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June 29, 2023

Mr. Chris Derrick Reliability Engineer Port Townsend Paper Corporation 100 Mill Road Port Townsend, WA 98368

#3 Boiler Feed Water Pump Bearing

Dear Chris,

Part of PetroCard's lubrication program is to provide Port Townsend Paper Corp (PTPC) with engineering service. Outlined in this report is documented data outlining a proven method to extend the life of the feed water pump bearings.

Background

In the steam and power area, PTPC has three feed water pumps that provide the mill with water. These pumps are critical to the operation of the mill. The pumps are coupled with precision bearings. These bearings are lubricated with a very small oil reservoir between 4 and 8 gallons. There is no filtration on the system. Over the years the reservoirs have accumulated contamination, and the only way keep the oil somewhat clean is to change it during a down. Because of the small reservoir and the precision bearings, adding any filtration has not been possible.

Contamination Study #3 Pump

To understand the amount of contamination, we utilized PetroCard's oil analysis program and took representative samples from the reservoir. The analysis revealed a high level of contamination; 37,709 particles/ml greater than 4 microns with an ISO cleanliness code of 22/20/15.

Evaluation of New Filtration System

PetroCard's on-site engineer is recommending that PTPC run a test using a newly developed hand carry filtration system. This system, designed and developed by Fluidloop, uses a variable speed pump with flow rates of 0.25 to 1.0 gallons/minute. In addition, the filter has the following features —

- 1. Slow flow/low pressure
- 2. High dirt holding capacity
- 3. Both water and particle removal. See attached brochure.

The results proved out. The 4 micron and greater number dropped from the 37,709 particles to 650 particles with an ISO code of 17/15/11. See oil analysis dated June 15. This is an acceptable cleanliness level.

Savings to PTPC

Using the LET (Life Extension Table) we can calculate that the life of the bearings will be extended by 3 times. See attached LET and Reliability Solutions Table.

Recommendations

PetroCard recommends that PTPC purchase a Fluidloop system, and set-up of all the feedwater pumps for filtration.

Respectfully,

Duane DeNotta Sales Engineer PetroCard

WEAR CONTAMINATION FLUID CONDITION **ABNORMAL** ABNORMAL **ATTENTION**

STEAM AND POWER

269.0095 #3 BOILER FEED WATER PUMP

Bearing Lube

RECOMMENDATION	Test	HOM	Method	LinitiAto	Current	History1	History?
Resample at the next service interval to monitor, (Customer Sample Comment, Pre-litter cart added)	Sample Number		Client Info		PEGGGGGGG	PF8000807	
	Sample Date		Client Info			22 May 2023	
	Machine Age	hrs	Client Info		0	0	
	Oil Age	hrs	Cherit Info		0	0	
	Filter Age	hrs	Client Info		0	0	
	Oil Changed		Chent Info		N/A	N/A	
	Filter Changed Sample Status		Client Info		N/A ABNORMAL	N/A ATTENTION	
WEAR	PO	*******	ASTM DB184		14	17	
VEAR	Iron	ppm	ASTM 16:185m	>120	6	3	
in the absence of other significant wear metals, suspect copper due to		ppm	ASTM EK: 85m		<1	-21	
sources other than wear (i.e. cooling core).	Nickel	ppm	ASTM (15186e)		<1	0	
	Titanium		ASTM DE185m	74.0	Ð	0	
	Silver	ppm	ASTM DE185m		9	0	
	Aluminum	ppm :	ASTM DS18Sm	-4	0	0	
	foad	ppm	ASIM DEISON		10	3	
		ppm	ASTM DS185m		A 137	A 66	
	Copper	ppm	ASTM (IS18Ser		0	0	
	Tim	ppm		>10		100	
	Vanadium	ppm	ASTM (Kritism	ASSOCIA	0	B	
	White Metal Yellow Metal	scalar scalar	"Visual "Visual	NONE	HONE	NONE	
CONTAMINATION	Silicon	ppm	ASTW(IS185es	>25	1	2	_
There is a high amount of particulates present in the oil. (PRE FILTER CART ADDED)	Potassaum	ppm	ASTW (5185e)	>20	質	3	
	R Particles >4µm		ASTM D7647	>2500	△ 37709	1985	
	Particles - Gum		ASTM D7647	>640	A 7974	396	
	Particles > 14um		ASTM D7647	>160	A 310	17	
	Particles >21µm		ASIM DIGG	>40	A 65	3	
BEFORE Filtration	Particles Shum		ASTM D7547	>10	3	0	
	Particles >/1um		ASTM 07647		0	0	
	Oil Cleaniness		ISO 4486 (c)		A 22/20/15	18/16/10	
	Sill	scalar	*Visual	NONE	NONE	NONE	
	Dobris	scalar	*Visual	NONE	NONE	NONE	
	Sand/Dirt	scalar	'Visual	NONE	HONE	NONE	
	Appearance	scalar	*Visual	NORM.	NORMU	NORM	
	Odor	scalar	*Visual	NORM.	HORML	NORME	
	Emulatinal Water	scalar	"Visual	-02	NEG	NEG	
FLUID CONDITION	Sodium	ppm	ASTM (5:185m		<1	a)	: (
	Boron	ppm	ASIM DE185m		0	0	
Additive levels indicate the addition of a different brand, or type of or	Banum	ppm	ASTM (6185m		0	0	
Confirm oit type. The AN level is acceptable for this fluid. The condition of the oil is suitable for further service.	Molybdenum	ppm	ASTM D5185m		<1	0	-
	Manganese	ppm	ASTM (75185m		<1	<3	
	Magnesium	ppm	ASTM DS185m		<1	<1.	
	Calcium	ppm	ASTM DS185m		7	8	
	Phosphorus	ppm	ASTM DS185m		A 321	▲ 305	
	Zinc	ppm	ASTM DS185m		A 213	A 110	
	Sultur	ppm	ASTW D5185m		A 1355	▲ 1250	-
	Acid Number (AN)		ASTM D8045		0.45	0.53	
	Visc @ 40°C	cSt	ASTM D445		60.6	65.0	

WEAR CONTAMINATION **FLUID CONDITION** NORMAL NORMAL NORMAL

STEAM AND POWER

269.0095 #3 BOILER FEED WATER PUMP

Bearing Lube

RECOMMENDATION	Test Sample Humber	MOU	Method Client Info	LimitAbn	Current PE0000002	History1 PE0000808	11story2 progress
Resample at the next service interval to monitor.	Sample Date		Client Info		15 Jun 2023	72 May 2023	22 May 707
	Machine Age	hrs	Client Info		0	0	0
	Oil Age	hes	Client Info		0	0	0
	Filter Age	hrs	Client Info		0	0	0
	Oil Changed	18.5	Client Info		N/A	N/A	N/A
	Filter Changed		Client Info		NA	NEA.	N/A
	Sample Status		Casa and		HORMAL	ABNORMAL	ATTENDO
VEAR	PQ		ASTM DB184	******	16	14	17
1 LAN	from	ppm	ASTM (E/85m	>120	4	6	3
All component wear rates are normal.	Chromium	ppm	ASTM DE185m	55	0	-11	<1
	Nickel	ppm	ASTM EK (85m		0	~1	0
	Titanium	ppm	ASTM EESt85m		0	0	(7
	Silver	ppm	ASTM DS185m		0	0	0
	Aluminum	ppm	ASTM EX185m	A	0	0	0
	Load	ppm	ASTM DS10Sm		3	10	3
	Copper	ppm	ASTM DS185m		62	▲ 137	▲ 66
	Tin	ppm	ASTM (16185m		0	6	0
	Vanadium	ppm	ASTM (16185m	- 10	<1	Ö	17
	White Motal	scalar	*Visual	NONE	NONE	11011	LIGHT
	Yellow Metal	scalar	Visual	NONE	NONE	NONE	NONE
CONTAMINATION	Silicon	ppmy	ASTM DESESOR	>25	2	3.	7
	Potassium	ppm	ASTM 05185m	>20	0	1	1
There is no indication of any contamination in the oil. The amount and size of particulates present in the system are acceptable.	Particles =4µm		ASTM 0/647	>2500	655	A=37709	1985
	40		A CONTRACTOR AND				
aze of particulates present in the system are acceptable.	Particles >Gum		ASTM D7647	>640	193	A 7974	396
ace of paraculates present in the system are acceptable.	Particles >6µm Particles >14µm		ASIM D/647	>640	193	▲ 7974 ▲ 310	396
size of paraculates present in the system are acceptable.	Particles >14µm				1719		
AFTER Filtration			ASIM D7547	>160	18	<u>▲</u> 310	17
	Particles >14µm Particles >21µm		ASIM D/GA/ ASIM D/GA/ ASIM D/GA/	>160	18	▲ 310 ▲ 65	3
	Particles >14µm Particles >21µm Particles >38µm		ASIM D/647 ASIM D/647	>160 >40 >10	18	▲ 318 ▲ 65 3	1/ 3 0 0
	Particles >14µm Particles >21µm Particles >38µm Particles >71µm Oil Cleanliness	scalar	ASIM D/647 ASIM D/647 ASIM D/647 ASIM D/647	>160 >40 >10 >3	18	▲ 318 ▲ 65 3 0	1/ 3 0 0 18/16/1
	Particles >14µm Particles >21µm Particles >38µm Particles >71µm	scalar scalar	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Visual	>160 >40 >10 >3 >181914	18 6 1 0 17/15/11	▲ 318 ▲ 65 3 0 ▲ 22/99/15	1/ 3 0 0 1816/1 NONE
	Particles >14µm Particles >21µm Particles >38µm Particles >71µm Oil Cleanliness Sét		ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c)	>160 >40 >10 >3 >1806/4 NONE	18 6 1 0 17/15/11 NONE	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE	1/ 3 0 0 18/16/1 NONE NONE
	Particles >14pm Particles >21pm Particles >38pm Particles >71pm Oil Cleanliness Sitt Debris Sand/Dirt	scalar scalar	ASIM D/647 ASIM D/647 ASIM D/647 ASIM D/647 ISO 4406 (c) "Visual "Visual	>160 >40 >10 >3 >181914 NONE NONE	18 6 1 0 17/15/11 NONE NONE	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE NONE	1/ 3 0 0 18/16/1 NONE NONE NONE
	Particles >14µm: Particles >21µm Particles >38µm Particles >71µm Oil Cleanliness Sáti Debris	scalar	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Visual "Visual "Visual	>160 >40 >10 >3 >181914 NONE NONE NONE	18 6 1 0 17/15/11 NONE NONE	▲ 318 ▲ 65 3 0 ▲ 22/2015 NONE NONE NONE	1/ 3 0 0 1836/1 NONE NONE NONE
	Particles >14µm Particles >21µm Particles >38µm Particles >71µm Oil Cleanliness Silt Debris Sand/Dirt Appearance	scalar scalar scalar	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Vestal "Vestal "Vestal	>160 >40 >10 >3 >18/16/14 NONE NONE NONE	18 6 1 0 17/15/11 NONE NONE NONE NORML	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE NONE NONE NORE	1/ 3 0 0 18/16/1 NONE NONE NORE
	Particles >14µm Particles >21µm Particles >21µm Particles >71µm Oil Cleanliness Silt Debris Sand/Dirt Appearance Odor	scalar scalar scalar scalar	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4466 (c) "Visual "Visual "Visual "Visual "Visual	>160 >40 >10 >3 >181614 NONE NONE NORM NORM	18 6 1 0 17/15/11 NONE NONE NORML NORML NEG	▲ 318 ▲ 65 3 0 ▲ 22/25/15 NONE NONE NORE NORM NORM NORM NORM	17 3 0 0 18/16/1 NONE NONE NOHM NOHM NEG
AFTER Filtration	Particles > 1 4µm: Particles > 21µm Particles > 30µm Particles > 71µm Oil Cleanliness Sill Debris Sand/Dirt Appearance Odor Emulsiled Water	scalar scalar scalar scalar scalar	ASIM DIGGI ASIM DIGGI ASIM DIGGI ASIM DIGGI SO 4406 (c) "Visual "Visual "Visual "Visual "Visual "Visual	>160 >40 >10 >3 >181614 NONE NONE NORM NORM	18 6 1 0 17/15/11 NONE NONE NORE NORML NORML	▲ 318 ▲ 65- 3 0 ▲ 22/25/15- NONE NONE NORE NORML NORML NORML	17 3 0 0 18/16/1 NONE NONE NOHM NOHM
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 71µm Oil Cleanliness Sill Debris Sand/Dirt Appearance Odor Emulsiled Water Sodium	scalar scalar scalar scalar scalar	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ (c) "Visual "Visual "Visual "Visual "Visual "Visual "Visual "Visual	>160 >40 >10 >3 >181614 NONE NONE NORM NORM	18 6 1 0 17/15/11 NONE NORE NORML NORML NEG	▲ 318 ▲ 65 3 0 ▲ 22/25/15 NONE NONE NORE NORM NORM NORM NORM	17 3 0 0 18/16/1 NONE NORM NORM NORM NORM
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 71µm Oil Cleanliness Sill Debris Sand/Dirt Appearance Odor Emulsiled Water Sodium Boron	scalar scalar scalar scalar scalar ppm ppm	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Visual "V	>160 >40 >10 >3 >81914 NONE NONE NORM NORM >0.2	18 6 1 0 17/15/11 NONE NORE NORML NORML NEG	▲ 318 ▲ 65 3 0 ▲ 22/25/15 NONE NONE NORM NORM NORM NORM 0 <1 0 <1	1/ 3 0 0 18/16/1 NONE NORM NORM NORM NORM NORM O
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 7 µm Oil Cleanliness Sitt Debris Sand/Dirt Appearance Odor Emulsited Water Sodium Boron Barium	scalar scalar scalar scalar scalar ppm ppm	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Vestal "ASIM D6/85/ ASIM D6/85/ ASIM D6/85/ ASIM D6/85/ ASIM D6/85/	>160 >40 >10 >3 >81914 NONE NONE NORM NORM >0.2	18 6 1 0 17/15/11 NONE NORE NORML NORML NEG	▲ 318 ▲ 65 3 0 ▲ 22/25/15 NONE NONE NORM NORM NORM NORM 0 <1 0 <1	17 3 0 0 18/16/1 NONE NORE NORM NORM NORM NORM O 0 0
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 7 µm Oil Cleanliness Sill Debris Sand/Dirt Appearance Odor Emulsiled Water Sodium Boron Barium Molybdenum	scalar scalar scalar scalar scalar ppm ppm ppm	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Visual "V	>160 >40 >10 >3 >81914 NONE NONE NORM NORM >0.2	18 6 1 0 17/15/11 NONE NORML NORML NEG	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE NONE NORM NORM NORM NORM 0 <1 0 <1 <1 <1	1/ 3 0 0 1RTG/ NONE NONE NOHN NOHN NO G
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 7 1µm Oil Cleanliness Silt Debris Sand/Dirt Appearance Odor Emulsited Water Sodium Boron Barium Molybdenum Manganese	scalar scalar scalar scalar scalar ppm ppm ppm ppm ppm	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Vestal "ASIM D6/85/ ASIM D6/85/ ASIM D6/85/ ASIM D6/85/ ASIM D6/85/	>160 >40 >10 >3 >81914 NONE NONE NORM NORM >0.2	18 6 1 0 17/15/11 NONE NORE NORML NORML NEG	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE NONE NORM NORM NORM NORM 10 0 <1 0 <1 <1 <1 <1	1/ 3 0 0 1RTG/ NONE NONE NOHN NOHN NO G
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 71µm Oil Cleanliness Silt Debris Sand/Dirt Appearance Odor Emulailed Water Sodium Boron Barium Molybdenum Manganese Magnesium	scalar scalar scalar ppm ppm ppm ppm	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Visual "ASIM Dilikso ASIM Dilikso ASIM Dilikso ASIM Dilikso ASIM Dilikso ASIM Dilikso	>160 >40 >10 >3 >8194 NONE NONE NORM NORM >0.2	18 6 1 0 17/15/11 NONE NORML NORML NEG	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE NONE NORE NORM NORM NORM 10 0 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1	1/ 3 0 0 IRTG/ NONE NONE NOHN NOEN NOEN 0 0
AFTER Filtration	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 71µm Oil Cleanliness Silt Debris Sand/Dirt Appearance Odor Emulsiled Water Sodium Boron Barium Molybdenum Manganese Magnesium Calcium	scalar scalar scalar scalar ppm ppm ppm ppm ppm	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Vestal "SIM D61856 ASIM D61856 ASIM D61856 ASIM D61856 ASIM D61856	>160 >40 >10 >3 >81914 NONE NONE NORM NORM >0.2	18 6 1 0 17/15/11 NONE NORML NORML NORML NEG 0 0	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE NONE NORM NORM NORM NORM 10 0 <1 0 <1 <1 <1 <1	1/ 3 0 0 IRTG/ NONE NONE NOHN NOHN NO G
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 71µm Oil Cleanliness Silt Debris Sand/Dirt Appearance Odor Emulsiled Water Sodium Boron Barium Molybdenum Manganese Magnesium Calcium Phosphorus	blow blow blow blow blow blow blow blow	ASIM DIGAT ASIM DIGAT ASIM DIGAT ASIM DIGAT ASIM DIGAT ASIM DIGAT VEGLAL VEGLAL VEGLAL VEGLAL ASIM DIGAT ASIM	>160 >40 >10 >3 >81974 NONE NONE NORM NORM >0.2	18 6 1 0 17/15/11 NONE NORML NORML NORML NEG 0 0 0	▲ 318 ▲ 65 3 0 ▲ 22/95/15 NONE NONE NORE NORM NORM NORM 10 0 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1	1/ 3 0 0 18/16/1 NONE NONE NOHM NOHM NEG -1 0 0 0 -1 -1 8
AFTER Filtration LUID CONDITION The AN level is acceptable for this fluid. The condition of the oil is	Particles > 1 4µm Particles > 21µm Particles > 30µm Particles > 71µm Oil Cleanliness Silt Debris Sand/Dirt Appearance Odor Emulsiled Water Sodium Boron Barium Molybdenum Manganese Magnesium Calcium Phosphorus Zinc	scalar scalar scalar scalar scalar scalar ppm ppm ppm ppm ppm ppm ppm ppm ppm	ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ASIM D/64/ ISO 4406 (c) "Vestal "ASIM D61866 ASIM D61866 ASIM D61866 ASIM D61866 ASIM D61866 ASIM D61866 ASIM D61866 ASIM D61866 ASIM D61866 ASIM D61866	>160 >40 >10 >3 -181914 NONE NONE NORM NORM >-0.2	18 6 1 0 17/15/11 NONE NORE NORML NEG 0 0 0 0 0 286 104	▲ 318 ▲ 65 3 0 ▲ 22/25/15 NONE NONE NORE NORM NORM NORM NORM 10 0 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1	17 3 0 0 18/16/1 NONE NONE NOHM NOHM NEG 0 0 0 -1 -1 -8



TypeISO Cleanliness Code	
ball bearings	15/13/11
roller bearings	16/14/12
journal bearings	17/15/12
industrial gearboxes	17/15/12
mobile gearboxes	17/16/13
diesel engines	17/16/13
steam turbine oils	18/15/12
paper machine oils	19/16/13
Hydraulic systems less than 1,500 psi	
servo valves	16/14/12
proportional valves	17/15/12
variable volume pump	17/16/13
cartridge valve	18/16/14
fixed piston pump	18/16/14
vane pump	19/17/14
pressure/flow control valve	19/17/14
solenoid valve	19/17/14
gear pump	19/17/14
Hydraulic systems 1500 to 2500 psi	
servo valves	15/13/11
proportional valves	16/14/12
variable volume pump	17/15/12
cartridge valve	17/16/13
fixed piston pump	17/16/13
vane pump	18/16/14
pressure/flow control valve	18/16/14
solenoid valve	18/16/14
gear pump	18/16/14
Hydraulic systems greater than 2500 psi	
servo valves	14/12/10
proportional valves	15/13/11
variable volume pump	16/14/12
cartridge valve	17/15/12
fixed piston pump	17/15/12
vane pump	17/16/13
pressure/flow control valve	17/16/13
solenoid valve	18/16/14
gear pump	18/16/14

Remember, these ISO cleanliness targets are suggested base targets. Improvement should be made on desired reliability and cost performance. To achieve these standards care must be taken to see that accurate sample results are there.