TRANE®

Condition Monitoring

Chiller Vibration Report

Jobsite: Waters Edge

Location: Minneapolis, MN.

Unit Tested

Trane Centrifugal Chiller
Tag# CH-1 MN CVHE050 SN L96M09223

Prepared For

Trane

January 29, 2008

Chiller Vibration Report

Jobsite: Waters Edge
Location: Minneapolis, MN.

Report Date: January 29, 2008   **Run Hours:**
Equipment Type: Centrifugal   **# Starts:**
Operating RPM: 3585   **Load: 15%**

Chiller Condition:

The vibration readings on this chiller are low with the present level at .05-in/sec velocity at the motor speed or less. The manufacturer allows up to .10-in/sec velocity in the radial direction on air without elbow. The axial readings that look at the bearing condition show no faults and the waveforms are below the nominal levels in both ranges. The motor current readings do not indicate any faults.

Recommendation:

Repeat readings when chiller is back on refrigerant for new baseline data.

Continue data collection to monitor for any changes in the vibration amplitude and content on unit.

Status: OK

Extreme: Chiller should not be operated; one or more significant faults were noted in vibration readings.

Serious: Chiller has significant energy that appears to have faults that are continuing to increase. Take readings more often so faults levels can be monitored closely.
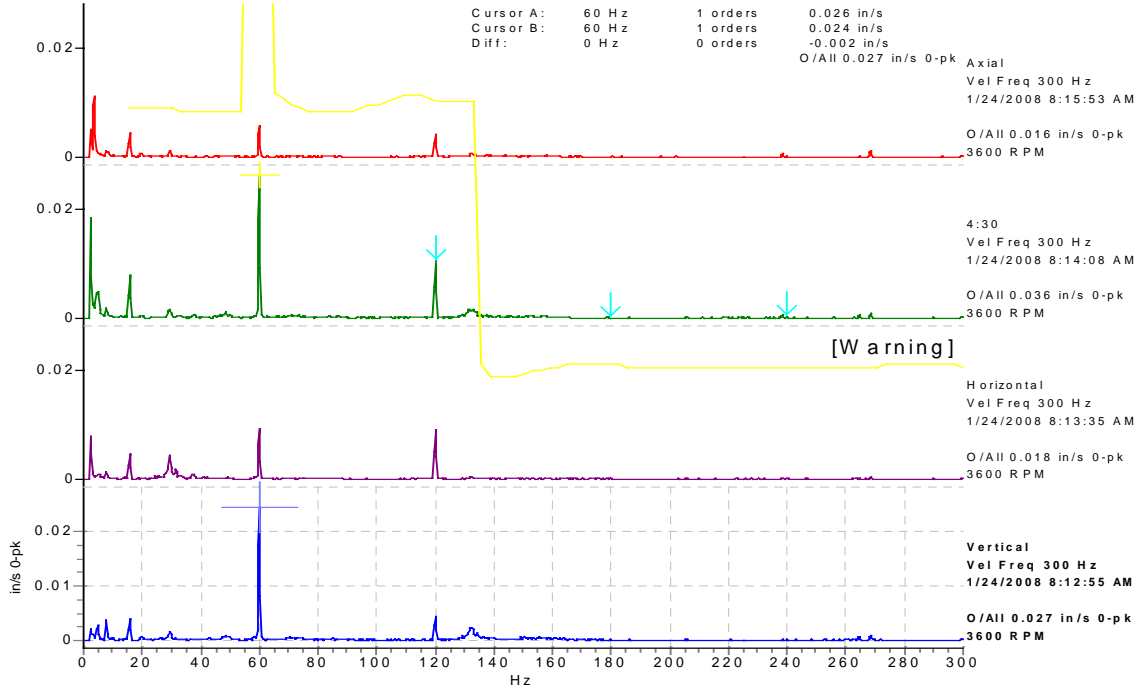
Moderate: Chiller has levels that are high enough that additional readings should be collected to understand the nature of the present levels.

Slight: Chiller has some minor indications of raised levels. Continue to monitor for changes in content and amplitude.

OK: Chiller has no faults. Continue to monitor for changes in content and amplitude.
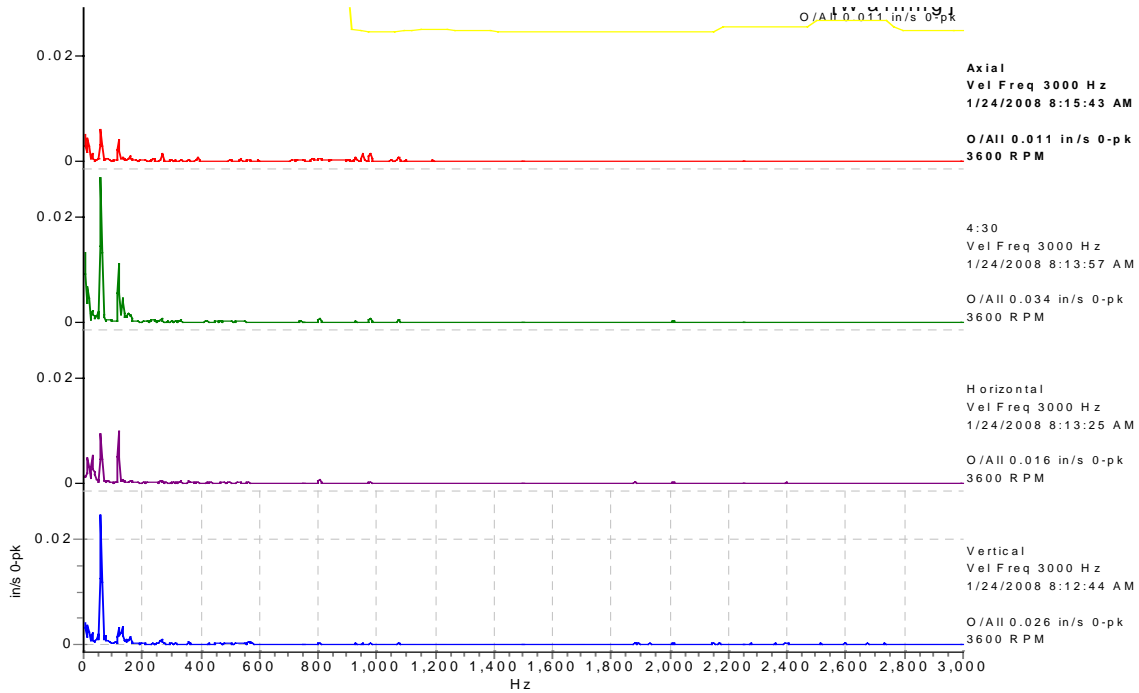
CH-1 - Motor Outboard

Machine Note (1/24/2008 7:42:13 AM)
Air run after overhaul CVHE500/L96M09223

Cursor A: 60 Hz   1 orders   0.026 in/s
Cursor B: 60 Hz   1 orders   0.024 in/s
Diff: 0 Hz   0 orders   -0.002 in/s
O/All 0.027 in/s 0-pk

Axial
Vel Freq 300 Hz
1/24/2008 8:15:53 AM

O/All 0.016 in/s 0-pk
3600 RPM

4:30
Vel Freq 300 Hz
1/24/2008 8:14:08 AM

O/All 0.036 in/s 0-pk
3600 RPM

[Warning]

Horizontal
Vel Freq 300 Hz
1/24/2008 8:13:35 AM

O/All 0.018 in/s 0-pk
3600 RPM

Vertical
Vel Freq 300 Hz
1/24/2008 8:12:55 AM

O/All 0.027 in/s 0-pk
3600 RPM

in/s 0-pk

Hz

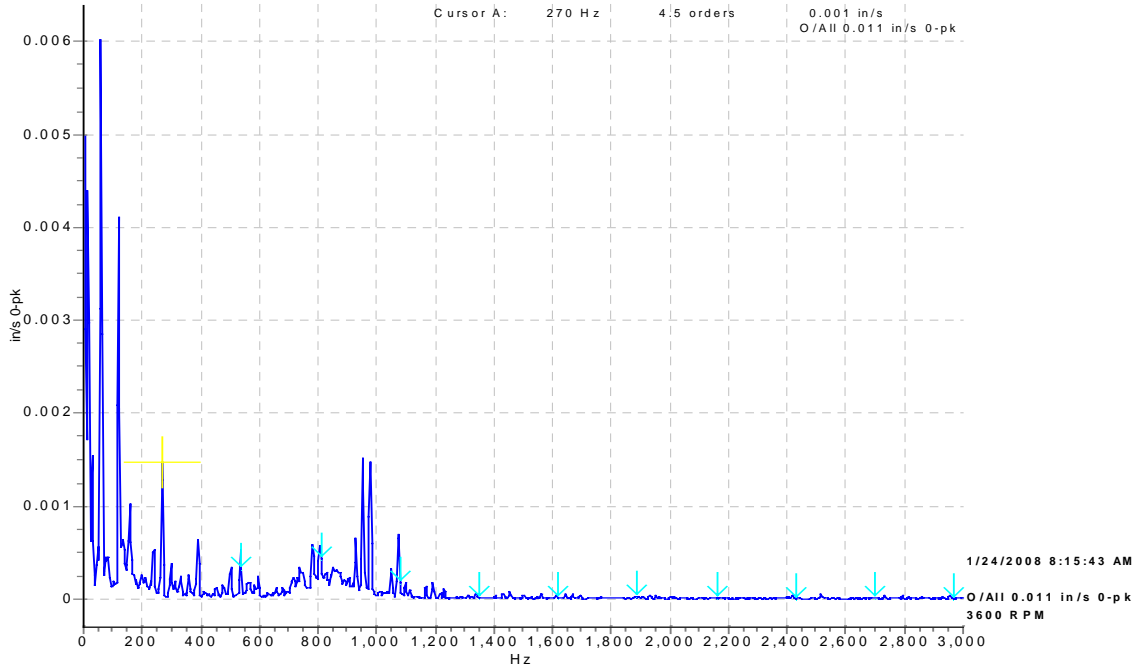**Very good 1xrpm levels seen in the motor outboard readings. Less than .05 ips noted.**

CH-1 - Motor Outboard

Machine Note (1/24/2008 7:42:13 AM)
Air run after overhaul CVHE500/L96M09223

O/All 0.011 in/s 0-pk

Axial
Vel Freq 3000 Hz
1/24/2008 8:15:43 AM

O/All 0.011 in/s 0-pk
3600 RPM

4:30
Vel Freq 3000 Hz
1/24/2008 8:13:57 AM

O/All 0.034 in/s 0-pk
3600 RPM

Horizontal
Vel Freq 3000 Hz
1/24/2008 8:13:25 AM

O/All 0.016 in/s 0-pk
3600 RPM

Vertical
Vel Freq 3000 Hz
1/24/2008 8:12:44 AM

O/All 0.026 in/s 0-pk
3600 RPM

in/s 0-pk

Hz

CH-1 - Motor Outboard - Axial - Vel Freq 3000 Hz
1/24/2008 8:15:43 AM

Cursor A: 270 Hz   4.5 orders   0.001 in/s
O/All 0.011 in/s 0-pk

1/24/2008 8:15:43 AM

O/All 0.011 in/s 0-pk
3600 RPM

No faults noted in the axial mid frequency range.

CH-1 - Motor Outboard - Axial - Acc Freq 20000 Hz

O/All 0.185 g rms

1/24/2008 8:15:33 AM

O/All 0.185 g rms
3600 RPM

1/24/2008 8:15:29 AM

O/All 0.39 g rms
3600 RPM
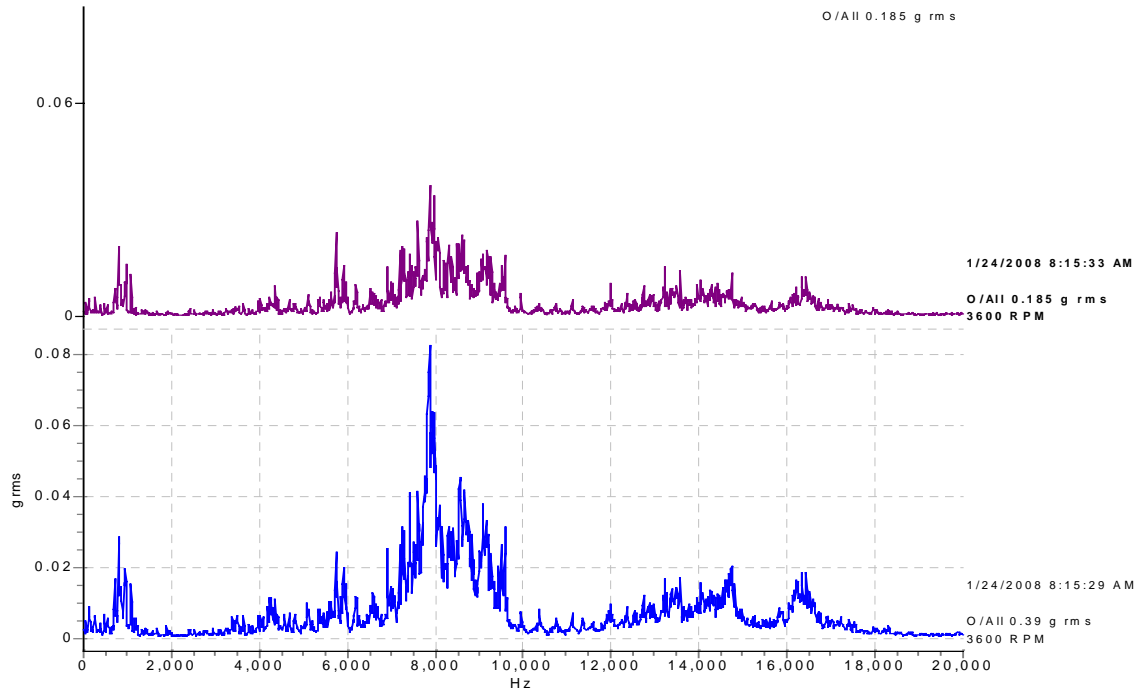
CH-1 - Motor Outboard - Axial - Demod (2-10kHz) 1000 Hz
1/24/2008 8:15:19 AM

Cursor A: 120 Hz   2 orders   0.015 g
                                                     O/All 0.088 g rms

1/24/2008 8:15:19 AM

O/All 0.088 g rms
3600 RPM

y-axis: g rms — 0.016, 0.014, 0.012, 0.01, 0.008, 0.006, 0.004, 0.002, 0

x-axis: Hz — 0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000

CH-1 - Motor Outboard - Axial

O/All 0.047 g rms

y-axis: g — 0.8, 0.6, 0.4, 0.2, 0, -0.2, -0.4, -0.6, -0.8

x-axis: revs — 0, 2, 4, 6, 8, 10, 12

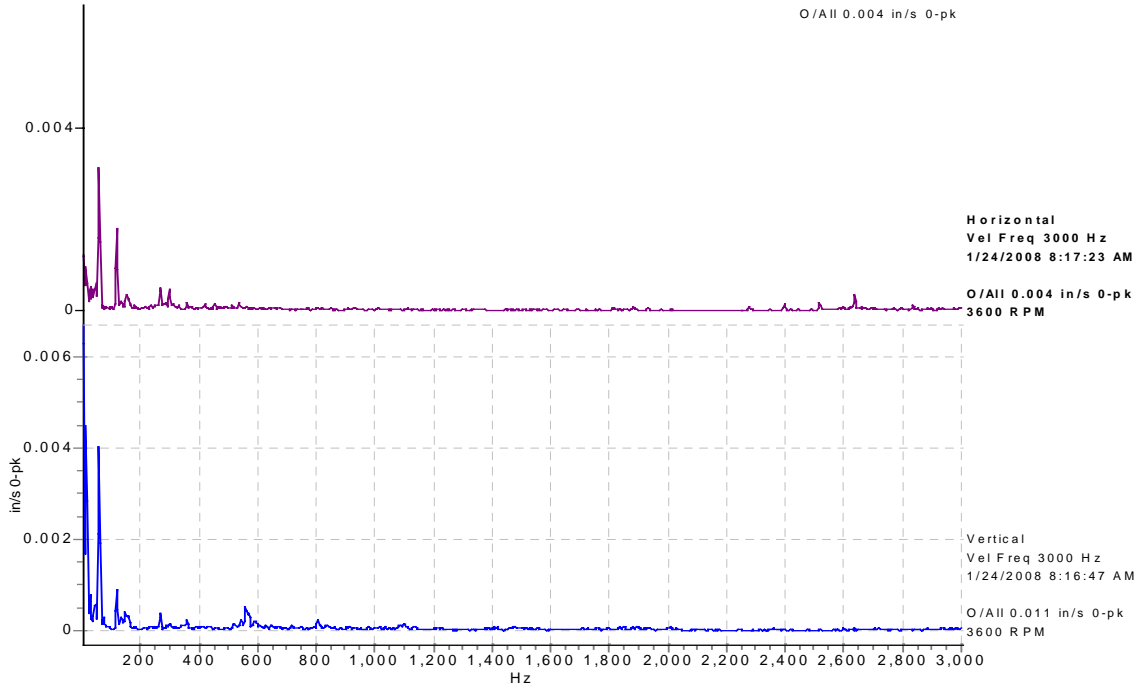|			
Acc Time 200 ms	1/24/2008 8:15:38 AM	O/All 0.047 g rms	3600 RPM
Acc Time 80 ms	1/24/2008 8:15:23 AM	O/All 0.219 g rms	3600 RPM
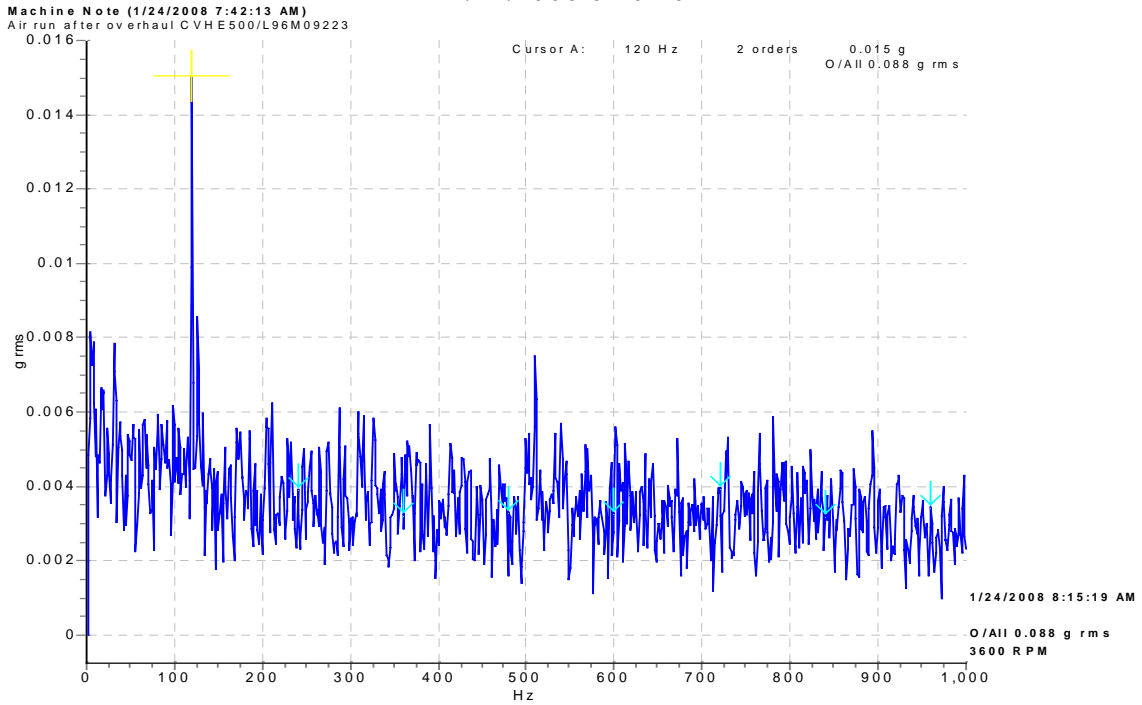
Axial waveform levels are below the nominal 2 G pk for the higher frequency and less than the nominal 1 G pk for the lower frequency range.
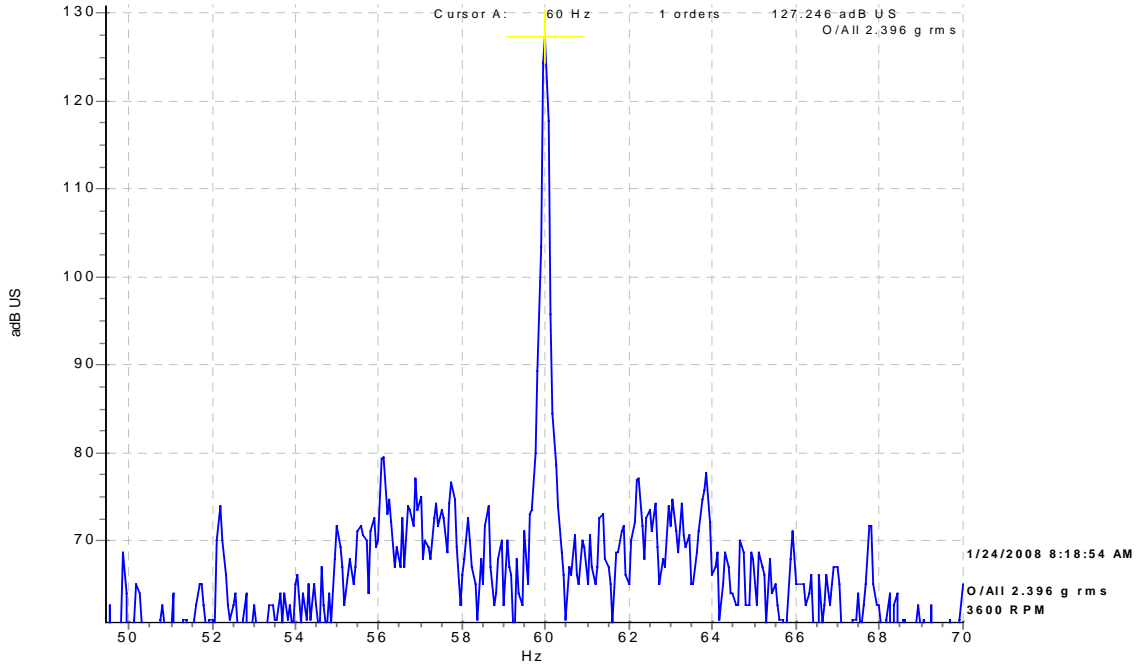
CH-1 - Motor Inboard

O/All 0.004 in/s 0-pk

0.004

Horizontal
Vel Freq 3000 Hz
1/24/2008 8:17:23 AM

0

O/All 0.004 in/s 0-pk
3600 RPM

0.006

in/s 0-pk

0.004

0.002

Vertical
Vel Freq 3000 Hz
1/24/2008 8:16:47 AM

0

O/All 0.011 in/s 0-pk
3600 RPM

200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000 2,200 2,400 2,600 2,800 3,000

Hz

CH-1 - Motor Current - Motor Current - Acc Freq 100 Hz
1/24/2008 8:18:54 AM

130

Cursor A: 60 Hz   1 orders   127.246 adB US
O/All 2.396 g rms

120

110

100

adB US

90

80

70

1/24/2008 8:18:54 AM

O/All 2.396 g rms
3600 RPM

50   52   54   56   58   60   62   64   66   68   70

Hz

No faults noted in the motor current readings!

CH-1 - Motor Current - Motor Current - Acc Freq 5000 Hz
1/24/2008 8:18:25 AM

Machine Note (1/24/2008 7:42:13 AM)
Air run after overhaul CVHE500/L96M09223

Cursor A: 300 Hz   5 orders   0.244 g
O/All 0.263 g rms

1/24/2008 8:18:25 AM
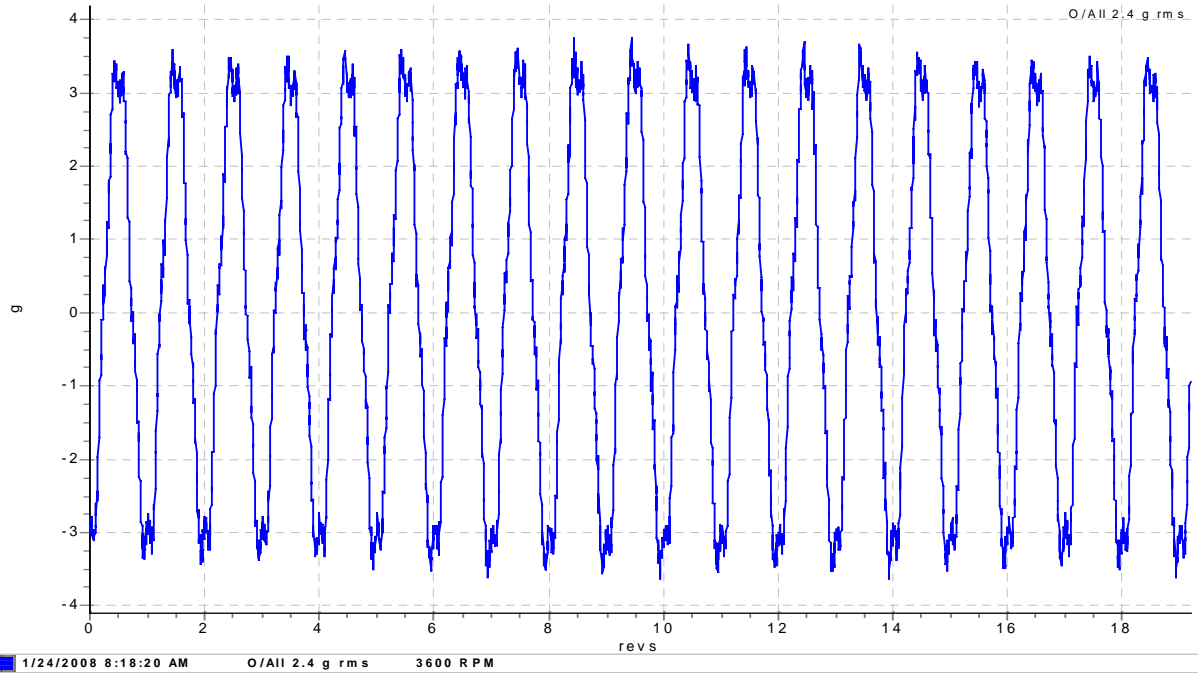
O/All 0.263 g rms
3600 RPM

g rms

Hz
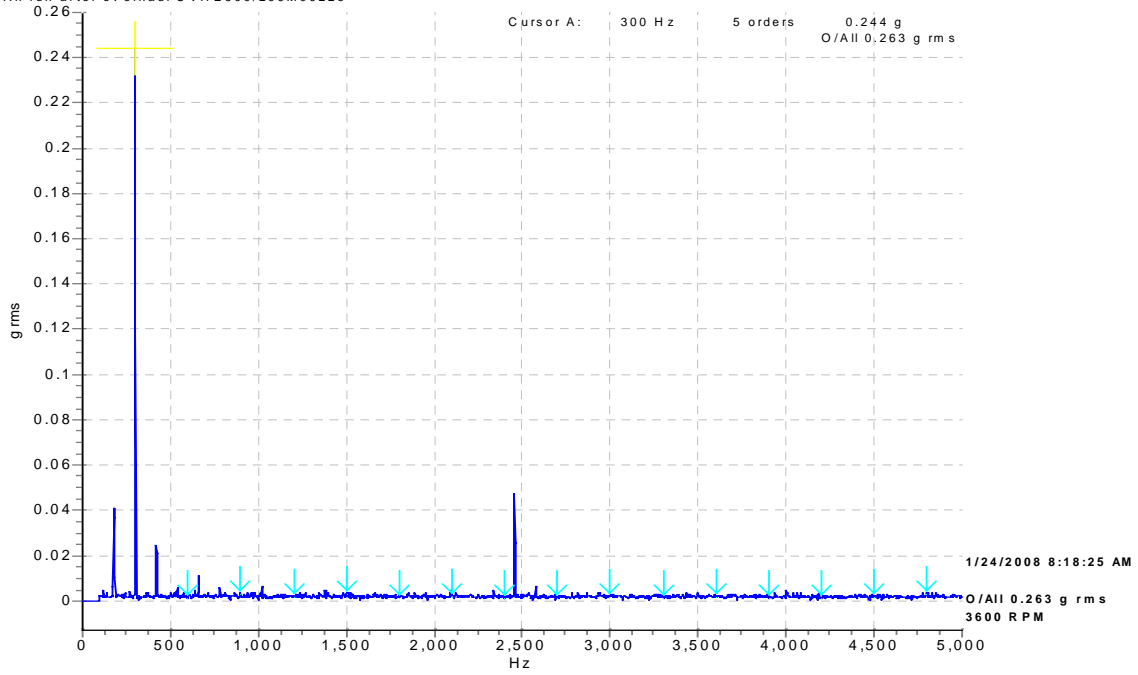
CH-1 - Motor Current - Motor Current - Acc Time 320 ms
1/24/2008 8:18:20 AM

Machine Note (1/24/2008 7:42:13 AM)
Air run after overhaul CVHE500/L96M09223

O/All 2.4 g rms

g

revs

1/24/2008 8:18:20 AM   **O/All 2.4 g rms**   **3600 RPM**

Vibration Terms

A

Acceleration

A vector quantity that specifies the time derivative of velocity.

Ambient vibration

The all-encompassing vibration associated with a given environment, usually a composite of vibration from many sources, far and near.

Amplitude

The maximum value of a sinusoidal quantity.

Antinode

A point, line or surface in a standing wave where some characteristic of the wave field has a maximum amplitude.

Amplitude distortion

Of a transducer. Distortion that occurs when the ratio of the output of the transducer to its input at a given frequency varies with the input amplitude.

Accelerometer

A pickup that converts an input acceleration to an output (usually electrical) that is proportional to the input acceleration.

B

Beats

Periodic variations in the amplitude of an oscillation resulting from the combination of two oscillations with slightly different frequencies.

Beat frequency

The absolute value of the difference between the frequencies of two oscillations with slightly different frequencies.

C

Cycle

The complete range of states or values through which a periodic phenomenon or function passes before repeating itself identically.

Crest factor

Of an oscillating quantity. The ratio of the peak value to the r.m.s. value.

Circular vibration

A vibration in which the locus of a vibration point is circular in form.

Critical speed

A characteristic speed at which a predominant response occurs at resonance. (Note : In the case of a rotating system, the critical speed is the speed that corresponds to a resonance frequency of the system (it may also include multiples and submultiples of the resonance frequency); for example, speed in revolutions per unit time is equal to the resonance frequency in cycles per unit of time).

Calibration factor

Of a transducer. The average sensitivity within a prescribed frequency range.

Complex Wave

The resultant form of a number of sinusoidal waves that are summed together forming a periodic wave. Such waves may be analyzed in the frequency domain to readily determine their component parts.

D

Displacement

A vector quantity that specifies the change of position of a body or particle with respect to a reference frame.

Dominant frequency

A frequency at which a maximum value occurs in a spectral density curve.

Damped natural frequencies

The frequency of free vibration of a damped linear system.

Dynamic vibration absorber

A device for reducing vibrations of a primary system over a desired frequency range by the transfer of energy to an auxiliary resonant system so tuned that the force exerted by the auxiliary system is opposite in phase to the force acting on the primary system.

Detuner

An auxiliary vibratory system with an amplitude-dependent frequency characteristic that modifies the vibration characteristics of the main system to which it is attached.

Displacement pickup

A pickup that converts its input displacement to an output (usually electrical) that is proportional to the input displacement.

Dynamic stiffness

(a) The ratio of change of force to change of displacement under dynamic conditions.

(b) The complex ratio of force to displacement during simple harmonic motion.

E

Extraneous vibration

The total other than vibration of interest.

Elliptical vibration

A vibration in which the locus of a vibrating point is elliptical in form.

F

Forced vibration

The steady-state vibration caused by external excitation.

Free vibration

Vibration that occurs after the removal of excitation or restraint.

Frequency

The reciprocal of the period when the independent variable is time.

Fundamental frequency

(a) Of periodic quantity. The reciprocal of the fundamental period when the independent variable is time

(b) Of a system. The lowest natural frequency.

Form factor

Of an oscillating quantity. The ratio of the r.m.s. value to the mean value for half cycle between two successive zero crossings.

Fundamental natural mode of vibration

The mode of vibration of a system having the lowest natural frequency.

Fixed base natural frequency

A natural frequency that a system would have if the foundation to which the equipment is attached were rigid and of infinite mass.

Frequency distortion

Of a transducer. Distortion that occurs within a given frequency range when the amplitude sensitivity of the transducer for a given amplitude of excitation is not constant over the range.

Frequency response

Of a transducer. The output signal of the transducer expressed as a function of the frequency of its input signal.

FFT

Fast Fourier Transform. A computationally efficient mathematical technique which converts digital information from the time domain to the frequency domain for rapid spectral analysis.

G

g

The force of acceleration due to gravity equal to 32.1739 ft/sec2 or 386 in./sec2.

H

Harmonic

Of a periodic quantity. A sinusoidal quantity whose frequency is an integral multiple of the fundamental frequency of the quantity.

Hertz (Hz)

Units in which frequency is expressed. Synonymous with cycles per second.

J

Jerk

A vector quantity that specifies the time derivative of acceleration.

L

Lag

1. A time delay between the output of a signal and the response of the instrument to which the signal is sent. 2. A time relationship between two waveforms where a fixed reference point on one wave occurs after the same point of the reference wave.

M

Mode

A characteristic of a system undergoing vibration, indicating the pattern of nodes and antinodes assumed by the system in which the motion of every particle, for a particular frequency, is simple harmonic (for linear systems) or has corresponding decay patterns.

Mode shape

Of a given mode of vibration of a mechanical system. The shape given by the maximum change in position , usually normalised to a prescribed deflection magnitude at a prescribed point, of its neutral surface (or neutral axis) from its mean value for that mode of vibration.

N

Node

A point, line or surface in a standing wave where some characteristic of the wave field has essentially zero amplitude.

Natural mode of vibration

A mode of vibration assumed by a system when vibrating freely.

O

Output Noise

The RMS, peak-to-peak (as specified) AC component of a transducer's DC output in the absence of a measurand variation.

P

Periodic vibration

A periodic quantity whose values recur for certain equal increments of the independent variable.

Phase angle

Of a periodic quantity. The fractional part of a period through which the quantity has advanced, as a measure from a value of the independent variable as a reference.

Phase difference

Between two periodic quantities with the same frequency, the difference between their respective phases.

Peak value

The maximum value of a quantity during a given interval.

Peak-to-peak value

Of an oscillating quantity. The algebraic difference between the extreme values of the quantity.

Q

Quasi-periodic vibration

A vibration that deviates only slightly from periodic vibration.

R

Random vibration

A vibration whose magnitude cannot be precisely predicted for any given instant of time.

Rectilinear vibration

A vibration in which the locus of a vibration point is in a straight line.

Resonance

Of a system in forced oscillation. The condition of the system when any change in the frequency of excitation, however small the change , causes a degrease in a response of the system.

Resonance frequency

A frequency at which resonance occurs.

Resonant vibration generator

A vibration generator that contains a vibration system that is excited at its resonance frequency.

Response

Of a system. A quantitative expression of the output of a system.

Repeatability

The ability of a transducer to reproduce output readings when the same measurand value is applied to it consecutively, under the same conditions, and in the same direction. Repeatability is expressed as the maximum difference between output readings as a percent of full scale.

S

Steady-state vibration

Continuing periodic vibration.

Self-induced vibration

Vibration of a mechanical system resulting from conversion, within the system, of a non-oscillatory energy to oscillatory excitation.

Simple harmonic motion

A motion that is a sinusoidal function of time.

Sensitivity

Of a transducer, for a stated value of the input quantity. The relationship of a change in the input quantity to the corresponding change in the input quantity.

Spectrum

A description of a quantity as a function of frequency or wavelength.

Static Unbalance

Static unbalance is that condition of unbalance for which the central principal axis is displayed only parallel to the shaft axis.

T

Transient vibration

The vibratory motion of a system as it changes from one state to another.

Transducer

A device that receives energy from one system and supplies energy, of either the same or a different kind, to another system in such a manor that the desired characteristics of the input energy appear at the output.

True RMS

The true root-mean-square value of an AC or AC-plus-DC signal, often used to determine power of a signal. For a perfect sine wave, the
RMS value is 1.11072 times the rectified average value, which is utilized for low-cost metering. For significantly non-sinusoidal signals, a true RMS converter is required.

U

Undamped natural frequency

Of a mechanical system. A frequency of free vibration resulting from only elastic and inertial forces of the system.

V

Velocity

A vector quantity that specifies the time derivative of displacement.

Vibration

The variation with time of the magnitude of a quantity that is descriptive of the motion or position of a mechanical system, when the magnitude is alternatively greater than and smaller than some average value or reference.

Vibration severity

Of a machine. The maximum r.m.s. value of the vibration velocities measured at significant points on the machine such as bearings or mountings.

Velocity pickup

A pickup that converts an input velocity to an output (usually electrical) that is proportional to the input velocity.

W

Wavelength

Of a periodic wave. The distance, measured perpendicular to the wave front in the direction of propagation, between two successive points on the wave that are separated by one period.