

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



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POWERPLANT CHAIRMAN'S FACTUAL REPORT

March 1, 2024

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A. ACCIDENT

Location: Sterling, Texas
Date: November 29, 2023
Time: 1430 central standard time
Helicopter: MD Helicopters MD 600N, Registration Number N745MB

B. POWERPLANT CHAIRMAN'S FACTUAL REPORT

Group Chair Harald Reichel
National Transportation Safety Board
Washington, D.C.

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C. SUMMARY

On November 29, 2023, about 1430 central standard time, a MD Helicopters Inc. MD600N helicopter, N745MB, sustained substantial damage when it was involved in an accident near Sterling City, Texas. The commercial pilot and the aerial lineman sustained fatal injuries. The helicopter was operated as a Title 14 Code of Federal Regulations Part 133 rotorcraft external load flight.

The helicopter was operated by Brim Aviation, Ashland, Oregon. The purpose of the flight was to perform aerial power line system work. There were no known witnesses to the accident sequence.

Various impact marks were observed on a static arm, about 12 feet long, at the top of the electrical pole. The static arm supported optical ground wire (OPGW). The impact marks were located about 4 feet from the base of the static arm. The pole and attached wires were all found intact.

The helicopter came to rest on its left side, about 103 feet away from the electrical pole on a flat grass field. The fuselage sustained extensive crushing damage. The NOTAR (no tail rotor) system was found separated, about 30 feet away from the fuselage. All major structural items from the fuselage and empennage were

observed at the accident site. All six main rotor blades, from the fully articulated main rotor assembly, were present with extensive impact damage.

The helicopter was recovered from the accident site to a nearby secure location, where the engine was separated from the fuselage, boxed, and shipped to the Rolls Royce facilities in Indianapolis, Indiana where it was securely stored. The box was opened on February 20, 2024 when it was examined by the powerplant group.

An external examination of the engine revealed no un-containment, or fire damage. The disassembly and examination revealed rotational scoring in the compressor impeller and shroud as well as presence of metal spray¹ in the turbine section, an indication that the engine was operating during impact.

¹ Metal Spray - During normal engine operation, the compressor impeller rotor turns at high speeds. The impeller shroud is stationary, and is coated with a sacrificial thick aluminum material, The impeller and shroud are about 0.010 inches apart and a crash impact can cause them to contact each other, at which time the high-speed rotor shaves the soft aluminum shroud material and the engine airflow sends the small, shaved particles through the engine. As the aluminum particles enter the combustor, they become molten if there is a flame. The melted particles continue to the turbines where they become deposited on the cooler surfaces of the turbine blades and stator vanes. Visually, they appear as silver colored speckles.

Evidence of metal spray is an indication of engine operation; it indicates that there is engine rotation, positive engine airflow, and flame in the combustor.

D. DETAILS OF THE EXAMINATION

1.0 Powerplant

1.1 Engine Description

The engine was a Rolls-Royce (RR) M250-C47M 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 generator turbine. The compressed air from the axial compressor is diffused and then, via an external 180-degree compressor discharge tube system is directed into the combustor. The hot gases from the combustor drive the two-stage gas producer turbine and subsequently a two-stage power turbine 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. The engine power is managed by a full-authority digital electronic control (FADEC). The RR M250-C47M produces 650 shaft horsepower at takeoff.

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.

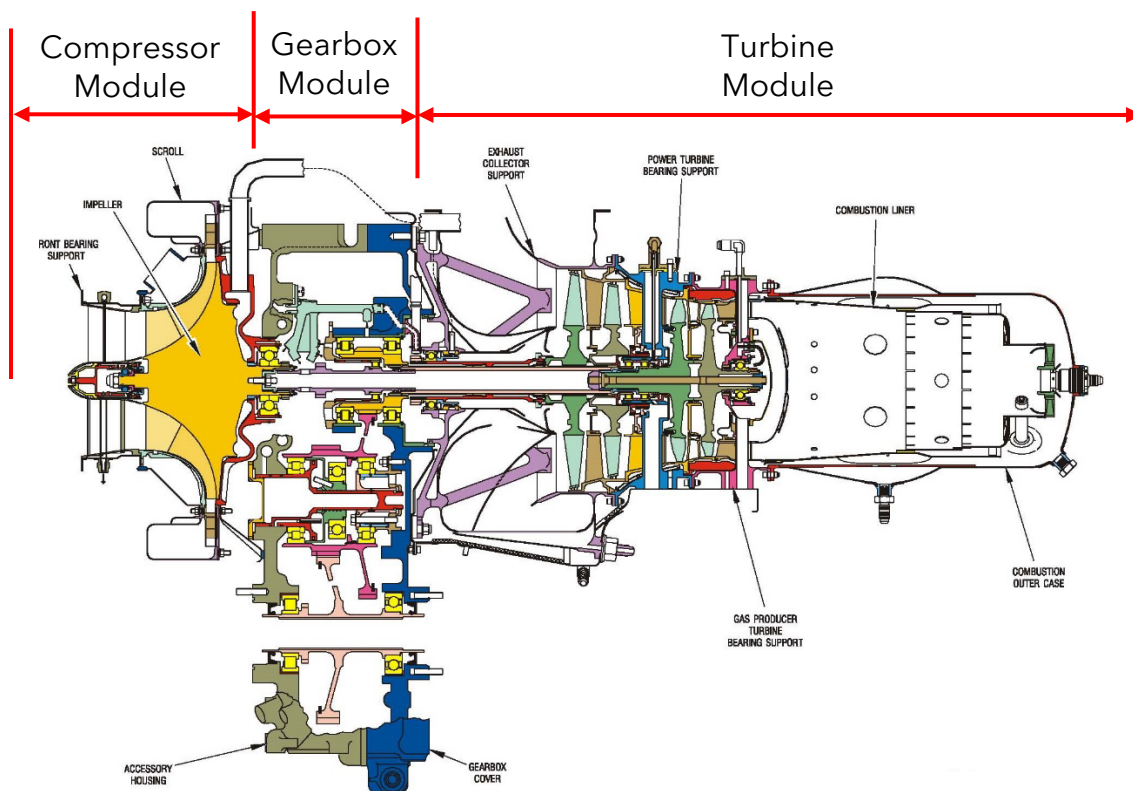


Figure 1 - Rolls Royce 250-C47M Cross Section - Courtesy Rolls-Royce

1.2 Engine History

The engine was a Rolls-Royce 250-C47M, assembly number 23065460, serial number (S/N) CAE-847247. The operators' engine logbook was not returned with the engine so the recent service and maintenance history of the engine could not be determined.

The gearbox assembly data plate identified it as part number P/N 23066745 and S/N CAG-47511. The data plate also indicated that the last overhaul occurred on February 20, 2014 at a gearbox total time of 4180.7 hours.

The turbine assembly data plate identified it as P/N M250-10557 and S/N CAT-44729. The data plate also indicated that the last overhaul occurred on September 9, 2013 at the turbine assembly total time of 5909.6 hours.

The compressor assembly data plate identified it as P/N 23065593 and S/N CAC-45907. There was no further data on the data plate that would indicate last overhaul or time.

2.0 Engine Examination and Disassembly

2.1 General Condition

The engine was in a wooden 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 or external impact or fire.

The airframe exhaust duct was still attached to the engine exhaust flange and was buckled inwards ([Photo 2](#)). The inner surfaces of the airframe exhaust duct were dry and clean ([Photo 3](#)). The outer combustor case (OCC) was dented on the left side discharge tube elbow and the left compressor discharge duct was dented on the outer surface ([Photo 4](#)), both consistent with an external impact.



Photo 1 - Rolls-Royce M250-C47M S/N CAE-847247- As Received

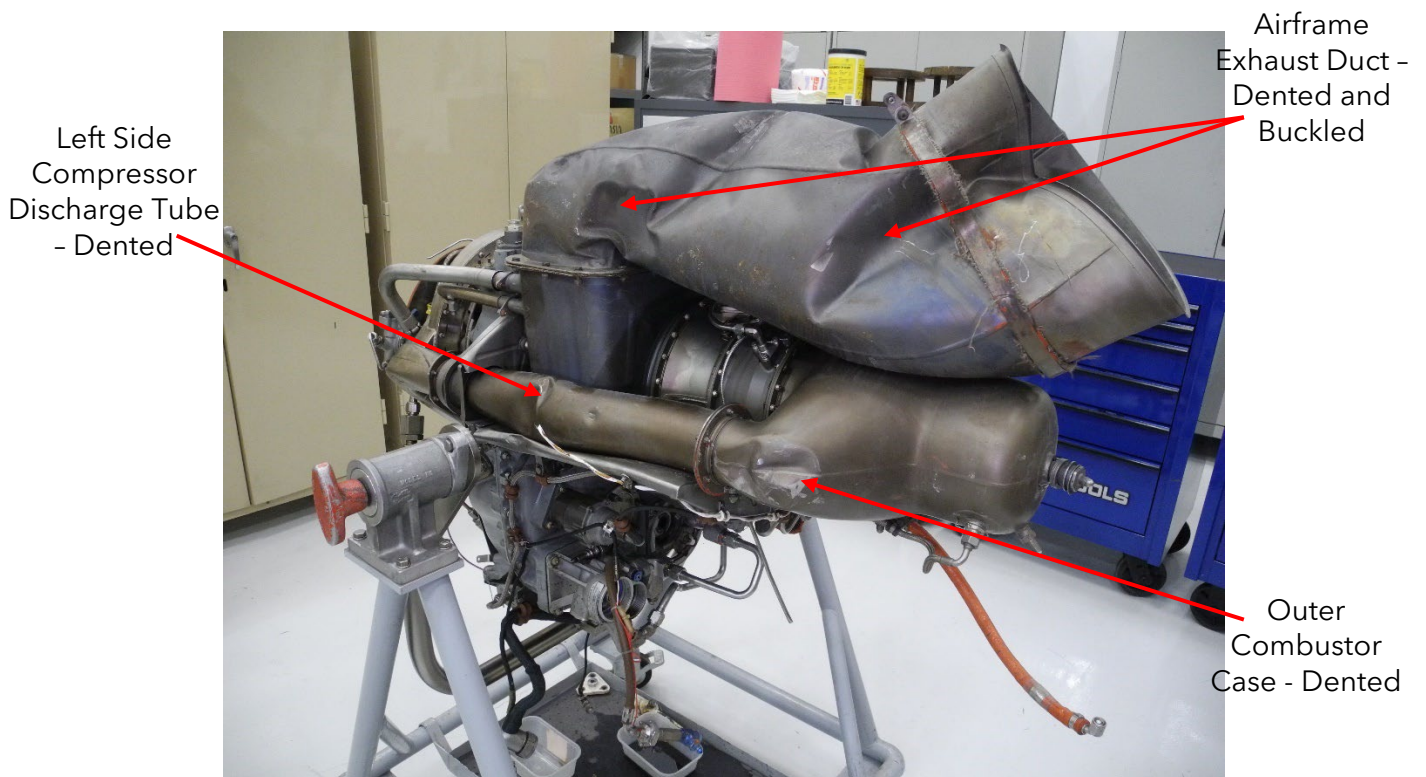


Photo 2 - Exhaust Duct - Buckled



Photo 3 - Airframe Exhaust Duct - Internal Surfaces Dry



Photo 4 - Left Side Compressor Discharge Tube - Dents

The internal surface of the exhaust collector duct was clean (Photo 5). The 4th stage turbine wheel (2nd stage power turbine) was clean and undamaged (Photo 6).

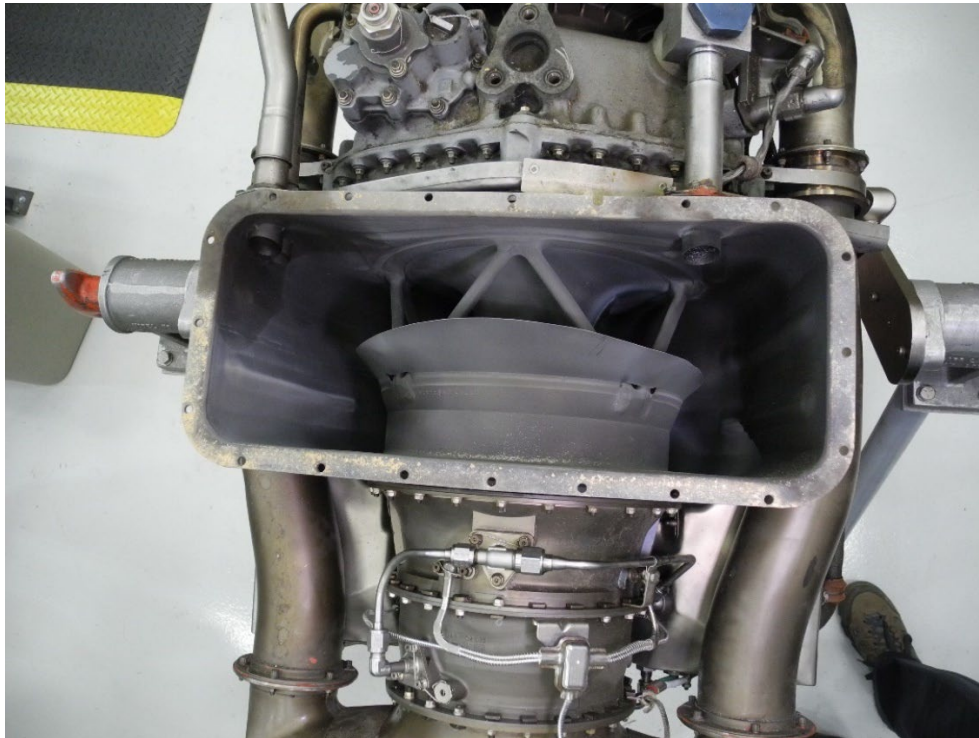


Photo 5 - Exhaust Collector Duct - Clean



Photo 6 - 4th Stage Turbine Wheel - Undamaged

The compressor inlet was clean, and the visible impeller vane leading edges were intact and clean (Photo 7). Both the low-pressure rotor (N1) and the high-pressure rotor (N2) spools could be easily turned with normal hand effort.



Photo 7 - Compressor Impeller Inlet - Clean

The oil pressure filter bypass button was not extended, an indication that there was no blockage of the oil filter during previous operation. The scavenge oil filter bypass indicator on the combined engine filter assembly (CEFA) was not returned; however, the RR technical advisor who was present in the field examination stated that it was not extended. The fuel filter impending bypass indicator was not extended, an indication that there was no blockage of the fuel filter during previous operation.

The FADEC was undamaged and in location with the electrical connectors still intact and undamaged.

The two chip detectors in the gearbox were clean and oil wetted (Photo 8). The oil filter was clean and oil wetted (Photo 9).



Photo 8 - Gearbox Oil Chip Detectors - Clean



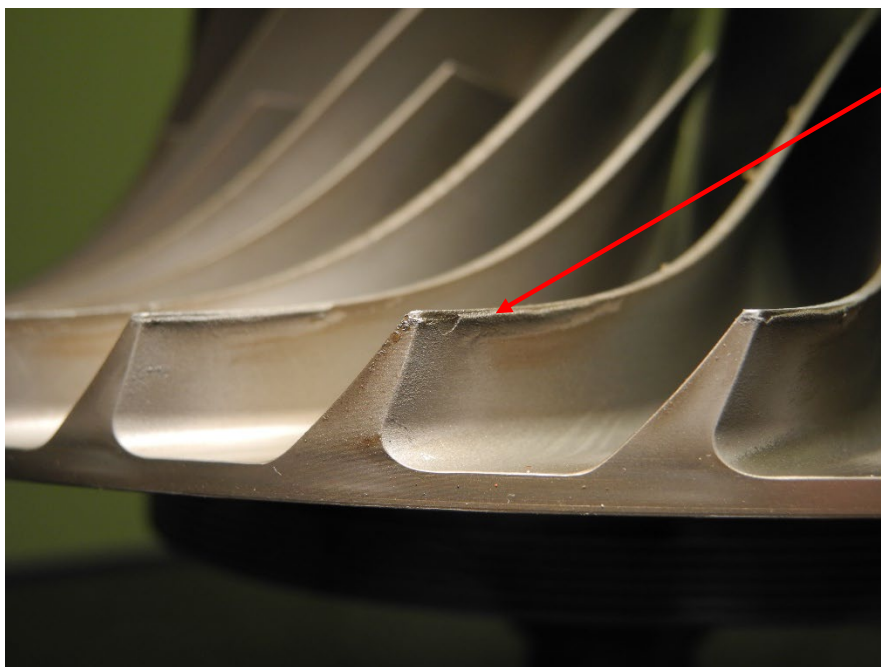
Photo 9 - Oil Filter - Clean

2.2 Compressor Module

The compressor turned freely, and the Nos. 1 and 2 bearings were clean and oil wetted. The impeller ([Photo 10](#)) was intact; however, there was a buildup ([Photo 11](#)) of transferred material at the last 1½ inches at exducer shroud line, consistent with the rotational scoring observed on the matching shroud location.



Photo 10 - Compressor Impeller - Intact



Buildup of
Transferred
Material

Photo 11 - Impeller Exducer - Buildup of Transferred Material

The impeller shroud ([Photo 12](#)) was intact; however, it was heavily rotationally scored, consistent with contact against the rotating impeller vane shroud line ([Photo 13](#) & [Photo 14](#)).

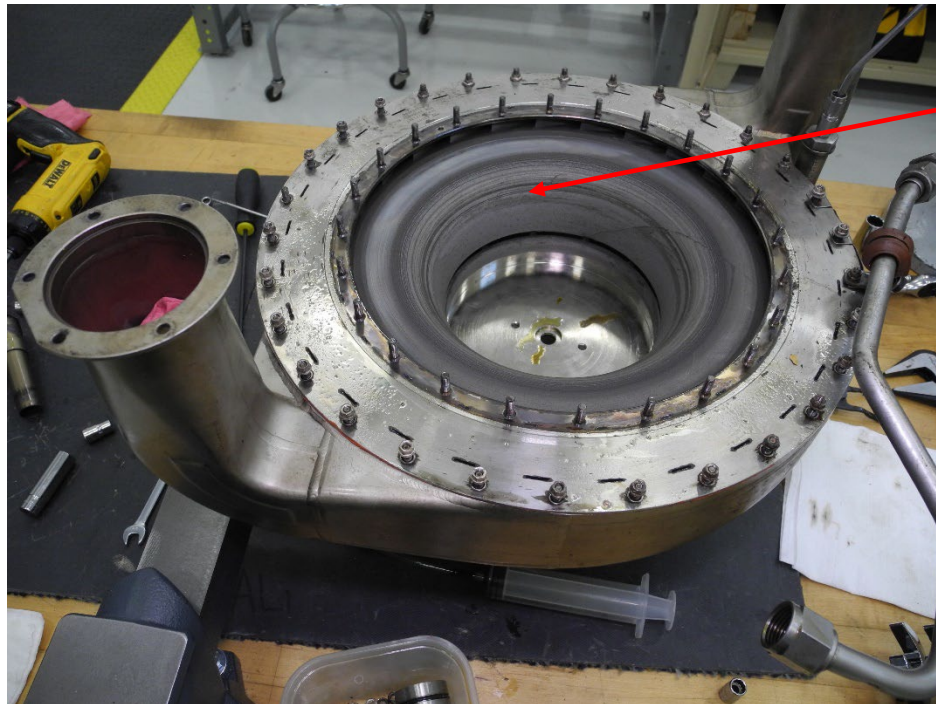


Photo 12 - Impeller Shroud - Still Installed in Diffuser Housing



Photo 13 - Impeller Shroud - Scored



Photo 14 - Impeller Shroud - Scoring Details

The spur adapter gearshaft was intact and undamaged ([Photo 15](#)).



Photo 15 - Spur Adapter Gearshaft - Undamaged

2.3 Gearbox Module

The gearbox was intact and undamaged. The N1 and N2 gear trains turned easily and smoothly using normal effort. When the oil filter housing was removed, an internal examination of the gearbox ([Photo 16](#)) confirmed that all internal components were oil wetted. All the related spline shafts turned in unison, indicating internal continuity and therefore the gearbox was not further disassembled.

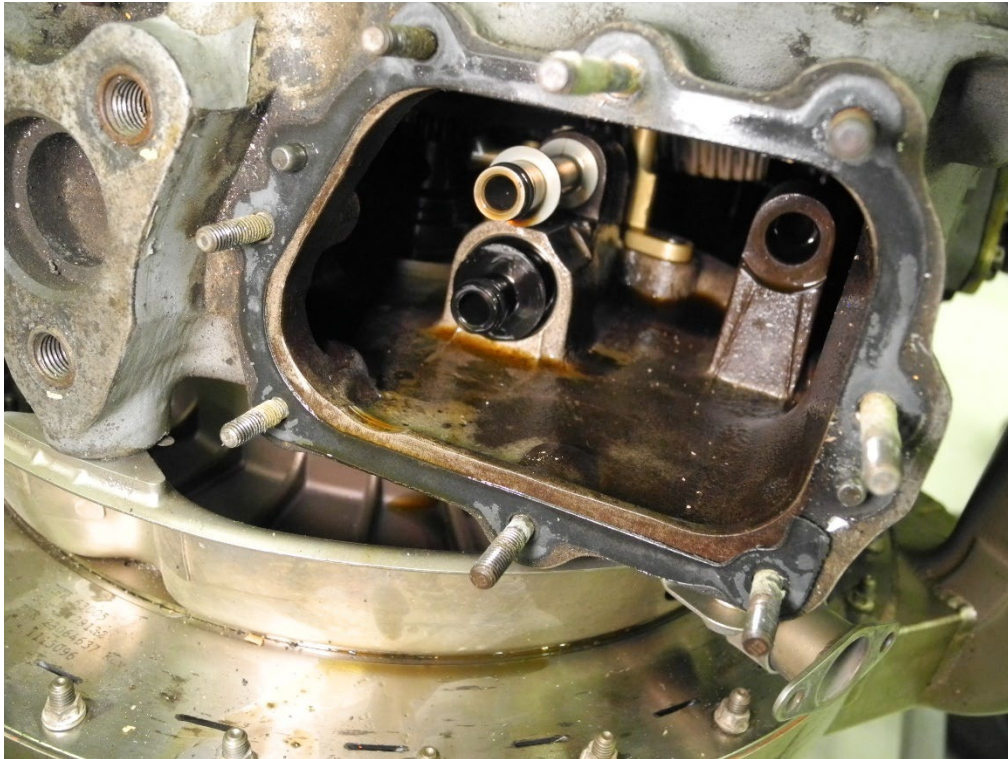


Photo 16 - Gearbox Internal View - Oil Filter Housing Removed

2.4 Turbine Module

2.4.1 Combustor

The OCC was intact; however, it was dented on the left side discharge tube elbow and the left compressor discharge duct due to external impact. The combustor liner was intact and undamaged ([Photo 17](#), [Photo 18](#) & [Photo 19](#)). The fuel nozzle was intact and undamaged ([Photo 20](#)).

The turbine-to-compressor coupling was intact and undamaged.



Photo 17 - OCC and Combustor Liner - Undamaged



Photo 18 - OCC Internal View - Undamaged

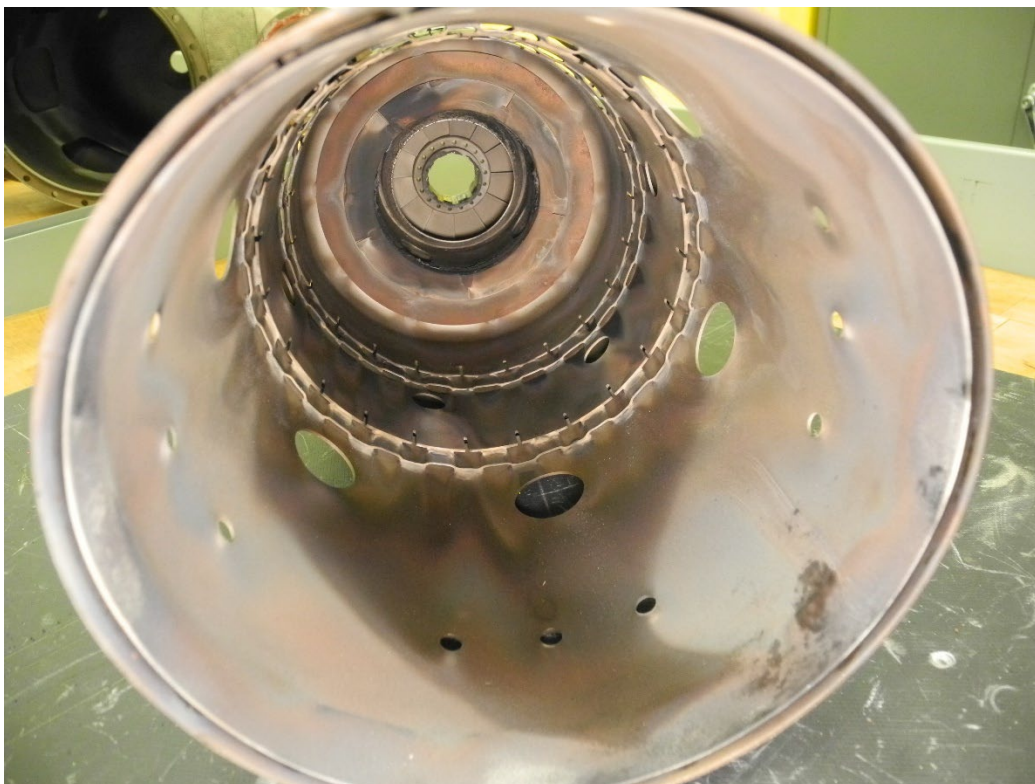


Photo 19 - Combustor Liner - Inner View - Undamaged



Photo 20 - Fuel Nozzle - Undamaged

2.4.2 Gas Producer Turbine

The 1st stage nozzle and 1st stage rotor were intact and undamaged ([Photo 21](#)).

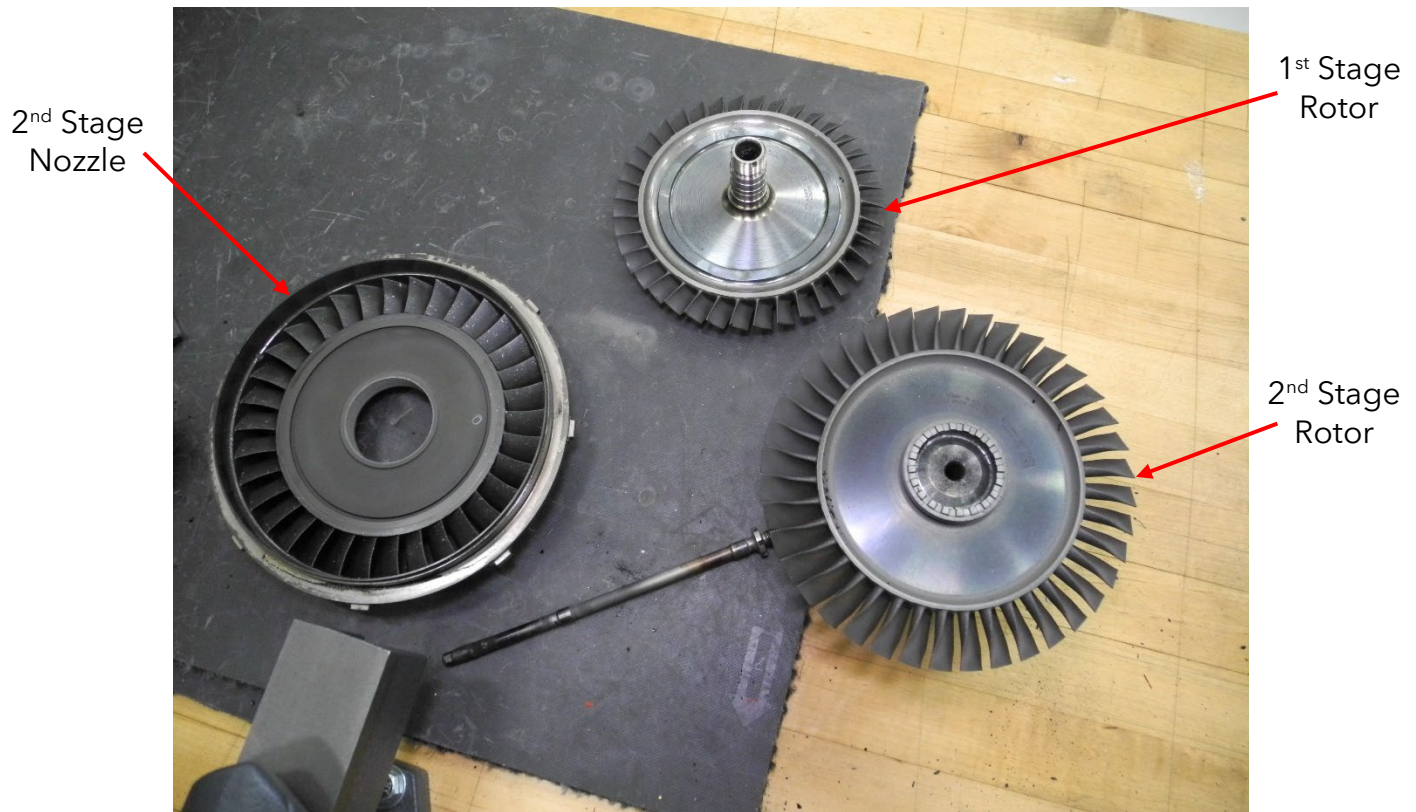


Photo 21 - Compressor Turbines

The 2nd stage nozzle was intact; however, it exhibited metal spray on the convex side of all the vanes and rotational scoring on the aft face (downstream side) of the vanes platform ([Photo 22](#)), consistent with contact against the rotating 2nd stage rotor blade platform ([Photo 23](#)). The 2nd stage rotor was otherwise intact.

The Nos. 7 and 8 bearings were undamaged and oil wetted.

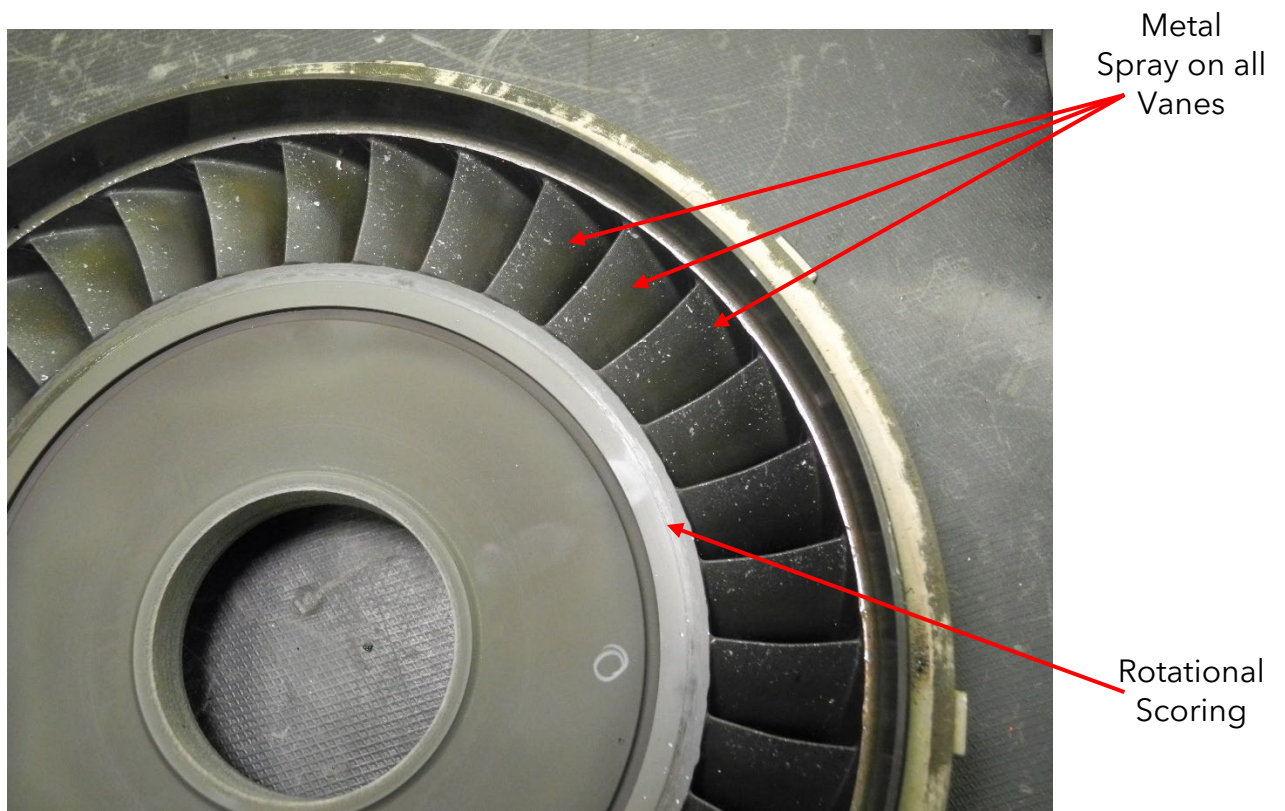


Photo 22 - 2nd Stage Nozzle

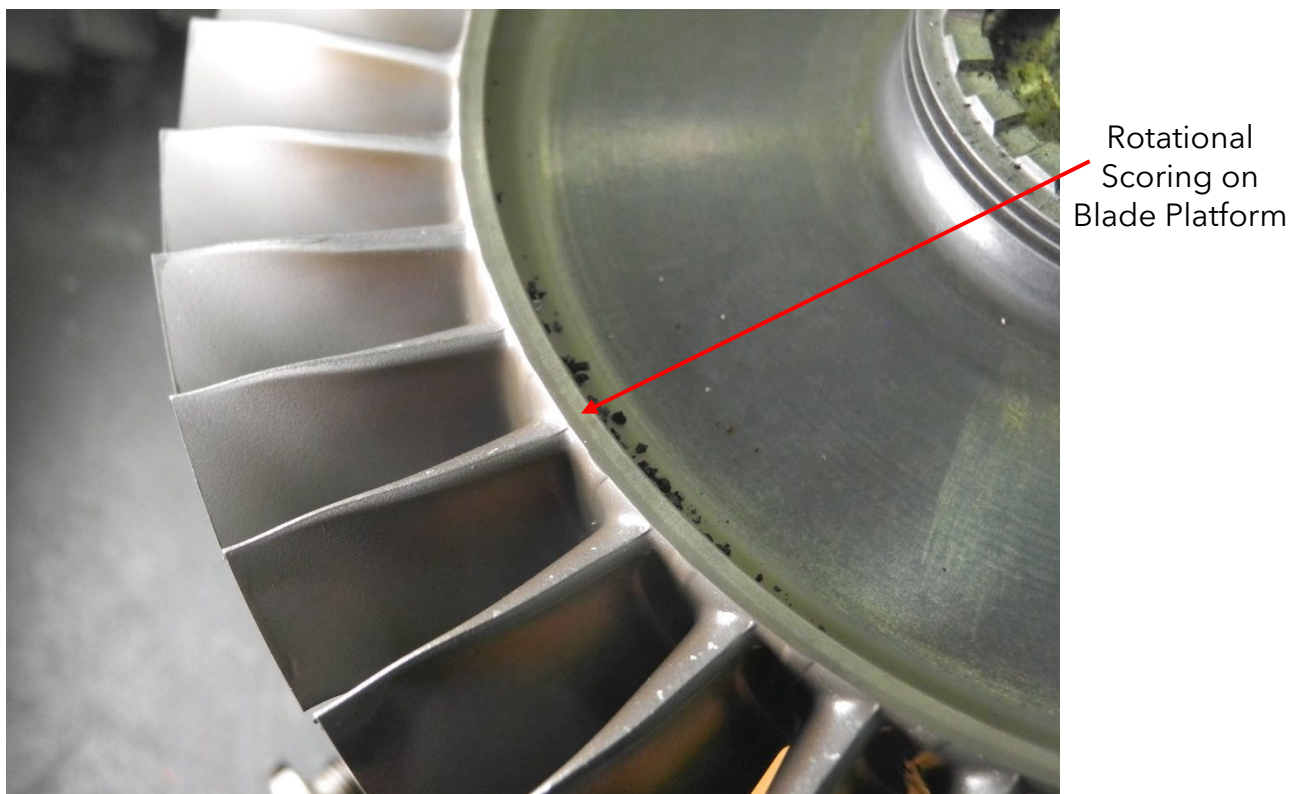


Photo 23 - 2nd Stage Turbine Rotor - Rotational Scoring

2.4.3 Power Turbine

The 3rd stage nozzle (Photo 24) and 3rd stage turbine were intact and undamaged. The 3rd stage nozzle exhibited metal spray on all the convex sides of the vanes (Photo 25).



Photo 24 - 3rd Stage Nozzle - Undamaged



Photo 25 - 3rd Stage Nozzle - Metal Spray Details

The 4th stage nozzle and 4th stage rotor were intact and undamaged. The 4th stage nozzle exhibited metal spray on most of the convex sides of the vanes ([Photo 26](#)).

The Nos. 5 and 6 bearings were undamaged and oil wetted.



Photo 26 - 4th Stage Rotor & Nozzle - Metal Spray

The FADEC was not further examined because:

- 1) It was found intact and undamaged, and in location with all the electrical connectors undamaged.
- 2) The fuel filter was found to be clean.
- 3) Significant rotational scoring, metal spray were found in the impeller, rotors, and nozzles, consistent with normal operation during impact.

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