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Office of Aviation Safety

Washington, DC 20594



CEN23LA232

POWERPLANTS

Group Chair's Factual Report - Attachment #1

Honeywell Lab Analysis Report

January 8, 2024

**Pages 1-15 of
ERS-ASYS-PENG-MA-0000952 are
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BACKGROUND

The TPE331-1-151A engine S/N P-92203C was torn down at Product Integrity in support of a NTSB accident investigation. The torsion shaft (P/N 3102028-2), 1st stage stator (P/N 896450-5), and fuel collected from the fuel control unit (FCU) were submitted for evaluation. The engine has 8506 hours since new (TSN), 6964 cycles since new (CSN), 1016 hours since the hot section interval (TSHSI), and 476 cycles since the hot section interval (CSHSI).

PROBLEM STATEMENT

Determine the fracture mode of the submitted torsion shaft. Document the 1st stage stator and identify the composition of any metal spray observed on the blades. Identify the composition of the two liquids collected from the FCU.

SUMMARY/CONCLUSIONS

- Scanning electron microscope (SEM) and energy dispersive X-ray (EDX) examination of representative 1st stage stator blades revealed areas where the coating had spalled off revealing the blade base material. No metal spray was observed on the 1st stage stator blades.
- Representative EDX spectra generated from analysis of the 1st stage stator blade base material and coating were suggestive of the specified IN713 base material and simple aluminide coating, respectively.
- The torsion shaft had separated 1.224" from the aft end.
- SEM examination of the separated torsion shaft revealed fracture features indicative of torsional overload as indicated by the elongated dimples in the counterclockwise direction, forward looking aft.
- EDX spectrum generated from analysis of the torsion shaft base material was indicative of the specified AM355 material.
- The majority liquid collected from the FCU lower fitting was a 90% match to jet A fuel and the bubble sample was a 96% match to water.
- See Findings.

PART NAME:	See Table 1
PART NUMBER:	See Table 1
PART S/N:	See Table 1
MODEL/PROGRAM:	TPE331-1-151A
MODEL/PROGRAM S/N:	P-92203C
OPERATING TIME:	1016 Hours (TSHSI)
OPERATING CYCLES:	476 Cycles (CSHSI)
MATERIAL:	See Table 1
MATERIAL SPEC:	See Table 1
SUPPLIER:	Not Reported
SUPPLIER P/N:	Not Reported

Findings

A Grumman G-164B airplane, N48485, was substantially damaged when it was involved in an accident near Bloomfield, Nebraska. The pilot was not injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 137 aerial application flight. The pilot reported a loss of engine power during takeoff. He executed a forced landing to an agricultural field off the end of the runway. The airplane sustained damage to the upper and lower right wings.

The TPE331-1-151A engine S/N P-92203C was torn down at Product Integrity in support of a NTSB accident investigation. The engine has 8506 hours since new (TSN), 6964 cycles since new (CSN), 1016 hours since the hot section interval (TSHSI), and 476 cycles since the hot section interval (CSHSI). The torsion shaft (P/N 3102028-2), 1st stage stator (P/N 896450-5), and fuel collected from the fuel control unit (FCU) were submitted for evaluation (reference Table 1). A schematic of the TPE331-1 engine showing the submitted hardware is shown in Diagram 1.

1st Stage Stator

Overall images showing the 1st stage stator in the as-received condition are shown in Figures 1-2. The stator blades were labeled 1-29, clockwise, forward looking aft, aligned with the "TOP" marking.

The part markings observed on the 1st stage stator appeared to be "P/N 896450-5", "W/O 0231R02", "S/N 7-01345-6348", and "A.F.=4.729 STI 72 50-201 R00" (Figure 1C).

Backscattered electron (BSE) scanning electron microscope (SEM) examination of representative Blades 2 and 15 are shown in Figure 3. Energy dispersive X-ray (EDX) spectrum generated from analysis of the various areas on the pressure side of the blades were suggestive of the specified IN713 base material (Figure 4A), suggesting that the coating had spalled off revealing the blade base material. No evidence of metal spray was observed on the 1st stage stator blades.

Representative EDX spectra generated from analysis of the 1st stage stator blade base material and coating were suggestive of the specified IN713 base material and simple aluminide coating, respectively (Figure 4).

Torsion Shaft

The as-received condition of the submitted torsion shaft is shown in Figure 5. The shaft had separated 1.224" from the aft end. Wear was observed on the loaded side of the external spline teeth.

SEM examination of the separated torsion shaft revealed fracture features indicative of torsional overload as indicated by the elongated dimples in the counterclockwise direction, forward looking aft (Figure 6).

Representative EDX spectrum generated from analysis of the torsion shaft was indicative of the specified AM355 base material (Figure 7).

Fuel Analysis

Images showing the fuel collected from the fuel control unit (FCU) lower fitting are shown in Figure 8. Two liquids were identified and analyzed using Fourier transform infrared (FTIR) spectroscopy. The majority liquid was a 90% match to a jet A fuel (Figure 9) and the bubble sample was a 96% match to water (Figure 10).

Per customer request, no additional work was conducted on the submitted hardware.

Table 1: Hardware Information

Product Line	Program/Model	Program/Model Serial Number	Time Since Hot Section Interval (Hours)	Cycles Since Hot Section Interval (Cycles)
Propulsion Engine	TPE331-1-151A	P-92203C	1016	476
Part Name	Part Number	Part Serial Number	Material	Material Specification
Torsion Shaft	3102028-2	Not Reported	AM355	AMS5743
1 st Stage Stator	896450-5	7-01345-6348	IN713 Haynes 25	EMS55317 AMS5537

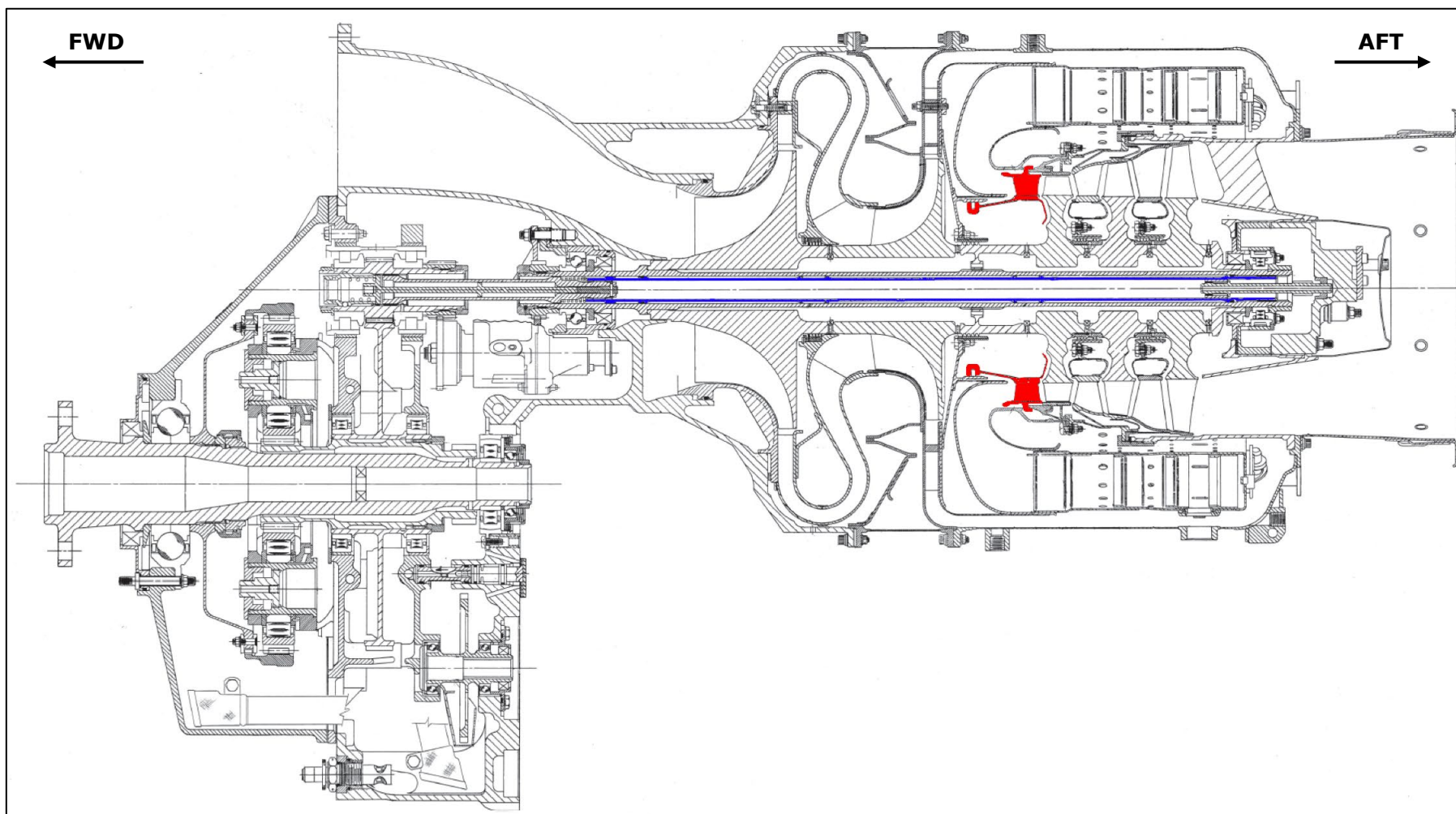
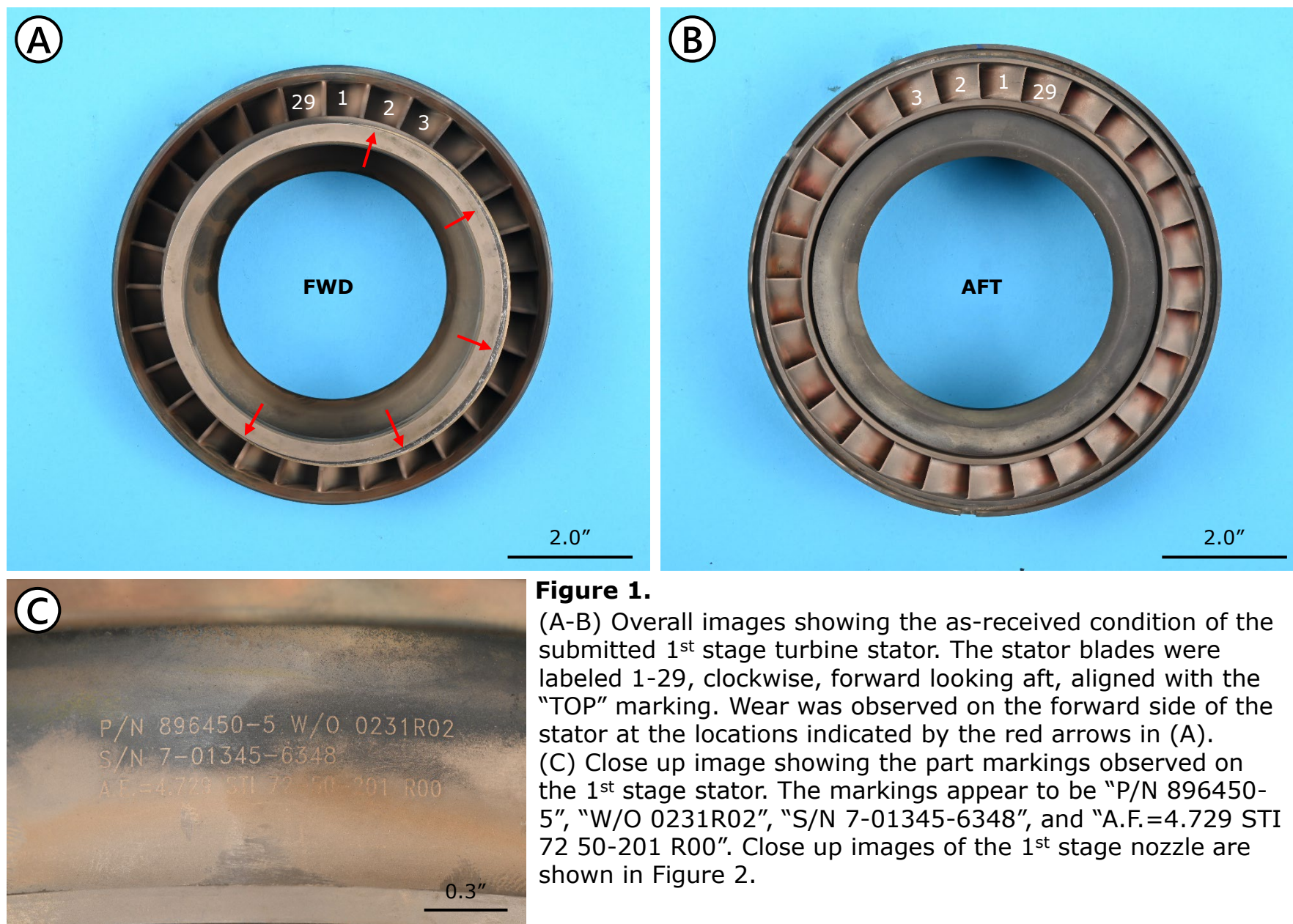


Diagram 1.

Schematic of the TPE331-1 engine showing the submitted 1st stage nozzle (P/N 896450-5, colored in red), and torsion shaft (P/N 3102028-2, colored in blue).



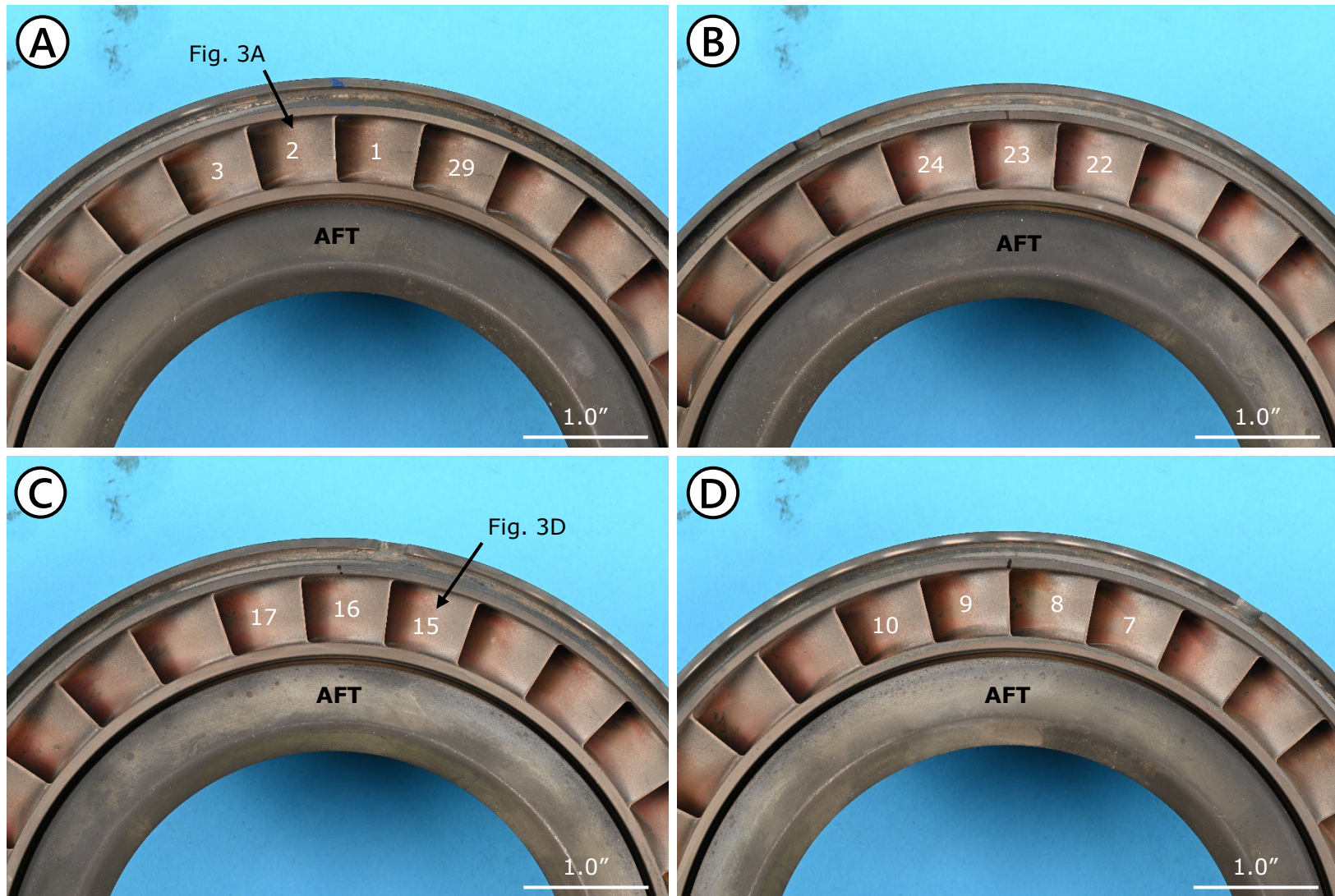


Figure 2.

(A-D) Close up images showing the aft side of the 1st stage nozzle (reference Figure 1B). Scanning electron microscope (SEM) images of the representative blades identified in (A) and (C) are shown in Figure 3, as indicated.

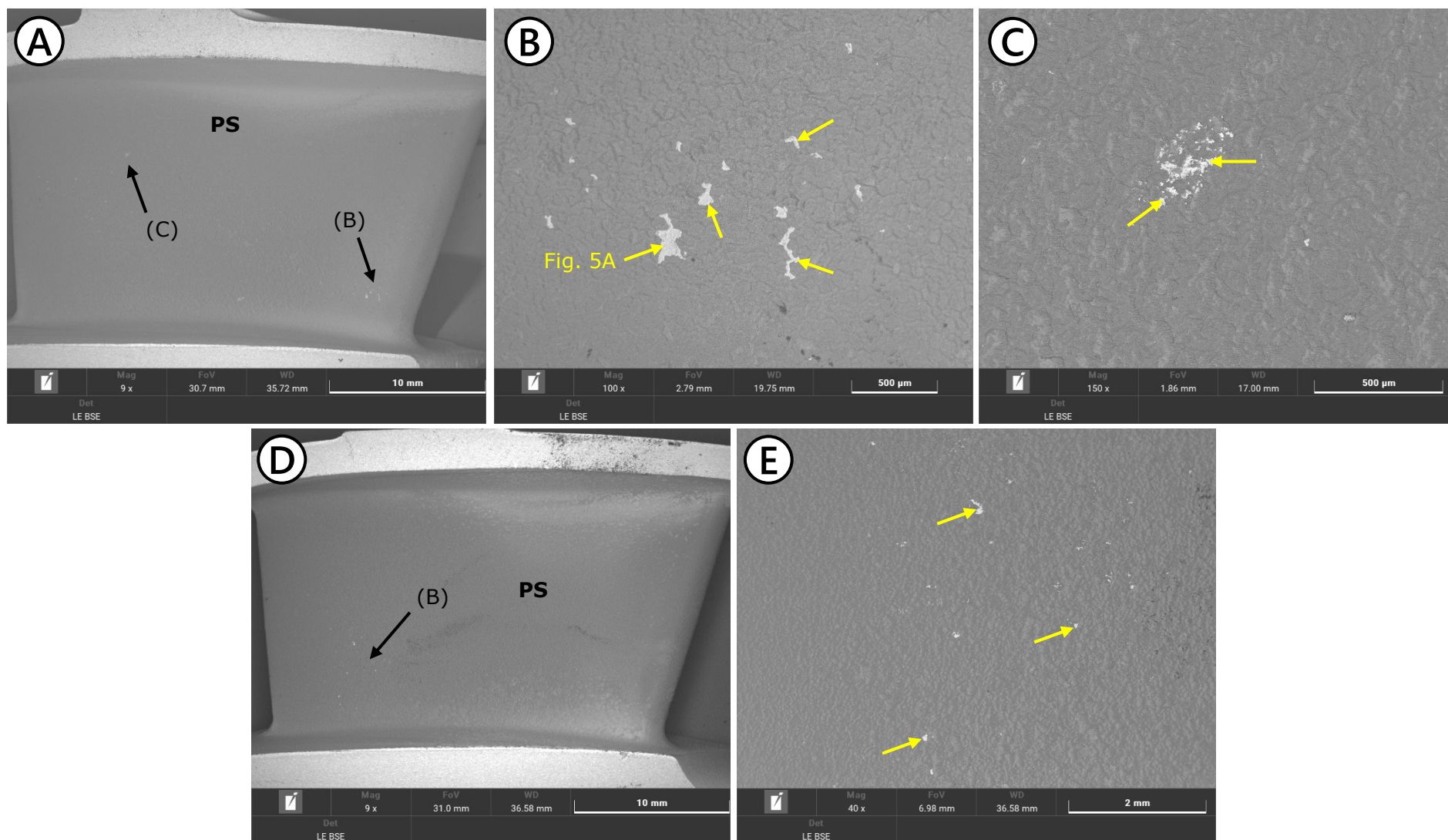


Figure 3.

(A-F) Backscattered electron (BSE) SEM images of representative 1st stage stator blades at the locations indicated in Figures 2A and 2C. The yellow arrows in (B-C) and (E) identify areas where the coating was missing from the 1st stage nozzle. Energy dispersive X-ray (EDX) spectra generated from analysis of the areas is shown in Figure 5A. Note that no evidence of metal spray was observed on the representative 1st stage stator blades.

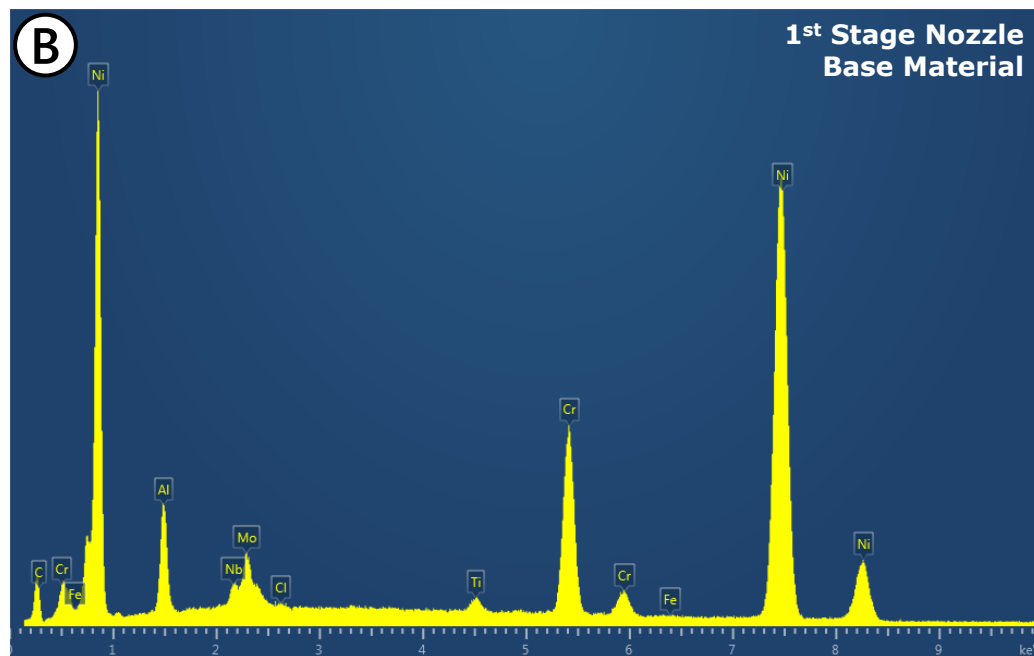
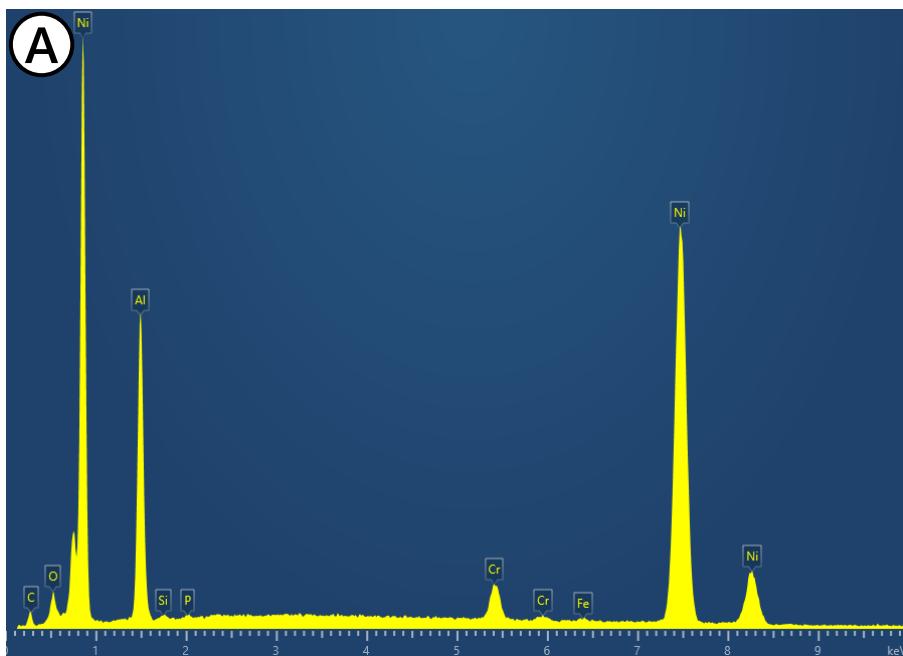
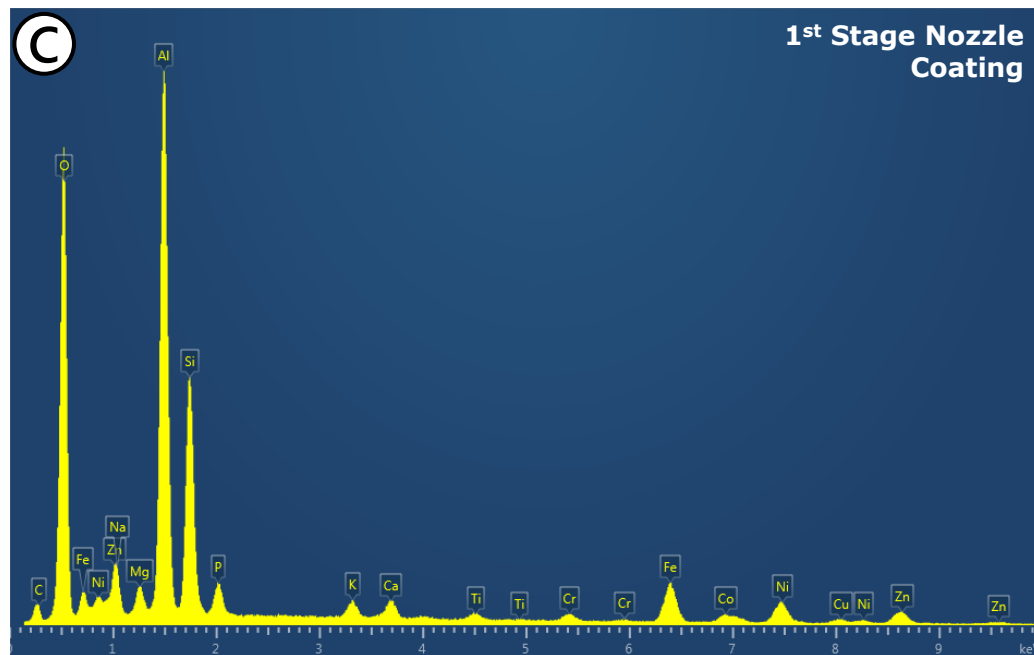


Figure 4.

(A) Representative EDX spectrum generated from analysis of the areas identified by the yellow arrows in Figure 3. The spectrum was indicative of a nickel alloy similar to the specified IN713 base material.

(B) Representative EDX spectrum generated from analysis of the 1st stage blade base material was suggestive of the specified IN713 nickel alloy.

(C) Representative EDX spectrum generated from analysis of the 1st stage stator coating. The spectrum was rich in aluminum, oxygen, and silicon, with lower concentrations in other elements, suggestive of the specified simple aluminide coating.



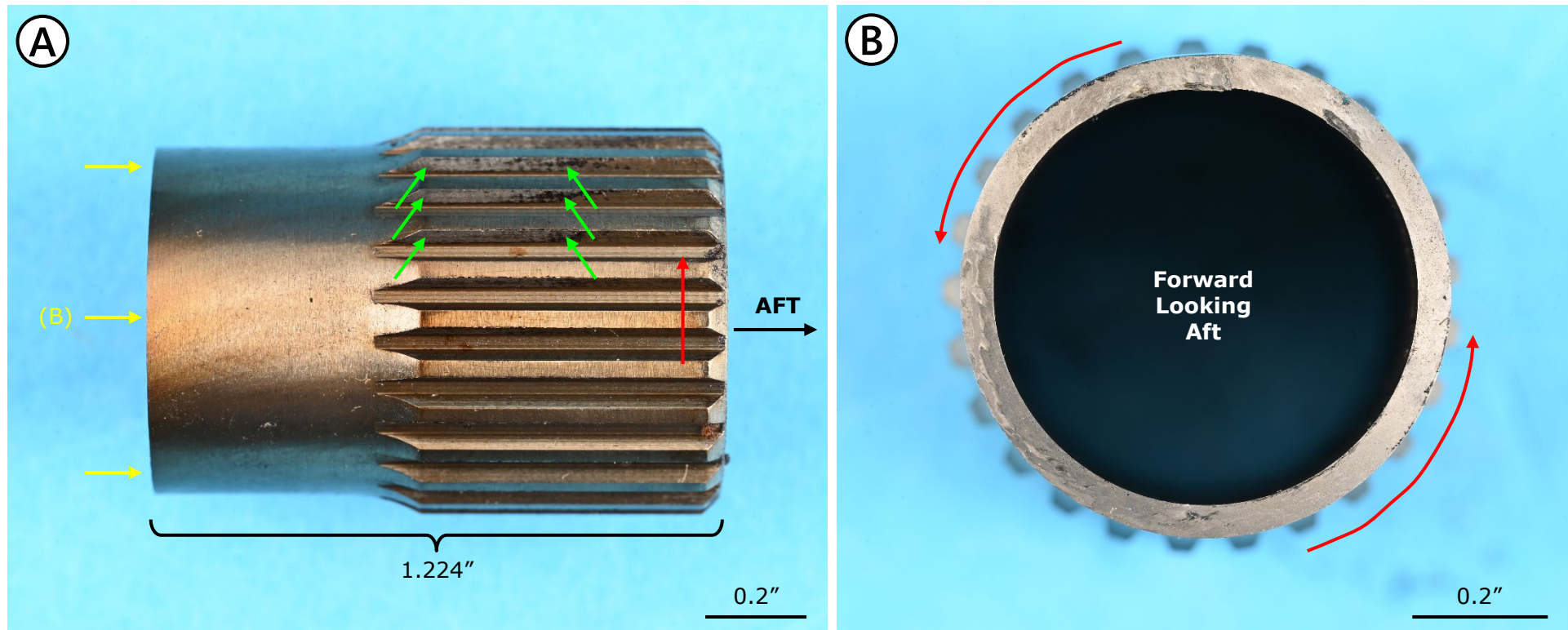


Figure 5.

(A) Close up image showing the aft end of the fractured torsion shaft. The torsion shaft had separated 1.224" from the aft end (yellow arrows in (A)) . Wear was observed on the loaded side of the external spline teeth (green arrows in (A))). (C) Image showing the fracture surface on the aft side of the shaft separation. The red arrows indicate the specified direction of the shaft rotation within the engine (counterclockwise, FLA). Scanning electron microscope (SEM) images of the separated shaft fracture surface are shown in Figure 6.

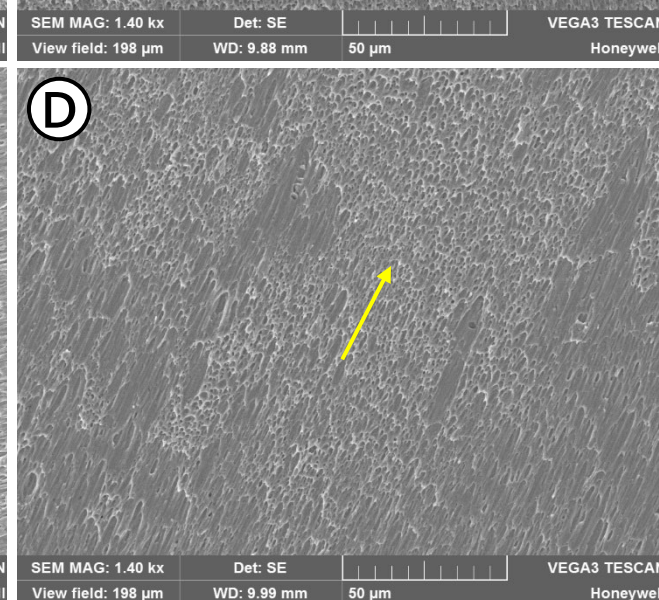
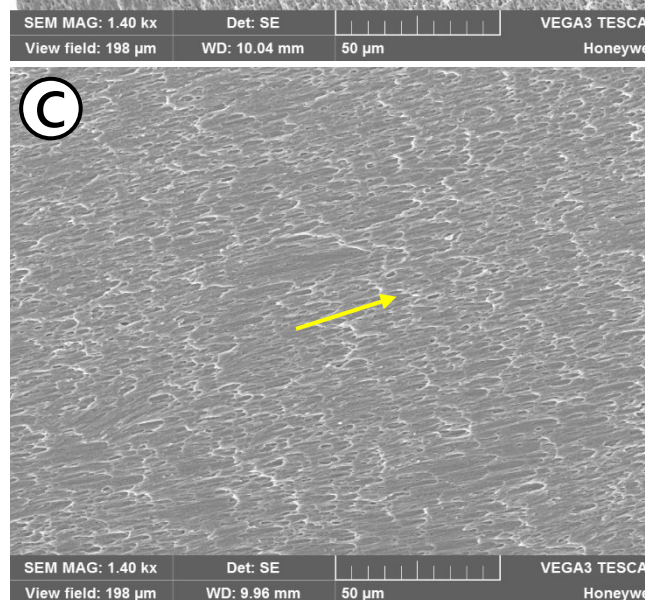
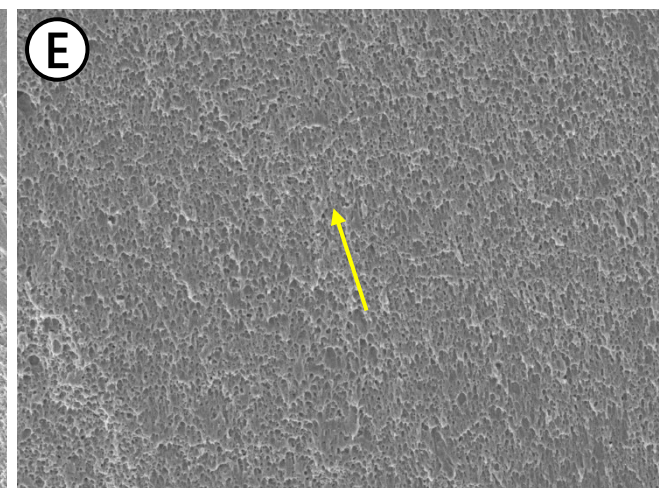
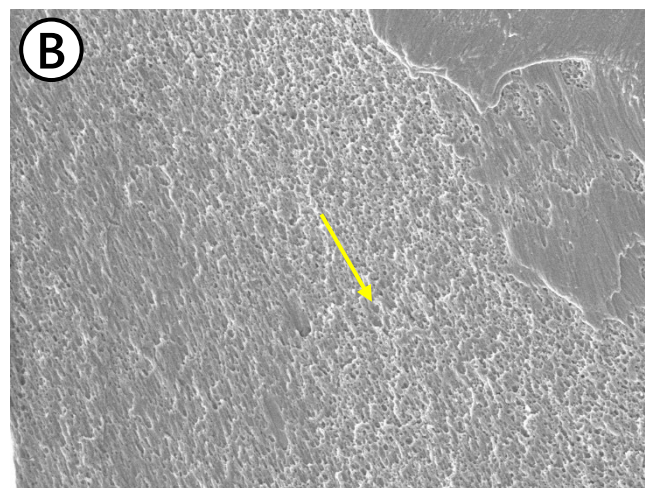
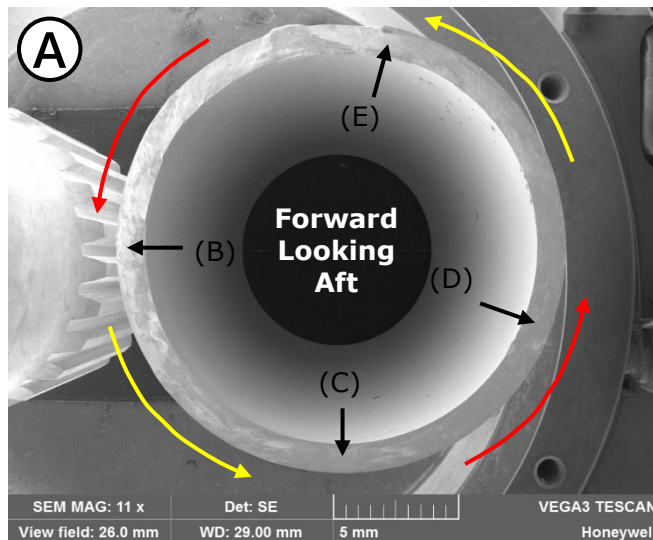
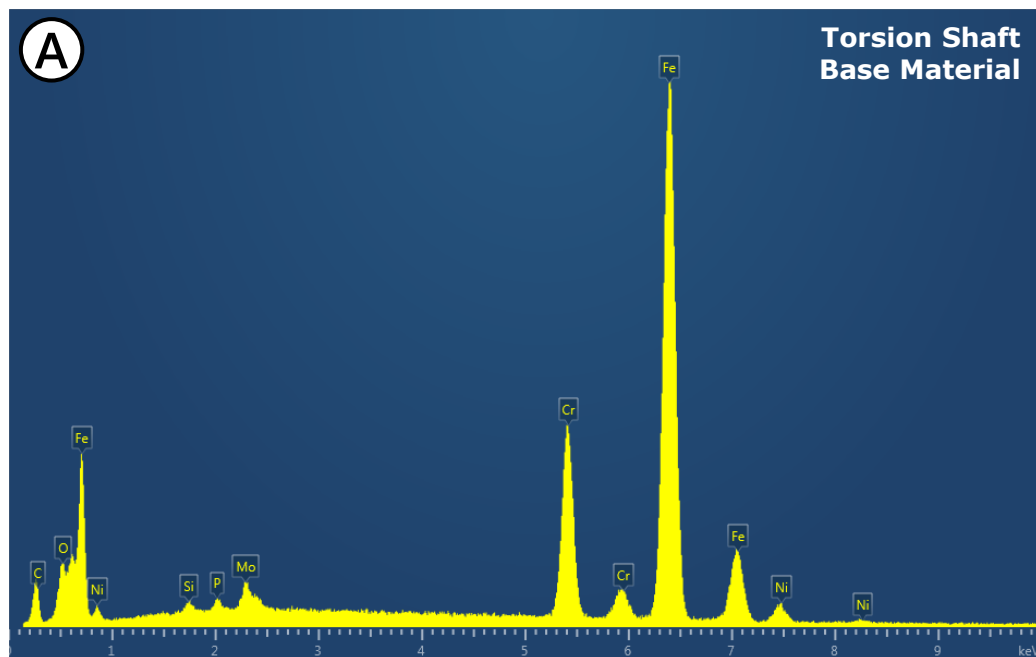
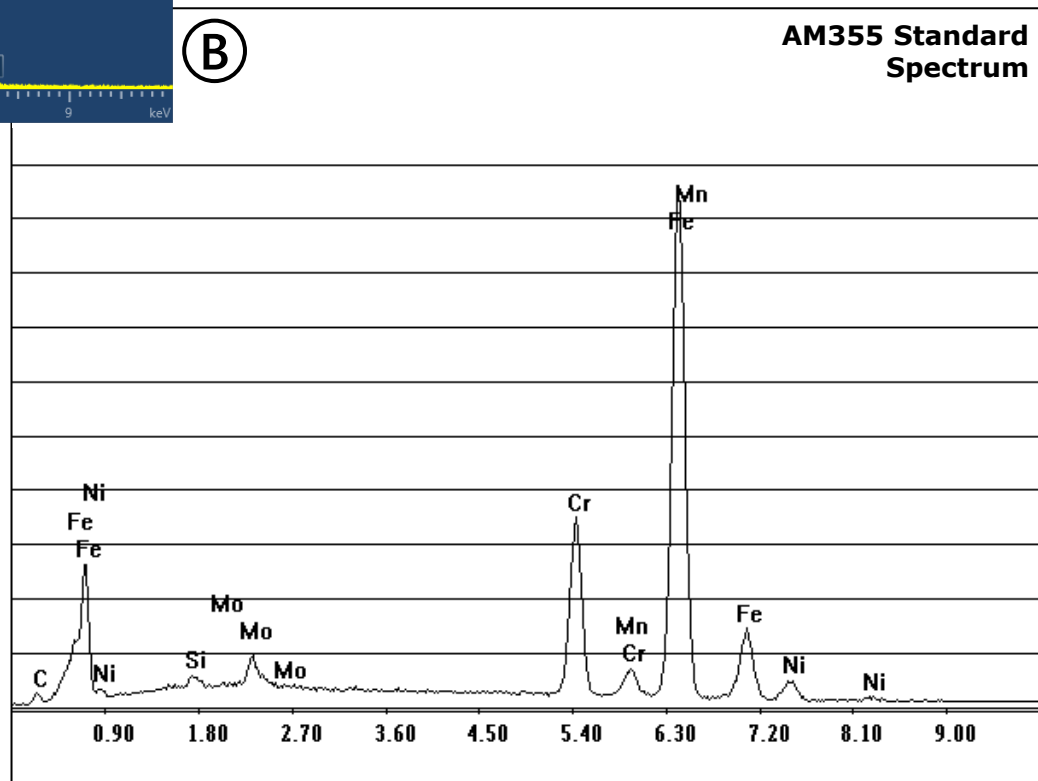


Figure 6.
(A-E) Secondary electron (SE) SEM images showing the fracture surface on the separated torsion shaft (reference Figure 5B). The fracture features were indicative of torsional overload as indicated by the elongated dimples. The yellow arrows indicate the direction of rotation with respect to the mating fracture surface. The red arrows in (A) indicate the specified direction of the shaft rotation within the engine (counterclockwise, FLA).

**Figure 7.**

(A) Representative EDX spectrum generated from analysis of the torsion shaft base material. (B) Laboratory standard reference EDX spectrum for AM355. The spectrum in (A) was indicative of the specified AM355 base material.



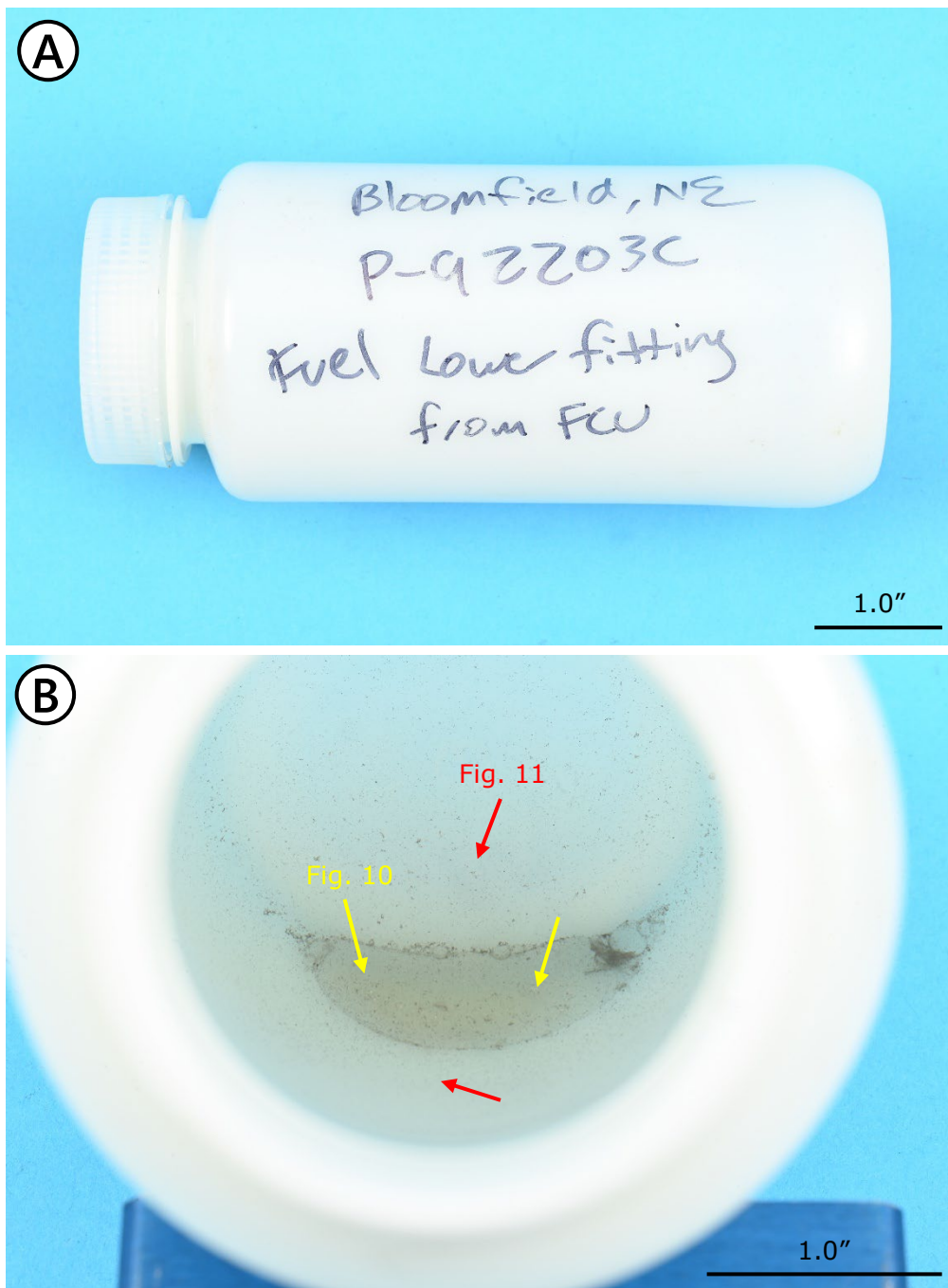
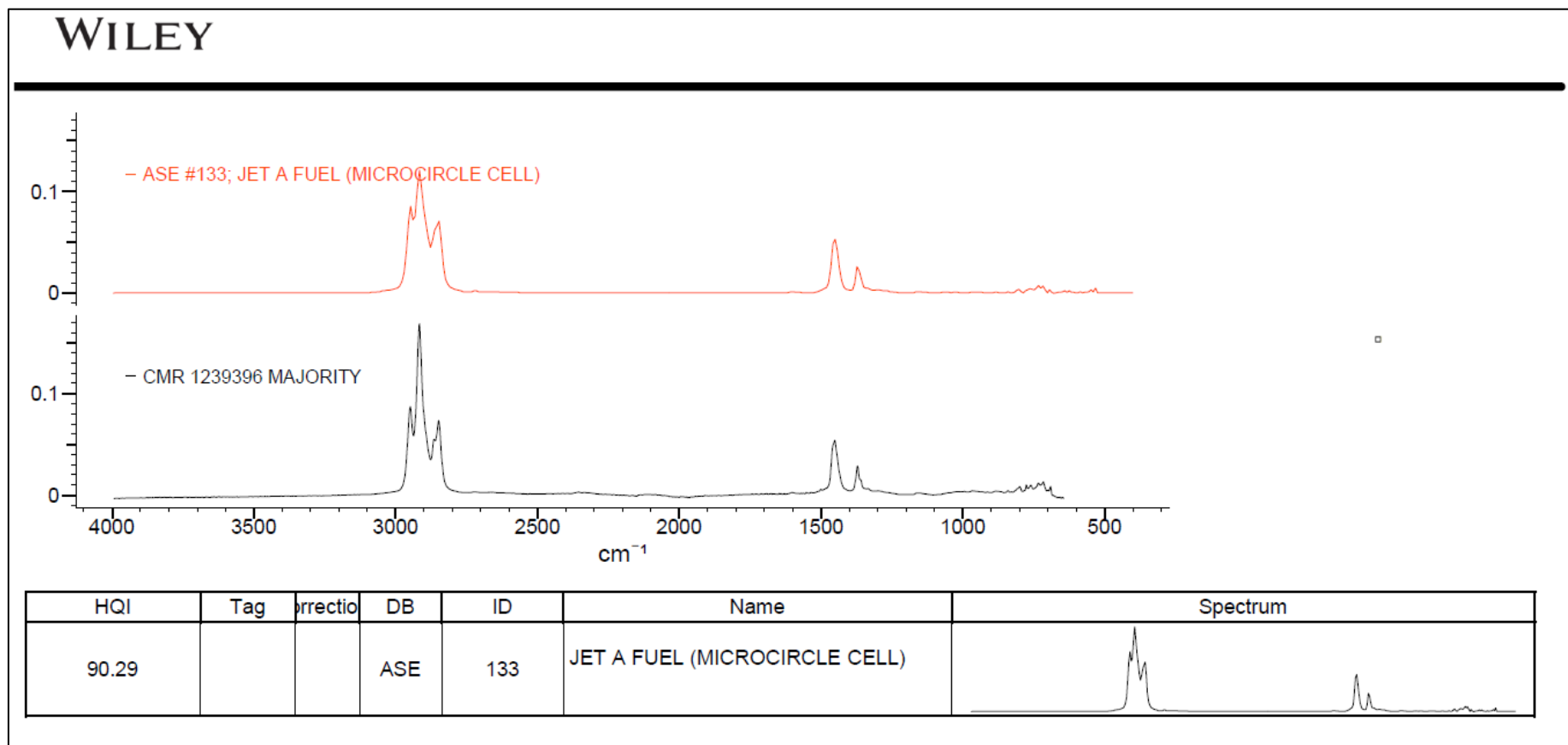
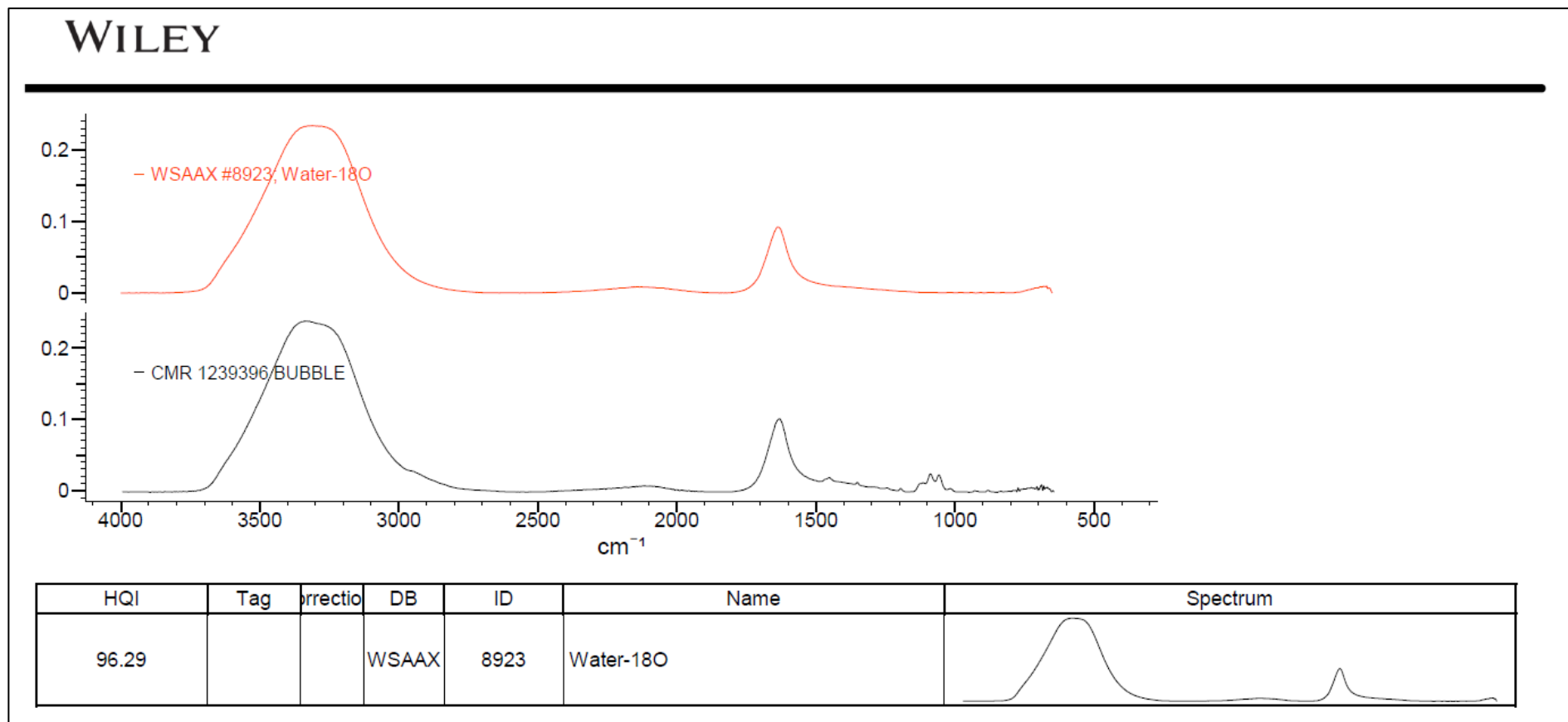


Figure 8.

(A-B) Images showing the as-received condition of the liquid collected from the fuel control unit (FCU) lower fitting. The two liquids identified by the yellow and red arrows in (B) were analyzed using Fourier transform infrared (FTIR) spectroscopy and are shown in Figures 9-10, respectively.

**Figure 9.**

FTIR spectrum generated from analysis of the majority liquid identified by the yellow arrows in Figure 8B. The spectrum was a 90% match to jet A fuel.

**Figure 10.**

FTIR spectrum generated from analysis of the bubble sample identified by the red arrows in Figure 8B. The spectrum was a 96% match to water.