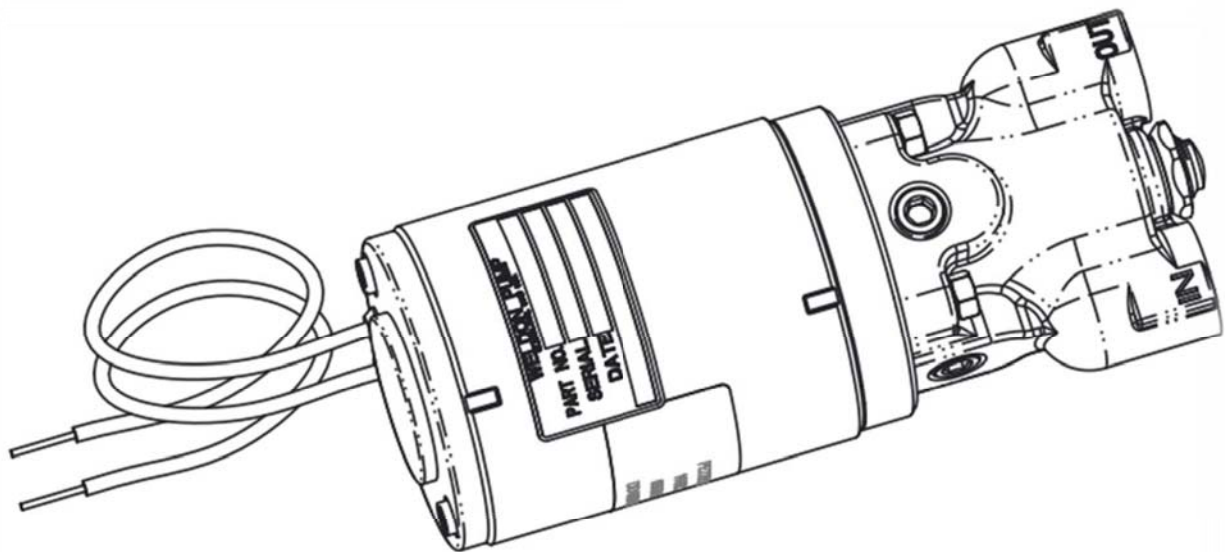




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**Evaluation of Auxiliary Fuel Boost Pump
P/N B8120-M, Non-Weldon Serial Number: 1807225
From Make: Extra, Model: EA300 L, Aircraft: N19AM
for NTSB Case: WPR19LA218**

Evaluated 27/Feb/2020



WITNESSES

Inspection, evaluation, and testing of the auxiliary fuel boost pump from Extra EA300 L WPR19LA218 as documented in this report was witnessed by the following:


Steve Carpenter
Evaluation Technician
Weldon Pump


Dan Ramser
Chief Engineer
Weldon Pump

David Osborne
Aviation Safety Inspector
FAA-FSDO Cleveland Office

Sandor Janosy
Aviation Safety Inspector
FAA-MIDO Cleveland Office

Qiong Jia
Aviation Safety Inspector
FAA-MIDO Cleveland Office.

1.0 SCOPE

This report documents the inspection, evaluation, and testing of the auxiliary fuel boost pump from the Extra EA300 L aircraft with registration number N19AM. Note, this article has NON-Factory “part marking” with the following header to its’ label (shown in Figure IV):

Aeromotors LLC.
CR# 01MR357Y
304 East Murray ST.
Browntown, WI 53522

Immediately below the header is “Weldon Fuel Pump” followed by the known/valid Weldon part number of B8120-M. Next, the label states a NON-Weldon serial number of 1807225 (as of this writing Weldon isn’t into seven digit serial numbers). Note, due to the lack of a Weldon factory serial number traceability to original factory condition is not possible. The label concludes with “14.0 Volts 5.5 Amps Max, 40 GPH at 26 PSI, 40 PSI Max”.

2.0 RECEIPT OF PACKAGE

A sealed package was received, via common carrier, at Weldon Pump’s Oakwood Village facility. As per Weldon’s standard procedures the package was externally marked DO NOT OPEN and otherwise remained undisturbed. See Figure I for image of exterior packaging and Figure II for image of Shipping Label.

Said Package was only opened in the presents, and under the instruction, of the FAA personnel named on page 2 of this report. See Figure III for image of the article in last stage of unpack.

3.0 EXTERNAL VISUAL INSPECTION

The article was removed from packaging and inspected, see Figure IV for image of the article as first unpacked. At first glance the Pump-Motor Assembly's configuration was a close approximation to that of a Weldon Pump B8120-M. Upon closer scrutiny the motor was obviously not of Weldon factory origin. The motor’s factory label was not present. The motor field shell was devoid of the stamped keying features at both ends. The hook-up wires exited the motor’s endframe thru a non-factory grommet (See Figure VI for image). The wire strands being silver plated unlike the factory non-plated strands. The “anti-drive end” endframe was machined aluminum as opposed to the factory die cast component. The motor case bolts were Phillips head as opposed to the factory socket head (prior factory revisions employed slotted head - but never Phillips). The drive endframe was devoid of the correct factory chamfered edge break and countersunk case bolt hole chamfers. The motor was mounted to the pump assembly such that both the case bolts and lead wire exit were 90° off radial position relative to the factory design data. Further, the relief valve adjusting screw was not a factory Weldon part as it was not anodized and had an alternate profile (not of any known lineage of approved design data) to the unthreaded slotted area (See Figures IV, V, & X for images). The cast pump body was the only, non-COTS, item visible from the exterior that was believed to be of Weldon factory origin.

- Inlet port fitting assembly (See Figures IV, V, & VIII for images);
 - Fitting body appearing to be AN833-6D *“Elbow-Flared Tube and Bulkhead Universal, 90°”* or equal. quantity one.

- Fitting O-ring appearing to be AS568A -906 “*Aerospace Size Standard for O-Rings*” or equal of unidentified elastomeric compound. quantity one.
- Fitting Nut appearing to be AN924-6D “*Nut, Tube, Bulkhead and Universal Fitting*” or equal. quantity one.
- Outlet port fitting assembly (See Figures IV, V, & VIII for images);
 - Fitting body appearing to be AN833-6D “*Elbow-Flared Tube and Bulkhead Universal, 90°*” or equal. quantity One.
 - Fitting O-ring appearing to be AS568A -906 “*Aerospace Size Standard for O-Rings*” or equal of unidentified elastomeric compound. quantity One.
 - Fitting Nut appearing to be AN924-6D “*Nut, Tube, Bulkhead and Universal Fitting*” or equal. quantity One.
- Overboard seal drain port fluid fitting;
 - Fitting body appearing to be AN816-4D “*Adapter, Straight, Pipe to Tank*” or equal. quantity one (See Figure V for image).
 - Aluminum Taper Pipe Plug appearing to be AN932-2 /MS27769D2 “*Plug, Pipe, Countersink Hex Head*” or equal. quantity Three (See Figure IV for image).

4.0 PHYSICAL INSPECTION/TESTING/DISASSEMBLY

The physical inspection and testing, in this section, was conducted utilizing equipment including that listed below;

- Sperry Electrical Multimeter
- HP DC power supply;
 - Volts: 0-40.
 - Amps: 0-25.
- Inspection Pin/Plug Gages;
 - 0.0445” O.D.
- Inspection Ring Gage;
 - 0.4993” I.D.

The initial action was to employ an electrical multimeter to measure the resistance between;

- First, the positive hook-up wire and motor case
- Second, the negative hook-up wire and motor case.

The results indicated infinite resistance to case from both polarity hook-up wires. This result is consistent with a healthy motor of the type/variety/design employed on Weldon’s B8120-M.

The DC power supply was adjusted to 14 VDC, switched off, and power was allowed to bleed back to 0 VDC.

Pump-Motor Assembly's hook-up wires were connected to the DC power supply. As is procedural, a few drops of SAE 30 oil were added into the Pump-Motor Assembly's inlet port as not to allow the pump to run dry for damaging periods of time.

The power supply was momentarily turned on ("jogged") applying 14 VDC to the pump-motor assembly and this determined the motor was turning (by virtue of the sound and low current draw) thus ruling out a "locked armature condition".

The technician placed his thumb over the inlet and repeated the momentary power application thus determining the pump wasn't producing a normal/sufficient/healthy suction.

The following diagnostic tests were purposely conducted in order of lesser to greater Intrusiveness for suspected/possible failure modes/root causes.

One of the three factory overboard seal drain port plugs was removed. A small flashlight was used to view into this port and view/discover the non-factory (not of any known lineage of approved design data) motor shaft to plastic intermediary coupling to rotor shaft (See Figures XIII & XIV for images). A mark was applied to the OD of the plastic intermediary coupling with a felt tip marker to aid in the following. Momentary application of power was repeated while viewing the rotating assembly. This determined that the motor shaft, plastic intermediary coupling, and rotor shaft were all spinning when power was applied thus ruling out a worn out or broken drive shaft to rotor interface.

The Inlet and Outlet port fitting assemblies were removed and a visual inspection of the bypass valve conducted (See Figure IX for Image). Next, a successful leak down test of the bypass valve was conducted by filling the Pump body's inlet port with isopropyl alcohol and finding no detrimental/rapid leakage.

Both the Inlet and Outlet fittings were checked for blockage – no blockage was found.

The relief valve assembly was removed and it was discovered that (in addition to the aforementioned relief valve adjusting screw not being of any know lineage of approved design data) the relief valve spring & poppet were not of Weldon factory origin. Although it didn't appear that the relief valve assembly was a contributing factor to failure at hand (See Figures X, XI, & XII for images).

At this point it was requested that the Pump-Motor Assembly be reassembled and an attempt to conduct the standard ATP be tried. Thus the relief valve, inlet fitting, and outlet fitting assemblies were reinstalled.

The Pump-Motor Assembly was installed into the ATP set-up (exception from standard ATP used for the B8120-M is connection was made to the reinstalled inlet and outlet fitting assemblies instead of installing the lab quick connect fittings directly into fluid ports) and then powered. The article failed to prime within the ATP set-up (See Figure VII for image).

Having failed the ATP attempt, and in order to determine the cause of the non-prime condition, the relief valve assembly, inlet fitting assembly, and outlet fitting assembly were again removed.

The motor was unbolted from the pump assembly via four pump mounting screws. Apparent/Confirmed at this point was the following;

- The motor's drive shaft was of a foreign design (not per any known lineage of approved design data) having a male drive tenon (See Figure XIII for Image). Factory motor drive shaft has a

female drive slot to couple directly to the pump rotor's male drive tenon without any intermediate part.

- There was plastic intermediary coupling of a foreign design (not per any known lineage of approved design data) between the male drive tenons of the rotor and motor (See Figure XIV for Image).
- The Weldon factory "face seal" employed on the B8120-M model of pump was not present. Instead it appears that the factory bronze insert had been heavily modified/machined to add a counterbore accepting a replacement foreign seal design (not per any known lineage of approved design data). *It should be noted that, based on experience, Weldon would never machine this type of feature after the close tolerance blade slots, rotor head counterbore, and rotor shank bore are finished as it is nearly impossible not to distort these critical features...* (See Figure XV for Image).
- The rotor was turning freely without the "normal/healthy" resistance changes as the blades/vanes transition the rotor lobes. Just the constant resistance of a seal lip seemed to be present.

The pump cartridge was removed from the pump body by removing the internal snap ring and pushing on the large end of the rotor per the service manual. The failure mode of the pump-motor assembly was immediately apparent once the pump cartridge was removed, a failed blade retaining ring (see Figure XVI of Images). Said blade retaining ring had two notches cut/worn, one thru, by the blade/vane interaction (Due to the extreme wear it is suspected that an additional contributing factor may be the blade retaining ring isn't of the correct alloy steel and/or may not meet the required temper. During this evaluation it wasn't feasible to test for this theory). The pump cartridge was disassembled by removing the four cover screws, the cover. Also of significance was that the blades/vanes were not moving as freely, as designed, within their corresponding slots in the insert. The blades were carefully pushed out to allow for measurements without damaging the parts. Although having heavy abrasion and badly worn blade retaining ring notch the blades/vanes were measured for service manual wear limits be in tolerance. Utilizing inspection pin/plug gages the width of the blade slots within the insert were measured and found to allow a maximum size of 0.0445". This value is under the approved design data's low limit and creates a potential "press fit" with the blades/vanes tolerance range (*this "closing of the slots was likely caused by the aforementioned modifying/machining of the insert*). Additionally it was apparent that the "cover" was not per any known lineage of approved design data based on the profile of the O-ring gland as well as what appeared to be an alternate alloy bronze by virtue of a significantly different patina (See Figure XVII for Image). Utilizing the 0.4993 No Go Ring Gage the rotor was checked for wear per the service manual and found to easily pass thru therefore it is deemed under the Ø0.4993" low limit.

5.0 EVALUATION SUMMARY

The evidence suggests that the pump-motor assembly, having been produced with defective and inferior subcomponents, wasn't operating "freely" as designed and thereby caused accelerated mechanical wear at the blade retaining ring to blade notch interface. This accelerated wear rapidly cut through the blade retaining ring as shown in figure XVI. Once cut thru, the blade retaining ring no longer applied force to the cut thru side blade. The cut thru side blade came to rest in its' most retracted position due to the rotor lobe forcing it there and having no motive force to move it back. With this blade retracted there was a direct leak path between the inlet and outlet port holes in the insert thereby rendering the pump inoperable.

APPENDIX A



Figure I

Image of shipment as received from common carrier



Figure II

Image of common carrier shipping document



Figure III
Pump-Motor Assembly in package as shipped



Figure IV
Label View of Pump-Motor Assembly



Figure V
Opposite Label View of Pump-Motor Assembly



Figure VI
Lead Wire End View of Pump-Motor Assembly

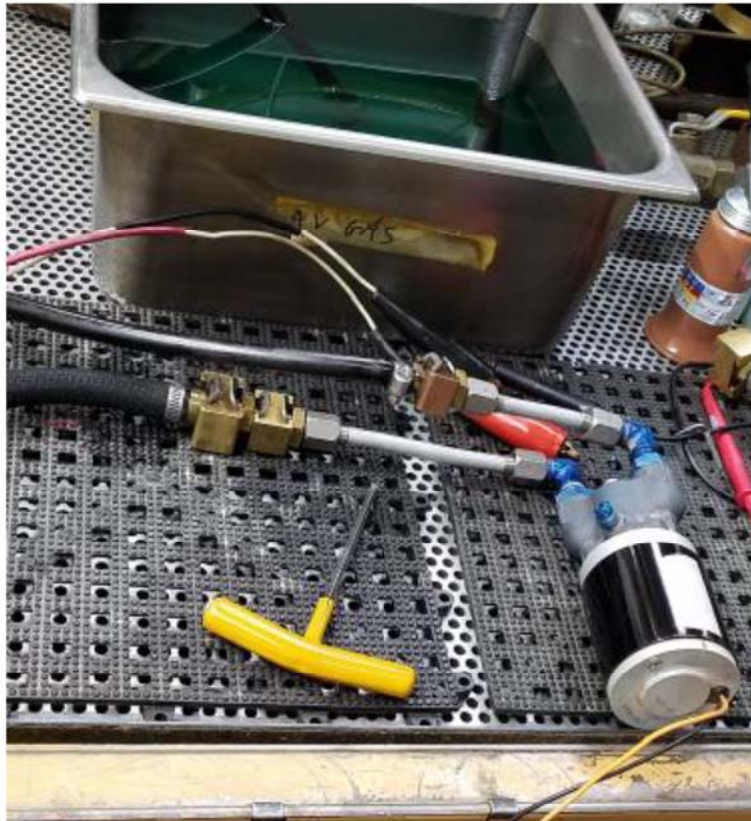


Figure VII
Pump-Motor Assembly installed in ATP set-up



Figure VIII
Inlet & Outlet Port Fitting Assemblies



Figure IX

Image of Outlet Port, Relief Valve Port, & Inlet Port (including Bypass Valve)



Figure X

Image of Relief Valve Assembly



Figure XI
Image of Relief Valve Poppet and Spring



Figure XII
Image of Relief Valve Poppet



Figure XIII
Image of Motor Assembly's Drive End



Figure XIV
Image of Plastic Intermediary Coupling



Figure XV

Image of Heavily Modified/Machined Factory Bronze Insert with Foreign Seal Installed



Figure XVI

LEFT; Image of the Failed Blade Retaining Ring From the Subject Pump.

RIGHT; Image of Example Normal/Healthy Weldon Factory Blade Retaining Ring.



Figure XVII

Image of Non-Factory Cover (Missing O-Ring Gland Edge Breaks)

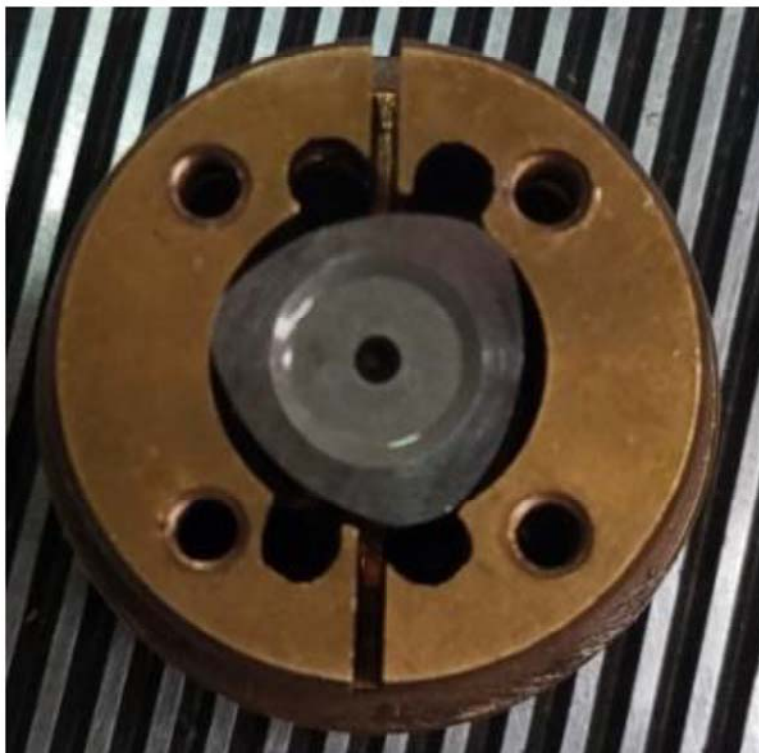


Figure XVIII

Image of Heavily Modified Insert, Note “Out of Round” Distortion of two center bottom port holes.



Figure XIX

Image of Heavily Abraded Blade/Vanes. Note Blade Retaining Ring Notch Wear on the left component.