



The Not So Scary World of Centrifugal Chillers

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9/19/2014

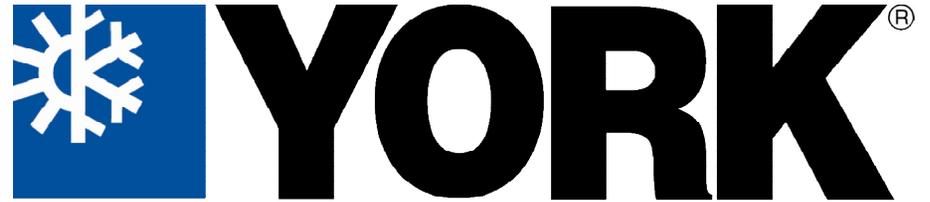
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Common Manufacturers



TRANE[®]



BY JOHNSON CONTROLS



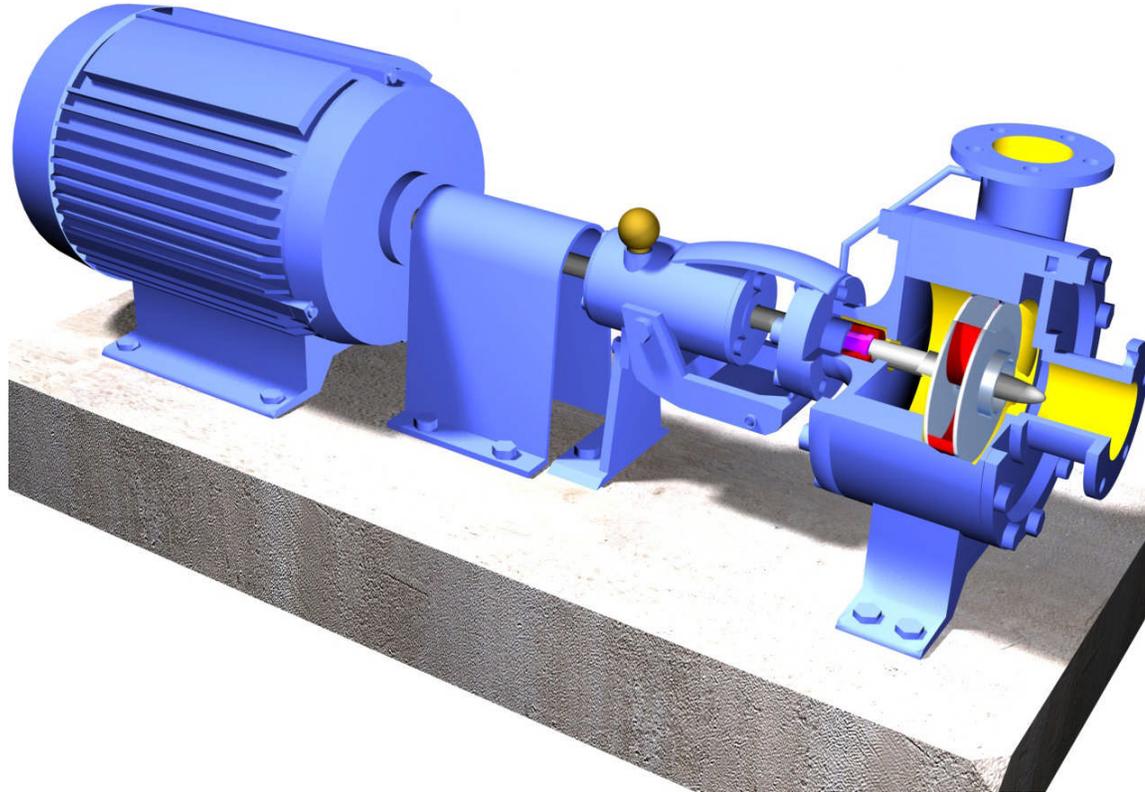
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-
- Do you have any Centrifugal chillers at your facility?
 - Are you performing routine vibration data collections?
 - If not, why not?
 - Complexity
 - Lack of understanding
 - Size
 - Dynamics
 - Safety concerns



Do you test your Pumps?



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Basic Understanding



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Types of Centrifugal Chillers

- Direct Drive
 - Multi-stage Semi hermetic (Trane)
 - Multi-Stage Semi Hermetic High Speed MagLev (TurboCor)
- Gearbox Driven
 - Single Stage Semi hermetic (Carrier)
 - Single Stage open drive (York)
 - Single stage Semi Hermetic High Speed (McQuay)



Safety Concerns

- Elevated work area with limited handholds and poor footing.
- Hot surfaces
- Oily and/or wet surfaces
- Pressurized refrigerant and oil lines
- Electrical lines and sensors
- Rotating components (usually well guarded)

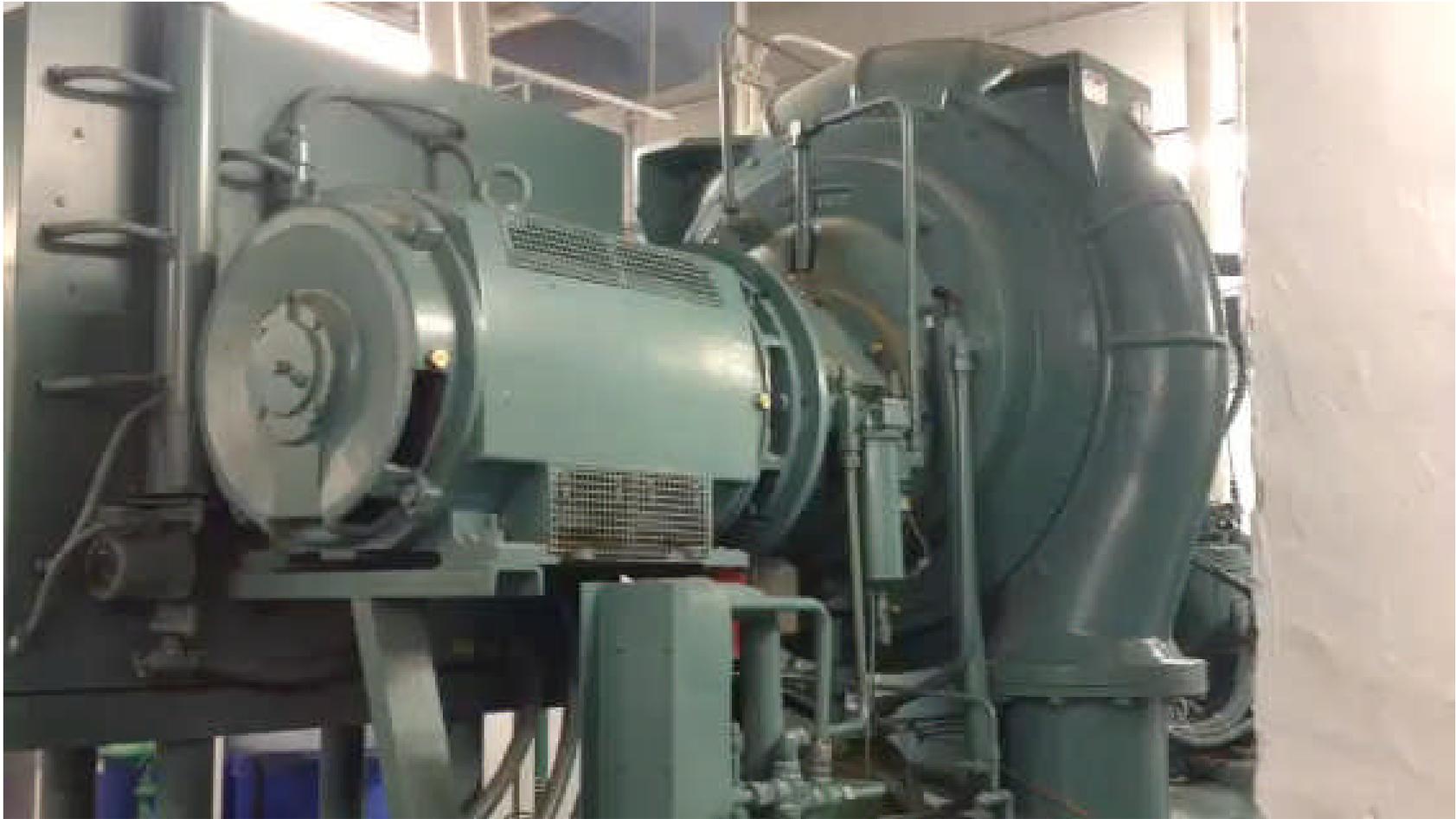


When to Collect Data

- When it's running
 - Ideally 30 minutes or longer
- When it's loaded
 - Preferably at or above 70% FLA but good data can be gathered at lower loads
- When it's stable



When NOT to collect



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What to collect

- As much operational data as possible
 - Load %FLA
 - Hours
 - Starts
 - VFD Output
 - Oil pressure
 - Water temps
 - Refrigerant pressures



Direct Drive Compressors

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Trane Centrifugal



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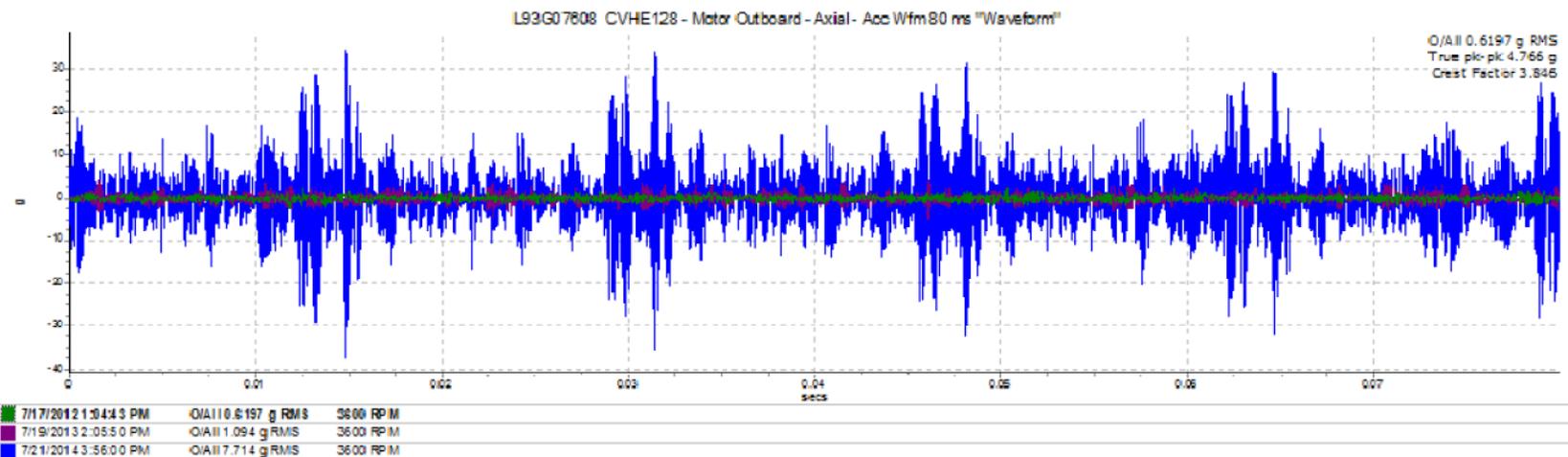
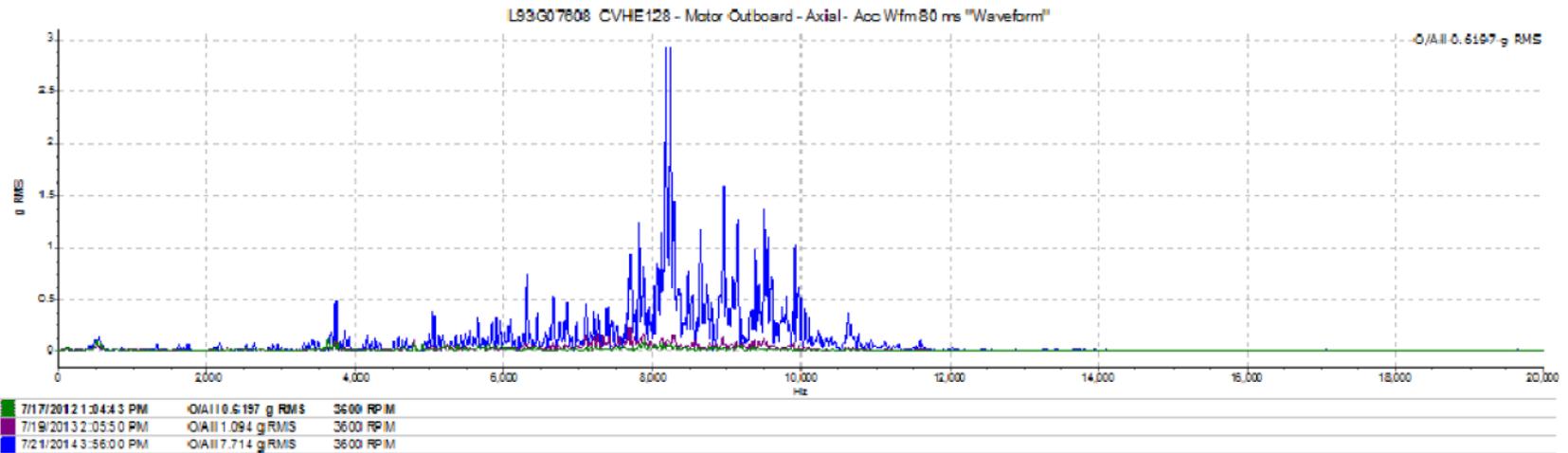
Trane Points Location



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Inner race Defect

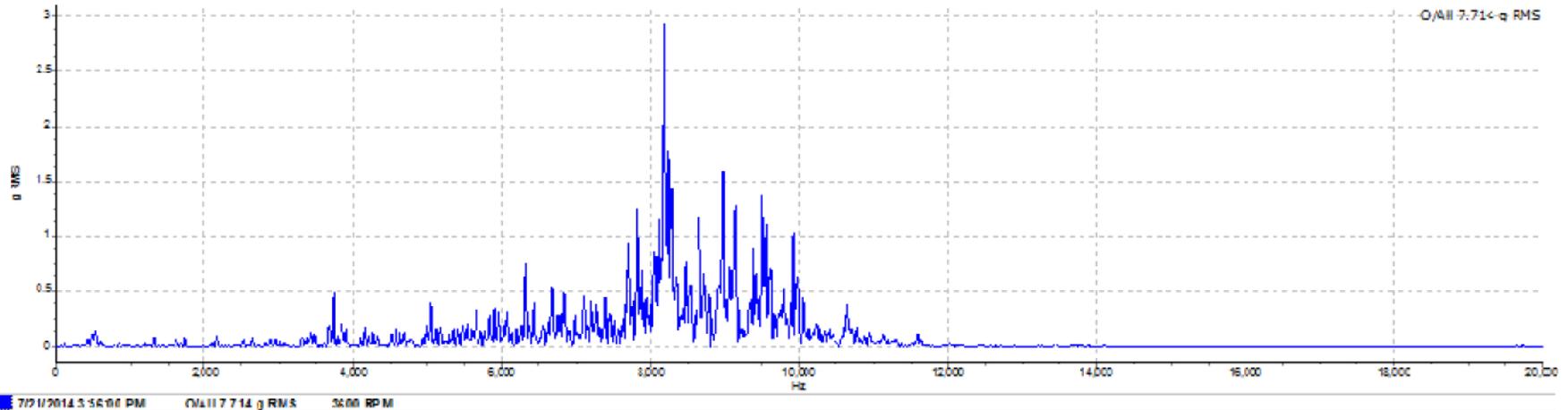


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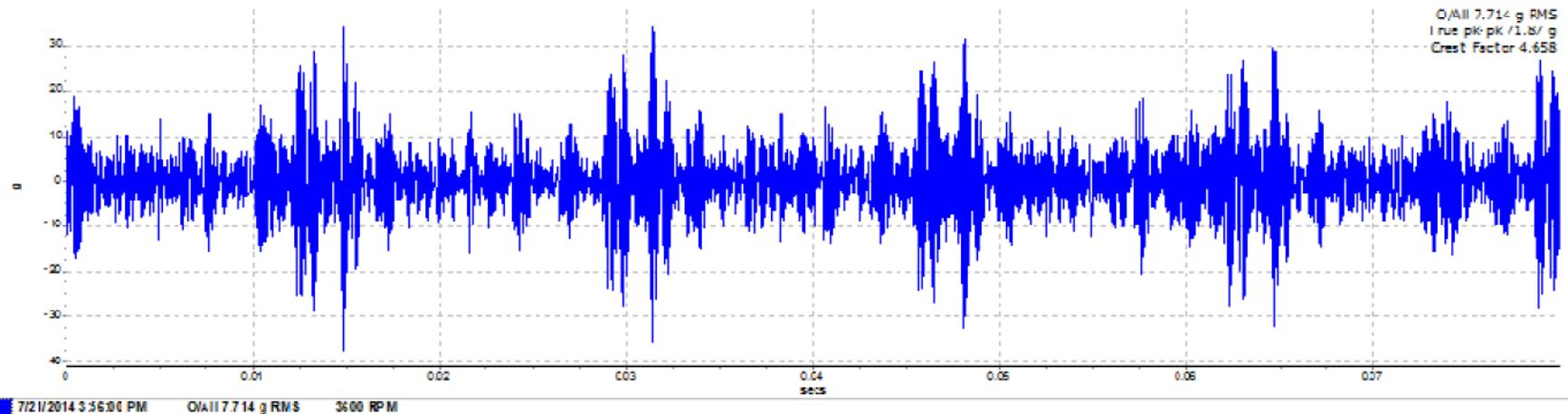


Inner Race Defect

L93G07808 CVHE128 - Motor Outboard - Axial - Acc Wfm80 ms "Waveform"
7/2/2014 3:56:00 PM



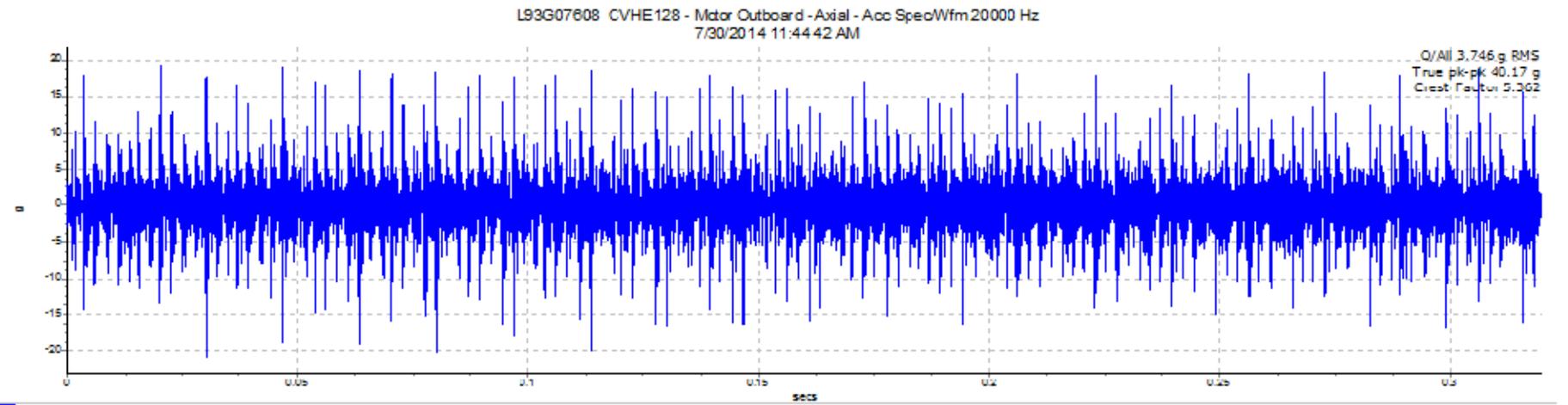
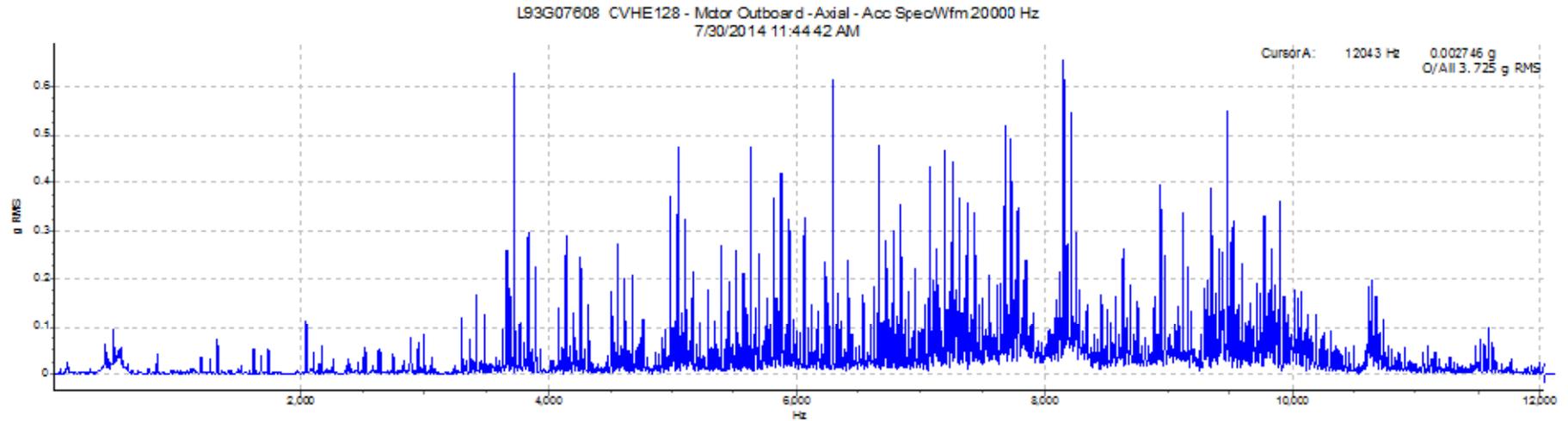
L93G07808 CVHE128 - Motor Outboard - Axial - Acc Wfm80 ms "Waveform"
7/2/2014 3:56:00 PM



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Inner Race Defect

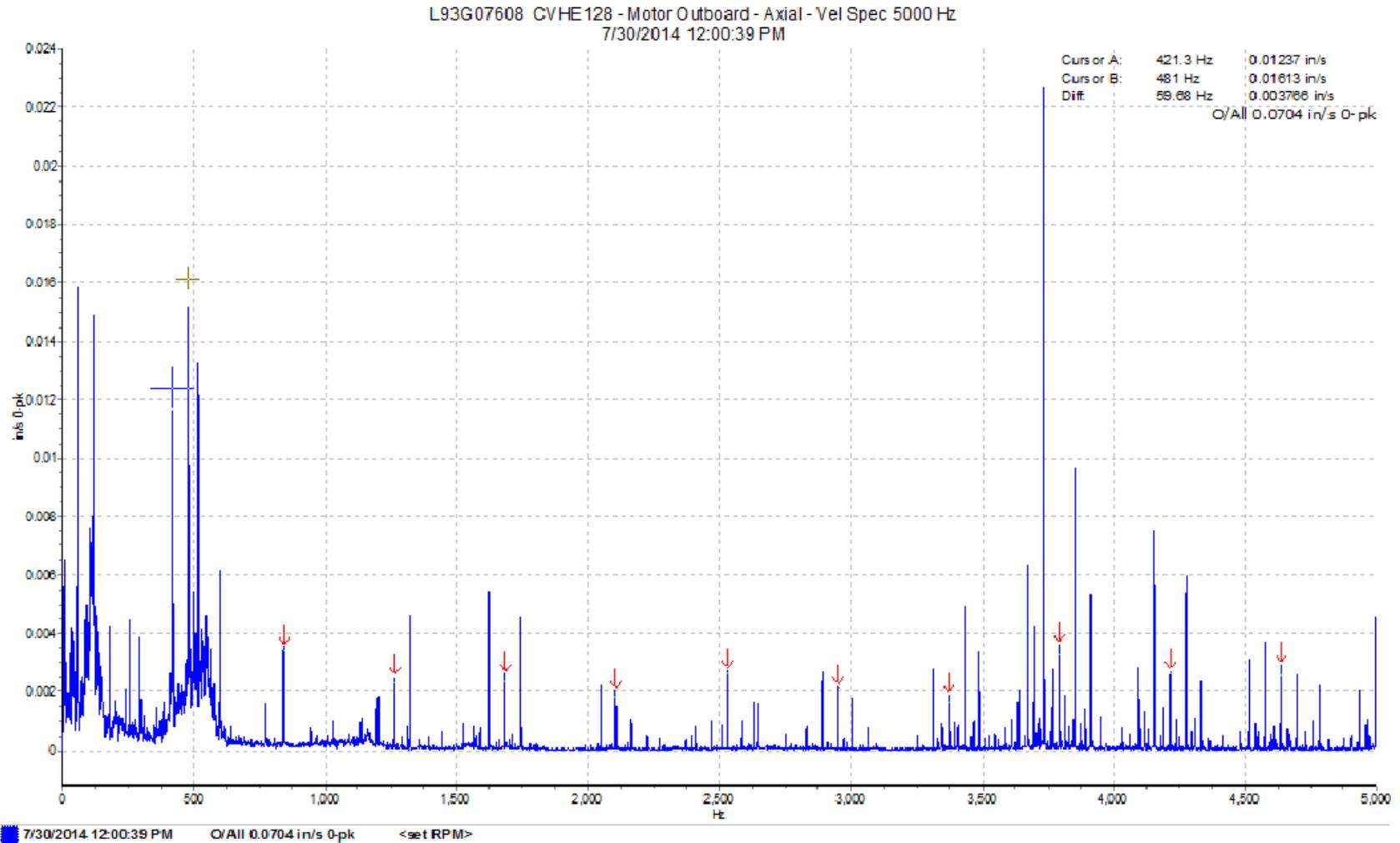


7/30/2014 11:44:42 AM Q/All 3.746 g RMS <set RPM>

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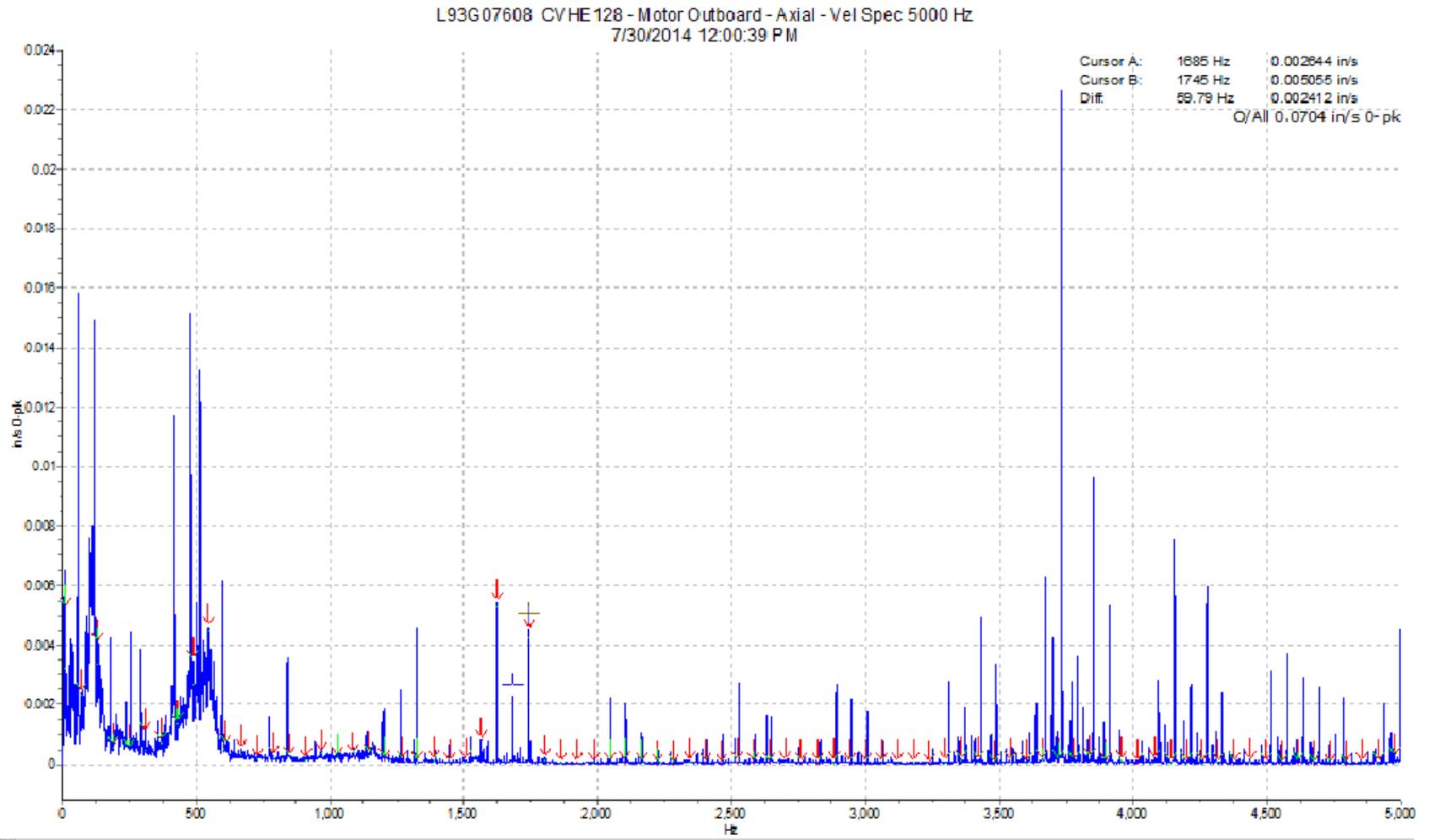
BPFI & Harmonics



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Sidebands



7/30/2014 12:00:39 PM O/All 0.0704 in/s 0-pk <set RPM>

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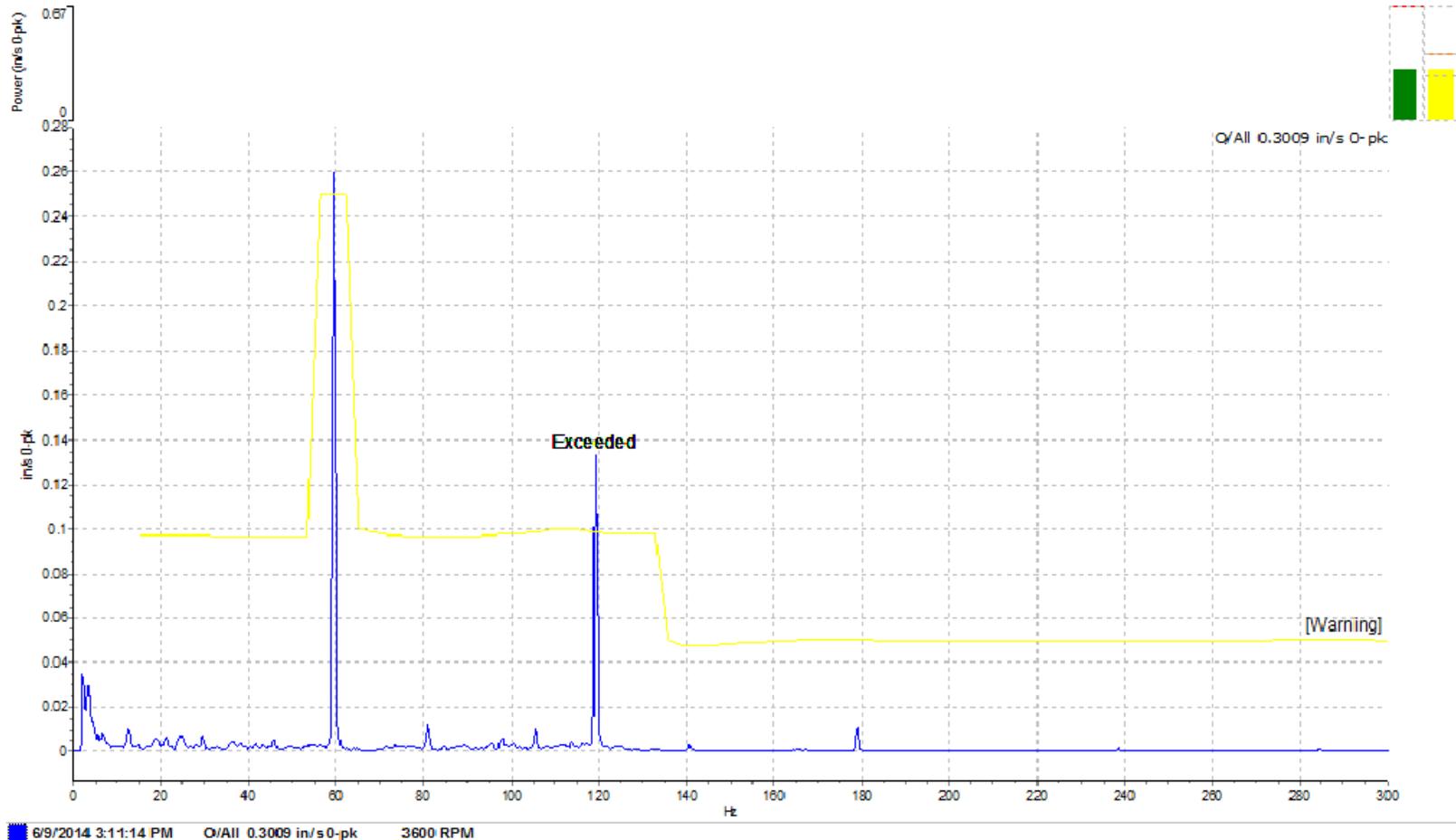


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MOV Reading

L94H08420 CVHF 128 - Motor Outboard - Vertical - Vel Spec 300 Hz *300 Hz*
6/9/2014 3:11:14 PM

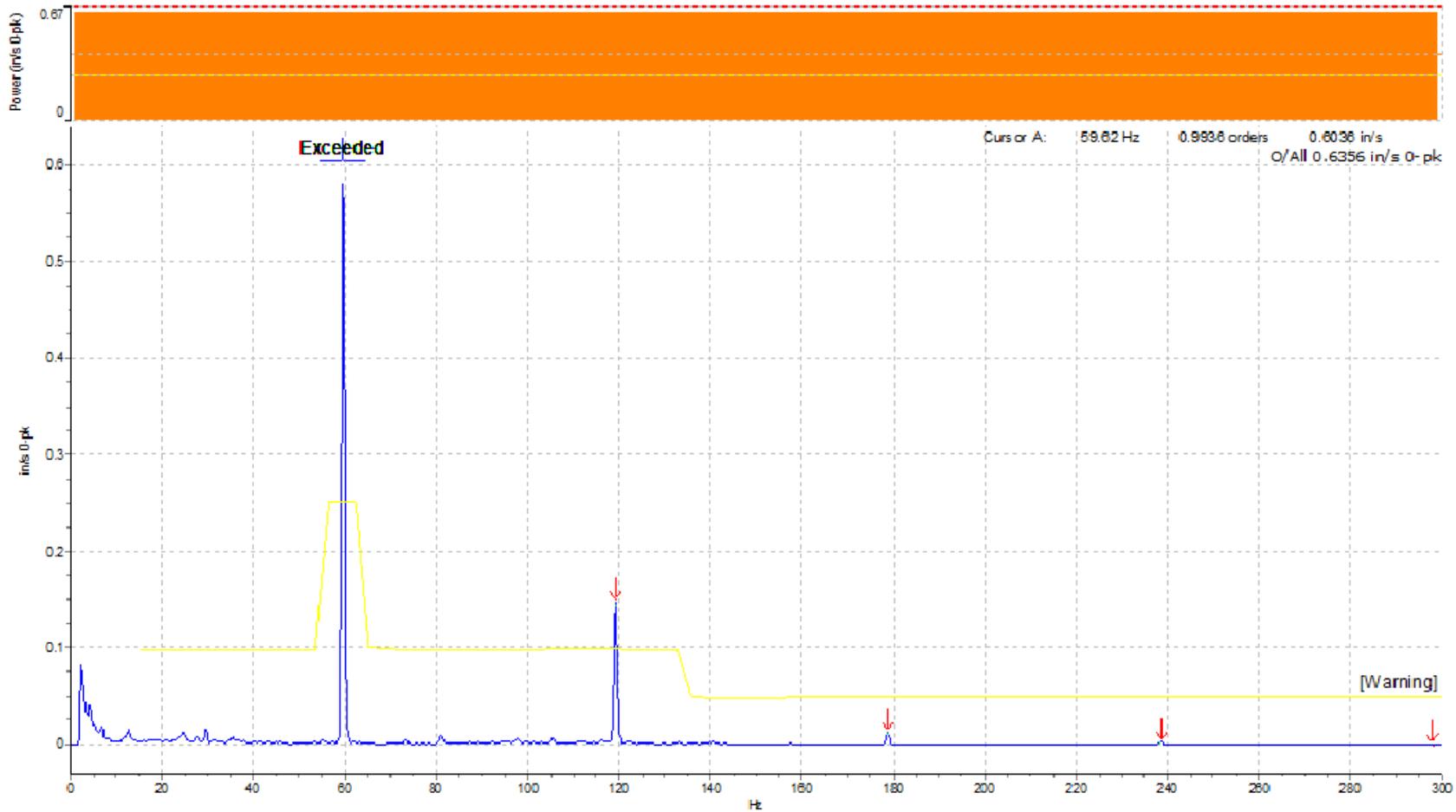


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MOH Reading

L94H08420 CVHF128 - Motor Outboard - Horizontal - Vel Spec 300 Hz "300 Hz"
6/9/2014 3:11:40 PM

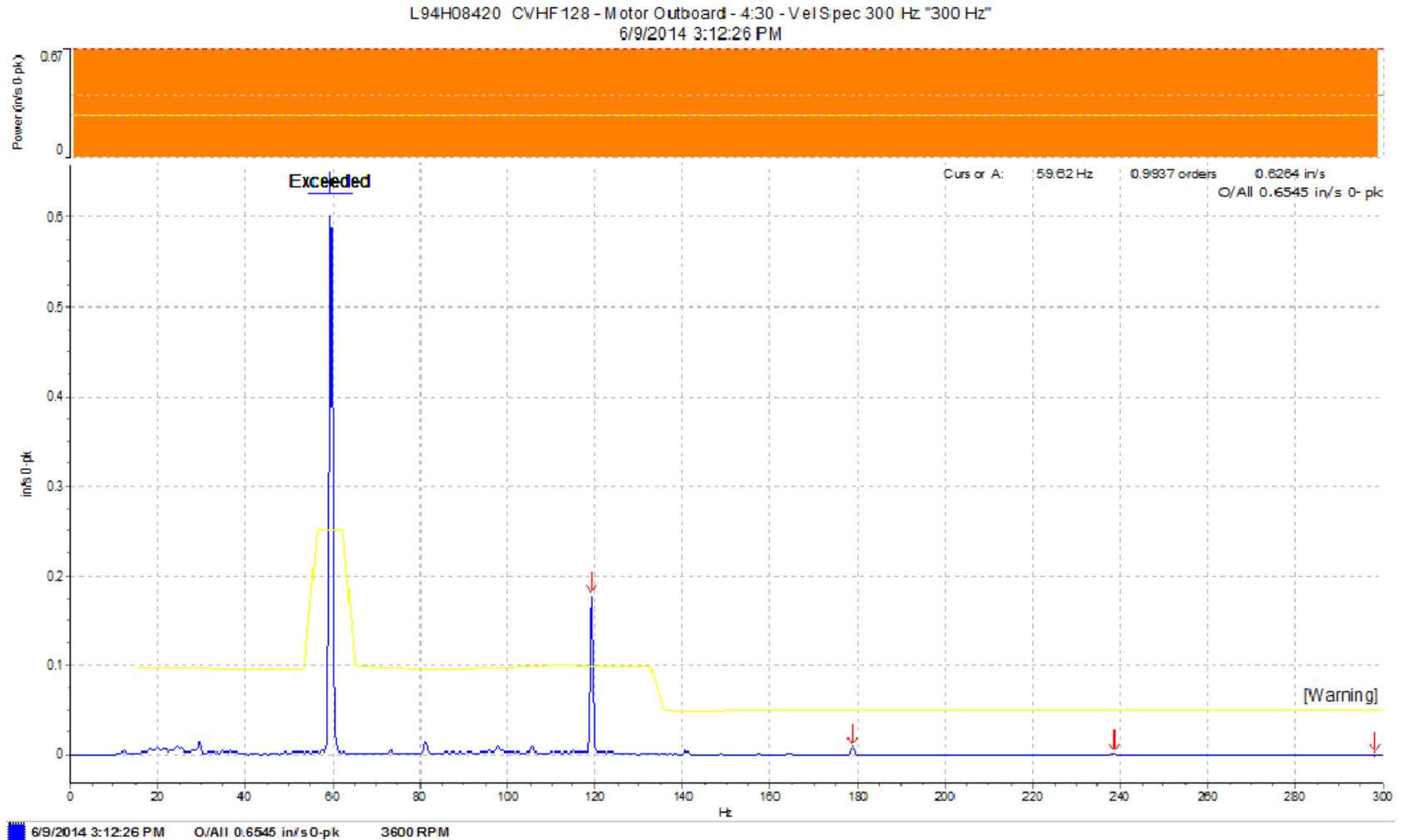


6/9/2014 3:11:40 PM O/All 0.6356 in/s 0-pk 3600 RPM

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4:30 position reading

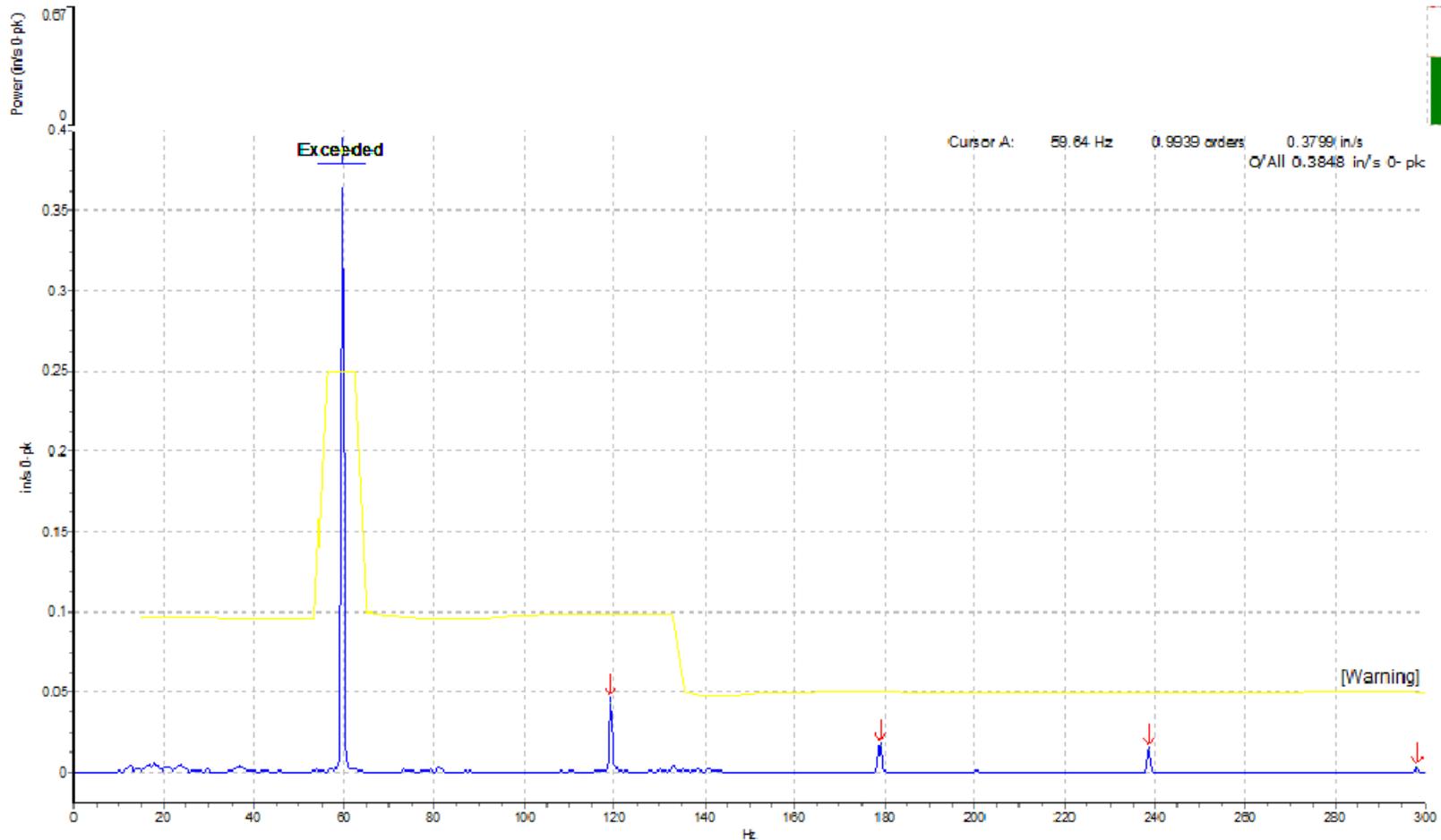


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Axial Reading

L94H08420 CVHF128 - Motor Outboard - Axial - Vel Spec 300 Hz "300 Hz"
6/9/2014 3:13:04 PM

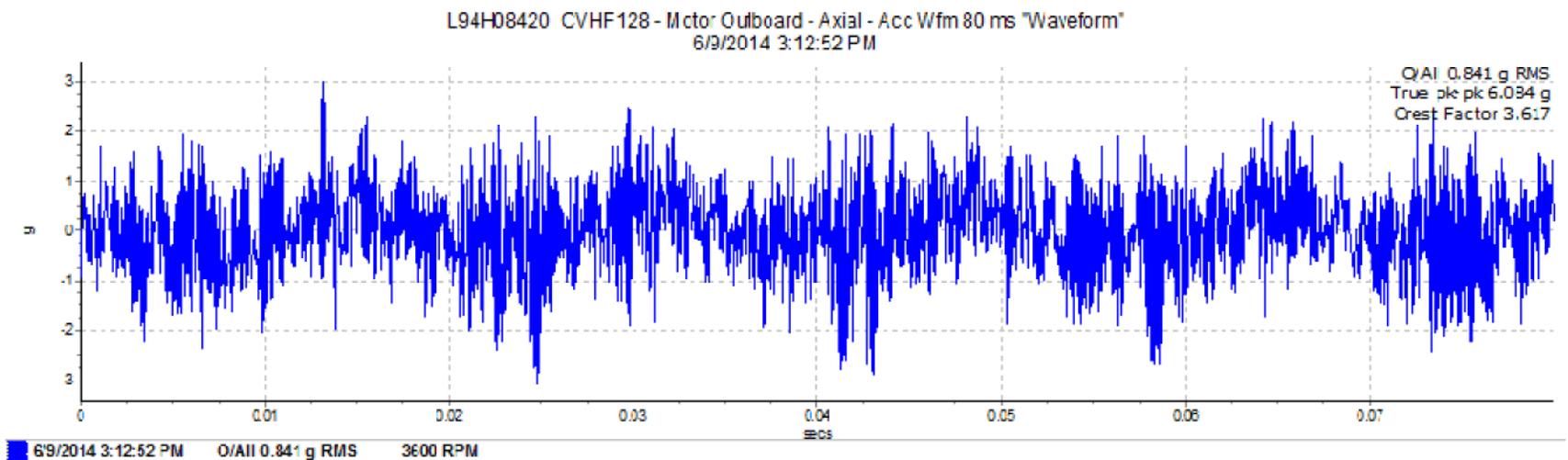
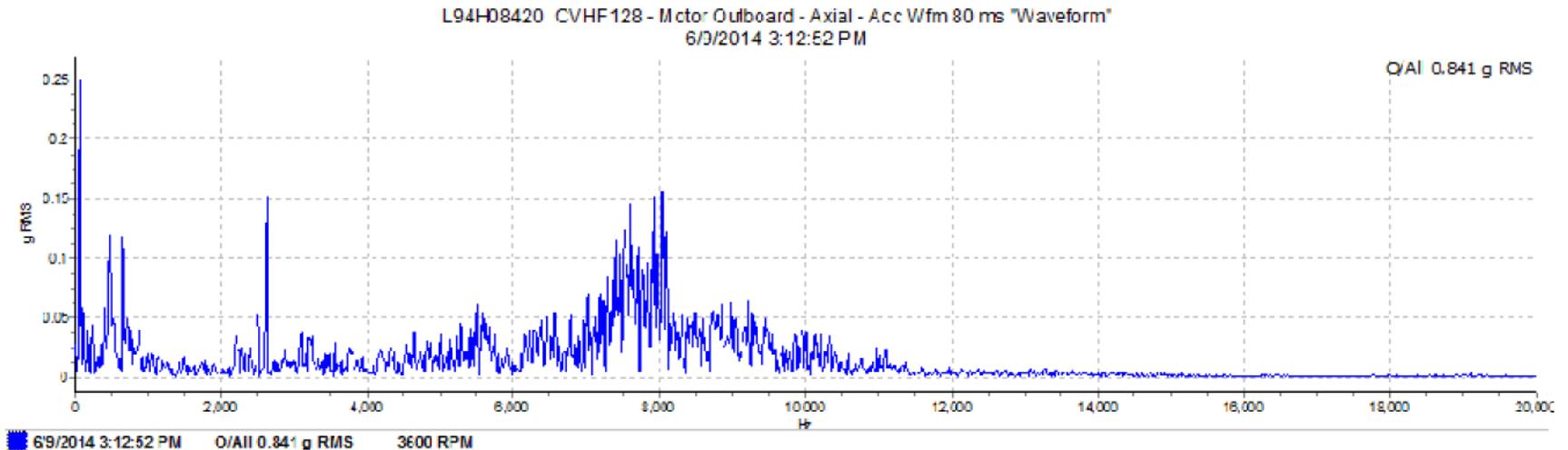


6/9/2014 3:13:04 PM O/All 0.3848 in/s 0-pk 3600 RPM

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Waveform energy

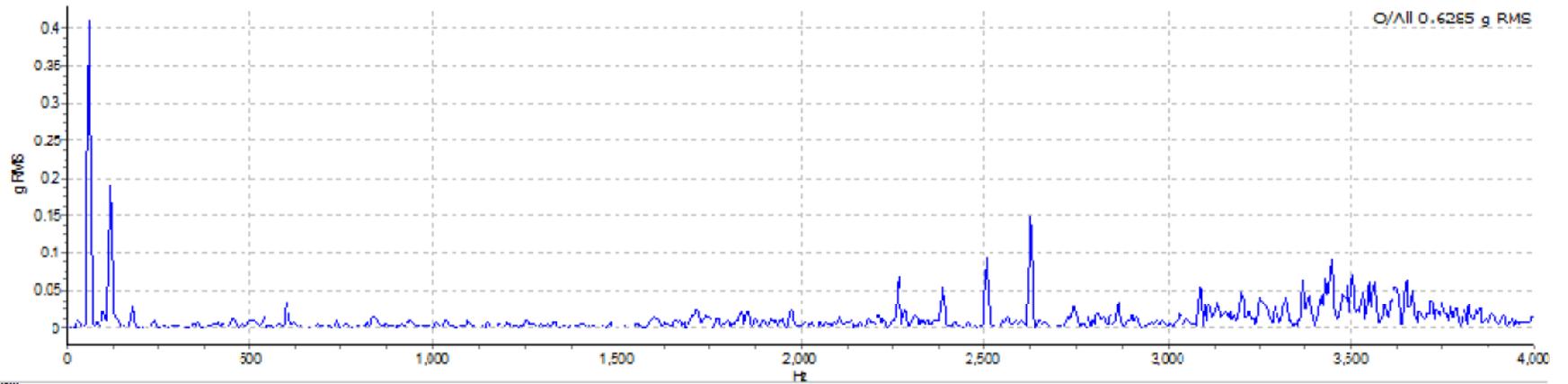


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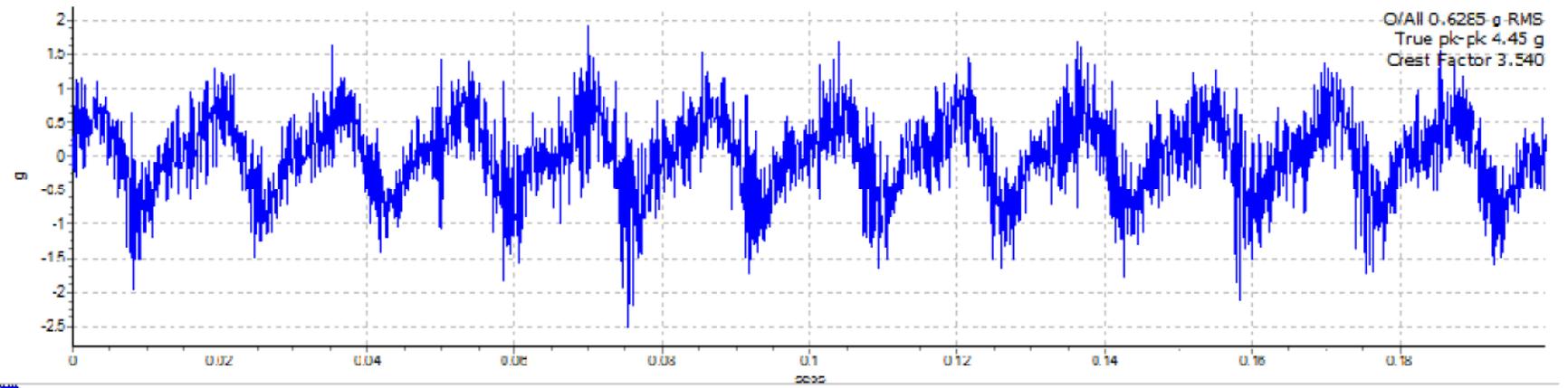


Waveform

I 94H08420 CVHF128 - Motor Outboard - Horizontal - Acc Wfm 200 ms "Waveform"
6/9/2014 3:11:31 PM



L94H08420 CVHF128 - Motor Outboard - Horizontal - Acc Wfm 200 ms "Waveform"
6/9/2014 3:11:31 PM

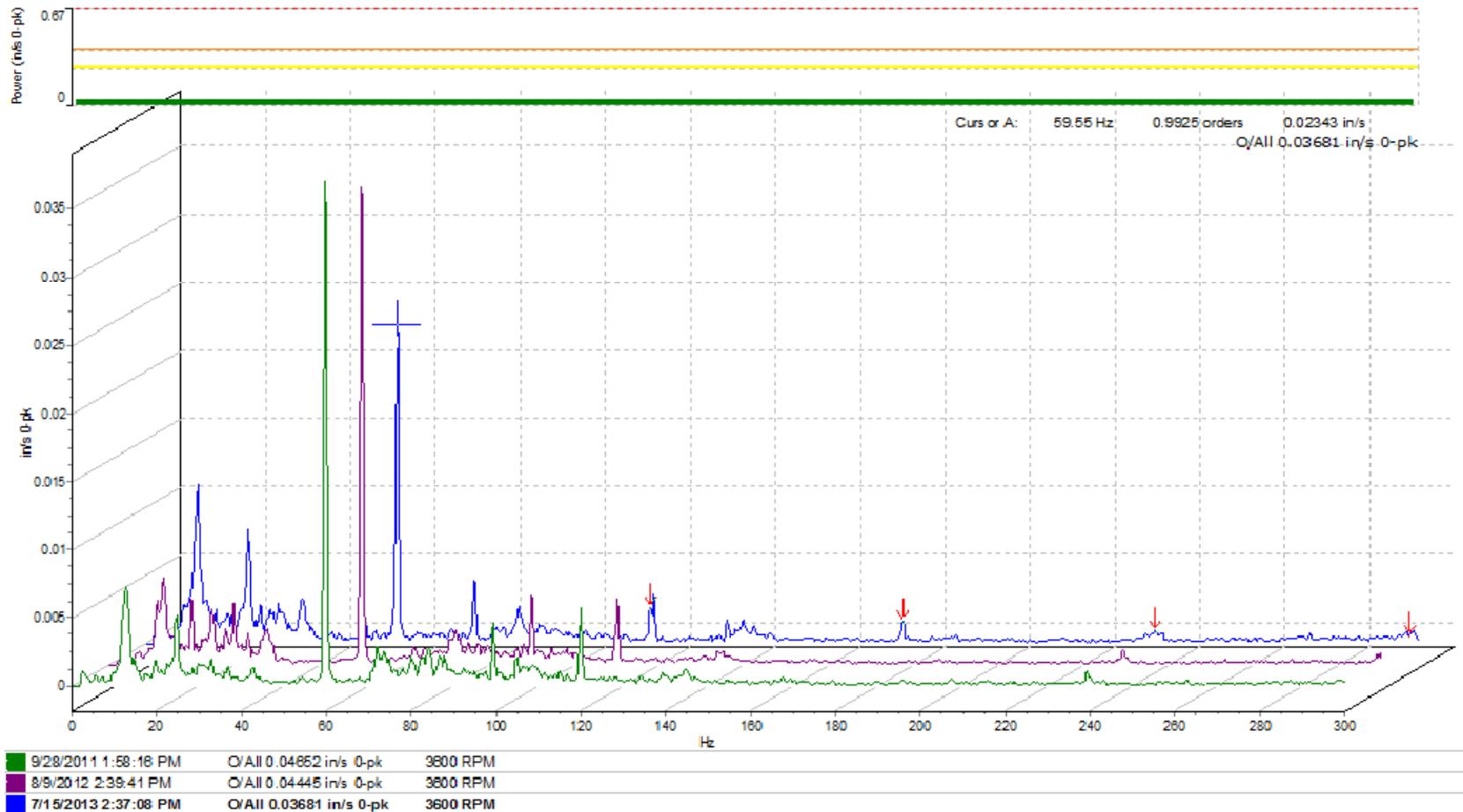


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MIH Readings Historical

L94H08420 CVHF 128 - Motor Inboard - Horizontal - Vel Spec 300 Hz "300 Hz"

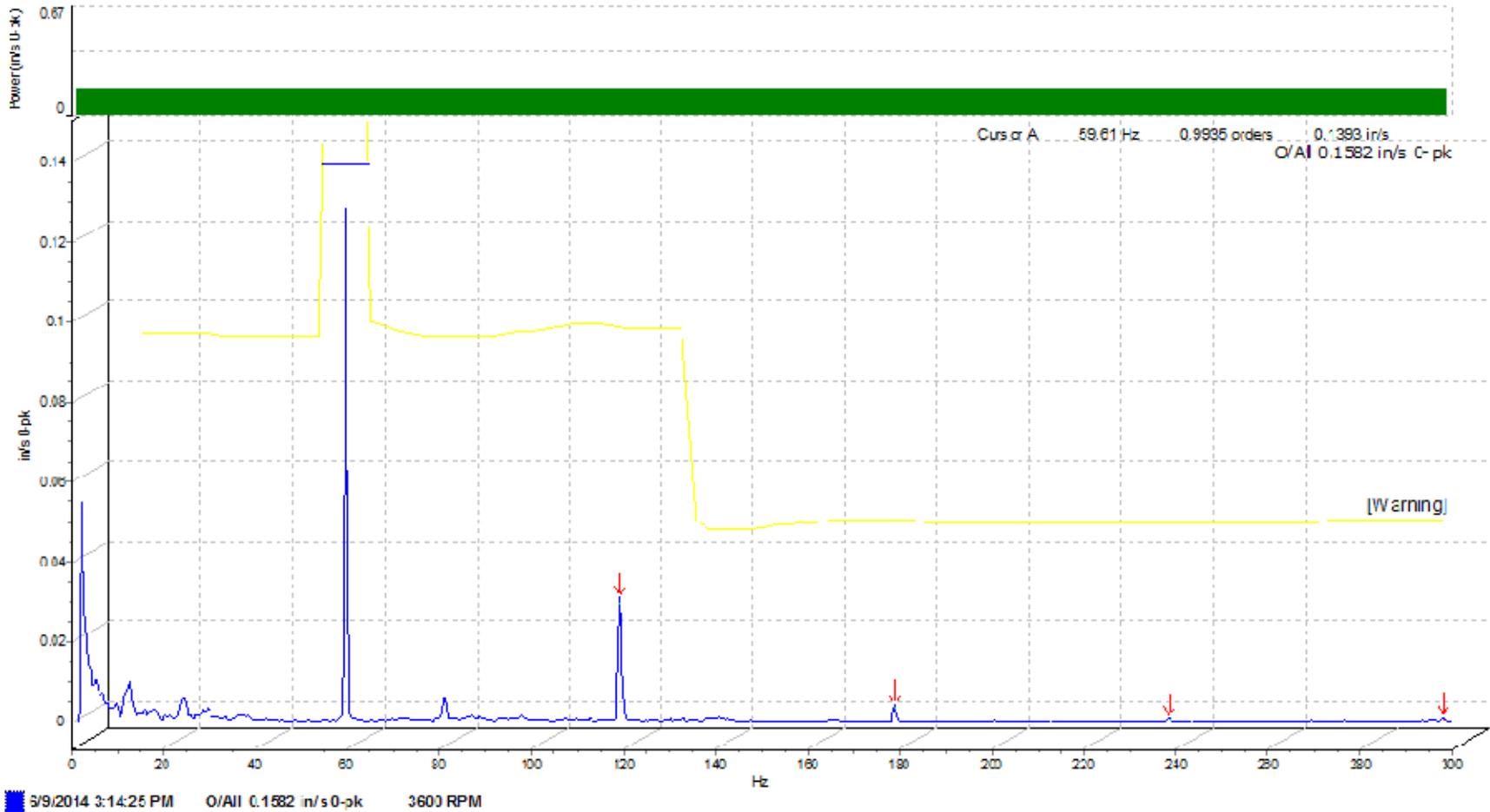


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MIH Readings Current

L94-H03420 CVHF 128 - Motor Inboard - Horizontal - Vel Spec 300 Hz "300 Hz"
6/9/2014 3:14:25 PM

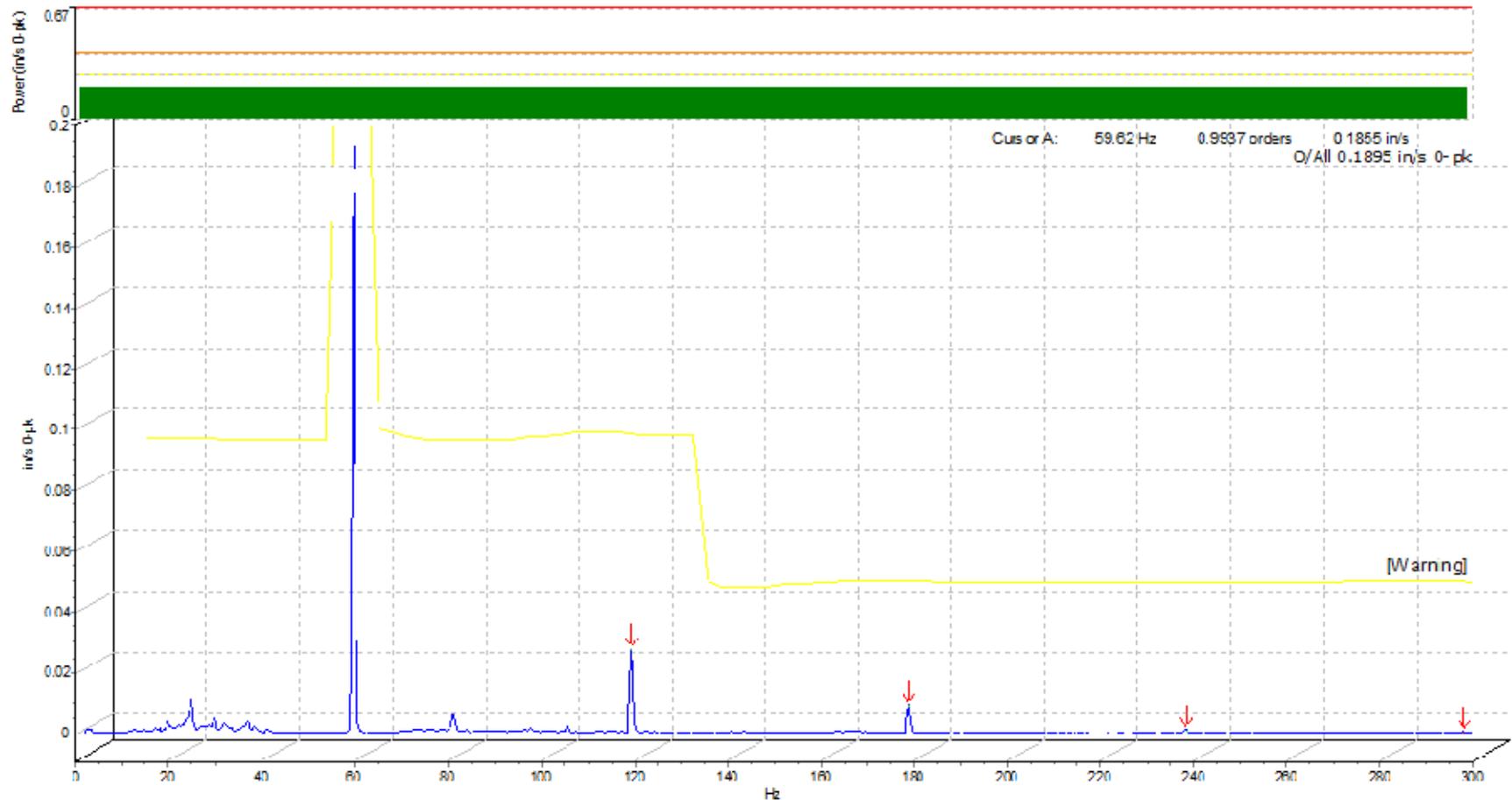


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MIV Current

L94H08420 CVHF 128 - Motor Inboard - Vertical - Vel Spec 300 Hz "300 Hz"
6/9/2014 3:13:57 PM

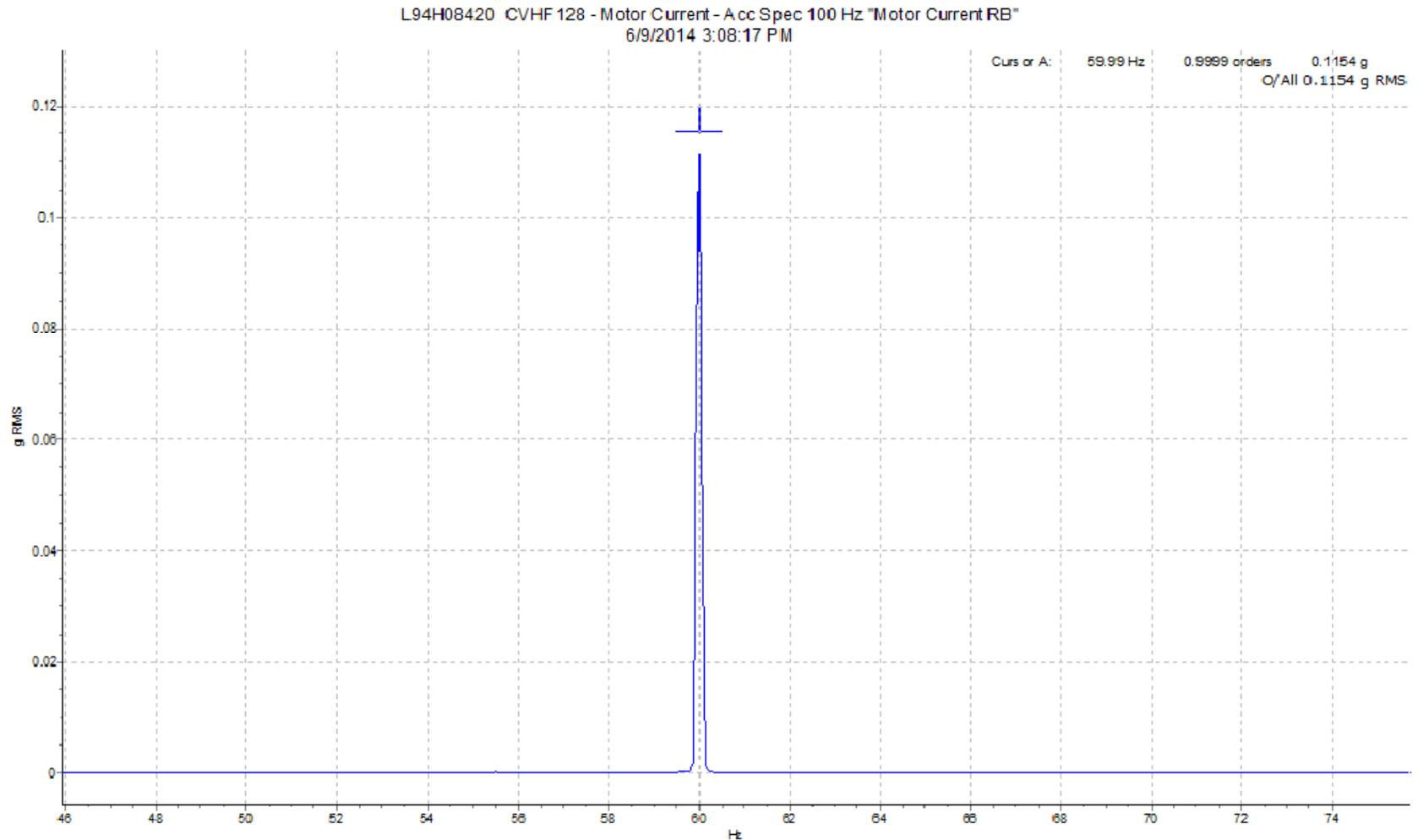


6/9/2014 3:13:57 PM O/All 0.1895 in/s 0-pk 3600 RPM

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Motor Current/Rotor bar

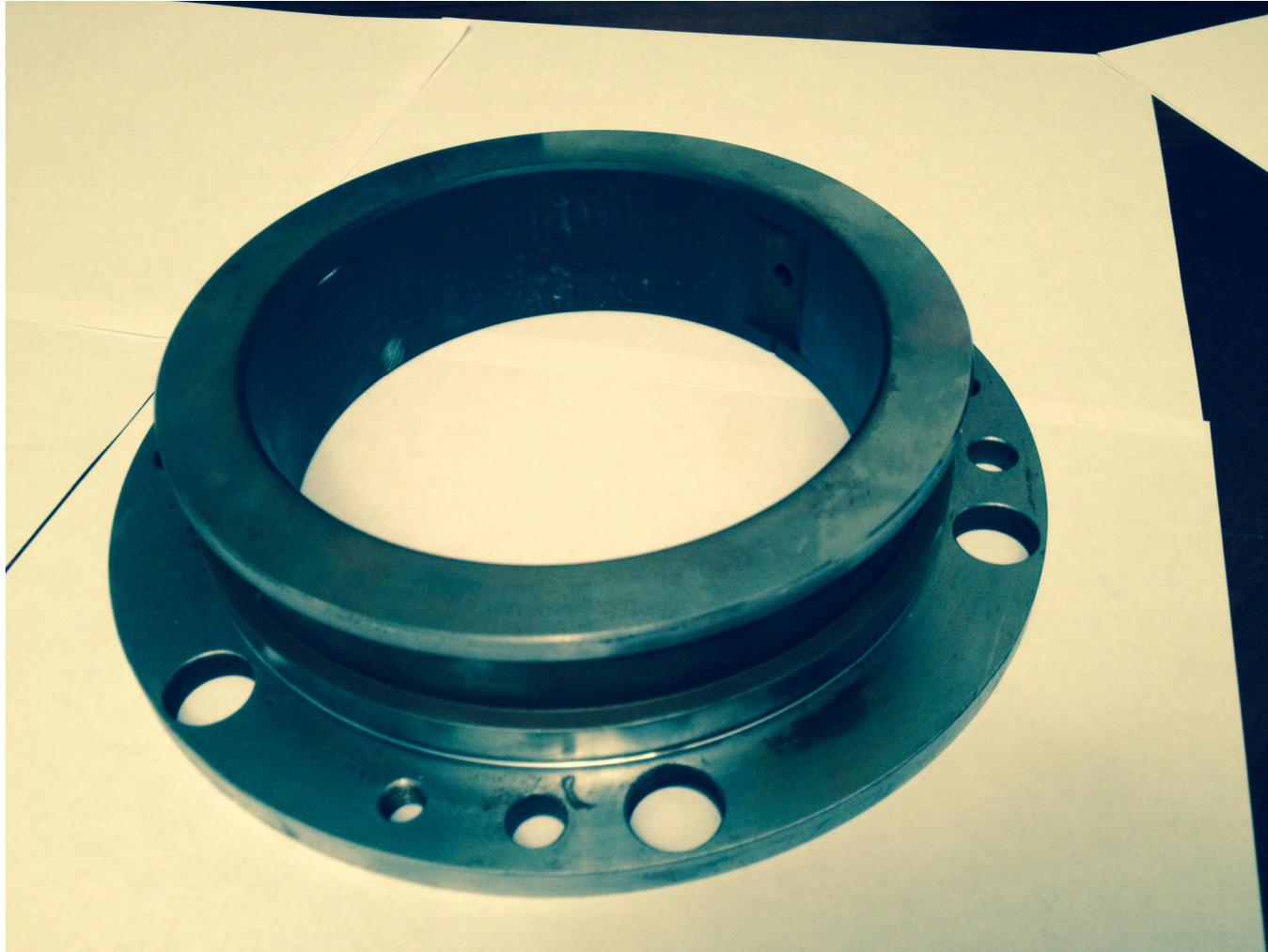


6/9/2014 3:08:17 PM O/All 0.1154 g RMS 3600 RPM

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Journal Bearing



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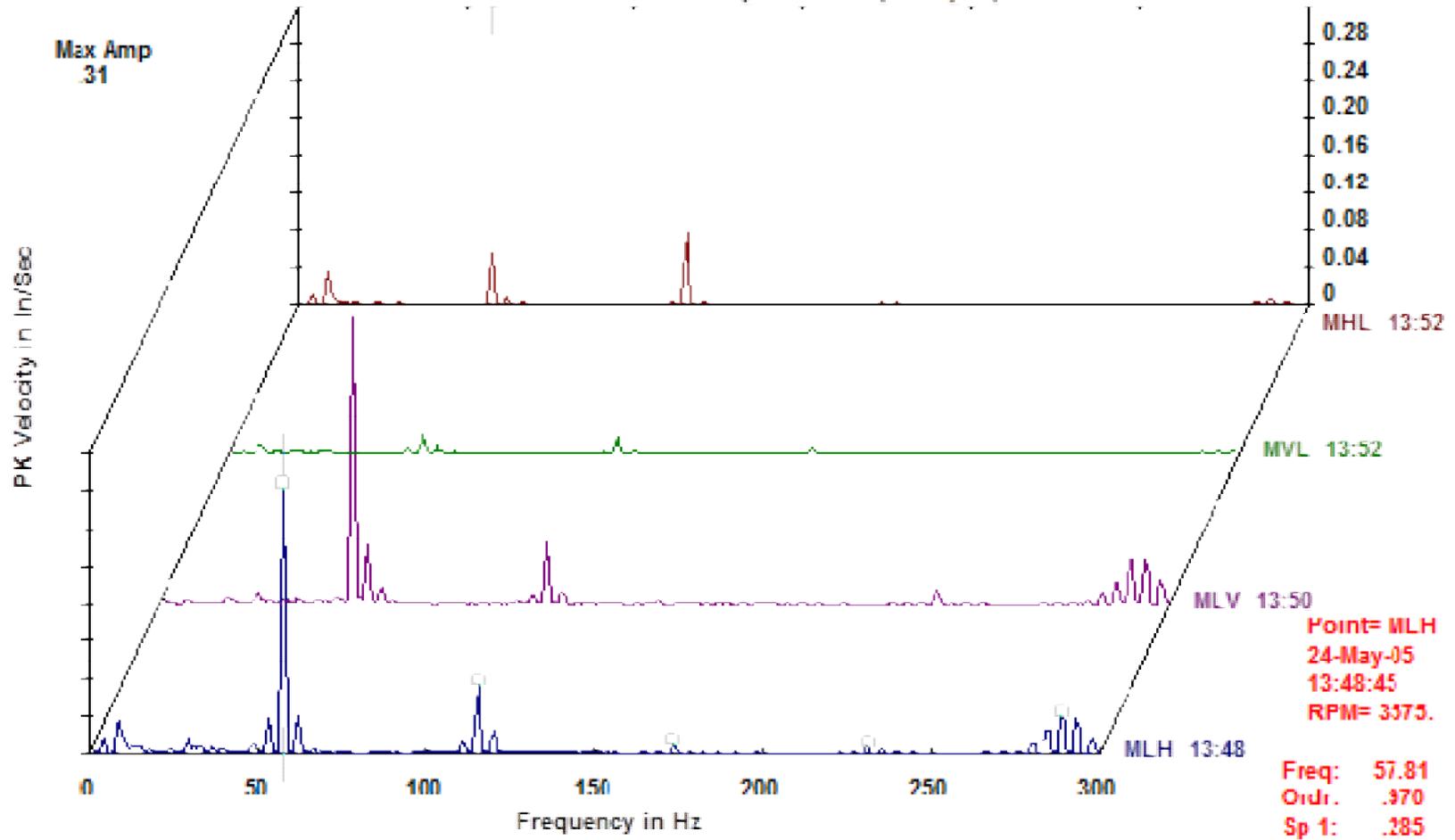
Journal Bearing Damage



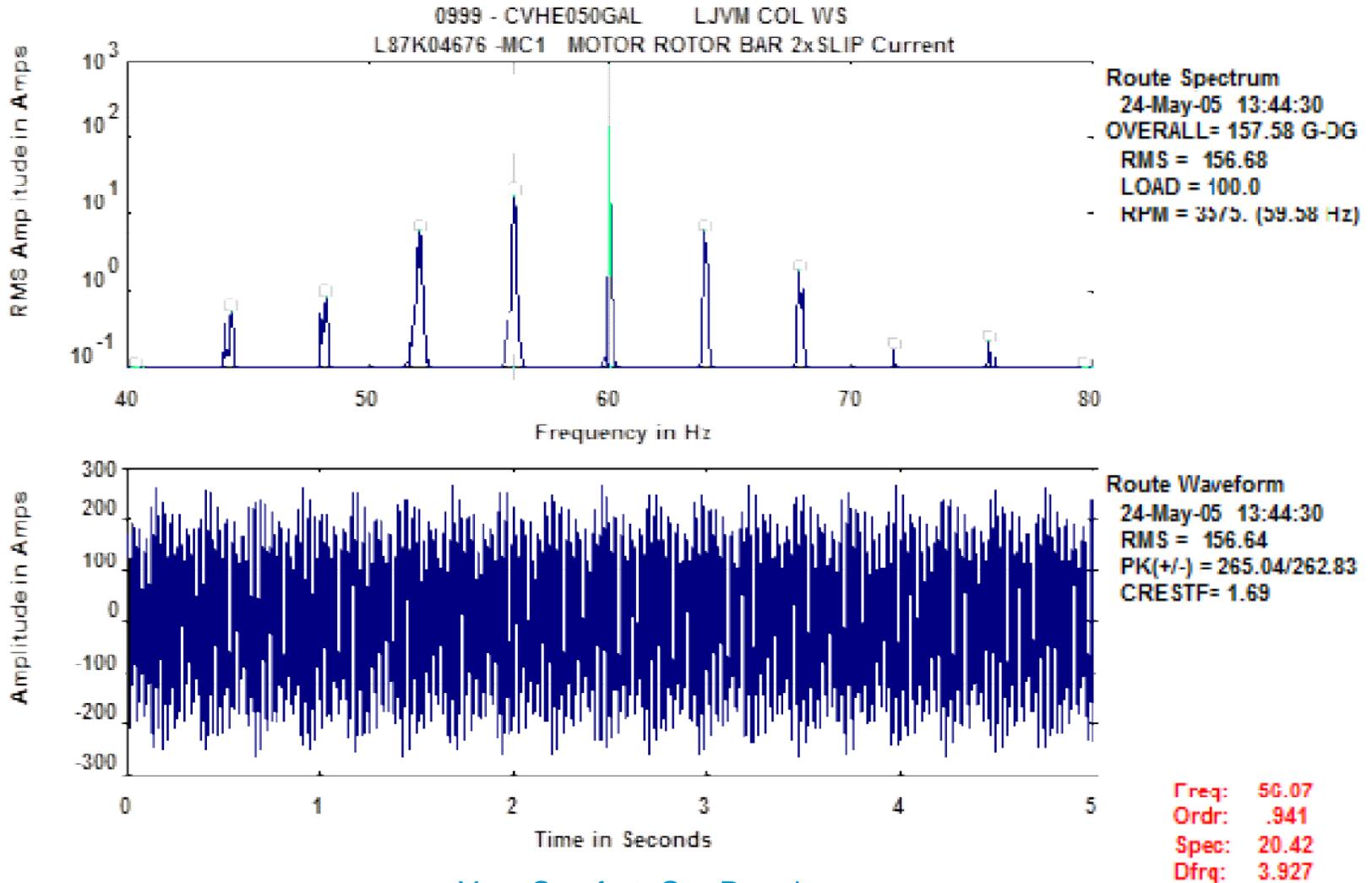
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0999 - CVHE050GAL LJVM COL WS
L87K04676 - Multiple Points (24-May-05)



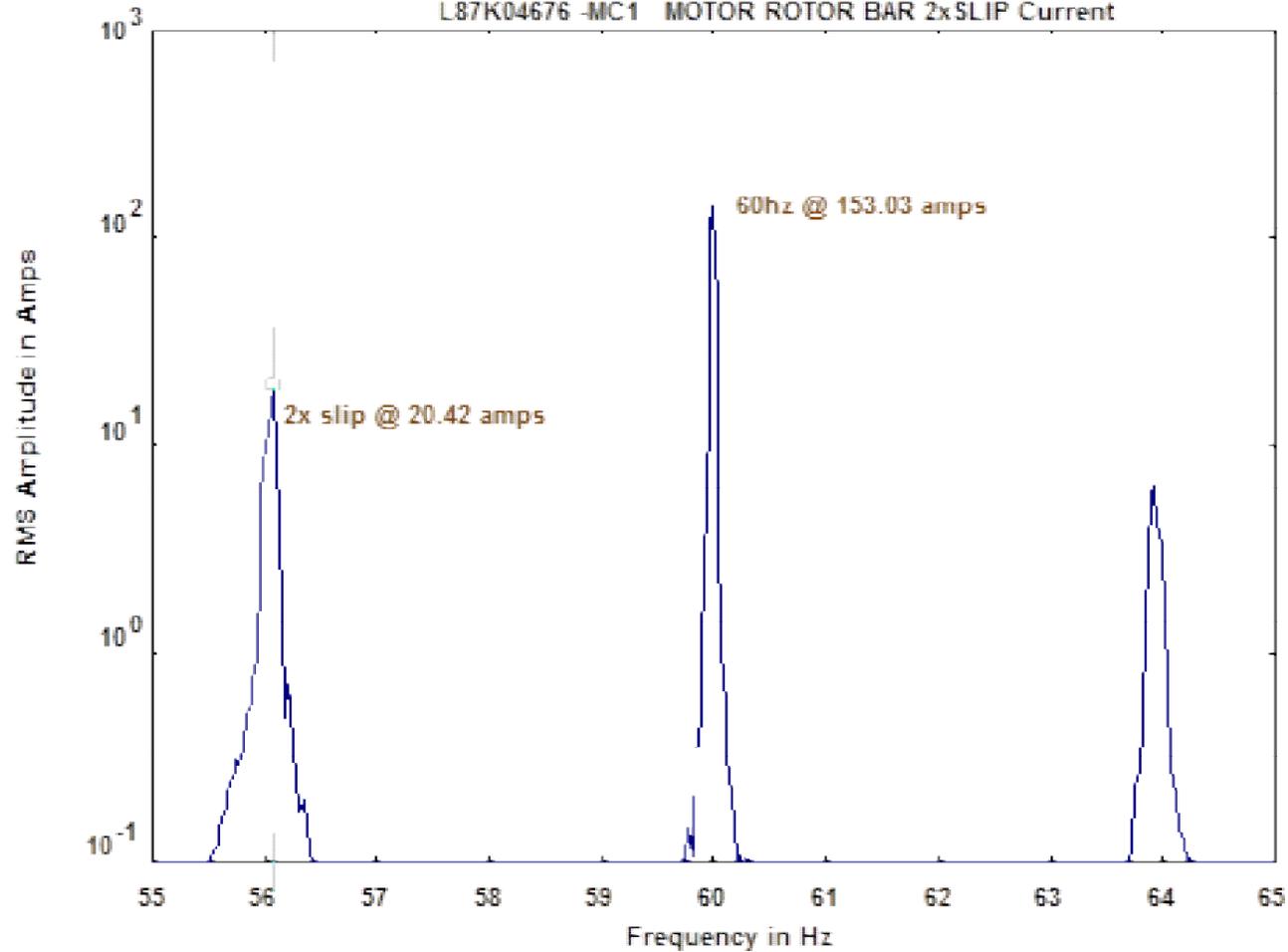
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0999 - CVHE050GAL LJVM COL WS
L87K04676 -MC1 MOTOR ROTOR BAR 2xSLIP Current

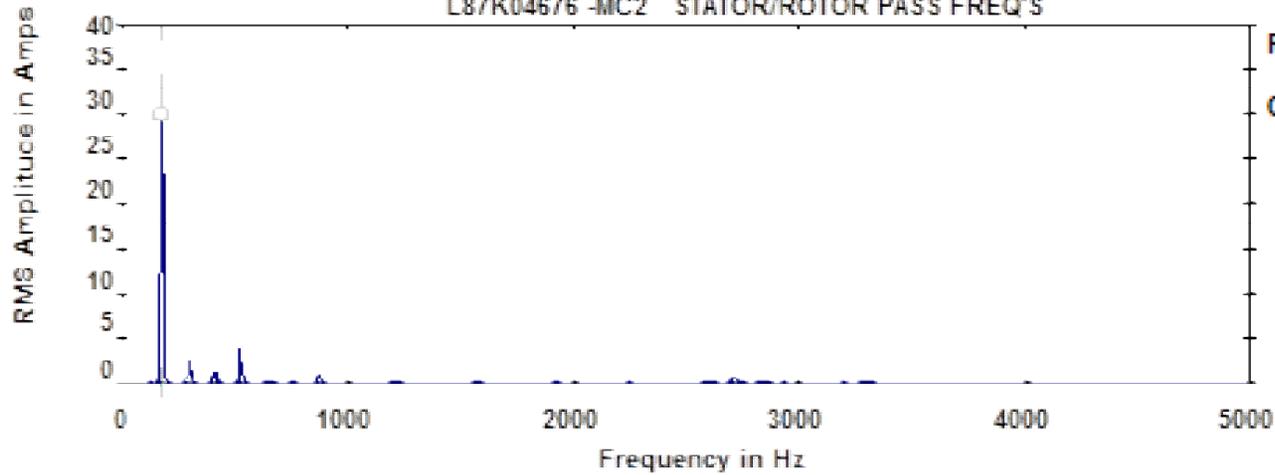


Freq: 56.07
Ordr: .941
Spec: 20.42

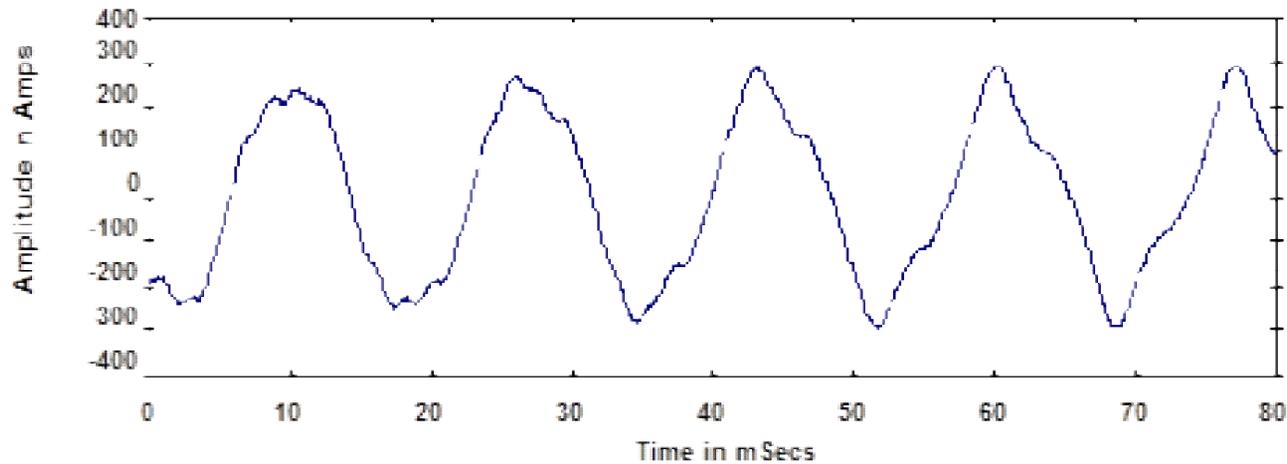
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0999 CVHE050GAL LJVM COL WS
L87K04676 -MC2 STATOR/ROTOR PASS FREQ'S



Route Spectrum
24-May-05 13:45:59
OVERALL= 153.88 G-DG
RMS = 34.40
LOAD = 100.0
RPM = 3575. (59.58 Hz)



Route Waveform
24 May 05 13:45:59
RMS = 180.49
PK(+/-) = 292.85/296.66
CRESTF= 1.64

Freq: 177.26
Crdr: 2.891
Spec: 29.80

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Broken Rotor Bar

Broken Rotor Bar Estimation - IF02

Number of Poles	:	<input type="text" value="2"/>	
Number of Rotor Bars	:	<input type="text" value="58"/>	
Speed of Motor in RPS	:	<input type="text" value="57.72"/>	
Line Frequency (60.00 Hz) Amplitude:		<input type="text" value="153.03"/>	Amps
Lower Slip SDB (55.44 Hz) Amplitude:		<input type="text" value="20.42"/>	Amps
Percent Full Load When Measured:		<input type="text" value="100.0"/>	

ESTIMATED NUMBER OF BROKEN ROTOR BARS

Predicted By Theory	=	12.22
Adjusted By Experience	=	19.55

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Direct Drive High Speed

DANFOSS TURBOCOR

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TurboCor MagLev



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Overview

GEARBOX DRIVEN COMPRESSORS

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Gearbox driven single stage

YORK

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York Point Locations



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The Odd Ball



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-
- So what happens when we take data in an unstable condition?



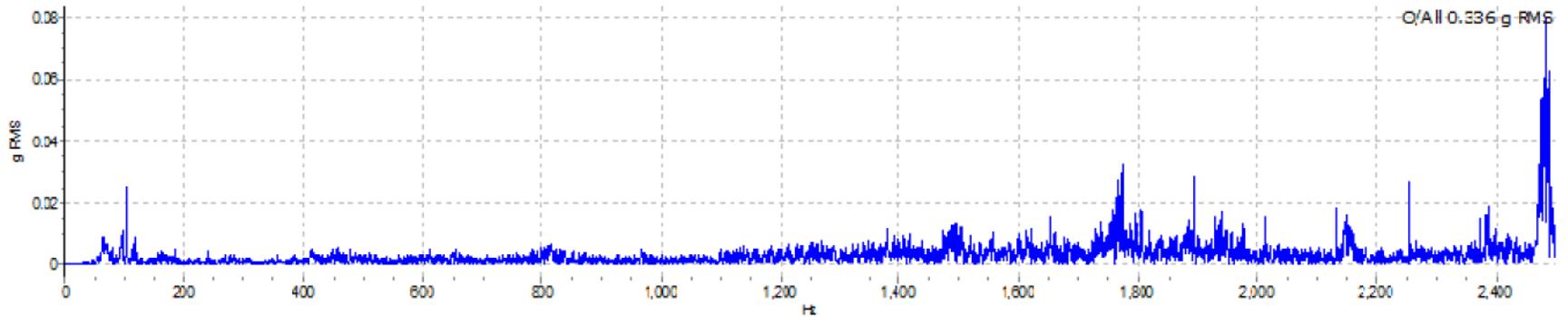
York Chiller #3 GDGM 265455 - Compressor Inbd - Vertical - Acc Spec Wfm 2500 Hz

Machine Note (8/11/2014 11:53:47 AM)

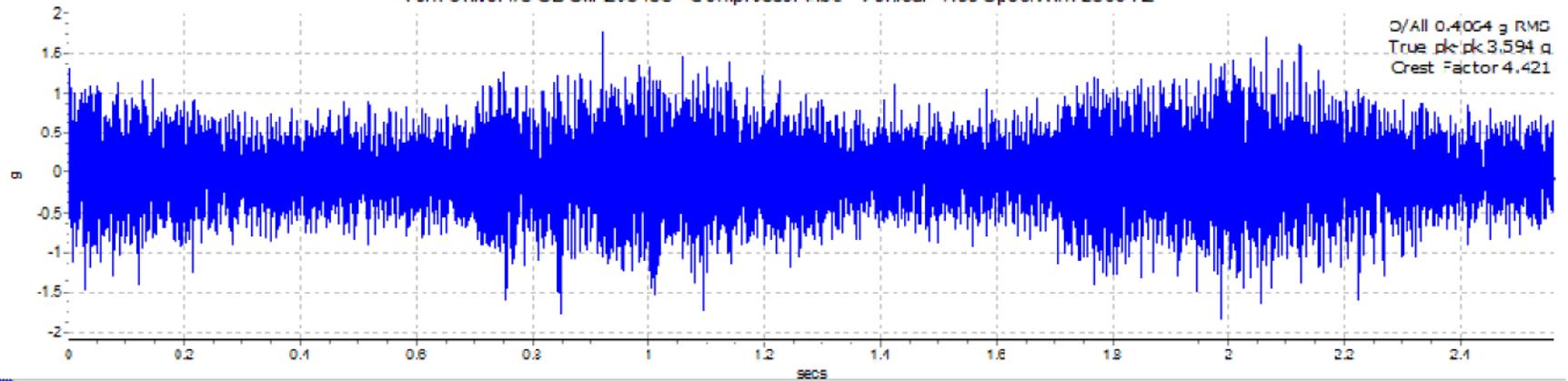
GDGM-280455

Machine Note (8/11/2014 11:54:42 AM)

GDGM-285455



York Chiller #3 GDGM 265455 - Compressor Inbd - Vertical - Acc Spec Wfm 2500 Hz



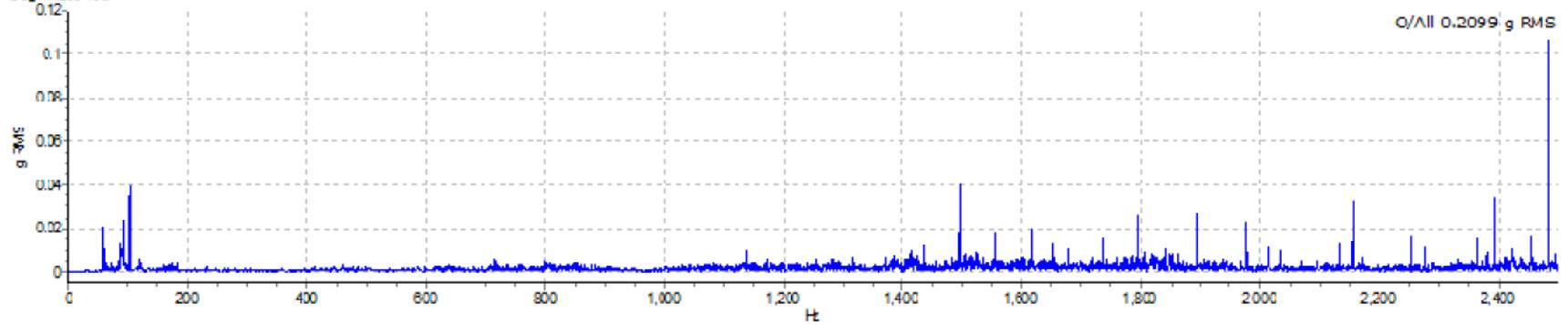
8/11/2014 1:01:32 PM O/All 0.4064 g RMS 3600 RPM

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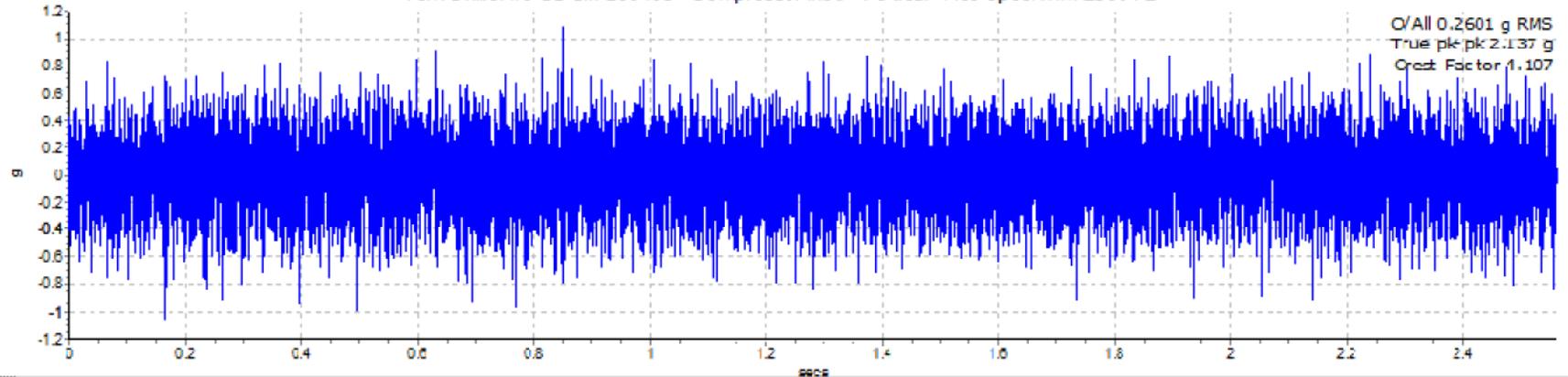


York Chiller #3 GDGM 265455 - Compressor Inbd - Vertical - Acc Spec/Wfm 2500 Hz

Machine Note (8/11/2014 11:53:47 AM)
GDGM2604bb
Machine Note (0/11/2014 11:54:42 AM)
Gdgm-265455



York Chiller #3 GDGM 265455 - Compressor Inbd - Vertical - Acc Spec/Wfm 2500 Hz



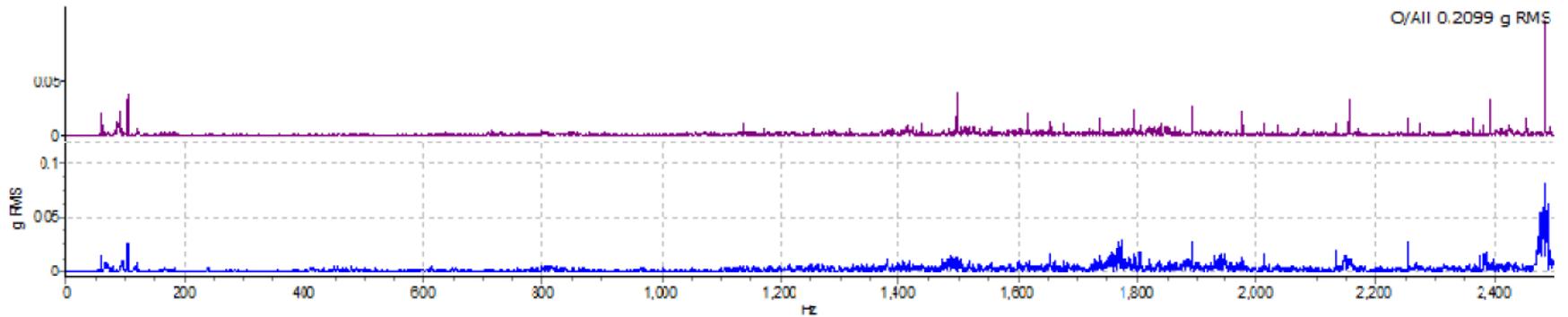
8/13/2014 8:26:34 AM O/All 0.2601 g RMS 3600 RPM

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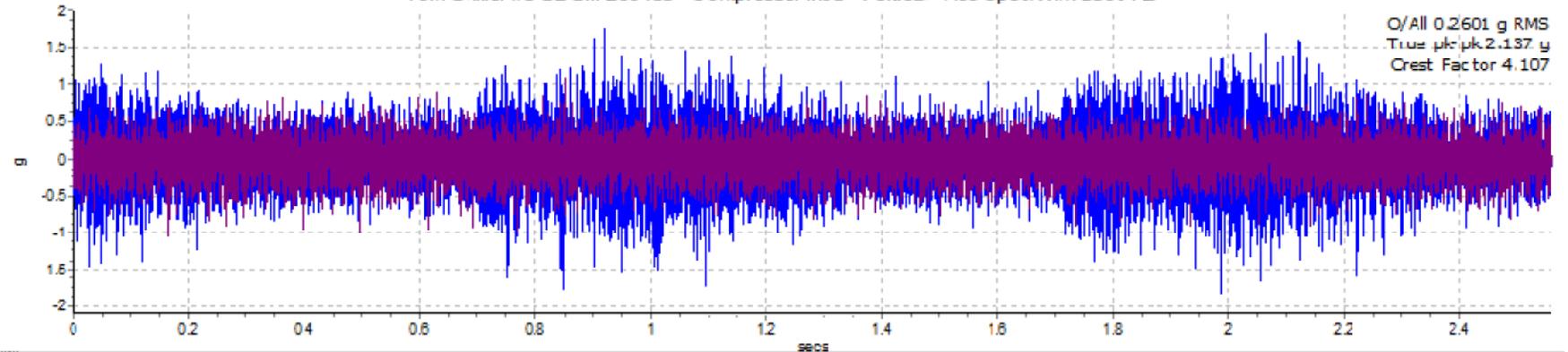


York Chiller #3 GDGM 265455 - Compressor Inhd - Vertical - Acc Spec/Wfm 2500 Hz

Machine Note (8/11/2014 11:53:47 AM)
GDGM-200455
Machine Note (8/11/2014 11:54:42 AM)
Gdgm-265455



York Chiller #3 GDGM 265455 - Compressor Inhd - Vertical - Acc Spec/Wfm 2500 Hz



8/13/2014 8:26:34 AM	O/All 0.2601 g RMS	3300 RPM
8/11/2014 1:01:32 PM	O/All 0.4064 g RMS	3300 RPM

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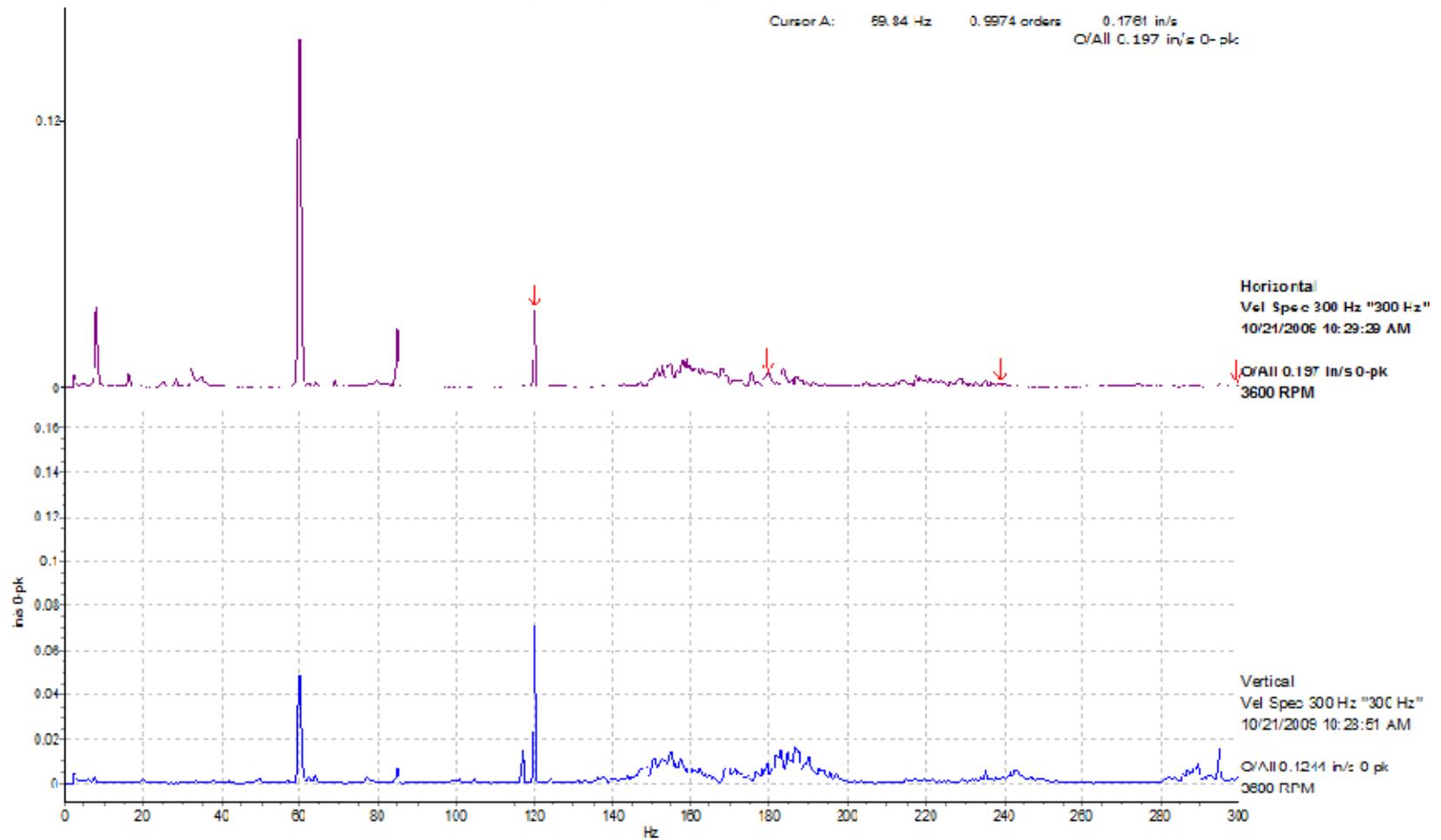


-
- Are you sure there is a problem?
 - Are you sure of what the problem is?



YLYM /93509 YORK Y1L6M6F2CYP - Motor Outboard

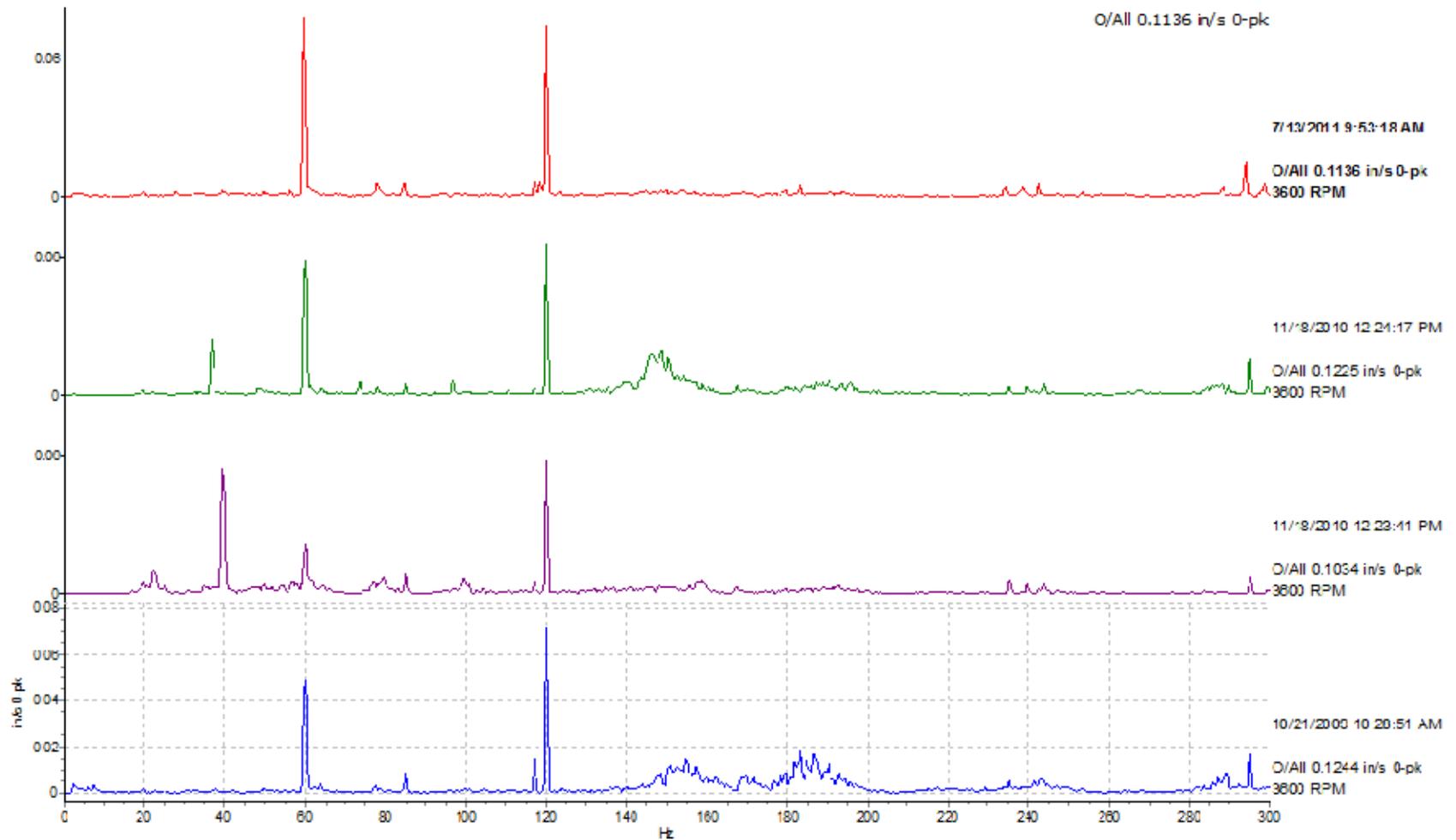
Cursor A: 89.84 Hz 0.9974 orders 0.1781 in/s
Q/All 0.197 in/s 0-pk



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YLYM793509 YORK YTL6M6F2CYF - Motor Outboard - Vertical - Vel Spec 300 Hz *300 Hz"



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Gearbox Driven Semi-hermetic single stage

CARRIER

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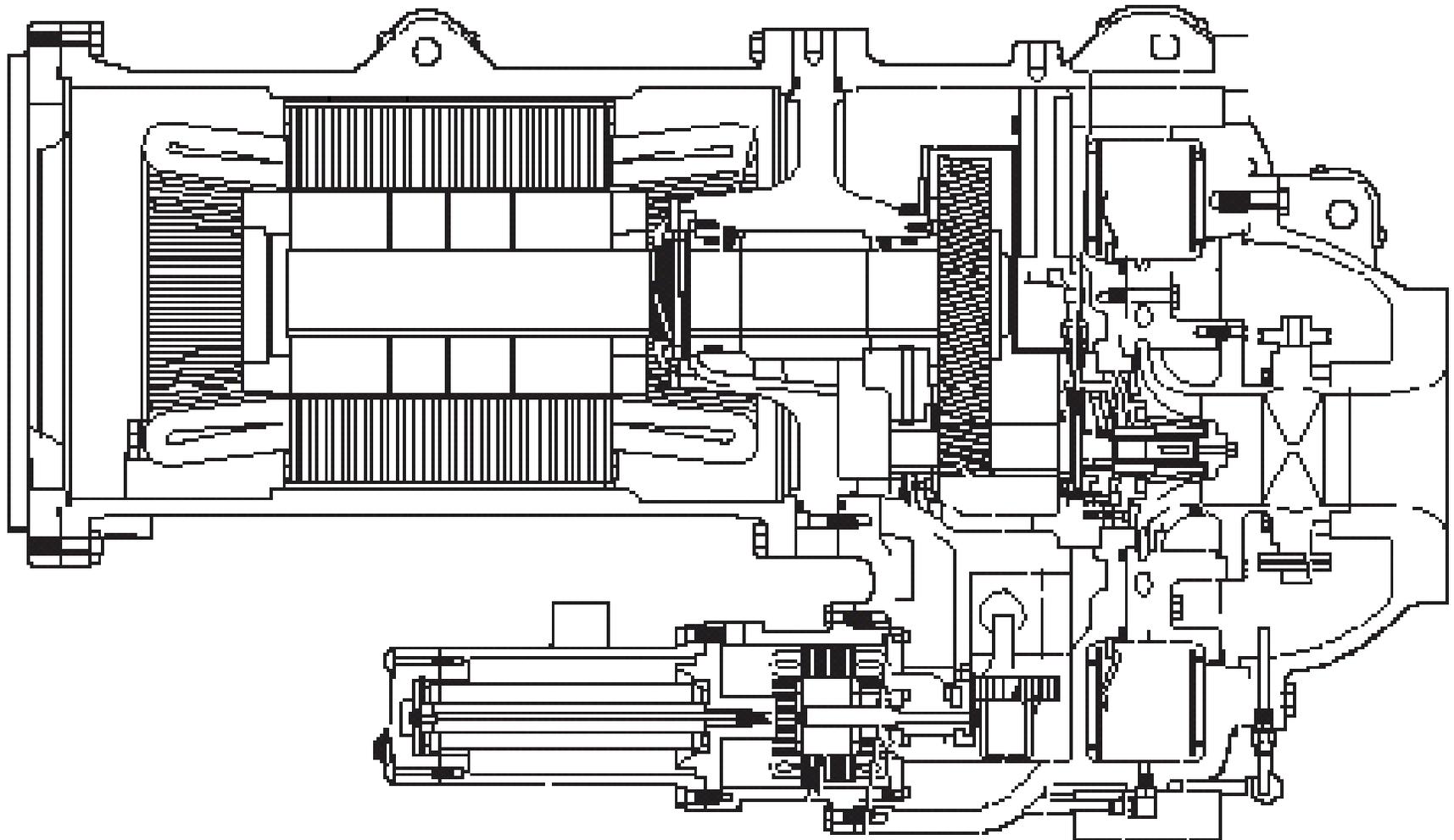
Internal



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Compressor Cutaway

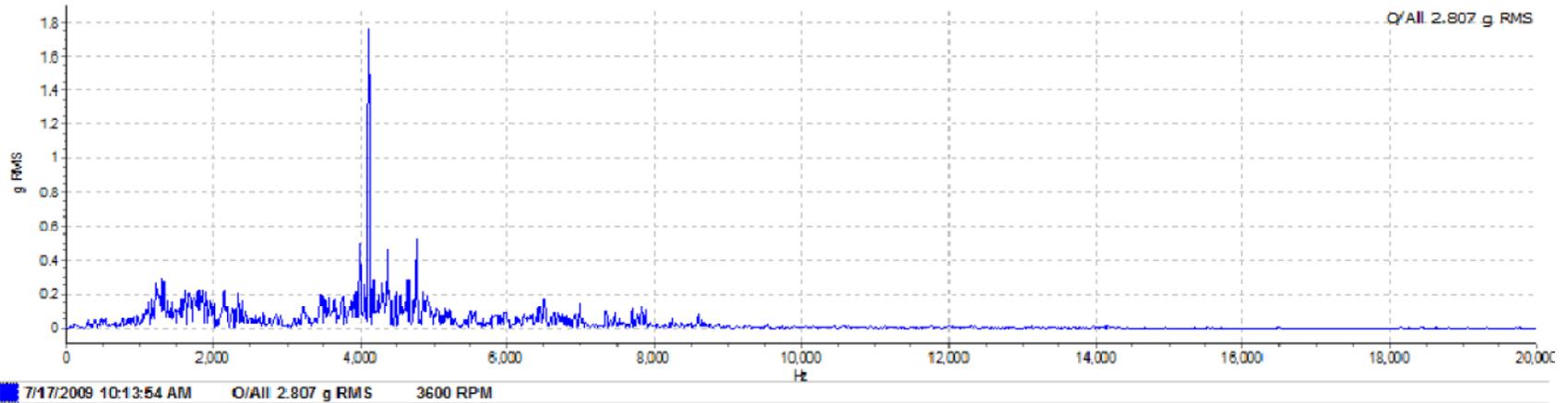


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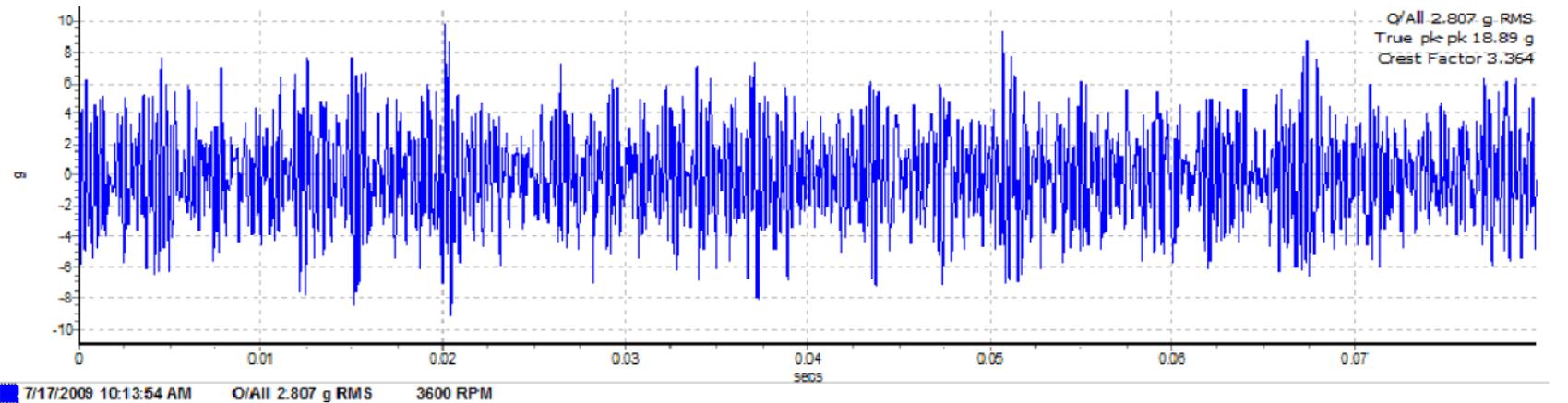


Baseline Compressor Axial

870639308 19DM76405CM - Compressor Inbd - Axial - Acc Wfm 80 ms "Waveform"
7/17/2009 10:13:54 AM



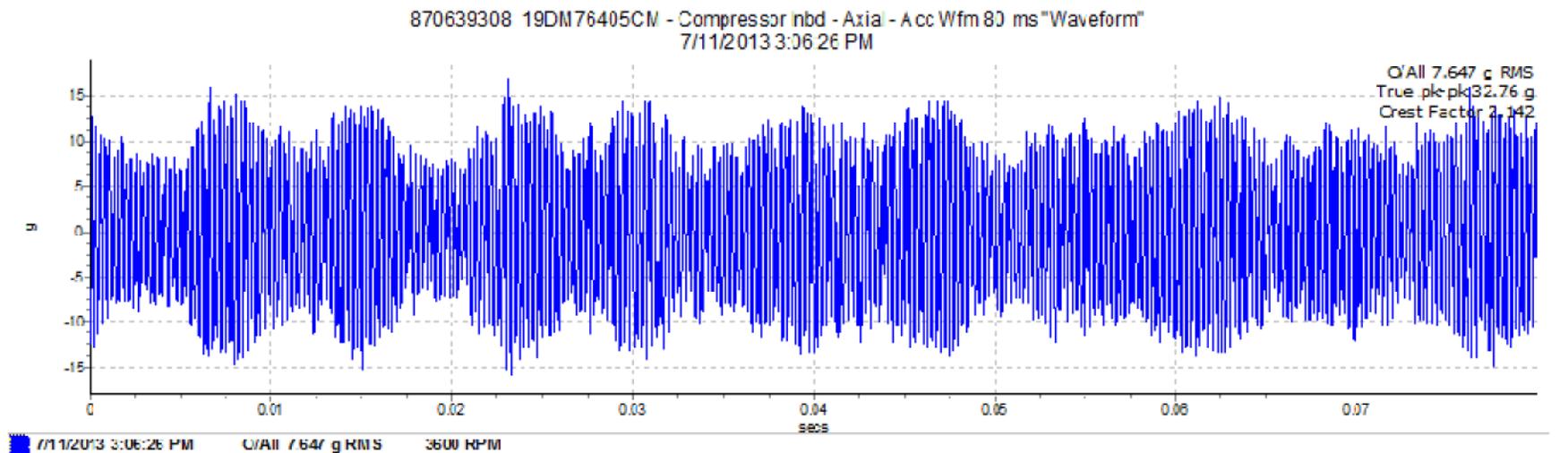
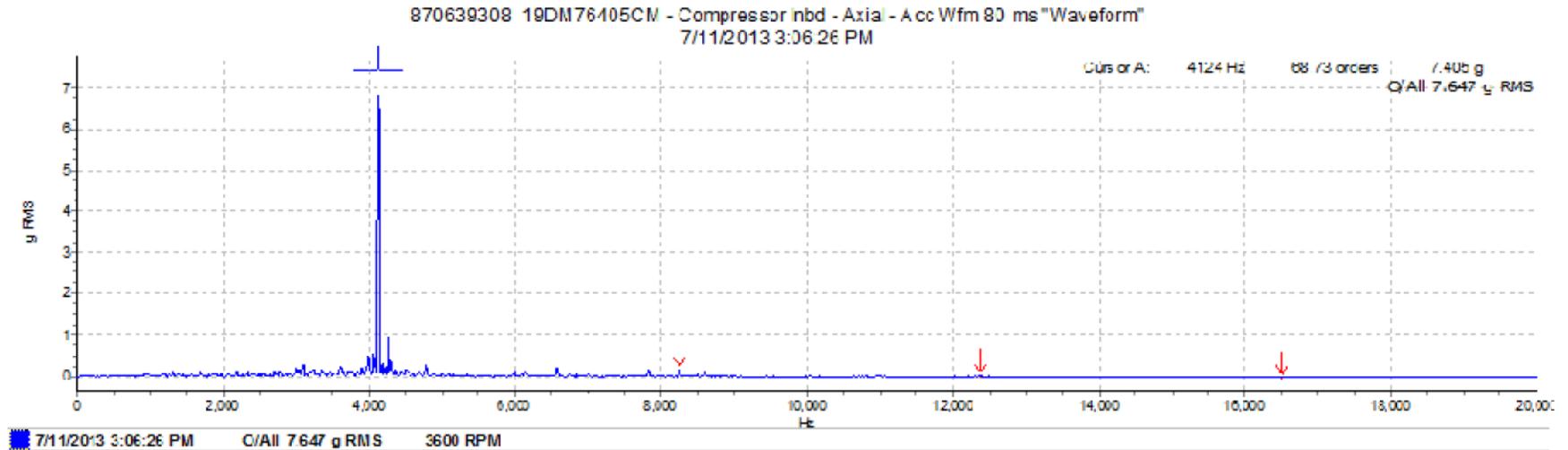
870639308 19DM76405CM - Compressor Inbd - Axial - Acc Wfm 80 ms "Waveform"
7/17/2009 10:13:54 AM



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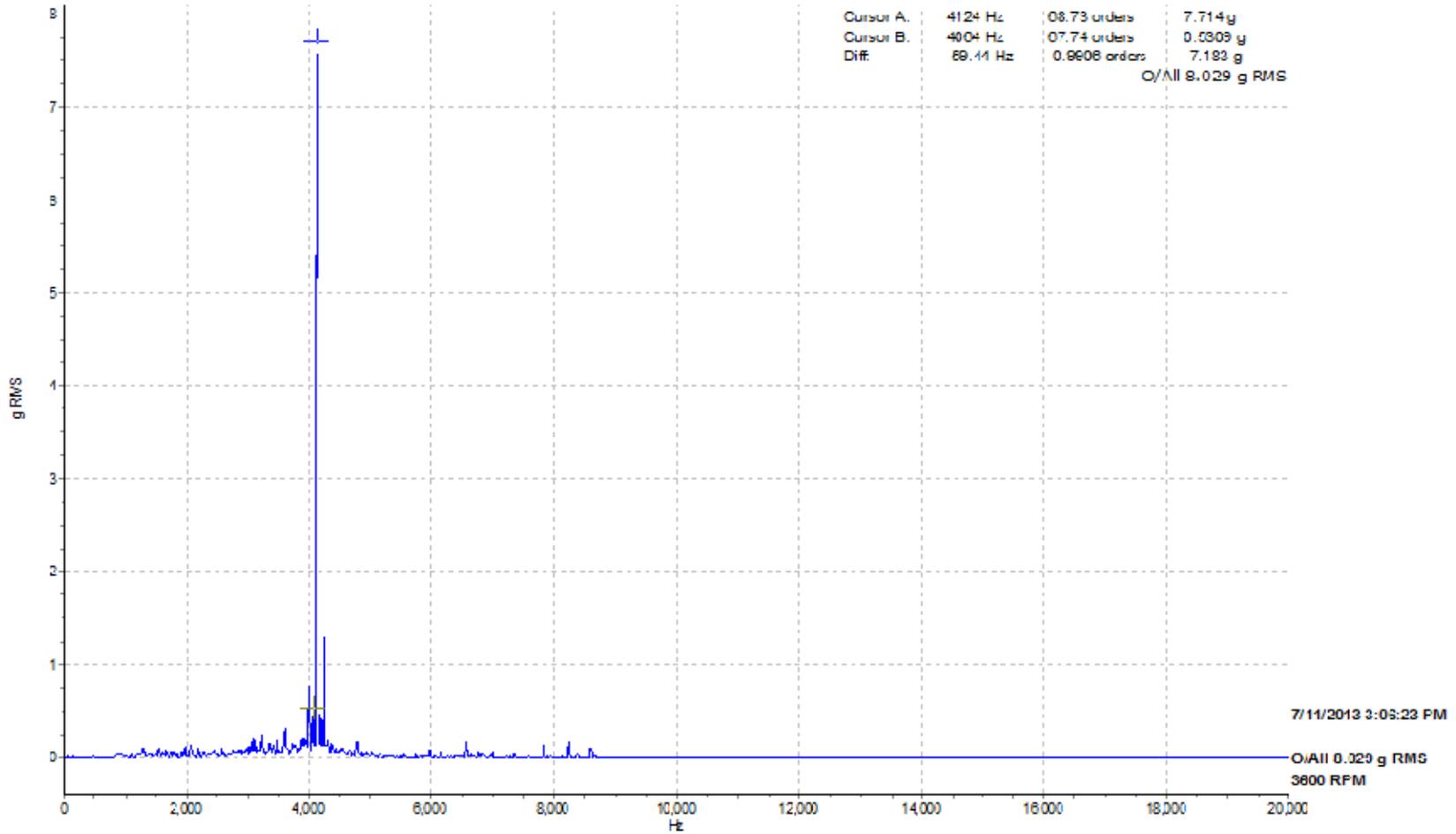
Problem Axial



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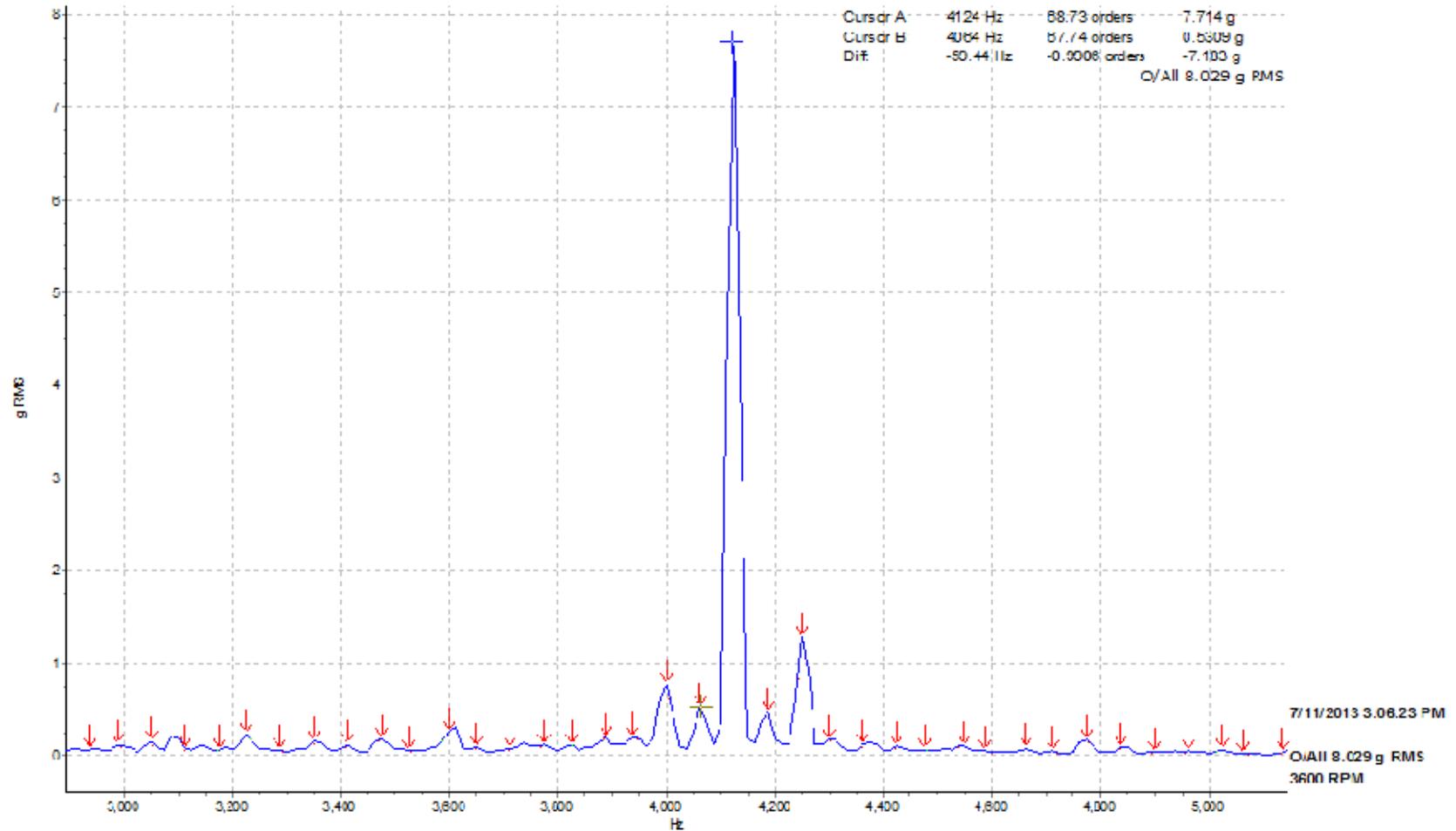
870639308 19DM76405CM - Compressor hbd - Axial - Acc Spec 20000 Hz "20.000 Hz"
7/11/2013 3:06:23 PM



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870639308 19DM76405CM - Compressor Inbd - Axial - Acc Spec 20000 Hz "20,000 Hz"
7/11/2013 3:06:23 PM



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Gearbox driven Semi-hermetic High Speed

McQUAY

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McQuay Point Location



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The End

QUESTIONS?

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