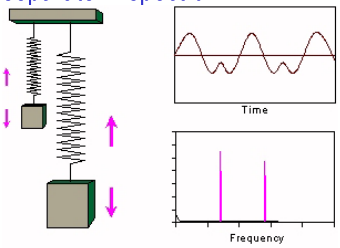
Vibration Reference Guide

Basic Vibration Theory

Time vs. Frequency Analysis

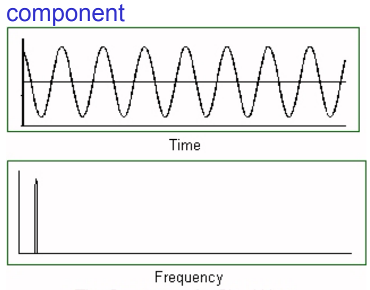
Individual frequency components are separate in spectrum



Time Domain vs Frequency Domain

Rule 1 for Frequency Analysis

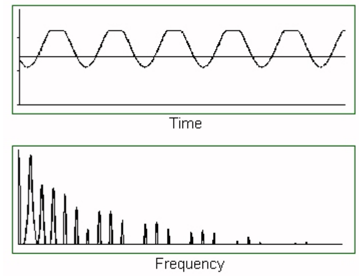
A sine wave only has <u>one</u> frequency component



The Spectrum of a Sine Wave

Rule 2 for Frequency Analysis

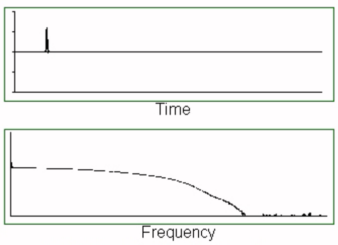
Periodic signals in machinery produce Harmonics



The Spectrum of a Periodic Signal

Rule 3 for Frequency Analysis

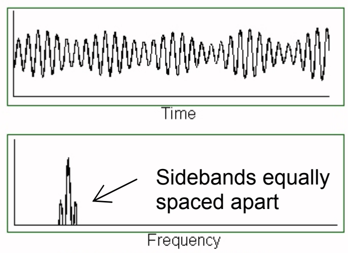
An impulse or random noise produces a continuous spectrum



The Spectrum of a Short Impulse

Rule 4 for Frequency Analysis

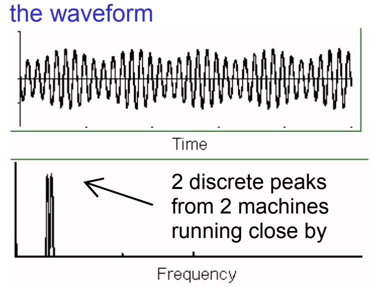
Amplitude Modulation produces Sidebands (e.g. gear fault)



The Spectrum of an Amplitude Modulated Wave Form

Rule 5 for Frequency Analysis

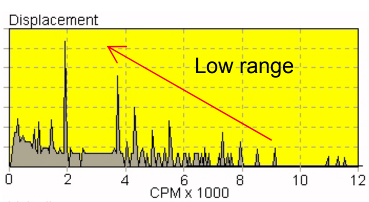
Beats look like amplitude modulation in the waveform

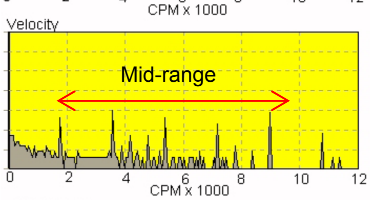


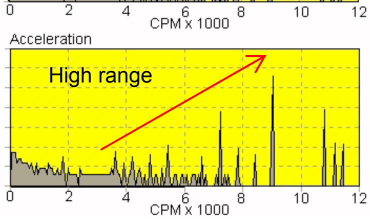
Spectrum of a Beating Signal

Presentation of Data

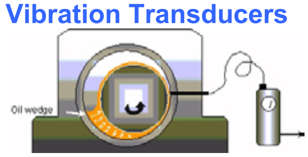
Each curve below contains the same information! Select the units for the flattest curve – provides the most visual information. Displacement (distance from a reference point) is used for low speeds. Velocity (rate of change of displacement) is the most commonly used for machine diagnostic work. Acceleration (rate of change of velocity) is used for high-speeds.



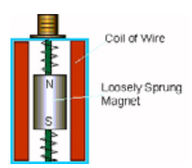




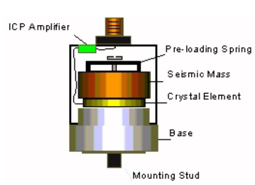
Vibration Transducers



Proximity Probe Displacement



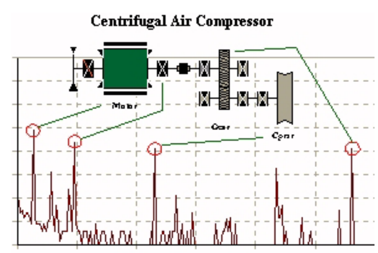
Velocity Probe – Velocity

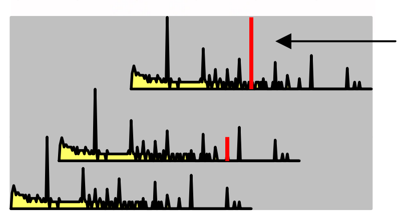


Accelerometer Acceleration

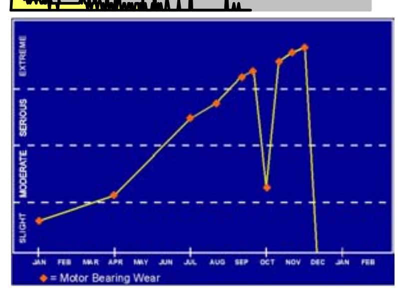
Vibration Analysis – 3 Step Process

1. **Identify Peaks**: Relationship to machine component
2. **Trend Amplitude of Peak**: Severity of machine fault
3. **Repair Priority**: Based on fault severity





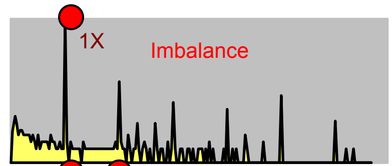
Bearing Fault grows

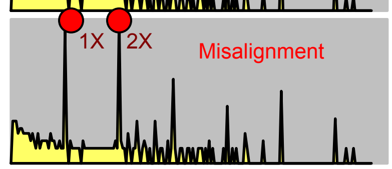


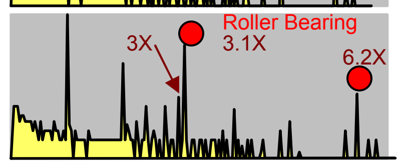
Vibration Reference Guide

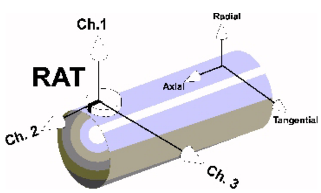
Simplified Diagnostic Chart

Vibration Source	Exciting Freq.	Dominant Axes	Comments
Imbalance, Supported	1X	R & T	Most common
Imbalance, Overhung	1X	A, R, T	Axial deflection
Bent or bowed shaft	1X	A, R, T	Mimic imbalance
Parallel misalignment	2X	R & T	Both sides of coupling
Angular misalignment	1X	A	Both sides of coupling
Combination	1X, 2X	A, R, T	Most common
Coupling Wear	3X	any, all	Both sides of coupling
Rolling Bearing	Non Integer	R, T, A	With harmonics, 1X sidebands, noise floor
Shaft Looseness And Journal Bearing	1X and Harmonics	R, T, A	High 4X – 15X
Foundation flexibility	1X	T	T > R by 6 dB
Motor Lamination	MB	R, T, A	120 Hz sidebands (twice line freq.)
Unbalanced Phase	120 Hz	R, T, A	Twice line freq
Fan or Pump wear	PV or FB	R, T, A	Vane or blade pass freq. and harmonics
Cavitation	Noise	R, T, A	Hump of random high freq. noise 20X – 50X









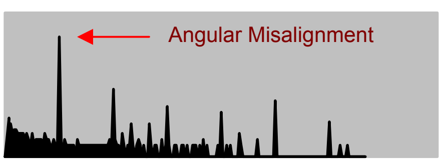
3 Axes of Data
Horizontal Shaft:
Radial = Vertical
Tangental = Horiz.

2 Frequency Ranges
Low Range = 0-10 Orders of shaft rotation
High Range = 0-100 Orders of shaft rotation

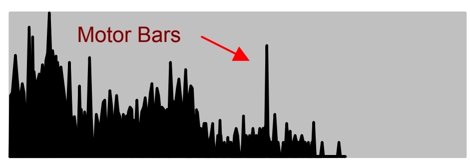
3 Axis and 2 Frequency Ranges

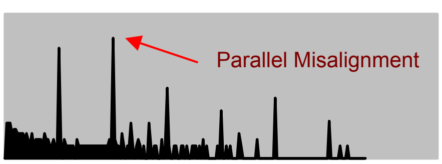
Low Range Data
Imbalance, Misalignment, Bearings, Fan blades, Pump Impeller, Looseness, Foundation Flexibility

High Range Data
First bearing fault indication, Motor Bars, Gear Mesh, Turbine vanes, harmonics

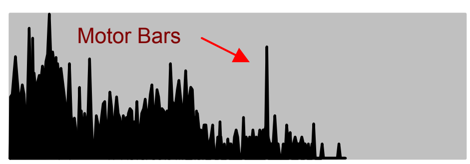


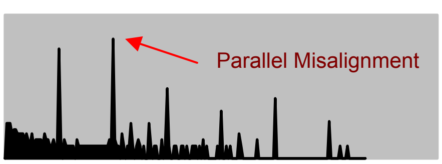
Axial
(Axial)



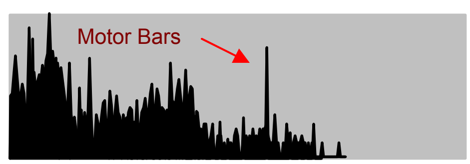


Vertical
(Radial)



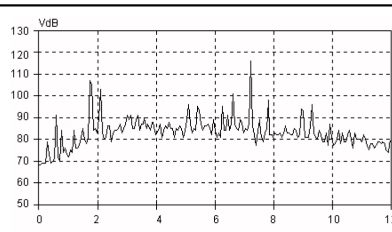


Horizontal
(Tangental)

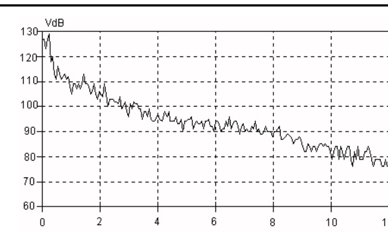


Data Validity

Bad Data comes from:
- Improper test conditions
- Wrong machine tested
- Sensor amplifier problem
- Incorrect orientation



Loose Sensor (magnet mount)



Overheated sensor (ski slope)