

Metallurgical Investigation Report

Log No. FAL2017-17956

METALLURGICAL EVALUATION OF A CF34-8C LPT CASE FROM ESN 965-352 OPERATED BY GOJET

P/N 4117T50G02
S/N IHI355DA

SR 00427476



imagination at work

Background Information

Operator:	GoJet
Customer ID:	
Occurrence Consequence:	IFSD
Occurrence Date:	11/29/16
Engine Type:	CF34-8C
Engine Serial Number:	965-352
Engine TSN/CSN	33,207 / 23,814
Part Name:	LPT Case
Part Number:	4117T50G02
Part Serial Number:	IHI355DA
Part TSN/CSN:	33,207/23,814
Part Material:	Waspaloy
Part Specification:	AMS 5707
Date Assigned	2/7/17
LAWS Number	FAL2017-17956

Summary Information

Initiation Site:	Case Surface
Initiation Mode:	Overstress
Propagation Mode:	Overstress
Discrepancy:	Impacts
Grain Size:	~ASTM 5
Hardness:	HRC 43
Date Completed:	2/23/17

Background

- A section of a CF34-8C LPT case (P/N 4117T50G02, S/N IHI355DA) from ESN 965-352 operated by GoJet was submitted for metallurgical evaluation after an HPT stage 2 blade liberation event, which fractured all the blades in the set (see Figure 1) and punctured the LPT case locally. During teardown all stage 2 blades were found fractured, but 7 were fractured below the platform. Reportedly the stage 2 blades are made of N5 with platinum-aluminide coating. The blades accumulated 33,207 hours / 23,814 cycles since new. Since the event was classified as “uncontained” the NTSB is involved in the investigation.

Observations

- A cross-sectional view of the turbine section showing the location of the punctured case can be seen in Figure 1, along with a view from the tear-down of the fractured HPT stage 2 blades.
- Visual examination showed that the case had bulk outward deformation/impacts at other circumferential locations in the same plane as the puncture, but at the puncture location a more defined impact area was observed (Figure 2).
- Optical examination showed that the fracture features had bulk deformation, often fractured on slant planes, and in one area examined in the scanning electron microscope (SEM) had ductile dimples, all features consistent with event-related shear/overstress (Figures 2-4). No evidence of progressive/fatigue growth was observed.
- Energy dispersive spectroscopy (EDS) analysis of the overstress showed a spectrum consistent with the requirement of Waspaloy per AMS 5707 (EDS 1). In the impacted areas was transferred debris containing altered Waspaloy peaks and Ta/W/Hf, consistent with a mixing of base alloy and liberated N5 HPT blade material (EDS 2 and 3- Figures 4 and 5).
- The average case wall thickness measured with a micrometer in less damaged areas of the fragment was 63 mils (0.063 inch), conforming to the drawing requirement.
- A metallographic mount showed a wrought microstructure consistent with properly processed Waspaloy with an average grain size of approximately ASTM 5, conforming to the requirement of AMS 5707.
- The average Vickers micro-hardness was HV 423 (HRC 43), conforming to the requirements of AMS 5707.

Summary/Discussion

- The overall damage was consistent with event-related accumulated debris that impacted and overstressed the case locally. There were many bulged areas, but at the punctured region there was a more well-defined impact area with transferred metal consistent with HPT blade material (in addition to case base alloy elements).

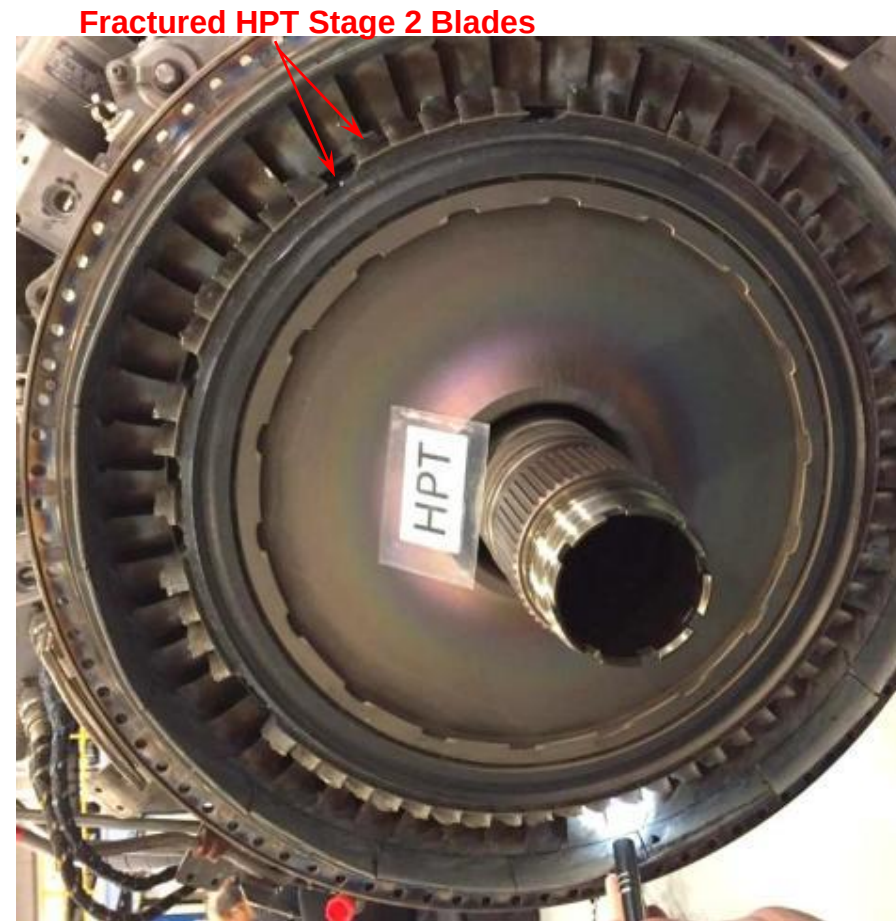
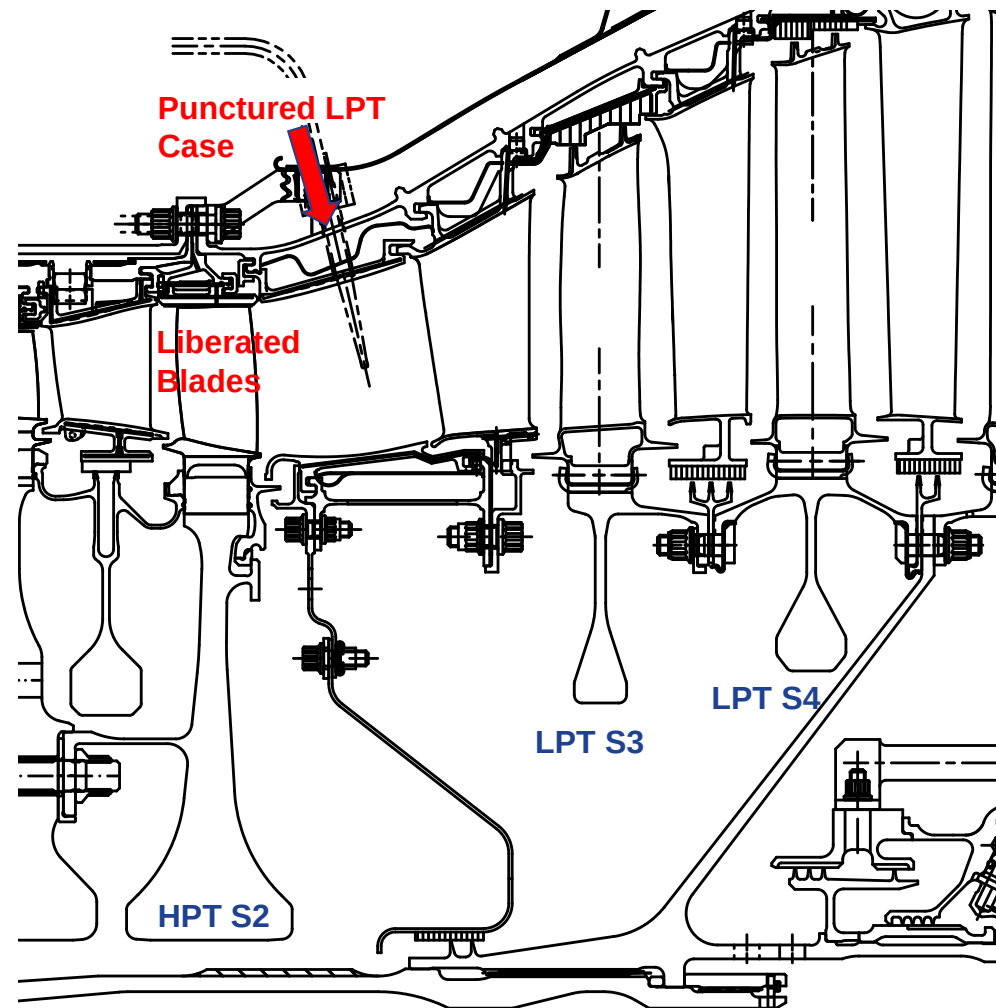


Figure 1: Schematic of the CF34-8 turbine cross-section showing the location of the liberated HPT stage 2 blades and LPT case puncture. The right image is a view of the stage 2 blades during teardown, showing that they were all fractured (7 below the platform).

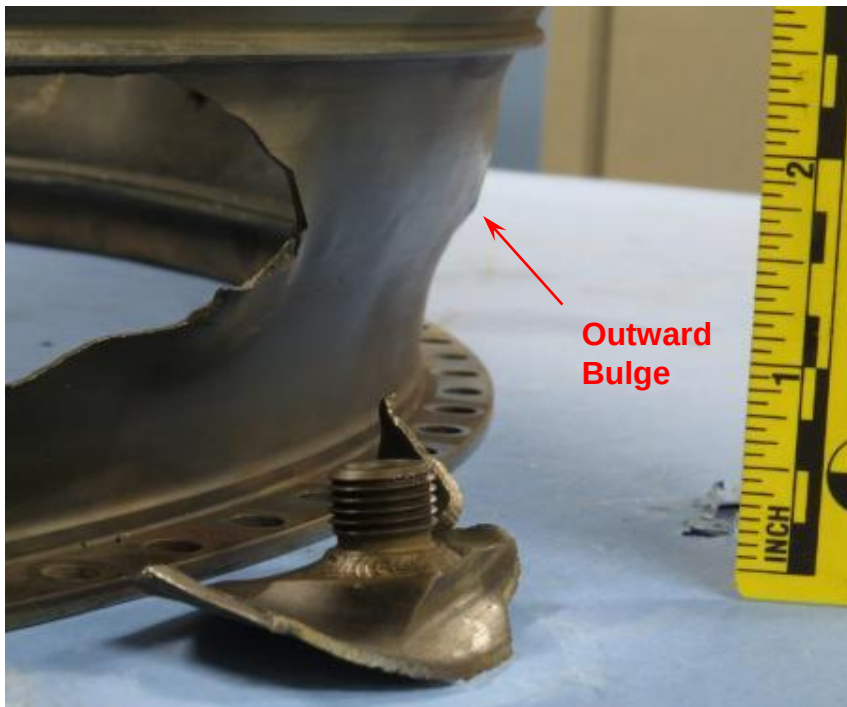
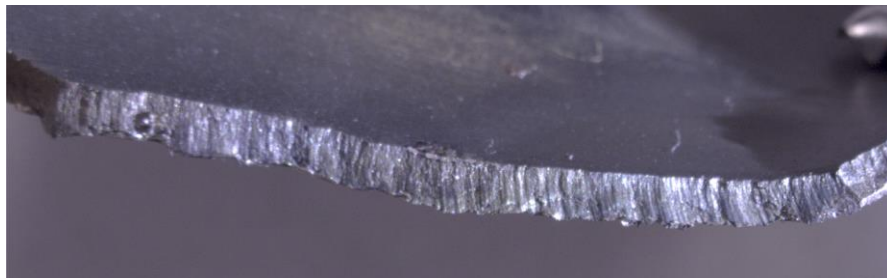


Figure 2: Optical views of the case inner and outer diameter surfaces showing an approximate 3 inch long puncture in a plane aft of the liberated stage 2 blades. Also visible was the bulk deformation in the same circumferential plane, consistent with a build-up/impacts from liberated debris.

Figure 3: Optical views of the fracture surfaces of the liberated piece showing bulk deformation and rough/sheared fracture features consistent with instantaneous overstress/shear fracture.



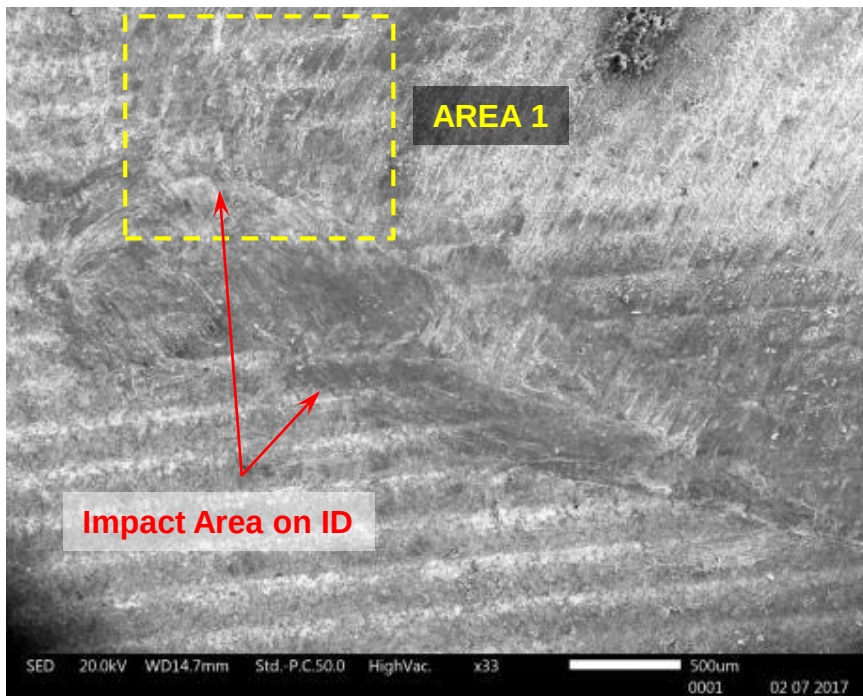
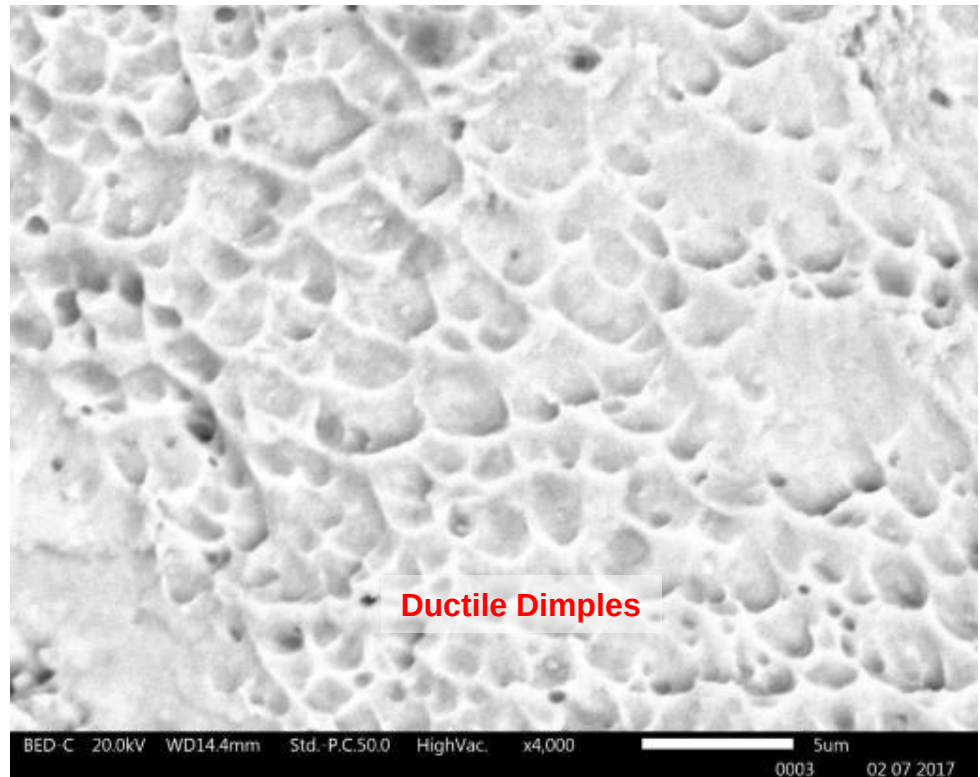


Figure 4 : SEM view of an impact area on the inner diameter surface that was analyzed further (top image) and a representative view of a fracture surface area showing ductile dimples, consistent with overstress (bottom image).



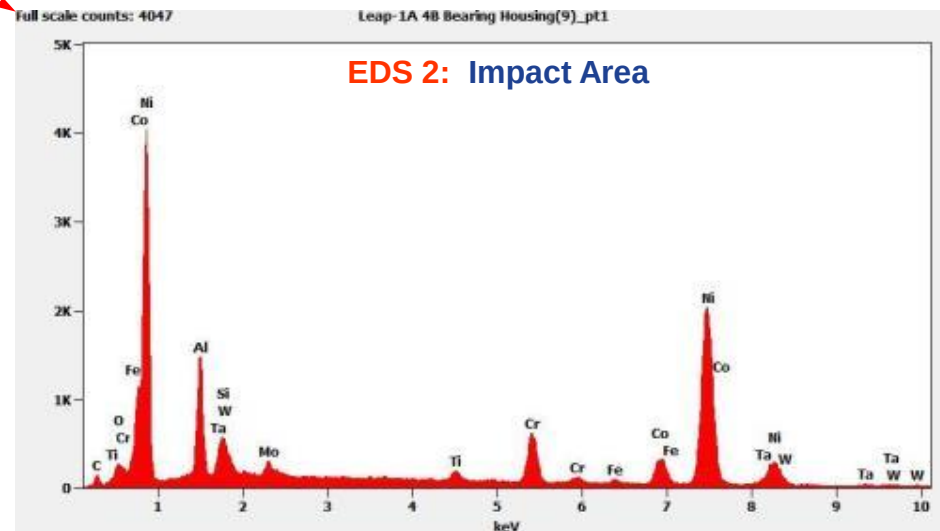
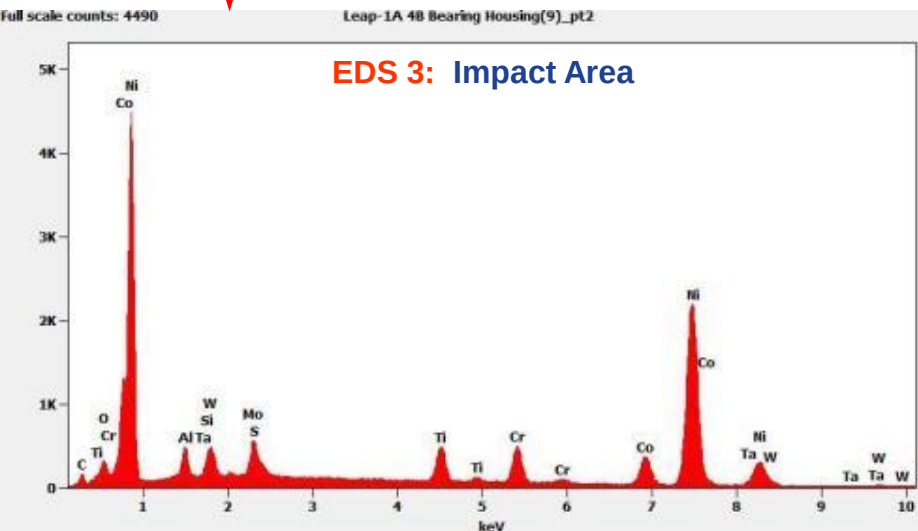
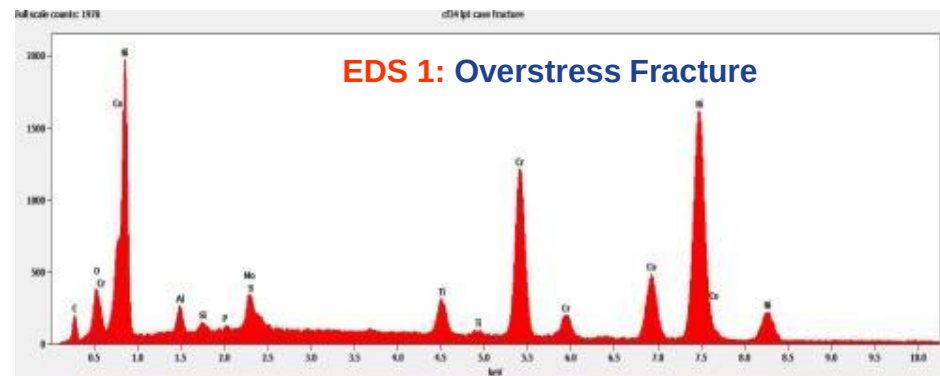
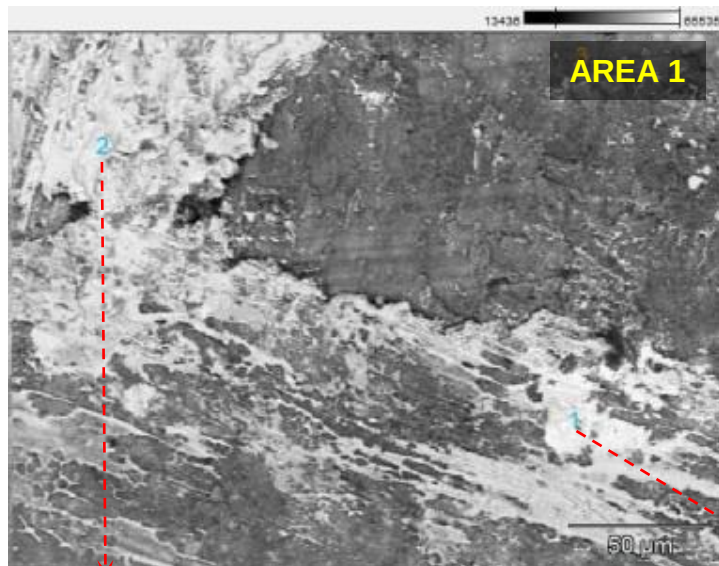


Figure 5 : EDS analysis of the overstress region showed a spectrum consistent with the requirement of Waspaloy (EDS 1), with spectra taken in the impact regions showing altered peak heights and the addition of Ta/W/Hf, consistent with a mixing of base metal and liberated N5 HPT blade material (EDS 2 and 3).



Figure 6 : A cross-sectional metallographic mount was made near the impact area showing a wrought structure with an average grain size of approximately ASTM 5, conforming to the requirement of AMS 5707. At the fracture (lower left) the wall was distorted and the grains were locally deformed consistent with a shear region.

