

2016

Flowserve Corporation
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NAES – GAINESVILLE RENEWABLE ENERGY CENTER

*Provide Supervision to Site Mechanical Maintenance Personnel With Troubleshooting and Repairs to “B”
Boiler Feedwater Pump.*



Flowserve® Pumps

SERVICE REPORT

CUSTOMER

NAES – Gainesville Renewable Energy Center
11201 NW 13th Street
Gainesville, FL 32653

SERVICES REQUESTED

Provide Supervision to Site Mechanical Maintenance Personnel With Troubleshooting and Repairs to "B" Boiler Feedwater Pump.

DATE: 28 November 2016 – 2 December 2016

FY NO: 16-0348

FIELD ENGINEERING SERVICES PROVIDED BY JOHN THOMPSON

SIZE(S) AND TYPE(S):

6x14 WXH 7 stg.

SERIAL NUMBER(S):

M-151533



SITE POINT(S) OF CONTACT:

Tommy Gardner, Maintenance Supervisor, NAES
Phone: (386) 315-8012; E-Mail: tommy.gardner@grecbiomass.com

John Thompson
Field Engineer
Nuclear Projects Supervisor
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FIELD NOTES

Monday, 28 November 2016

Traveled from base to hotel in Gainesville, FL. (Traveled 8 hours)

Tuesday, 29 November 2016

Traveled to site. Met with Tommy Gardner, NAES Maintenance Supervisor. He states that the "B" BFWP was initially operated for approximately 2 years after commissioning. Then the plant was "mothballed" for approximately 1 year. The plant has since been started as an "on demand" operated plant. *Because of this type of operation, the pump does not start with the proper required ΔT between the source fluid as stated in the IOM. The site, also, does not operate the aux oil system as designed. It is not run continuously when the pump is secured, again, as stated in the IOM. It is started remotely prior to pump start.* Oil samples are taken monthly for analysis. Routinely with no foreign material noted. An oil sample taken in September returned with "debris", however, in the sample. The debris turned out to be water. The aux oil tank was drained, wiped out and refilled with oil. It was determined, by site personnel, that the water was allowed to enter the aux oil tank by a loose fitting flange on top of the tank. Since this pump is physically outside, oil falls on the sump during rain events. The flange was properly sealed and the pump continued "normal" operation with no additional water noted. *The oil filters in the system were recently cleaned and a substantial amount of "metallic" particles were found on the oil filters.* Site DCS reports no abnormal vibration or bearing temperatures noted during recent pump operation. Tommy Gardner reports that the pumps were tested to develop pump curves for comparison during initial site testing. The "B" pump actually performs better than the "A" pump based on flow rates, temperatures and vibrations. Site personnel have asked for assistance in determining the source of the "metallic" particles and repairing the pump as necessary.

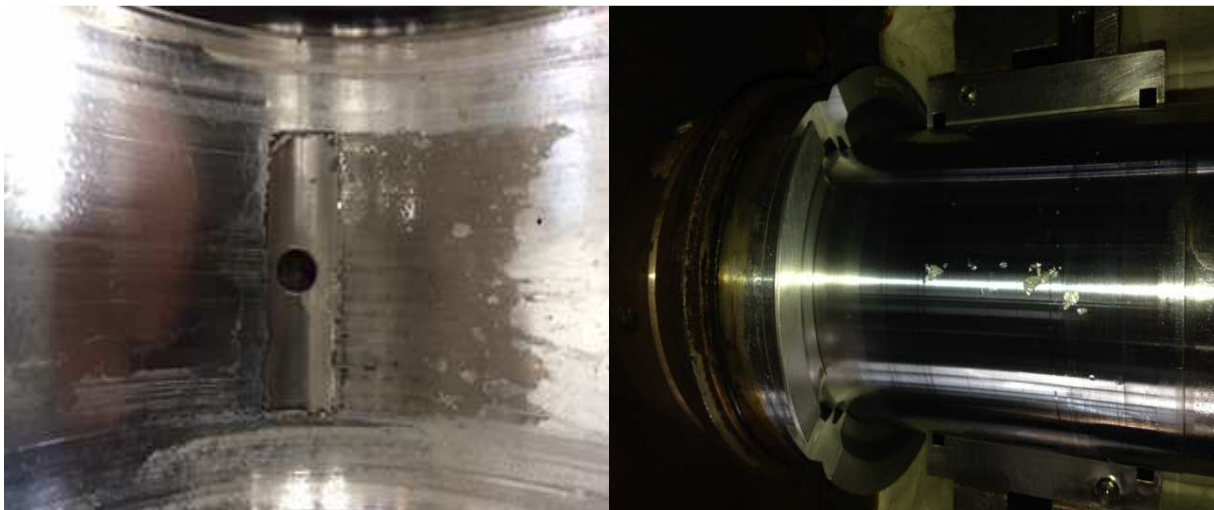
Attended site safety indoctrination. Participated in site JSEA. Locked onto site clearance. Traveled to pump site. Met with site personnel and explained the troubleshooting process we will follow. Began troubleshooting:

- Removed coupling guard.
- This coupling is a Flender manufactured coupling (Siemens dwg 6325235). Match marked pump / motor coupling flanges to spool piece. Attempted to remove coupling spool piece disc packs. Based on site provided coupling IOM, it would appear that the spool piece was previously installed incorrectly. *The spool piece does not appear to have been properly oriented to the pump / motor coupling flanges.* This has made safely removing the disc packs extremely difficult. Disc packs and spool piece were removed.
- Pump rotates freely with no rubbing or binding.
- Measured "as found" pump thrust at 0.0155" (repeated).
- I&C personnel removed RTD's and prox probes from NDE bearing housing for bearing inspections.
- Site personnel removed all NDE oil piping from IMO pump.
- Removed NDE bearing housing end cover with IMO pump and Lovejoy coupling.
- Removed NDE bearing housing upper half with dowel pins. Dowel pins were reinstalled into their original holes.
- Verified NDE sleeve bearing was properly installed for rotation.
- Pushed pump (thrust collar) hard against the active thrust shoes.
- Removed thrust setting plate and outboard oil seal from shaft.
- Removed inactive thrust shoes and inactive thrust shoe cage. No visual damage or smearing of babbitt noted. Cages are free to pivot.
- Set up a dial indicator and zeroed. Thrusted the pump hard to the outboard. Total shaft movement was 0.056" (repeated).

- Thrusted pump inboard hard against the active thrust shoes. Set the dial indicator at zero. Removed the active thrust shoes and moved the shaft towards the motor to check the balance drum setting. The pump did not move. Balance drum is against the balance disc.
- Removed active thrust shoes and active thrust shoe cage. No visual damage or smearing of babbitt noted. Cages are free to pivot.
- *There is a significant amount of "metallic" material in the base of the NDE bearing housing.*

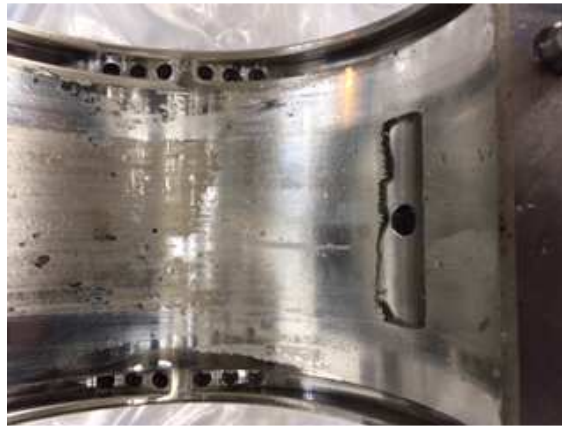


- Removed the NDE sleeve bearing upper half. *There is babbitt smearing on the sleeve bearing upper half and babbitt found on the pump shaft.*



- Rolled out the NDE sleeve bearing lower half. *There is smeared babbitt on the sleeve bearing lower half as well.*

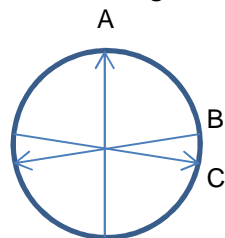
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- There does not appear to be any damage to the pump shaft in the bearing area or the prox probe chromed area. Installed a protective coating on the prox probe chromed area.
- Measured the “as found” thickness of the active (0.7497”-0.7525”) and inactive (0.750”-0.7524”) thrust shoes.



- Measured the thickness of the new thrust shoe at 0.754” simply for comparison. I will attempt to pull the thrust shoe drawing to determine “exact” wear found but this simply shows that there is wear as expected but not excessive.
- Pulled a new sleeve bearing from the warehouse and site personnel measured the ID of the new sleeve bearing as follows:



A: 4.1323”
 B: 4.1324”
 C: 4.1322”

- Removed NDE lower bearing housing lower half oil supply and return piping.

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- Removed NDE bearing housing lower half with dowel pins. Dowel pins were reinstalled in the casing holes that they were removed from. Delivered bearing housing lower half to machine shop for cleaning and inspection.
- Removed oil supply gallery plug along with supply orifices and checked for debris that would cause decreased oil flow to the sleeve bearing. None noted.
 - Orifice Sizes:
 - Inactive thrust shoe-0.088"
 - Active thrust shoe-0.177"
 - Sleeve bearing-0.145"
- Cleaned and stoned NDE lower bearing housing.
- Removed DE bearing housing RTD's and prox probes.
- Removed DE bearing housing upper half with dowel pins. Returned dowel pins back to their original holes.
- There is NO evidence of debris inside the DE bearing housing.
- Removed the DE sleeve bearing upper and lower halves and noted no abnormal wear or damage noted.
- Speaking with Tommy Gardner, NAES maintenance supervisor, we have decided to replace the NDE mechanical seal for preventative maintenance purposes.



Discovery for today is complete. We will continue with disassembly of the NDE shaft and seal replacement tomorrow. Removed lock from clearance. Returned to hotel. (Worked 10 hours) Completed admin (Worked 2 hours)

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Wednesday, 30 November 2016

Traveled to site. Met with Tommy Gardner. Participated in site JSEA. Locked onto site clearance. Traveled to pump site. Met with site personnel and explained the process forward.

- Loosened shaft nut setscrews and removed shaft nut with IMO gear and key.
- Awaiting hot work permit in order to remove the thrust collar.
- Rolled NDE seal setting plates into place and locked in place.
- Loosened seal locking collar set screws.
- Site operations personnel are modifying their clearance to allow for replacement of the mechanical seal. Removed my lock and signed off the clearance. Standing by awaiting clearance before continuing.
- Reinstalled the NDE oil supply orifices in the same location as removed.
- Reinstalled the NDE oil supply gallery plug using Teflon tape.
- Cleaning all the removed parts from the coupling spool piece and spring packs with bolting for reinstallation.
- Clearance has been modified for continued work and all personnel are locked on.
- Heated thrust collar slightly and removed with key and shaft centering shims.
- Removed inboard oil seal and thrust shoe cage backing plate.
- Removed NDE labyrinth seal with o-ring.
- Removed all seal flange piping connections.
- Cleaned shaft and applied a light coat of turbine oil.
- Removed seal gland nuts and washers.
- Lifted NDE pump shaft and removed NDE mechanical seal with o-rings.
- Cleaned NDE stuffing box and stoned stuffing box flange.
- Applied Molykote to new seal gland o-rings.
- Installed new NDE mechanical seal with seal gland washers and nuts loose.
- Installed NDE lower bearing housing with dowels and bolts hand tight.
- Rolled in new NDE sleeve bearing lower half with turbine oil verifying proper rotation.
- Tightened seal gland nuts with washers.
- Removed NDE sleeve bearing lower half.
- Removed NDE lower bearing housing with dowels.
- Torqued all seal gland nuts to 150 ft-lbs.
- Installed NDE labyrinth seal with o-ring using Molykote.
- Installed NDE lower bearing housing with dowels bottomed out and bolts hand tight.
- Rolled in new NDE sleeve bearing lower half with turbine oil verifying proper rotation.
- Torqued NDE lower bearing housing bolts to 240 ft-lbs.
- Cleaned DE lower bearing housing parting flange and stoned.
- Installed DE sleeve bearing lower half with turbine oil verifying proper rotation.
- Installed DE sleeve bearing upper half.
- Applied Molykote to DE labyrinth seal o-rings. Awaiting Loctite 518 to complete reassembly of DE bearing housing.
- Received Loctite 518 and installed DE bearing housing upper half with dowel pins. Torqued bearing housing bolting to 125 ft-lbs.
- Installed active thrust shoe cage backing plate and inboard oil seal.
- Heated and installed thrust collar.
- Installed shaft nut and tightened.
- Pushed balance drum hard against the balance disc. Set up dial indicator and zeroed.

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- Pushed thrust collar outboard and installed active thrust shoe cage and active thrust shoes.
- Pushed shaft hard towards motor. Balance drum is 0.041" off the balance disc currently. Will need to add 0.039" additional shims to set balance drum at 0.002" off balance disc.
- Removed active thrust shoes and thrust shoe cage.
- Removed shaft nut.
- Heated and removed thrust collar.
- Installed an additional 0.039" shim.
- Installed thrust collar key.
- Heated and installed thrust collar.
- Installed shaft nut and tightened. Tightened set screws. Filed high spots due to tightening.
- Pushed balance drum hard against the balance disc. Zeroed dial indicator.
- Pushed thrust collar outboard and installed active thrust shoe cage and active thrust shoes.
- Pushed shaft hard towards motor. Balance drum is 0.002" off the balance disc (repeated).
- Removed active thrust shoes and cage.
- Installed bellville washers and buttons in NDE bearing housing lower half behind active thrust shoe cage backing plate.
- Installed active thrust shoe cage and active thrust shoes.
- Installed inactive thrust shoe cage and inactive thrust shoes.
- Installed outboard oil seal and thrust setting plate.
- Verified both thrust shoe RTD shoes are properly located.
- I&C personnel installed both DE and NDE sleeve bearing RTD's.
- Installed NDE bearing housing end cover with IMO pump and Lovejoy coupling. Tightened bottom 4 capscrews.
- Measured "as found" pump thrust at 0.016" as previously noted. Need to add 0.005" shim to properly set thrust at 0.011".
- Removed NDE bearing housing end cover with IMO pump and Lovejoy coupling.
- Removed outboard oil seal and thrust setting plate.

Site does not currently have any 0.005" shim stock on site. They have ordered shim stock that will be delivered tomorrow before lunch. The only work available to do at this point is to manufacture gaskets for the NDE bearing housing oil supply and return lines and make up those joints. Site personnel will take care of that tomorrow morning while we are waiting on shim material to arrive. Will continue with pump reassembly and alignment check tomorrow. Removed lock from clearance. Returned to hotel. (Worked 10 hours) Completed admin (Worked 2 hours)

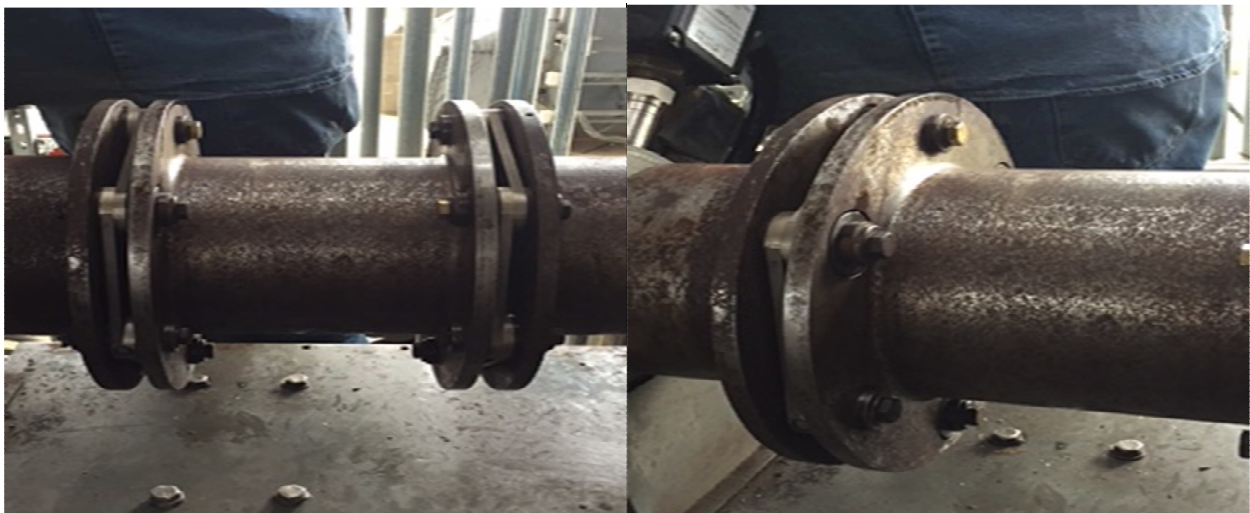
Thursday, 1 December 2016

Traveled to site. Met with Tommy Gardner. Currently standing by on site awaiting arrival of shim material. Participated in site JSEA. Locked onto site clearance. Traveled to pump site. Met with site personnel and explained the process forward.

- Site personnel have manufactured new garlock gaskets for the NDE bearing housing oil supply and return lines. Both lines have been made up and bolts have been tightened.
- Shim material has been received and a 0.005" gasket has been manufactured.
- Installed shim.
- Installed NDE bearing housing end cover with IMO pump and Lovejoy coupling. Tightened bottom 4 capscrews.
- Checked thrust. Thrust measured at 0.016".
- Manufactured and installed another 0.005" shim. Thrust measured at 0.011" (repeated).

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- Removed NDE bearing housing end cover with IMO pump and Lovejoy coupling.
- Added oil to shaft and installed NDE sleeve bearing upper half verifying proper rotation.
- Added oil to thrust shoes and cages.
- Verified proper Molykote on NDE labyrinth seal o-ring.
- Installed bellville washers and buttons in NDE bearing housing upper half.
- Applied Loctite 518 to bearing housing split and installed NDE bearing housing upper half with dowel pins. Torqued bearing housing bolting to 125 ft-lbs.
- Applied Loctite 518 to NDE bearing housing end cover with IMO pump and Lovejoy coupling.
- Installed NDE bearing housing end cover with IMO pump and Lovejoy coupling. Torqued capscrews to 125 ft-lbs.
- Removed bearing housing plugs and verified proper thrust shoe alignment for RTD's.
- Site personnel reattached all seal piping and IMO pump oil piping.
- Attempted to prime suction line of IMO pump piping. *Piping would not hold oil!* Aux oil tank level continued to rise. Checked ImageViewer for drawings of the oil system based on pump serial number with no luck. Contacted Bill Rath and Watson Tomlinson, FLS, to discuss and they agree that a foot valve would normally be attached in this configuration. Removed all oil from the aux tank and removed the inspection access cover. The suction to the IMO pump has a straight pipe down to approximately 1.5" off bottom of tank with no foot valve and no threads cut into the pipe for such a valve. I have asked for follow-up with Coslada to ensure the design is correct.
- Reinstalled the aux oil tank inspection access cover. Filled with new oil.
- Site I&C personnel are connecting RTD's and prox probes at this time.
- I have asked that an informational discharge pressure gage be installed on this pump on the IMO discharge piping to ensure the IMO pump is physically pumping oil. Site personnel are installing at this time.
- Installed coupling spool piece IAW Siemens Dwg 6325235.



- Torqued NDE seal locking collar set screws to 24 ft-lbs IAW FLS dwg D0112019.
- Loosened NDE seal bolts and rolled setting devices away from seal sleeve. Tightened seal bolts.
- Installed NDE seal protective cover.
- Pump rotates freely with no rubbing or binding.

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- Installed coupling guard.

Pump work is complete. Received word from Bill Rath and Watson Tomlinson, FLS. They report that Coslada engineering reports the IMO pump is able to operate correctly without a foot valve on the suction line. Provided this information to Tommy Gardner, NAES. Pump is now ready to align for operation, place the oil system in operation to check for flow and leakage and to make preps for PMT. Removed lock from clearance. Standing by on site awaiting site operations personnel at this time. Clearance has been removed and the system is lined up. Oil system is operating in auto. Oil pressure is approximately 24 psig. DE / NDE seals have been vented. Oil temperature is approximately 65 degrees. Pump is ready for a start. Started pump. Oil pressure increased to approximately 38 psig and the aux oil pump secured. Oil pressure dropped to approximately 26 psig. Vibrations reported from DCS for the pump were all <1 mil and the motor were <1.5 mils. No oil or water leakage noted. No abnormal noise or vibration present. Pump appears to be operating normally. Pump was secured. Pump coasted down smoothly. Oil system operated as expected in auto. PMT completed satisfactorily. Released from site. Returned to hotel. (Worked 10 hours) Completed admin (Worked 2 hours)

Friday, 2 December 2016

Traveled to base (Traveled 8 hours)

Root Cause Analysis: *The metallic material noted in the oil filters was, in fact, babbitt from the NDE sleeve bearing. There was some smearing of babbitt noted on this bearing only. The DE and thrust bearings showed no damage.*

The NDE sleeve bearing damage was caused by water emulsion in the oil system. In journal bearings, the incompressibility of water relative to oil can result in a loss of the hydrodynamic oil film that in turn leads to excessive wear. As little as one percent water in oil can reduce the life expectancy of a journal bearing by as much as 90 percent. Damage was only noted on the NDE sleeve bearing. This is because the NDE sleeve bearing is the first bearing in the oil system flow path and, due to the infrequent operation of the pump, the water and damage was identified early and corrected.



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