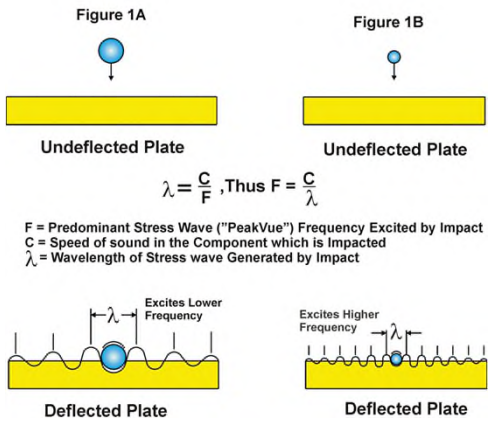
Welcome to the Reliability Solutions Webinar

We will begin momentarily!



Managing Your Assets with PeakVue™ Plus Actionable Diagnostics

Presenters:

Scott Bassett – Scott.Bassett@Emerson.com

Michael Szurkowski – Michael.Szurkowski@emerson.com

Asad Malik – Asad.Malik@Emerson.com

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Safety Moment: Stay Physically Active During Self-Quarantine

- In many states, fitness centers remain temporarily closed
- Sedentary behavior and low levels of physical activity can have negative effects on the health, well-being and quality of life
- Self-quarantine can also cause additional stress and challenge your mental health

- Physical activity and relaxation techniques can be valuable tools to help you remain calm and continue to protect your health during this time
  - Take short active breaks during the day
  - Put time on your calendar to exercise
  - Deep or Belly Breathing

Stay Home, Stay Safe, Stay Physically Active

Presenters

Scott Bassett

ISO Cat IV Vibration Analyst
Sales Enablement
Been with Emerson 7 yrs.
Previously an analyst in paper industry

Michael Szurkowski

ISO Cat III Vibration Analyst
Business Development / SME
Been with Emerson 16 yrs.
Previously an analyst in power industry

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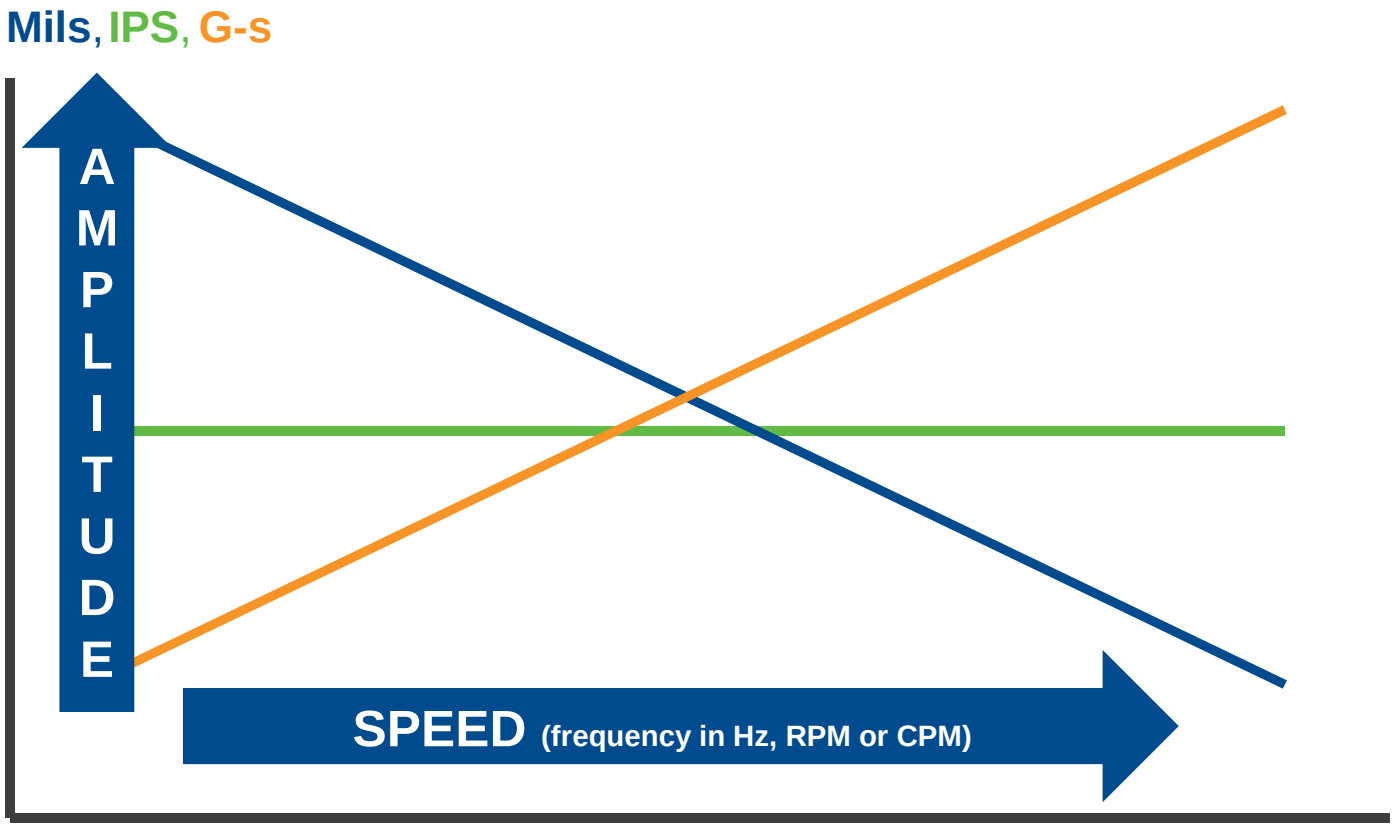
Vibration Measurement



Acceleration
(high freq.)

Velocity
(general purpose)

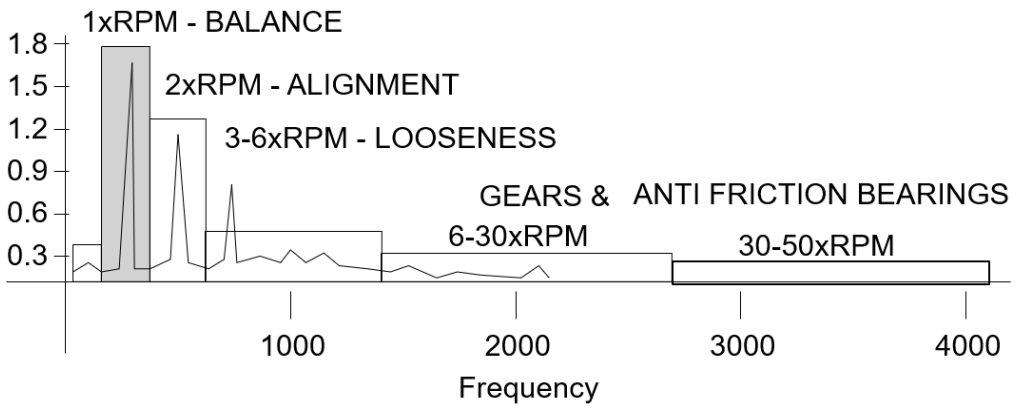
Displacement
(low freq.)

Vibration Measurement

Mils, IPS, G-s

AMPLITUDE

- Vibration data is usually rich in information



SPEED (frequency in Hz, RPM or CPM)

Typical vibration data is looking for ***Specific Events*** that happen at ***specific Frequencies*** within a frequency range.

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PeakVue

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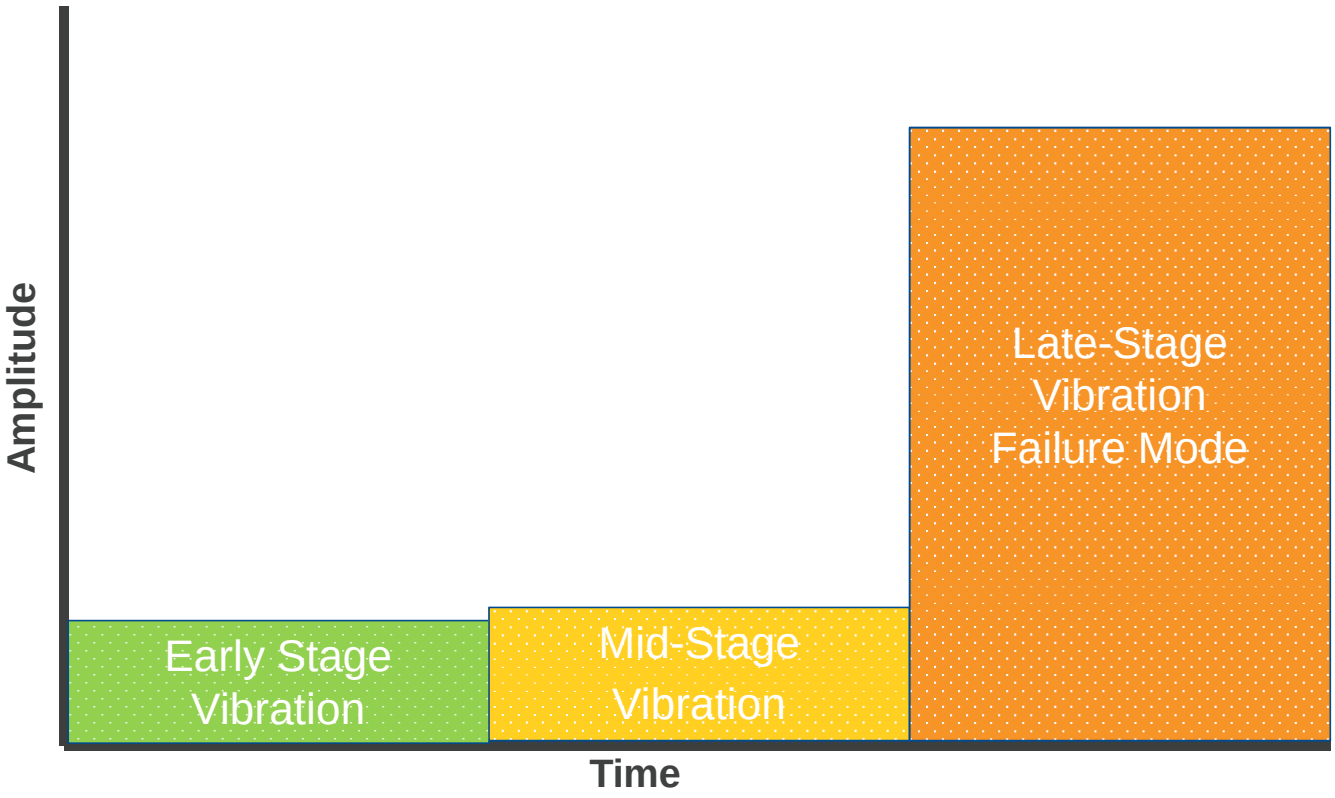
What is PeakVue?

PeakVue is **Emerson's patented method of separating very high frequency, short duration stress waves** from regular vibration data.

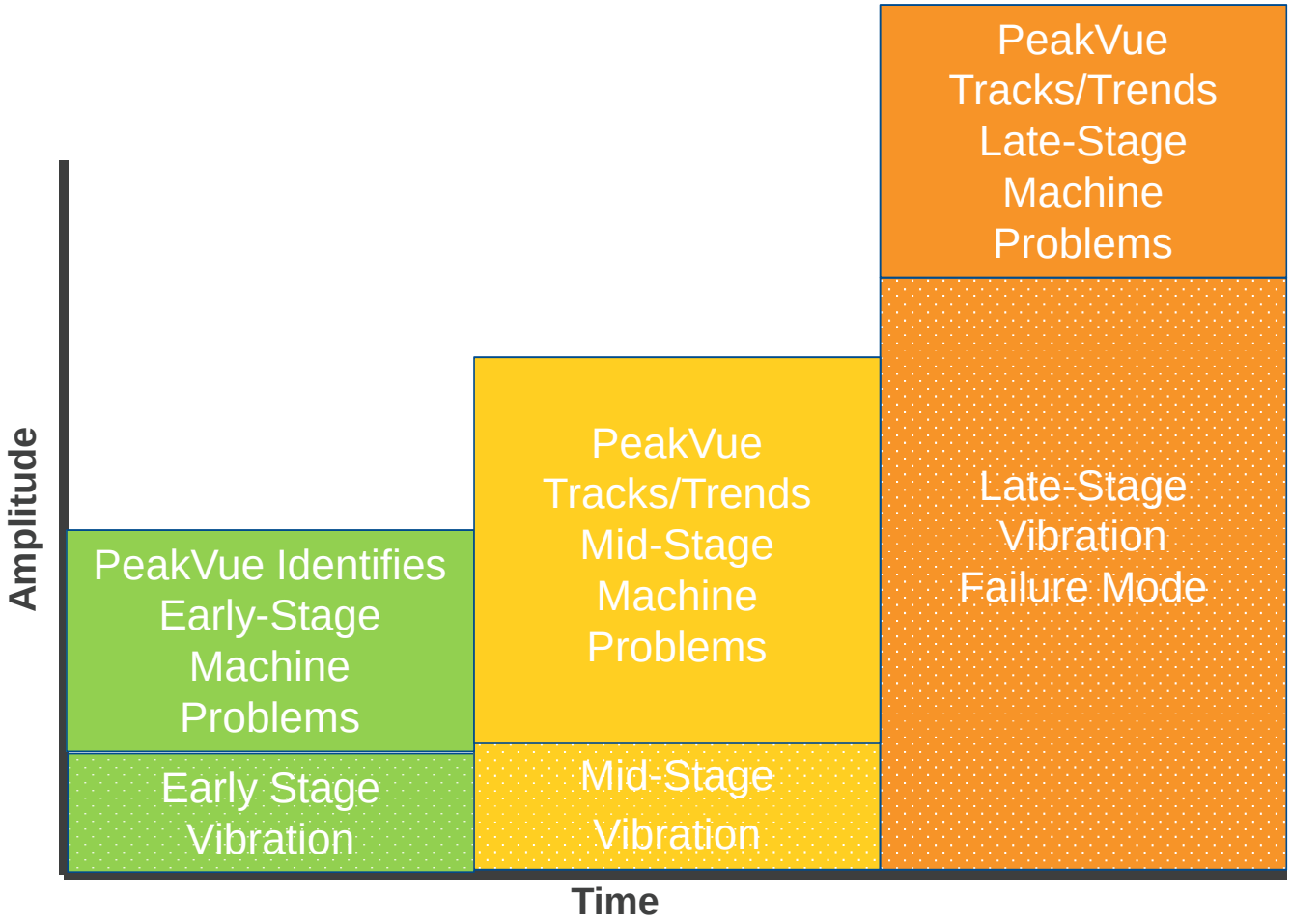
In layman's terms, it detects *impacting*.

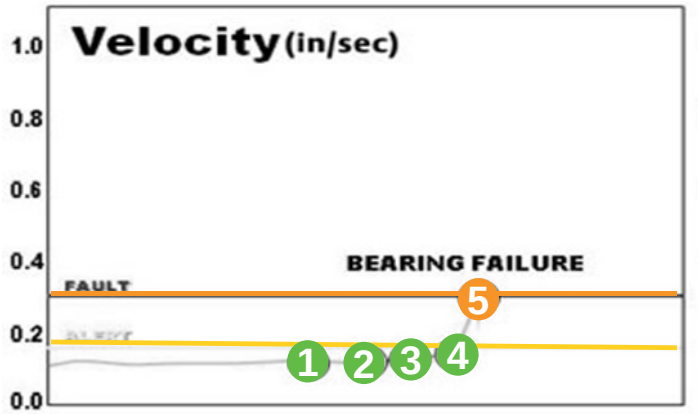
Why Monitor with PeakVue?

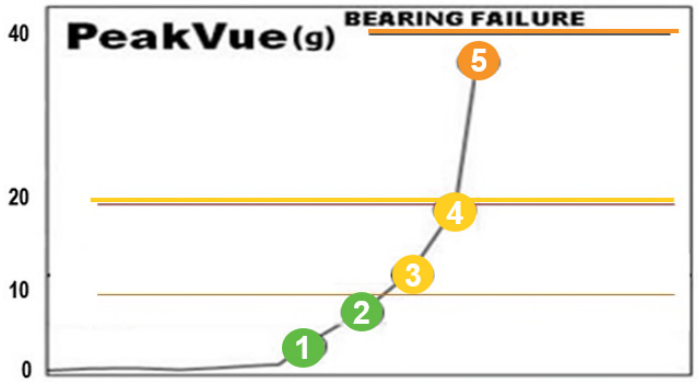
How is PeakVue different?



How is PeakVue different?

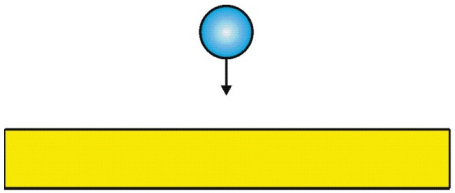






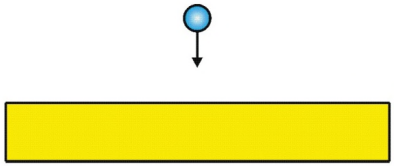
What are Stress Waves?

Figure 1A



Undeflected Plate

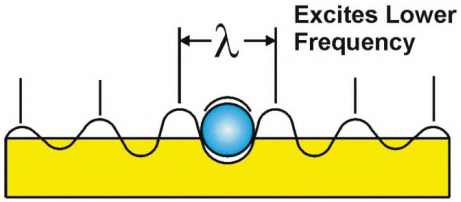
Figure 1B



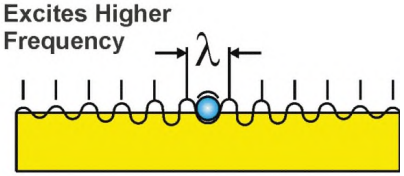
Undeflected Plate

$$\lambda = \frac{C}{F}, \text{Thus } F = \frac{C}{\lambda}$$

F = Predominant Stress Wave (”PeakVue”) Frequency Excited by Impact
C = Speed of sound in the Component which is Impacted
λ = Wavelength of Stress wave Generated by Impact



Deflected Plate

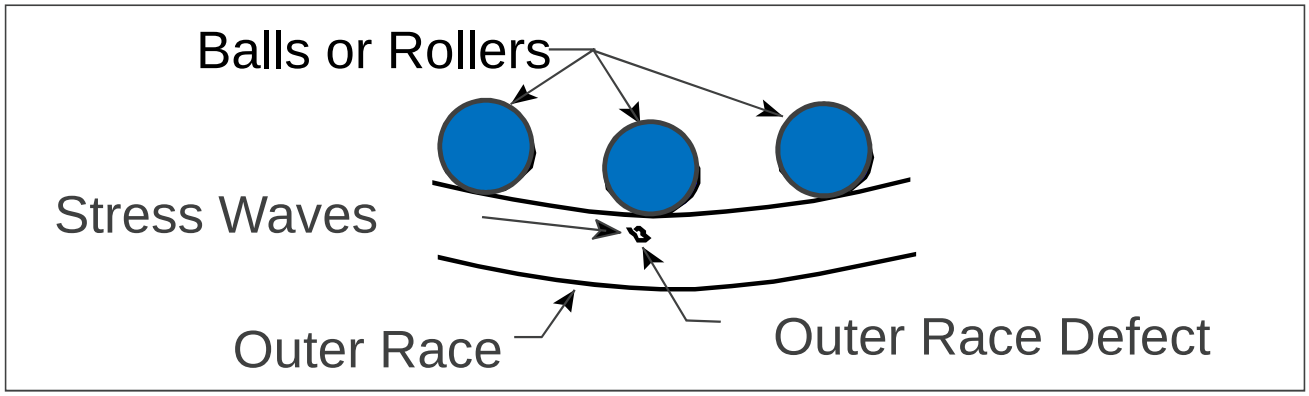


Deflected Plate

NOTE: The speed of sound (c) in most metals ranges from approximately 5000 to 10,000 ft/sec (1520 to 3040 m/sec).

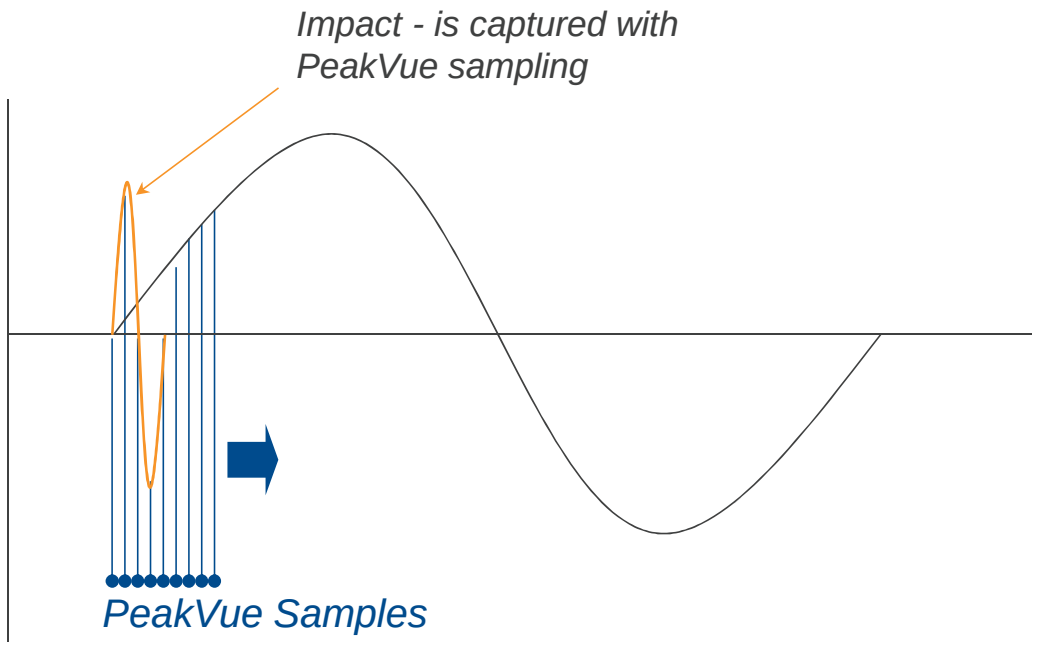
What are Stress Waves?

- Stress Waves are generated due to
  - Impacting, fatigue cracking, scoring, scuffing, abrasion, friction, etc.
- Stress Wave emissions are typically very short term
  - Lasting several microseconds to a few milliseconds.
  - Normal sampling rates will not detect stress waves.
- High Frequency 1000 – 15000 Hz
  - Dependent on the mass & geometry of impacting object.
  - A larger roller will result in lower frequencies



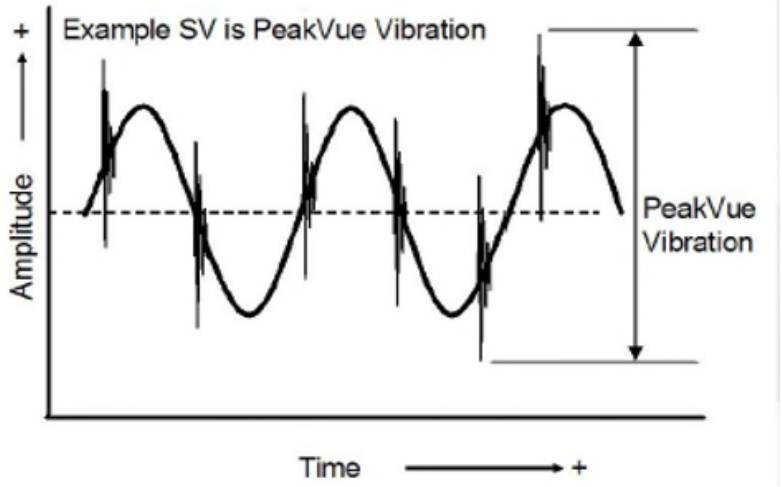
How does PeakVue work?

This diagram shows sampling of data using PeakVue data collection.



PeakVue provides EARLY Warning

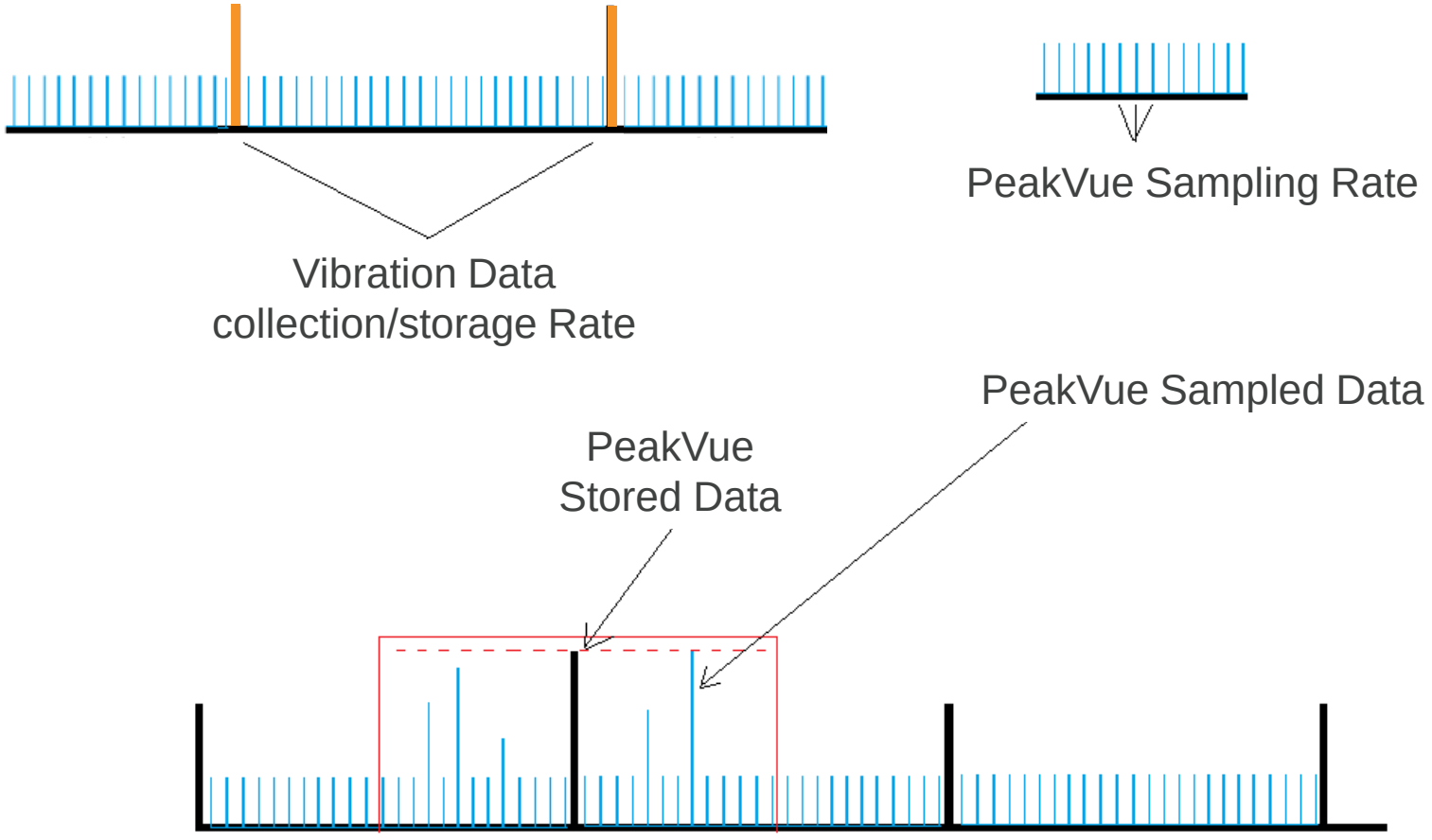
PeakVue uses High Sampling Rates
(Typically 50 to 100 Ksamples/second)



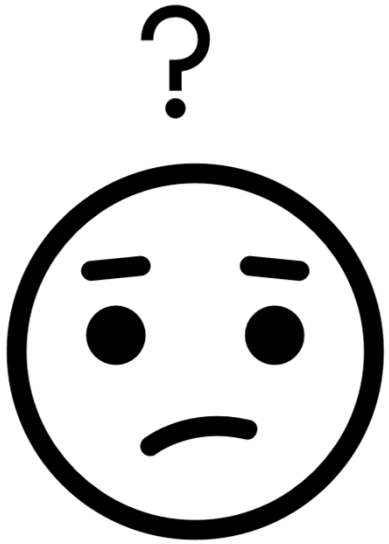
Identifies bearing, gear or impacting problems months or years before failure.

PeakVue Sampling and Filtering

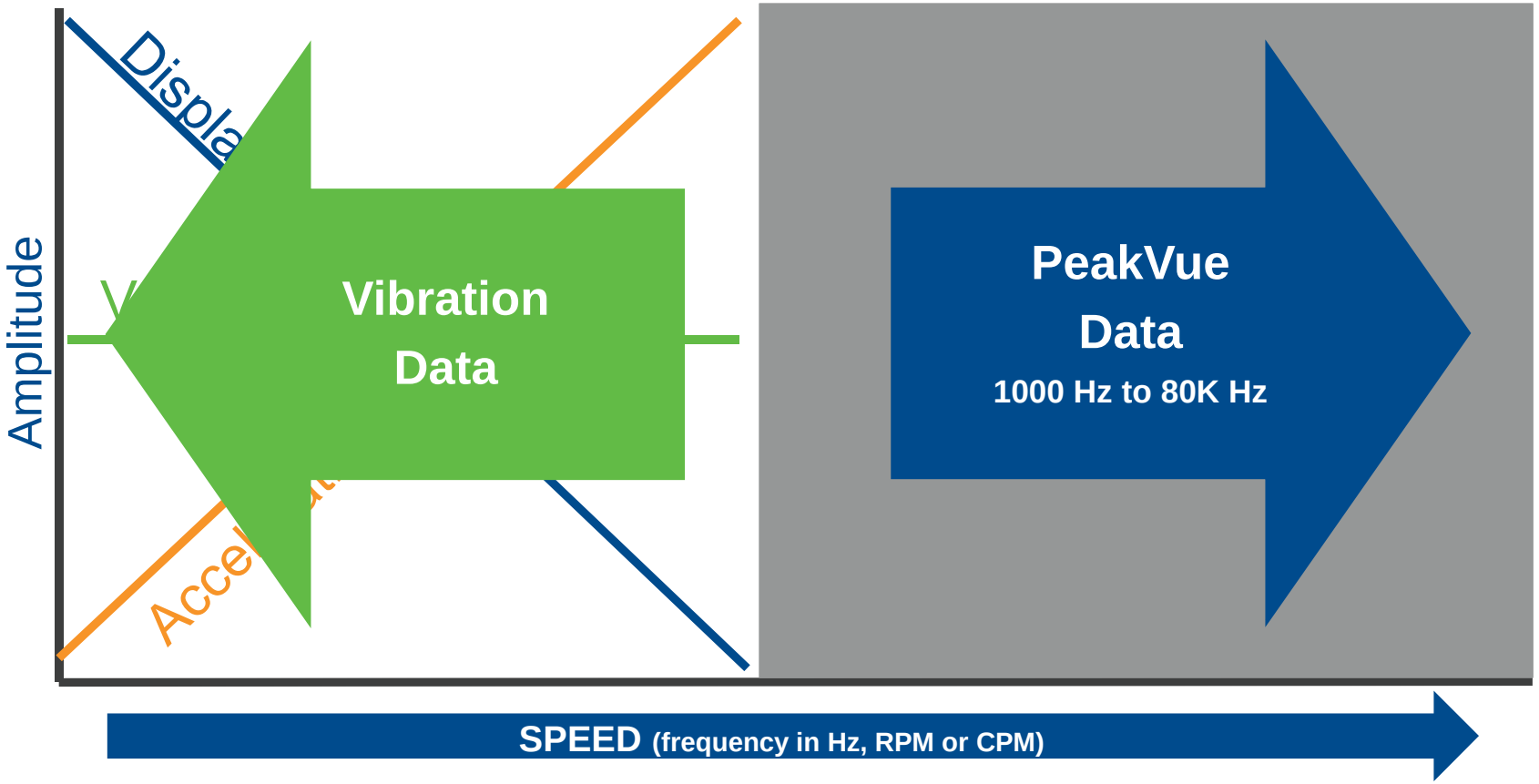
This oversimplified example indicates how PeakVue data is collected and stored.



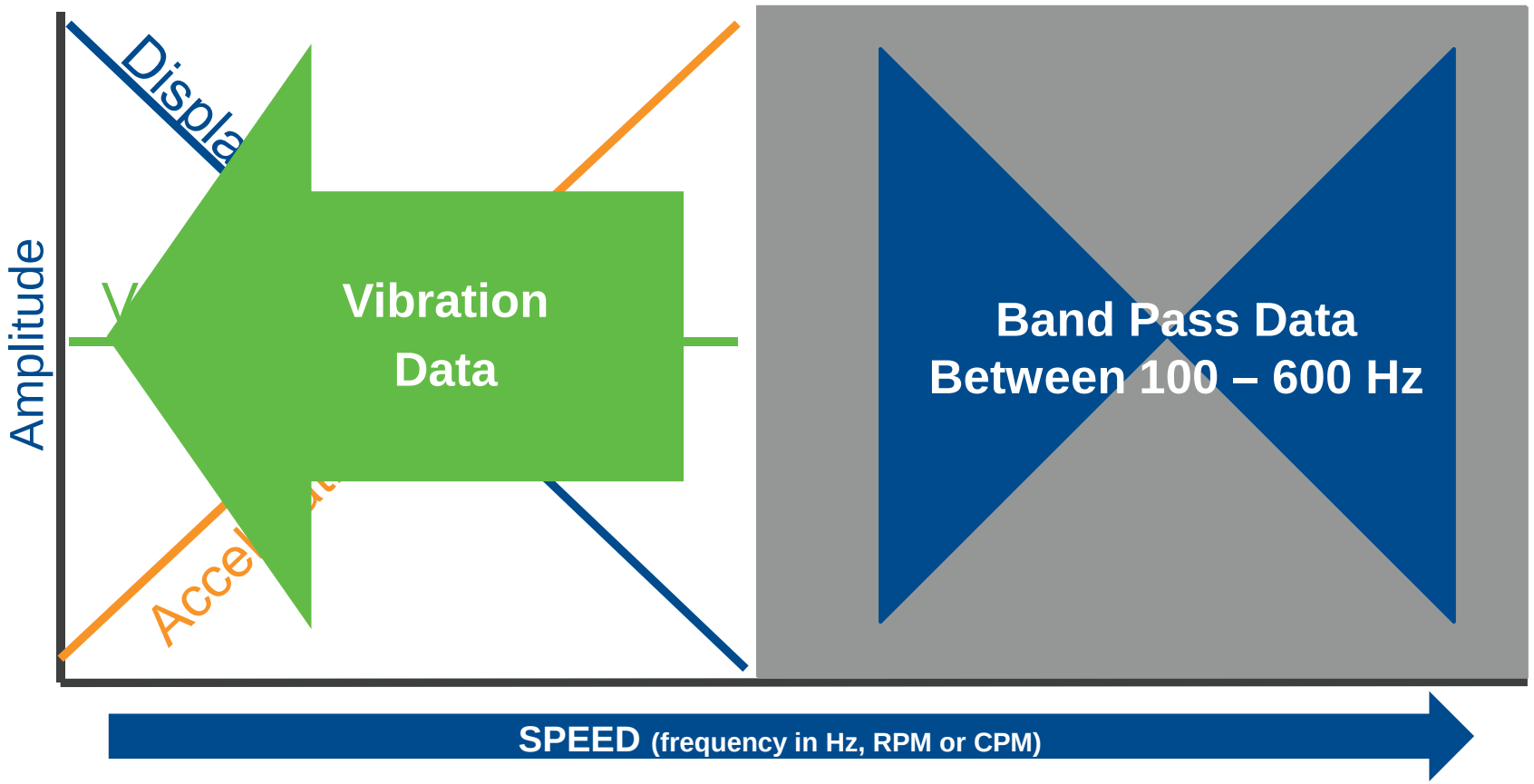
Correct filter?



PeakVue High Pass Filter



PeakVue High Pass Filter



Guidelines for Application of Filters

Filter (Hz)	Application
500	Low speed machines having gear mesh < 125 Hz. Bearing and gear problems
1,000	Intermediate speed machinery (<2000 RPM) with gear mesh <300 Hz.
2,000	Medium speed machinery (<4000 RPM) with gear mesh < 600 Hz.
5,000	Machinery up to 9000 RPM and gear mesh <1500 Hz. Required attention be paid to how the sensor is mounted as well as the sensor's frequency response.
10,000	High speed machinery with gear mesh <3000Hz. Sensor must be permanently mounted with frequency response of 3 dB in the 30 kHz or higher range.
20,000	High speed machinery with gear mesh <6000Hz. Sensor must be "high frequency' and permanently mounted.

Filter (Hz)	Application
20-150	Low speed machines having gear mesh < 125 Hz. Bearing and gear problems
50-300	Intermediate speed machinery (<2000 RPM) with gear mesh <300 Hz.
100-600	Medium speed machinery (<4000 RPM) with gear mesh < 600 Hz.
500-1000	Machinery up to 9000 RPM and gear mesh <1500 Hz. Required attention be paid to how the sensor is mounted as well as the sensor's frequency response.

Tip: Bandpass for excitation of structural resonance (e.g. gear mesh)
High Pass to detect metal-on-metal impacting or fatigue cracking

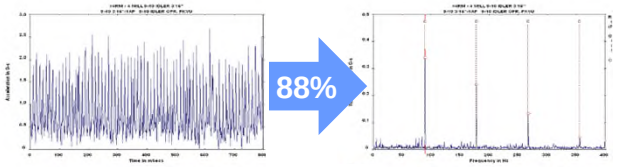
Measurements Comparisons

Features	Enveloping	Demodulation	PeakVue
Severity Values (meaningful & interpretable)	G's values may decrease as failure becomes imminent.	G's fault severity difficult to determine. Measures average not peak value.	G-s trend values will increase as fault gets worse. ★★★★
Waveform (shows actual impacting)		Does not show true impact amplitude.	Waveform true amplitude in G-s & Impact pattern ★★★
Spectrum	Four or five averages to process spectrum using low-pass filter. Effective early fault identification.	Anti-aliasing FFT filter. Spectral data may have broad-band noise floor from machine resonance.	Spectral defect peaks & fault frequencies. Reduced noise floor. ★
Sensor	Standard accelerometer	Standard accelerometer	Standard accelerometer.
Measurement	Signal is band-pass filtered, rectified & 2.5K – 5K Hz envelop filtered.	Signal sampled at 2.56xFmax, amplified & low-pass filtered. Amplitude dependent on event duration & filter setting.	Oversampled at 50-100Ksamples/sec. High-pass or Band-pass filter. Typically measures from 1KHz-40KHz.
Slow Speed Measurement	Slow-speeds may limit modulation of the defect frequencies below 2.5k Hz	Slow-speeds may limit modulation of the defect frequencies for fault amplitudes.	Measures down to 0.5 RPM ★★
Variable Speed (VFD)	Four or five averages to process spectrum; limits use for variable speed measurements.	Not trend-able on variable speed machines.	PeakVue severity will be maintained through various speeds. Order Tracking capable. ★★
Pervasive Sensing	No Pervasive Sensing capability.	No Pervasive Sensing capability.	Autocorrelation / PeakVue Plus distinguishes between mechanical & lubrication faults. ★★★★★

The Waveform is Key

1. **Amplitude information is only retained in the waveform.**
2. **Must look at waveform *only* for severity information.**
3. **Amplitude loss in the spectrum varies from 85-99%!**
4. **Even with clear impacting (e.g. Rolling Element Defect) amplitude can drop by 98%.**
5. **Lubrication defects (e.g. random impacting) drop most severely – up to 99%+.**

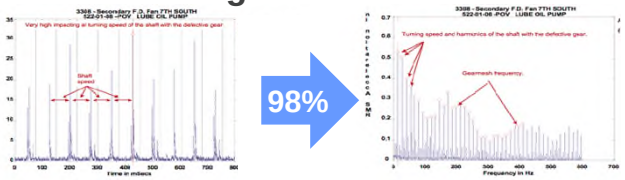
Outer Race Defect



Max Waveform = 2.6 g's

Max Spectrum = 0.3 g's

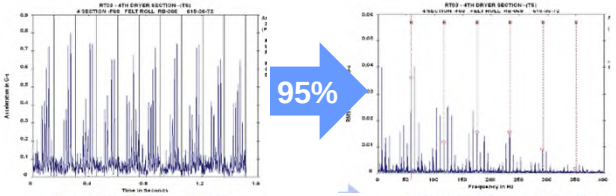
Rolling Element Defect



Max Waveform = 30.9 g's

Max Spectrum = 0.5 g's

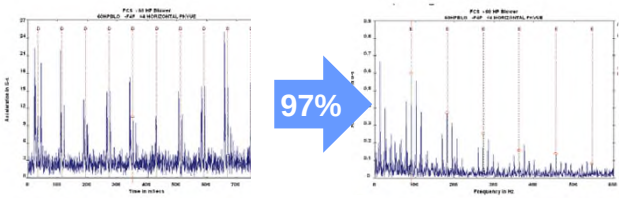
Cracked Inner Race



Max Waveform = 0.8 g's

Max Spectrum = 0.04 g's

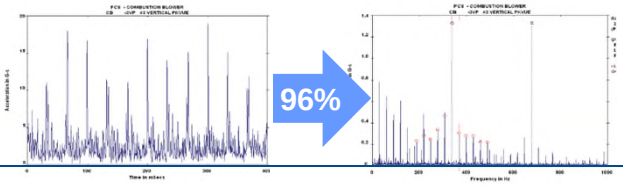
Gear Defect



Max Waveform = 25 g's

Max Spectrum = 0.67 g's

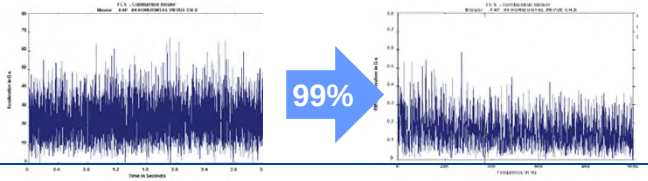
Inner Race Defect



Max Waveform = 19 g's

Max Spectrum = 0.8 g's

Lubrication Fault

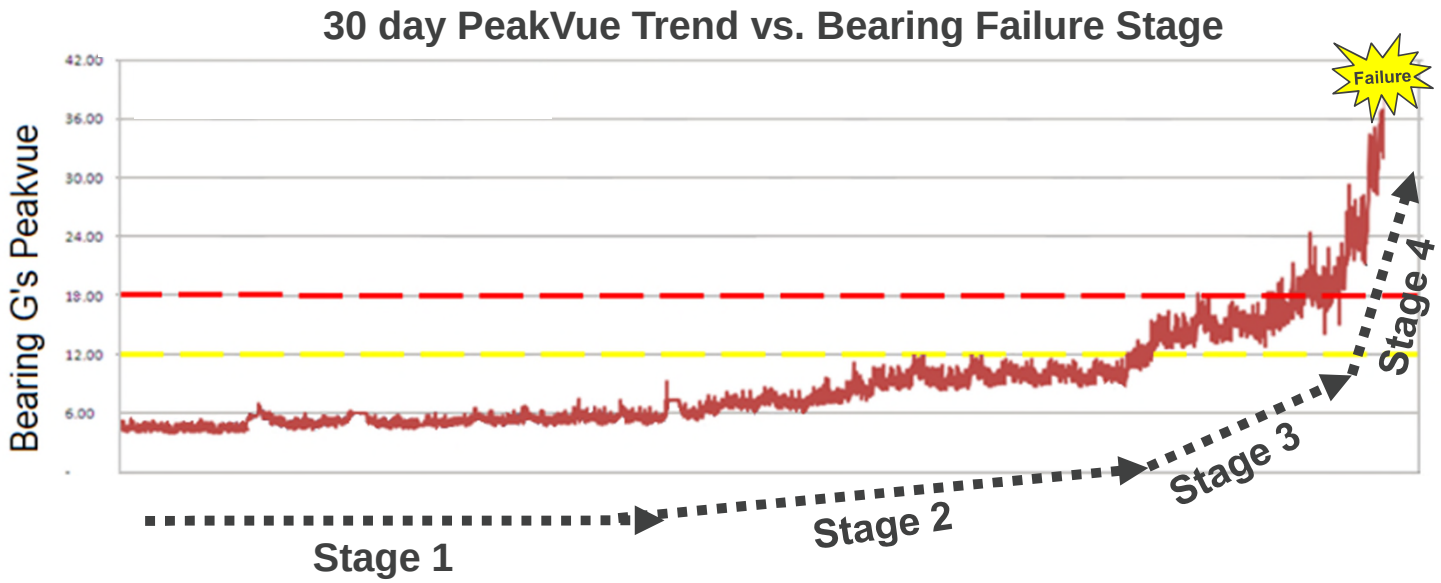


Max Waveform = 70 g's

Max Spectrum = 0.6 g's

Trending the Max Amplitude in the Waveform

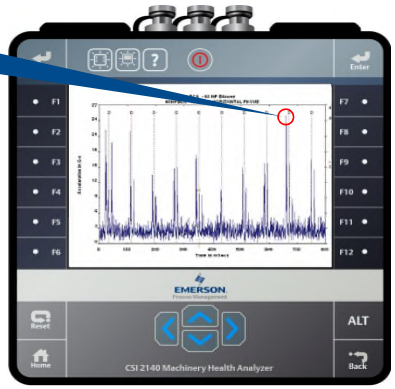
- The key indicator of severity is the Max Amplitude in the PeakVue waveform.
- Unlike vibration, this value is monotone increasing.
- Rate of increase indicates stage of bearing wear.
- Near vertical trend line indicates bearing is about to wipe.



PeakVue Route Set-up for the AMS 2140

HP Filter ≥ Fmax

AMS 2140 automatically locates maximum peak in the waveform



Single Average

Periodic Analysis Parameter Set [033] - DB26

Spectrum Parameters | Signal Processing Parms | ...rs

Set Description: PEAKVUE for 1800 (1600)
Spectral Frequency Setup : Hz
Low Frequency Signal Conditioning Limit (Hz): 0.0
Upper Freq (Hz/ORDER) : 500.0
Lower Freq (Hz/ORDER) : 0.0
Number of Lines : 1600
Number of Averages : 1
Spectral Averaging Mode: Normal Mode
Window Type : Hanning
Spectral Weighting : None
Perform 1/3 Octave Analysis?
Number of Analysis Parameters: 1

Periodic Analysis Parameter Set [033] - DB26

Spectrum Parameters | Signal Processing Parms | Waveform Parameters

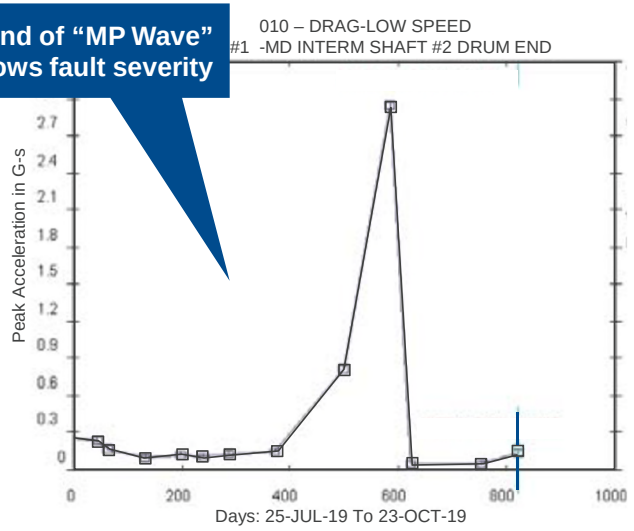
SST Control :
Pre-process Signal ? ☑
Method : PeakVue
Filter Setting : 500 Hz HP

Parameter Type: MP Wave

Analysis Parameter Set 33 - PEAKVUE 1800 (1600) - DB27

Description	Parameter Units Type	Type of Parameter	Lower Frequency	Upper Frequency
MP Waveform	ACCEL	MP Wave	0.0	0.0

Trend of "MP Wave" shows fault severity



Autocorrelation

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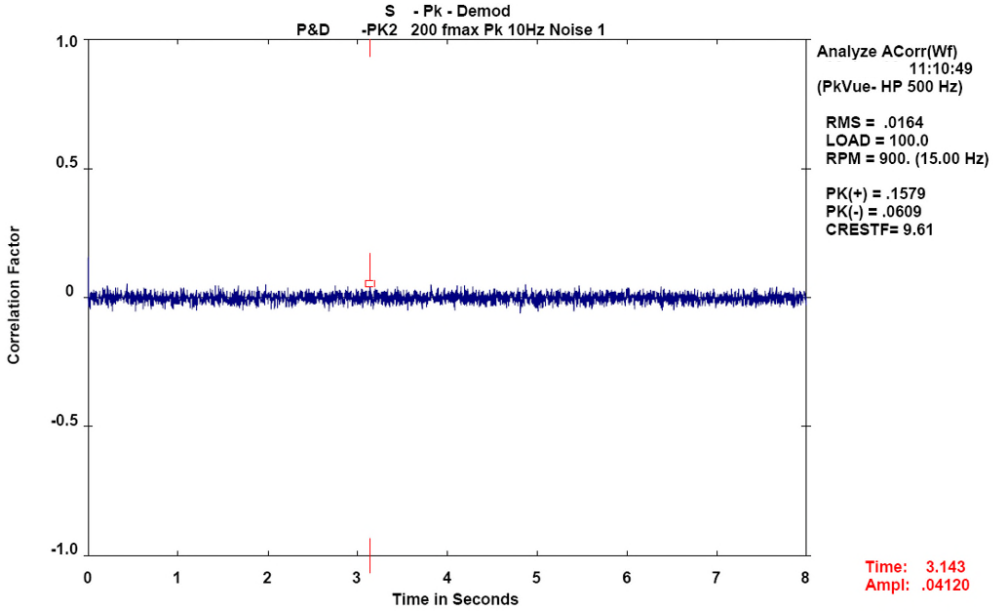
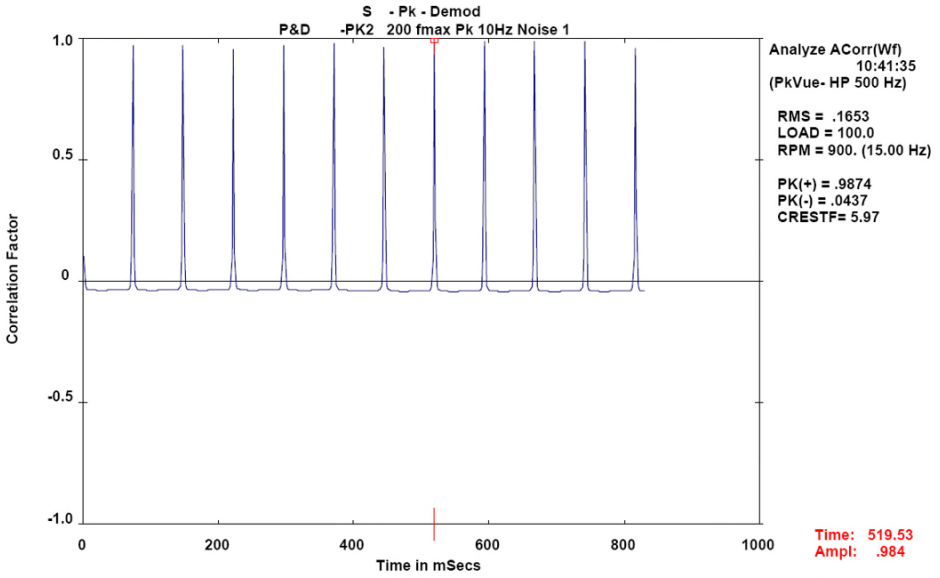
Autocorrelation

What is autocorrelation and why would we use it?

Autocorrelated PeakVue Waveform

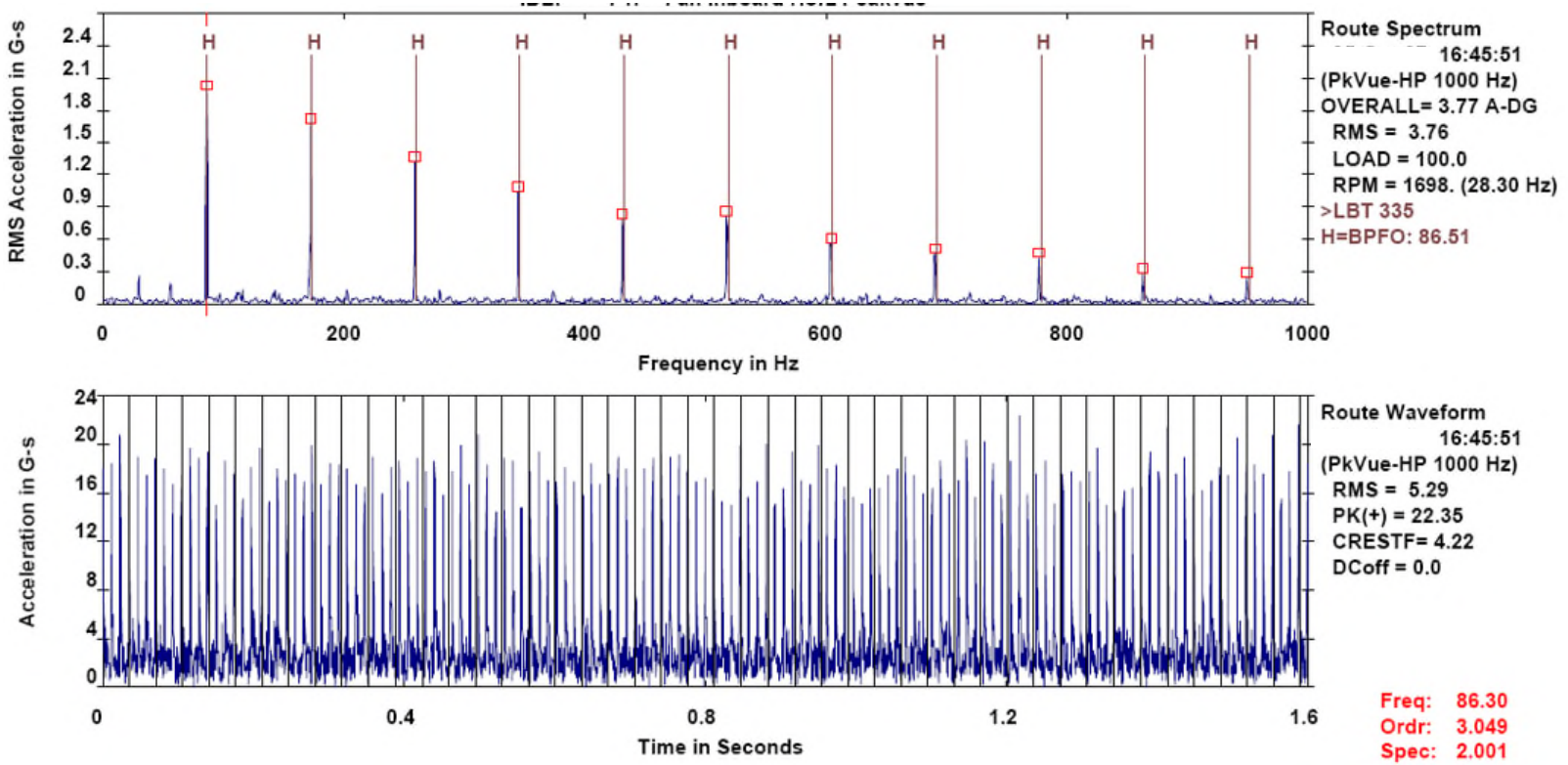




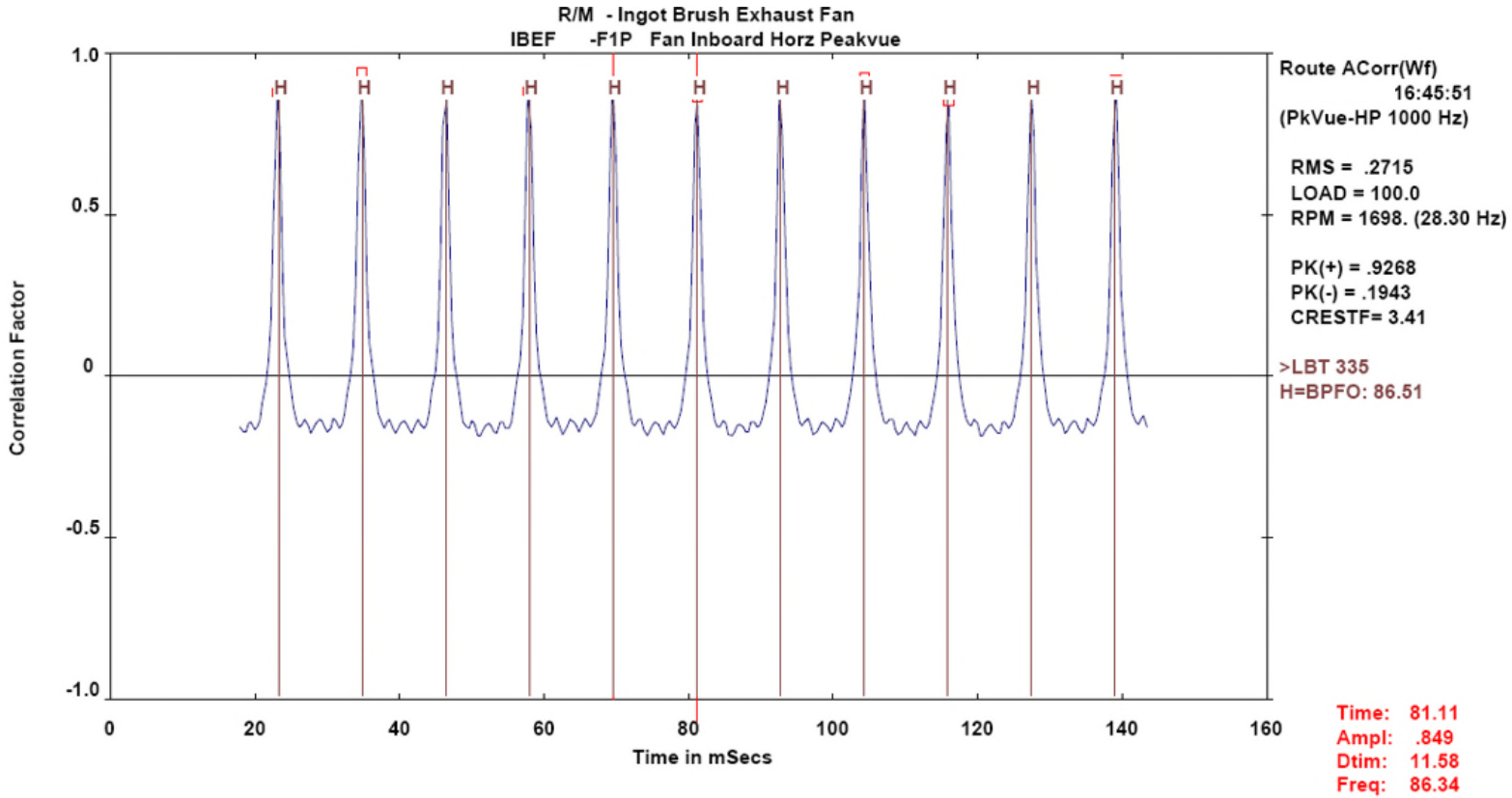
Non Periodic

Periodic

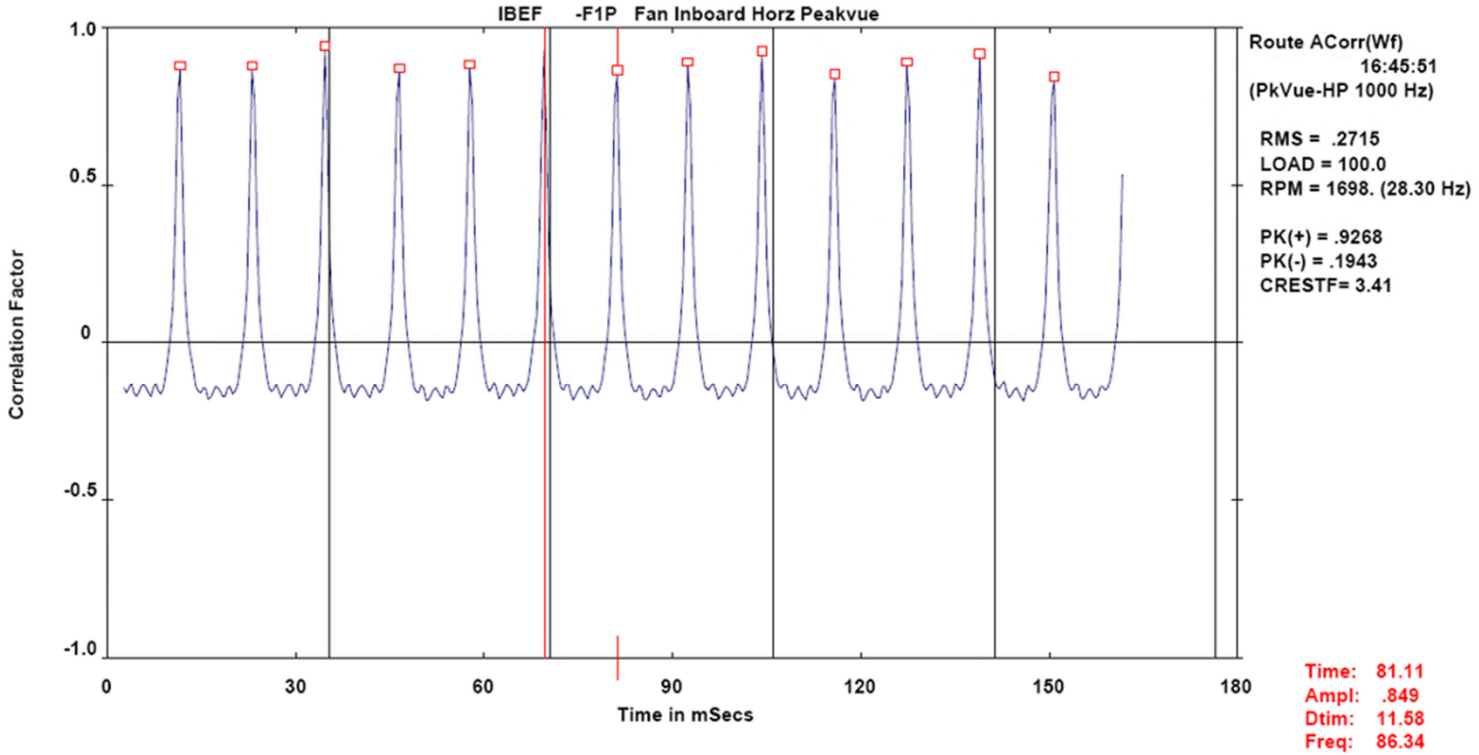
PeakVue data with bearing outer race defects marked



PeakVue autocorrelated waveform has a 86.5 Hz period from a bearing outer race defect.



PeakVue autocorrelated waveform with bearing outer race defect.



Square root of .849 is .92 or 92% of the energy *(about 20.5 of the 22.35 G's in the waveform)* is generated by the outer race fault.

If the amplitude of the periodic event is somewhere between zero and one, the square root of the peak amplitude will be the approximate percentage of energy contributed by the fault with that period.

The periodic events that are present in the waveform, are the events that will be seen in the PeakVue spectrum.

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PeakVue

Severity Calculations

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PeakVue Alert Level:
Periodic Data Collection

When monitoring machines infrequently, the alert level needs to be conservative to ensure that you catch a defect prior to failure.

This table provides a **Guideline** for suggested alert levels. The fault level is normally set at twice this value.

(Keep in mind that these are the levels after the autocorrelation calculations are performed)

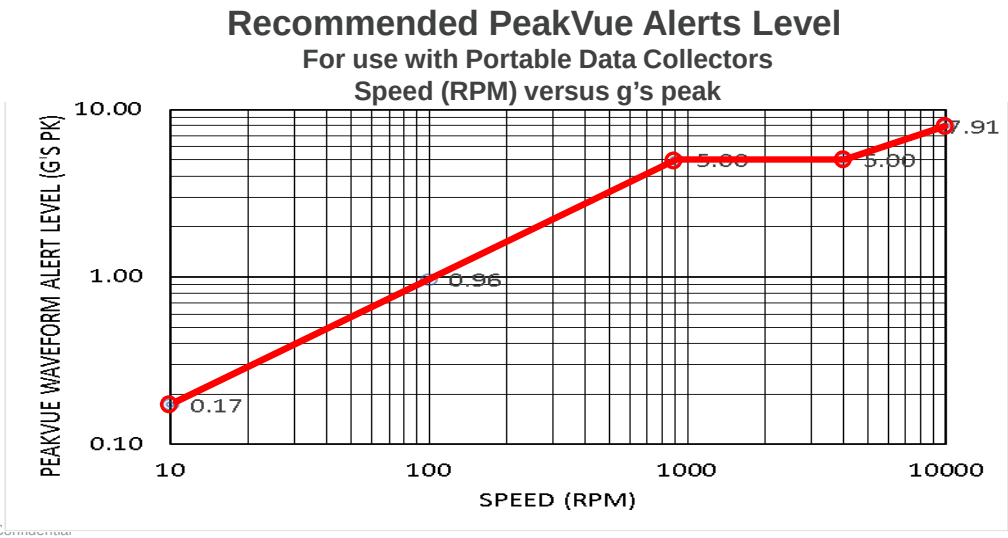


TABLE IV. PEAKVUE "ALERT" ALARMS IN TIME WAVEFORMS FOR BEARING AND GEAR PROBLEMS AT VARIOUS SPEEDS[1,2] (Peak-Peak g)

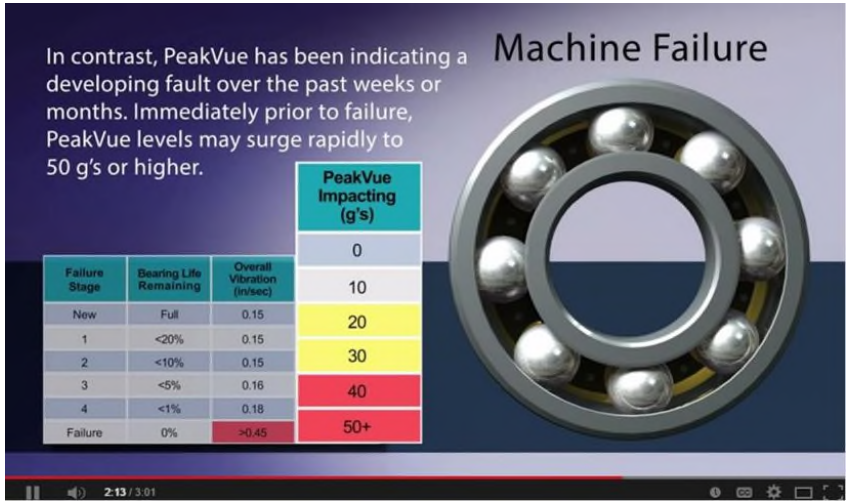
COMPONENT RPM	R.E. BEARING FAULTS		GEAR FAULTS	
	Inner Race, Cage or Rolling Element Fault	Outer Race Fault	Worn or Scored Teeth[3]	Cracked Teeth[4] (Fully Loaded)
0-900	$\text{Nominal Speed Alarm } X \left\lvert \frac{\text{Actual RPM}}{900} \right\rvert^{0.75}$			
901-4000 (Nominal Speed)	5g	10g	5g	10g
4001-10,000	$\text{Nominal Speed Alarm } X \left\lvert \frac{\text{Actual RPM}}{4000} \right\rvert^{0.5}$			
10,001-UP	8g	16g	8g	16g

Rule of 10’s for Automated Collection on Common Assets

With Automated Data Collection, readings are typically updated at least once per hour. Therefore, alert level can be set higher.

A good rule of thumb for most process equipment with turning speeds between 900 and 4000 RPM is called the “Rule of 10’s”.

PeakVue (reading in g’s peak)	Interpretation
10	Some Issue
20	Serious problem
40	Action Point



[PeakVue on YouTube]

[PeakVue Homepage]

PeakVue Plus

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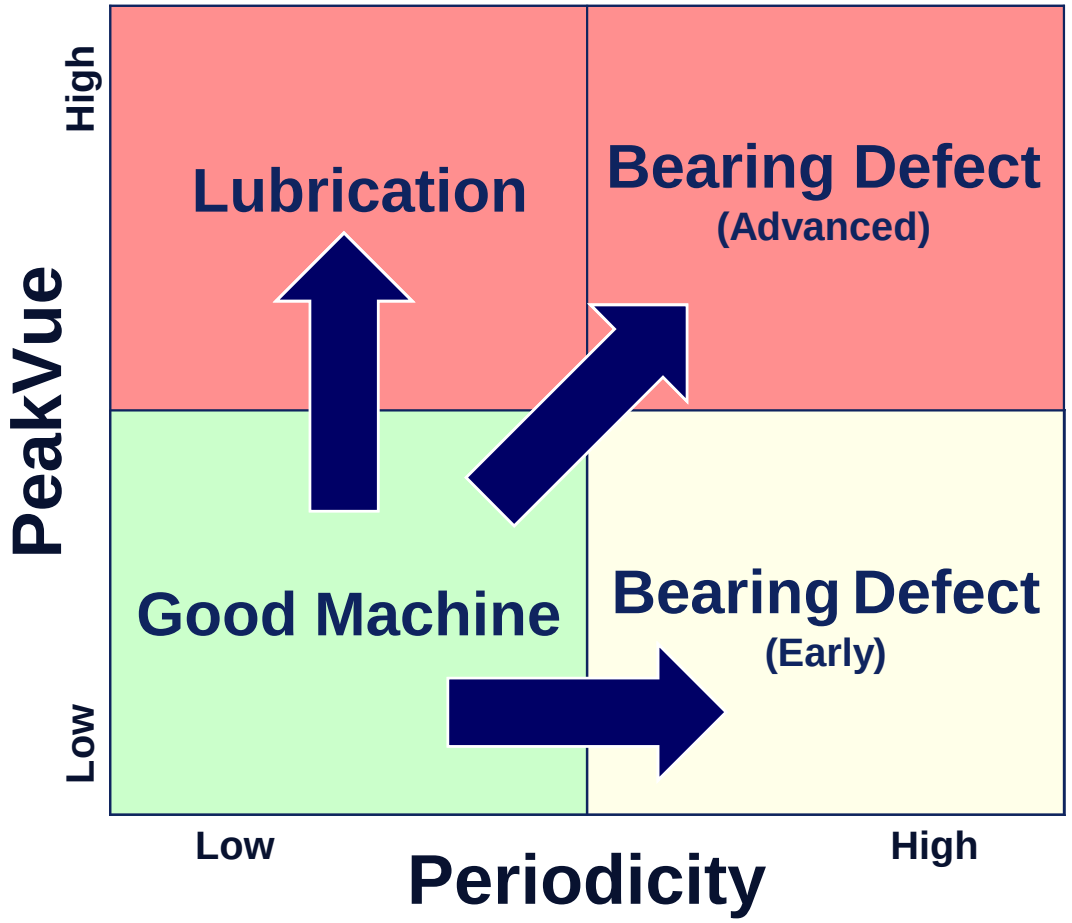
PeakVue Plus Analytics



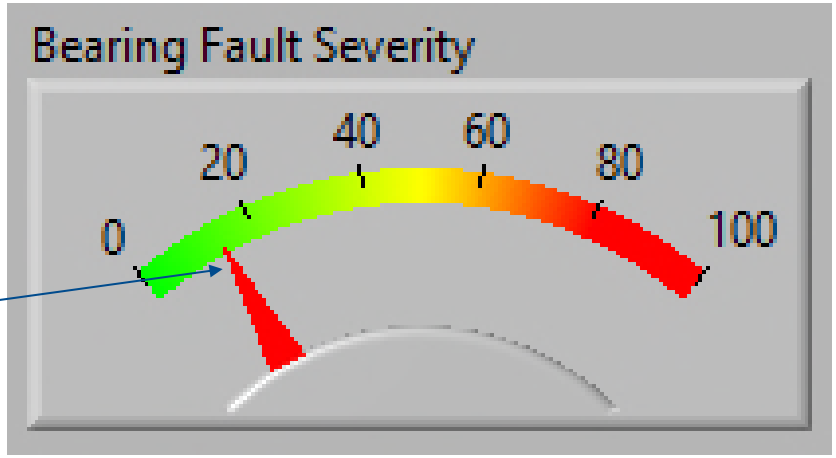
PeakVue Plus – Bearing Fault Severity

Below is an example of how PeakVue Plus performs it's calculation

$$\left(\frac{Max\ PeakVue\ Waveform\ Peak\ (g's)}{Fault\ limit\ (g's)}\right) * (\%\ nonsynchronous\ periodic\ energy)$$

In this example, our max PeakVue waveform is 20 g's. The Fault limit is 12 g's
And the % of the energy is 14
(20/12) * .14 = .233

The fault severity graph uses 80 as @ 100% of fault level
.233 * 80 = 18.6



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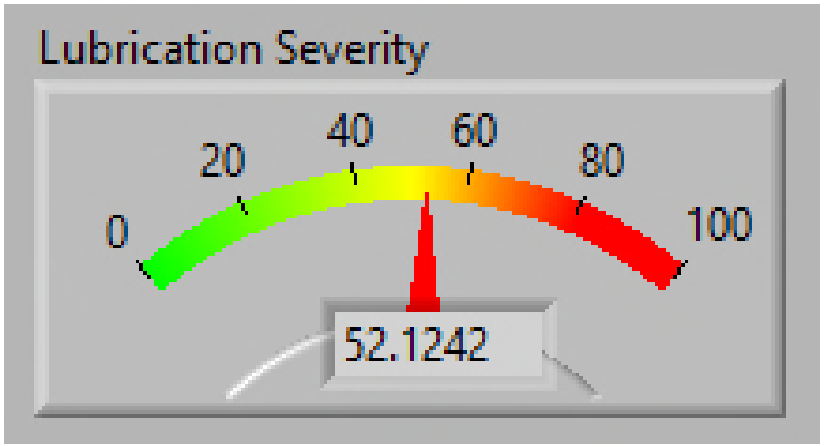
PeakVue Plus – Lubrication Severity

$$\left(\frac{Max\ PeakVue\ Waveform\ Peak\ (g's)}{Fault\ limit\ (g's)}\right) * \left(\frac{100 - \%\ periodic\ energy}{100}\right) * 100$$

Non-periodic energy



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PeakVue Plus in AMS 2140

PeakVue:

Signature technology

+ Detects impacting
+ Confirms good operation
+ Early warning about developing faults
+ Increase with severity

Periodicity:

Shows nature of impacting:

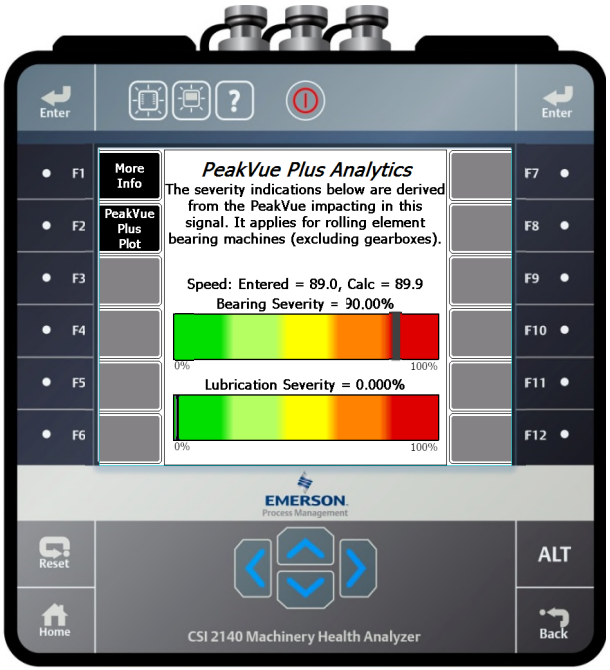
- Mechanical (bearing/gear)
- Random (lubrication)

60%

Bearing failure can be attributed to lubrication issues

https://www.machinerylubrication.com/Read/967/lubrication-failure

End User Screen:



Shows Information – *Not* Data

PeakVue Plus
Case Histories

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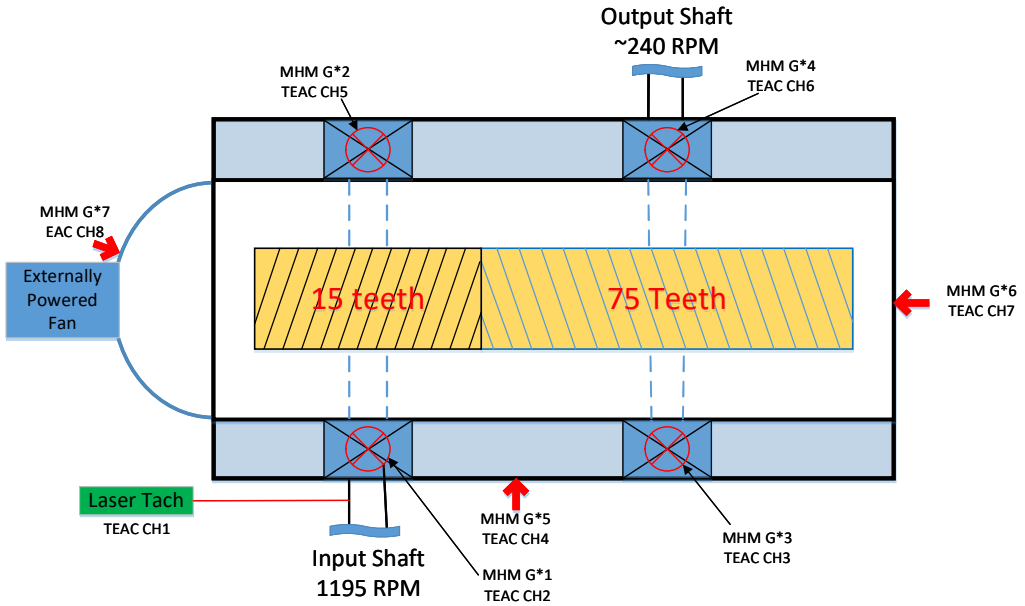
Case Study #1 - Vacuum Pump Gearbox

Bearing fault measurement point G*1

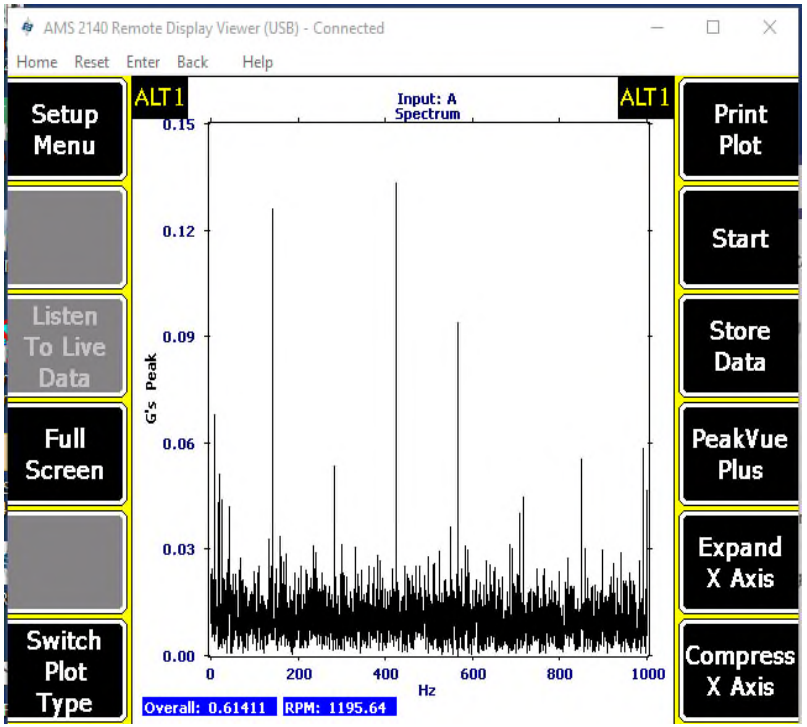
Input speed 1195 RPM, 15 tooth pinion, 75 tooth bull gear, Output speed at 239 RPM

Input bearing reported as defective.
Customer sees about 4 g's and calls a fault for this application at that level

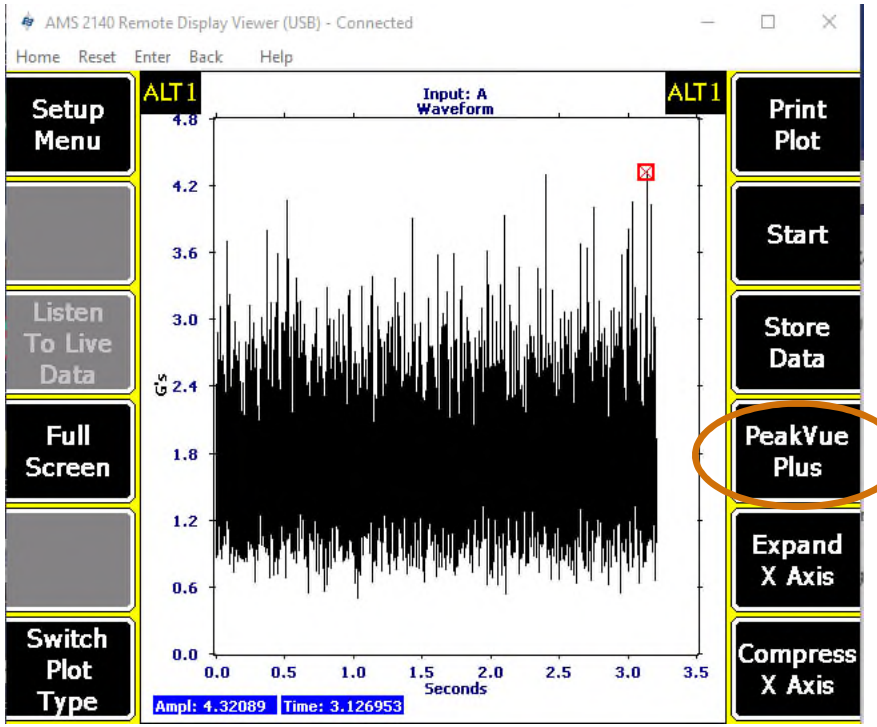


Vacuum Pump Gearbox

PeakVue spectral data



PeakVue waveform data



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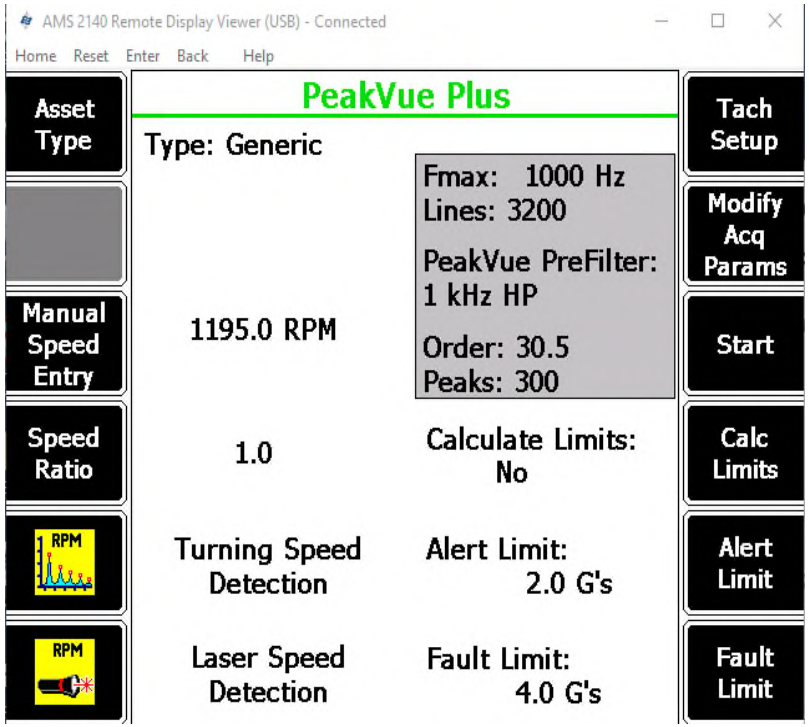
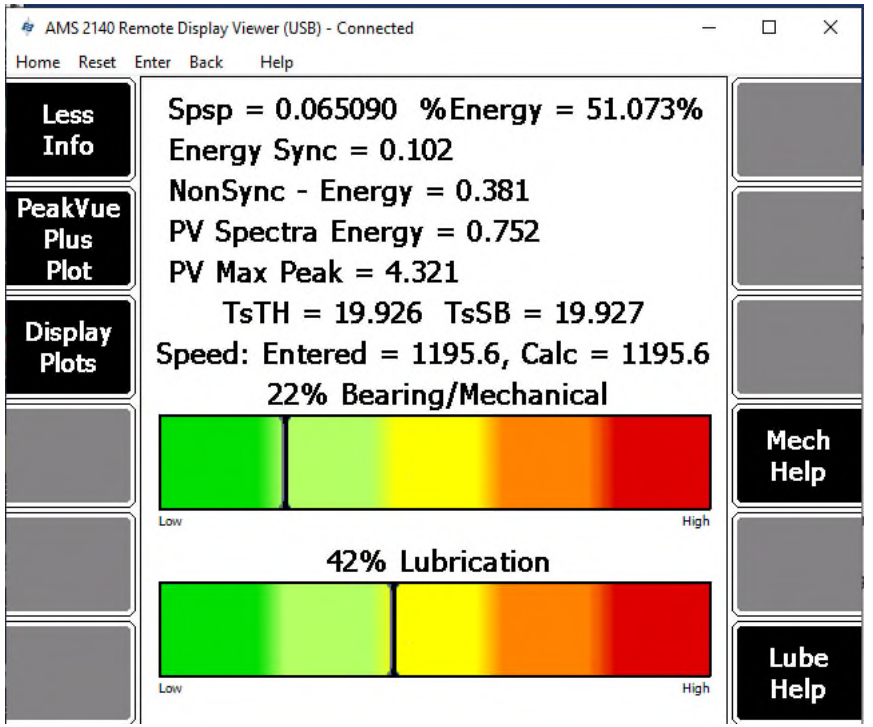
Vacuum Pump Gearbox

PeakVue Plus configuration screen



PeakVue Plus results



Vacuum Pump Gearbox

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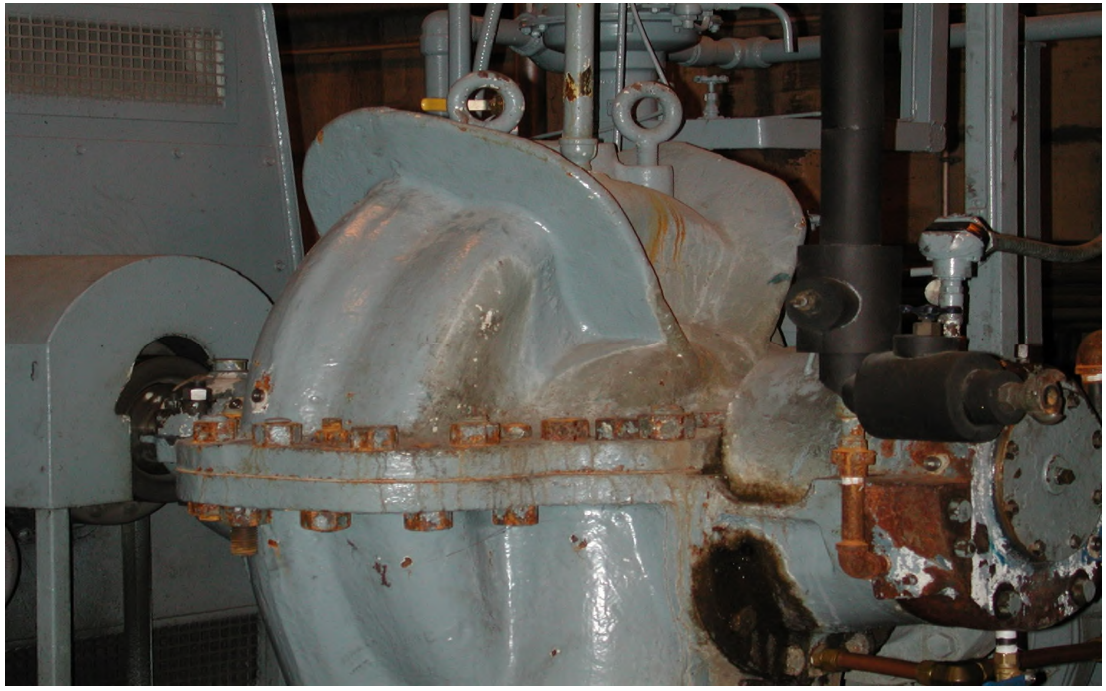
Case Study #2 - Ash Sluice Water Pump

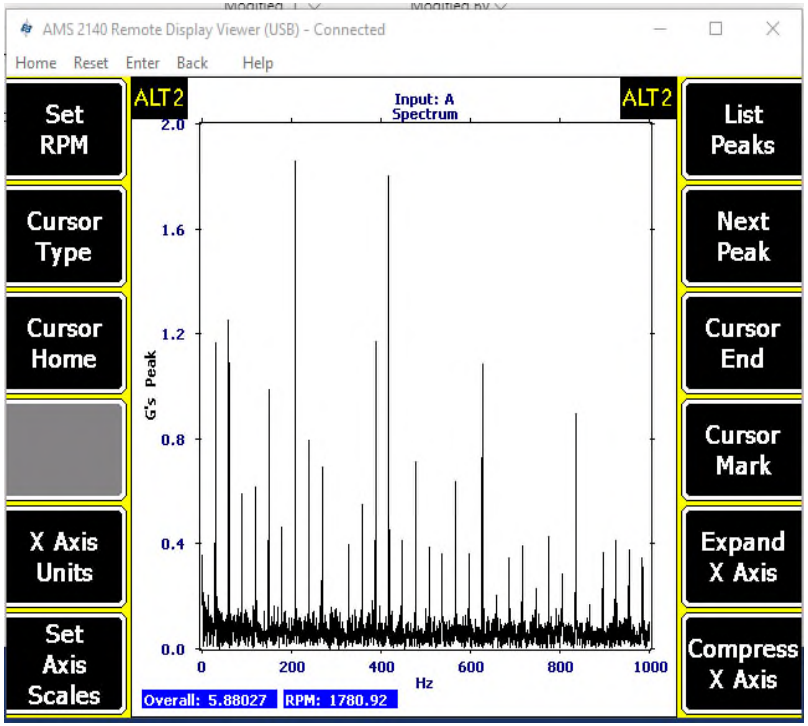
Outboard bearing location on pump. This is the thrust bearing.

Bearing is an SKF 7315 BECBM

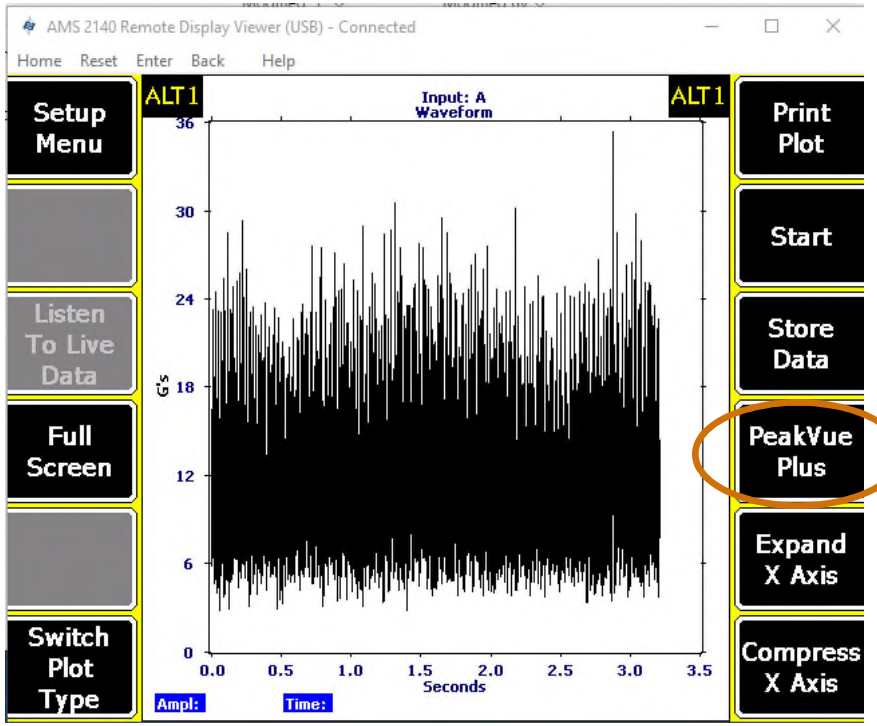


Ash Sluice Water Pump

PeakVue spectral data

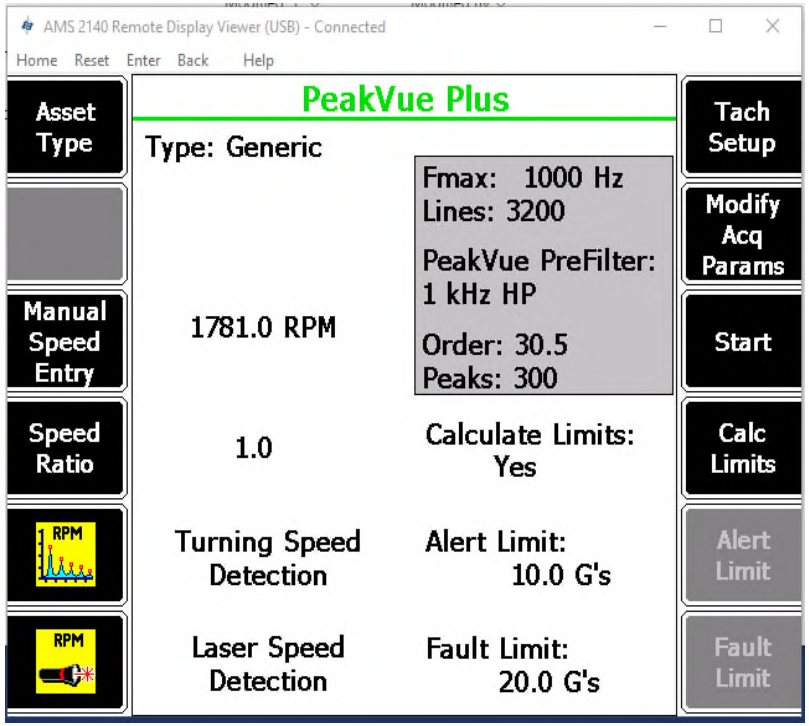


PeakVue waveform data

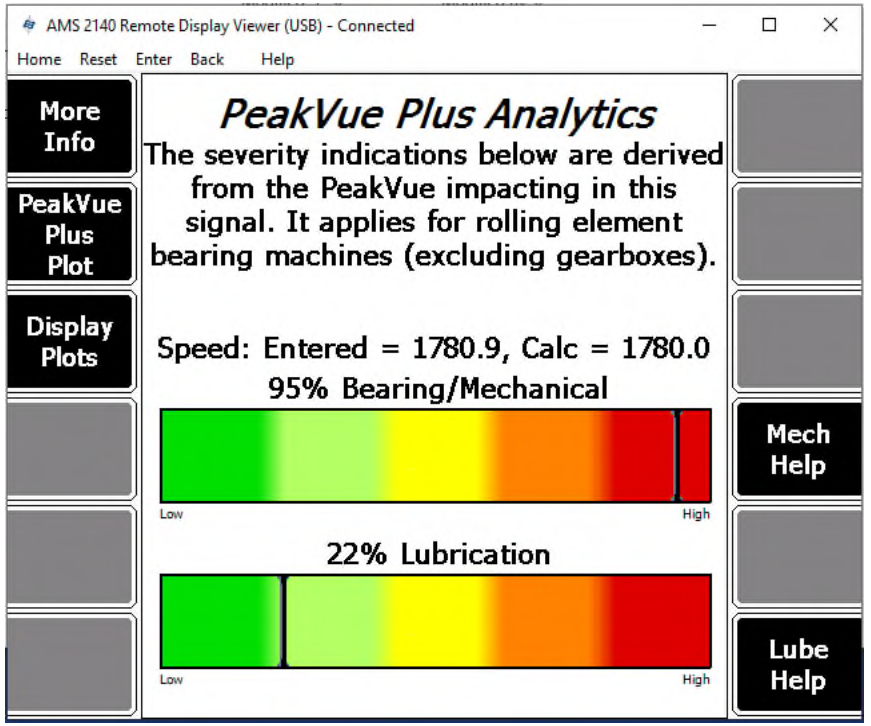


Ash Sluice Water Pump

PeakVue Plus configuration screen



PeakVue Plus results



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Ash Sluice Water Pump

AMS Asset Monitoring Training Courses - Path to Success Approach

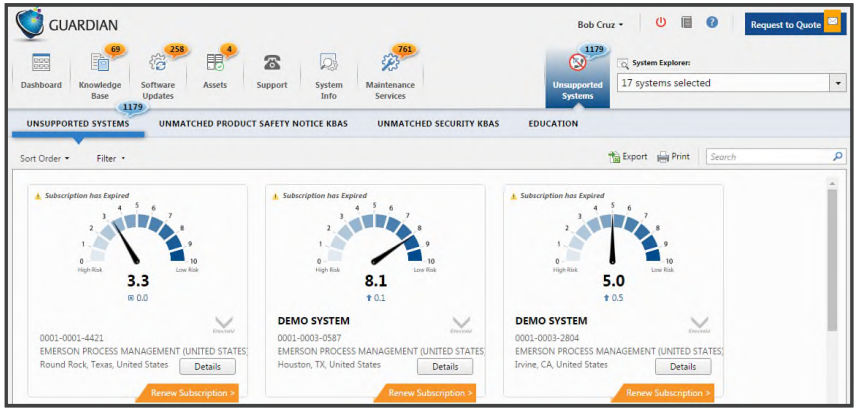
Category I Vibration Analyst Path	Category II Vibration Analyst Path	Category III Vibration Analyst Path	Category IV Vibration Analyst Path	Lubrication Analyst Path	Online Monitoring Path	Complementary PdM Technology
Introduction to Vibration Analysis (course 2069)	Intermediate AMS Machinery Manager Software (course 2074)	Advanced AMS Machinery Manager Software (course 2070)	Basic Rotor Dynamic Analysis for Vibration Analysts (course 2034)	Lubrication Level 1 and Level 2 with certification exam (course 2082)	Online Prediction Operation & Maintenance (course 2088)	Balancing Theory and Applications with CSI 2130 (course 2015) or with AMS 2140 (course 2016)
Fundamentals of CSI 2130 (course 2072) or AMS 2140 (course 2076)	Intermediate Vibration Analysis (course 2032) &Category II exam (course 2022EX)	Advanced Vibration Analysis (course 2033) & Category III exam (course 2023EX)	Advanced Instrumentation & Analysis Techniques (course 2044)	Wear Debris Analysis Workshop (course 2084)	Online Protection Operation & Maintenance (course 2080)	Laser Alignment with CSI 2130 (course 2092) or AMS 2140 (course 2096)
Introduction to AMS Machinery Manager Software (course 2068)			Category IV Exam (course 2024EX)	OilView for AMS Machinery Manager Software (course 2083)	AMS 6500 ATG Operation and Maintenance (course 2086)	Electric Motor Diagnostics and Basic MotorView (course 2081)
Basic Vibration Analysis (course 2031) & Category I Exam (course 2021EX)	Highly recommended optional courses: ■ PeakVue & Autocorrelation (course 2035) ■ Advanced AMS 2140 (course 2094) or CSI 2130 (course 2091) ■ Time Waveform Analysis (course 2051) ■ Customizing Analysis Parameter Sets (course 2051)	Highly recommended optional courses: ■ PeakVue & Autocorrelation (course 2035) ■ AMS Machinery Manager Database Optimization Workshop (course 2003) ■ Time Waveform Analysis (course 2051) ■ Customizing Analysis Parameter Sets (course 2051)			Turbomachinery Diagnostics (course 2089)	Reciprocating Equipment Analysis (course 2050)
Highly recommended optional course: AMS Machinery Manager: Vibration Analysis Workshop for the PDM Professional (course 2008B)						AMS 9420 Wireless Vibration Transmitter for AMS Machinery Manager (course 2025)

Emerson Training and Certification Path

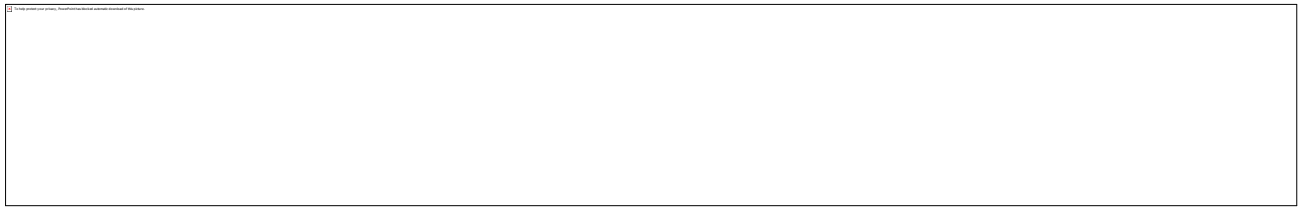
https://www.emerson.com/en-us/automation/services-consulting/educational-services/ams-training

Summary

- Emerson has made PeakVue an integral part of our monitoring systems. Include PeakVue monitoring and PeakVue Plus pervasive sensing on all your machines in your Reliability program.
- Attend a PeakVue & Autocorrelation training class.
- Contact ***Guardian Support*** or ***Local Emerson Impact Partner*** for the latest version of the AMS 2140 firmware that includes PeakVue Plus.



Please Join Us for Remote Asset Monitoring Solutions Webinar series



Webinar #1: Edge Analytics for Automated Monitoring of Assets Remotely
WEDNESDAY, APRIL 29, 2020
9 a.m. CT – Austin | 3 p.m. – London | 6 p.m. – Dubai | 10 p.m. – Singapore / Manila

Webinar #2: Utilizing IIoT Wireless Vibration Solutions to monitor Your Assets
WEDNESDAY, MAY 6, 2020
9 a.m. CT – Austin | 3 p.m. – London | 6 p.m. – Dubai | 10 p.m. – Singapore / Manila

Webinar #3: Integrating Solutions to Enable Remote Monitoring
WEDNESDAY, MAY 13, 2020
9 a.m. CT – Austin | 3 p.m. – London | 6 p.m. – Dubai | 10 p.m. – Singapore / Manila

For registration, contact Emerson Impact Partner or Asad.Malik@Emerson.com

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IT'S NEVER BEEN DONE BEFORE

We say
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