamaged. The compressor assembly was not disassembled further.

D.3.3.2 Gas Producer (Compressor) Turbine

The gas producer turbine module S/N was CAT-23412. The gas producer turbine support was intact and undamaged. The No. 8 bearing support was undamaged, oil wetted and oil darkened.

The 1st stage turbine nozzle and the 1st stage turbine wheel and it's curvic coupling were intact and undamaged ([Photo 11](#)).

The 2nd stage turbine nozzle and the 2nd stage turbine wheel and it's curvic coupling were intact and undamaged.

The turbine-to-compressor coupling ([Photo 12](#)) was intact; however, the aft 1-½ inch of the tube was deformed and the outer surface was rotationally scored.

The N1 (Gas Producer) turbine spool bearing set consists of the No. 6, No.7 and No. 8 bearings. The Nos. 6 and 7 bearing support was fractured around 360 degrees and the released ring was retained by the No. 6 bearing. Bearing No. 6 was intact and oil wetted, however; the roller cage was battered, making the bearing difficult to turn. Bearing No. 7 was intact, oil wetted, however, the roller cage was battered but the bearing could be turned by hand. Bearing No. 8 was intact, undamaged and oil wetted and undamaged.

D.3.3.3 Inter-turbine Temperature Thermocouple (ITT) Harness

The thermocouple harness assembly was intact and undamaged.

D.3.3.4 Combustor

The compressor discharge tubes (CDT), the outer combustor case and liner were all intact and undamaged.

D.3.3.5 Power Turbine Module

The 3rd stage turbine nozzle was generally intact. The leading edges of the vanes were undamaged (Photo 13). The trailing edges of all the vanes were dented and missing material, with most of the damage occurring on the outer $\frac{1}{3}$ of the vane chord (Photo 14). Each vane had approximately a fingernail sized portion missing. Five vanes exhibited heavy gold-colored metal spray on their downstream faces (Photo 15).

The 3rd stage turbine wheel was missing one blade with the corresponding 1.5 inch-long, 2-blade span of outer shroud segment (Photo 16). The 3rd stage turbine wheel, as cast, features 35 blades that are supported along the outer edge with a continuous shroud. During manufacturing, 5 wire electrical discharge machining (EDM) slots are cut into the shroud, forming 5 'packets' of 7 blades each. The blade fractured at the root near the inner platform was the last in its 'packet'. The missing segment was not found. A visual examination of the blade root fracture surface revealed a fatigue zone from the trailing edge to approximately $\frac{2}{3}$ along the chord, at which point the fracture surface abruptly changed texture, becoming rough, consistent with overload failure (Photo 17). The leading adjacent blade was present; however, the shroud segment had fractured from the tip (Photo 18). The labyrinth air seals were heavily rotationally scored, consistent with contact against the blade track. The leading-edge convex surfaces all had a $\frac{1}{4}$ inch wide gold-colored metal spray deposit along the chord. The curvic coupling was undamaged. The wheel was identified as a component of a post-SB CEB -1365 or 'enhanced' turbine assembly design.

The 4th stage turbine nozzle was generally intact (Photo 19), however a 60-degree segment of the 3rd stage turbine blade track was heavily scored, consistent with contact against the 3rd stage turbine wheel labyrinth seals and fractured at two locations. All the nozzle vanes were present; however, one vane leading edge was dented at the mid span. Several vane trailing edges exhibited minor impact damage at the mid span (Photo 20). The 4th stage blade track was rotationally scored. The convex side of the trailing edges exhibited a gold-colored metal spray.

The 4th stage turbine wheel (Photo 21) was intact; however, the shroud was fractured at one location (Photo 22) with no loss of material. The shroud labyrinth seal was heavily scored, and heat discolored along a 90-degree segment with the fracture occurring at approximately the middle of the scoring. The trailing edges were undamaged; however, a minor amount of gold-colored metal spray was observed on the convex side of the blades. Both curvic couplings were undamaged.

The N2 (power turbine) bearing set consists of the No. 3, No. 4, No. 5, and No. 6 bearings. The No. 5 bearing snap ring was found dislodged from its groove ([Photo 23](#)), and the shim was loose.

The exhaust collector was intact; however, the internal surface of the exhaust collector duct exhibited numerous small dents, consistent with impact from high-speed particles. Additionally, the duct was fractured at the 12 o'clock location near the upper mount strut and the upper mount strut was fractured at two locations ([Photo 24](#)), liberating the strut. It was still retained in the cavity between the exhaust collector and the gearbox.

D.3.3.6 Externals

The FCU, power turbine governor, fuel pump, oil pump, lube distribution systems were intact and externally undamaged and were not further examined or tested.

D.4 Materials Laboratory Findings

The following parts were returned to Rolls Royce materials laboratory for further investigation:

Component	Part Number	Serial Number
1 st -Stage GP Nozzle	23062750	KD508816
1 st -Stage GP Wheel	M250-10223	X635160
2 nd -Stage GP Nozzle	23086070	X28300
2 nd -Stage GP Wheel	23073854	X642985
3 rd -Stage PT Nozzle	23069744	X615844
3 rd -Stage PT Wheel	23065818	X637545
4 th -Stage PT Nozzle	23055939	X615217
4 th -Stage PT Wheel	23055944	X638996
Gas Producer Support	23038118	DW36563
Power Turbine Support	6898731	DW22331
Exhaust Collector Support	6879879	32305
No. 5 Bearing	6871509AL	TA3205129292
No. 6 Bearing	Unknown	Unknown
No. 7 Bearing	Unknown	Unknown
No. 8 Bearing	Unknown	Unknown
PT Inner Shaft	Unknown	Unknown
PT Inner Shaft Nut	Unknown	Unknown
PT Outer Shaft Nut	Unknown	Unknown
No. 7 Bearing Nut	Unknown	Unknown
GP Rotor Tiebolt	23068265	NM81442

Turbine to Compressor Shaft	Unknown	SG35357
PT to Pinion Gear Shaft	6870832	QT1251

D.4.1.1 A Summary of the Findings of the Materials Laboratory:

- 1) A single packet trailing 3rd stage turbine airfoil was fractured and liberated. The fracture initiated at the trailing edge tip approximately 0.025-inch outboard of the rim in low cycle fatigue (LCF) and propagated at least 0.012 inch toward the leading edge before transitioning to high cycle fatigue (HCF). The fracture grew to a total length of 0.546 inch before the airfoil was liberated in overload.
- 2) All of the other packet trailing airfoils on the 3rd stage turbine wheel as well as the airfoil immediately preceding the fractured and liberated airfoil exhibited crack-like FPI² indications.
- 3) The pressure side wax weld adjacent to every airfoil intersected the airfoil root radius (Figure 2)
- 4) The hardness, chemistry, and microstructure of the 3rd stage turbine wheel were consistent with the material required by the component definition.
- 5) FPI of the first and fourth stage turbine wheels did not reveal any crack-like indications.
- 6) Damage to the other components submitted to the laboratory was consistent with secondary damage that would occur after the 3rd stage airfoil was liberated.

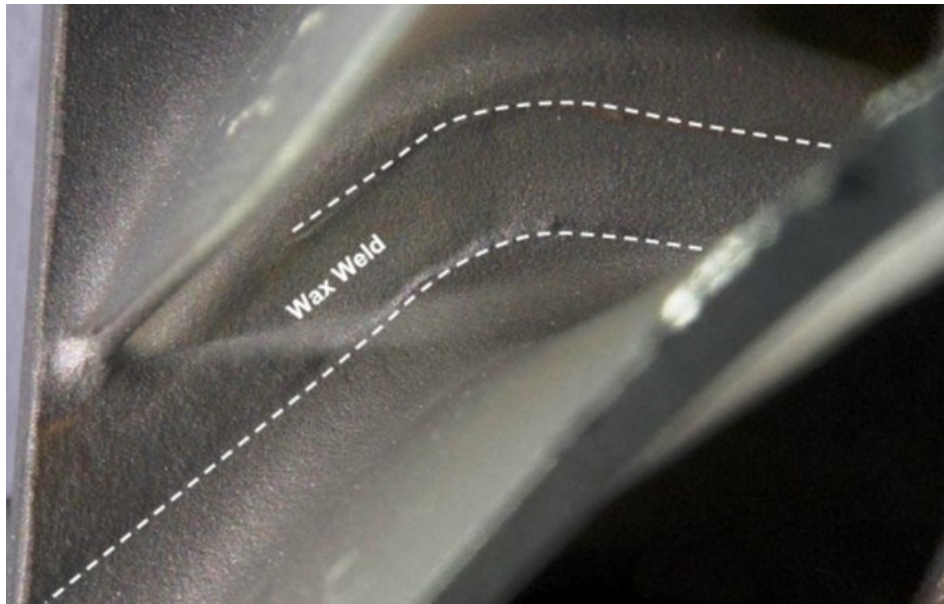


Figure 2 – Example of the wax weld intersected the airfoil root radius of both airfoils.

² Fluorescent penetrant inspection (FPI) is a non-destructive inspection process that uses a penetrating fluid containing a dye that will fluoresce under black light which is applied to the surface of a non-porous material in order to detect defects.

E. Historical Data of the 3rd Stage Turbine

E.1 A Review Rolls-Royce Service Bulletins Relating to the Enhanced Power Turbines

E.1.1 Rolls-Royce SB CEB-1365

The ‘enhanced’ power turbine section was developed by Rolls-Royce as a product improvement, designed to increase both power and fuel efficiency. SB CEB-1365 hardware was a major re-design of the 3rd and 4th stage turbine assembly, with the main differences between the pre- and post-SB CEB-1365 being different airfoil size, shape, tilt, lean, flow, and quantity of airfoils per stage for both turbine nozzles and wheels.

The enhanced power turbine design was released for new production engines built after August 1999. It was then released as a customer option to fielded engines via Rolls-Royce SB CEB-1365 in November 1999. The modification applied to all M250-C20 series engines, with the exception of turbo-prop variants, and was to be complied with as a customer option. Release of enhanced power turbine to M250-B17F/2 turbo-prop variants occurred in August 2008, while release of all other turbo-prop applications was in November 2009. The previous “non-enhanced” power turbine part numbers were discontinued from production in August 2009 and discontinued from Service/Spares orders in March 2013. Thus, the SB CEB-1365 enhanced power turbine was the only available production and service released 3rd stage turbine disk hardware until the issuance of SB CEB A-1428 on July 30, 2021.

E.1.2 Rolls-Royce Alert SB CEB A-1400 Review and Highlights

SB CEB-A-1400, entitled ‘Steady State Operation Avoidance Range Limit’ was originally released in December 2006 and specified power turbine (N2) revolutions per minute (RPM) of the transient speed ranges and power that should be avoided during operation. The SB was intended to reduce the possibility of HCF in the 3rd and 4th stage turbine wheels by restricting the dwell time in the off-operating speeds that imposed frequencies that were harmonic with the natural blade frequencies.

Revision 3 of SB CEB-A-1400 issued on January 19, 2009 recommended to avoid steady state N2 engine operation in the speed range of 75 - 88 percent for operation above 85 shaft horsepower (SHP). Steady-state operation below 85 SHP or transient operation thru the speed avoidance range was allowable. The SB required a maintenance record entry documenting any steady-state operation in the speed avoidance range when operating above 85 SHP.

Revision 4 of SB CEB-A-1400 was released on March 16, 2016 adding a more stringent definition of transient engine operation by removing the 60 sec and 85 SHP limits. The 85 HP power level restriction was replaced with ‘only transient operation permitted’ in speed avoidance range; transient operation was defined as no dwell at an N2

speed of more than a 1 second duration. Additionally, an Nr / N2 needles split was allowed in steady-state operation in speed avoidance range. This revision also updated the required speed avoidance range for SB CEB-1365 (enhanced) wheels to a widened 71-88 percent N2. Because the limitations were widened, a maintenance action was no longer required when operating in the speed avoidance range.

Revision 5 of SB CEB-A-1400 was released on July 29, 2016 and permitted operation within the speed avoidance range during preflight safety checks specified in original equipment manufacturer (OEM) flight manuals.

Revision 6 of SB CEB A-1400 issued on April 12, 2018 added permission to operate within the speed avoidance range during postflight checks specified in OEM flight manuals in addition to preflight checks. Additionally, it clarified applicability of speed avoidance range for non-enhanced wheels P/N 23065833 during one engine inoperative (OEI) operation of multi-engine aircraft, not just specific to one application.

Revision 7 of SB CEB A-1400 issued on January 10, 2019 updated bulletin to continue 71-88 percent N2 speed avoidance range for all enhanced wheel part numbers and subsequent part numbers. This change was made to address all potential responsive wheel modes and avoid confusion as to which speed avoidance range to follow for all future turbine wheel part numbers.

E.1.3 Rolls-Royce Alert SB CEB A-1407

SB CEB A-1407 was issued on November 29, 2010 and was only applicable to M250-C20B engines installed on MDHI 369 models equipped with a post-SB CEB-1365 hardware. It required a one-time inspection of the 3rd and 4th stage turbine wheels for possible airfoil cracks to be completed within 1750 hours and required the removal of the applicable turbine wheels for fluorescent-penetrant and visual inspections. The SB mandated the replacement of any wheel that contained any fracture of an airfoil trailing edge where the platform fillet engages. Additionally, it warned operators to avoid prolonged engine operation in the 75-88 percent N2 speed range, failure of which could result in possible turbine wheel airfoil fracture and separation. New turbine wheels installed after September 2011 were not subject to this inspection due to issuance of MDHI 's bald rotor blade tracking procedure and prior speed avoidance actions regarding tail rotor balancing. The compliance category of this SB was 6: 'To be complied with at or within next 1750 hours gas producer turbine overhaul'.

Revision 1 of SB CEB A-1407, issued on February 7, 2011, pertained to M250-C20B engines installed with an enhanced power turbine 4th stage power turbine wheel P/N 23055944, revealed that the analysis of recent failures of enhanced power turbine wheels determined the most possible cause to be operation of the engine in the N2 speed avoidance range of 75 to 88 percent. The SB called for a one-time inspection of the 3rd and 4th stage turbine wheels for cracks in the airfoils. The compliance code of this SB was 6: 'To be complied with at the next 1750 hours.'

Airworthiness Directive (AD) 2012-14-06, effective July 10, 2012 was issued to mandate the incorporation of SB CEB A-1407, which required a one-time visual inspection and fluorescent penetrant inspection (FPI) on post-SB CEB 1365 3rd and 4th stage turbine wheels for cracks in the trailing edges of the turbine blades. Compliance required the removal the 3rd stage turbine wheel, P/N 23065818, and the 4th stage turbine wheel, P/N 23055944, within 1750-hours since last inspection (HSLI) to perform a one-time visual and a fluorescent penetrant inspection on the 3rd and 4th stage turbine wheels for cracks at the trailing edge of the turbine blades near the fillet at the rim. If any cracks in the trailing edge near the rim were detected, the wheel was to be scrapped.

Revision 2 of SB CEB A-1407, issued on August 20, 2012, stated that 3rd or 4th stage turbine wheels that were installed after September 2011 were not subject to the one-time inspection due to the issuance MDHI Helicopter bald rotor blade tracking procedure revision and prior speed avoidance actions regarding tail rotor balancing. The compliance code of this SB was 6: 'To be complied with at the next 1750 hours.'

Revision 3 of SB CEB A-1407, issued on May 19, 2014, after a total of 4 – 4th stage failures, increased the compliance code from 6 to 2 'To be complied with at each 1750-hour gas producer turbine wheel replacement, a continuing repetitive rather than a one-time inspection. It also retracted Revision 2 by requiring all turbine wheels, even those installed after September 2011 to be subject to the inspection.

AD 2012-14-06 was issued to mandate SB CEB A-1407, revision 3.

Revision 4 of SB CEB A-1407 issued on October 13, 2015, rewording the compliance code 2, by removing the mention of "1750hrs" to allow replacement when GP wheels reach their hour life limit of 1775hrs.

AD 2015-02-22 was issued on March 9, 2015, to supersede AD 2012-14-06, and mandated a repetitive visual inspection and FPI on post-SB CEB 1365 3rd and 4th stage turbine wheels for cracks in the trailing edges of the turbine blades. The compliance stated:

(1) Within 1750 HSLI, remove the affected turbine wheels and perform a visual inspection and an FPI on the removed turbine wheels for cracks at the trailing edge of the turbine blades near the fillet at the rim.

(2) Any time the power turbine is disassembled, perform a visual inspection and an FPI on the affected turbine wheels for cracks at the trailing edge of the turbine blades, near the fillet at the rim.

(3) Thereafter, re-inspect every 1750 HSLI.

(4) Do not return to service any turbine wheels that have cracks detected.

Revision 5 of SB CEB A-1407 issued on September 13, 2017, removed the 4th stage turbine wheel P/N 23055944 from the SB. Inspections on the 4th stage turbine wheels no longer needed since they were being replaced per SB CEB A-1422. It reworded the compliance making it clearer that wheels needed to be inspected anytime the

turbine was disassembled for any reason, and no later than the next GP turbine wheel replacement.

AD 2017-18-14 was issued on October 13, 2017, and superseded AD 2015-02-22. It mandated repetitive visual inspections and FPIs of 3rd stage turbine wheels while removing from service 4th stage turbine wheels.

Revision 6 of SB CEB A-1407, issued on October 13, 2017, reinforced the inspection of the enhanced 3rd stage turbine wheels by introducing a recurring inspection that was no longer tied to 1750 hours, (the wheel has a 1775-hour overhaul time) but rather at any time the turbine module was inducted into an authorized repair/overhaul facility and disassembled for any reason visual and FPI.

Revision 7 of SB CEB A-1407 was issued on November 8, 2021 stating that it was superseded by SB CEB A-1428.

E.1.4 Rolls-Royce Alert SB CEB A-1428:

Alert SB CEB A-1428 was issued on July 30, 2021, and required the replacement of the 3rd stage turbine wheel P/N 23065818, (which were introduced by CEB-1365) with a newly designed wheel P/N M250-10473, which features a large fillet radius at the trailing edge by the blade platform, at the next time the turbine is accessed for any reason, or no later than the next GP turbine wheel replacement time.

Revision 1 of Alert SB CEB A-1428 was issued on September 29, 2021, removing the reference to single engine applications from the effectivity.

Revision 2 of Alert SB CEB A-1428 was issued on December 8, 2021, defining a more stringent scrapping definition.

An FAA AD is planned to mandate the incorporation of CEB A-1428; however, the release of the AD has not yet been established.

F. Summary

Disassembly and examination of the engine revealed no un-containment. One blade of the 3rd stage turbine wheel was fractured near the inner platform at the blade root. Visual examination of the blade platform fracture surface of the blade root revealed a high cycle fatigue zone from the trailing edge to approximately $\frac{2}{3}$ along the chord, at which point the fracture surface changed texture, becoming rough, consistent with overload failure. The Rolls Royce materials laboratory report stated that the fracture initiated in low-cycle fatigue near the trailing edge radius of the blade to the inner platform which progressed to a high cycle fatigue process along the blade chord and final

overload failure. The wheel was introduced as part of a SB CEB-1365 or ‘enhanced’ turbine assembly design released in November 1999.

The Rolls Royce mitigation plan was to redesign the 3rd stage turbine wheel, featuring a modified fillet radius at the platform and improved manufacturing processes to reduce fillet variations, with production that began in December 2020. An in-service replacement program was begun on July 30, 2021, via SB CEB A-1428, requiring removal of the SB CEB-1365 3rd stage turbine wheel and installation of the new SB CEB A-1428 3rd stage turbine wheel at the next replacement time. The new design is expected to increase low and high cycle fatigue resistance.

Harald Reichel
Aerospace Engineer – Powerplants

Photo 1 - Rolls-Royce M250-C20B S/N CAE-832565 - As Received



Photo 2 – Exhaust Duct – Small Dents



Photo 3 – Fracture at 12 O'clock Location in Exhaust Duct

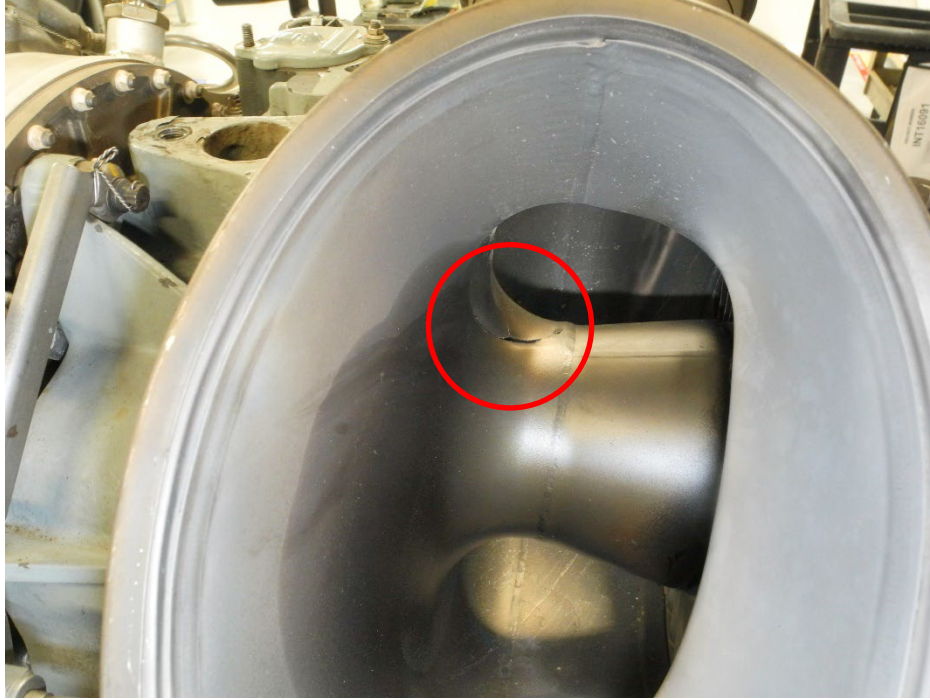


Photo 4 – Gearbox Module - Undamaged

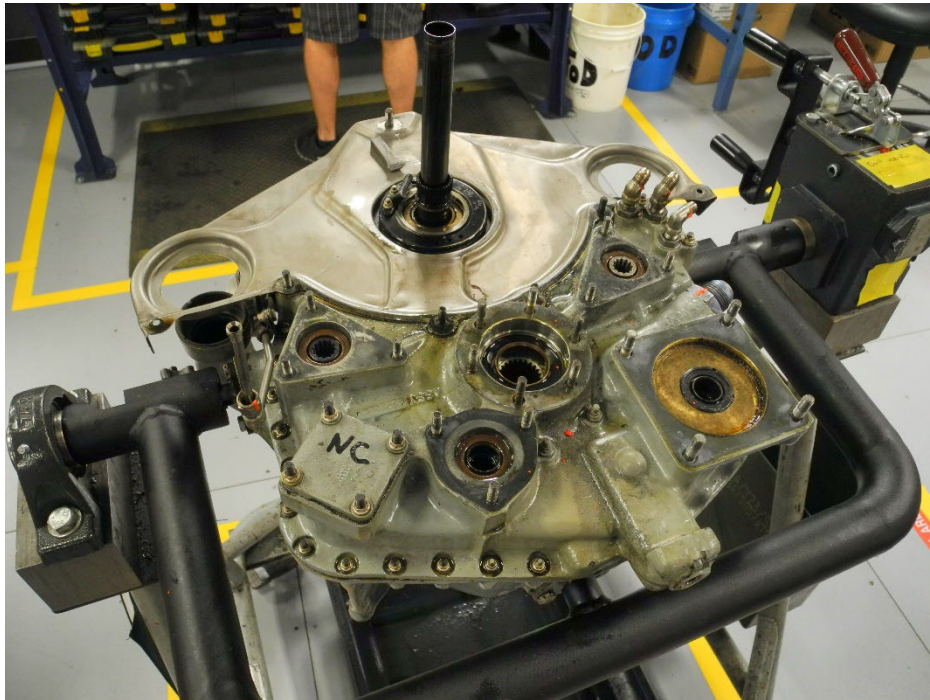


Photo 5 – Chip Detectors - Clean



Photo 6 - #6 and #7 Bearing Oil Sump Can



Photo 7 – Last Chance Oil Screen

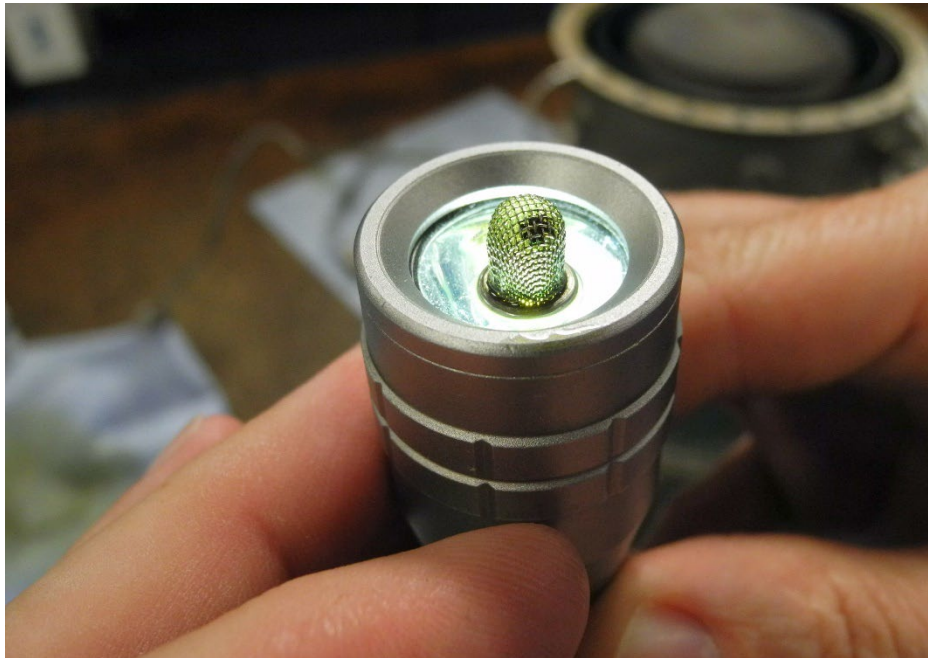


Photo 8 – Oil Filter - Clean

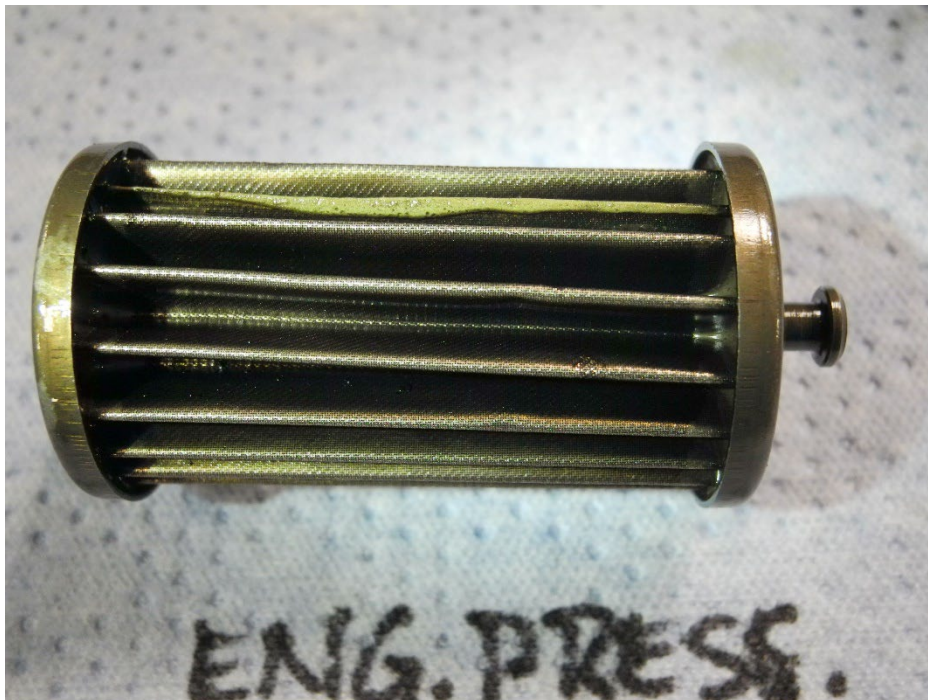


Photo 9 - Spur Adapter Gear Shaft



Photo 10 - 1st Stage Compressor Blades

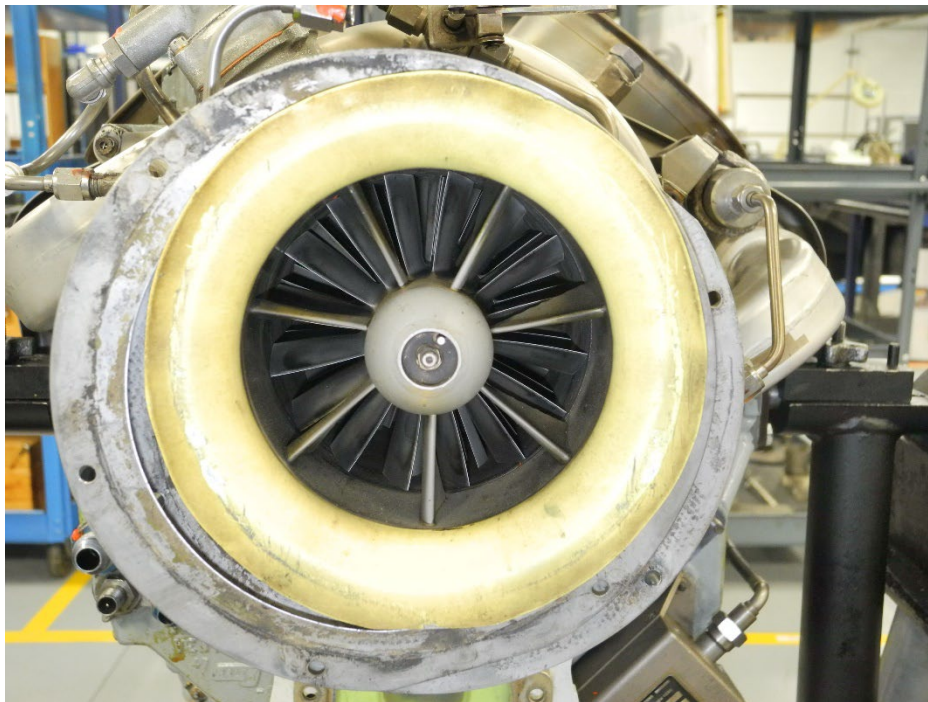


Photo 11 – Compressor Turbine Components



Photo 12 – Turbine-to-Compressor Coupling



Photo 13 - 3rd Stage Turbine Nozzle – Upstream Face

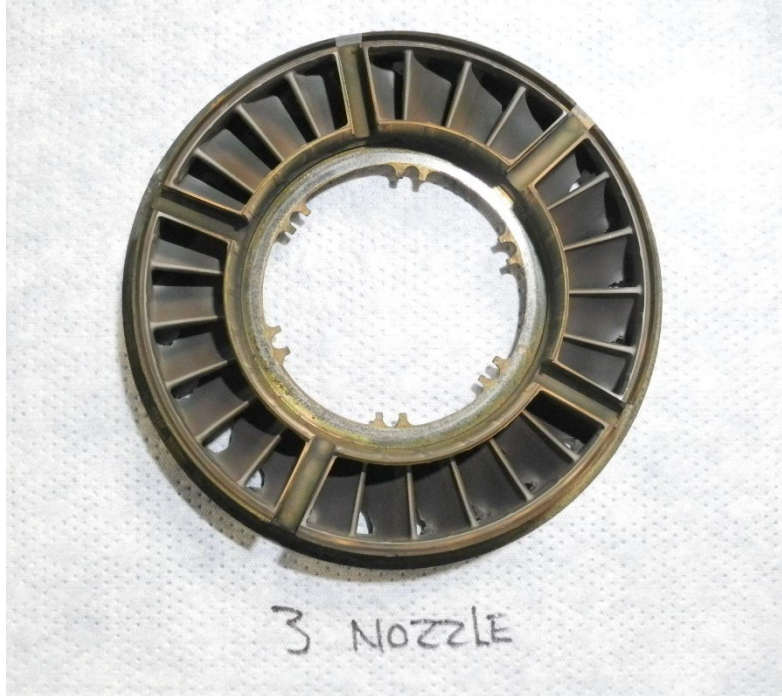


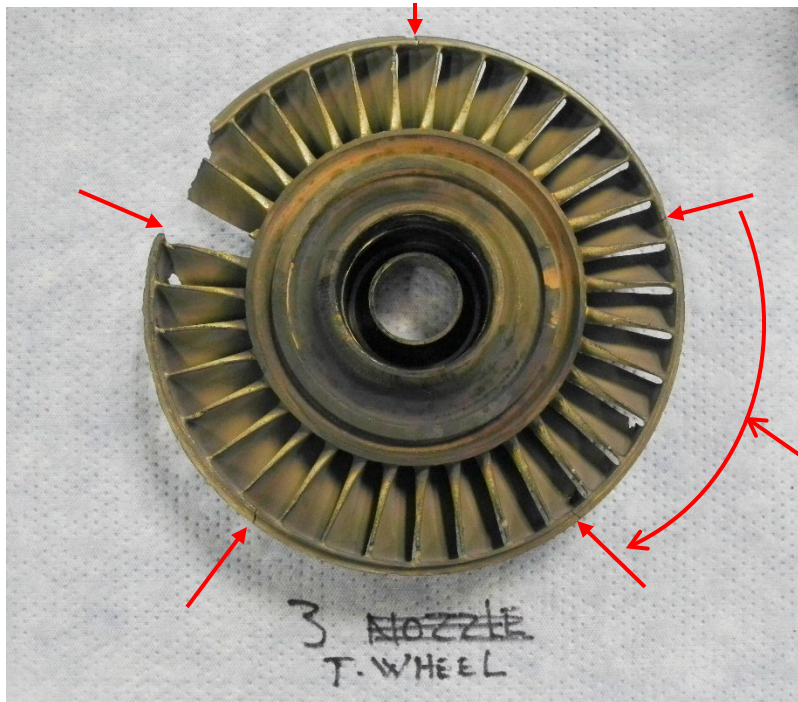
Photo 14 - 3rd Stage Turbine Nozzle – Downstream Face



Photo 15 - 3rd Stage Turbine Nozzle – Downstream Face - Detail



Photo 16 - 3rd Stage Turbine Wheel – Upstream Side



Red Arrows
Indicate Location
of EDM Slots in
Rim

One 'packet' of
7 blades. 5
Packets in
Wheel.

Photo 17 – Fracture Surface of 3rd Stage Turbine Wheel Blade

Fatigue Zone

Overload Fracture

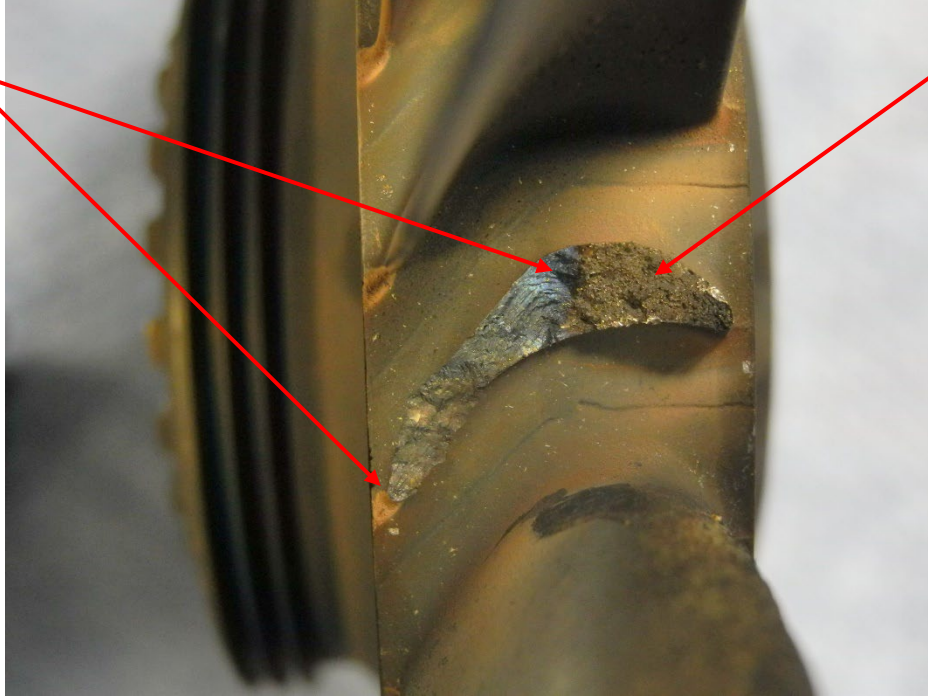


Photo 18 - Adjacent Blade Fracture Detail



Photo 19 - 4th Stage Turbine Nozzle – Upstream Side

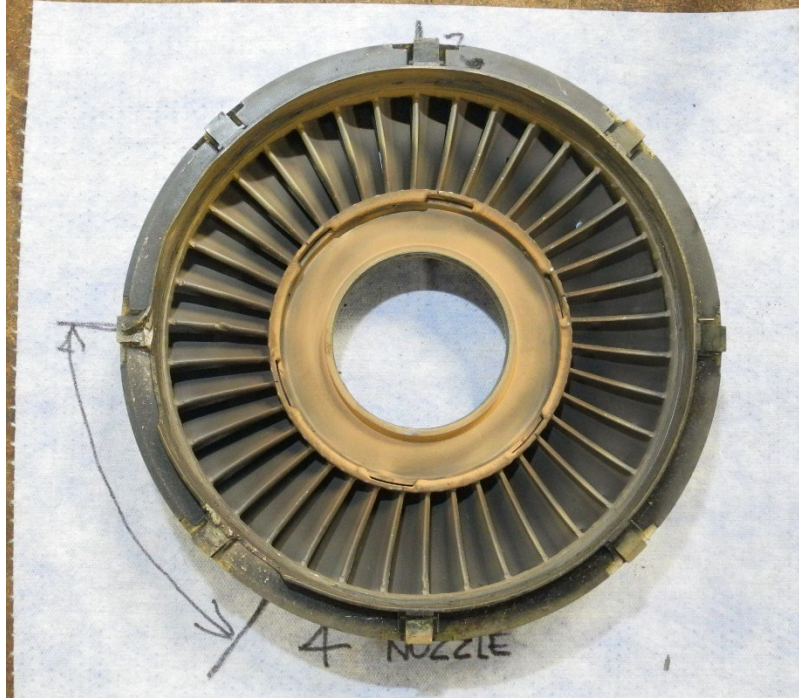


Photo 20 - 4th Stage Turbine Nozzle – Downstream Side

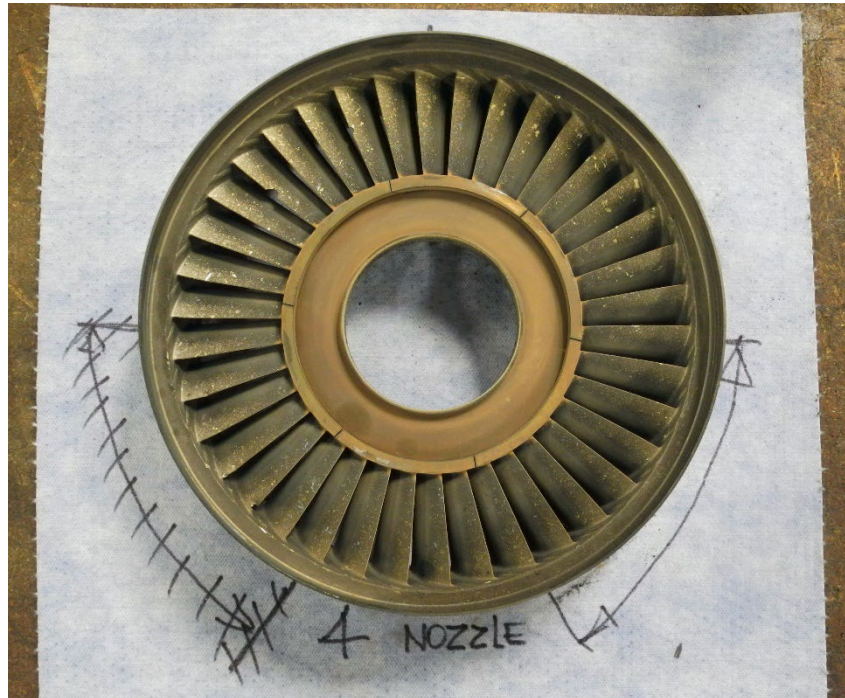


Photo 21 - 4th Stage Turbine Wheel – Upstream Side



Photo 22 - 4th Stage Turbine Wheel – Shroud Fracture



Photo 23 - #5 Bearing & Snap Ring with Spacer



Photo 24 - Exhaust Collector Support Strut and Duct Fracture

