



NATIONAL TRANSPORTATION SAFETY BOARD

**Office of Aviation Safety
Western Pacific Region**

FOLLOW-UP AIRFRAME & ENGINE EXAMINATION

**NTSB Accident: WPR18FA251
Accident Date: September 4, 2018**

Examination Date: October 24, 2018

This document contains 27 embedded images

A. ACCIDENT

Location: Palo Alto, California
Date: September 4, 2018
Aircraft: Mooney M20J, N701JM, Serial # 24-3281
NTSB IIC: Michael Huhn

B. EXAMINATION PARTICIPANTS:

Michael Huhn	Mark Platt
Air Safety Investigator	Air Safety Investigator
National Transportation Safety Board	Lycoming Engines
Federal Way, WA	Williamsport, Pennsylvania

C. EXAMINATION SUMMARY

The accident occurred on September 4, 2018, and a partial examination of the wreckage was conducted on scene. The wreckage was recovered the day after the accident,, and transported to a secure facility in Sacramento, California.

The engine and selected airframe components/systems were examined in detail at the recovery facility on October 24, 2018.

No evidence of any pre-impact mechanical failures or deficiencies that would have affected normal operation or continued flight was observed.

D. AIRFRAME INFORMATION

1.0 Wing Flap System

- The two wing flaps (one per wing) are electrically operated and interconnected through push-pull tubes and bellcranks
- A jackscrew-type electro-mechanical flap actuator is located in the fuselage approximately adjacent to the left flap
- Flap position is controlled by a pre-select switch on the lower control console
- A cable attached to the flap jackscrew operates the cockpit flap position indicator
- Both flaps were found in their fully retracted positions, and unable to be moved
 - All mechanical flap linkages and their attachments were intact
- Per the POH, nominal flap travel is from 0° to 33°, and is controlled by limit switches
 - Takeoff flap setting is 15°
 - Landing flap setting is fully extended (33°)
- The POH states that deploying flaps will result in an airplane nose down pitch moment, and retracting the flaps will result in an airplane nose up pitching moment

2.0 Stall Warning System

- The stall warning system (SWS) consisted of three primary components, plus associated system wiring
 - Wing-mounted vane and switch assembly
 - Cockpit-mounted circuit breaker
 - Cockpit warning horn
- System wiring continuity/integrity was not able to be completely evaluated
 - All connections were determined to be secure
 - All sections of wiring that were observed were intact
 - No indications of arcing or other non-impact damage were observed
- The 1A circuit breaker had not 'popped'
 - The CB was intact in its mount
 - Its connections were secure
 - The CB was able to be physically cycled without difficulty
 - Its electrical functionality was not checked
- The SWS horn was securely mounted in its installed position
 - This location was in the overhead panel approximately adjacent to the left seat occupant's right ear
 - The wiring was securely attached, and showed no indications of arcing or other damage
 - The horn was a Mallory brand 'Sonalert' Model SC628 8941-1
 - The horn functioned/sounded normally upon application of 24vdc
 - Tone was loud and constant
- The SWS vane and switch assembly remained securely mounted in the LE of the left wing
 - It appeared undamaged
 - It could be moved easily/freely with light finger pressure
 - The wing access panel for the vane was affixed by blind rivets
- The vane and switch assembly was removed from the wing
 - Its wiring was securely attached and undamaged
 - The vane/switch operated normally with regard to making/breaking the electrical circuit
 - The vane calibration was not determined



Figure 1 - SWS Circuit Breaker



Figure 2 - SWS Horn (in situ)

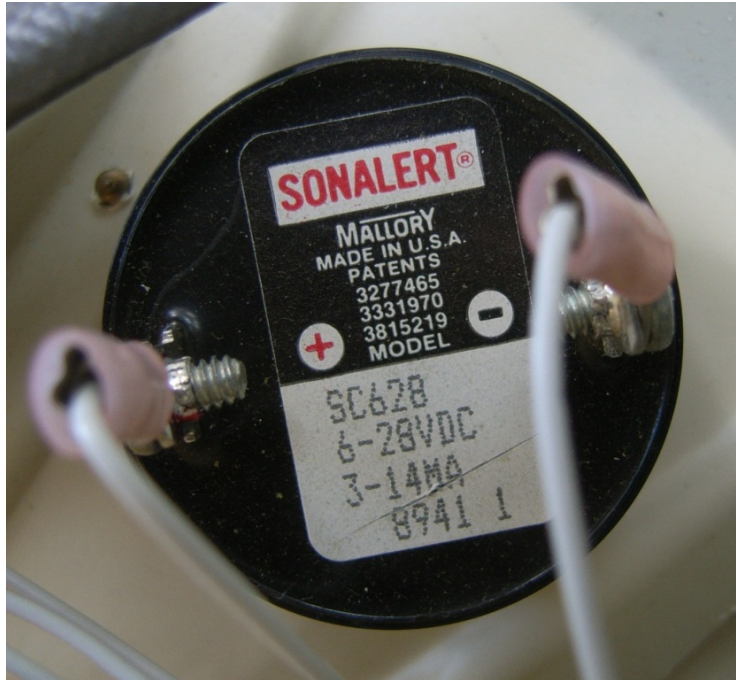


Figure 3 - SWS Horn (back)



Figure 4 - SWS Vane (in situ)



Figure 5 - SWS Vane & Switch Assembly

3.0 Pitch Trim Information

- The pitch trim mechanism for this airplane was a pivoting empennage which consisted of an attach hinge assembly and an actuating jackscrew
- The jackscrew was electrically controlled and actuated
 - The pitch trim was also able to be operated via a manual cockpit trim wheel
- The cockpit was equipped with a pitch trim setting indicator, situated on the center pedestal below the main instrument
- The empennage access panels and jackscrew flexible boot were removed to obtain physical and visual access to the jackscrew
- The jackscrew was observed to be extended to the position where 5 full threads were exposed
 - This was measured to be approximately 1 1/4 inches (from the actuator aft face to the centerline of the jackscrew attach bolt on the empennage), but access limitations prevented an exact measurement
- Per a Mooney Aircraft representative, the following are the correlations between jackscrew extension and airplane pitch trim setting:
 - 16 threads – Full airplane nose up (ANU)
 - 7 threads – Normal takeoff setting (approx. 1 1/4 inch extension)
 - 0 threads – Full AND
- Based on these values, the airplane pitch trim was found slightly AND from the normal T/O setting
- The cockpit trim position indicator also depicted a setting AND from the normal T/O setting
- The hinge angles were measured as a backup means for determining pitch trim setting
 - Those values were not compared to any manufacturer's values
 - It is undetermined whether Mooney has such data

- o See Figure 6 for values (below)

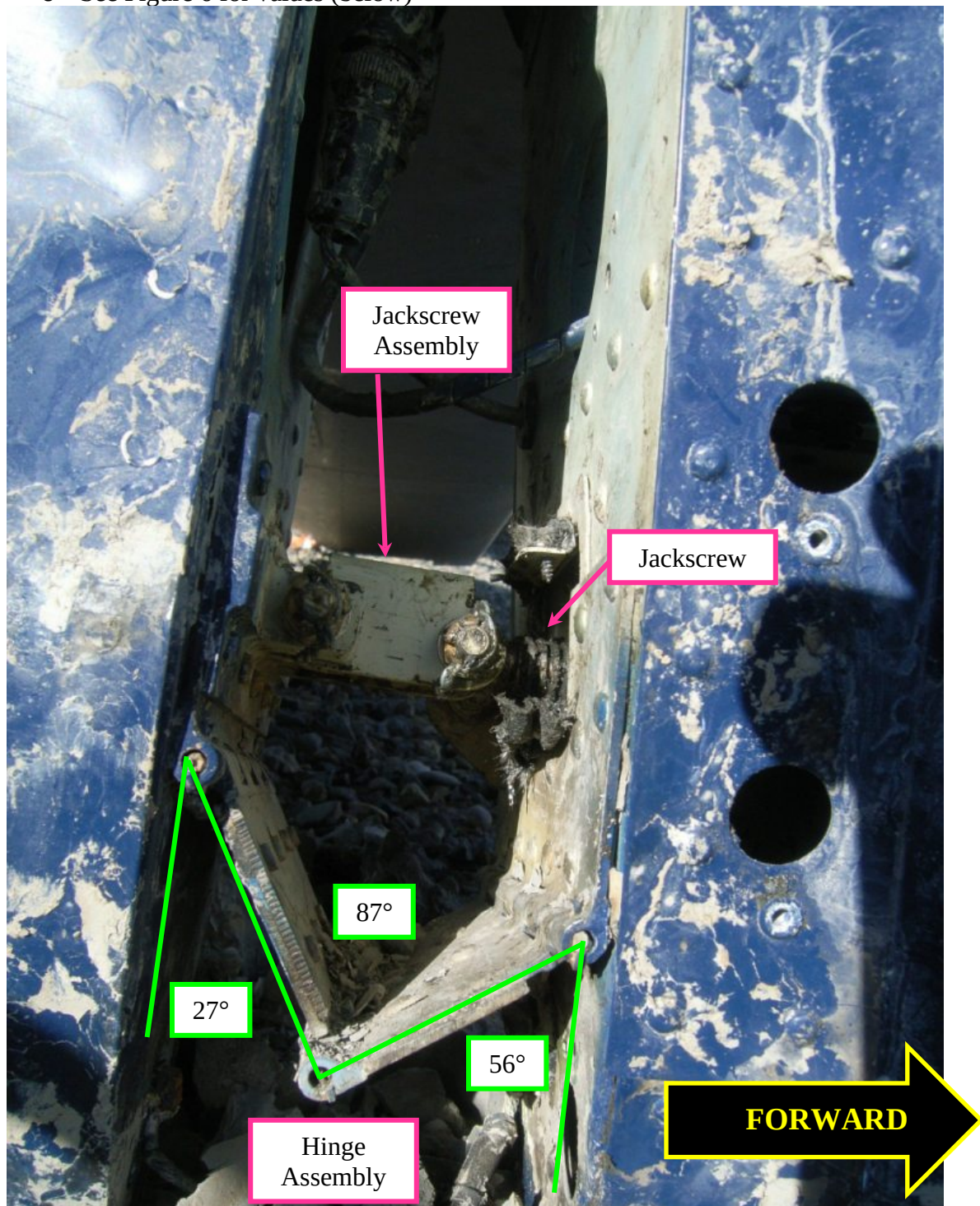


Figure 6 - Pitch Trim Hinge and Jackscrew Assemblies



Figure 7 - Pitch Trim Jackscrew



Figure 8 - Pitch Trim & Flap Cockpit Indicators

4.0 Fuel System Information

- The airplane was equipped with one integral fuel tank per wing
- The 3-position (OFF, LEFT, RIGHT) fuel selector valve cockpit handle was found set to the RIGHT tank
 - The handle was unable to be rotated
- The caps were present and securely attached
 - The left cap operated easily and correctly
 - The right cap was stiffer in operation; this was assumed to be a result of impact and exposure effects
- No tank/wing deformation or breaches were observed
- Both tanks were empty on the date of this examination
 - Both retained the odor of avgas
- The recovery facility personnel reported the following fuel quantities were recovered
 - Left wing: 17 gallons
 - Right wing: One cup fuel, plus one cup water
- About 1 quart of clean water was poured into the right tank as a test
 - The water was soon observed to be running freely from the damaged right wing sump drain near the fuselage juncture
- The main fuel strainer was not examined, due to access limitations as a result of airplane damage



Figure 9 - Fuel Selector

E. ENGINE INFORMATION

Engine:	Engine Information
	Experimental Engine ☐ Yes ☒ No
Model Number:	IO-360-A3B6D
Serial Number:	L-26018-51A
Total Time:	unknown Hours Since Field O/H
Crankshaft S/N:	unknown
Case Match #:	5131

There was no Lycoming Engines travel to the accident site. The airplane was removed from the site and transported to the facilities of Faeth Aircraft, Sacramento, California, where the Lycoming representative conducted his examination. The powerplant is a four cylinder, air cooled, direct drive, horizontally opposed, normally aspirated (fuel-injected), internal combustion engine rated at 200hp @ 2700rpm.

The engine and portions of the engine mount had been liberated from the airframe during the accident and recovery sequence. The engine had come to rest submerged in mud and silt. The engine sustained minor impact damage. Recovery personnel rinsed the engine off with fresh water. The engine exhibited external and internal corrosive signatures consistent with water immersion. Visual examination of the engine revealed no evidence of pre-impact catastrophic mechanical malfunction or fire.

The top spark plugs were removed, examined and photographed. Hand rotation of the crankshaft was attempted utilizing the propeller. Rotation of the crankshaft was precluded by the effects of internal corrosion within the cylinders and internal rotating components. The rocker covers were removed. The complete valve train within the rocker box areas appeared to be free of any pre-impact mechanical malfunction. The combustion chamber of each cylinder was examined through the spark plug holes utilizing a lighted borescope. The combustion chambers remained mechanically undamaged, and there was no evidence of foreign object ingestion. The valves were intact and undamaged. There was no evidence of valve to piston face contact observed. The gas path and combustion signatures observed at the spark plugs, combustion chambers, rocker boxes and exhaust system components displayed varying degrees of coloration due to the presence of water, mud, silt and organic material.

To facilitate further internal examination, holes were strategically drilled through the top of the engine case in-line with the rotational plane of each connecting rod. A lighted borescope was inserted to view the connecting rod, crankshaft and camlobes at the respective cylinder position. There was no evidence of lubrication deprivation or contamination observed. The crankshaft and connecting rods remained free of heat distress. There were no signatures or conditions observed consistent with any pre-impact catastrophic mechanical malfunction. The camshaft was intact and each of the camlobes exhibited their characteristic elliptical shape. The crankcase internal cavities exhibited the presence of water, mud, silt and organic material.

A lighted borescope was inserted into the accessory case at the magneto and fuel pump mounting pad holes to visualize internally. The accessory gears including the crankshaft gear, bolt and dowel were intact and remained undamaged by any pre-impact malfunction.



Figure 10 - Engine and Propeller



Figure 11 - Engine



Figure 12 - Engine Accessory End



Figure 13 - Engine Left Side



Figure 14 - Engine Right Side

Fuel System:

The fuel injection servo remained securely attached at the mounting pad of the plenum. The throttle/mixture controls were found securely attached to the servo at their respective control arms. The castellated nut and cotter pin remained secure and the serrated interface at the throttle and mixture arm remained securely mated. The plug on the side of the injector body was secure with the safety wire in place. The servo fuel inlet screen was found properly installed and free of contamination.

Approximately 1 ounce of fluid consistent with the appearance and odor of aviation fuel was drained from the fuel injection servo drain plug. A water test of the fuel sample was conducted using "Kolor-Kut" water finding paste with negative results.

The fuel injection servo and induction system were examined and observed to be free of obstruction. The paper filter element remained securely attached to the airbox bracket. The filter element remained intact and exhibited no evidence of pre-impact obstruction to airflow.

The fuel flow divider ('spider') remained secure at the mounting bracket situated at the top of the engine. The fuel lines remained secure at each flow divider fitting and fuel injector at each cylinder. The flow divider was disassembled. There was no evidence of pre-impact internal mechanical malfunction or obstruction to fuel flow. The diaphragm remained intact and undamaged.

The fuel injection nozzles remained secure at each cylinder with the respective fuel line attached. The nozzles were removed and examined. The number two cylinder nozzle appeared partially obstructed at the discharge end. Close examination determined that the material closely matched the organic material/mud/silt covering the engine. The remaining nozzles 1, 3, and 4 were unobstructed.

The bulk of the fuel pump was fracture-separated from the engine, while some of the mounting flange remained secure at the mounting pad. The fracture surfaces exhibited signatures consistent with overload. The fuel pump was opened for examination. The fuel pump remained free of internal mechanical malfunction and obstruction to flow. The diaphragm remained intact.



Figure 15 - Fuel Servo



Figure 16 - Fuel Screen and Fuel



Figure 17 - Manifold Fuel Distribution Valve

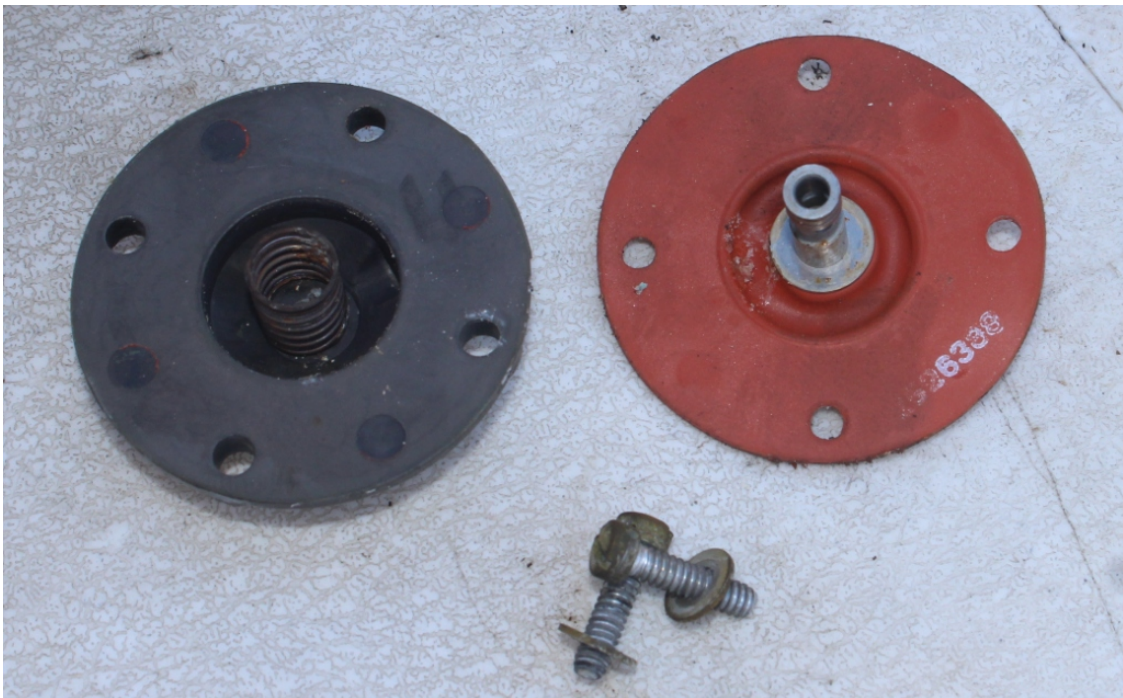


Figure 18 - Fuel Distribution Valve Diaphragm



Figure 19 - Fuel Pump Mounting Pad



Figure 20 - Disassembled Fuel Pump

Ignition System

Magnetos:

☐ Left ☒ Dual Magneto ☐ Electronic ☐ Destroyed			
Manufacturer:: TCM		Model: D4LN-3000	P/N: 10-682555-11 S/N: H059202G
Impulse Coupling? ☒ Yes ☐ No		Functioning? ☐ Yes ☐ No ☒ Unknown	
Timing Checked? ☐ Yes ☒ No		Results:	
Drive Secure? ☒ Yes ☐ No ☐ Unknown		Sparks at all leads ☐ Yes ☐ No ☒ Unknown	
Damage: Water emersion-corrosion-organic material			

The single-drive dual magneto was found securely clamped at the mounting pad. Magneto to engine timing could not be ascertained. The magneto cap was removed to expose the internal mechanism, contact assemblies, and gears. The magneto internal cavities exhibited the presence of water, mud, silt and organic material. The magneto was removed for further examination. The impulse coupler drive was observed to be intact and properly safetied. There were no mechanical disconnects or damage to any gear teeth. Due to the effects of water immersion and resulting corrosion the magneto drive could not be turned by hand.



Figure 21 - Dual Magneto

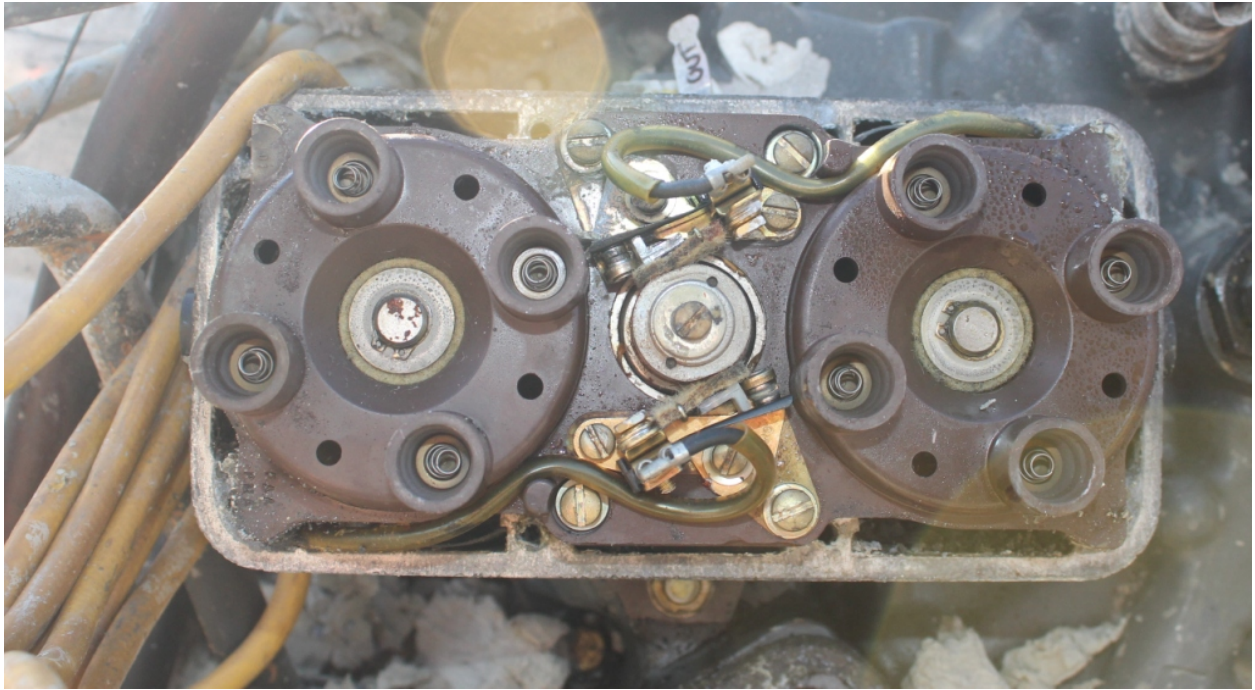


Figure 22 - Opened Magneto (base)



Figure 23 - Opened Magneto (cover)

Spark Plugs

Manufacturer: Champion		Type: RHM-38E		SI 1042 Approved? ☒ Yes ☐ No	
Spark Plug Condition (per Champion Aviation Check-A-Plug Card AV-27)					
1 Top	See Below	1 Bottom	See Below		
2 Top	See Below	2 Bottom	See Below		
3 Top	See Below	3 Bottom	See Below		
4 Top	See Below	4 Bottom	See Below		
5 Top		5 Bottom			
6 Top		6 Bottom			
7 Top		7 Bottom			
8 Top		8 Bottom			

Spark Plug Remarks:

The spark plugs were secure at each position with the lead attached. The spark plugs were removed, examined and photographed. The spark plug electrodes remained mechanically undamaged, and displayed varying degrees of corrosive effects due to the water immersion at the accident site. The spark plug electrodes were coated with varying degrees of mud, silt and organic material.

The ignition harness had sustained varying degrees of impact damage and was not tested. All ignition harness leads were attached at each magneto and respective spark plug.



Figure 24 - Top Spark Plugs

Vacuum Pump:

Manufacturer: Tempest	☐ Destroyed ☐ Unknown ☐ N/A
Part No: AA3215CC	Serial No.: N27475

Remarks:

The rear-mounted vacuum pump was secure at the mounting pad. The vacuum pump was not removed for examination.

Lubrication System:

Oil Suction Screen: Clean	Oil Pressure Screen: N/A
Oil Filter: Undetermined	Oil Cooler Integrity: Secure
Oil Cooler Hoses: Secure	

Oil System Remarks:

The oil filter was secure at the mounting pad and was not removed for examination. The oil suction screen was found secure and uncontaminated by any pre-mishap debris. There was no evidence observed of any pre-mishap lubrication system contamination found during the examination.

F. PROPELLER INFORMATION

The two-bladed, constant-speed, all-metal propeller remained attached at the crankshaft flange. The metal spinner was attached to the propeller and had sustained impact damage. The propeller blades remained attached to the propeller hub. The propeller blades displayed varying degrees of leading edge gouging, torsional twisting, chordwise striations across the cambered surface and trailing edge "S" bending. The signatures were consistent with the absorption of rotational forces applied at the crankshaft at the time of impact.



Figure 25 - S-bent Blade



Figure 26 - S-bent Blade



Figure 27 - Other Blade

Propeller Governor ☐ Rotorcraft ☐ N/A			
Manufacturer	Part Number		Serial Number
McCauley	C290D5-G/T17		920437
Governor Control Position: Destroyed		Gasket Screen Condition: Unobstructed	
Governor Oil Line:	Properly Secured?	☐ Yes ☐ No ☒ Unknown	☐ N/A
	Correct Line Nuts?	☐ Yes ☐ No ☒ Unknown	☐ N/A
	Correct Fittings?	☐ Yes ☐ No ☒ Unknown	☐ N/A

The propeller governor was securely attached at the mounting pad. The pitch control arm and attached control rod had been liberated from the governor. The governor was removed for examination. The drive was intact and free to rotate by hand. The gasket screen was free of visible contamination.