

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



January 18, 2013

MATERIALS LABORATORY FACTUAL REPORT

Report 13-004

A. ACCIDENT

Place : Wichita, KS
Date : November 6, 2012
Vehicle : Cessna 208 Caravan, N793FE
NTSB No. : CEN13FA049
Investigator : Carol Horgan, AS-40

B. COMPONENTS EXAMINED

Oil line and oil nozzle/fitting for supercharger oil supply

C. DETAILS OF THE EXAMINATION

The Materials Laboratory received an oil cooler from a Cessna 208 Caravan, depicted in Figures 1 through 3. A group examination of the part was conducted at the Materials Laboratory at NTSB Washington, DC headquarters on January 11, 2013. Steve Miller, a Senior Air Safety Investigator, represented Cessna Aircraft Company.

The cooler exhibited multiple impact marks on all sides of the part, particularly observed on the fins and tubes in the main body. Many of the impressions in the impacted areas are consistent with those typical of collisions with adjacent metallic parts. The most substantial damage in Figure 2 exhibited impressions on the crushed fins consistent with a threaded bolt. Also shown in Figure 2 is an area where the attachment flange was bent over the welded plenum.

Of primary concern was the fractured plenum on the side of the cooler, depicted in Figures 3 and 4. An approximately 2" x 1" segment of the plenum housing was missing from the cooler, and three cracks appeared to emanate outward from this area. The largest crack ran along the plenum housing corresponded and with an indented section across the side (see Figure 4). The area near the fracture exhibited a slight outward bulge from the body of the part. A third crack traversed around the part along the weld between the plenum and the forward flange (Figure 5). This crack ran approximately 1.5 in along the weld on the flange side (see Figure 6).

Almost all of the crack faces and fracture surfaces exhibited a dull luster and tortuous morphology. Isolated flat shiny areas were observed along the fracture surface. However, as illustrated in Figure 7, these areas contained deep irregular streaks consistent with smearing. In addition, these areas were adjacent to deformed protrusions inward, which are consistent with collisions with other metallic parts. There was no visible evidence of crack arrest marks or ratchet marks that would indicate progressive cracking.

Closer examination of large sections of the fracture surface using a scanning electron microscope revealed dimple rupture, as displayed in Figure 8. This fracture morphology is indicative of overstress. The crack along the weld was backcut and opened in order to examine the crack faces. Dimple rupture was the only fracture morphology found along the weld. A small pore (approximately 0.015" diameter) was located at the end of the crack tip along the weld. However, no indication of fatigue or other progressive cracking was found emanating from the defect, and the location of the defect is not consistent with one that might lead to the fracture observed on the cooler plenum. No indications of other defects were found along the weld crack. In addition, there were no signs of other failure modes on the other fracture surfaces away from the weld.

Erik Mueller
Materials Research Engineer

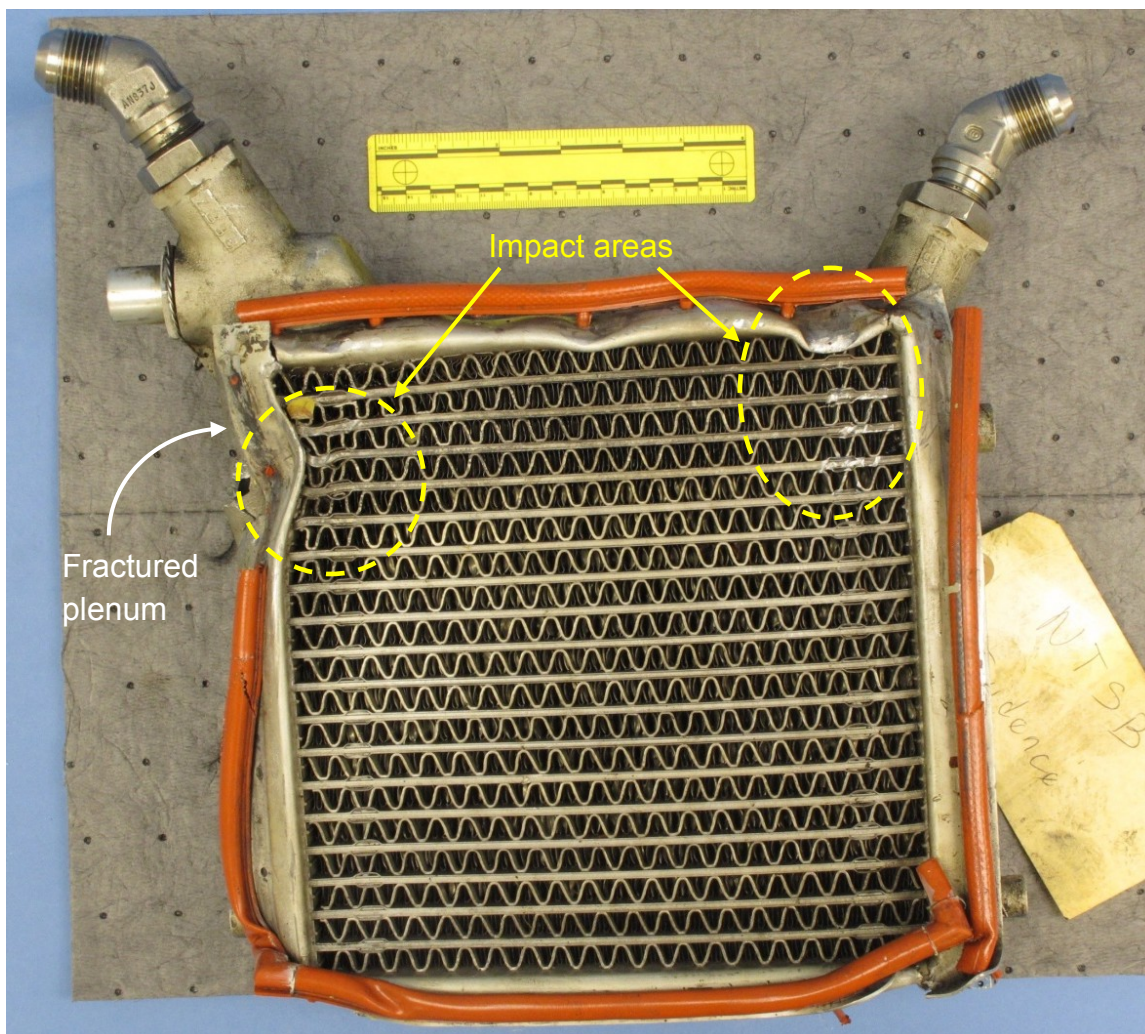


Figure 1 – The oil cooler, as received. The location of the fractured plenum on the side is identified, and the areas where the cooler collided with adjacent parts are circled.

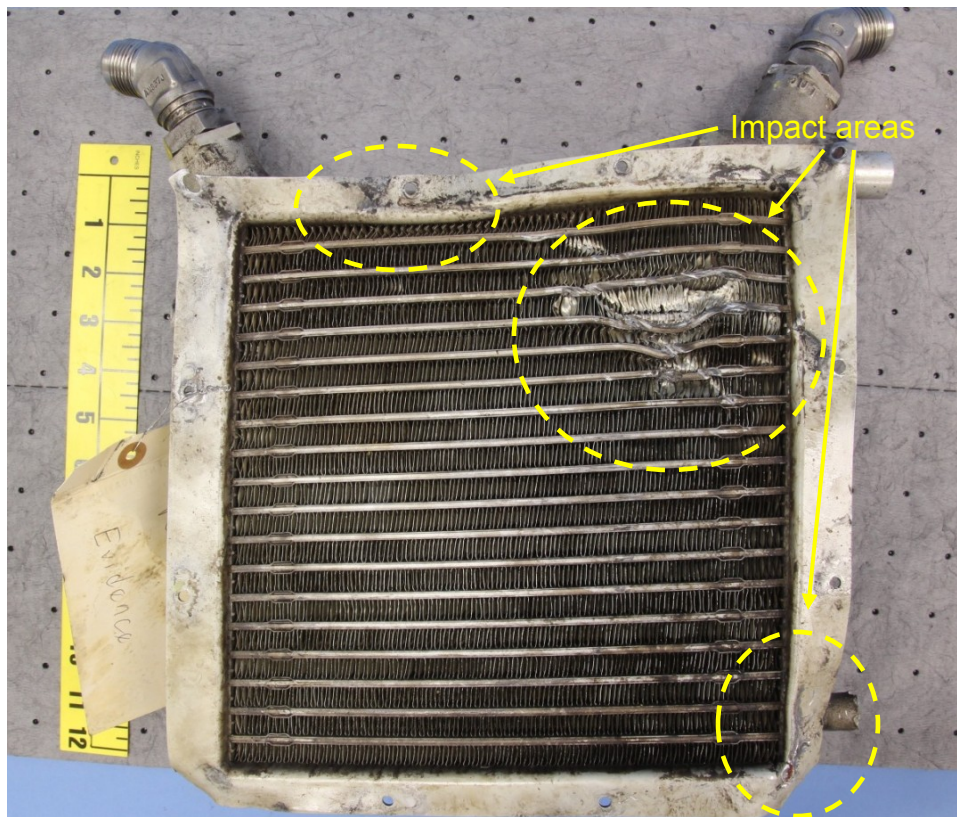


Figure 2 – The oil cooler, from the reverse side shown in Figure 1. The impact areas on the tubes are circled.

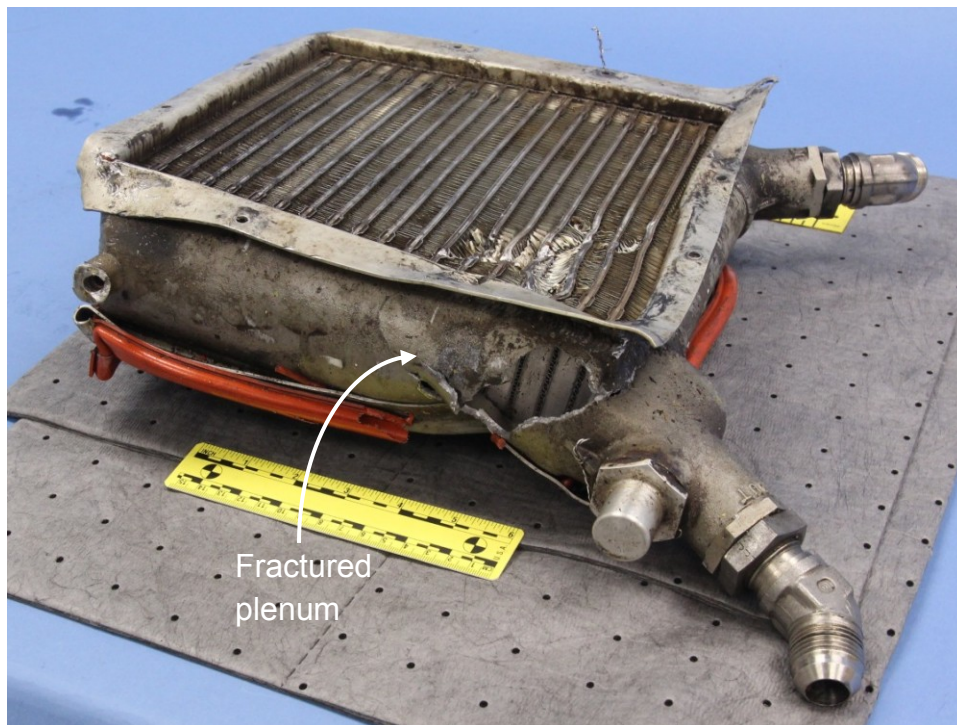


Figure 3 – The oil cooler, from the side showing the fractured plenum.

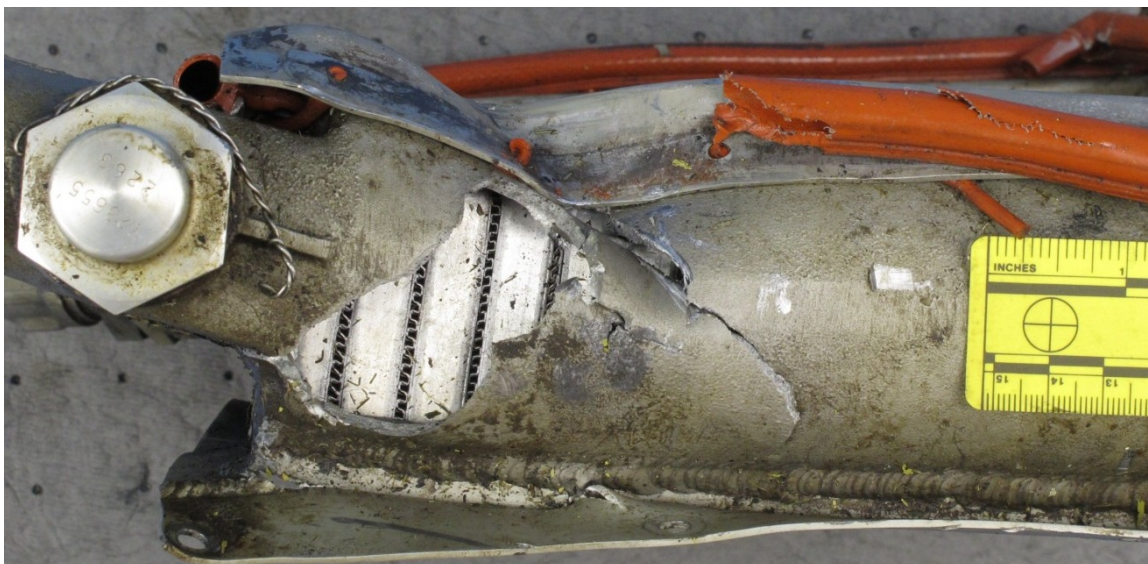


Figure 4 – The fractured plenum on the side of the cooler, showing a longitudinal impact mark and the exposed interior from the missing segment.



Figure 5 – The fractured plenum, rotated 45° from Figure 4, showing the crack along the weld.



Figure 6 – The cracked weld from Figure 5, after cleaning with ethyl alcohol.

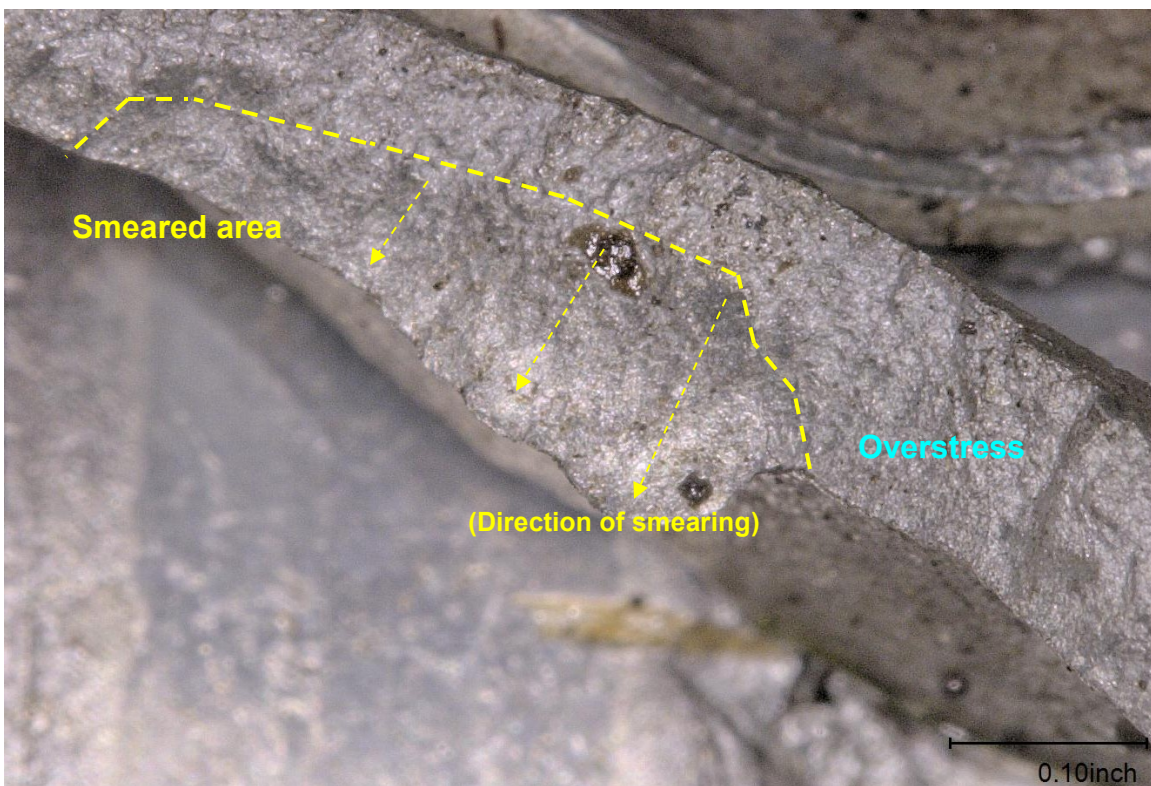


Figure 7 – An area of smearing along the fracture surface. Material in the smeared area had been deformed inward.

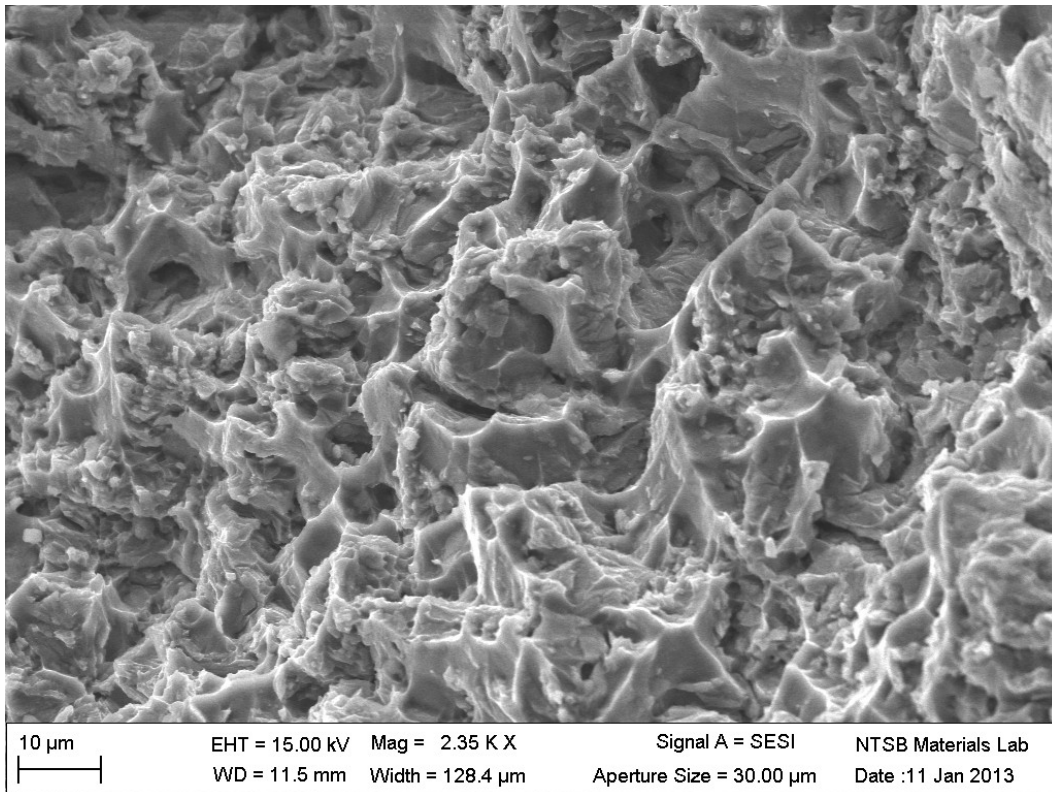


Figure 8 – Secondary electron (SE) micrograph of a typical area along the cooler fracture surface, revealing dimple rupture indicative of overstress.

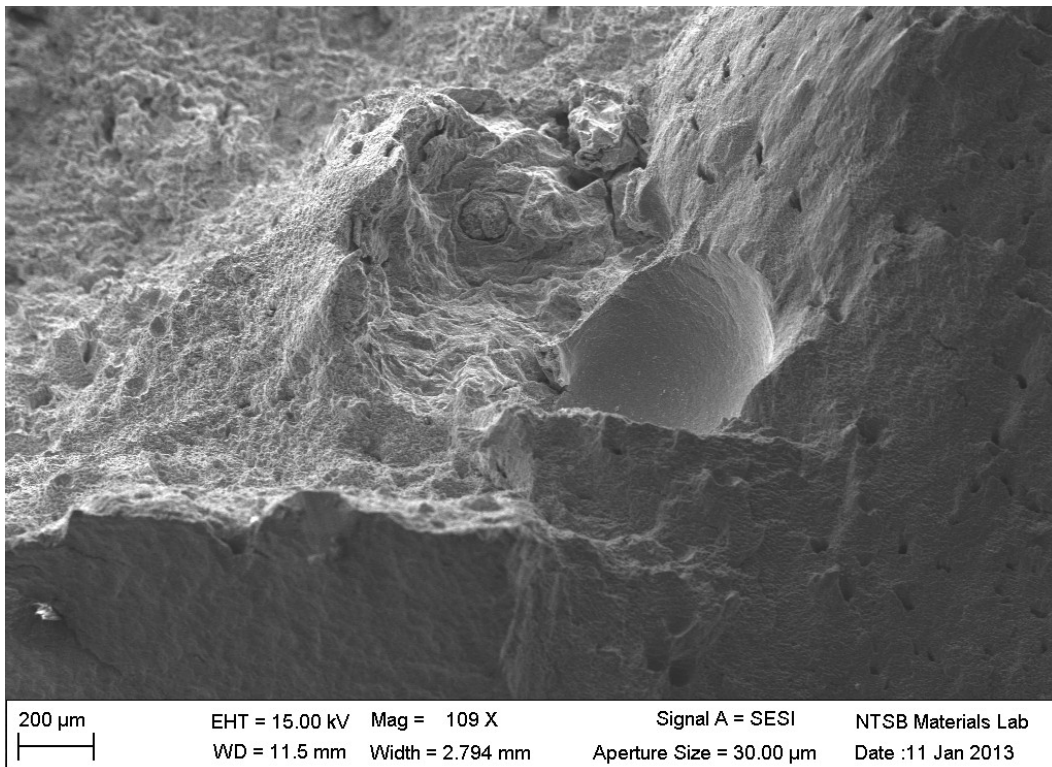


Figure 9 – SE micrograph of a small pore in the cracked weld, at the end of the crack tip.