



# Aviation Investigation Final Report

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<b>Location:</b>	Oswego, Illinois	<b>Accident Number:</b>	CEN11FA383
<b>Date &amp; Time:</b>	June 13, 2011, 09:47 Local	<b>Registration:</b>	N390TH
<b>Aircraft:</b>	Boeing B-17G	<b>Aircraft Damage:</b>	Substantial
<b>Defining Event:</b>	Fire/smoke (non-impact)	<b>Injuries:</b>	1 Minor, 6 None
<b>Flight Conducted Under:</b>	Part 91: General aviation - Positioning		

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## Analysis

The weekend before the accident, a fuel leak was identified. The fuel leak was subsequently repaired, and a final inspection the morning of the accident flight reportedly did not reveal any evidence of a continued fuel leak. Shortly after takeoff, the flight crew noticed a faint odor in the cockpit and a small amount of smoke near the radio room. The flight crew immediately initiated a turn with the intention of returning to the departure airport. About that time, they received a radio call from the pilot of the accompanying airplane advising that there was a fire visible on the left wing. The accident pilot subsequently executed an emergency landing to a corn field. Emergency crews were hampered by the muddy field conditions, and the fire ultimately consumed significant portions airframe.

In-flight photographs showed the presence of fire on the aft lower portion of the left wing between the inboard and outboard engines. Located in the same area of the fire were fuel tanks feeding the left-side engines. After landing, heavy fire conditions were present on the left side of the airplane, and the fire spread to the fuselage.

A postaccident examination noted that the C-channel installed as part of the No. 1 main fuel tank repair earlier in the week was partially separated. During the examination, the tank was filled with a small amount of water, which then leaked from the aft section of the repair area in the vicinity of the partially separated channel. Metallurgical examination of the repair area revealed a longitudinal fatigue crack along the weld seam.

The fatigue nature of the crack was consistent with a progressive failure along the fuel tank seam that existed before the accident flight and was separate from the damage sustained in the emergency landing and postlanding fire. The repair earlier in the week attempted to seal the leak but did not address the existing crack itself. In fact, the length of the crack observed at the time of the repair was about one-half the length of the crack noted during the postaccident examination, suggesting that the crack progressed rapidly during the course of the accident flight. Because the repaired fuel tank was positioned within the open wing structure, a fuel leak of significant volume would have readily vaporized, producing a

flammable fuel vapor/air mixture. Although the exact ignition source could not be determined due to the fire damage, it is likely that the fuel vapor and liquid fuel encountered hot surfaces from nearby engine components, which initiated the in-flight fire.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

An inadequate repair of the fuel tank that allowed the fuel leak to continue, ultimately resulting in an in-flight fire.

### Findings

<b>Aircraft</b>	Fuel storage - Incorrect service/maintenance
<b>Personnel issues</b>	Repair - Maintenance personnel

## Factual Information

### History of Flight

<b>Initial climb</b>	Fire/smoke (non-impact) (Defining event)
<b>Landing</b>	Off-field or emergency landing

On June 13, 2011, about 0947 central daylight time, a Boeing B-17G "Flying Fortress" airplane, N390TH, experienced an in-flight fire and emergency landing near Oswego, Illinois. One passenger sustained a minor injury. The remaining 3 flight crew members and 3 passengers were not injured. The airplane was substantially damaged as a result of the postimpact fire. The airplane was registered to and operated by The Liberty Foundation under the provisions of 14 Code of Federal Regulations Part 91 as a repositioning flight. Visual meteorological conditions prevailed for the flight, which was not operated on a flight plan. The flight originated from the Aurora Municipal Airport (ARR), Sugar Grove, Illinois at 0938, with an intended destination of the Indianapolis Regional Airport (MQJ).

The airplane had been at ARR for the weekend before the accident flight as a planned stop for education/demonstration flights; however, a fuel leak had interrupted the scheduled flights. A mechanic associated with the Foundation evaluated and repaired the fuel leak the day prior to the accident flight. According to the mechanic, a final inspection of the repair the morning of the accident flight did not reveal any evidence of a continued fuel leak at that time and the airplane was subsequently returned to service.

The flight crew reported that they noticed a faint odor during initial climb after takeoff. While attempting to locate the source of the odor, the pilot noticed a small amount of smoke near the radio room. The flight crew immediately initiated a turn with the intention of returning to ARR. About that time, they received a call from the pilot of the accompanying airplane advising that there was a fire visible on the left wing. The third crew member onboard the B-17 subsequently confirmed a fire behind the no. 2 engine. The pilot took control of the airplane from the co-pilot and setup for an emergency landing to a field off the left side of the airplane. The co-pilot then shut down the no. 2 engine and discharged the fire bottles. The pilot executed an emergency landing to a corn field about 8 miles southeast of ARR. The co-pilot noted that the airplane touched down smoothly on speed about one-third of the way down the field. The ground was firm and the airplane came to a smooth stop.

Emergency crews were hampered by the muddy field conditions, and the fire ultimately consumed portions of the fuselage and the inboard portions of both wings.

## Pilot Information

<b>Certificate:</b>	Airline transport	<b>Age:</b>	48
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 1 Without waivers/limitations	<b>Last FAA Medical Exam:</b>	May 17, 2011
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	14178 hours (Total, all aircraft), 438 hours (Total, this make and model), 4454 hours (Pilot In Command, all aircraft), 127 hours (Last 90 days, all aircraft), 49 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

## Co-pilot Information

<b>Certificate:</b>	Airline transport; Flight instructor	<b>Age:</b>	64
<b>Airplane Rating(s):</b>	Single-engine land; Single-engine sea; Multi-engine land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>		<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 1 With waivers/limitations	<b>Last FAA Medical Exam:</b>	March 4, 2011
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	15000 hours (Total, all aircraft), 6 hours (Total, this make and model), 10000 hours (Pilot In Command, all aircraft), 20 hours (Last 90 days, all aircraft), 8 hours (Last 30 days, all aircraft)		

The pilot held an Airline Transport Pilot certificate with single and multi-engine land airplane ratings. His certificate included type ratings for B-17, B-737, B-757, and B-767 airplanes. He was issued a first class airman medical certificate without limitations on May 17, 2011. He reported a total flight time of 14,178 hours, with 438 hours in B-17 airplanes. His most recent regulatory checkride was completed on April 17, 2011.

The co-pilot held an Airline Transport Pilot certificate with single and multi-engine land airplane ratings. His certificate included type ratings for DC-9, B-757, B-767, and A320 airplanes. He was issued a first class airman medical certificate with a limitation for corrective lenses on March 4, 2011. He reported a total flight time of 15,000 hours, with 6 hours in B-17 airplanes. His most recent regulatory checkride was completed on August 26, 2010.

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Boeing	<b>Registration:</b>	N390TH
<b>Model/Series:</b>	B-17G	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Limited (Special)	<b>Serial Number:</b>	44-85734
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	36
<b>Date/Type of Last Inspection:</b>	June 10, 2011 AAIP	<b>Certified Max Gross Wt.:</b>	54000 lbs
<b>Time Since Last Inspection:</b>	1 Hrs	<b>Engines:</b>	4 Reciprocating
<b>Airframe Total Time:</b>	2579 Hrs as of last inspection	<b>Engine Manufacturer:</b>	WRIGHT
<b>ELT:</b>	Installed, not activated	<b>Engine Model/Series:</b>	R-1820-97
<b>Registered Owner:</b>	Liberty Foundation, Inc.	<b>Rated Power:</b>	1200 Horsepower
<b>Operator:</b>	Liberty Foundation, Inc.	<b>Operating Certificate(s) Held:</b>	None

The accident airplane was a Boeing B-17G "Flying Fortress," serial number 44-85734. It was mid-wing monoplane design, configured with a retractable, tail wheel landing gear. The cockpit and cabin were accessible through a door located on the right side of the fuselage just forward of the horizontal stabilizer, or through a hatch located in the bottom of the fuselage below the cockpit. The airplane was powered by four 1,200 horsepower Wright model R-1820-97 nine-cylinder, radial engines.

Available information indicated that the accident airplane was delivered to the United States Army Air Force in 1945. In 1947, the airplane was included in a lot of aircraft sold for scrap. However, the accident airplane was not scrapped and was subsequently sold to the United Aircraft Corporation/Pratt & Whitney Aircraft Division for use as an engine development test bed. In 1967, the airplane was donated to the Connecticut Aviation Historical Association. Unfortunately, in 1979, the airplane was severely damaged in a tornado. In 1999, a private individual purchased the airplane with the intention of restoring it. During the restoration process, the airplane was sold to the Liberty Foundation. The restoration was completed in 2004 and the airplane was returned to an airworthy condition. The FAA issued a limited special airworthiness certificate in May 2005. At the time of the accident, the airplane was being operated as a historical demonstration/exhibition aircraft by the Liberty Foundation.

The airplane was maintained under a progressive inspection program. The program was comprised of four incremental inspection procedures designated "A", "B", "C", and "D", which were to be conducted at 25-hour intervals, and periodic/non-routine inspection procedures as applicable. The most recent incremental inspections were completed on: March 25, 2011, at 2,501.9 hours total time airframe (TTAF); April 21, 2011, at 2,529.6 hours TTAF; May 14, 2011, at 2,552.7 hours TTAF; and June 10, 2011, at 2,579.0 hours TTAF.

Documentation on file with the Federal Aviation Administration (FAA) revealed that a modification of the fuel system was completed during restoration of the airplane. This modification involved removal of the outboard fuel cells, also known as "Tokyo" tanks, and related fuel lines. In addition, the fuel tank-to-fuel tank transfer system was replaced with a fuel tank-to-engine cross-feed system. A corresponding

FAA form 337, Major Repair and Alteration, dated April 26, 2005, was on file with the airplane records.

An airplane maintenance logbook entry, dated February 24, 2011, at 2,474.7 hours TTAF, noted that the aluminum fuel tanks had been removed from the airplane, and that the rubber fuel bladder liners were removed from the tanks. The aluminum tanks were subsequently welded to close the bladder liner mounting relief holes and re-installed into the airplane. An operational check of the fuel tank modification did not reveal any anomalies and the airplane was returned to service. There was no corresponding Major Repair and Alteration (FAA form 337) on file with the airplane records. The mechanic that conducted the work noted that the fuel bladders were degrading and occasionally clogging the fuel sumps.

The final maintenance logbook entry was dated June 13, 2011, the day of the accident. The entry noted a repair to the inboard end of the no. 1 main fuel tank. A subsequent leak check did not reveal any anomalies and the airplane was returned to service.

The mechanic who accomplished the fuel tank repair reported that he had examined the no. 1 fuel tank the day before the accident because of a fuel leak. He determined that the leak was due a 3-inch crack that was located in the weld bead at the bottom edge of the tank near the sump drain valve. The fuel leak was repaired by installing 5 bolts through the fuel tank flange. An aluminum C-channel was then installed with sealant over the fuel tank flange.

### Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	ARR,712 ft msl	<b>Distance from Accident Site:</b>	8 Nautical Miles
<b>Observation Time:</b>	09:52 Local	<b>Direction from Accident Site:</b>	150°
<b>Lowest Cloud Condition:</b>	Clear	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	10 knots /	<b>Turbulence Type Forecast/Actual:</b>	/
<b>Wind Direction:</b>	60°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	30.15 inches Hg	<b>Temperature/Dew Point:</b>	18°C / 9°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Aurora, IL (ARR )	<b>Type of Flight Plan Filed:</b>	None
<b>Destination:</b>	Indianapolis, IN (MQJ )	<b>Type of Clearance:</b>	None
<b>Departure Time:</b>	09:38 Local	<b>Type of Airspace:</b>	

At 0952, the ARR Automated Surface Observing System recorded weather conditions as: Wind from 060 degrees at 10 knots; 10 miles visibility; clear skies; temperature 18 degrees Celsius; dew point 9 degrees Celsius; altimeter 30.16 inches of mercury.

## Airport Information

<b>Airport:</b>	Aurora Municipal ARR	<b>Runway Surface Type:</b>	
<b>Airport Elevation:</b>	712 ft msl	<b>Runway Surface Condition:</b>	
<b>Runway Used:</b>		<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>		<b>VFR Approach/Landing:</b>	Forced landing

## Wreckage and Impact Information

<b>Crew Injuries:</b>	3 None	<b>Aircraft Damage:</b>	Substantial
<b>Passenger Injuries:</b>	1 Minor, 3 None	<b>Aircraft Fire:</b>	Both in-flight and on-ground
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	1 Minor, 6 None	<b>Latitude, Longitude:</b>	41.662498,-88.36444

The airplane came to rest on its landing gear in an agricultural field located about 8 miles southeast of ARR. Ground tracks indicated that the emergency landing was performed toward the east; approximate course 090 degrees. There did not appear to have been any damage to the airplane as a direct result of off-airport landing. However, the in-flight and ground fire substantially damaged the airplane.

In-flight photographs of the accident airplane showed the presence of fire on the aft lower portion of the left wing between the no. 1 (outboard) and no. 2 (inboard) engines. Also located in the same area of the fire were fuel tanks feeding the left-side engines.

In photographs taken shortly after the accident aircraft landed, heavy fire conditions were present on the left side of the aircraft with the fire spreading to the fuselage. By the time the fire was extinguished, the inboard portion of both the left and right wings had been destroyed by fire as well as most of the fuselage. The engines, empennage, fuselage nose, and the outboard portions of both wings remained intact.

## Tests and Research

A postaccident examination of the no. 1 main fuel tank was conducted under the direct supervision of the NTSB investigator-in-charge. The upper, inboard end of the fuel tank was deformed and ruptured consistent with damage sustained after the landing. However, the area repair area itself located at the center portion of the lower, inboard seam of the tank appeared to exhibit minimal deformation. The aft portion of the repair C-channel was partially separated from the tank seam. The remainder of the C-channel appeared to be securely bonded to the tank. The bolts installed at the time of the repair were intact and appeared to be secure. The tank was filled with a small amount of water, which was

subsequently observed to leak from the aft section of the repair area in the vicinity of the partially separated C-channel.

Further examination of the fuel tank was conducted by the NTSB materials laboratory. A longitudinal crack, about 7.2 inches in length, was located along the center of the weld seam. The fracture surface features were consistent with fatigue, consistent with a progressive failure at the weld seam. The sealant in the vicinity of the aft two repair bolts was thin and the cured sealant did not conform to the inside shape of the C-channel. The sealant along the remainder of the repair had adhered to the fuel tank and provided full coverage over the weld seam. Additionally, the cured sealant along this portion of the repair conformed to the inside shape of the C-channel.

## **Additional Information**

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FAA regulations (14 CFR Part 1) define a major alteration as one that is not listed in the aircraft, aircraft engine, or propeller specifications: (1) that might appreciably affect weight, balance, structural strength, performance, powerplant operation, flight characteristics, or other qualities affecting airworthiness; or (2) that is not done according to accepted practices or cannot be done by elementary operations. The regulations (14 CFR Part 43) related to a major alteration specifically include "changes to the basic design of the fuel, oil, cooling, heating, cabin pressurization, electrical, hydraulic, de-icing, or exhaust systems" as airframe alterations.

The FAA Major Repair and Alteration Data Approval Job Aid provides guidance to Aviation Safety Inspectors in evaluating requests for field approvals. The document notes that a change to, or addition of, permanent fuel tanks or fuel system components, may be eligible for approval by means other than a Supplemental Type Certificate (STC), but require FAA approved data. This data may be obtained from a Designated Engineering Representative (DER), Organization Designation Authorization (ODA) approved engineering data or through ACO coordinated field approval.

The airplane records on file with the FAA included approvals for modification of the fuel crossfeed system and removal of outboard fuel tanks, radio room seating, and a tail wheel modification, as well as lighting and avionics upgrades. However, the file did not include any application for, or approval of, the most recent modification to the fuel tanks, which included removal of the fuel bladders.



## Administrative Information

<b>Investigator In Charge (IIC):</b>	Sorensen, Timothy
<b>Additional Participating Persons:</b>	Victoria E Anderson; FAA-Accident Investigation; Washington, DC Raymond E Fowler; The Liberty Foundation, Inc.; Miami, FL
<b>Original Publish Date:</b>	April 10, 2014
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	The NTSB traveled to the scene of this accident.
<b>Investigation Docket:</b>	<a href="https://data.ntsb.gov/Docket?ProjectID=80751">https://data.ntsb.gov/Docket?ProjectID=80751</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).