



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

AIRFRAME AND ENGINE EXAMINATION

WPR17FA146

Accident Date: July 8, 2017
Exam Dates: July 10, 2017

This document contains 48 embedded images

A. ACCIDENT

Location: Pt Mugu, CA
Date: July 8, 2017
Aircraft: Quicksilver Sport MX II, N2812, Serial # 1763
NTSB IIC: Michael Huhn

B. EXAMINATION PARTICIPANTS:

Michael Huhn
NTSB
Western Pacific Region

Ray Martin
FAA Airworthiness Inspector
Van Nuys, CA

C. SUMMARY

The aircraft ditched into the Pacific Ocean just offshore of Pt. Mugu about 1647 local time. Although it sank shortly thereafter, post accident photos of the aircraft depicted a highly intact aircraft. Sometime overnight, the aircraft washed ashore onto the rocky coast; the airplane and engine sustained severe damage due to the wave action, rocks, sand, and salt water. The aircraft was removed from the shore the morning of July 9, transported to the SKFC hangar, and rinsed with fresh water. Detailed examination of the engine, as well as some airframe components, was conducted by the NTSB at the hangar on July 10, 2017. No evidence of preimpact mechanical malfunction was noted during the examination, but it was determined that the ocean immersion and wave action obscured or destroyed a significant amount of evidence.



Figure 1 - Aircraft at Impact



Figure 2 - Submerged but Intact Aircraft

D. AIRFRAME

1.0 General

The aircraft was discovered the morning after the accident, situated on the rocks just above the waterline, consistent with it having been washed in during high tide and then caught on the rocks as the tide receded. The airframe sustained severe damage; when discovered it was a large mass of fractured tubing held together by some connectors, the wing cloth, and the numerous structural and control cables.



Figure 3 - Aircraft Washed Up On Shore

Some components (such as the instrument panel) were missing, and some (such as the seats, propeller, and fuel tank) sustained cracks or fracture-separated portions. The wing cloth was shredded, and the engine bore numerous impact marks on all exposed sides. Corrosion, and salt and sand infiltration, were nearly omnipresent.

Each of the three wheel assemblies remained attached to its respective axle, and all three tires remained inflated. The fuselage and wing structures lost all their shape due to the numerous fractures and bends of the structural tubing.

The wing cloth was removed, and structural and electric cables were cut or disconnected to gain access to the engine and other components of interest. The battery and ELT were removed from their respective mounting boxes.



Figure 4 - Aircraft Post-Recovery



Figure 5 - Aircraft Post Recovery

2.0 Flight and Engine Controls

The severe damage to the aircraft structure, combined with the recovery and initial examination efforts, precluded determination of flight control continuity; however this was mitigated by the fact that the pilot reported an engine power problem, as opposed to any flight control problems.

The rudder pedals and their mounting assembly were relatively intact. The control sticks were damaged and not examined.

Each pilot station was provided a separate throttle lever. The two levers were attached to each end of a transversely-mounted rod, outboard of each seat. The rod attached to the fuselage, and was free to rotate about the rod's central axis. A single throttle push-pull control cable attached to a fitting at the approximate lateral center of the throttle control rod. The throttle rod was partially fracture-separated from its fuselage pivot mount. Both throttles remained securely affixed to their respective ends of that rod. The throttle cable had been pulled from its rod connection, but its swaged end remained captive in the connector on the rod. The adjustable fitting for the throttle cable end adjacent to the throttle control rod remained securely attached to the fuselage tubing. The throttle mechanical stop arms remained securely attached to the rod. Their functionality/range could not be determined due to the damage to the aircraft.

Representatives of the operator reported that the occupant lap restraint belts could droop down between the seats if not properly secured and stowed, and thereby interfere with throttle control travel. Occupant egress and damage precluded determination of whether such a condition

occurred during the flight. In a separate email communication, the surviving pilot stated that "4 Point seat belt secured, adjusted and checked. Any excess strap after adjustment is tucked under the lap belt to keep from flapping in the wind."

The aircraft was not equipped with carburetor heat or mixture controls.

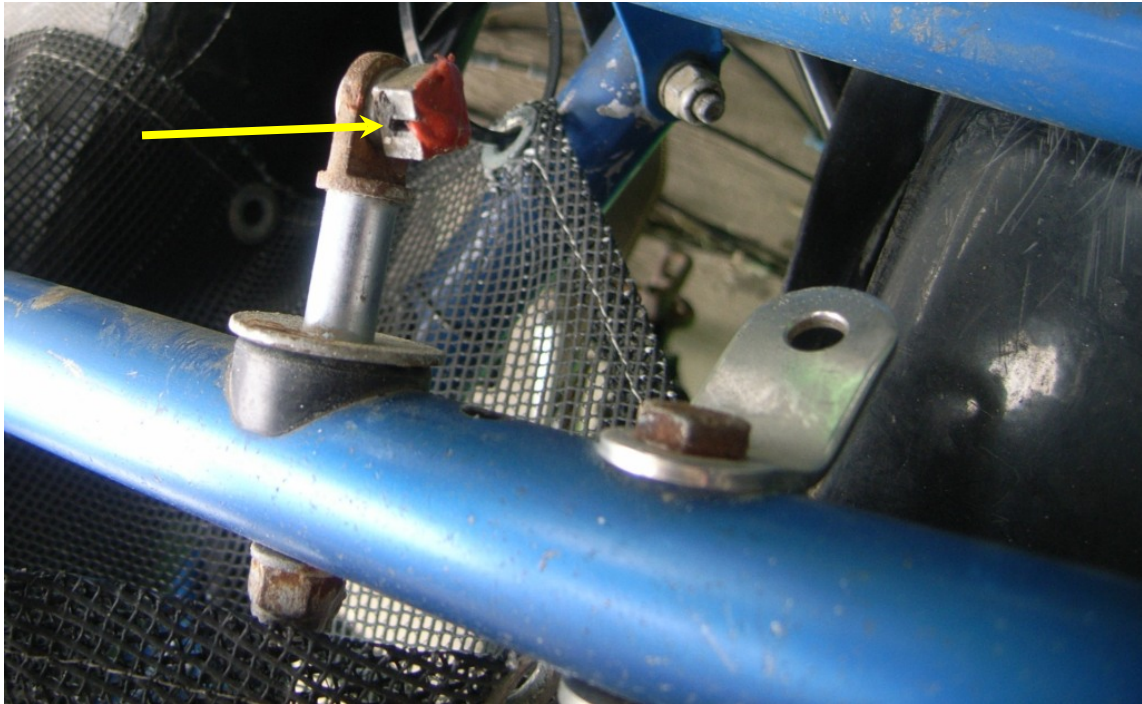


Figure 6 - Throttle Bar and Cable Clamp (note absent cable, yellow arrow)

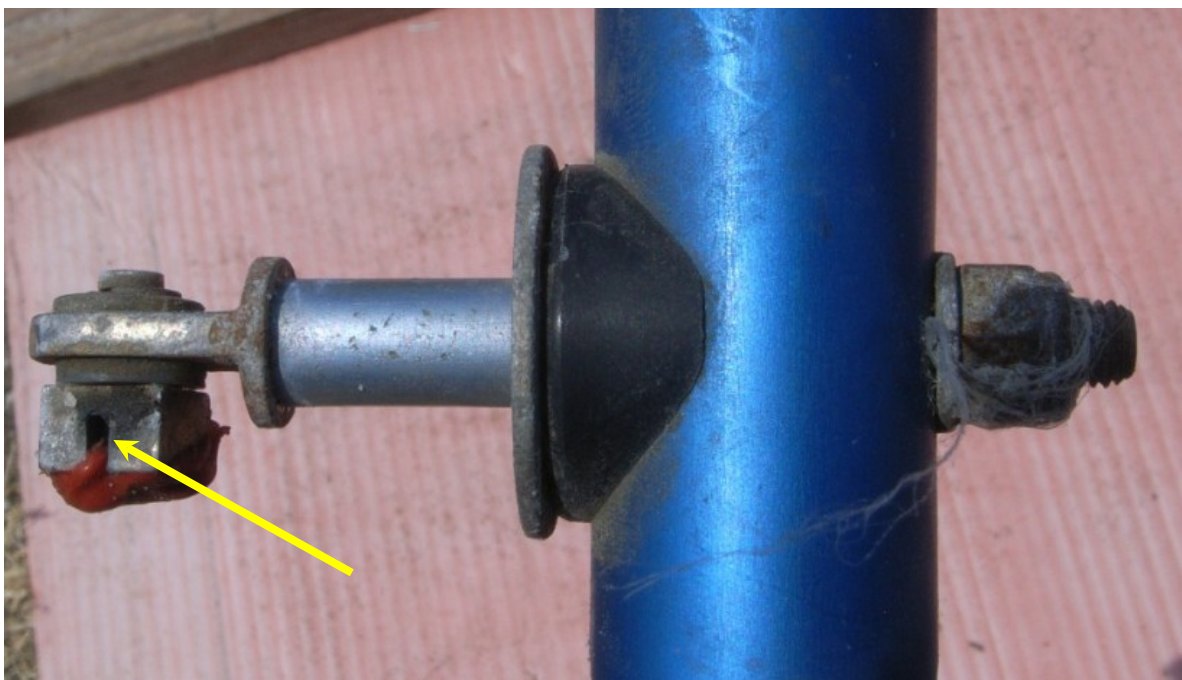


Figure 7 - Throttle Bar and Cable Clamp (note absent cable)

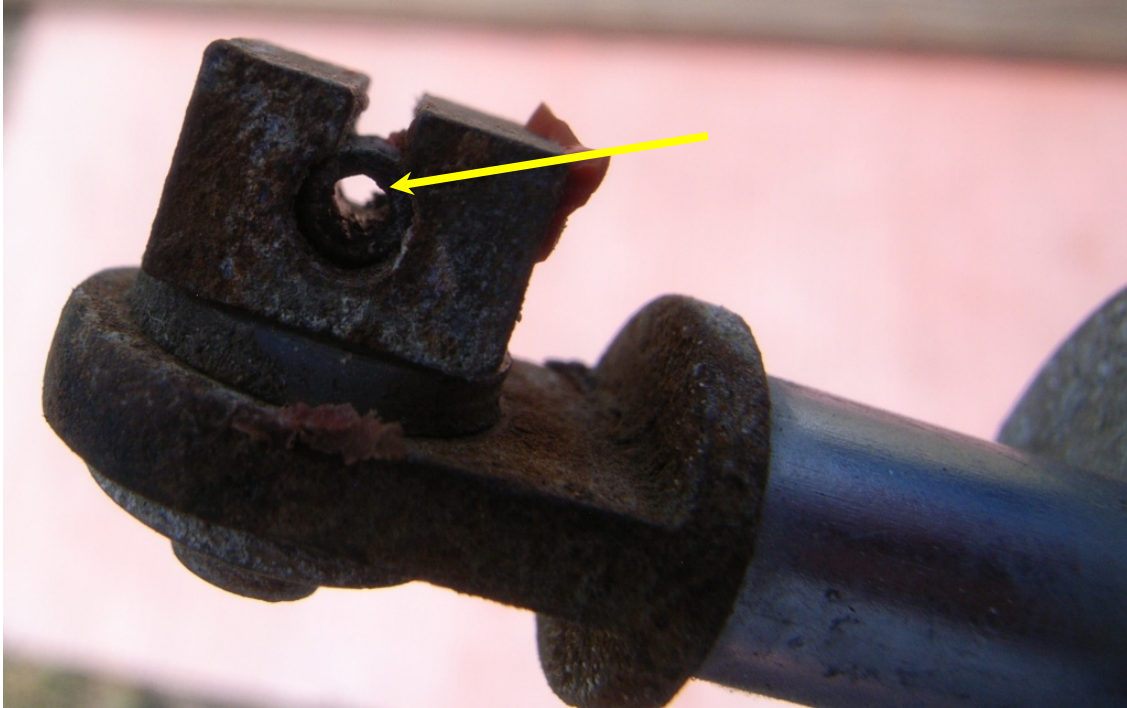


Figure 8 - Throttle Bar and Cable Clamp (note absent cable)

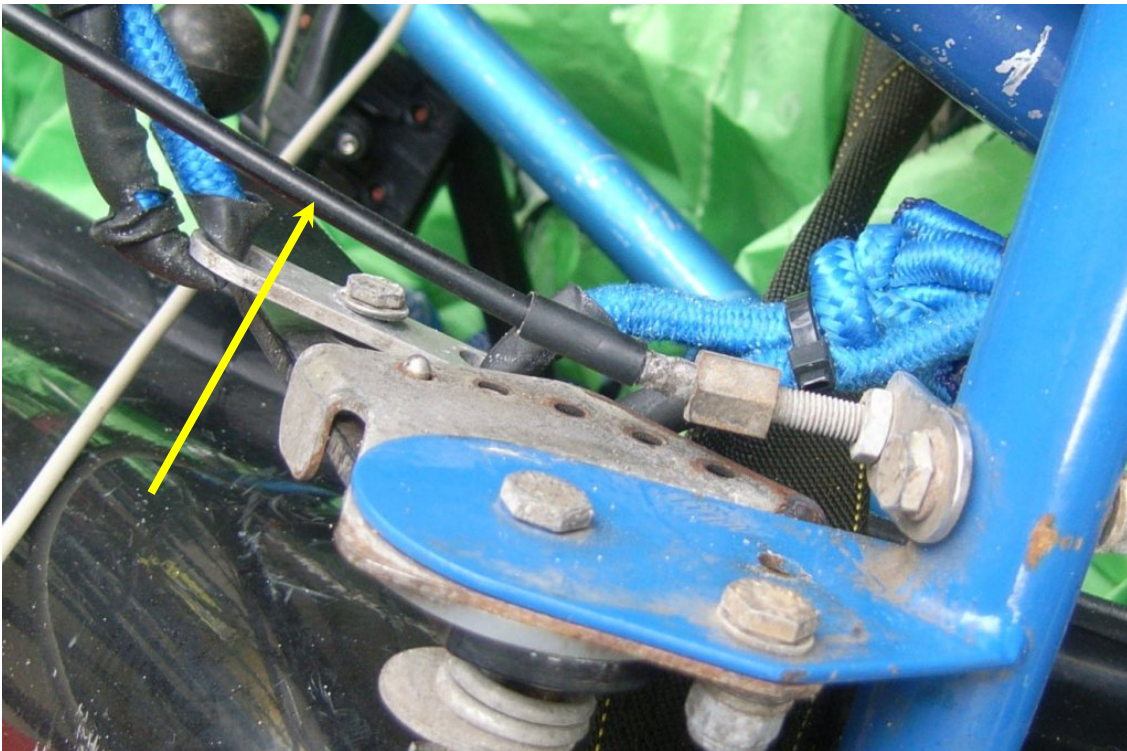


Figure 9 - Throttle Cable Shroud



Figure 10 - Exemplar Throttle Bar (looking up/aft)

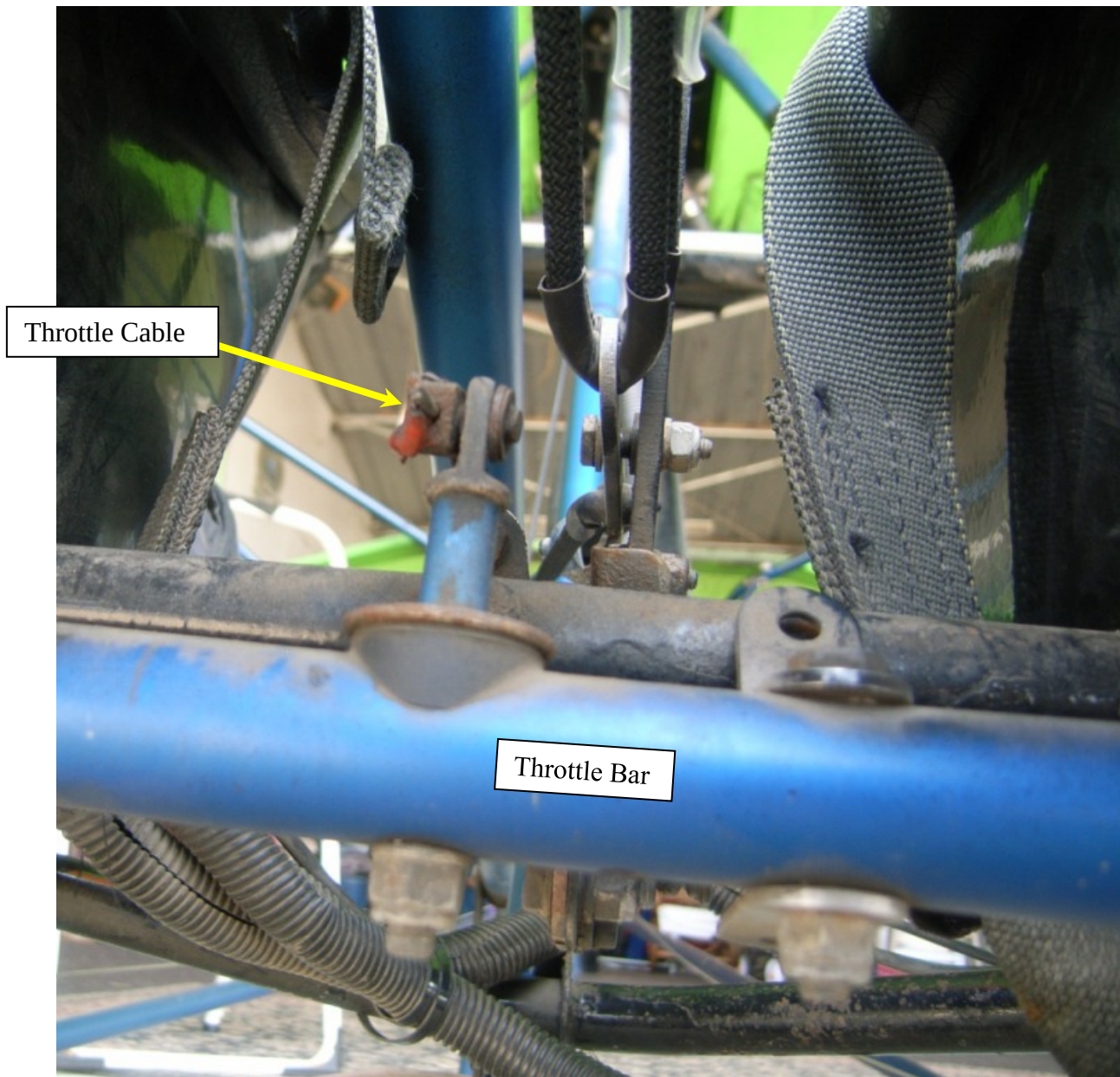


Figure 11 - Exemplar Throttle Bar (looking up/aft)



Figure 12 - Exemplar Central Throttle Linkage (looking down)



Figure 13 - Exemplar Central Throttle Linkage (looking down)

3.0 Control Console

A center-mounted overhead console unit, which housed several components, remained attached to the structural tubing, but it and some of its components exhibited impact damage. Externally, this unit included:

- Hobbs brand engine hour meter. Attached, intact, registered 3184.6 hours
- ELT Artex ELT-200 TSOC91a 121.5 MHz
- Facet brand electric fuel pump (see engine section for details)
- Ignition switch set to "R", key absent
- "Light Switch" found in aft (off) position
- "Fuel Pump" switch, found in forward (on) position
- "Master Switch" position indeterminate

Internally, this unit included:

- Voltage regulator, Key West Controls brand, Model 9400-0013, leads securely attached to all four terminals
- Fuse panel with provisions for four fuses, all intact, and leads securely attached to all terminals



Figure 14 - Hobbs Meter



Figure 15 - ELT



Figure 16 - Center Overhead Console

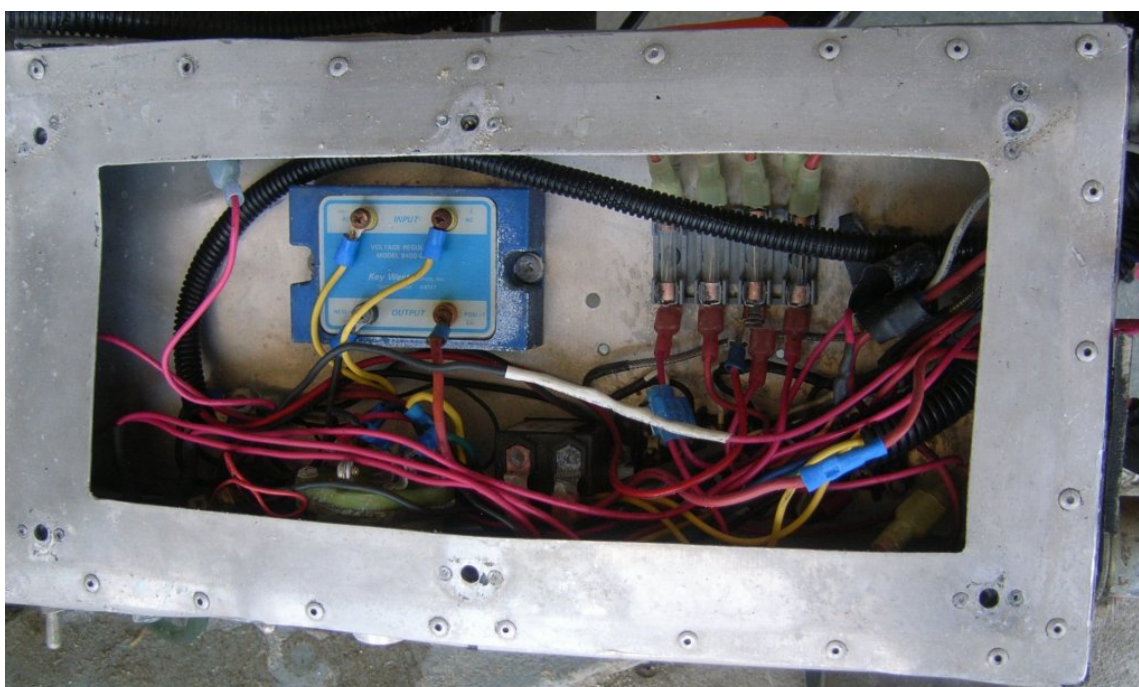


Figure 17 - Interior of Center Overhead Console

E. ENGINE

1.0 General

According to FAA registration information, the aircraft was equipped with a Rotax 503 series engine. The engine data plate was no longer attached to the engine, the engine appearance and configuration was consistent with a Rotax 582 Model 99 "Blue Head" series liquid-cooled, two-cylinder, two-stroke cycle version.

The engine was mounted upright in a pusher-configuration. The cylinders travel vertically, and were situated in line fore and aft. In this report, "left, right, up, down, fore, and aft" denote

orientation with respect to the aircraft longitudinal axis. Rotax uses the following abbreviations to denote the cylinder and engine aspects:

- PTO denotes the power take-off end, which is where the propeller gearbox and propeller attach
- MAG denotes the magneto end, which is the opposite end from the PTO

The engine remained attached to its mounting pad, which remained attached to the fuselage structure. The propeller hub remained attached to the engine gearbox flange, but all three composite blades were fracture-separated from the propeller hub. The engine exhibited significant impact damage, corrosion, and sand infiltration. The engine was unable to be rotated manually. There was no external evidence of any catastrophic failure of any engine components.

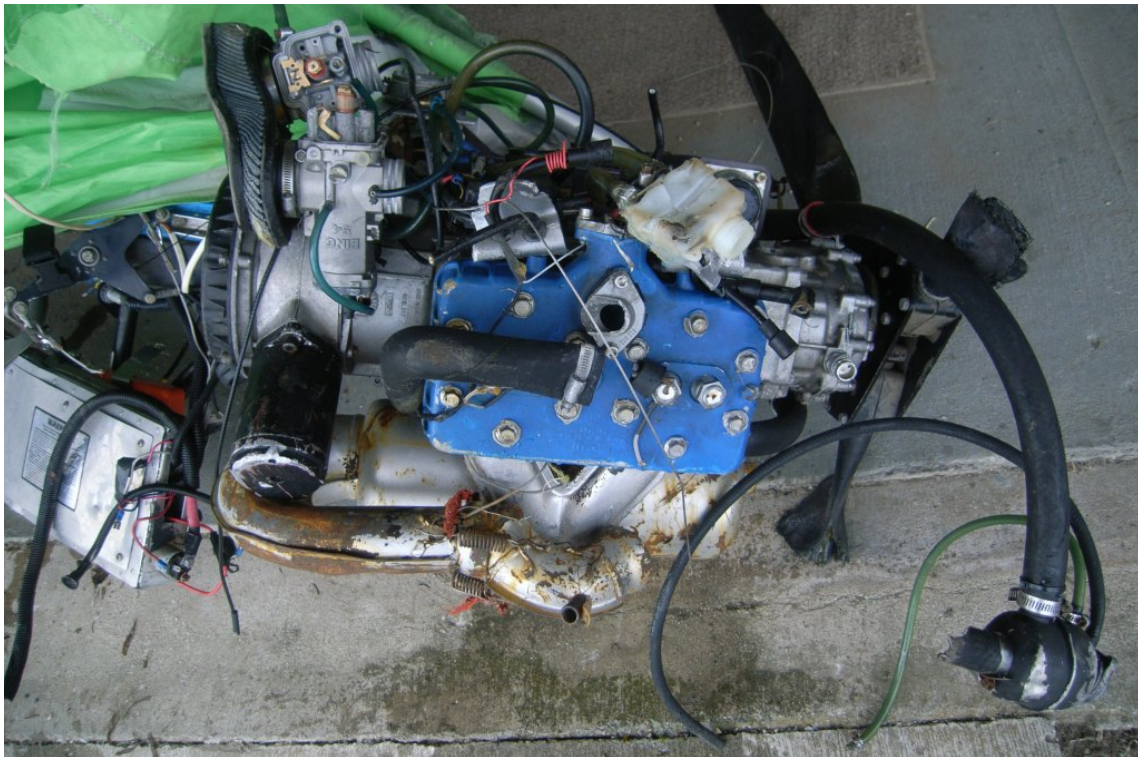


Figure 18 - Engine Overview

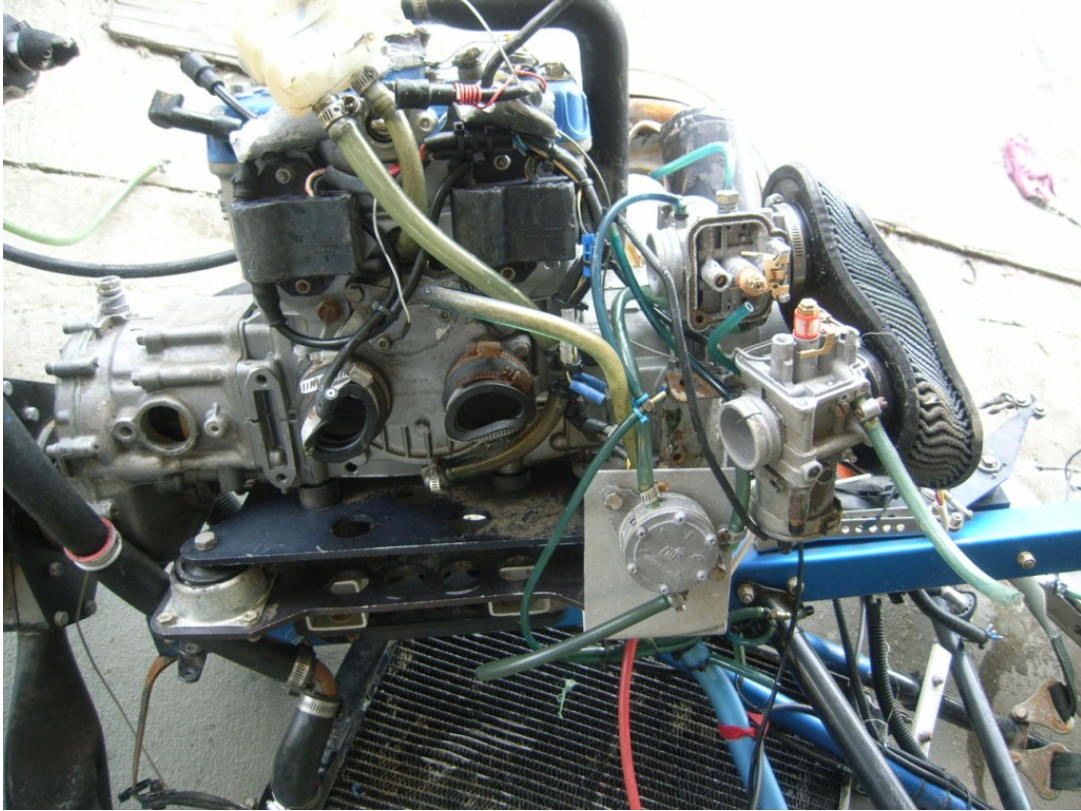


Figure 19 - Engine Right Side



Figure 20 - Top of Engine

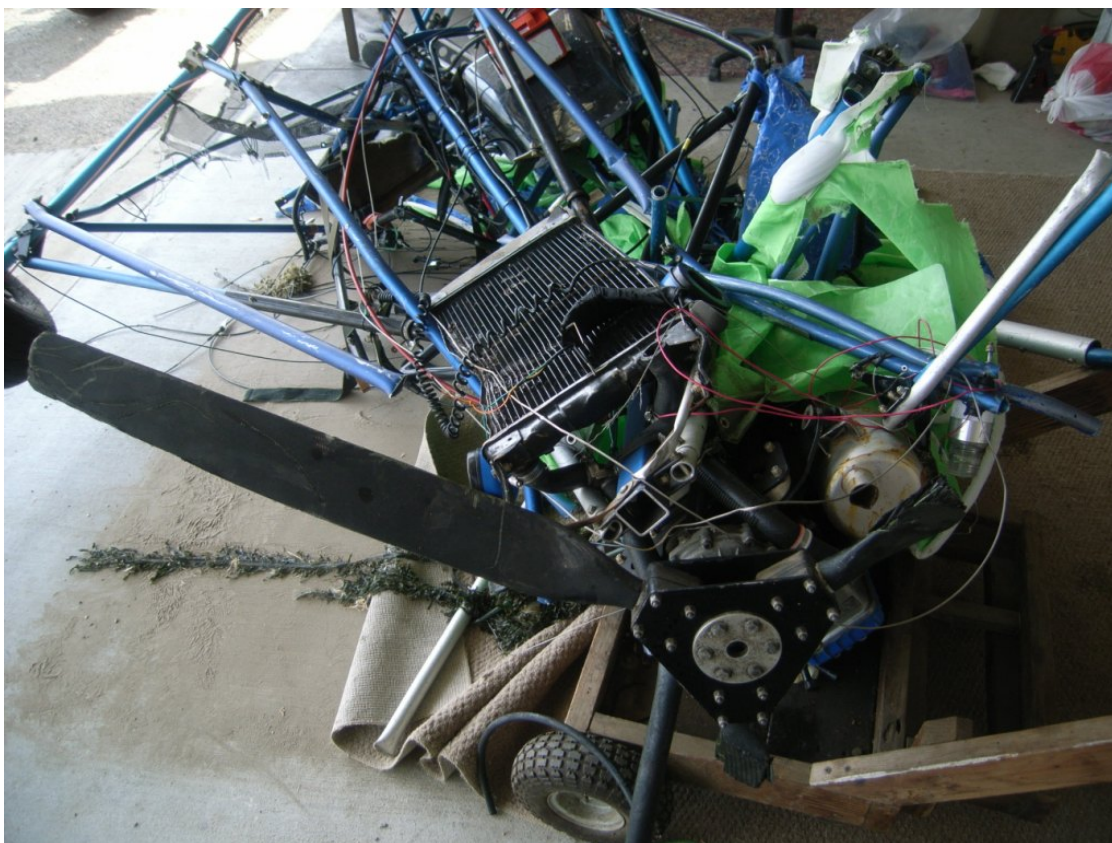


Figure 21 - Engine (looking forward)

2.0 Ignition System

The engine was equipped with a breakerless dual capacitor discharge ignition (DCDI) with an integrated generator that separately powered two ignition coils. Each coil powered one spark plug in each cylinder. Spark/ignition timing was a function of crankshaft rotation angle and not user adjustable.

The integrated generator was not examined. Both coils remained attached and appeared intact. The ignition leads to the spark plugs were partly damaged and/or separated from the engine. All four spark plugs were found securely installed, but all four were missing the bulk of their upper insulator sections, which were all fracture-separated, consistent with rock impact damage. No spark plug model numbers were available on the remaining portions. The four spark plug bases were removed and examined. All were contaminated and/or corroded, consistent with salt water immersion. The gaps of the remaining electrodes were measured, but due to corrosion, those values may not be indicative of their in-service gaps. These were:

- SP I (PTO end, aft) 0.022"
- SP II (PTO end, forward) 0.024"
- SP III (MAG end, aft) undetermined due to corrosion
- SP IIII (MAG end, forward) 0.024"

The Rotax-specified spark plug gap value was 0.016" to 0.020"

Due to damage and/or because the engine could not be rotated, the ignition system was not tested, nor were any of the components individually tested.



Figure 22 - Fractured Spark Plugs (PTO side to right)



Figure 23 - Spark Plugs I to IIII (left to right)



Figure 24 - SP I



Figure 25 - SP II



Figure 26 - SP III



Figure 27 - SP III

3.0 Fuel System

Identification and tracing of the available fuel system components and lines indicated the following components and configuration details:

- Composite 12 gallon fuel tank mounted below engine; bottom of tank about 14" lower than engine mounts
- ON-OFF fuel valve situated at bottom of tank, within reach of pilot(s). fuel line provisions from valve exit; fuel line not attached
- Electric fuel pump in series between tank and filter
 - o Electric pump about 12" higher than fuel tank outlet in level flight
 - o Electric pump about 6" lower than engine-driven pump in level flight
- In-line fuel filter (immediately downstream of electric fuel pump)
- Engine-driven (pneumatic) fuel pump, with output line 'Y-d' to each carburetor
 - o Engine-driven pump located about 4" lower than carburetors in level flight
- Two Bing 54 cross-draft slide carburetors, one per cylinder, attached to a common air intake filter
- A plunger-type primer system was 'T-d' into the fuel delivery line and to the two carburetors
- The single throttle cable from the cockpit was split via a mechanical 'splitter' to dual cable links ('Bowden cables') at the engine, with one cable each to each carburetor

All observed system fuel lines were clear or colored but transparent, flexible plastic. The lines displayed varying degrees of clarity and flexibility. Aircraft damage precluded a full layout and accounting of the fuel system lines. None of the observed lines exhibited obvious evidence of in-service cracking or failure. The discoloration (mostly blackening) of the lines was a mix of internal and external. The reason(s) for the discoloration was not determined. Many lines were found separated from their components at one end, and some were found cut or torn. Worm-type clamps were used to secure the fuel line ends to their respective components, but post recovery condition precluded the determination of the presence or security of several of these clamps.

The aircraft was involved in a previous engine power loss accident on June 28, 2013 (NTSB accident # WPR13LA318). The examination report produced by a Rotax representative included the following statements:

The fuel lines between the fuel tank and fuel pump (negative pressure side) were secured with non Rotax approved gear type worm clamps and tie wraps. These clamps do not tighten uniformly and could cause air to leak into the fuel system especially when there are multiple connecting joints.

In the Rotax repair manual section **10.2.5) Elimination of air leaks in the fuel line:** It states that "Some commercial clips are often not very satisfactory on small pipes, as they tend to tighten up oval, creating a possible leak. "Crimp on" clips can be unsatisfactory if incorrectly applied, and are difficult to remove for servicing. Replace all doubtful fuel line clamps with good quality approved ones." Rotax recommended clips are P/N 938 195 which are a spring type clamp.

In the Rotax repair manual **section 10.2.4) Examination of fuel line between tank and fuel pump:** it states "This section of pipe is under considerable negative pressure when the engine is running hard, and the tiniest flaw in any joint will cause air to be sucked into the system, considerably reducing the capacity of the fuel pump. Air leaks are much more dangerous when the fuel tank is mounted below the fuel pump and carburetor."

The same non-Rotax approved worm-type clamps were observed to be installed on the aircraft fuel system lines during the July 2017 post-accident examination.

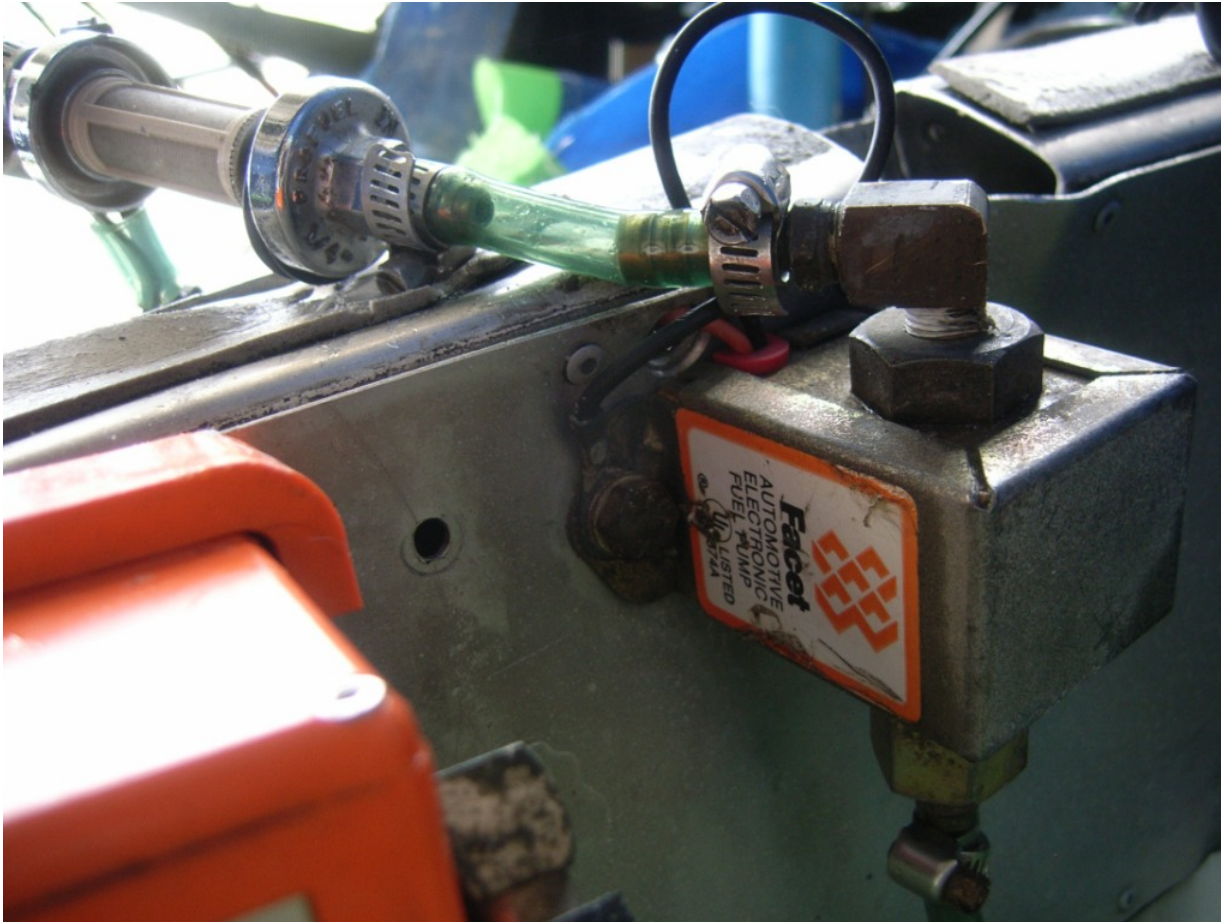


Figure 28 - Fuel System with Worm Clamps

The composite fuel tank was observed to have been separated from the aircraft, but it was not determined when or by whom, or if it was separated by the wave action. The tank was equipped with two dedicated sump drains. The tank was empty, and the external surface exhibited several damage locations consistent with shore rock damage. No punctures or through-cracks were observed. The filler neck cap was absent and not recovered. The fitted valve at the tank bottom was present but corroded, and lacking its fuel line.



Figure 29 - Fuel Tank

The electric fuel pump was a Facet brand part number 40105. According to the Rotax 582 engine installation manual "If the fuel tank is considerably lower than the engine an electric pump should be used. This pump is to be connected in parallel as in case of series connection the fuel pressure would be excessive." The manual did not define "considerably." The pump was plumbed in series with the rest of the fuel system. The pump was removed from the aircraft and 12VDC were applied in an attempt to test it. No noise or vibration of the pump was observed on the application of the voltage.



Figure 30 – Electric Aux Fuel Pump

The electrical functionality of the console-mounted "Fuel Pump" switch was tested; the switch was determined to be functional (able to open and close a circuit) via an ohmmeter.

The fuel filter was originally equipped with a clear glass encasement, which was not observed in the wreckage. This was consistent with destruction and loss of the glass during the shore rock impact. The filter element present and clean, but absent the glass, the filter element was exposed to the ambient post-accident environment.

The engine-driven fuel pump (EDP) remained attached to its mount on a plate at the lower forward section of the engine. The pump cover bore information that appeared to be the manufacturer ("MIC Mikuni Kogyo Japan") but no part numbers were observed on the exterior. The single input fuel line and the two output fuel lines remained securely attached to the pump. The two output lines to the carburetors were intact and attached to the appropriate sites on the carburetors, but the input line was torn and terminated about 3 inches from the pump. The pneumatic line for pump actuation remained connected to the appropriate fittings on the pump and the engine crankcase. The pump was removed from the engine and partly disassembled. There was liquid in the pump that appeared to be a mix of avgas and seawater. All internal pump diaphragms and flapper valves were intact and flexible. The flapper valve orientation was correct, and their action tested satisfactorily with low pressure air. The internal chambers contained sand similar to that found throughout the wreckage, and corrosion consistent with salt water exposure. No mechanical anomalies with the pump were observed.

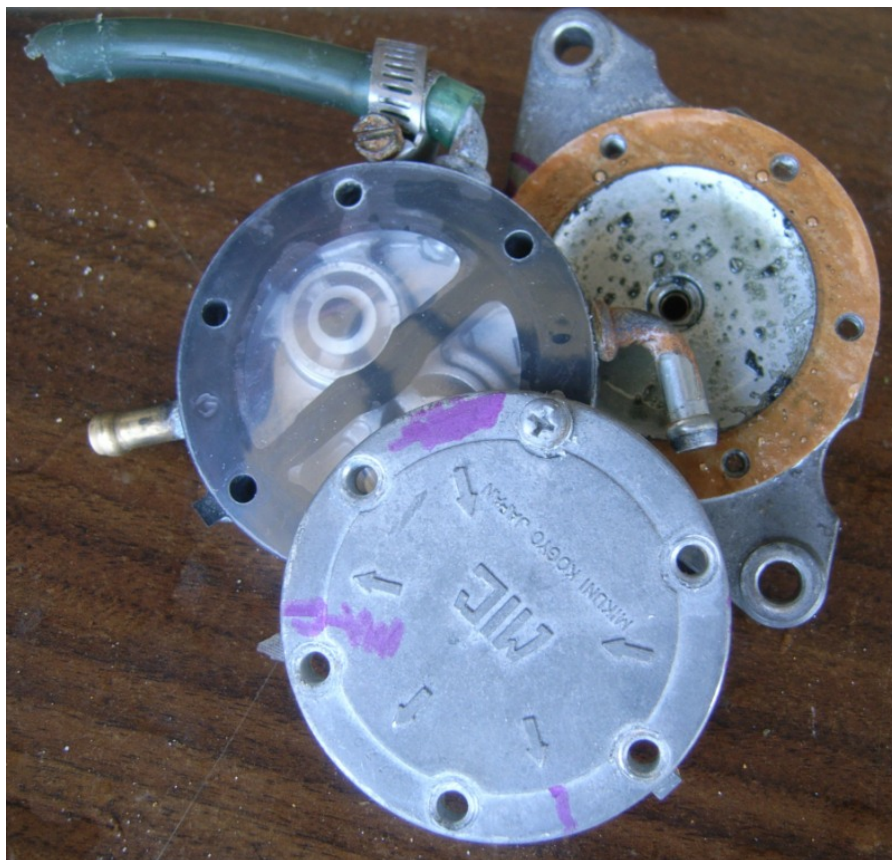


Figure 31 - Engine Driven Fuel Pump

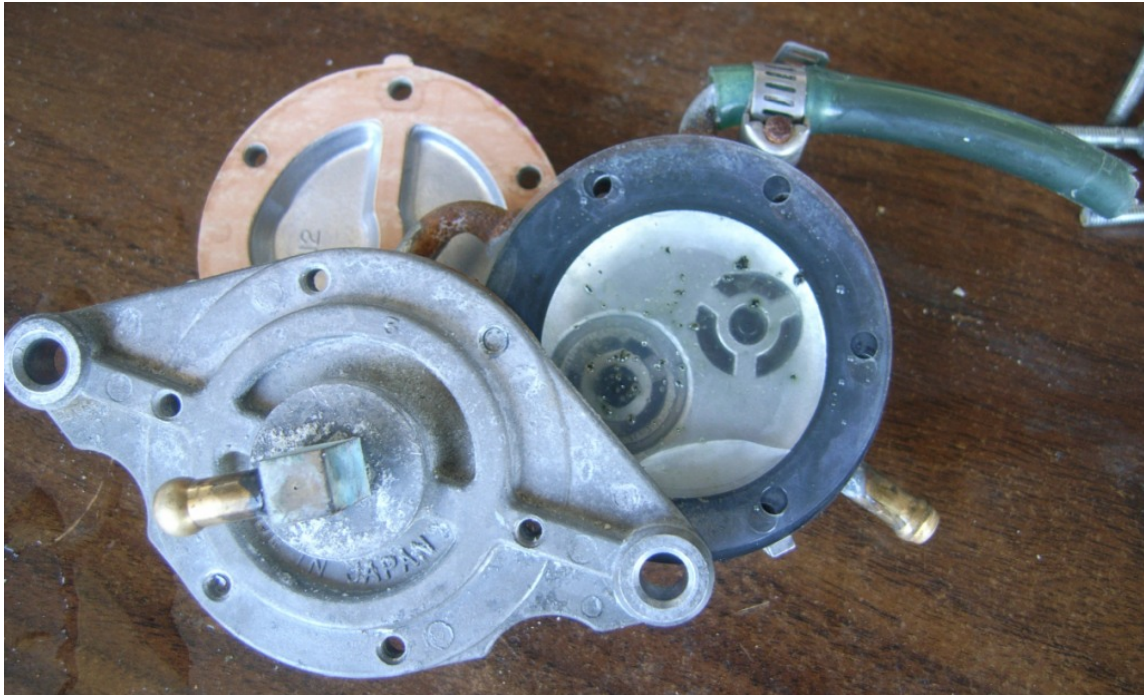


Figure 32 - Engine Drive Fuel Pump (interior)

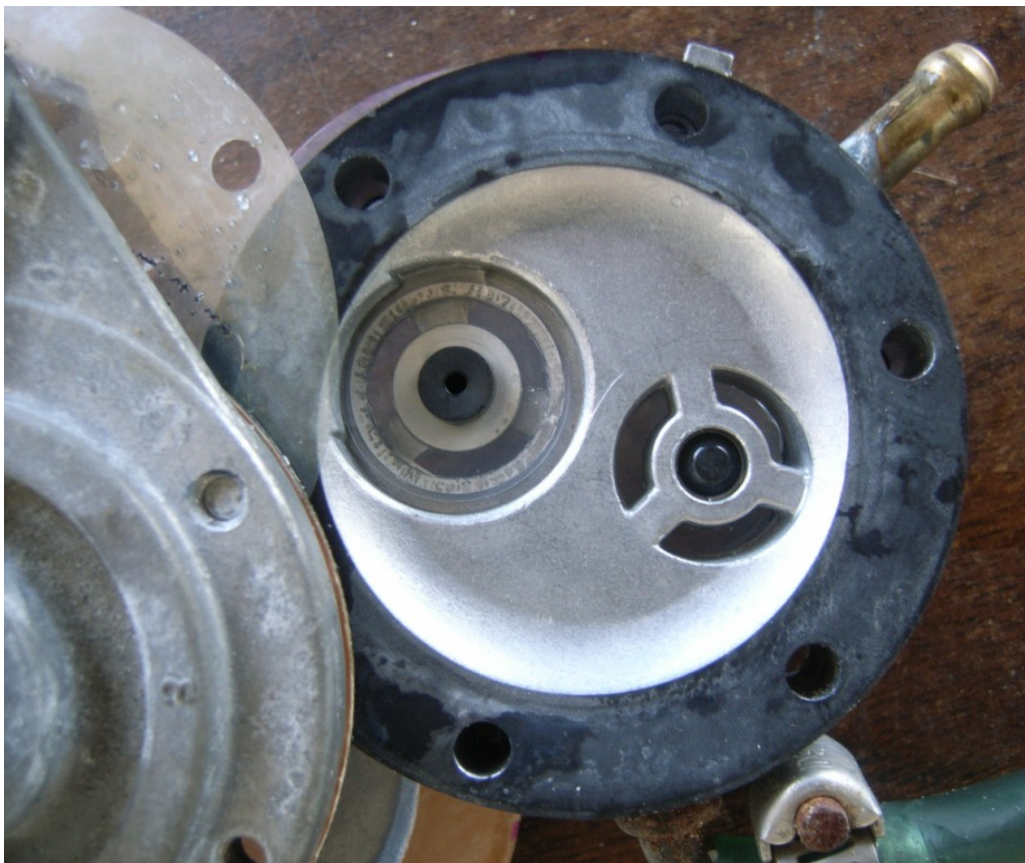


Figure 33 - Engine Driven Fuel Pump (interior)

Regarding the installation location of the EDP, the Rotax installation manual stated that "if possible, the pump should be located below the fuel tank level." The EDP location was near the bottom of the engine, which was above the top of the fuel tank.

At the time of this exam and report, the Rotax specs for the EDP have not yet been obtained by the investigation. It was not determined whether the EDP has an internal pressure regulating mechanism, but there was no separate, pressure regulator in the fuel system.

According to the Rotax Installation Manual, the electric pump must produce a minimum pressure of 3 psi, and a maximum pressure (in combination with the pneumatic pump) of 7 psi. The electric pump "must allow free flow even when switched off."

According to specifications on the Facet/Purolator web site, the minimum pump output pressure is 3.0 psi, the maximum pressure is 4.5 psi, and the pump flow capacity is 30 gph. The specification also cited an "average wet lift" of 12 inches. "Wet lift" is the distance below the pump that the pump can draw fluid from; in this case the pump can pull fluid from a source 12 inches below the pump. With the aircraft in a level pitch attitude, the bottom of the electric pump was situated about 12" above the bottom (and outlet) of the fuel tank.

The two carburetors were found separated from the engine at their flexible boot ("carburetor socket") connections, but remained attached to the engine by cables and fuel lines. The single air filter remained attached to the two carburetors. The air filter was crushed and otherwise deformed, contained sand, and exhibited corrosion, consistent with salt water immersion and wave action at the shoreline. The air filter was Rotax part # 825 723, which was the correct part for that engine.

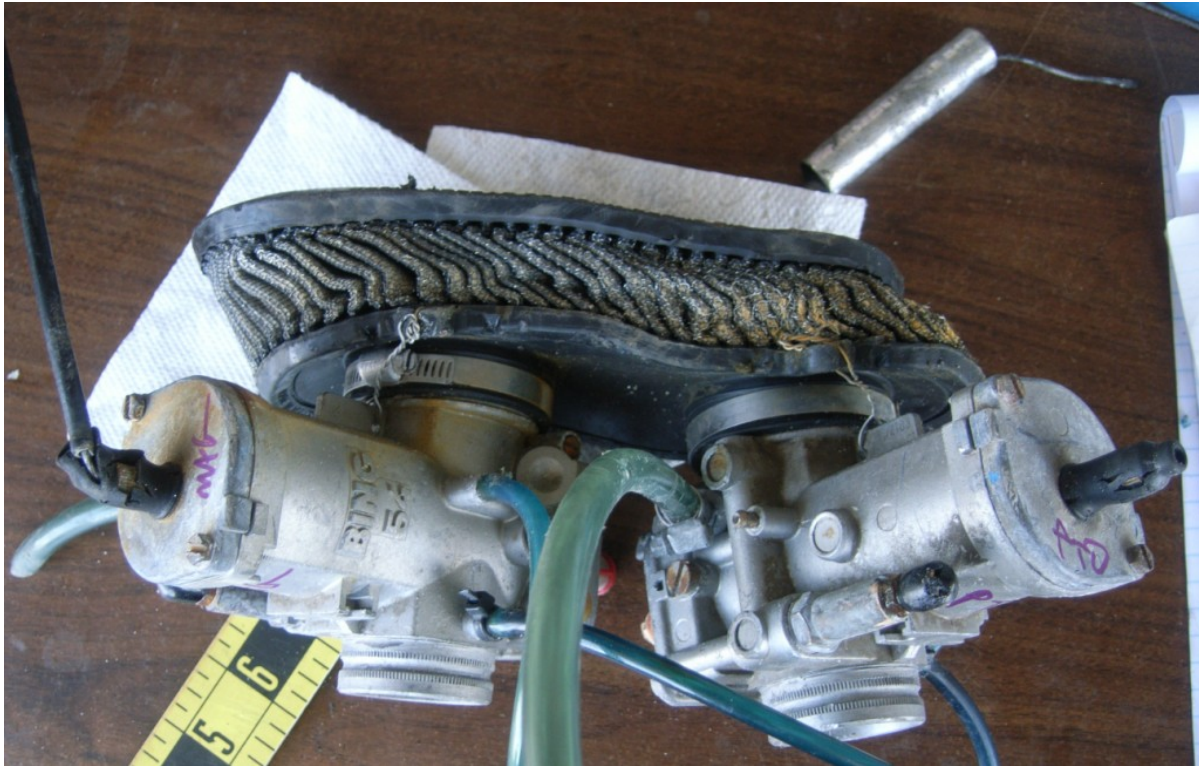


Figure 34 - Carburetors and Air Filter

Both carburetors were missing their bowls, and their internal float mechanisms and other components were crushed, deformed, and corroded, again consistent with the accident environment. The Bowden cable was displaced but remained attached to the MAG carburetor, but the Bowden cable was separated from the PTO carburetor. The carburetor pistons ('throttle slides') on both carburetors were firmly stuck in the wide open throttle position. The main jets of both carburetors were stamped as size "165," and were unobstructed. Per Rotax guidance, 165 was the proper main jet size for this engine and carburetor installation. The cover plates were secured on both carburetors, and removal revealed no failed springs or other abnormalities.

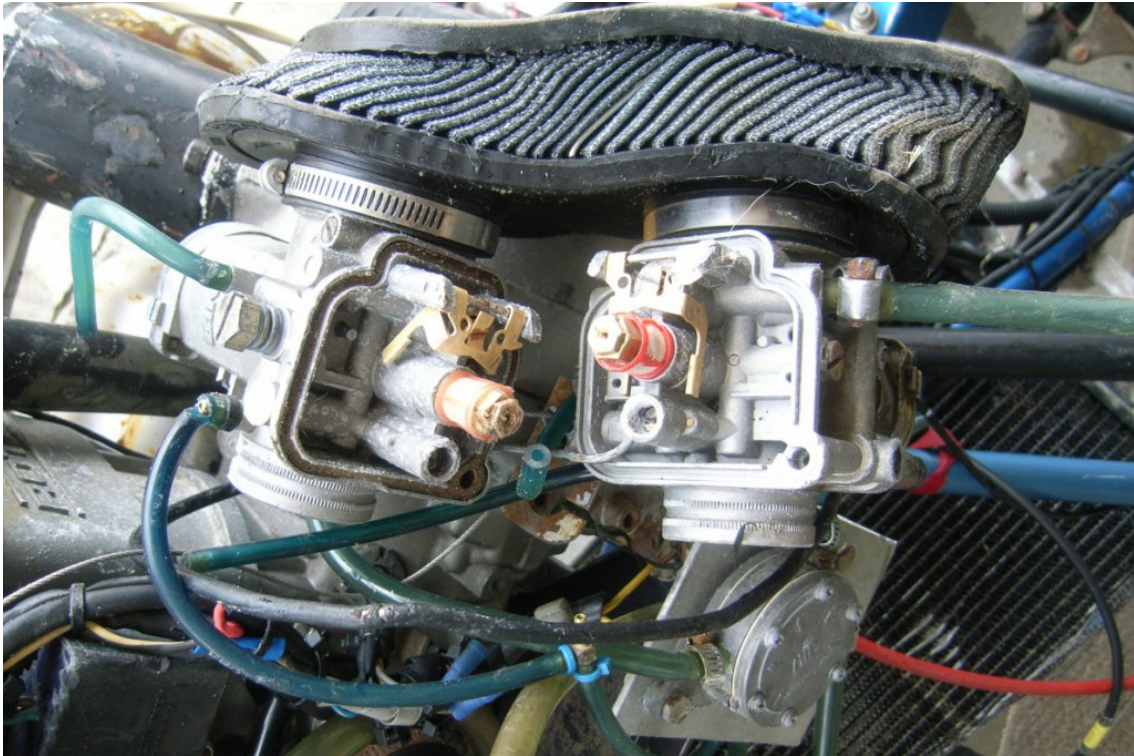


Figure 35 - Carburetors (note missing bowls)



Figure 36 - PTO End Carburetor

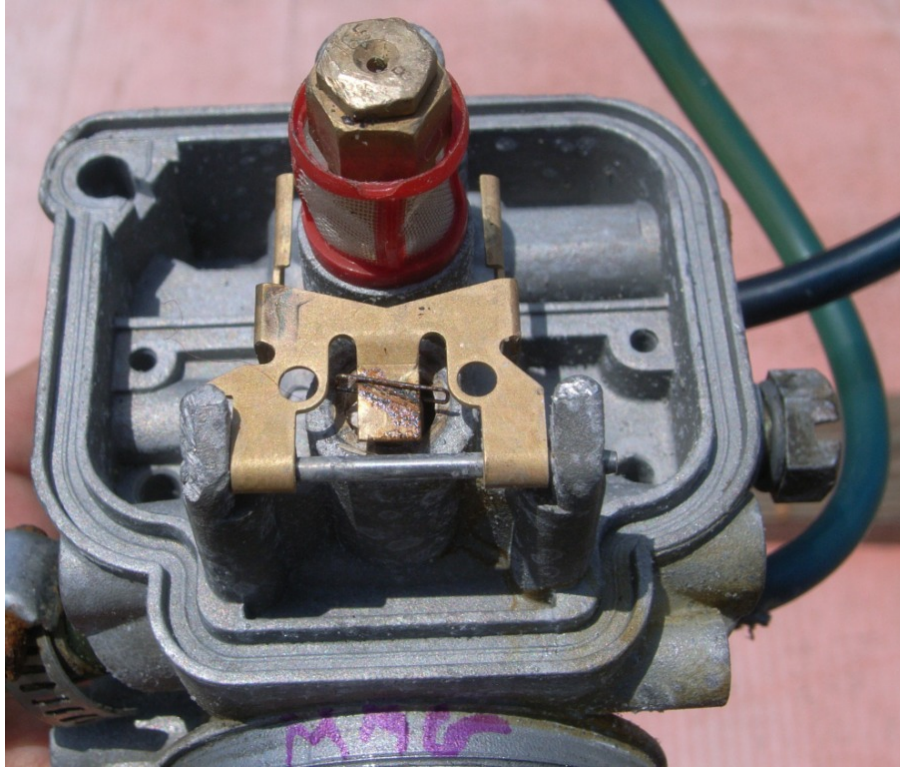


Figure 37 - MAG End Carburetor



Figure 38 - PTO End Carburetor Throat



Figure 39 - Inside Slide Spring Assembly (typical of both carbs)

The two sockets remained installed on the engine, and retained all four attaching worm clamps. The sockets were removed and examined; both were flexible, and no through-cracks were observed. Examination of the maintenance records indicated that the carburetor socket for the PTO carburetor was replaced on July 2, 2017 by the SKFC mechanic. That work was completed at a Hobbs meter reading of 3183.9 hours. The logbook entry did not contain any information regarding an operational check of the new installation. Discussions with the mechanic and another SKFC member revealed that no operational check was conducted, and that the installed socket was not brand new. According to the aircraft 'Flight Log', the next aircraft/engine run (unknown if actually flown) was on July 6, 2017, for 0.2 hours. The next entry on the Flight Log was for the accident flight.

The number on the newly-installed PTO socket (867696) matched the part number specified in the Rotax Parts manual. Comparison of the newly-installed socket with the socket from the MAG carburetor indicated that the two were slightly different dimensionally (in diameters), but of the same height, and that the number (07-100-21) on the MAG socket did not match the Rotax-specified part number. The socket did not bear any manufacturer identification, so no cross-check of applicability was able to be conducted.

The socket ODs and wall thicknesses were measured, which allowed the calculation of the socket ID values, as follows:

CARBURETOR SOCKET DIMENSIONS			
Socket End		Dimension (mm)	
		PTO Socket PN 867696	MAG Socket PN 07-100-21
Engine End	OD	64.5	62.0
	Wall	6.0	4.5
	ID	52.5	53.0
Carburetor End	OD	54.5	51.0
	Wall	6.0	5.0
	ID	42.5	41.0



Figure 40 - Carburetor Sockets (PTO & MAG respectively)



Figure 41 - PTO End Socket (correct PN)



Figure 42 - MAG End Socket (incorrect PN)

The primer plunger handle was found in the stowed/locked position

The throttle cable splitter device was examined. It was mechanically intact but was very stiff in operation, likely due to salt water immersion and sand infiltration; its pre-accident functionality and range could not be determined.

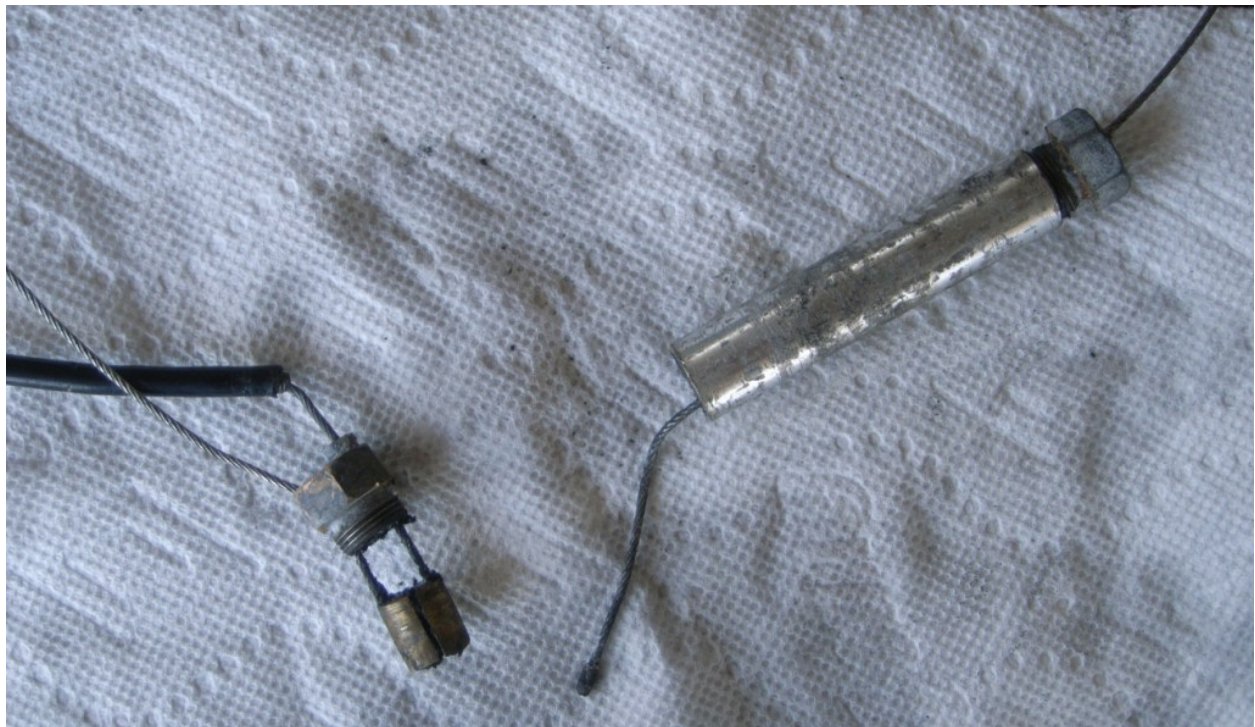


Figure 43 - Throttle Cable Splitter (disassembled)

4.0 Exhaust System

The exhaust Y pipe remained securely attached to the engine, and the muffler remained securely attached to the exhaust Y and its other mounting hardware. According to the operator, the muffler had recently been replaced, using an OEM part. The maintenance records indicated that the muffler was replaced in February 2015, which meant that it had accumulated a TT of about 290 hours at the time of the accident.

All exhaust components were in generally good condition. Some dents and corrosion were present, but these were consistent with the water immersion and shore rock impacts. No penetrations, cracks, or re-welds were observed. The muffler tailpipe was partly dented, again consistent with the shore rock damage. No obstructions were visible in the tailpipe. The muffler was partially unbolted from the engine, and shaken and rapped to listen for any loose internal parts (baffles); none were detected.

5.0 Lubrication Systems

This particular engine was not equipped with the oil injection option. The owner/pilot was responsible for pre-mixing the fuel with 2 stroke injection oil at a 50:1 ratio. The SKFC representatives stated that they premixed and stored the fuel/oil in a 55 gallon drum in Hangar U2 at KCMA. They reported that they exclusively used Peak brand TC-W3 oil.

The lubrication system for the rotary valve was present but impact-damaged, and its tank was empty. The rotary valve was partly visible through the intake ports. Some visible portions of the valve exhibited corrosion consistent with salt water immersion, but no significant mechanical anomalies were observed.

6.0 Pistons and Cylinder Head

The exhaust Y pipe was removed to gain access to the pistons. The pistons and cylinders were examined for any signs of oil starvation, seizure marks and stuck piston rings. No evidence of oil starvation, piston seizure, or stuck piston rings was observed.

The cylinder head was intact and securely attached. No evidence of any leaks was observed along the head/cylinder joints. The head was removed, and the exposed cylinders, pistons, and head cylinder domes were examined. No evidence of any mechanical anomalies was observed.



Figure 44 – MAG End Piston (via exhaust port; note lack of scoring, typical)

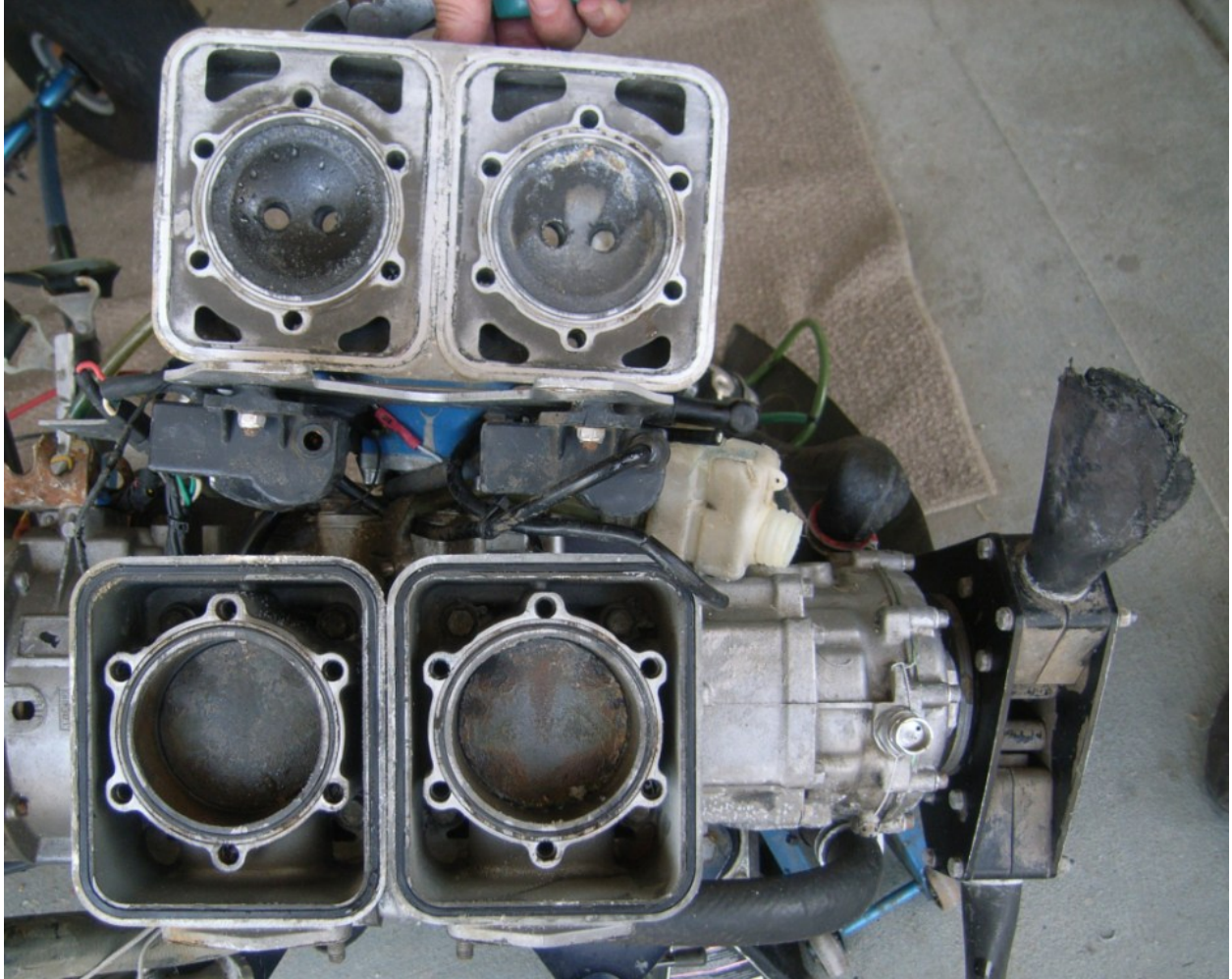


Figure 45 - Head Assembly Removed

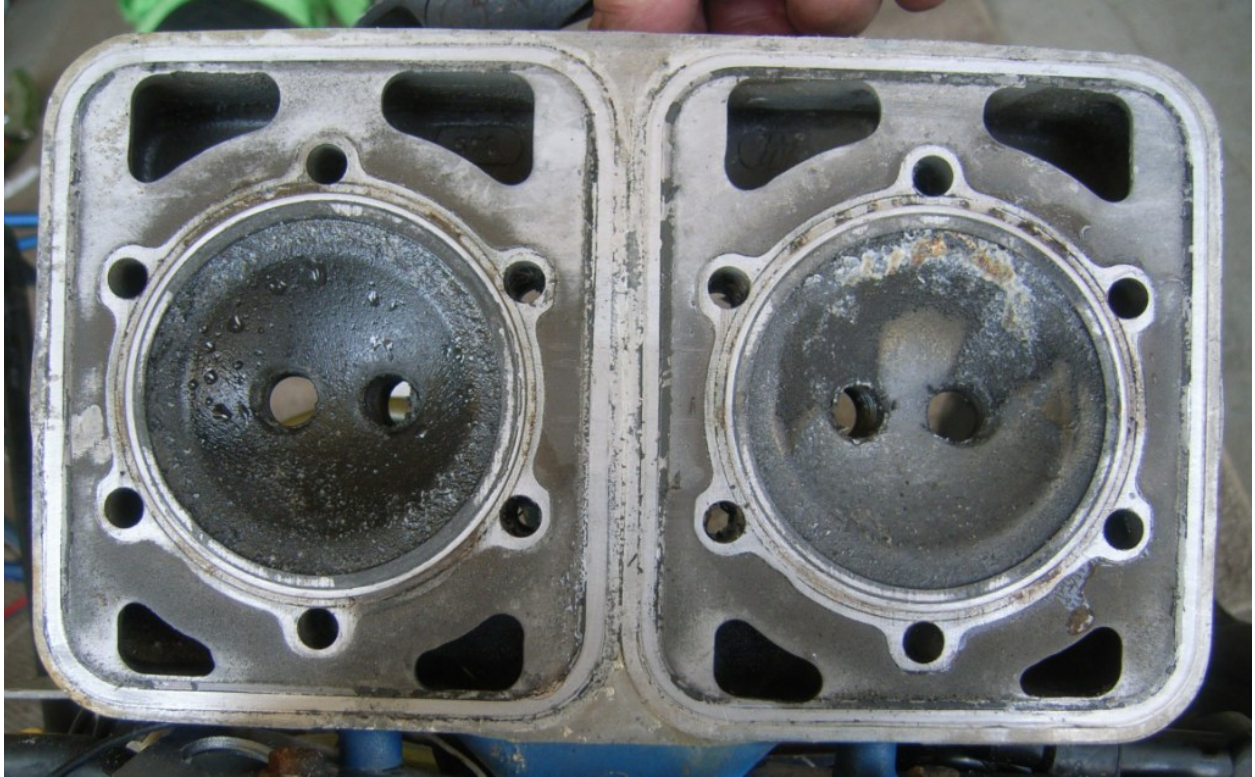


Figure 46 - Head Domes (PTO to right)

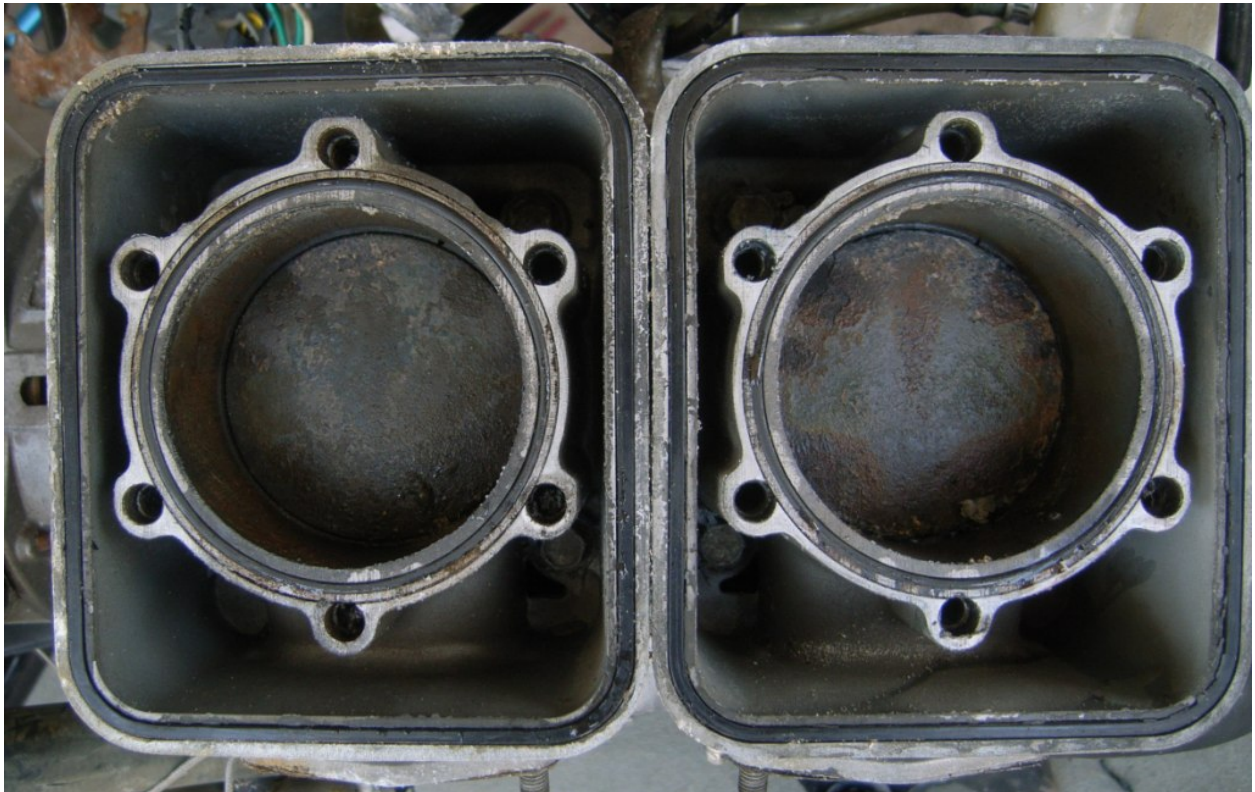


Figure 47 - Cylinders and Pistons (PTO to right)

7.0 Electric Starter

The engine was equipped with both a manual pull-start mechanism and an electric starter. The electric starter was unbolted from the engine and examined. The starter 'Bendix drive' was found in the retracted position, decoupled from the engine ring gear. Neither gear showed any evidence of distress due to abnormal contact. There was evidence of salt water immersion and resultant corrosion inside the gear housing.



Figure 48 - Electric Starter (Removed)