



Memorandum For Record

Timothy W. Monville
Sr. Air Safety Investigator
Eastern Region

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Examination of the accident site revealed parallel impact marks on the grass immediately adjacent to the northern most lane of the three-lane highway 85 South. The marks which were about 9.4 ft apart were oriented on a magnetic heading of 172° and were nearly perpendicular to the highway in that area. The center point between them was located at 35.77398261° north latitude and -080.3158019° degrees west longitude, or about 1,930 ft and 238° straight line distance and direction from the departure end of runway 24¹. The marks were associated with the initial ground impact location.

The main wreckage consisting of the cockpit, cabin, full span of the right wing and attached section of left wing from the wing root to the engine nacelle was located at 35.773760° north latitude and -080.317098° west longitude. That portion of the wreckage was upright on a magnetic heading of 213° and was located about 394 ft and 257° from the initial ground impact location. A tractor trailer that was impacted by the airplane was resting on its left side immediately adjacent to the main wreckage. Boxes from the truck were scattered on the ground near the truck.

Examination of the flight controls revealed no evidence of preimpact failure or malfunction of the primary or secondary controls. The left and right flap actuators were extended 2.25 inches and 2.0 inches, respectively, which equated to flaps retracted. The left and right elevator trim tab actuators were extended 1.3 inches and 1.6 inches, respectfully, which equated to 15° tab trailing edge down, and 27° tab trailing edge down². The rudder trim tab actuator was extended about 4.6 inches which equated to 25° tab trailing edge left³. The aileron trim actuator was extended 1.4 inches, which equated to 2° tab trailing edge up.

The landing gear doors were observed closed. The landing gear actuator drive rods and the landing gear trunnions were in the retracted position.

¹ The straight-line distance and direction does not depict the flight path of the airplane during the accident flight.

² According to the Airplane Type Certificate Data Sheet, the maximum down deflection is 23°.

³ According to the Airplane Type Certificate Data Sheet, the maximum left and right deflection is 25°.

Each fuel selector was positioned to its respective tank. The fuel supply system on each engine sustained thermal damage which consumed portions of the hoses and aluminum lines. The fuel supply line and hose nuts that remained attached to the associated fittings throughout the fuel system were secured. Both fuel boost pumps sustained thermal damage and were not tested.

LEFT ENGINE AND PROPELLER OBSERVATIONS

Examination of the left engine, Continental IO-520-C(5) CCB, serial number 243832R, which was separated from the airframe revealed it sustained extensive heat and impact damage. The propeller remained attached to the crankshaft flange. Borescope examination of each cylinder was performed without moving the propeller⁴. That inspection revealed no failure of any piston. Crankshaft, camshaft, and valve train continuity, and thumb suction and compression were confirmed for each cylinder during multiple 360° rotations of the crankshaft. The exhaust and induction systems exhibited impact and heat damage.

Examination of the ignition system revealed one magneto was separated from the engine while the other remained attached by the ignition leads which sustained extensive impact and heat damage.

Examination of the spark plugs revealed⁵:

No. 1 T – The ignition lead remained connected at both ends and was tightly secured at both ends. The plug was black and normal wear.

No. 1 B – The plug came out with the ignition lead. The ignition lead was tightly installed at the spark plug was slightly tight. The plug was black and normal wear.

No. 3 T – The ignition lead remained connected at both ends and the ignition lead was tightly secured at the spark plug. The plug was black and normal wear.

No. 3 B – The ignition lead remained connected at both ends and was tightly secured at both ends. The plug was black and normal wear.

No. 5 T – The plug came out with the ignition lead, which was also connected to the magneto. The spark plug was bent and was light brown in color and normal wear.

No. 5 B – The plug came out with the ignition lead. The ignition lead was tightly secured to the spark plug but the ignition lead was damaged. The plug was brown in color and normal wear.

No. 2 T – The plug was broken. It was black and normal wear.

No. 2 B – The ignition lead was tight, but the spark plug was finger tight. The plug was dark color and normal wear.

No. 4 T – The ignition lead was finger tight and the spark plug was tight. The ignition lead was broken. The spark plug was brown in color and normal wear.

No. 4 B – The plug came out with the ignition lead. The plug was slightly tight and the ignition lead was tight. The plug was dark in color and normal wear.

No. 6 T – The plug was broken and exhibited dark color and normal wear.

No. 6 B – The plug came out with the ignition lead. The spark plug was slightly tight and the ignition lead was tightly attached to the ignition lead. The spark plug exhibited dark color and normal wear.

⁴ The inspection documented the pistons.

⁵ The plug manufacture and model could not be determined.

Examination of the engine fuel system components revealed:

No. 2 Fuel Injector Nozzle – The fuel injector line and injector nozzle were loose. The nozzle was bent. Free of obstructions.

No. 4 Fuel Injector Nozzle – The fuel injector line and injector nozzle were tight. The nozzle was free of obstructions.

No. 6 Fuel Injector Nozzle – The fuel injector line was tight and injector nozzle was finger tight. The nozzle was bent. Free of obstructions.

No. 1 Fuel Injector Nozzle – The fuel injector line and injector nozzle were tight. The nozzle was free of obstructions.

No. 3 Fuel Injector Nozzle – The injector nozzle remained attached to the injector line, but the nozzle was separated from the cylinder. The threads of the nozzle and cylinder were not damaged. The threads of the nozzle and cylinder were coated in soot along their full length.

No. 5 Fuel Injector Nozzle – The fuel injector line and injector nozzle were tight. The nozzle was free of obstructions.

Examination of the manifold valve part number 631427-2A10, serial number D148920CR revealed the cover was safety wired. Following removal of the cover, the screen was clean, and no fuel was noted inside. The diaphragm and spring were intact. The forward hose attached to the manifold valve was not associated with the fuel flow transmitter but did have a restrictor fitting installed⁶. The B-nut was tight.

Examination of the mechanical fuel pump which remained attached to the engine revealed the drive coupling was intact. Impact damage to the pump precluded operational testing. The adjustment bolt was bent. The diaphragm was not damaged. No fuel or contaminants were noted inside. The rotor and vanes were intact.

Examination of the throttle body and fuel metering valve which remained in the engine nacelle revealed it exhibited slight heat damage. The throttle valve was 3/4 closed. The inlet screen was clean. The throttle lever was impact damaged. Sections of throttle and mixture control cables remained attached to their respective levers at the fuel metering valve. The positions of the throttle and mixture settings were not reliable due to the separated cables. The throttle lever was tightly secured to the throttle shaft. Movement of the throttle lever resulted in movement of the throttle plate.

Examination of the engine lubrication system revealed no evidence of preimpact failure or malfunction of the lubrication system. Disassembly inspection of the oil pump revealed both gears were ok. The oil filter was impact separated and damaged which precluded using the normal metal blade to extract the filter media. The filter housing was cut open using a metal cutting wheel near the base of the filter. Inspection of the filter element revealed no contamination. The oil sump was heavy impact damaged.

Examination of the propeller governor which remained attached to the engine revealed a section of control cable remained attached. The position of the control head was not documented

⁶ This hose was associated with the original fuel pressure gauge in the cockpit.

because of separation of the engine from the airframe. The governor was heat damaged, and the screen was clean. The control arm did move, and the return spring was loose (likely from the heat). While moving the control head arm in the area where feathering would occur, with further movement of the arm towards feather, the spool valve was lifted up (normal).

Examination of the left propeller revealed both propeller blades as first viewed were bent forward in the thrust direction consistent with developing power. The propeller blades were examined for impact marks and the following was noted for each blade.

L1 – SN D62389. Chordwise rotational scoring was noted on the cambered side of the blade near the blade tip and also on the blade face on the outboard 14 inches. Nicks/dents were noted on the leading edge. The blade was bent forward in the thrust direction about 30°. There was no remarkable leading edge twisting - or bending opposite the direction of rotation. The bearing races appeared OK. The pitch change block was broken. Marks were noted on the trailing edge blade shank caused by impact with the propeller hub.

L2 – SN D76328. The blade exhibited remarkable bending opposite the direction of rotation in the lead to trail axis, which was consistent with developing power, was twisted towards high pitch, and was bent forward in the thrust direction. The blade bearing races appeared OK, and the hub side bearing races exhibited mild corrosion. The leading edge exhibited rough damage. Marks were noted on the trailing edge blade shank caused by impact with the propeller hub. The damage to the blade was consistent with the propeller rotating with power and developing thrust.

The start locks were engaged but the start lock tower was fractured from the missing section of the cylinder. The start lock sleeve was removed and the start lock flyweight screws were damaged and prevented smooth operation of the flyweights. The pitch change rod was bent forward of the piston.

The preload plates for both propeller blades were examined for impact marks to determine blade angle at impact.

L1- There was a heavy impact mark in the feather range and also two impact marks in the low pitch range. The feather range mark was excluded after concluding it was an impact sequence mark, and two impact marks were noted in the low pitch range. One impact mark was noted at 21° forward of the split line, which resulted in a blade angle of 29°, while the other impact mark measured 34° forward of the split line, which resulted in a blade angle of 16°.

L2- There were 2 marks in the low pitch range. One mark was noted at 21° forward of the split line, which resulted in a blade angle of 29°, while the other impact mark measured 36° forward of the split line, which resulted in a blade angle of 14°.

RIGHT ENGINE AND PROPELLER OBSERVATIONS

Examination of the right engine, Continental IO-520-C(5) CCB, serial number 240627R, which was separated from the airframe revealed the propeller remained attached to the crankshaft

flange. Borescope examination of each cylinder was performed without moving the propeller⁷. That inspection revealed no failure of any valve or hole in any piston. Crankshaft, camshaft, and valve train continuity, and thumb suction and compression were confirmed for each cylinder during multiple 360° rotations of the crankshaft. During inspection of the cylinder exterior before removal, a white arching mark was noted on the No. 5 cylinder emanating from the base of the fuel injector nozzle. Following powertrain continuity check, each cylinder was removed.

Following removal of the No. 1 cylinder, damage was noted to the aft side of the piston (as installed) near the chamfered edge. The exhaust and induction systems exhibited extensive impact damage. Other than crushing of the exhaust, there were no obstructions noted.

Examination of the air induction system for the right side cylinders (1, 3, and 5) revealed the balance tube at the front of the engine was crushed against the oil sump. All cylinder induction tubes remained attached by the flex couplings. The No. 5 cylinder induction was crushed up at the bottom and was fractured near the cylinder attach. The bottom of the No. 3 cylinder induction pipe was crushed up and the induction tubes for the Nos. 1 and 3 cylinders were fractured near the cylinder attach. Examination of the No. 1 cylinder air induction system revealed the boot connecting the induction tubes of the Nos. 1 and 3 cylinders remained in place at both cylinders though the clamp closest to the No. 1 cylinder was displaced. A boot remained attached to the aft end of the No. 1 cylinder air induction tube by a single clamp, but the tube that connected the right bank of cylinders to the throttle body and metering valve was separated.

Examination of the ignition system revealed both magnetos were separated from the engine. Extensive impact damage was noted to the ignition leads. The right magneto was identified by the data plate and maintenance records. Inspection of the impact separated magneto revealed the cover and distributor block were impact separated and not recovered. The impulse coupling felt good. The rotor was in place. There were no missing teeth of either phenolic gear, and the coil tab was bent down.

Examination of the No. 1 cylinder top ignition lead revealed it was fractured about 9 inches from the ignition lead nut. The bottom ignition lead of the No. 1 cylinder was continuous from the spark plug to the magneto cap which was broken. The lead was damaged to the conductor in several areas. One area of the lead within close proximity to a clamp and about 2 inches from the nut at the spark plug was chafed.

Examination of the spark plugs revealed:

No. 1 T – The ignition lead was tightly installed on the spark plug which was minimally snug. Tempest URHB32E. Black color. Normal wear.

No. 1 B – The ignition lead and plug were tightly installed. Black color, normal wear. Tempest URHB32E.

No. 3 T – The ignition lead was tightly installed on the spark plug. Champion RHB32E. Black color. Normal Wear.

No. 3 B – The ignition lead and plug were tightly installed. Black color, normal wear. No lead. Champion RHB32E.

⁷ The inspection documented the piston, followed by the exhaust valve then intake valve for each cylinder.

No. 5 T – The ignition lead was tightly installed on the spark plug. Champion RHB32E. Base of plug corroded. Black color. Normal appearance.

No. 5 B - The ignition lead and plug were tightly installed. Black color, normal wear. No lead. Champion RHB32E.

No. 2 T – Plug broken, finger tight. Ignition lead connected to broken section of plug. Black color. Normal wear. Champion RHB32E

No. 2 B – The ignition lead and plug came out as unit. Ignition lead tight spark plug finger loose. Black color, normal wear. Some lead. Champion RHB32E.

No. 4 T – Plug ceramic and ignition lead broken. Plug bent. Black color, normal wear. Plug finger tight. Champion RHB32E

No. 4 B – The ignition lead was tight but the spark plug was finger loose. Black color, normal wear. No lead. Champion RHB32E.

No. 6 T – Plug removed when loosening ignition lead. Ignition lead broken. Plug bent and ceramic insulator broken. Black color, normal wear. Champion RHB32E

No. 6 B – The ignition lead and plug came out as unit. The ignition lead was tight. Black color, normal wear. No lead. Champion RHB32E.

Following examination of the spark plugs, the No. 1 cylinder top and bottom spark plugs were tested at 80 psi in a spark plug tester, and both produced strong blue spark.

Examination of the cylinders revealed the following:

No. 1 – Piston was damaged on the aft side near the chamfered edge. The Nos. 1 and 2 compression rings gaps were about 60° apart. Some scoring was noted on the cylinder wall.⁸

No. 3 – The exhaust valve depicted an appearance like it was sand blasted. The Nos. 1 and 2 compression rings gaps were about 30° apart. The No. 2 compression ring and the oil control ring gaps were nearly aligned.

No. 5 - The Nos. 1 and 2 compression rings gaps were nearly aligned.⁹

No. 2 - The Nos. 1 and 2 compression rings gaps were nearly aligned.

No. 4 - The Nos. 1 and 2 compression rings gaps were nearly aligned.

No. 6 - The Nos. 1 and 2 compression rings gaps were about 40° apart.

Examination of the engine fuel system components revealed:

No. 2 Fuel Injector Nozzle – Injector Line loose at nozzle. Line broken. Nozzle bent. GA173. Free of obstructions.

No. 4 Fuel Injector Nozzle – Injector Line finger loose at nozzle. Line broken. Nozzle bent. Black color. Free of obstructions. GM 156.

No. 6 Fuel Injector Nozzle – Wrench tight. Injector bent and broken. Black. GF 147. Free of obstructions.

No. 1 Fuel Injector Nozzle – Injector Line Finger tight at nozzle. Nozzle wrench tight. GA 173. Free of obstructions.

No. 3 Fuel Injector Nozzle – Still connect by injector line at manifold valve. The line was finger tight and the nozzle was wrench tight. GM 156. Free of obstructions.

⁸ The cylinder, piston, and piston pin were retained for examination by the NTSB Materials Laboratory.

⁹ The cylinder and piston were retained for examination by the NTSB Materials Laboratory.

No. 5 Fuel Injector Nozzle – Still connect by injector line at manifold valve. Line finger tight at nozzle. Nozzle loose. GF 147. Free of obstructions.

Examination of the manifold valve part number 631427 serial number A128309RC revealed the cover was safety wired. All 4 screws were finger tight. No washers were noted under the screws. No fuel was inside the valve. The screen was clean, and the diaphragm and spring were ok. The fuel injector line for the No. 1 cylinder was filled with 100 low lead aviation fuel and no obstructions were noted; the fuel flowed freely.

Examination of the engine-driven fuel pump which was impact separated from the engine revealed the drive coupling was not recovered. The adjustment bolt was bent. The diaphragm was not damaged. No fuel or contaminants were noted inside. The rotor and vanes were intact. The pump was disassembled and no preimpact failure or malfunction was noted. The disassembled engine-driven fuel pump was sent to Continental Aerospace Technologies (CAT) for operational testing which revealed that following replacement of impact damaged components but leaving the original adjustment the same, at 2,600 pump rpm the pump discharge pressure was 15.69 psig, or about 47% greater than the maximum specified limit.

Examination of the throttle body and fuel metering valve which remained in the engine nacelle revealed it exhibited extensive heat damage, including to the boots that connected it to an elbow. The inlet screen did not contain contaminants. The throttle lever was impact damaged. The throttle plate was full open. Sections of the mixture and throttle control cables remained attached. Movement of the throttle control lever did not result in movement of the throttle plate. The throttle lever was tightly secured to the lever. Following removal of the lever, the serrations of the shaft were found to have brass material consistent with the lever. Heat damage to the assembly precluded operational testing.

Examination of the engine lubrication system revealed no evidence of preimpact failure or malfunction. Disassembly inspection of the oil pump revealed both gears were ok but some non-ferrous particles were noted. The oil filter was impact separated and damaged which precluded using the normal metal blade to extract the filter media. The filter housing was cut open using a metal cutting wheel near the base of the filter. Inspection of the filter element revealed very slight non-ferrous contamination. The oil sump was heavily impact damaged. Following removal of the sump, a part of the oil quick drain was found.

Visual examination of the right propeller, BHC-J2YF-2CUF, SN DZ42, revealed both blades were near feather. Using a fabricated blade paddle, one blade was rotated from feather to low pitch and the other blade moved in concert in the proper direction, indicating the internal pitch change mechanism was intact. One blade exhibited chordwise static scoring on the blade face at the tip, while the other blade exhibited slight aft bending.

Examination of the propeller governor which remained attached to the engine revealed it rotated freely. The screen was clean. Some non-ferrous particles were noted in the oil that flowed from the pump during rotation of it. The position of the control head was not documented because of separation of the engine from the airframe.