NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

July 30, 2020

Airworthiness Group Chairman's Factual Report

ERA20MA001

A. ACCIDENT

Operator: Collings Foundation
Aircraft: B-17G, N93012
Location: Windsor Locks, CT
Date: October 2, 2019
Time: 0953 EST

B. AIRWORTHINESS GROUP

Member — Steven Magladry
National Transportation Safety Board
Washington, DC

Member — Thomas J. Davis
Federal Aviation Administration
Kansas City, Missouri

C. SUMMARY

On October 2, 2019, at 0953 eastern daylight time, a Boeing B-17G, N93012, owned and operated by the Collings Foundation, was destroyed during a precautionary landing and subsequent runway excursion at Bradley International Airport (BDL), Windsor Locks, Connecticut. The commercial pilot, airline transport pilot, and five passengers were fatally injured. The flight mechanic/loadmaster and four passengers were seriously injured, while one passenger and one person on the ground incurred minor injuries. The local commercial sightseeing flight was conducted under the provisions of Title 14 *Code of Federal Regulations* Part 91, in accordance with a Living History Flight Experience exemption granted by the Federal Aviation Administration (FAA). Visual meteorological conditions

prevailed in the area and no flight plan was filed for the flight, which departed BDL at 0947.

The airworthiness group chairman arrived on-scene at approximately 4 pm local time of October 2, and the FAA member about the same time the next day. The following summarizes the documentation of the accident scene.

D. DETAILS OF THE INVESTIGATION

General Information

The airplane exited to the right of runway 6, impacted jersey barriers, two deicing vehicles, and a glycol storage tank. Most of the cockpit, fuselage, and right wing were consumed by post impact fire. An overview image of the accident site (Figure 1), was reproduced here from the UAS Aerial Imagery factual report, Figure 19.

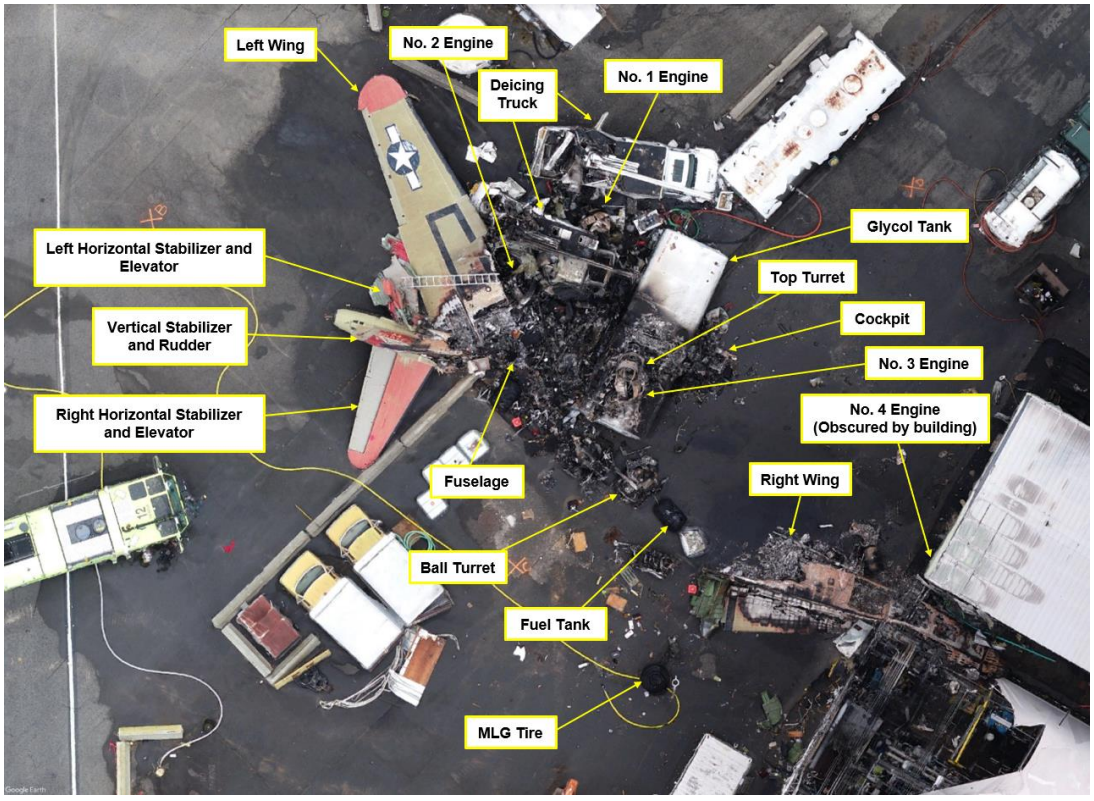

Figure 1 Aerial View of Accident Site

Structures and Flight Controls

General Information

All flight control surfaces are mechanically actuated from the cockpit controls through cables to each control surface quadrant. From the quadrant the ailerons are actuated by a pushrod, and the rudder and elevators are actuated by torque tubes. The left aileron, rudder, and both elevators have trim tabs operated by cables to the cockpit. Each wing has a trailing edge flap, operated by an electric motor in the left wing, located inboard of the #2 engine. The motor is connected through a gearbox to torque tubes and five actuating jackscrews per flap.

Left Wing

The left wing was mostly intact from the wingtip to outboard of the #2 engine (Figure 2). The aileron was intact, but the pushrod and most hinges were fractured. The trim tab was intact, the hinges were intact but the rod from the spool to the tab was bent (Figure 3). Rotation of the shaft moved the tab. The wing was placed upside down, the flap appeared to be retracted and there was 16 feet of the outboard portion intact (Figure 4). There was a small area of impact damage on the bottom of the flap. The access panels on the bottom side of the inner wing panel were opened to view the flap jackscrews. The cover was detached to show the threaded region and it was observed that there were no threads showing, indicating it was in full retracted position (Figure 5).

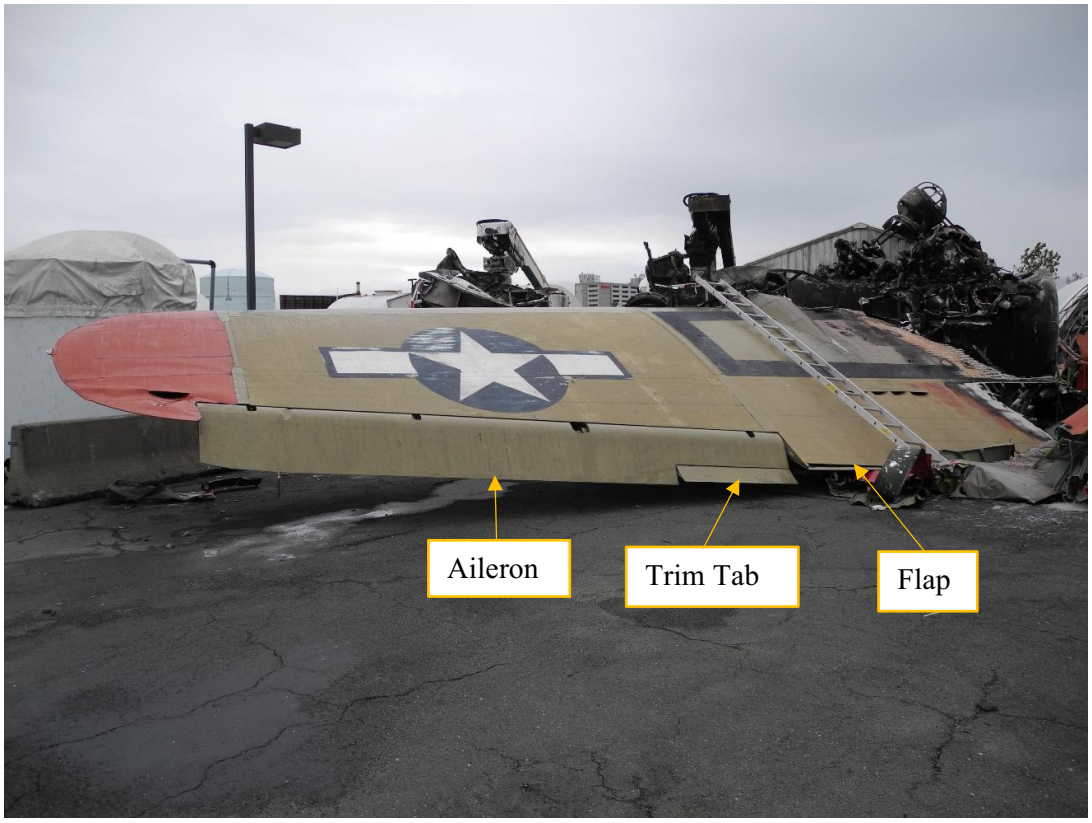

Figure 2 Left Wing

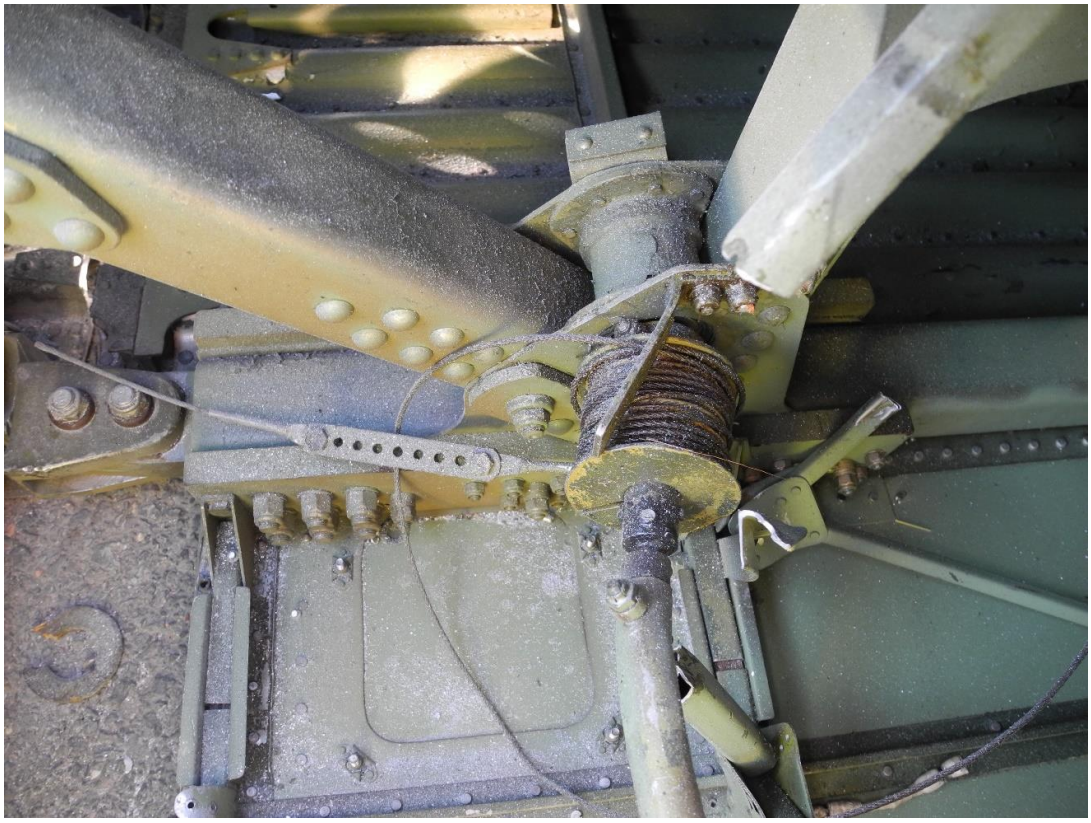

Figure 3 Trim tab cable drum

Figure 4 Left wing upside-down to show flap

Figure 5 Flap drive and jackscrew

Right Wing

The entire right wing separated from the fuselage and impacted a nearby building (Figures 6-8). There was considerable post impact fire damage. There was impact damage at the leading edge near the wingtip (Figure 9). The aileron condition could not be determined, it was consumed by the fire. The flap appeared to be retracted and the inboard most flap jackscrew was observed to be in the fully retracted position, the cover was found detached from the normal position (Figure 10).

Figure 6 Right wing leading edge inboard portion

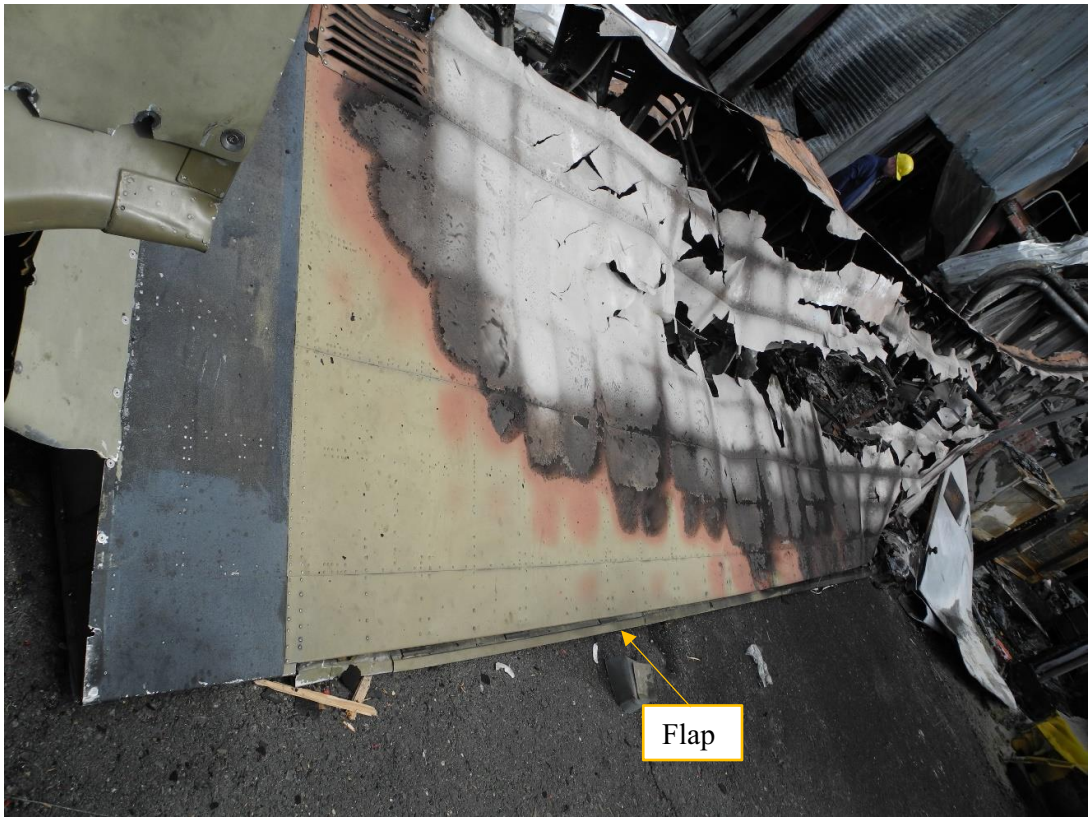

Figure 7 Right wing trailing edge inboard portion

Figure 8 Right wing outboard portion

Figure 9 Right wing tip impact damage

Figure 10 Flap jackscrew position

Vertical Stabilizer

The vertical stabilizer, rudder and tab were intact (Figure 11). The rudder control quadrant and cables were intact (Figure 12). The rudder trim cable drum was intact (Figure 13).

Figure 11 Vertical Stabilizer, rudder, and trim tab

Figure 12 Rudder control quadrant

Figure 13 Rudder trim cable drum

Horizontal Stabilizers

The right horizontal stabilizer, elevator and tab were all intact (Figure 14-15). There was impact at the leading edge of the tip and damage on the bottom (Figure 16). The elevator torque tube, horns, and cables were intact and connected to the right elevator (Figure 17). The torque tube was designed to provide a rigid connection between the right and left elevators, but the torque tube was fractured and detached from the left elevator. Also damaged was the right trailing edge down horn on the torque tube, it was loose and could rotate relative to the torque tube.

Figure 14 Right horizontal stabilizer, elevator, and tab

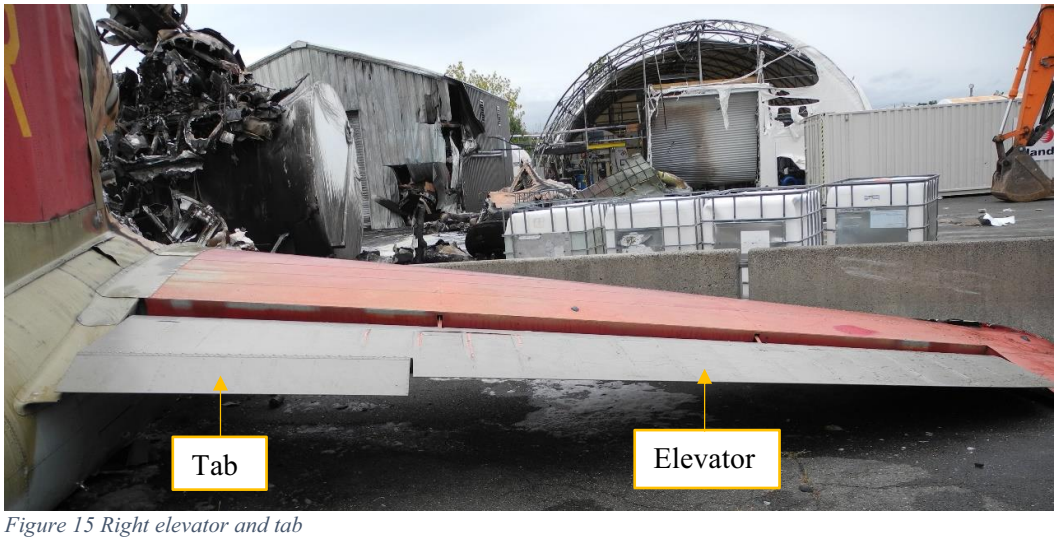

Figure 15 Right elevator and tab

Figure 16 Right horizontal stabilizer impact damage

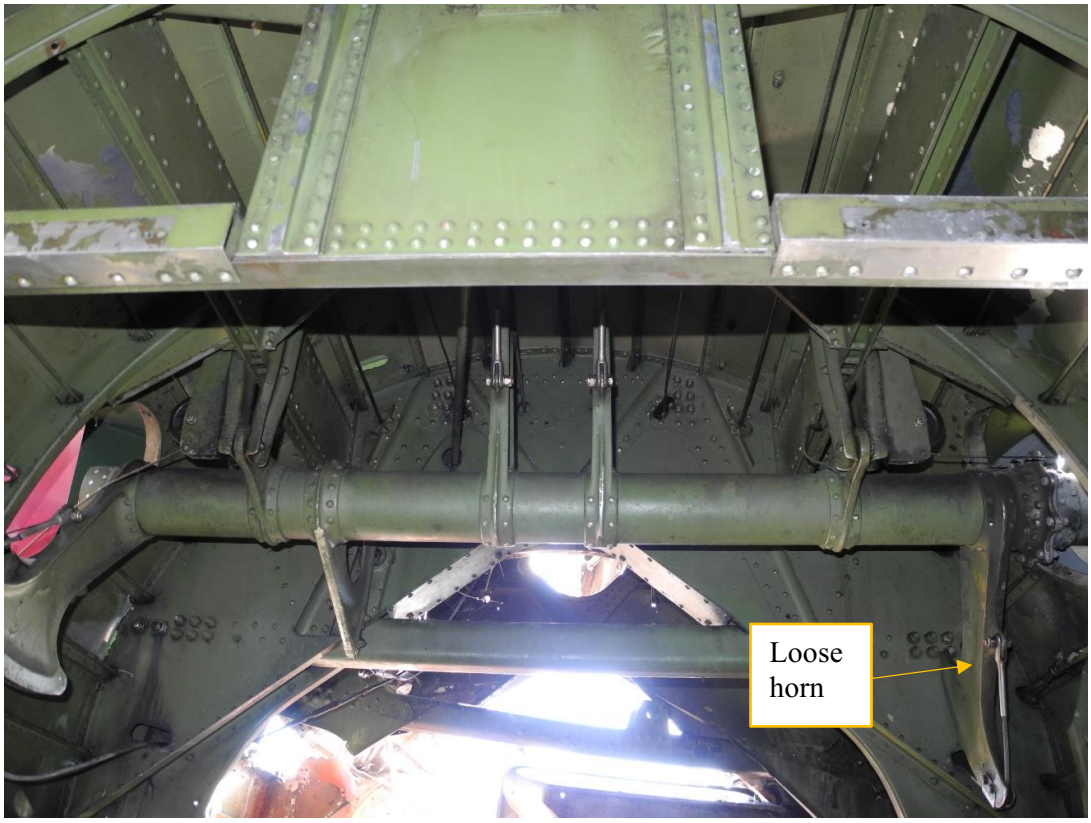

Figure 17 Elevator Controls

The left horizontal stabilizer was crushed at the leading edge and fractured such that the outer portion was upside down and underneath the left wing (Figure 18). The inboard portion of the elevator was separated from the stabilizer. After the wing was moved, the outer portion of the stabilizer and elevator could be seen to be present, including the tip (Figure 19). The trim tab was still connected to the elevator but had damage to the trailing edge. The trim cables were still attached to the drum and could be moved (Figure 20).

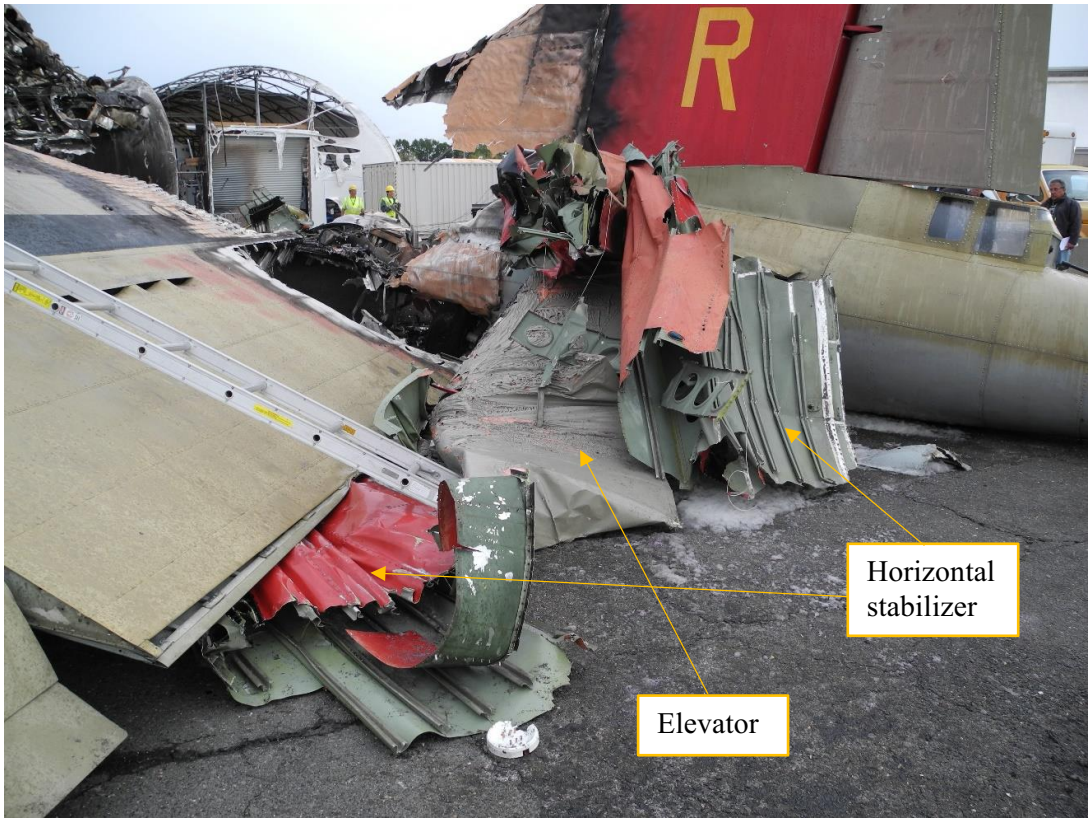

Figure 18 Left horizontal stabilizer and elevator

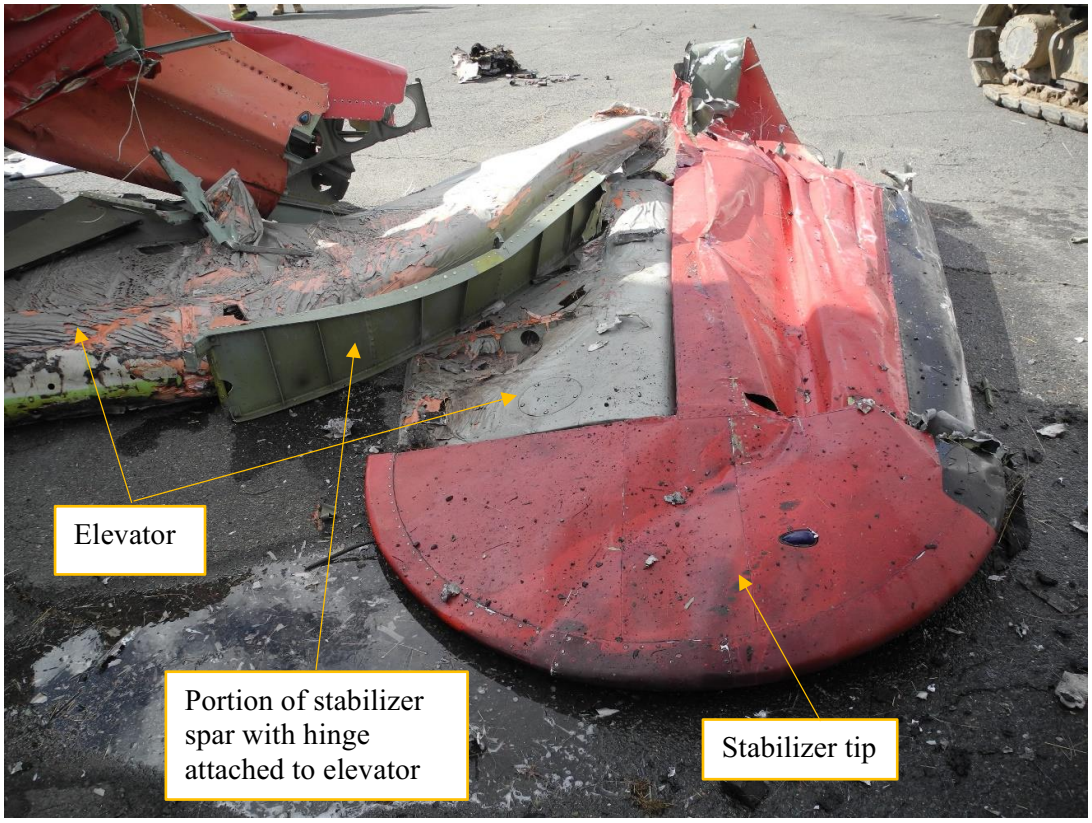

Figure 19 Right horizontal stabilizer tip inverted

Figure 20 Left elevator trim tab cables

Flight Control Cable Continuity

Because all cables passed through the heavily fire damaged fuselage area, end-to-end verification of cable continuity was not possible. However, local continuity was evaluated when possible. All of the cables that connected to the rudder and elevator surfaces and trim tabs in the empennage were still intact and extended well forward into the fire damaged portion of the fuselage, although many had come out of the cable pulleys. By pulling on the correct cables, the rudder and rudder trim tab could be moved right and left. The right elevator could be moved up and down. The right elevator trim tab could not be moved due to the restriction of the cable caused by the separation of the left elevator, because the right and left trim tabs are connected in a continuous cable loop. All the cables were traced forward, and except for the left rudder cables, were found fractured near the area of fire damaged fuselage. The left rudder cables appeared to be continuous except the rudder quadrant in the cockpit could not be found.

The aileron cables were found to be connected to both control wheels. The cables from one control wheel were fractured near the base of the control column, the cables from the other control wheel went further but were found to also be fractured. The right wing control quadrant could not be accessed because of the fire damage and position relative to the building, however, the aileron control cables were still present at the right wing root extending out toward the wing tip. The left wing aileron quadrant was located in the wreckage near the fuselage, and it had both cables still attached and a portion of the pushrod attached.

Landing Gear

The airplane was equipped with retractable landing gear. It had two main gear and a tail gear, each with one wheel. There was video evidence that showed all three gear down prior to touchdown. The two main gear were located in the wreckage and both were detached from structure, due to impact and fire damage, with wheel and tires intact, but deflated. The tail gear was still attached to tail structure with wheel and tire intact.

Tail Wheel Lock Mechanism

The tail wheel has a mechanical lock pin, controlled by cable from the cockpit. The pin is normally engaged for takeoff and landing and released for ground maneuvers. A shear bolt installed between the lock plate and the wheel structure prevents damage to the lock mechanism if the lock is not released during ground maneuvers. If the shear bolt fractures the wheel will be unlocked and free to turn 360 degrees even if the lock pin is engaged. The unlock cable was found to be still attached to the pin and the pulleys and levers intact in the area. The wheel lock pin was not engaged with the lock plate, it was rotated approximately 45 degrees. The shear bolt was missing from the mechanism (Figure 21). There was damage that caused a larger than normal gap between the upper structure (treadle) and the lock plate. The bottom half of the fractured shear bolt (Figure 22) was found approximately 100 yards from the wreckage, back along the accident path, near the taxi way barriers.

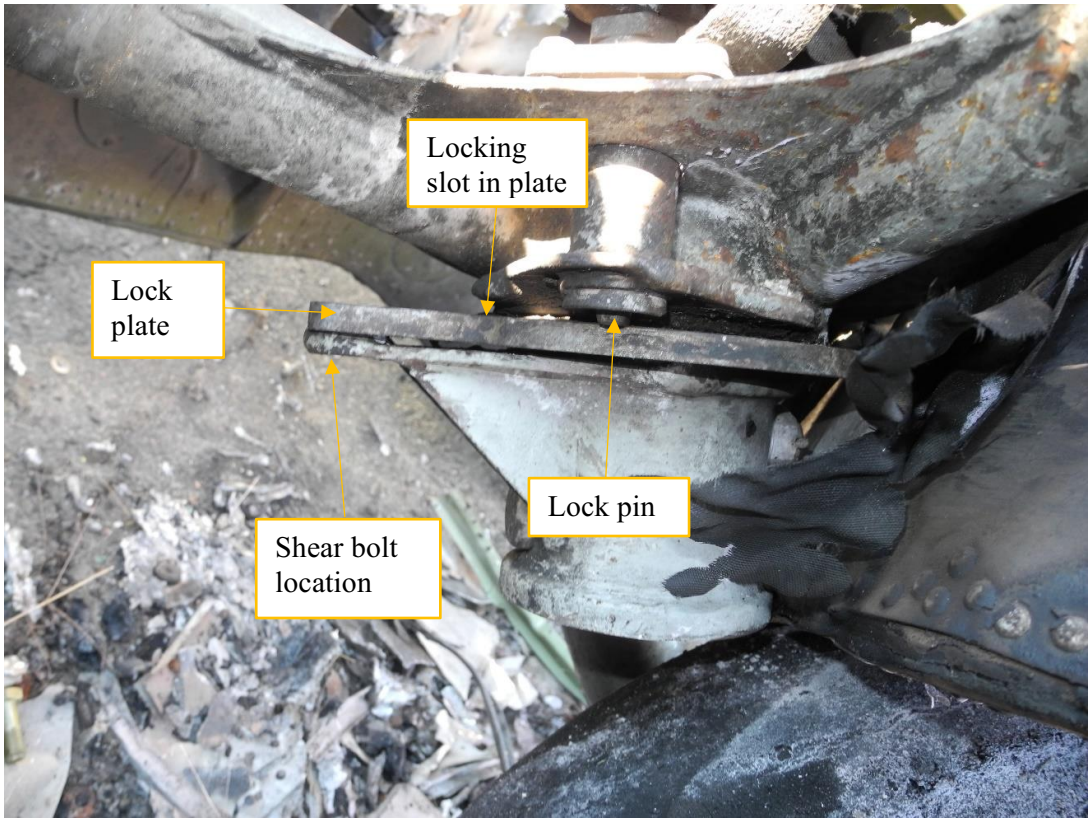

Figure 21 Tail wheel lock mechanism

Figure 22 Bottom half of fractured shear bolt

Cockpit

The fire damaged remnants of the cockpit controls were located on top of the glycol tank (Figure 23), The controls could not be documented in place, so they were removed by an excavator, resulting in additional damage. The instrument panel was found at the base of the tank on the opposite side as the fuselage (Figure 24-25). The instruments were heavily sooted so that the instruments could not be seen. The propeller feather push buttons were intact and in the extended position (Figure 26). In normal operation, the button is pushed, and, after the prop feathers, the push button automatically extends again.

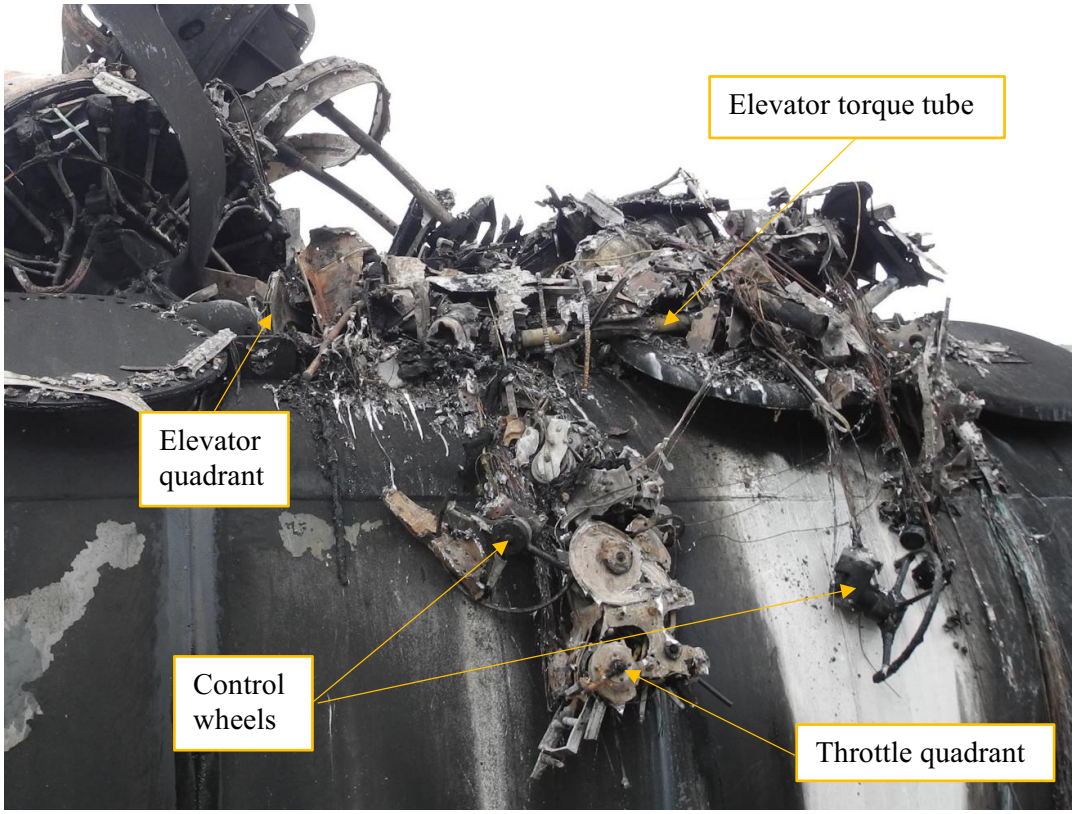

Figure 23 Cockpit controls

Figure 24 Cockpit instruments

Figure 25 Instrument panel

Figure 26 Propeller feather switches

Figure 27 shows the arrangement of the throttle and propeller controls. Each throttle lever has two handles, with the inboard engine levers nested between and below the outboards. The throttle quadrant was badly damaged by impact and fire (Figure 28). The upper portion of throttle lever 1 was missing both handles. Throttle 2 was intact but bent. Throttle 3 was intact. Throttle 4 had the upper handle missing. The propeller RPM levers for 1, 3, and 4 were near the high position, #2 was near low in this photo, but at the midpoint between high and low prior to being moved from glycol tank. The propeller lock lever was in the OFF position. The mixture lock lever was in the ON position (Figure 29). The position of the #1 lever was different before recovery from the top of the tank, it was slightly forward of the #2 lever instead of against the aft stop.

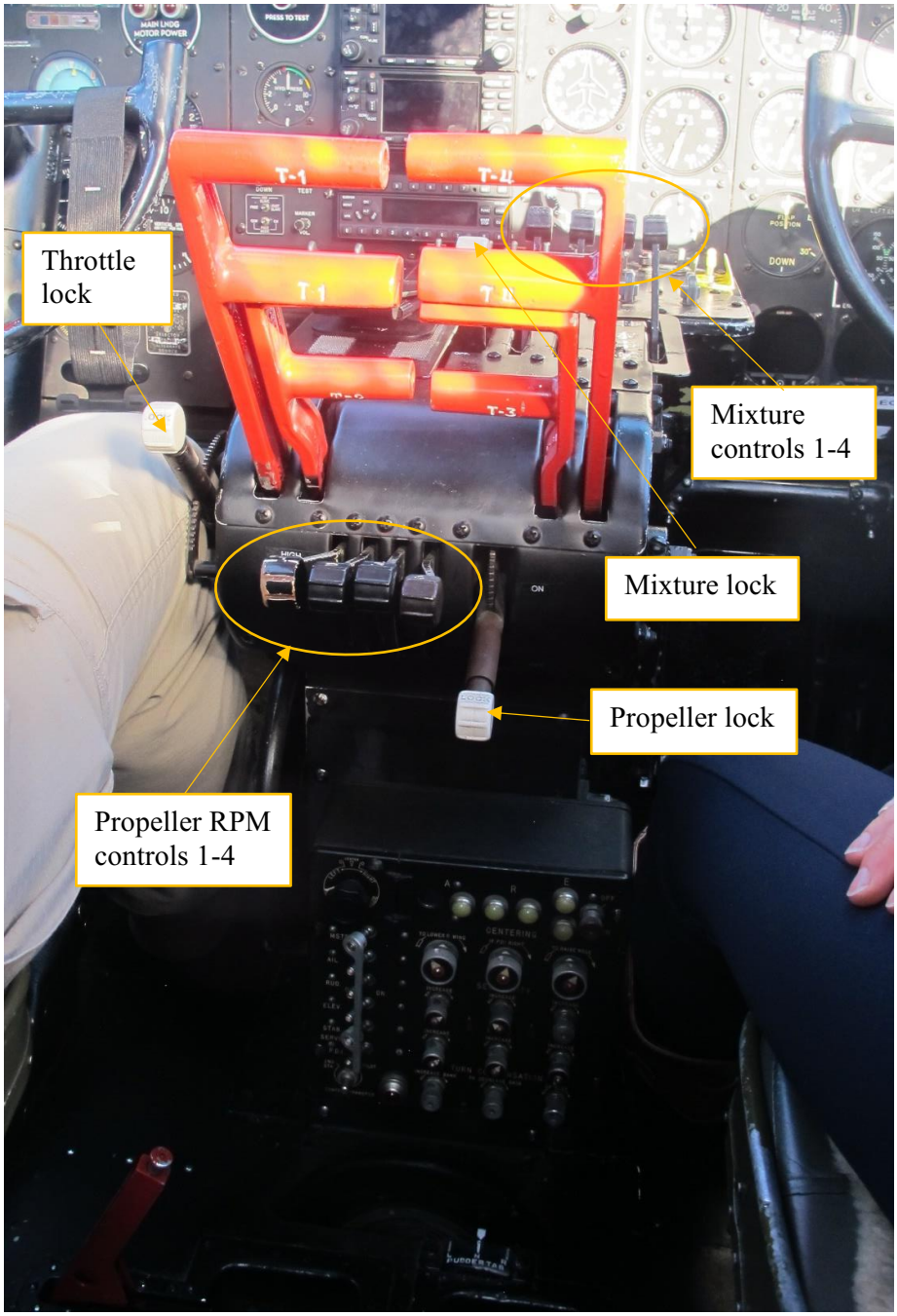

Figure 27 Throttle quadrant on exemplar airplane

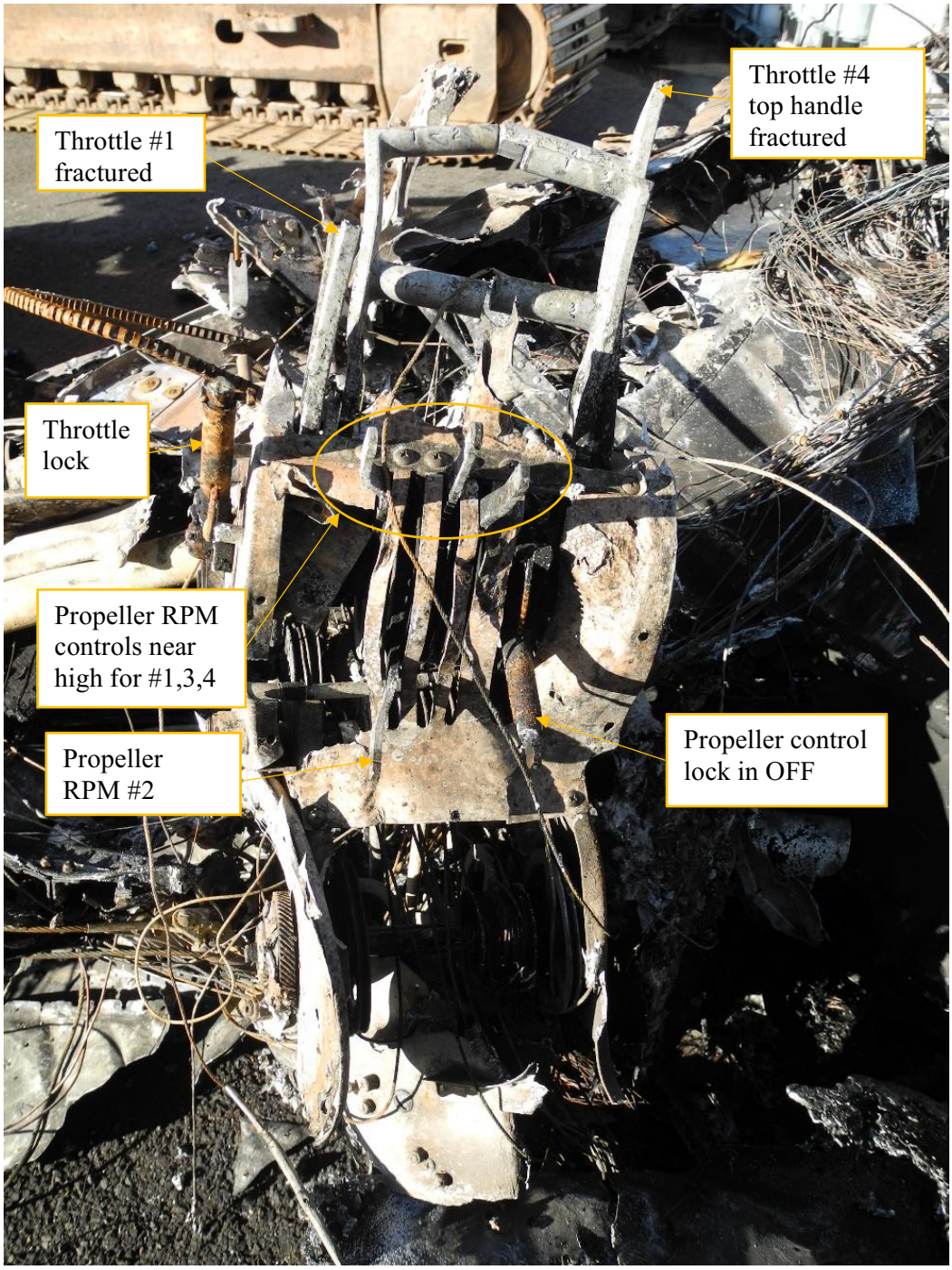

Figure 28 Throttle quadrant

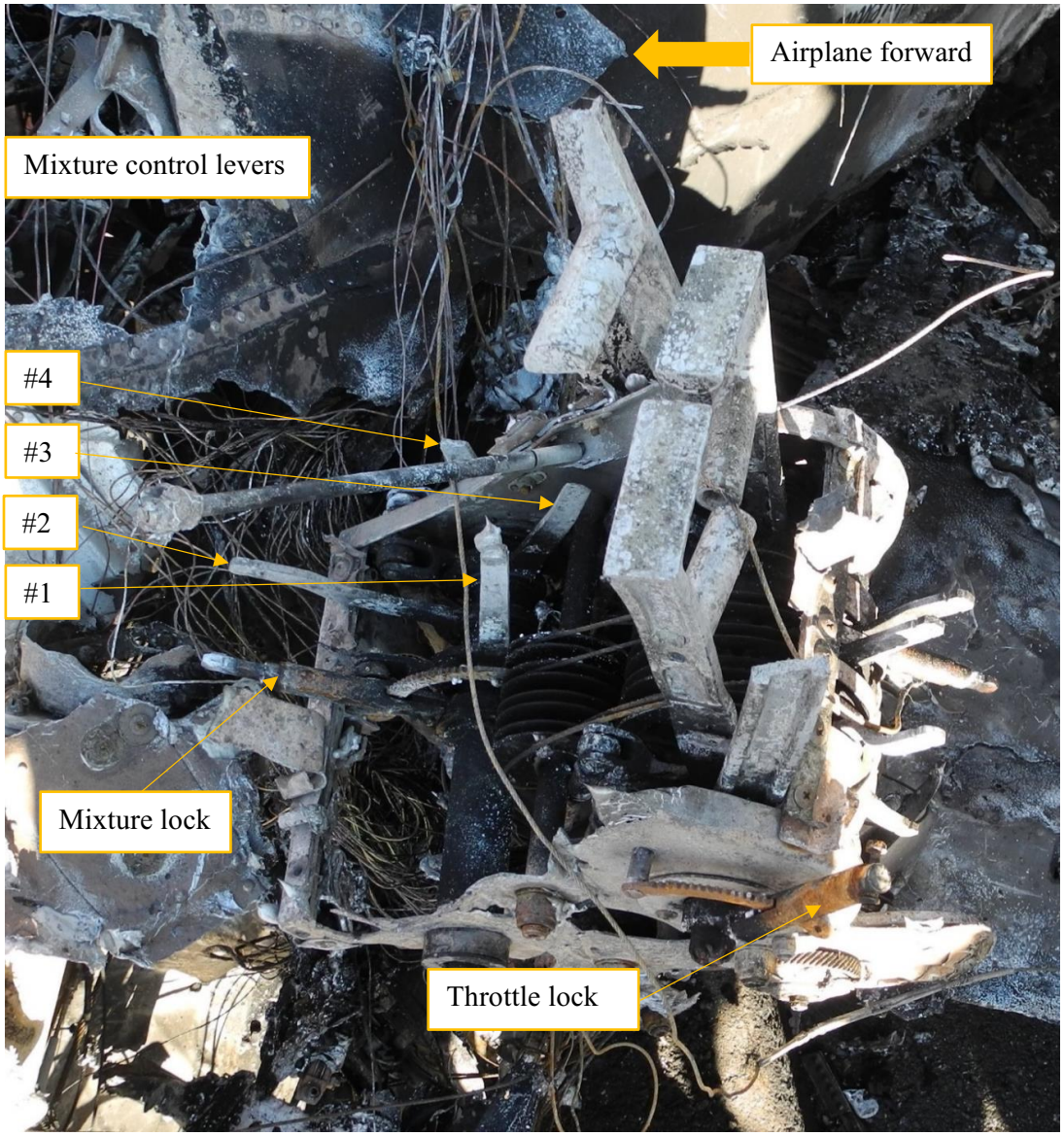

Figure 29 Mixture controls

Fuel

The airplane had one large (425 gallon) self-sealing rubber tank for the #1 engine, two smaller (213 gallon main, 212 gallon feeder) tanks for each inboard engine (#2 and #3), and one large (425 gallon) aluminum tank for the #4 engine (Figure 30). The airplane did not have the outboard "Tokyo" tanks or the bomb bay tanks installed. The bomb bay tanks were removable tanks only used on long range ferry flights. The tanks for #1 and #4 did not have a protective rubber covering and were consumed during the post impact fire (Figures 31-33). The tanks for #2 and #3 had a protective rubber covering and were still intact but heat damaged. A fuel sample was taken from the #3 tank (Figure 34).

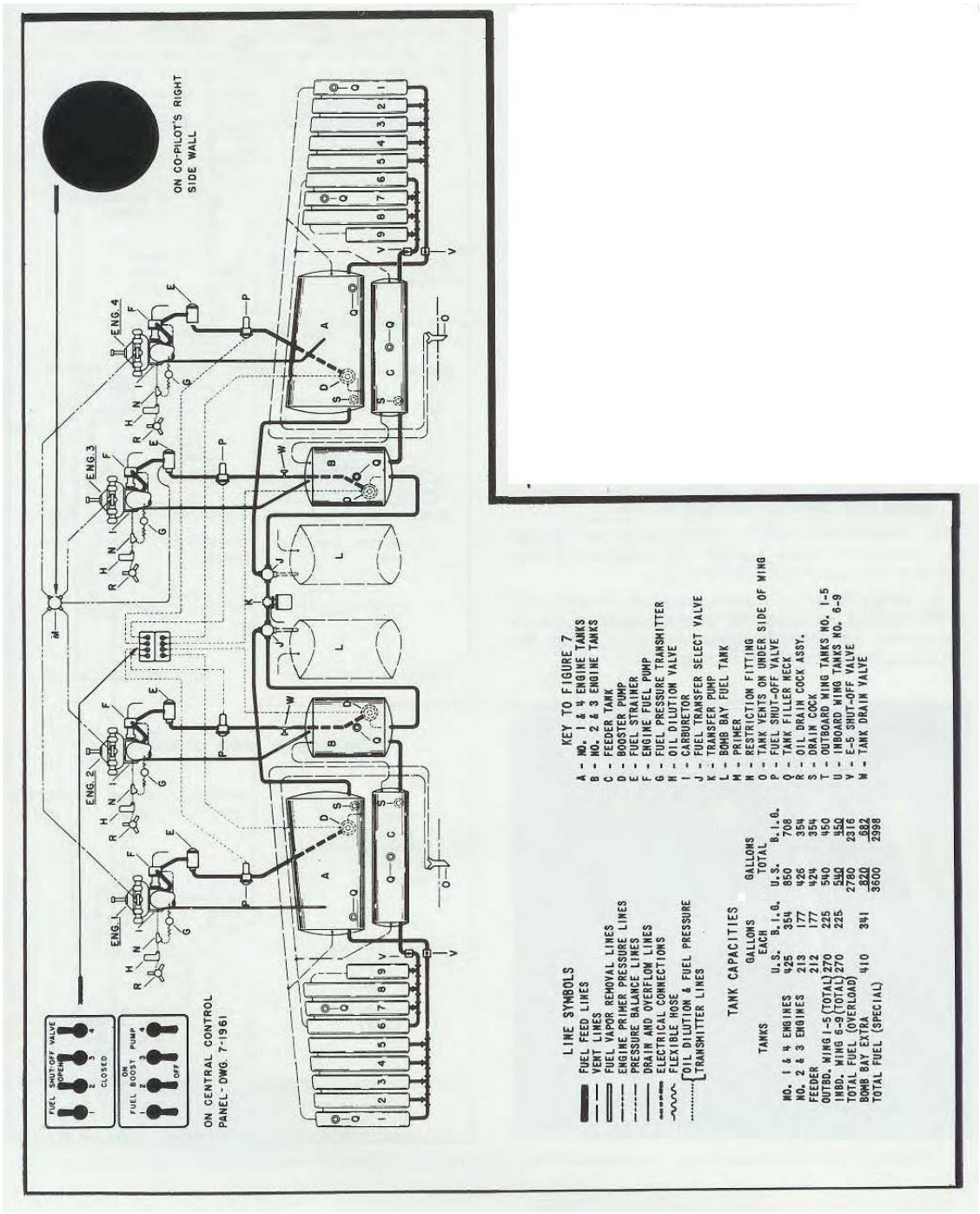

Figure 30 Fuel tank illustration

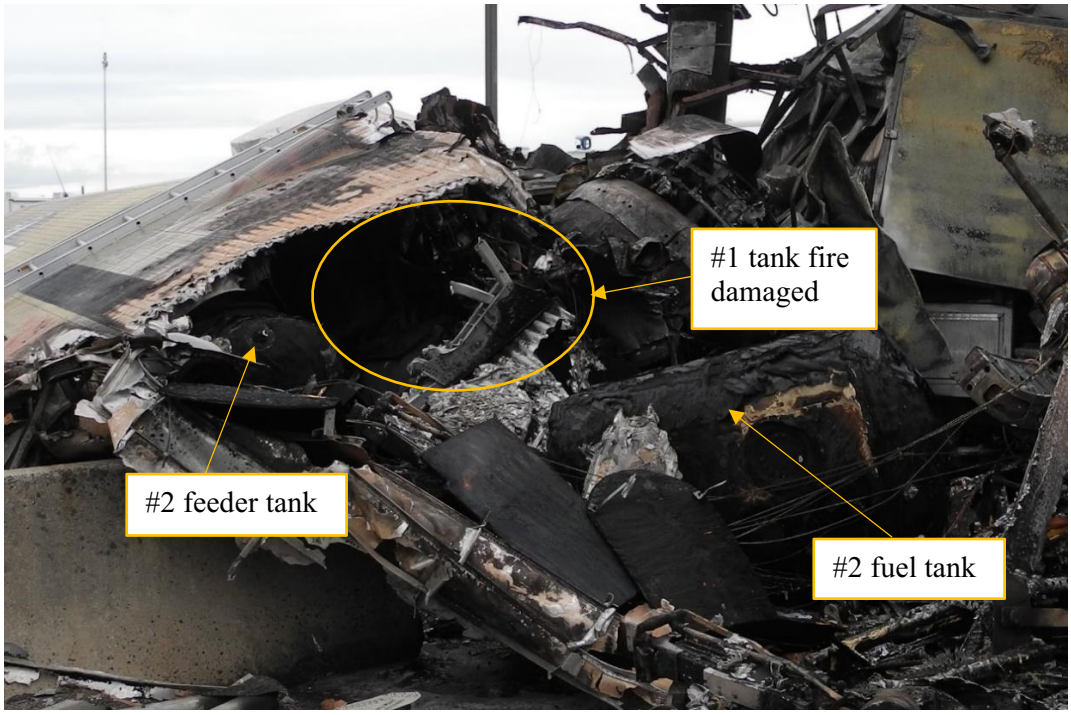

Figure 31 Left wing fuel tanks

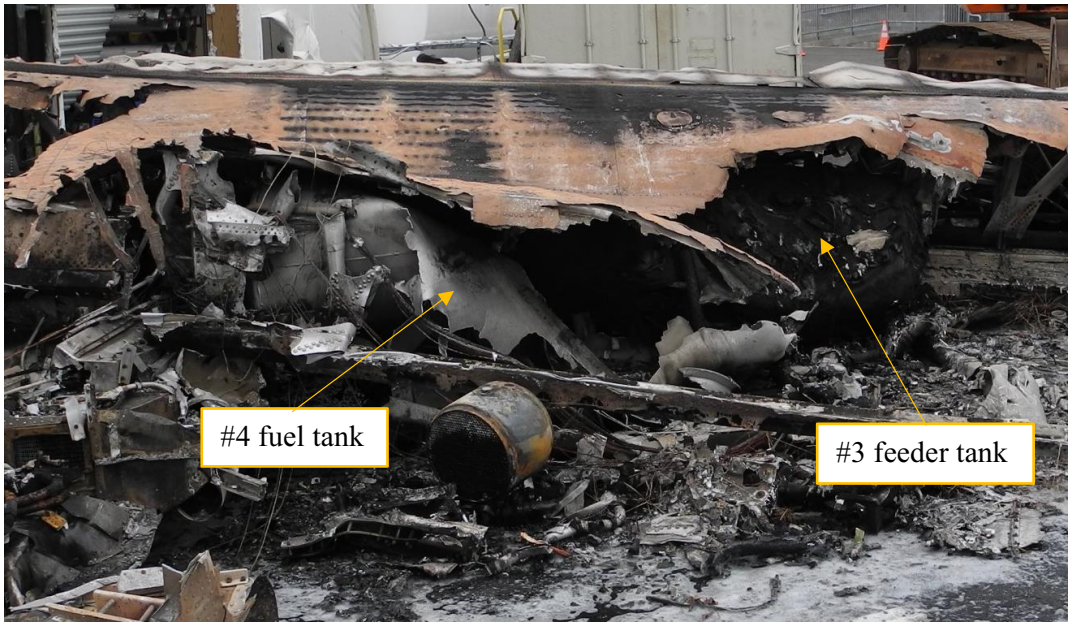

Figure 32 Right wing fuel tanks

Figure 33 Right wing fuel tank #3

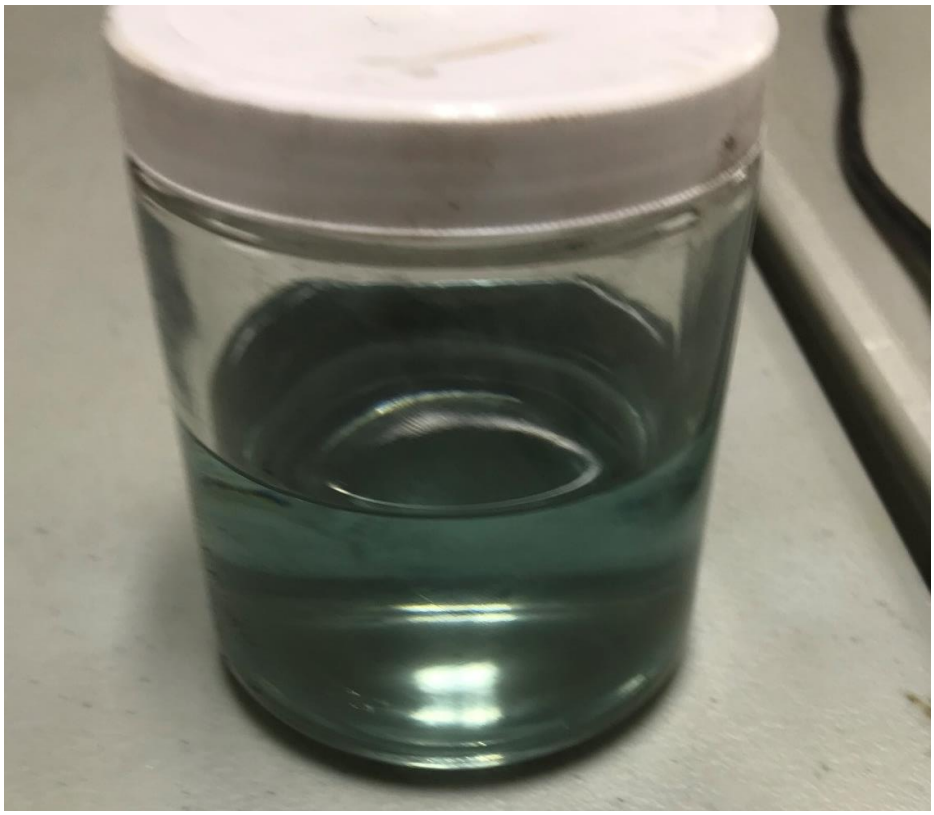

Figure 34 Fuel sample from #3 tank

Runway Lighting Parts

Near the tip of the right wing, between the buildings, a portion of the runway approach lighting was found (Figure 35). There were many damaged approach lighting support posts and crossbars (Figures 36, 37)

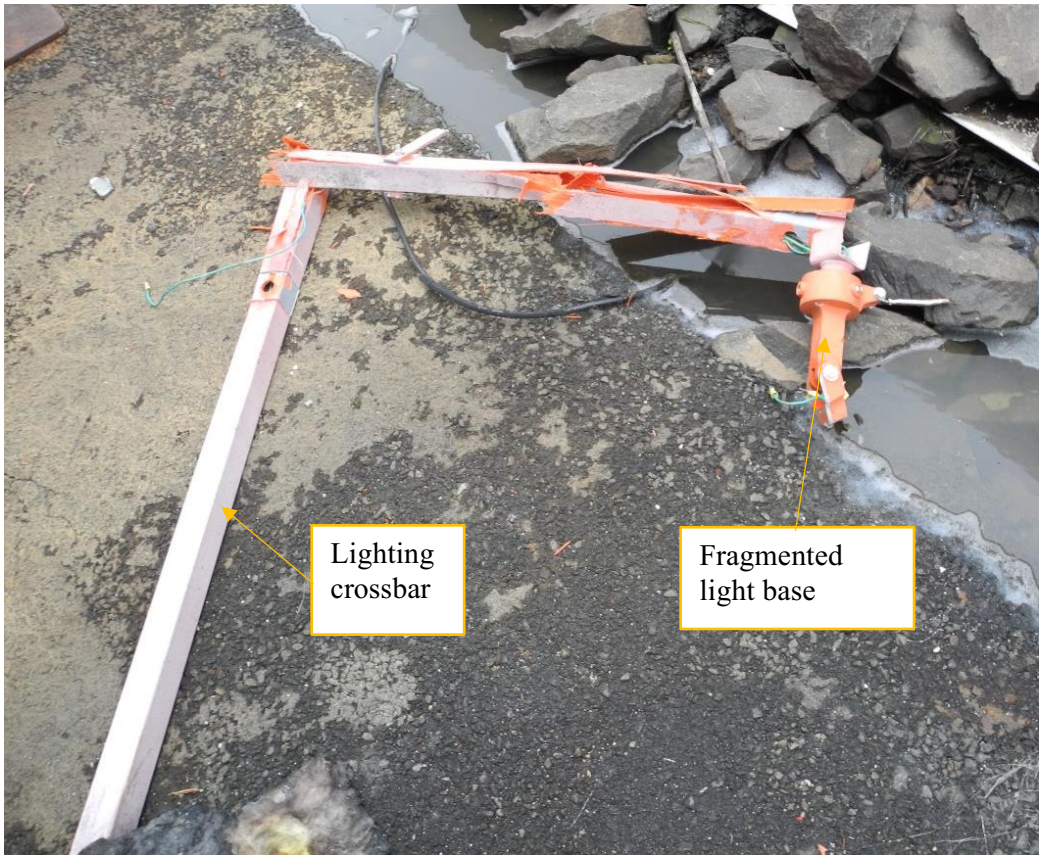

Figure 35 Approach lighting structure found near right wing tip

Figure 36 Damaged approach lighting

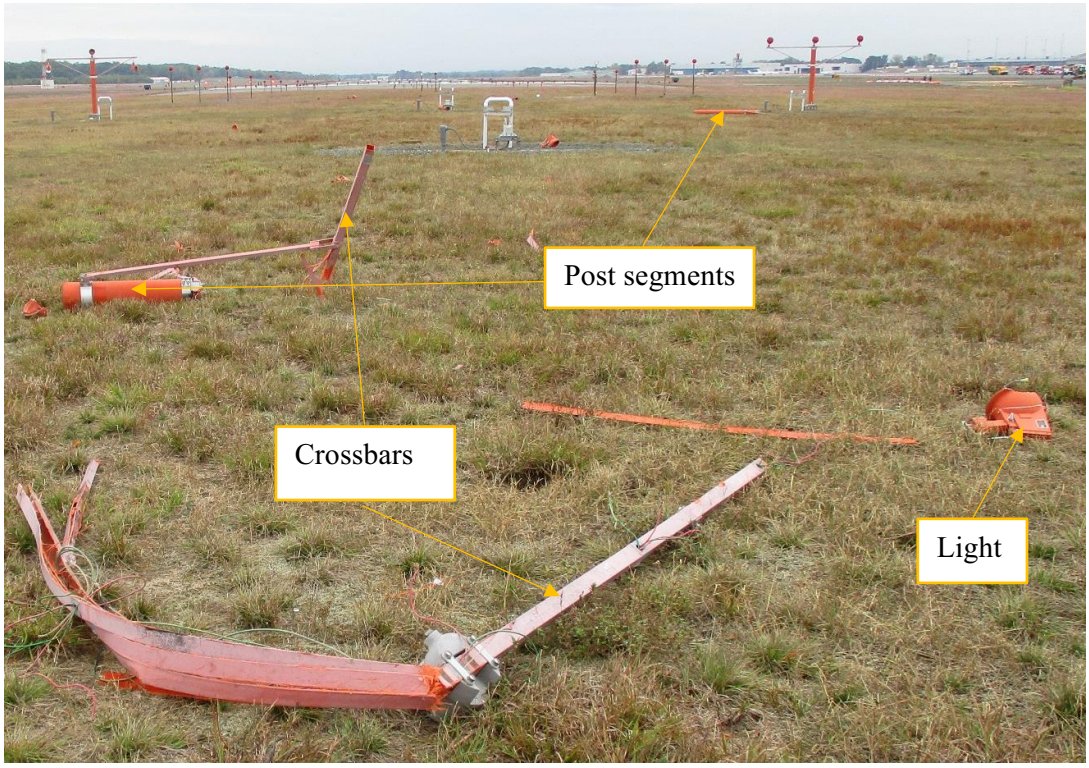

Figure 37 Damaged approach lighting

Engines

The airplane had four Curtis-Wright R-1820-97 engines with Hamilton Standard propellers 23E50, which has three blades. Figure 1 showed the approximate location of the engines in the wreckage. According to Collings engine logbooks the following engines were installed:

Engine 1
SN 46465
Installed Feb 21, 2019

This engine was found detached from the nacelle and it came to rest between the two deicing trucks (Figure 38). The propeller remained attached to the engine and all three propeller blades were in place on the hub. Two of the propeller blades were intact but deformed (Figure 39). One of the propeller blades was fractured at the tip, and the tip was found approximately 700 feet away (Figure 40). The data plate showed the serial number (Figure 41).

Figure 38 Engine #1


Figure 39 Engine #1 after moving by excavator

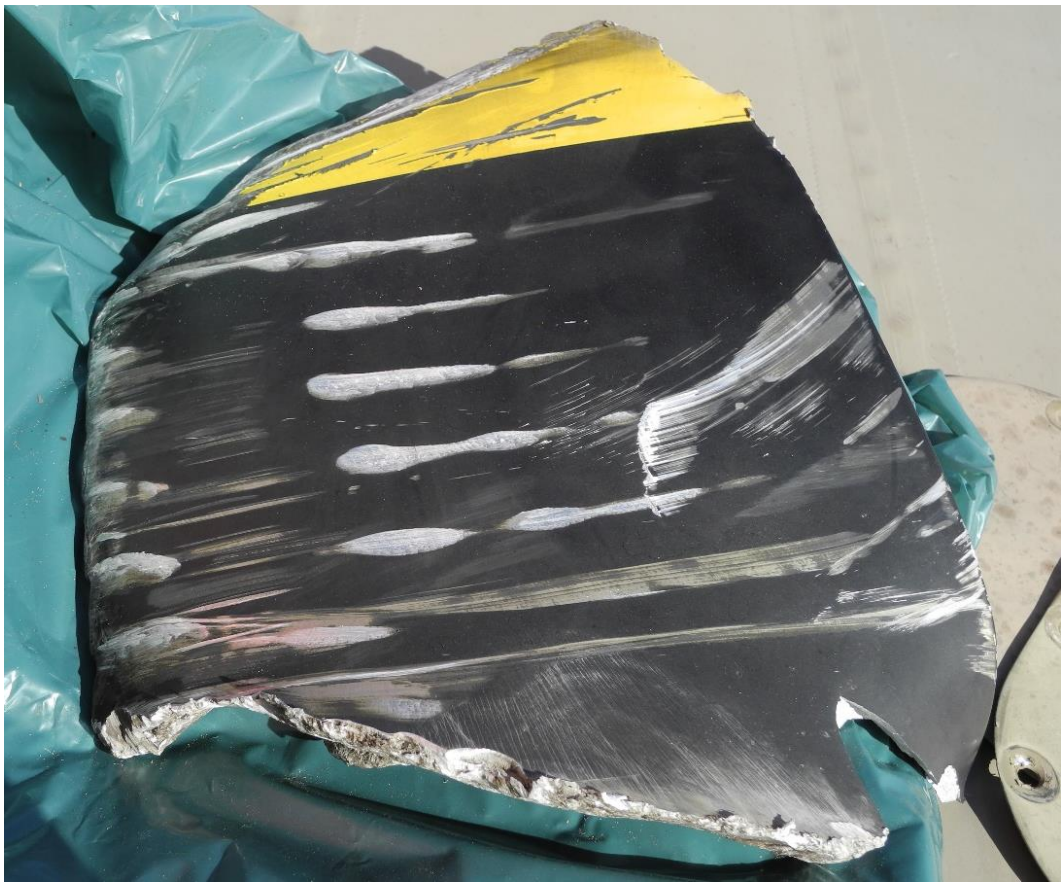

Figure 40 Fractured blade tip

Figure 41 Engine #1 data plate

Engine 2
SN 130945
Installed Jan 16, 2019

This engine was detached from the nacelle and situated between a deicing truck and the wing (Figure 42). The propeller remained attached to the engine and all three propeller blades were in place on the hub. All three of the propeller blades were intact but deformed (Figure 43). The data plate showed the serial number (Figure 44).

Figure 42 Engine #2

Figure 43 Engine #2 after moving

Figure 44 Engine #2 data plate

Engine 3
SN 041978
Installed Jan 15, 2019

This engine was found on top of a glycol tank (Figure 45). The propeller remained attached to the engine and all three propeller blades were in place on the hub. The tank was punctured by the propeller (see UAS Aerial Imagery factual report, Figure 17). The propeller dome was observed to be detached before removal from the tank. The engine was lifted off the tank by an excavator. The propeller without the soot on the tip was inside the tank. Two of the propeller blades, the one that penetrated the tank and one of the blades that was outside of the tank, were intact but deformed (Figure 46). The other propeller blade that remained outside of the tank had the tip fractured, two fragments were found (Figure 47), one found near the other fractured tip from engine #1 (approximately 700 ft from wreckage) and one was found approximately 100 feet from the main wreckage in the direction of the other fragments. The data plate showed the serial number (Figure 48).

Figure 45 Engine #3 on top of glycol tank

Figure 46 Engine #3 after recovery from tank

Figure 47 Fractured #3 Engine propeller tip (two pieces)

Figure 48 Engine #3 data plate

Engine 4
SN 156819
Installed Jan 16, 2019

The engine was found separated from the nacelle and came to rest in a nearby building (Figure 49). The propeller remained attached to the engine and all three propeller blades were in place on the hub. The magnetos were in place on the back of the engine (Figures 50,51). The data plate showed the serial number (Figure 52).

Figure 49 Engine #4

Figure 50 Engine #4 propellers

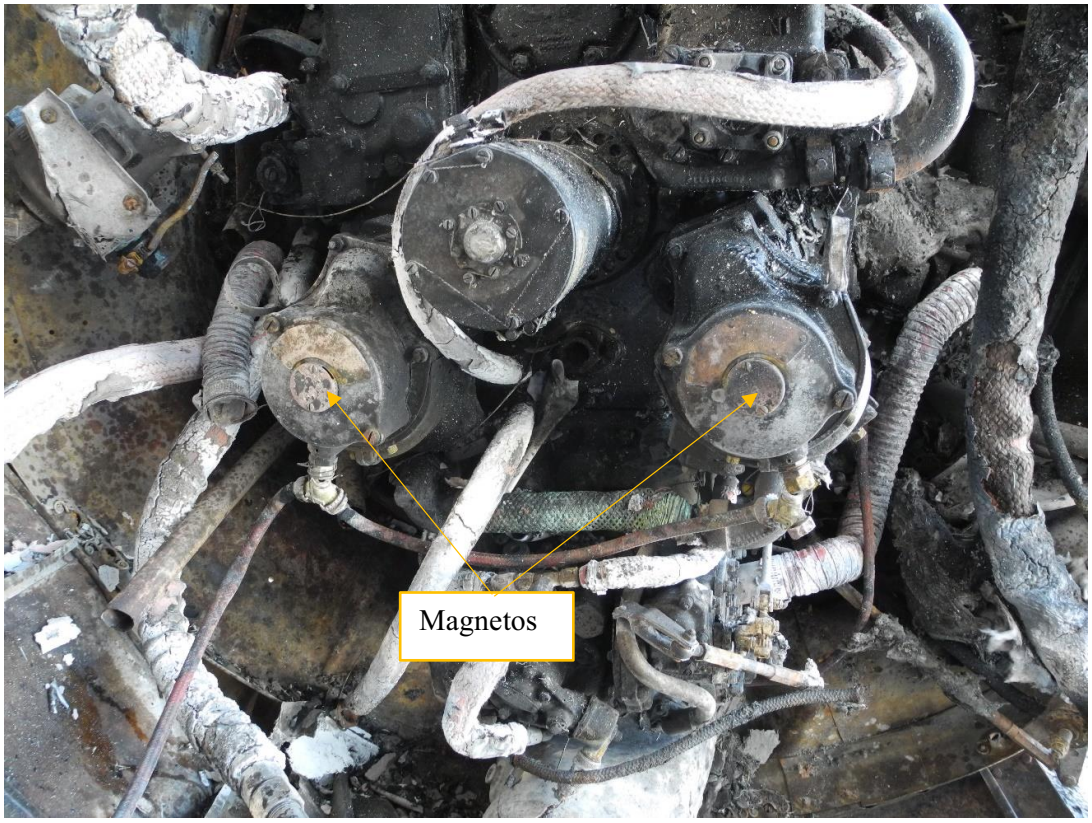

Figure 51 Engine #4 magnetos

Figure 52 Engine #4 data plate