

CEN24LA146

POWERPLANTS

Group Chair's Factual Report - Attachment #2
Pratt & Whitney Canada Materials Investigation Report
October 20, 2025



Service Investigation
Accident / Incident Report
P&WC 8114 (2021-02)

Extract from Report No.: 24-060

**Vincent Flying Service Inc.
Schweizer Grumman Ag-Cat Model 164B, N75099
Kaplan, Louisiana
April 2, 2024
PT6A-15AG, 14007**

Written By:

[Redacted]
Service Investigation Department

Approved By:

[Redacted]
Manager, Service Investigation Department

Date of Issue: **Day month year**

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NTSB Identification: CEN24LA146
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Red File No.: 24-060
RFA No.: 24SIE00100

[Redacted]

EXPORT CONTROL CLASSIFICATION		LOCATION		U.S. REGULATION			
				EAR		ITAR	
		U.S.		P-ECCN	9E991	P-USML	NSR
		OUTSIDE U.S.		ECCN	NSR	USML	NSR
				LOCAL REGULATION			
		CANADA	EIPA (ECL)		DPA (CG)		
Date of marking	28 October 2024		NSR		No		



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- 4.1 General view of the three bolts in their as-received condition arbitrarily identified as B#1, B#2 and B#3 (Photo No. 1). The bolt markings were no longer visible. The general aspect of the bolts showed oxidation and varying degrees of material loss, most likely due to erosion.



Photo No. 1

- 4.2 The bolt #1 showed no remnants of the silver plating on the surface (Photo No. 2). The bolt threaded portion was worn down/eroded with no remaining threads visible (Photo No. 2). The bolt head and the washer section have been worn and deformed (Photo No. 2 & Photo No. 3).

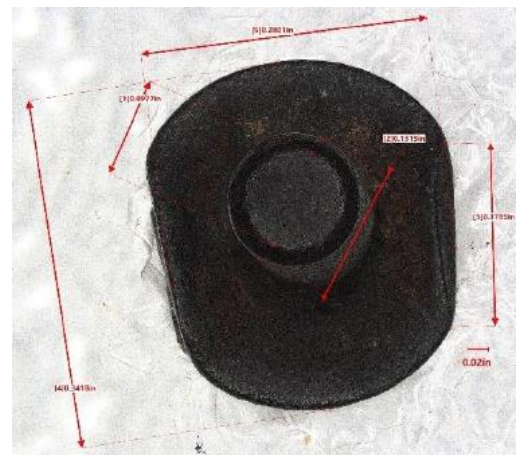
**Photo No. 2**

Photo No. 3



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- 4.3 Magnified view of the bolt #1 thread surface area showed faint remaining threads (Photo No. 4). The remaining surfaces were oxidized with corrosion product on the bolt head (red arrows, Photo No. 88). The general aspect of the bolt is consistent with being exposed to hot gasses.



Photo No. 4

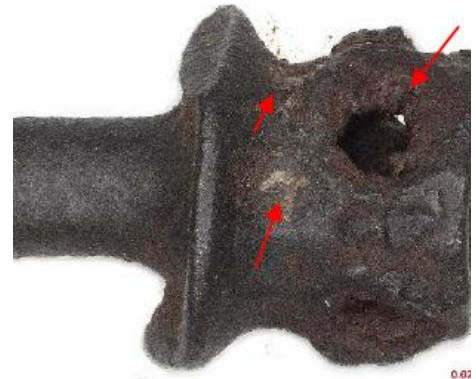


Photo No. 5

- 4.5 The bolt #2 showed no remnants of the silver plating on the surface. The measured diameter of the bolt is 0.177 inches at the bolt heads (Photo No. 6) which is within acceptable range as per drawing specification. A portion of the thread has been reduced to 0.161 inches at the mid-length of the bolt (red bracket, Photo No. 7).



Photo No. 6



Photo No. 7

- 4.6 Magnified view of the bolt #2 thread showed the progressive diameter reduction from the tip of the bolt toward the head (Photo No. 8).



Photo No. 8

- 4.7 Magnified view of the damaged area indicated by the red bracket in Photo No. 90 showed area of wear damage (green arrows, Photo No. 9 & Photo No. 10), stripped thread (double ended arrow, Photo No. 10) and presence of corrosion product (blue arrows, Photo No. 9 & Photo No. 10. The remaining thread of the bolt #2 did not show any evidence of damage indicative that the thread has been stripped. SEM images showed the surface of the bolt #2 and a suspected striped thread (Photo No. 94 & Photo No. 12). SEM-EDS analyses using semi-quantitative and standardless method were performed (Table No. 1). The contents of the primary elements detected (Fe, Mo, Cr, Mn) on the surface do not match the base material composition. High oxygen content was noted on the surface and near the thread indicating presence of corrosion.



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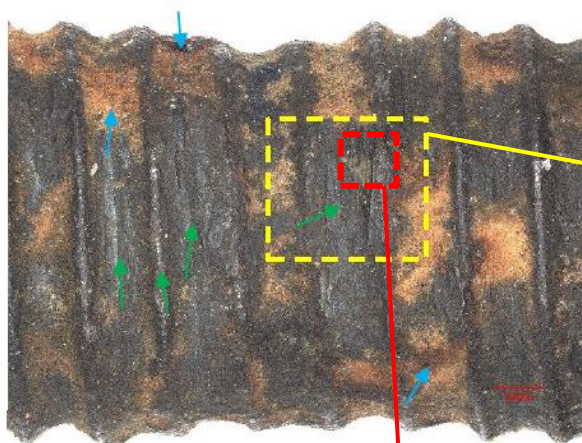


Photo No. 9



Photo No. 10

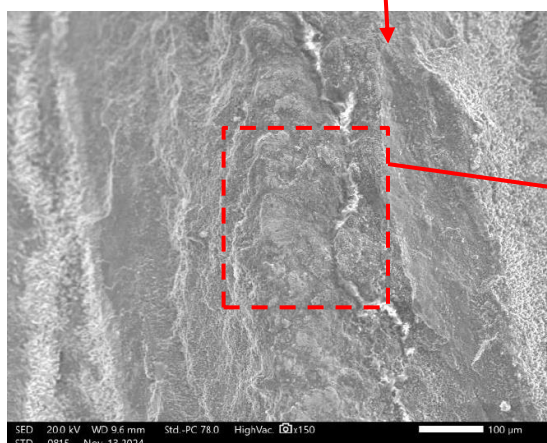


Photo No. 11

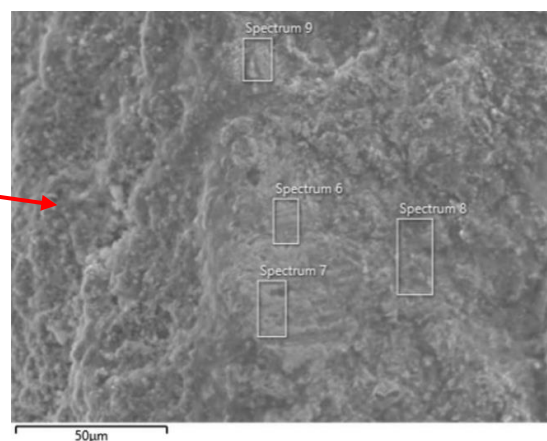


Photo No. 12

Spectrum Label	#6	#7	#8	#9
C ^[1]	10.58	9.93	24.34	12.02
N ^[1]	--	--	--	3.12
O ^[1]	5.10	6.09	15.44	8.40
Al	0.41	0.44	0.55	0.40
Si	0.74	0.89	0.84	0.20
P	0.23	0.30	0.24	0.26
S	1.30	1.30	1.06	1.19
Ti	0.58	1.04	1.64	1.81
V	0.16	0.22	0.42	0.40
Cr	4.42	5.34	9.55	9.56
Mn	--	0.06	0.09	0.08
Fe	10.11	9.60	11.50	9.85
Ni	64.08	61.82	30.60	45.61
Mo	2.28	2.27	3.74	7.10
W	--	0.72	--	--
Total	100.00	100.00	100.00	100.00

Table No. 1



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- 4.8 Cross section taken through the bolt #2 showed the reduction in diameter and material loss on the thread (Photo No. 13). Measurement of the thread showed variation between the damaged and undamaged threads.

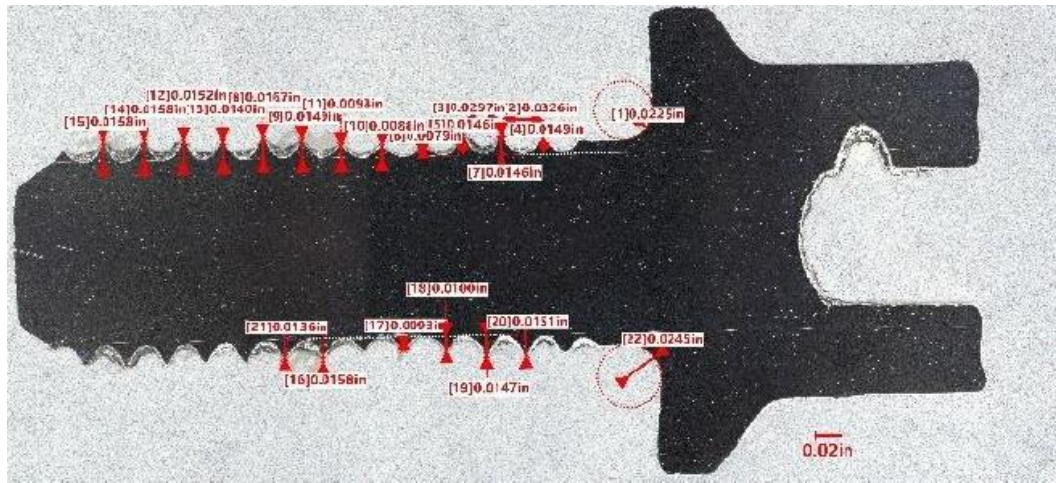


Photo No. 13

- 4.9 Metallographic cross section of the bolt #2 where the threads exhibited the most damage (red bracket, Photo No. 14). The bolt microstructure consists of an equiaxed grains typical of solutioned and aged stainless steel (Photo No. 14). No anomalies in the original material were observed. Microstructure of the damaged threads showed no significant variation in grain size between threads (Photo No. 15). Microhardness measurement taken on the threaded section and the core section of the bolt were 142.4 VHN500g and 128.6 VHN500g respectively suggesting that the material was exposed to hot temperature exceeding 1325°F which is the temperature of the precipitation heat treatment.

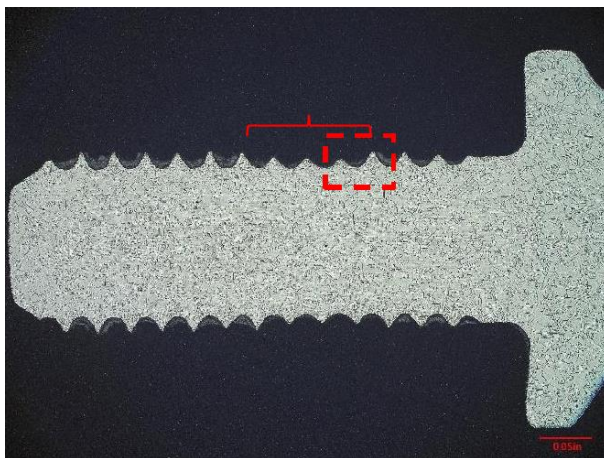


Photo No. 14

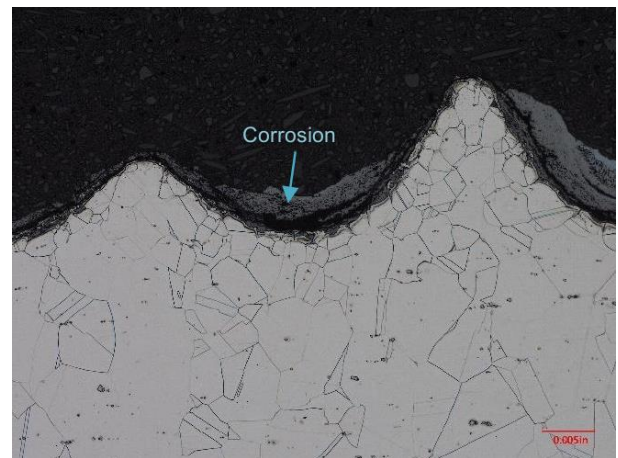


Photo No. 15

- 4.10 The bolt #3 showed no remnants of silver flash visible on the surface. The diameter of the bolt is within the acceptable range as specified in the drawing. Oxidation product and contamination were observed on the bolt threads (green arrows, Photo No. 16). SEM-EDS analyses of the bolt #3 surface and embedded contaminants were performed (Photo No. 17). Presence of compounds with concentration of Cr and O were observed on the thread surface indicative of corrosion products (Spectra No. 1 & 2, Table No. 2). Remnants of silver plating was detected indicative that the bolt #3 had less degradation than the bolt #1 & #2. Presence of high amount of N, Si, and C suggested presence of a foreign compound on the surface (Spectra No. 3 & 4, Table No. 2).



Photo No. 16



Photo No. 17

Spectrum Label	#1	#2	#3	#4
C ⁽¹⁾	18.10	18.80	30.42	31.13
O ⁽¹⁾	16.92	16.26	8.11	7.81
N ⁽¹⁾	--	--	33.78	33.25
Al	0.52	0.64	4.80	4.01
Si	1.68	1.91	11.13	7.95
P	0.54	0.40	0.31	0.30
S	0.36	0.16	0.74	0.80
Ti	3.40	6.29	0.45	--
V	0.82	0.72	--	--
Cr	36.71	24.80	0.57	0.54
Mn	0.34	0.67	0.34	0.80
Fe	10.73	16.98	6.45	9.37
Ni	7.25	10.99	2.08	2.88
Mo	1.13	0.94	--	--
Ag	1.31	0.45	--	--
Cd	0.20	--	0.17	--
Zn	--	--	--	0.44
K	--	--	0.46	0.47
Cu	--	--	--	0.24
Total	100.00	100.00	100.00	100.00

Table No. 2



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- 4.11 Examination of the thread on the bolt #3 showed no diameter reduction from the tip of the bolt toward the head (Photo No. 18). No significant wear or damage was observed on the bolt threads. High magnification of the thread revealed linear indication (red arrows, Photo No. 19). The bolt #3 head showed deformed regions (yellow arrows, Photo No. 20).

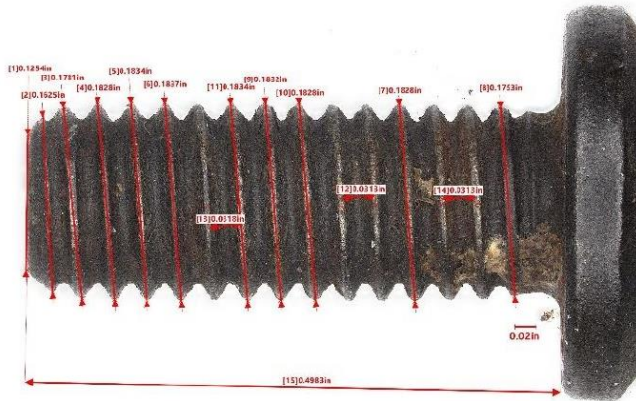


Photo No. 18

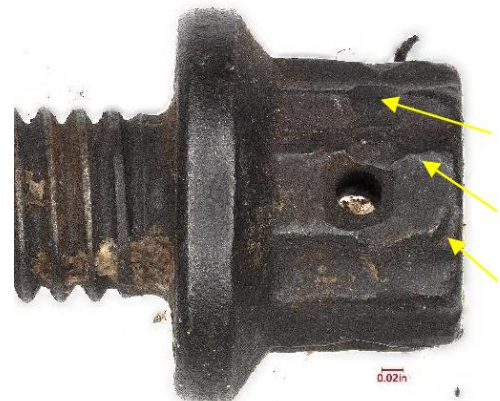


Photo No. 19



Photo No. 20

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- 4.12 Views of the damaged areas on the tip of the bolt #3 showed traces of rubbing damage (Photo No. 104 & Photo No. 22).

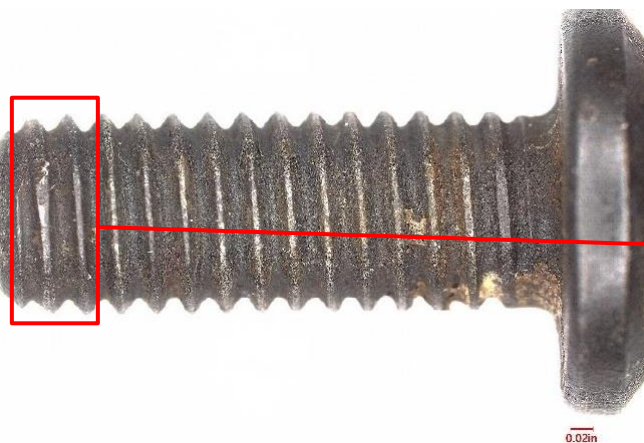


Photo No. 21

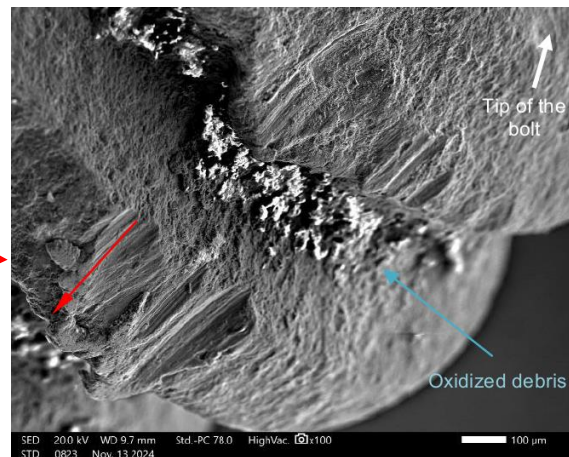


Photo No. 22

- 4.13 SEM-EDS using semi-quantitative and standardless method of the damaged area of the bolt #3 thread showed the main elements consistent with the material of the bolt. It was noted that the Cr content was lower than the minimum allowable criteria. Spectra #14 shows the Ni content higher than the maximum allowable content specified in the drawing which suggest possible transferred material from the power turbine containment ring where the bolt was assembled. The presence of high level of S and P is consistent with airborne contamination (Photo No. 23 & Table No. 3).

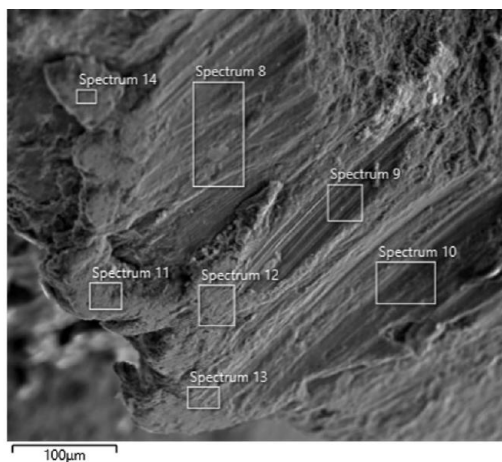


Photo No. 23

Spectrum Label	#8	#9	#10	#11	#12	#13	#14
C [1]	27.55	25.79	23.22	17.86	20.39	22.38	15.66
O [1]	17.22	12.81	20.67	7.98	6.80	9.00	7.42
Al	0.53	0.81	0.64	--	0.89	1.64	1.06
Si	0.73	1.12	0.99	1.44	1.55	1.46	1.16
P	0.37	0.29	0.39	0.36	0.36	0.42	0.56
S	0.60	0.61	0.49	0.42	0.39	0.45	0.92
Ti	0.87	0.94	0.99	1.33	1.14	1.17	1.01
V	0.13	0.14	0.15	0.18	0.15	0.14	0.13
Cr	7.13	7.92	9.84	9.87	8.98	7.82	7.84
Mn	0.40	0.66	0.52	0.85	0.85	0.65	0.59
Fe	21.26	29.60	24.77	36.08	35.36	31.09	32.46
Ni	21.73	18.18	15.76	22.07	21.75	22.45	29.41
Mo	1.48	1.13	1.56	1.55	1.40	1.34	1.79
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table No. 3



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- 4.14 General view of the 2nd stage compressor blades in their as-received condition arbitrarily identified from 1 to 32 (Photo No. 24). Two compressor blades (#5 and #26) exhibited significant damage and were selected for further analysis (yellow dashed rectangles, Photo No. 107).



Photo No. 24

- 4.15 View of the 2nd stage compressor blade #5 (post-cleaning) showed evidence of deformation and curled metal near the tip (red arrows, Photo No. 25 & Photo No. 26) and impact damage at the leading edge (yellow arrows, Photo No. 25 & Photo No. 26). The damage suggest that the impact occurred from the pressure side towards the suction side.



Photo No. 25

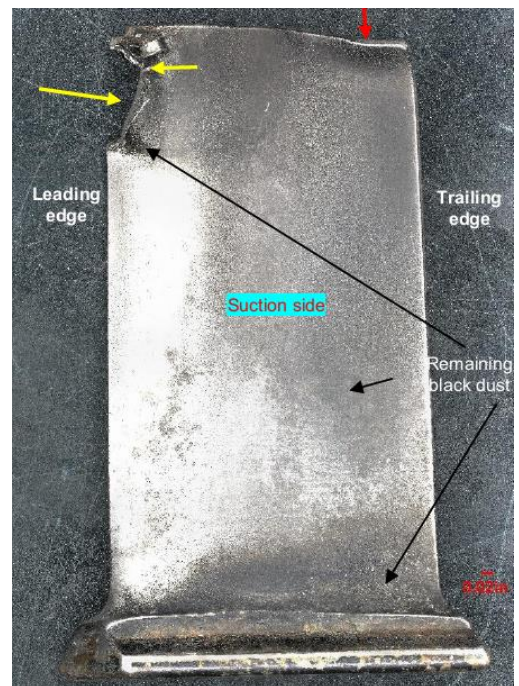


Photo No. 26



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- 4.16 SEM images of the deformed metal observed at the tip of the blade # 5 trailing edge and the impact damage at the leading edge showed that the main elements are consistent with the compressor blade material for all spectra except spectra #17 which shows high Al content suggesting smeared material (Photo No. 27 to Photo No. 30). All spectra show high aluminum content suggesting smeared/transferred material. The presence of Ti and V in spectra #16 and #17 is also considered as transferred materials. The dark region (spectra #17) showed elements that are consistent with ingested airborne contaminants. The presence of high level of S, P and Mg are consistent with airborne contamination (Photo No. 27 to Photo No. 30 and Table No. 4).

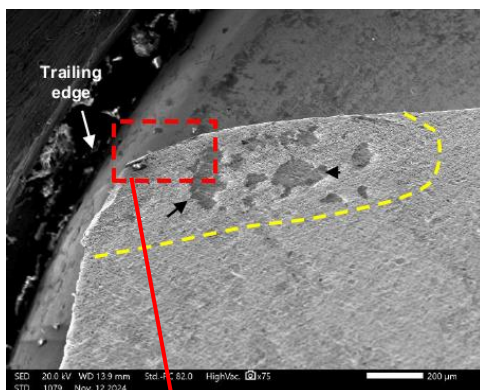


Photo No. 27

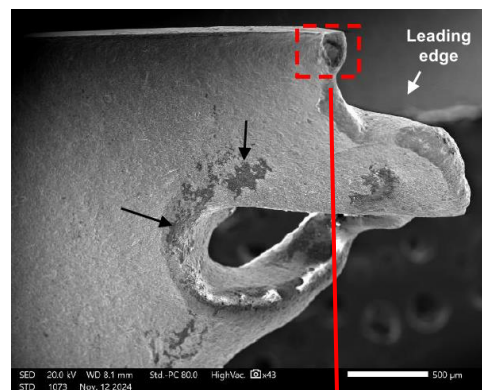


Photo No. 28



Photo No. 29

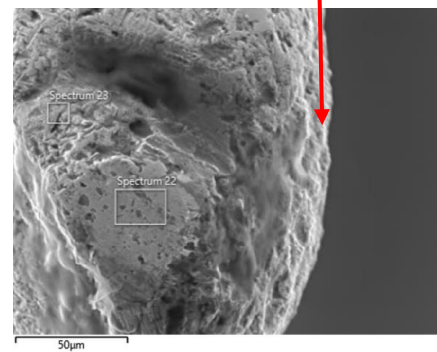


Photo No. 30

Spectrum Label	#14	#15	#16	#17	#22	#23
C ^[1]	16.10	18.54	22.41	18.02	26.40	32.49
O ^[1]	4.41	4.92	3.46	32.38	3.13	4.91
Al	3.86	3.79	3.53	6.43	5.18	3.51
Si	1.21	1.24	0.46	8.10	0.98	1.78
Cr	10.26	9.76	9.73	4.73	8.81	7.87
Mn	0.30	0.26	0.30	0.14	0.21	0.20
Fe	60.18	57.98	56.17	27.91	51.60	45.92
Ni	1.56	1.53	1.58	0.68	1.25	1.28
W	2.12	1.97	1.73	0.75	2.44	2.05
Ti	--	--	0.43	0.13	--	--
V	--	--	0.05	--	--	--
Cu	--	--	0.15	--	--	--
Mg	--	--	--	0.51	--	--
P	--	--	--	0.05	--	--
S	--	--	--	0.17	--	--
Total	100.00	100.00	100.00	100.00	100.00	100.00

Table No. 4



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- 4.17 View of the blade #26 (post-cleaning) showed evidence of deformation and curled metal near the tip (red arrows, Photo No. 31 & Photo No. 32) and impact damage at the leading edge (yellow arrows, Photo No. 31 & Photo No. 32). The damage suggest that the impact occurred from the pressure side towards the suction side. SEM-EDS analyses using a semi-quantitative and standardless method showed that the main elements are consistent with the compressor blade except for the spectra #10 (Photo No. 33 & Photo No. 34 and Table No. 5). All spectra showed a high level of Al content exceeding the specified material requirement. The fact that Al was found on all spectra, especially in area exhibiting no evidence of rubbing, suggest that transferred material could be from a coating upstream. In addition, Spectra #8, #9, and No 10 showed presence of Ti, Al and V as transferred materials. The spectra #8 and #9 V/Ti and Al/Ti ratio are close to the Ti6Al4V.



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Photo No. 31



Photo No. 32

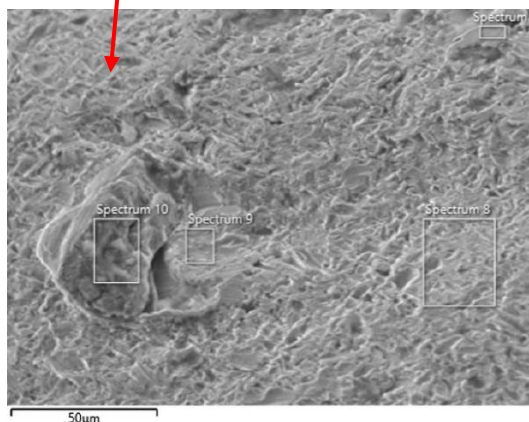


Photo No. 33

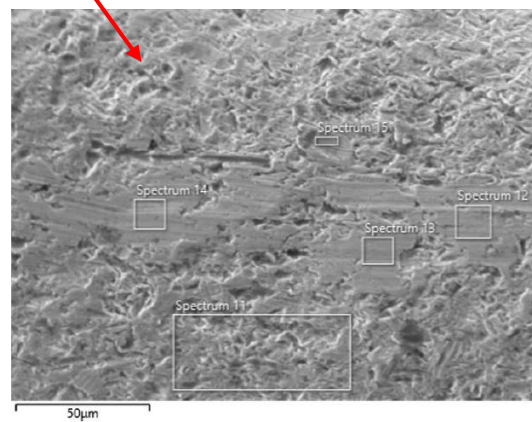


Photo No. 34

Spectrum Label	#7	#8	#9	#10	#11	#12	#13	#14	#15
C [1]	15.41	13.23	12.89	23.98	26.12	32.42	30.02	28.88	27.24
O [1]	--	3.08	2.54	20.69	2.90	2.46	1.95	2.37	1.55
Al	4.83	2.14	0.93	2.79	7.08	5.84	6.00	5.10	5.09
Si	0.52	0.86	0.86	0.92	0.40	0.31	0.21	0.36	0.25
Cr	11.27	10.99	10.94	2.52	8.31	7.99	8.21	8.31	8.76
Mn	0.37	0.32	0.32	--	--	0.35	--	0.30	0.34
Fe	63.56	65.38	66.55	13.73	51.48	47.48	50.10	51.79	53.20
Ni	1.71	1.58	1.55	0.30	1.11	1.22	1.33	1.31	1.45
W	2.30	2.31	2.23	0.33	1.97	1.70	1.91	1.41	1.90
Zn	--	--	--	4.53	0.29	--	--	--	--
Ti	--	0.06	1.09	27.58	--	--	--	--	--
V	0.04	0.05	0.09	1.24	--	--	--	--	--
Mg	--	--	--	--	0.33	0.23	0.27	0.18	0.22
S	--	--	--	0.09	--	--	--	--	--
Ca	--	--	--	1.30	--	--	--	--	--
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table No. 5



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- 4.18 SEM-EDS analyses using a semi-quantitative and standardless method showed that the main elements are consistent with the compressor blade (Photo No. 35 & Photo No. 36 and Table No. 6). No evidence of foreign material was detected.

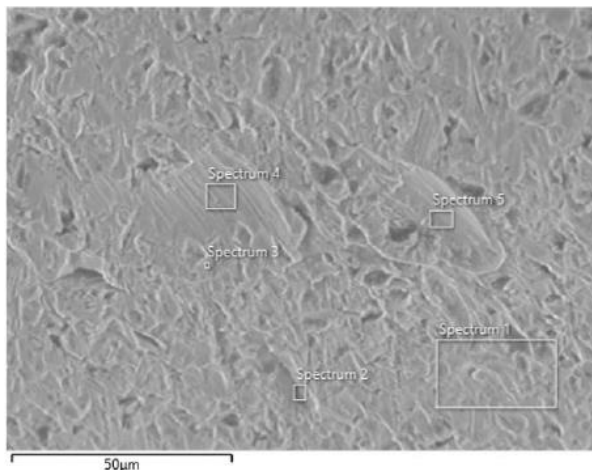


Photo No. 35

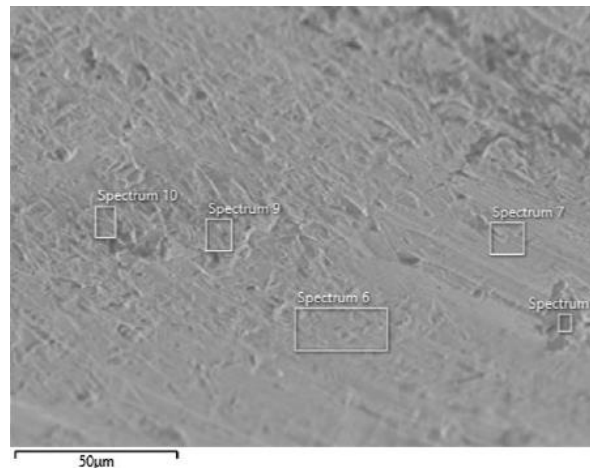


Photo No. 36

Spectrum Label	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
C ^[1]	8.22	0.78	8.39	4.57	4.60	10.83	10.99	20.76	6.92	8.64
O ^[1]	2.25	0.19	1.46	0.59	0.87	5.02	3.19	26.68	1.37	3.97
Al	0.60	0.67	0.38	0.34	0.39	2.44	3.74	1.33	1.40	0.97
Si	0.95	0.10	0.42	0.23	0.27	0.91	0.47	11.99	0.42	0.72
P	0.15	--	0.06	--	--	0.08	--	0.11	--	0.07
S	--	--	--	--	--	0.12	0.06	0.20	--	0.40
Cr	11.46	14.49	11.46	11.00	11.77	10.34	9.94	4.36	11.54	11.11
Mn	0.41	0.76	0.42	0.50	0.64	0.35	0.34	0.29	0.42	0.42
Fe	74.15	82.88	72.62	79.57	78.84	65.88	67.44	24.90	73.83	69.38
Ni	1.70	--	2.35	1.27	0.90	1.54	1.57	6.38	1.65	1.61
Cd	0.11	0.07	--	--	0.06	0.21	0.13	0.76	--	0.60
W	--	--	2.44	1.93	1.60	2.28	2.12	0.60	2.46	2.10
Ti	--	0.06	--	--	--	--	--	--	--	--
V	--	--	--	--	0.06	--	--	--	--	--
Mg	--	--	--	--	--	--	--	0.74	--	--
Zn	--	--	--	--	--	--	--	0.90	--	--
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table No. 6



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- 4.19 SEM-EDS analyses of the dust/black particles gathered from the surface of the compressor blade suction side using a semi-quantitative and standardless method showed significant presence of oxygen along with other elements such as sodium, calcium, potassium, magnesium and chlorine all consistent with ingested environmental contaminants (Photo No. 37 & Photo No. 38 and Table No. 7). The presence of high sulphur contents in two spectra along with high carbon content could suggest ingestion of exhaust gases. Aside from the elements consistent with the airborne contaminants, no element foreign to the assembly were detected.

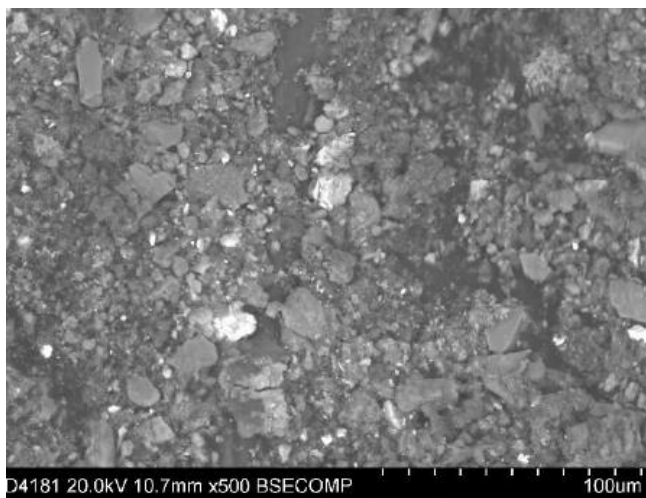


Photo No. 37

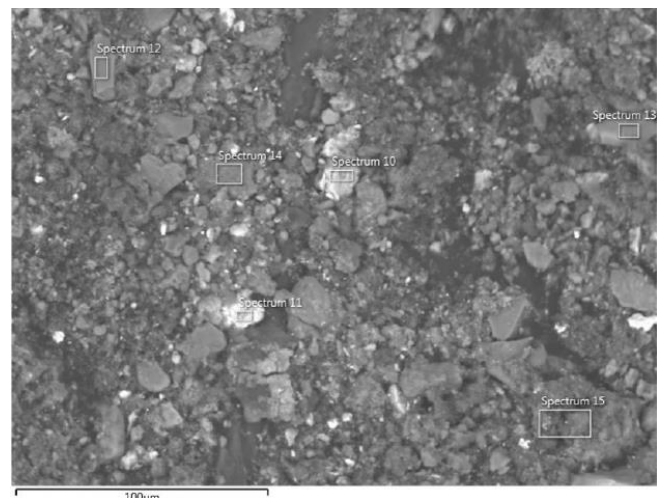


Photo No. 38

Spectrum Label	#10	#11	#12	#13	#14	#15
C ^[1]	18.28	16.80	8.02	34.68	13.92	43.42
O ^[1]	24.66	22.06	54.39	26.23	51.01	35.25
Na	--	--	--	--	--	0.15
Mg	0.25	--	--	--	--	0.39
Al	2.35	0.88	--	0.26	--	3.69
Si	4.98	1.72	37.52	38.47	34.40	9.31
P	0.31	--	--	--	--	0.29
S	3.72	6.16	--	--	--	0.60
Cl	0.30	--	--	--	--	0.54
K	0.74	--	--	--	--	0.57
Ca	--	--	--	--	--	0.37
Ti	0.16	--	--	--	--	0.20
Fe	2.52	1.06	0.07	0.37	0.25	2.87
Ni	0.68	0.32	--	--	--	0.56
Cd	38.03	50.99	--	--	0.43	1.78
Total	100.00	100.00	100.00	100.00	100.00	100.00

Table No. 7

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5.0 CHEMICAL ANALYSIS

- 5.1 The two particles mechanically detached from the CT vane (Photo No. 39) were sent to the chemical laboratory (Photo No. 40). SEM-EDX analyses were performed on both particles and were identified as nickel alloy in presence of aluminum, titanium, chromium, cobalt, niobium and molybdenum (Photo No. 41 & Photo No. 40 and Tables No. 8 & 9). The alloy is undefined to a specific material. The high level of aluminum concentration could suggest the presence of a coating.



Photo No. 39

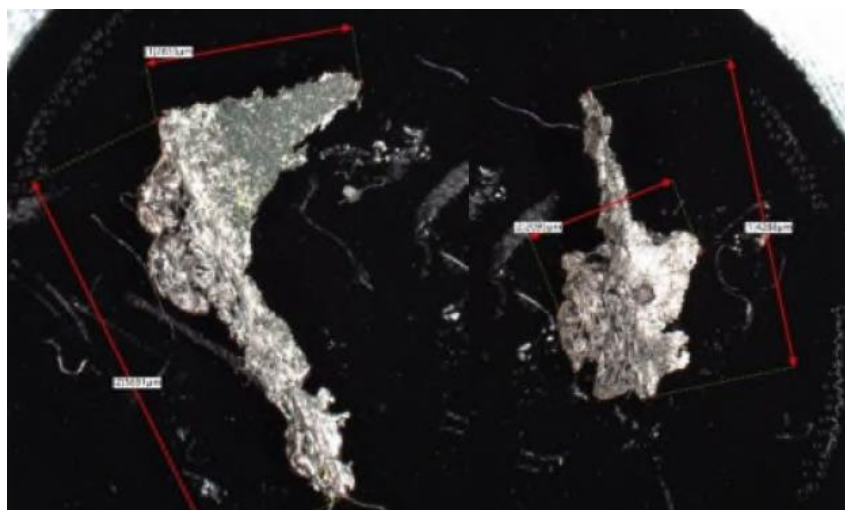


Photo No. 40



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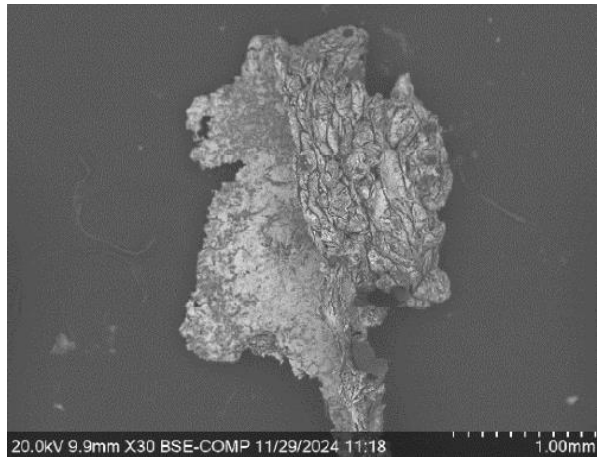


Photo No. 41

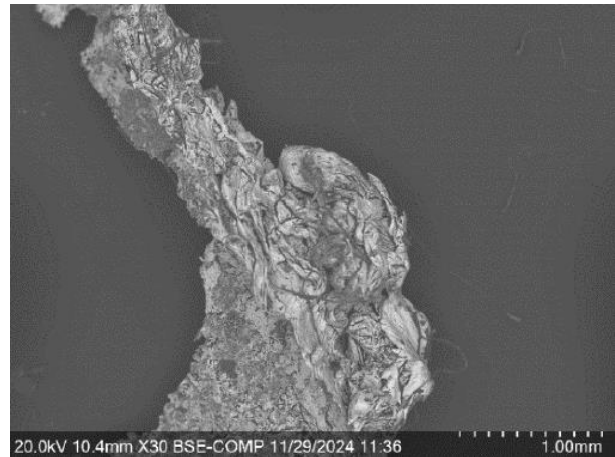


Photo No. 42

Element	Average Concentration, % (semi-quant)	Standard Deviation %
Aluminum	23.52	5.45
Titanium	4.52	0.69
Chromium	16.57	1.13
Cobalt	6.25	0.78
Nickel	40.41	4.94
Niobium	1.18	0.56
Molybdenum	2.23	0.88

Table No. 8

Element	Average Concentration, % (semi-quant)	Standard Deviation %
Aluminum	15.81	5.30
Titanium	4.82	0.54
Chromium	18.09	1.53
Cobalt	7.00	0.65
Nickel	43.87	4.10
Niobium	1.37	0.53
Molybdenum	2.41	0.42

Table No. 9

6.0 REFERENCE LISTING

- (A) P&WC Accessories Accident Report.