



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594
September 11, 2017

Group Chairman’s Factual Report

STRUCTURES

DCA17MA022

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A. ACCIDENT INFORMATION

Accident #: DCA17MA022
Location: Fort Lauderdale Hollywood International Airport (FLL)
Date: October 28, 2016
Time: At about 1751 eastern daylight time (EDT)
Airplane: McDonnell Douglas MD-10-10F, registration N370FE

B. STRUCTURES GROUP

Chairman: Brian K Murphy
National Transportation Safety Board (NTSB)
Office of Aviation Safety (AS-40)
Washington, DC

Member: S.T. (Steve) Haggerty
The Boeing Company
Manager – Service Engineering
Seal, Beach, CA

Member: J. Steve Cole
FedEx
Project Engineer
Memphis, TN

Member: Chris Heck
Air Line Pilots Association
Senior Staff Engineer
Herndon, VA

C. SUMMARY (reference Figures 1 and 2)

On October 28, 2016, at about 1751 eastern daylight time (EDT), FedEx flight 910, a McDonnell Douglas MD-10-10F, registration N370FE, experienced a left main landing gear collapse and subsequent fire in the left wing after landing on runway 10L at Fort Lauderdale–Hollywood International Airport (KFLL), Fort Lauderdale, Florida. The two flight crew members evacuated the airplane after the airplane came to rest on the side of runway 10L and were not injured. The airplane was substantially damaged. The cargo flight was operating under 14 Code of Federal Regulation Part 121 and originated from Memphis International Airport, Memphis, Tennessee.

D. DETAILS OF THE INVESTIGATION

1.0 Aircraft Description

N-number:	N370FE
Airplane Serial Number:	46608
Airplane Manufacturer:	McDonnell Douglas
Model:	MD10-10
Airplane Year:	1972
Airworthiness Certificate:	Standard
Approved Operations:	121
Aircraft Type:	Fixed Wing Multi-Engine
Engine Type:	Turbo fan
Airplane Category:	Transport
Number of Engines:	3
Type Certificate	A22WE Revision 12

2.0 Fire Damage

The left wing was damaged by post-crash fire and explosion.

3.0 Main Landing Gear Details (reference Figures 3 and 4)

3.1 Main Landing Gear

The main landing gears consists of two oleo-type shock struts, two truck beams, eight main gear wheels and eight brakes, and associated side brace linkages. One main gear shock strut is mounted on a trunnion support fitting attached to the rear spar in the right wing root area. The other main gear shock strut is attached to a similar fitting in the left wing root area. Each main gear shock strut supports a truck beam, each truck beam supports two axles, and each axle supports two wheels and two brakes. Both main gears rotate approximately 88 degrees inboard and up during gear retraction. The main gears are completely enclosed by the main gear doors and the main gear strut doors during flight.

Each main gear is supported vertically and longitudinally by the main gear trunnion fittings and bolts; lateral support is supplied by the side brace linkage. The side braces are locked in the down position by upper and lower downlock links which are driven hydraulically by the main landing gear downlock cylinder and mechanically backed up by main gear downlock springs on each gear. The side braces and the downlock links fold during gear retraction.

Each main gear shock strut supports a one-piece, tubular truck beam that provides a platform for the forward and aft axles, wheels, and brakes. The truck beam pivot bolt provides the attachment to the main gear shock strut piston fork, and allows the truck beam to pivot. The pivot action of the beam permits all main gear tires to maintain contact with

the ground whenever the airplane moves over uneven terrain or when the airplane lands in a nose-high attitude.

3.2 Main Landing Gear Shock Strut

The main landing gear shock struts are forged-steel cylinder and piston assemblies with internal metering provisions designed to control the rate of compression and extension of the piston. The shock struts support the weight of the airplane on a nitrogen and hydraulic fluid cushion, which absorbs landing shock. Internally, each strut contains a metering pin and an orifice plate that dampen strut compression motion, and a rebound snubber to prevent the piston from extending too rapidly.

Static and dynamic seals, located in a bearing at the lower end of the shock strut cylinder, serve to retain the hydraulic fluid and nitrogen pressure inside the cylinder. On a new or overhauled shock strut, the bearing also carries spare seals that can be used for two seal-change periods before it becomes necessary to remove the shock strut piston. A scraper and wiper are located directly above the piston gland nut, and serve to clean the piston upon entry into the cylinder.

3.3 Main Landing Gear Truck Beam and Axles

The main landing gear truck beam is a one-piece, tubular member that supports the forward and aft axles. The beam and axles are forged of high-strength steel, and the beam is attached to the piston fitting by a pivot bolt, which allows the beam to pivot. A series of lugs, which are part of the beam forging, are used as attach points for the beam lower side protective cover and for hose and line support. The beam and axles are hollow. The skid control transducer wiring is routed through the beam and axles to the transducer in each axle.

3.4 Side Brace and Attachments (Main Landing Linkage)

The main gear linkage consists of the upper and lower side braces, which provide lateral support for the gear, upper and lower downlock links, which lock the side braces and the landing gear in the down position. The lower end of the lower side brace is attached to a boss fitting located on the forward side of the shock strut. The upper end of the upper side brace is attached to a fixed brace which spans the the wheelwell between the trapezoidal panel and the main gear trunnion fitting. The downlock links are attached to the forward side of the landing gear shock strut below the trunnion fitting, and to the side braces at the junction point of the upper and lower side braces.

The main gear linkage consists of five members: the upper side brace, the lower side brace, an upper downlock link, a lower downlock link and a fixed brace to which the upper side brace is attached. The linkage is made of forged steel; each moving joint is bushed with clamp-up-bushings. The fixed brace ends are also bushed, although they do not move during gear travel. All main gear linkage fittings and attach points are provided with grease fittings.

4.0 Left Main Landing Gear Service History

The LH MLG was last overhauled on February 28, 2008. The landing gear was installed on N370FE on March 31, 2008. The aircraft time at installation was 74,340.02 hours and 29,953 total cycles at install. Time since install was 10,249.03 hours, cycles since install was 5653 and days since install were 3133. The time remaining in days (most restrictive) was 152 days as of October 28, 2016 (date of accident). The MLG assembly at overhaul had 33,422 cycles since new. The outer cylinder had 26,867 cycles since new and the piston (inner cylinder) had 33,422 cycles since new.

The main landing overhaul limit for FedEx is nine years or 30,000 flight hours, whichever occurs first. The Boeing Maintenance Planning Document recommends the restoration of the main landing gear assembly every eight years or 7500 flight cycles, whichever occurs first.

On May 3, 2000, the FAA CMO for FedEx approved the MSG-3 conversion from MSG-2 which had previously escalated overhaul of the MLG assembly to nine years or 30,000 hours as part of the MD10-10F maintenance program.

The main landing gear assembly part number D10-32-001-11 and serial number CPT00081 was overhauled by Hawker Pacific Aerospace Repair Station No. RJ3R817L located at Sun Valley, CA.

5.0 Left Main Landing Gear Damage

The left hand (LH) main landing gear (MLG) outer cylinder¹ was fractured midway through the air filler valve boss at port A on the aft side of the outer cylinder (Figure 5). The LH side MLG shock strut outer cylinder fractured around its entire circumference (reference Figures 6 and 8). The upper portion of the cylinder remained intact and attached to the airplane at the forward and aft trunnion lugs. The upper portion of the cylinder transitioned from about 13 inches on the outboard side to about 28 inches on the inboard side when measured from the top of cylinder.

The remaining lower portion of the cylinder transitioned from approximately 55 inches to 63 inches on the forward side as measured from the bottom of the cylinder. The inboard side lugs and bolt and nuts for the retract actuator attach points remained intact. The outboard side lugs and bolt and nut for the fixed door attach points also remained intact. On the aft side of the lower section of the fractured gear, 55 inches from the bottom, approximately half of the upper charging bore was visible (reference Figure 8). The fracture surface on outer cylinder in the area of the charging bore had features consistent with fatigue (reference Figure 9).

¹ The left hand (LH) main landing gear (MLG) shock strut was identified from the data plate as part number (P/N) ARG7393-5557, P/N NRG6020-525, serial number (S/N) CPT00081. The cylinder part and serial numbers are ARG7002-13 and CPT1037HT.

The lower portion of the LH main landing gear remained attached by the side braces. During aircraft recovery, the lower side brace nut was removed, and hydraulic lines and electrical conduit were cut to enable the LH gear lower portion to be removed from the airplane.

Three pieces of the left hand outer cylinder were found on the runway. One piece measured about 12 to 14 inches longitudinally by about 30 inches circumferentially (reference Figure 10). Two smaller portions, approximately 2 by 2 inches and 3 by 3 inches from the upper charging bore and boss were also found on the runway (reference Figures 11 and 12). The upper charging bore fill valve (shradler valve) was not found. The fracture surface of the 3 by 3 section had features consistent with fatigue in the area of the upper charging bore (reference Figures 13 and 14).

There were no anomalies noted with the trunnion lugs or trunnion bolt attachment points. The lower segment of the landing gear was folded aft into the left hand side inboard flap (reference Figures 15 and 16). The lower portion of the gear remained attached to the MLG side brace assembly.

The LH MLG truck beam remained attached to the lower portion of the cylinder and shock strut at the pivot pin. The truck beam exhibited a crack running aft from the number one wheel position axle to a hole on the top side near the pivot area. The hole was about 3 inches long by 2 inches wide, and was aligned with piston trim cylinder attachment lugs. The truck beam part and serial numbers ARG7004-511 and LCO159DA65HT.

Several of the internal components of the LH MLG shock strut were recovered from the runway, including the upper chamber, the orifice assembly, the upper bearing, the metering pin (fractured), and the upper bearing carrier (2 halves).

6.0 Left Wing

The LH wing sustained fire damage (reference Figures 17 and 18). The structural wing damage extended from inboard of the number one engine pylon outboard to the LH wing tip, and chordwise from the leading edge wing spars to the aft trailing edge wing spars.

The LH wing trailing edge upper and lower close out panels, inboard and outboard flaps, and ailerons, were disconnected from the hinge points common to the aft spar and sustained damage from the impact and fire. Slats 2 and 3 surrounding number 1 engine and pylon sustained fire damage. Slats 4 through 8 had impact damage.

A section of the upper LH wing skin measuring approximately 25-foot spanwise by 8.5 feet chordwise was missing from the upper wing surface (reference Figure 19). It was located just forward and to the left of the airplane. This section of the wing skin spanned from just outboard of the number 1 engine pylon from about wing station 402-433 to about 702-733.

There was fire damage, broken and missing wing stringers and wing ribs when viewed thru the missing wing section. The chordwise bulkheads and ribs along the open section of the wing were charred, bent and twisted outboard.

The LH inboard flap was separated from the flap hinge and inboard flap track. The flap assembly was wedged vertically between the trailing edge of the LH wing and the aft LH wing to body fairing.

The LH outboard flap remained attached to the inboard flap hinge and was separated from the outboard hinge. The outboard flap upper and lower skin panels exhibited both structural and fire damage.

The number one pylon sustained both fire damage and structural damage due to impact.

Other than the LH main landing gear and LH wing, the airplane sustained minimal damage and, except as noted above all of the examined fracture surfaces exhibited features consistent with overstress with no evidence of fatigue.

Submitted by:

Brian K Murphy
National Research Specialist
Aircraft Structures



Figure 1 – MD10-10F N370FE



Figure 2 – MD10-10F N370FE

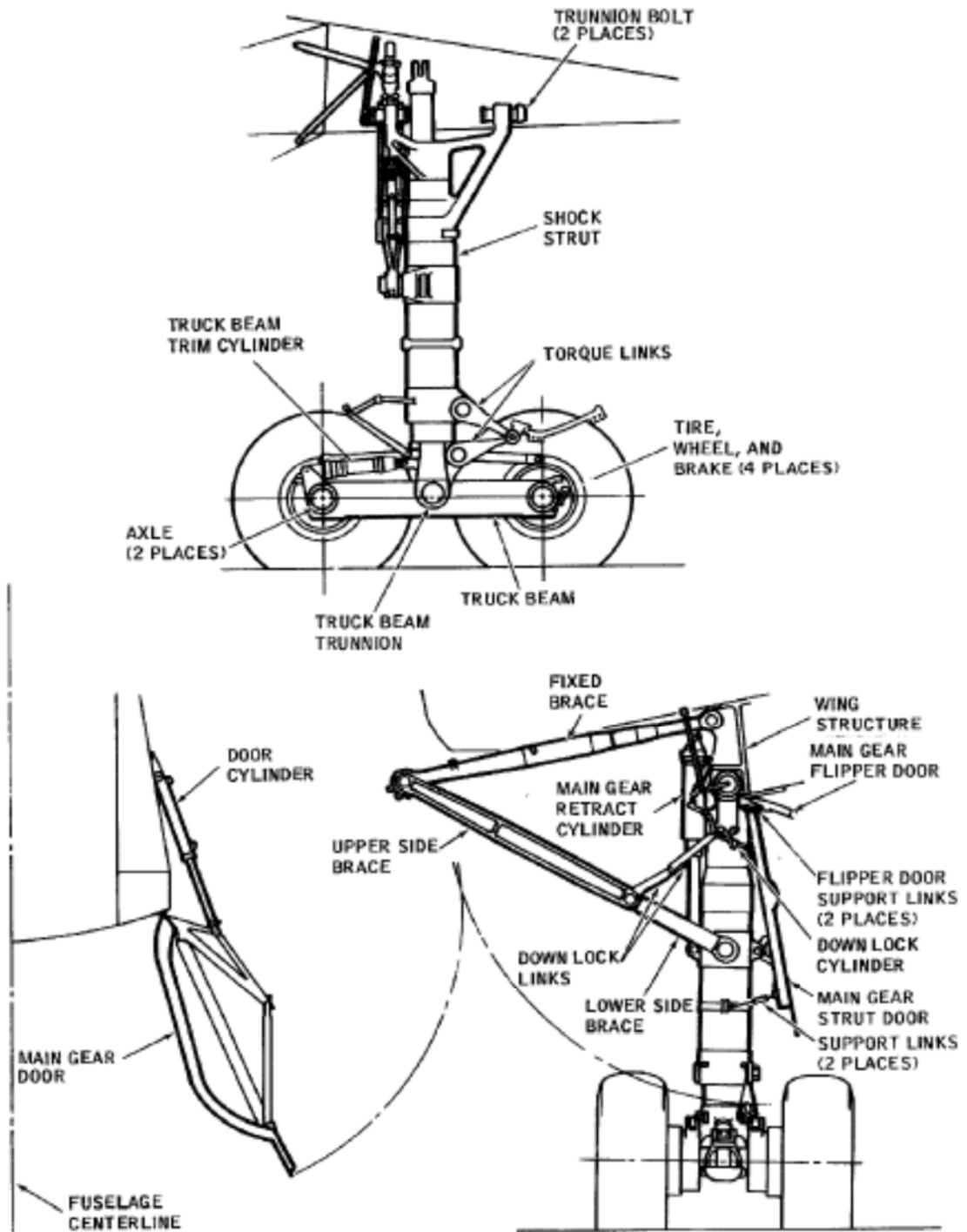


Figure 3 – Main Landing Gear (right shown)

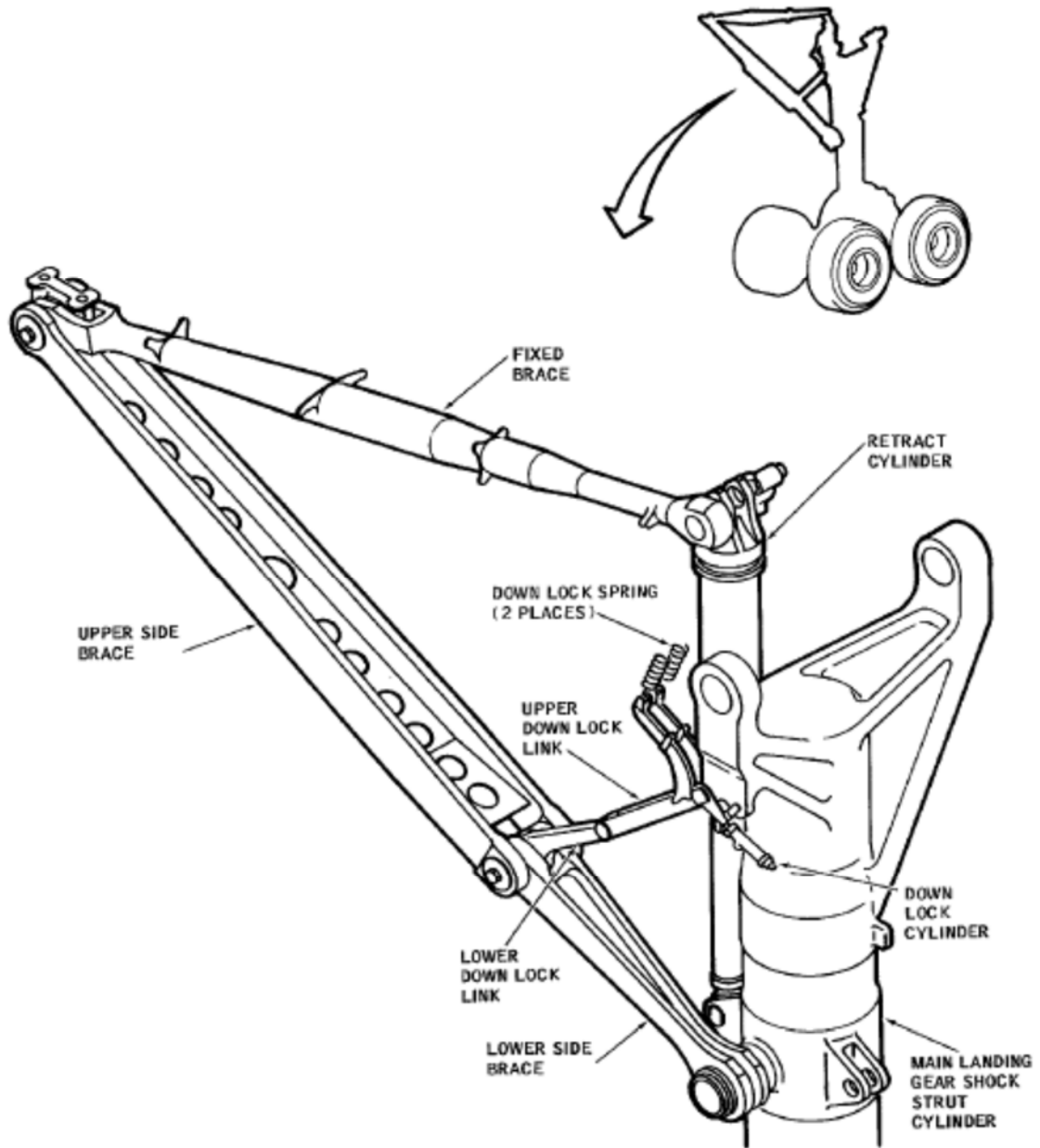


Figure 4 – Main Landing Gear Side Brace and Attachments

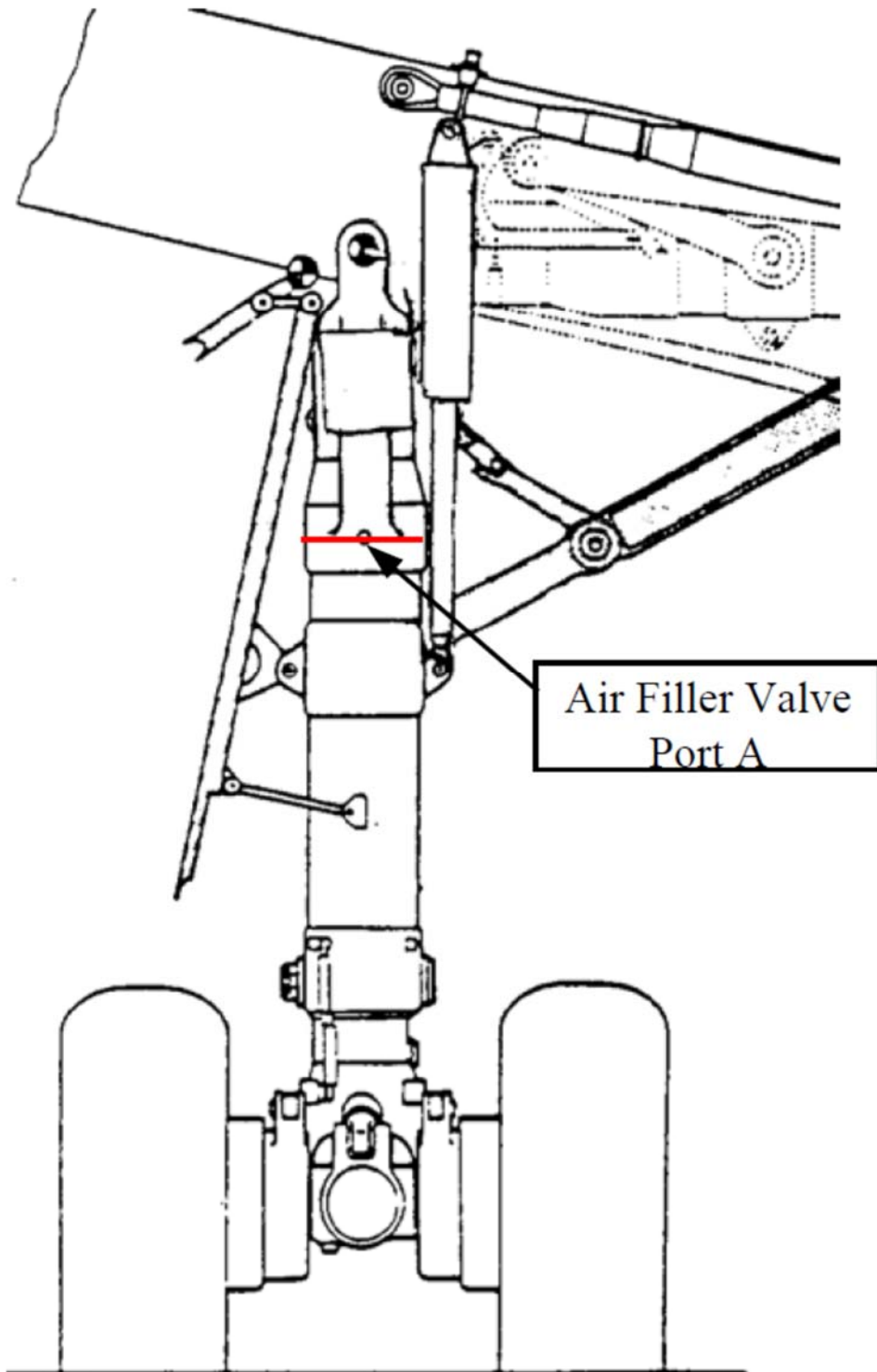


Figure 5 – Left hand main landing gear viewed looking forward



Figure 6 – Upper portion of left main landing gear attached to the airplane



Figure 7 – Lower portion of the left main landing gear after being detached from the side brace



Figure 8 – Aft side of lower section of the main cylinder and fill valve



Figure 9 – Fracture surface on the lower section of the left main landing gear cylinder exhibiting features consistent with fatigue



Figure 10 – Large section of main cylinder recovered from the runway



Figure 11 – Main cylinder pieces recovered from the runway



Figure 12 – Main cylinder pieces recovered from the runway

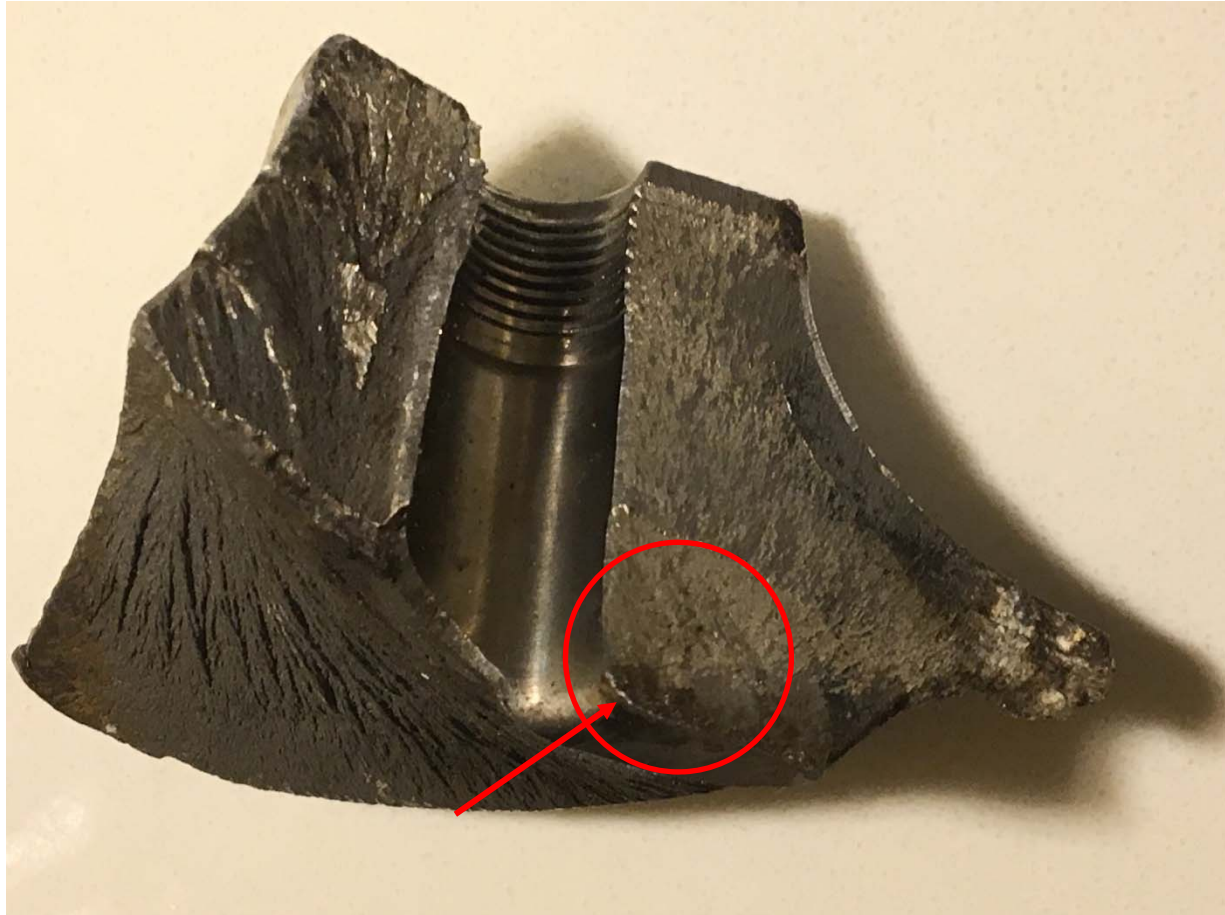


Figure 13 – 3 inch by 3 inch piece of main cylinder exhibiting features consistent with fatigue



Figure 14 – 3 inch by 3 inch piece of main cylinder exhibiting features consistent with fatigue



Figure 15 – Lower portion of the left main landing gear viewed looking inboard



Figure 16 - Lower portion of the left main landing gear viewed looking forward



Figure 17 – Left wing viewed looking inboard



Figure 18 – Left wing viewed looking inboard and forward



Figure 19 – Section of the left wing upper skin panel