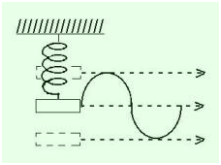


VIBETEC INC.

260 Collinge Rd. Hinton, AB T7V 1L3
Phone (780) 817-2233 Fax. (780) 817-2236
Email: rob@vibetec.com

Attention: **XXXXXXXXX**

Regarding: **Hyundai 750Hp Motor # 12353RMH263003**
400 Frame 3568 RPM

Dear Sirs,

The purpose of this letter is to summarize the details of our in-situ motor inspection

Reason for Investigation

High vibration amplitudes, most noticeably in the vertical direction.

Initial Inspection

Initial vibration signatures indicated high vibration amplitudes throughout the machine at 59.94 Hz (equivalent to rotational speed), normally the highest amplitudes would be found in the horizontal axis on this type of machine, however; the highest vibration amplitudes were recorded in the vertical axis. This gave me reason to suspect that the high vibration was the result of a resonance problem.

Tests Performed

Test #1

The first test to be carried out was a ring/bump test to see if the base/motor had any natural resonance around 60Hz – Nothing found.

Test #2

Motor/support plate/base-plate phase analysis:
All measurement recorded in the vertical

Location	Velocity In/Sec Peak	Phase Angle	Location	Velocity In/Sec Peak	Phase Angle

RIM	0.145	283°	LIM	0.178	215°
RIS	0.04	279°	LIS	0.035	230°
RIB	0.05	283°	LIB	0.027	242°
ROM	0.170	305°	LOM	0.120	280°
ROS	0.140	315°	LOS	0.080	296°
ROB	0.07	315°	LOB	0.05	295°

Legend:
R – Right, L – Left, I – Inboard, O – Outboard, M – Motor, S – Support Bracket, B – Base-Plate.
(Left & right looking from the back/ opposite drive end of the motor)

Conclusions all phase angles recorded gave no indication base or foundation problems, (a phase shift of 180° (on the same foot) is normally recorded when there is a foundation problem).

Test #3

The external cooling fan cover box had the highest amplitudes of vibration, I suspected that this could be the source of the resonance and had a hydraulic jack put underneath it to change the stiffness/natural frequency if the fan cover box.

This decreased the radial vibration on the outboard of the motor by approximately 40%; however the axial and inboard radial amplitudes increased slightly.

Test #4

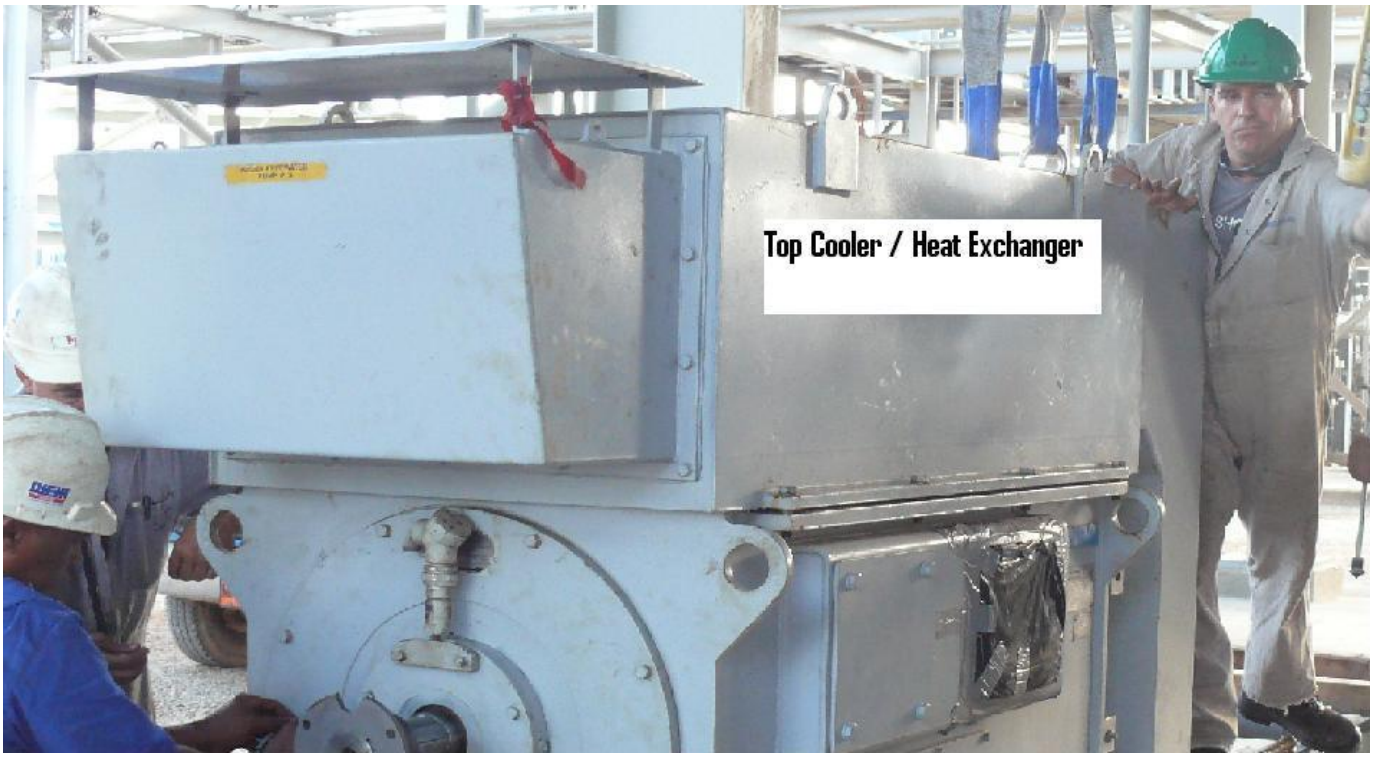
Visual and NDT testing of the machine found on broken support arm on the bottom left hand corner of the external fan shroud. The arm was welded and the hydraulic jack was removed. The vibration amplitudes dropped marginally at all measurement points except for the motor outboard horizontal.

Test #5

The fan cover box was removed and fan re-installed. Vibration amplitudes dropped by approximately 50% on the outboard of the motor (including axial vibration) but no significant change was found on the inboard of the motor.

Test #6

The heat exchanger was removed from the top of the motor.



All vibration amplitudes dropped to acceptable levels and amplitudes in the vertical axis are now lower than the horizontal.

The highest vibration amplitudes now emanated from the outboard bearing in the horizontal plane @ 0.14 In/Sec. I suspected that this remaining vibration amplitude was due to slight rotor/fan unbalance. With the knowledge that the main vibration issue was resonance, obtaining an extremely low balance quality would reduce the resonance exciting force.

There is no access to the inboard side of the rotor therefore a dynamic balance is not possible in-situ, I therefore decided to try a single plane balance with two measurement points, I have had a great deal of success with this method on slower speed machines but unfortunately it was unsuccessful on this motor.

Test #7

A new rubber gasket was installed and the heat exchanger was re-installed on the motor with the 8 bolts (4 per side) in place but not tight, the vibration amplitudes remained at acceptable levels. As soon as more than one bolt was tightened the vibration increased. The next four to five hours were spent trying to shim the heat exchanger, this did not successfully reduce the vibration; adding or subtracting a 0.005" shim dramatically changed vibration amplitudes and we were not able to find a good medium.

Test #8

The fan cover box was re-installed and the motor was analyzed again with the 8 heat exchanger bolts still not tight. All amplitudes remained at acceptable levels.

Test #9

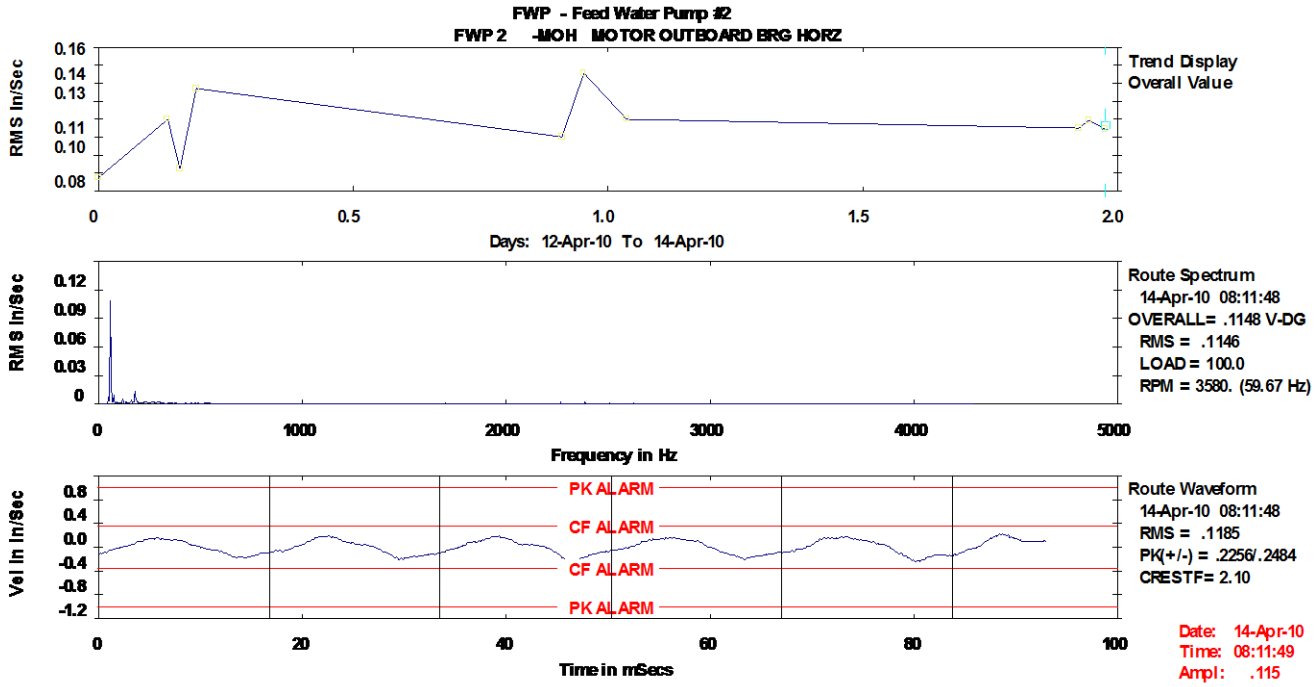
The motor was coupled and run under load with the heat exchanger still not tight and again all vibration amplitudes remained at acceptable levels.

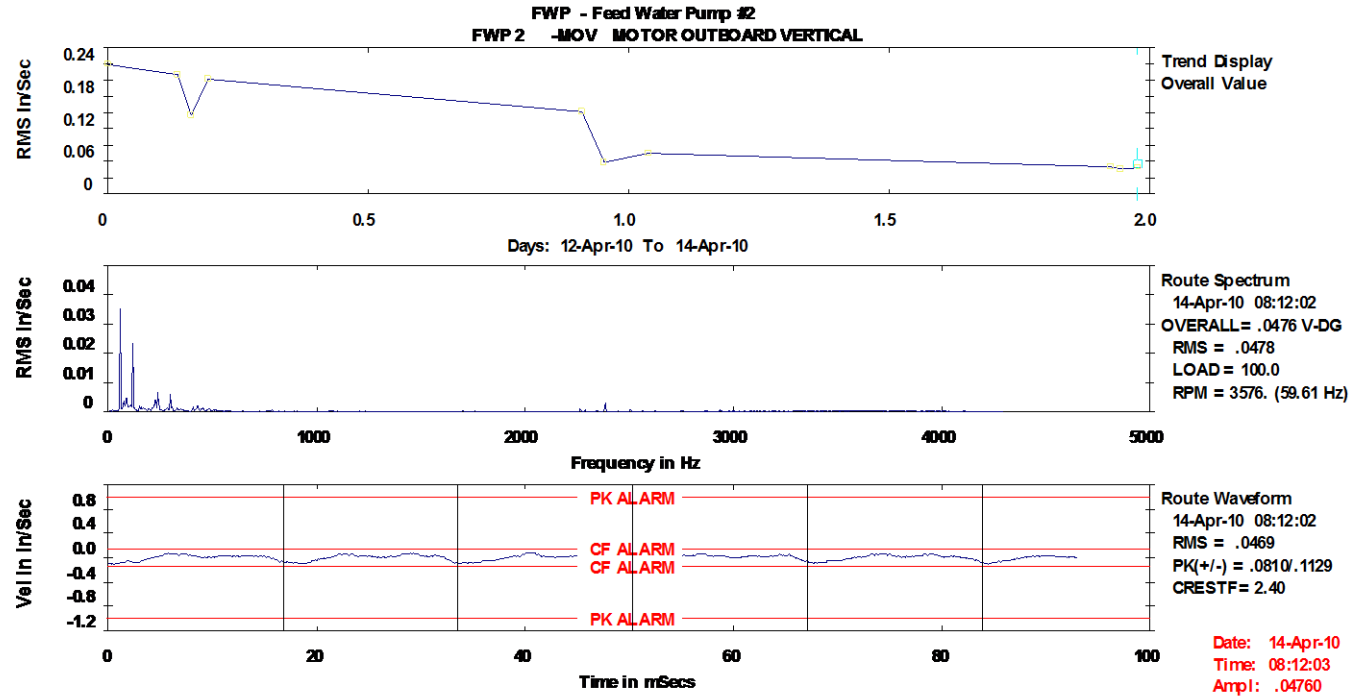
Vibration Trend Plots:

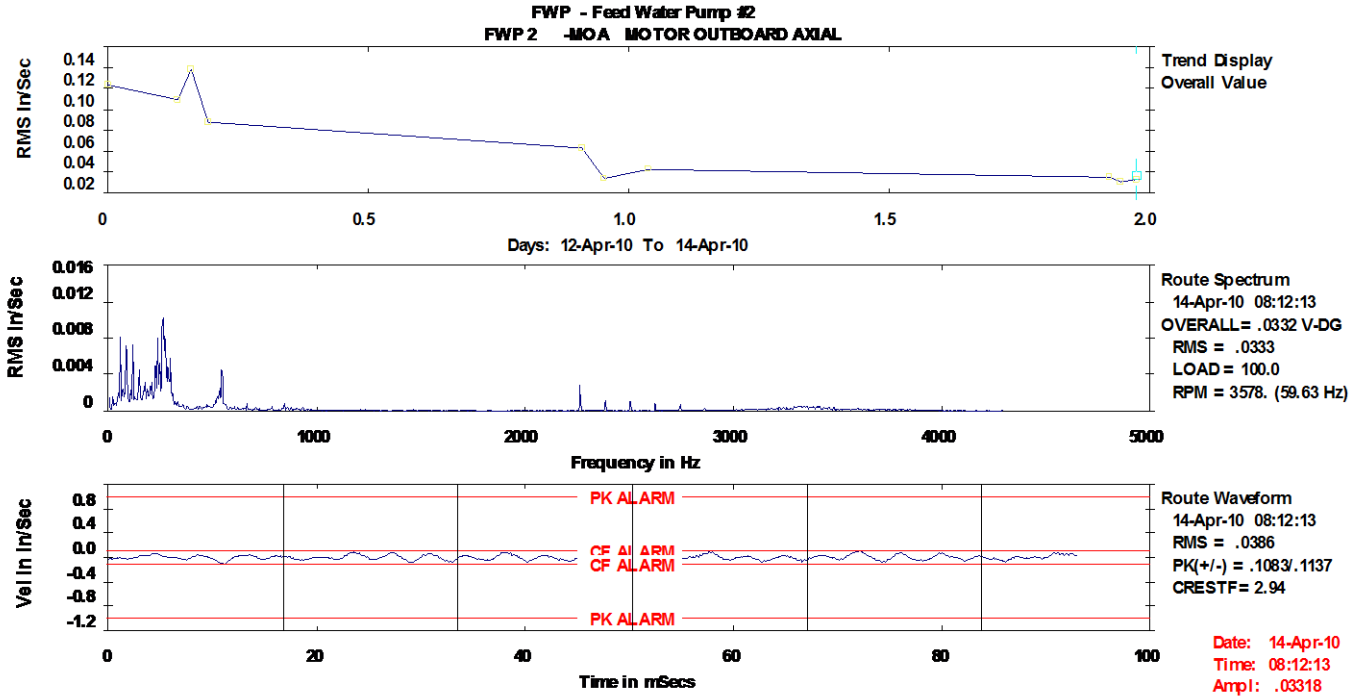
The 10 points on the trend plots are (from left to right):

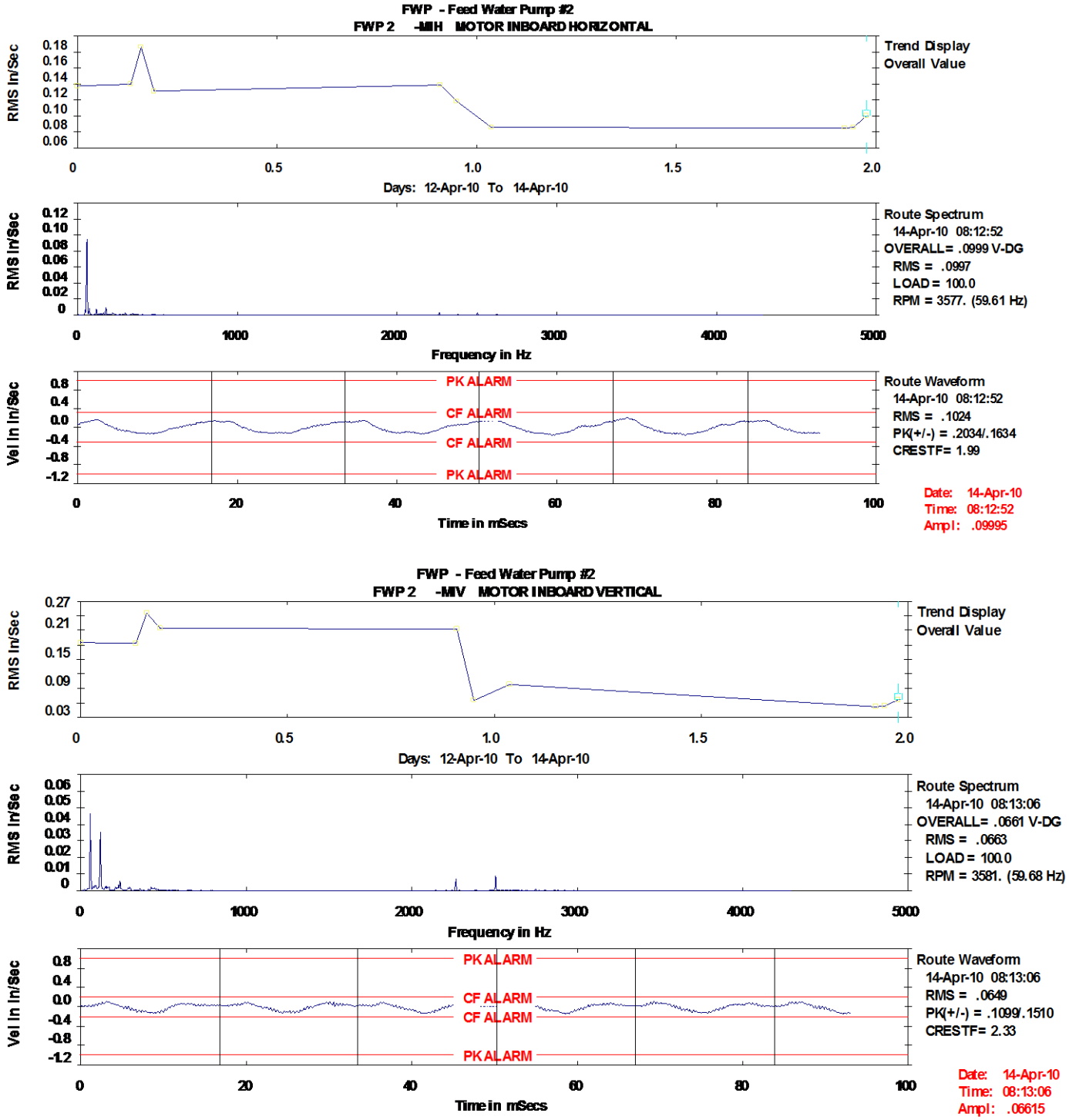
1/ Initial start – uncoupled
2/ After 3 hours – uncoupled
3/ External fan cover box jacked
4/ Fan cover box strut welded
5/ External fan cove box removed
6/ Heat Exchanger removed
7/ Heat Exchanger re-installed but not tightly bolted
8/ New rubber gasket installed
9/ External fan cover box re-installed
10/ Motor coupled and under load.

The spectrums and waveforms are with the motor coupled and under load.




FWP - Feed Water Pump #2
FWP 2 -MOV MOTOR OUTBOARD VERTICAL
RMS In/Sec
0.24
0.18
0.12
0.06
0
0
0.5
1.0
1.5
2.0
Trend Display
Overall Value
Days: 12-Apr-10 To 14-Apr-10
RMS In/Sec
0.04
0.03
0.02
0.01
0
0
1000
2000
3000
4000
5000
Frequency in Hz
Route Spectrum
14-Apr-10 08:12:02
OVERALL= .0476 V-DG
RMS = .0478
LOAD= 100.0
RPM = 3576. (59.61 Hz)
Vel In In/Sec
0.8
0.4
0.0
-0.4
-0.8
-1.2
PK ALARM
CF ALARM
CF ALARM
PK ALARM
0
20
40
60
80
100
Time in mSecs
Route Waveform
14-Apr-10 08:12:02
RMS = .0469
PK(+/-) = .0810/.1129
CRESTF= 2.40
Date: 14-Apr-10
Time: 08:12:03
Ampl: .04760


FWP - Feed Water Pump #2
FWP 2 -MOA MOTOR OUTBOARD AXIAL
RMS In/Sec
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0
0.5
1.0
1.5
2.0
Trend Display
Overall Value
Days: 12-Apr-10 To 14-Apr-10
RMS In/Sec
0.016
0.012
0.008
0.004
0
0
1000
2000
3000
4000
5000
Frequency in Hz
Route Spectrum
14-Apr-10 08:12:13
OVERALL= .0332 V-DG
RMS = .0333
LOAD= 100.0
RPM = 3578. (59.63 Hz)
Vel In In/Sec
0.8
0.4
0.0
-0.4
-0.8
-1.2
PK ALARM
CF ALARM
CF ALARM
PK ALARM
0
20
40
60
80
100
Time in mSecs
Route Waveform
14-Apr-10 08:12:13
RMS = .0386
PK(+/-) = .1083/.1137
CRESTF= 2.94
Date: 14-Apr-10
Time: 08:12:13
Ampl: .03318



Conclusion

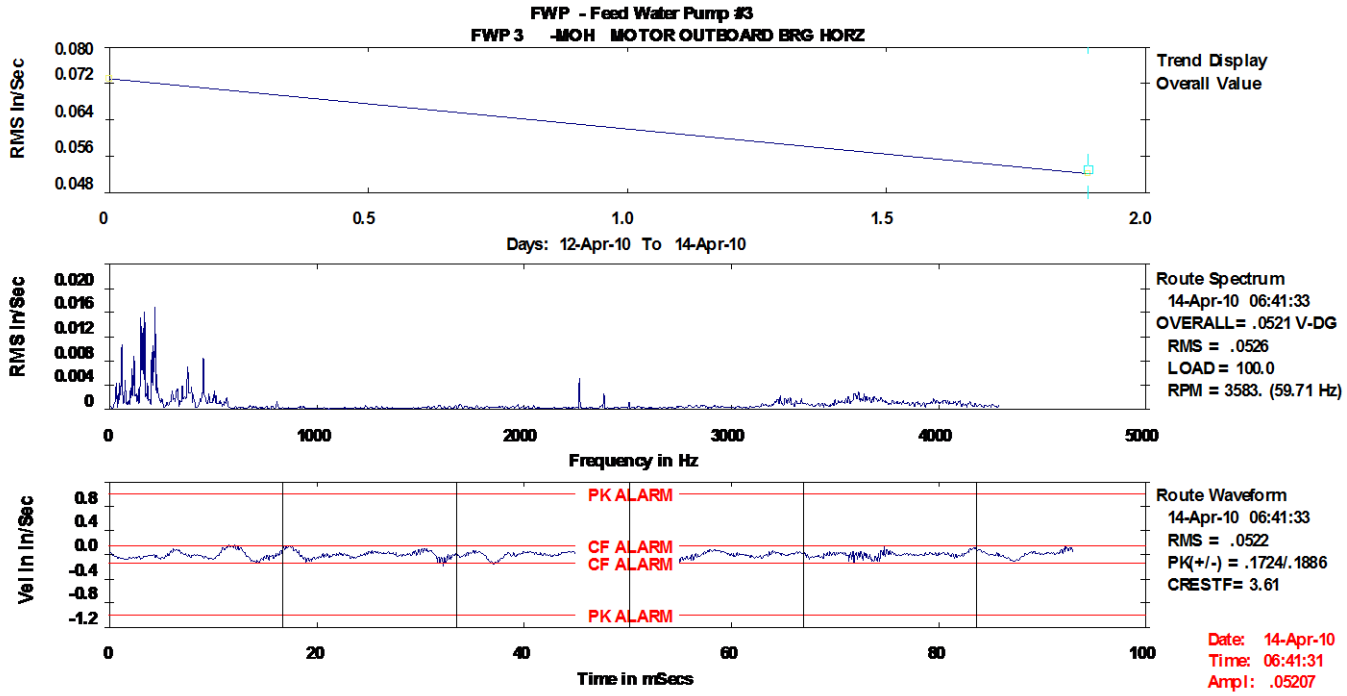
The high vibration levels are a result of resonance emanating from the heat exchanger on top of the stator. Considering that the vibration amplitudes change with slight adjustment of the heat exchanger and with temperature variation, would suggest that there is something damaged within the heat exchanger, possibly a broken weld on a cooling tube. Whatever is damaged within the heat exchanger is bringing the motor into a resonant frequency when it is secured tightly on top.

Option #1
Leave the heat exchanger with the bolts in place but not tightened. There is enough weight in the exchanger to create a seal between the motor and exchanger.

Option #2
Try to repair the heat exchanger, Hyundai may be able to issue a schematic diagram (this could be proprietary information and not available), of the internal construction of the exchanger this would help a feasibility decision to be made.

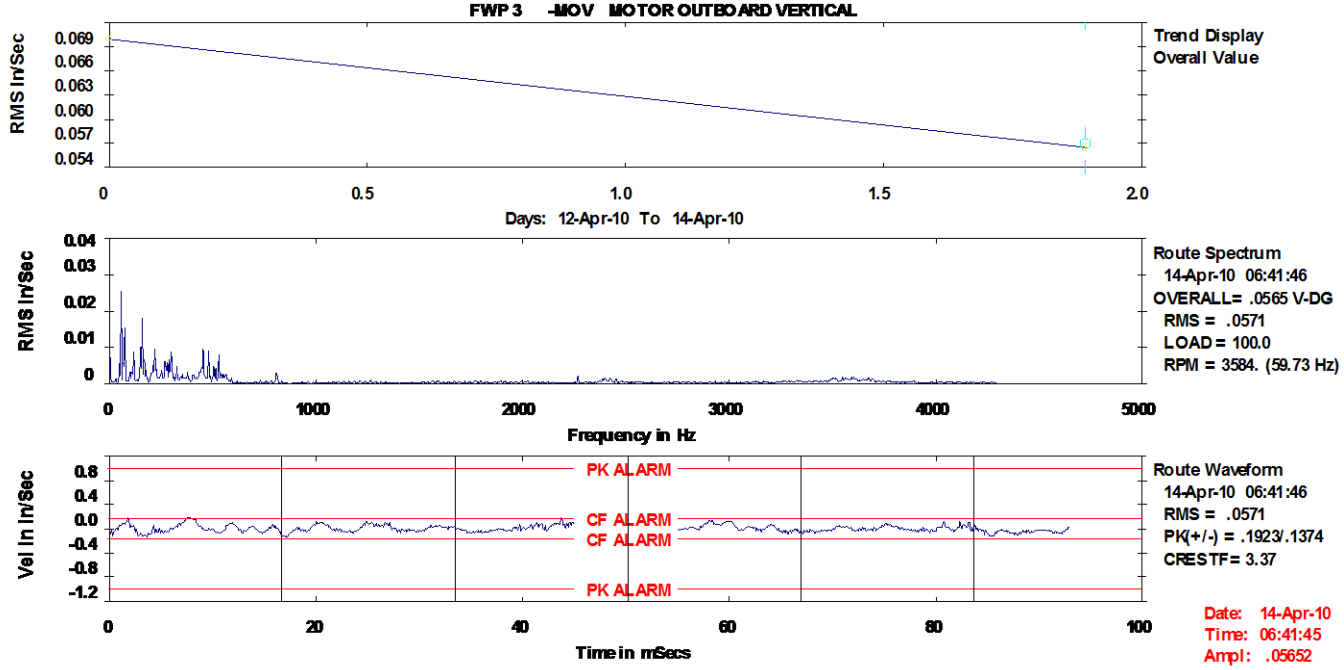
Option #3
Purchase a new heat exchanger.

Comment:
I analyzed all four feed water pumps, 1 & 4 are in good condition and pump #3 is in fair condition, however all motors have relatively high vibration amplitudes in the vertical direction. Pump #3 has the highest levels of vibration 0.73 in/sec (Motor Outboard Horizontal). When the heat exchanger was loosened all radial vibration levels dropped in amplitude. This is probably an early indication of a similar problem starting to occur.



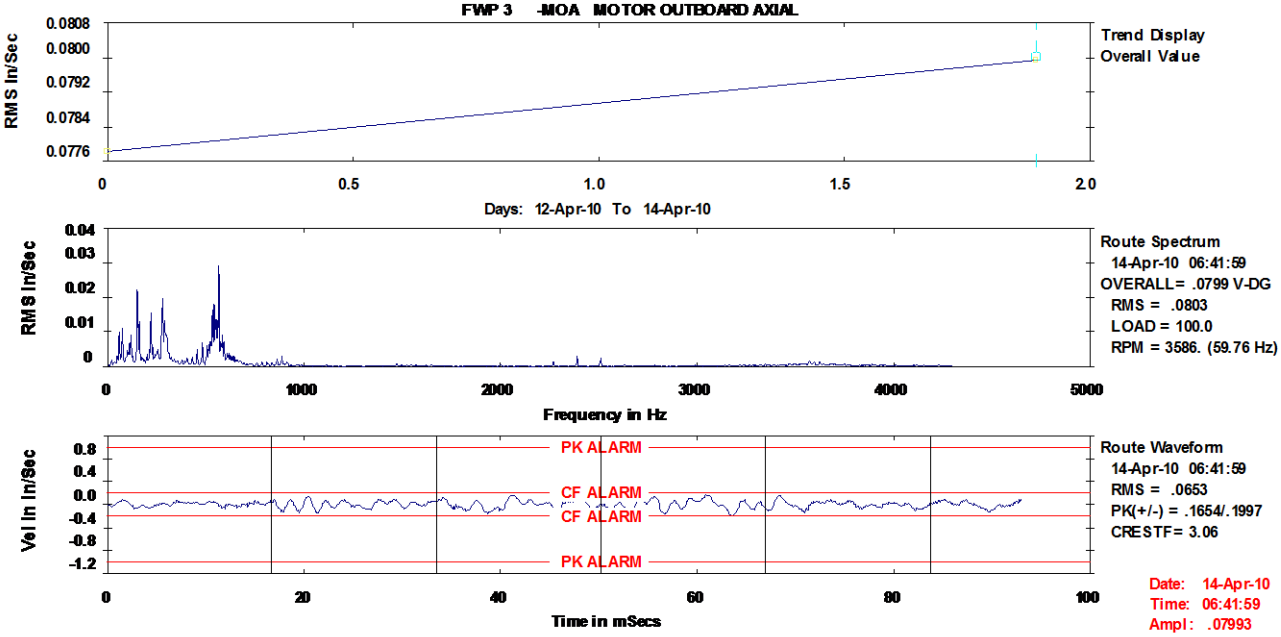
FWP - Feed Water Pump #3

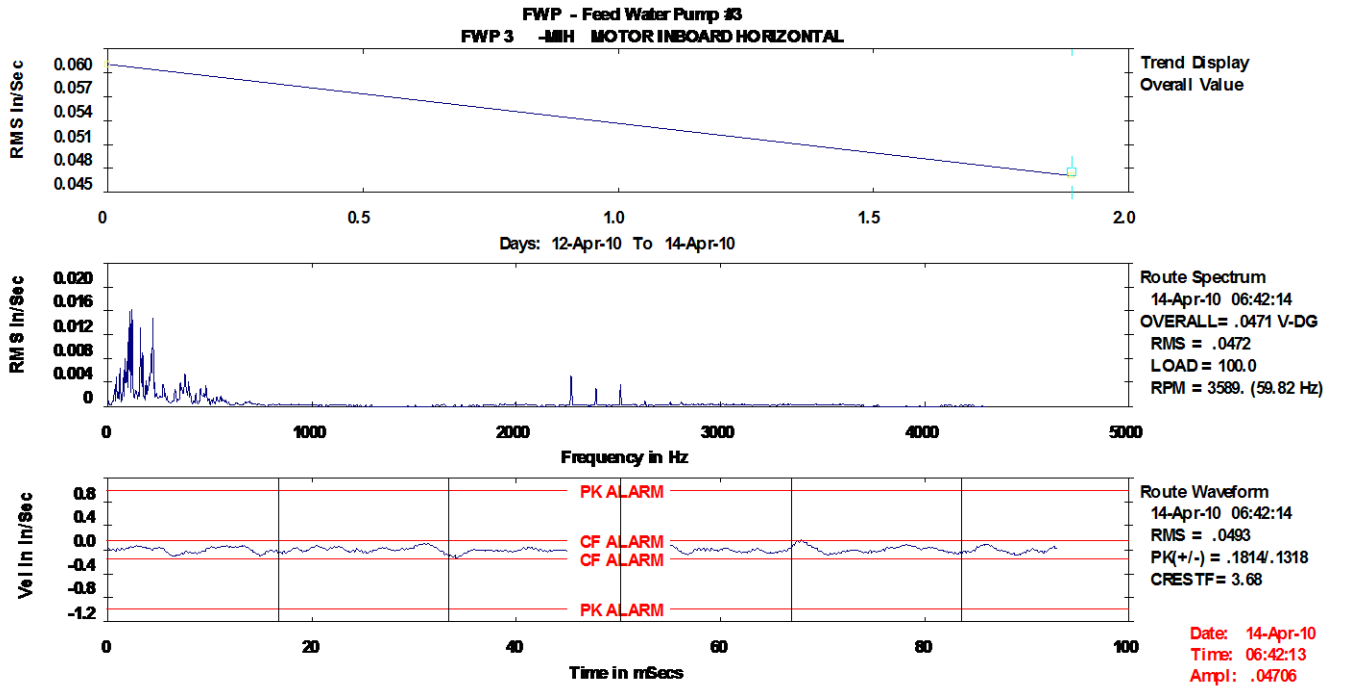
FWP 3 -MOV MOTOR OUTBOARD VERTICAL

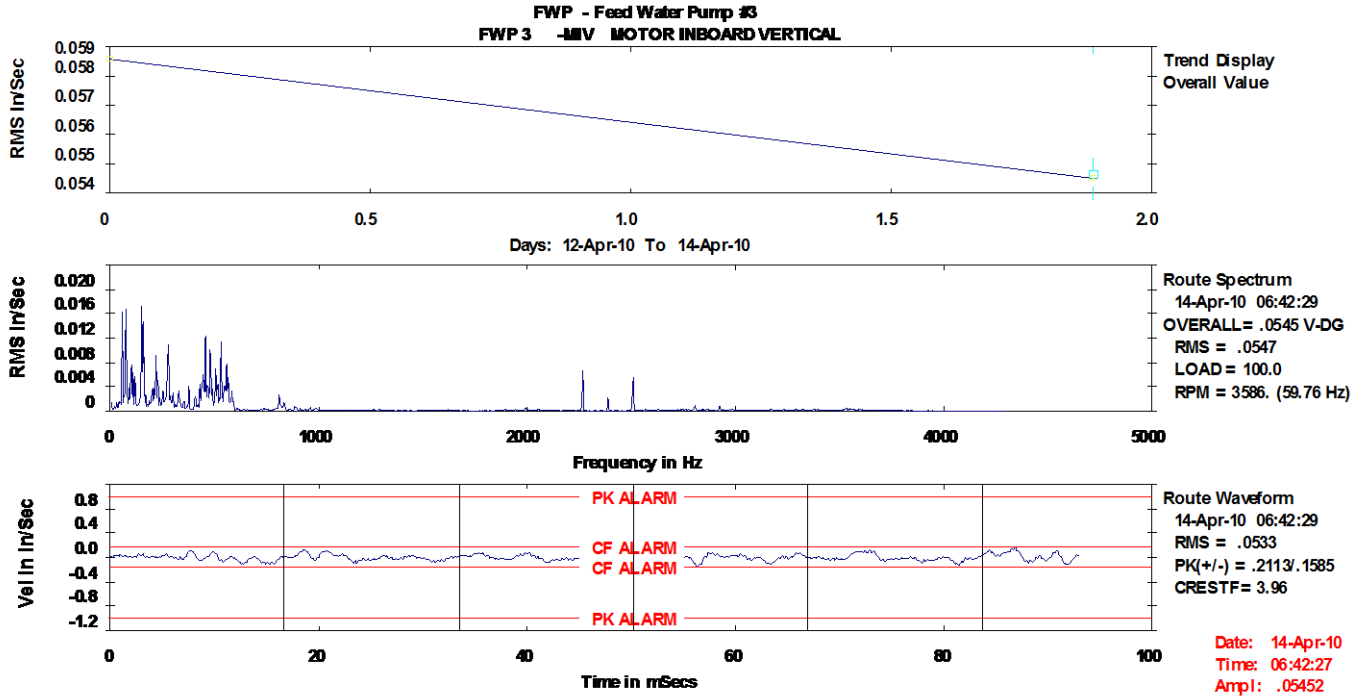


FWP - Feed Water Pump #3

FWP 3 -MOA MOTOR OUTBOARD AXIAL







I trust the above information is to your satisfaction. If you have any questions or require further information, please contact the undersigned.

Yours truly,

Rob Brentnall
(Major Accounts Manager)
Continental Electrical Motor Services Ltd.
(780) 920-1760