NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

June 26, 1997

METALLURGIST'S FACTUAL REPORT Report No. 97-117

A. ACCIDENT

Place	: Pensacola, Florida
Date	: July 6, 1996
Vehicle	: MD-88, N927DA
NTSB No.	: DCA96-M-A068
Investigator	: Thomas Conroy, As-10

B. COMPONENTS EXAMINED

Metallographic specimen through the fracture origin.

C. DETAILS OF THE EXAMINATION

The metallurgical examination of a section obtained from the fracture origin of the hub revealed a layer of altered microstructure in the region adjacent to the tierod hole surface[1]. Secondary Ion Mass Spectroscopy (SIMS) analysis of the altered microstructure was performed at Wright-Patterson AFB materials laboratory. Prior to the analysis, the section was removed from the mounting material and the examined surface was repolished. SIMS maps provided by the Wright-Patterson laboratory showed a relatively high concentration of oxygen up to a maximum depth of about 0.00547 inch (139 microns) from the surface of the hole. The mapping also showed elevated concentrations of iron and carbon in the oxygen-rich layer of the hub material. Large carbon particles were found immediately adjacent to the surface of the hole and are most likely attributed to artifact from metallographic mounting material. A thin iron-rich band was found 0.0017 inch (43 microns) below the surface of the hole within the zone of grossly deformed microstructure. The Wright -Patterson laboratory performed no SIMS analysis for nitrogen.

The section was returned to the NTSB materials laboratory and was subsequently analyzed by X-ray Energy Dispersive Spectroscopy (EDS) for iron distribution and content. The scanning electron microscope (SEM) image of the analyzed surface is shown in figure 1 with arrow "F" denoting the fracture face. The small thin isolated iron-rich band was located at a distance of about 0.0374 inch (0.95 mm) from the fracture face in the area indicated by arrow "b" in this figure. A higher magnification view of this band is shown in figure 2 (see arrow "b").

[1] Metallurgist's factual report No. 96-131.

In order to determine the extent and concentration of iron in the altered microstructure, EDS spectra were collected transversely through the thickness (from the hole wall radially inward) at four separate radial position lines at 0.15, 0.95, 2.25, and 6.0 millimeters (mm) from the fracture plane, as indicated by arrows "1", "2", "3", and "4", respectively, in figure 1. At each of this position, X-ray spot source data was collected every four to six microns inward from the hole wall until no iron was detected. No iron was found in the radial position that did not contain a layer of altered microstructure (position "4", 6.0 mm from the fracture). However, iron was found at the other three radial positions. Figures 3, 4, and 5 contain tables and graphical representations displaying iron concentrations at these three locations. The large peak of iron concentration in figure 4 corresponds to the thin band of iron indicated by arrow "b" in figure 2.

[redacted]

Jean Bernstein
Metallurgist

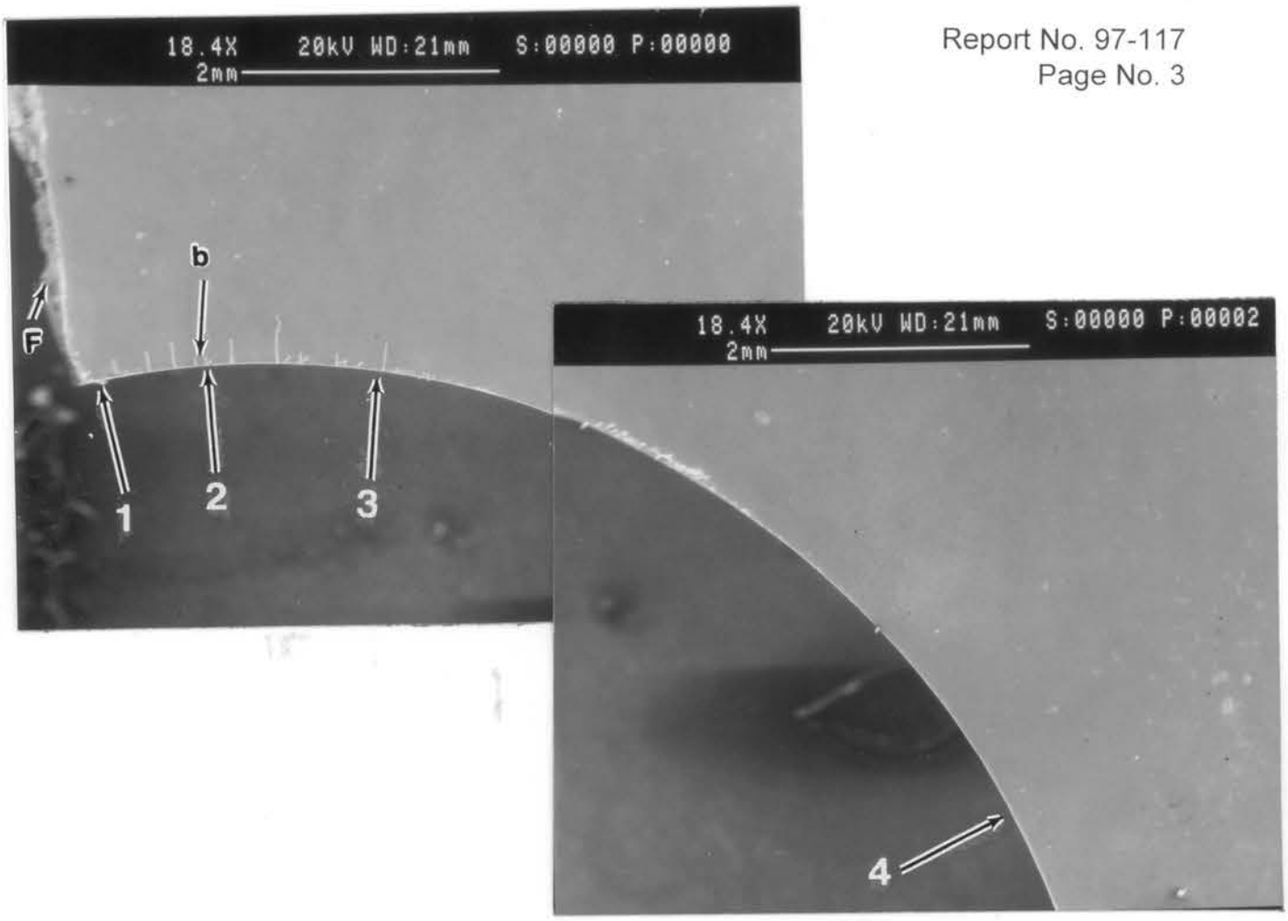

Figure 1. SEM view of the surface of the metallographic specimen through the fracture origin. Arrow "F" denotes the fracture face, arrow "b" -- the location of the small isolated iron-rich band, and arrows "1", "2", "3", and "4" – the locations of transverse (radially inward) EDS analyses.

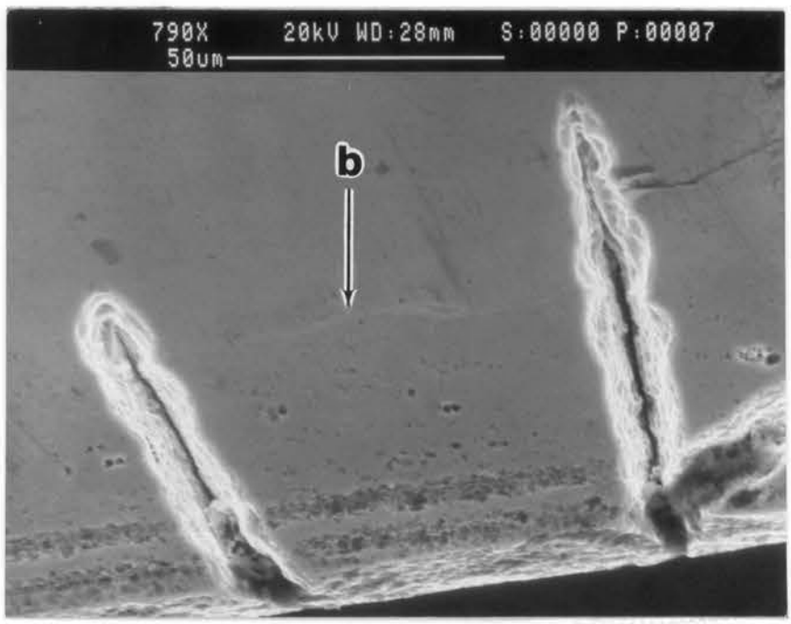

Figure 2. The small isolated iron-rich band (arrow "b") in the area of severely deformed material.

Iron concentration traverse at a radial position 0.15 millimeters from the fracture		
Depth from hole wall surface in inches	**Depth in microns**	**Iron (Fe) content, weight %**
2.362E-04	6	3.90
4.724E-04	12	2.53
7.087E-04	18	3.55
1.181E-03	30	1.04
1.417E-03	36	0.50
1.575E-03	40	0.00

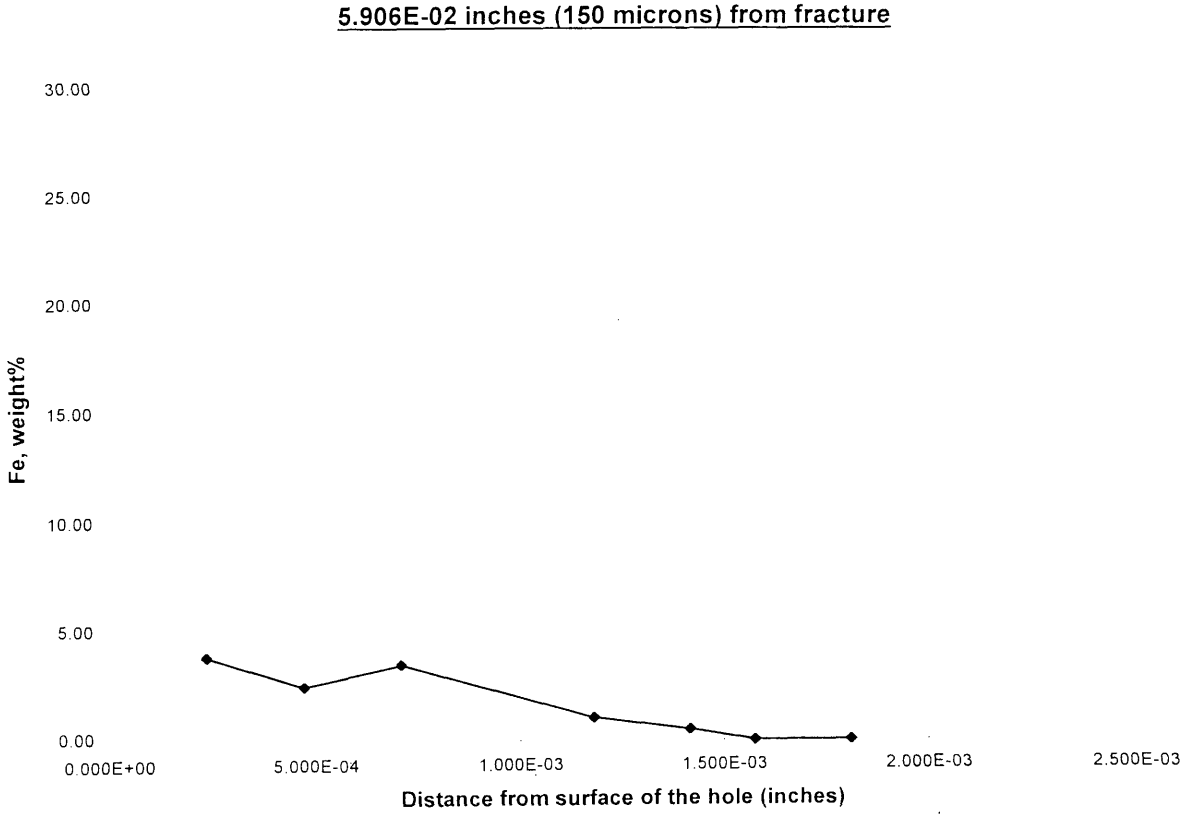

Figure 3. Concentration of iron radially inward from the hole wall (through the altered microstructure zone) at position 0.150 mm from the fracture face.

Iron concentration traverse at a radial position 0.95 millimeters from the fracture		
Depth from hole wall surface in inches	**Depth in microns**	**Iron (Fe) content, weight %**
2.362E-04	6	1.02
4.724E-04	12	4.25
7.087E-04	18	2.51
9.449E-04	24	1.62
1.181E-03	30	1.66
1.417E-03	36	2.81
1.575E-03	40	3.91
1.811E-03	46	26.72
2.047E-03	52	1.20
2.283E-03	58	0.00

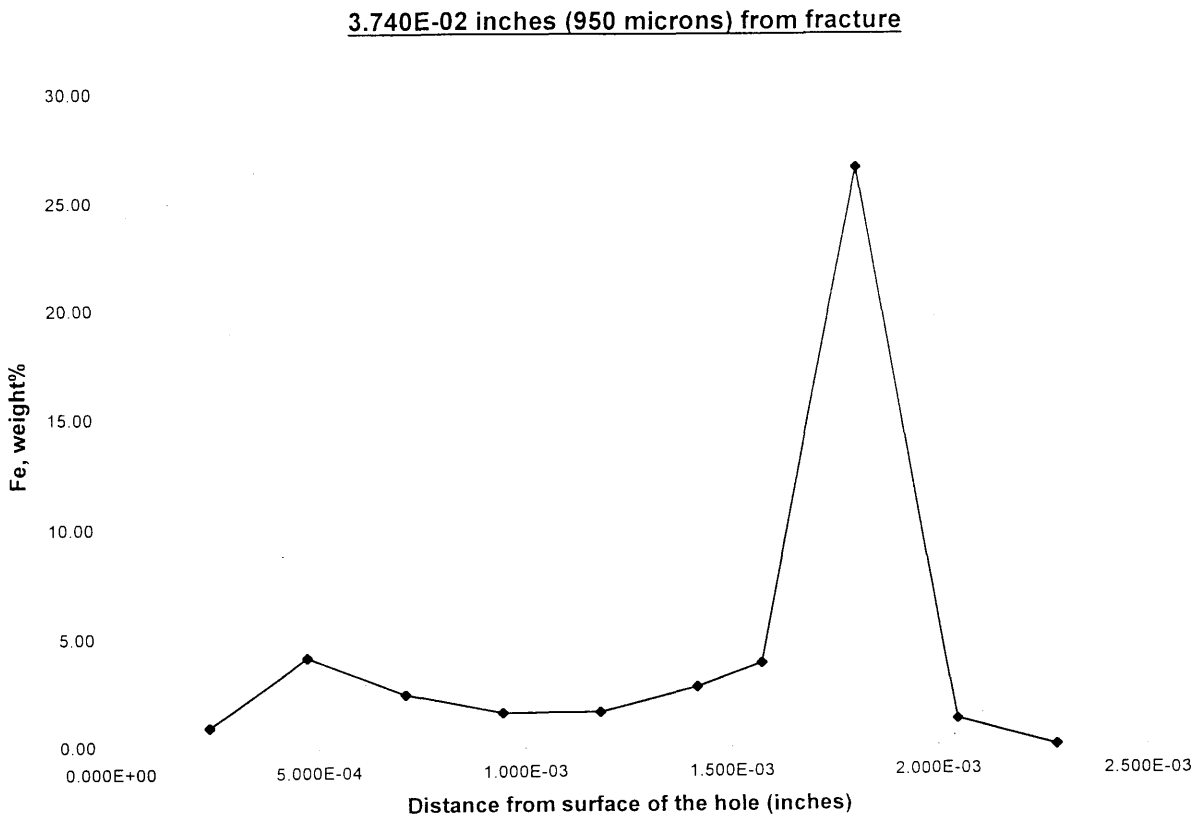

Figure 4. Concentration of iron radially inward from the hole wall (through the altered microstructure zone) at position 0.95 mm from the fracture face

Iron concentration traverse at a radial position 2.25 millimeters from the fracture		
Depth from hole wall surface in inches	**Depth in microns**	**Iron (Fe) content, weight %**
2.362E-04	6	2.55
4.724E-04	12	2.35
7.087E-04	18	2.90
9.449E-04	24	2.06
1.181E-03	30	1.31
1.417E-03	36	0.00

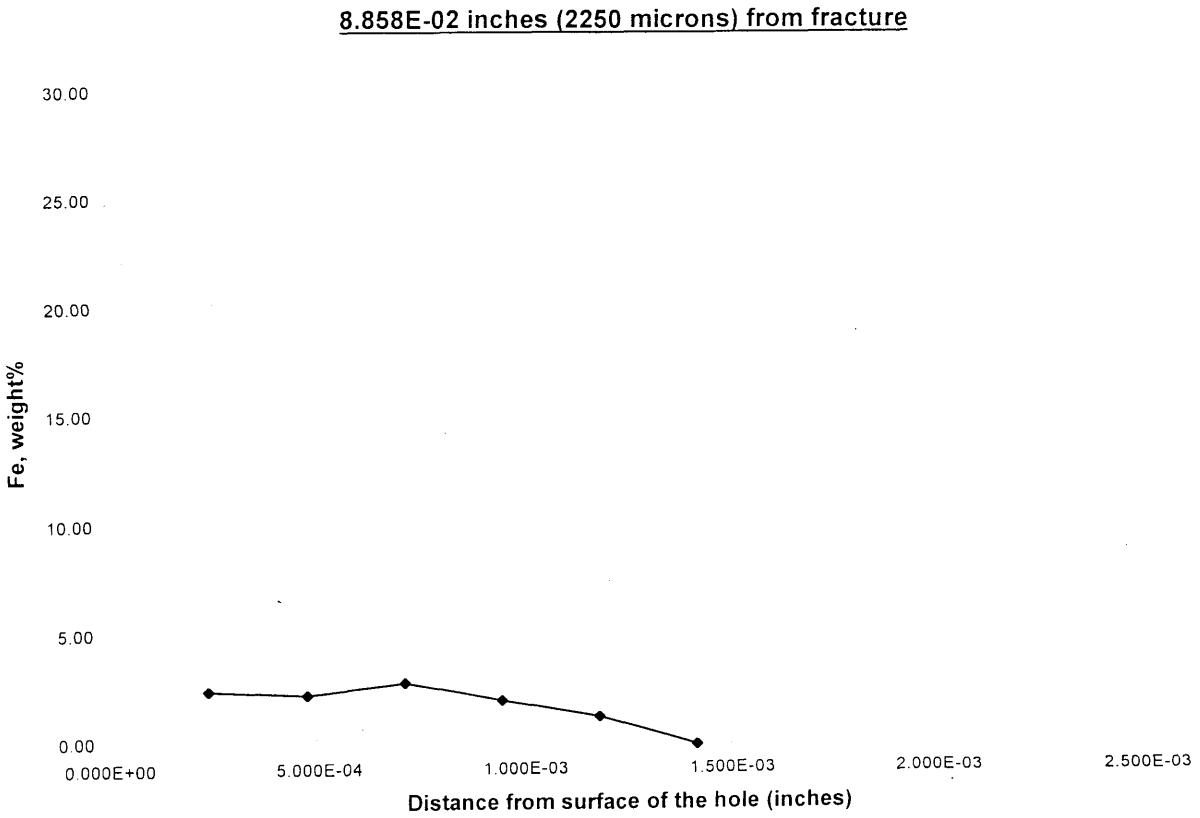

Figure 5. Concentration of iron radially inward from the hole wall (through the altered microstructure zone) at position 2.25 mm from the fracture face