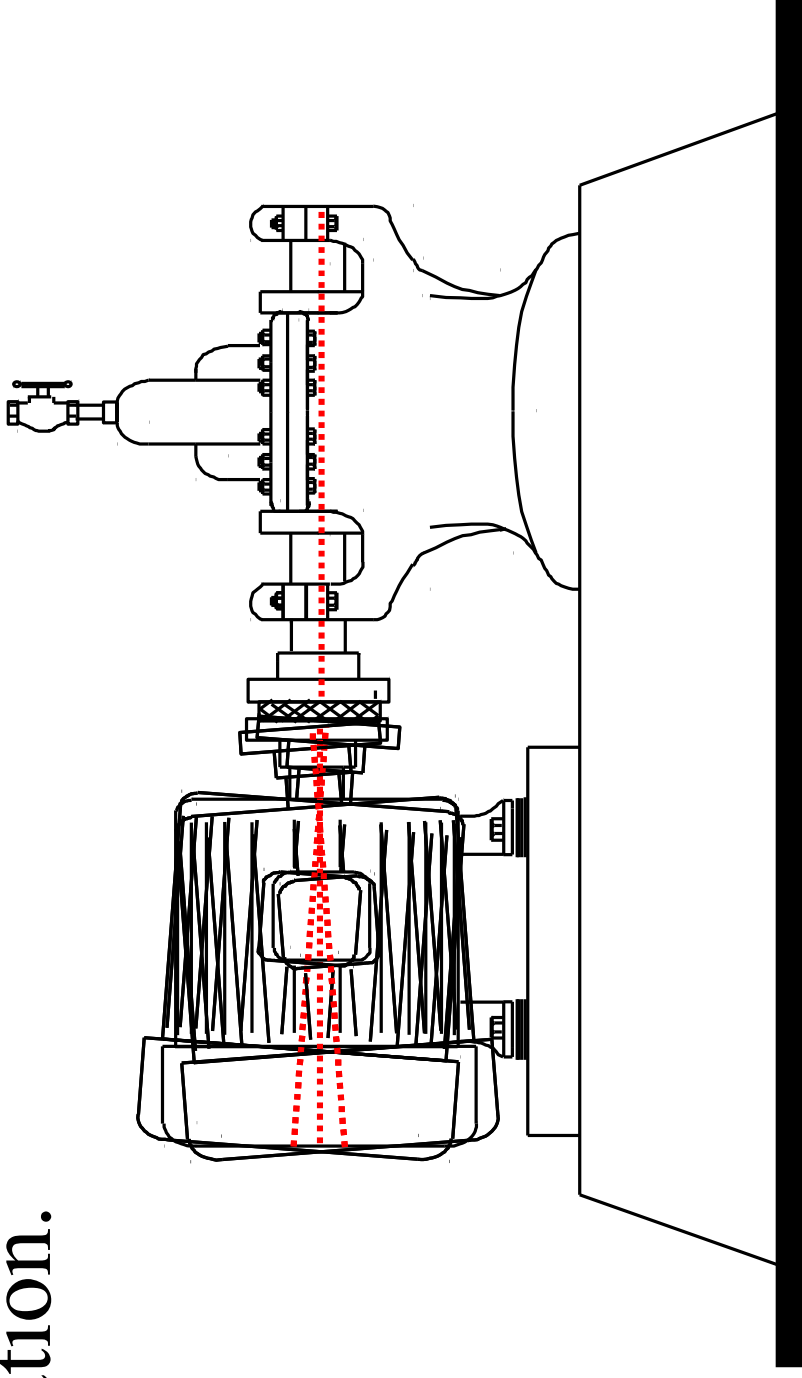


Misalignment

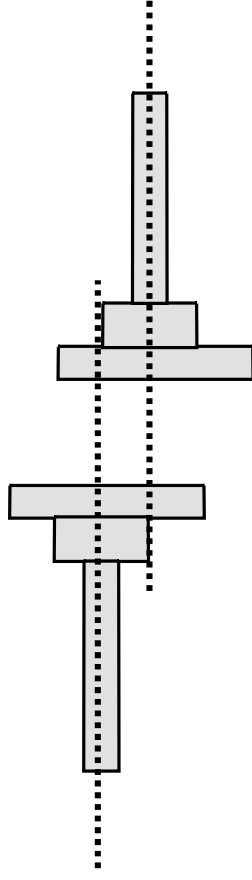
What is Misalignment?

- Deviation from a common centerline during operation.

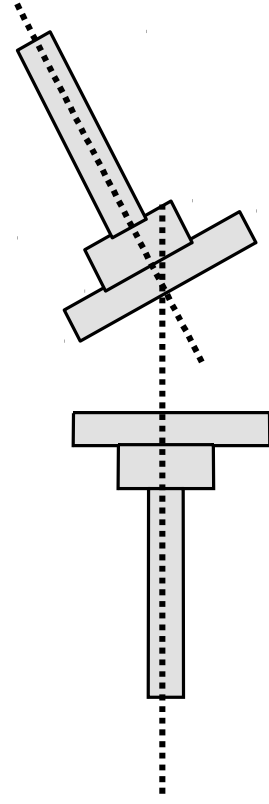


Types of Misalignment

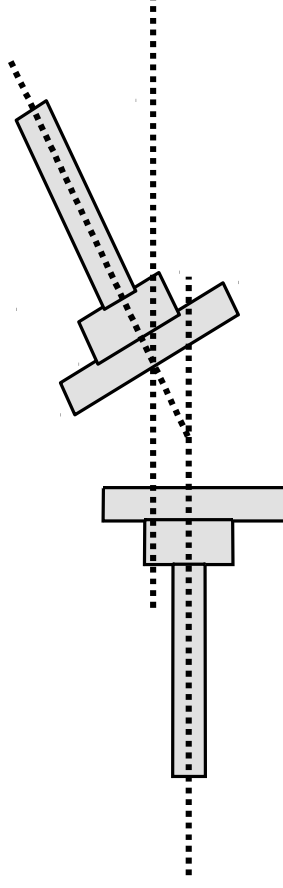
Offset



Angular



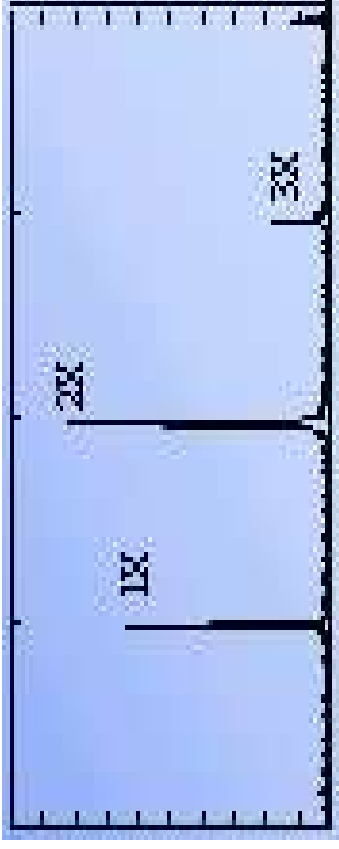
Both



Misalignment

- Characteristics:
 - High axial levels
 - High axial at 1, 2 and 3X shaft RPM
 - High radial at 1, 2 and 3X shaft RPM
 - Repeatable periodic waveform with one or two clear peaks per revolution
 - Phase readings show a 180° shift across the coupling

Misalignment: Characteristics



Angular - Axial vibration at 1X RPM

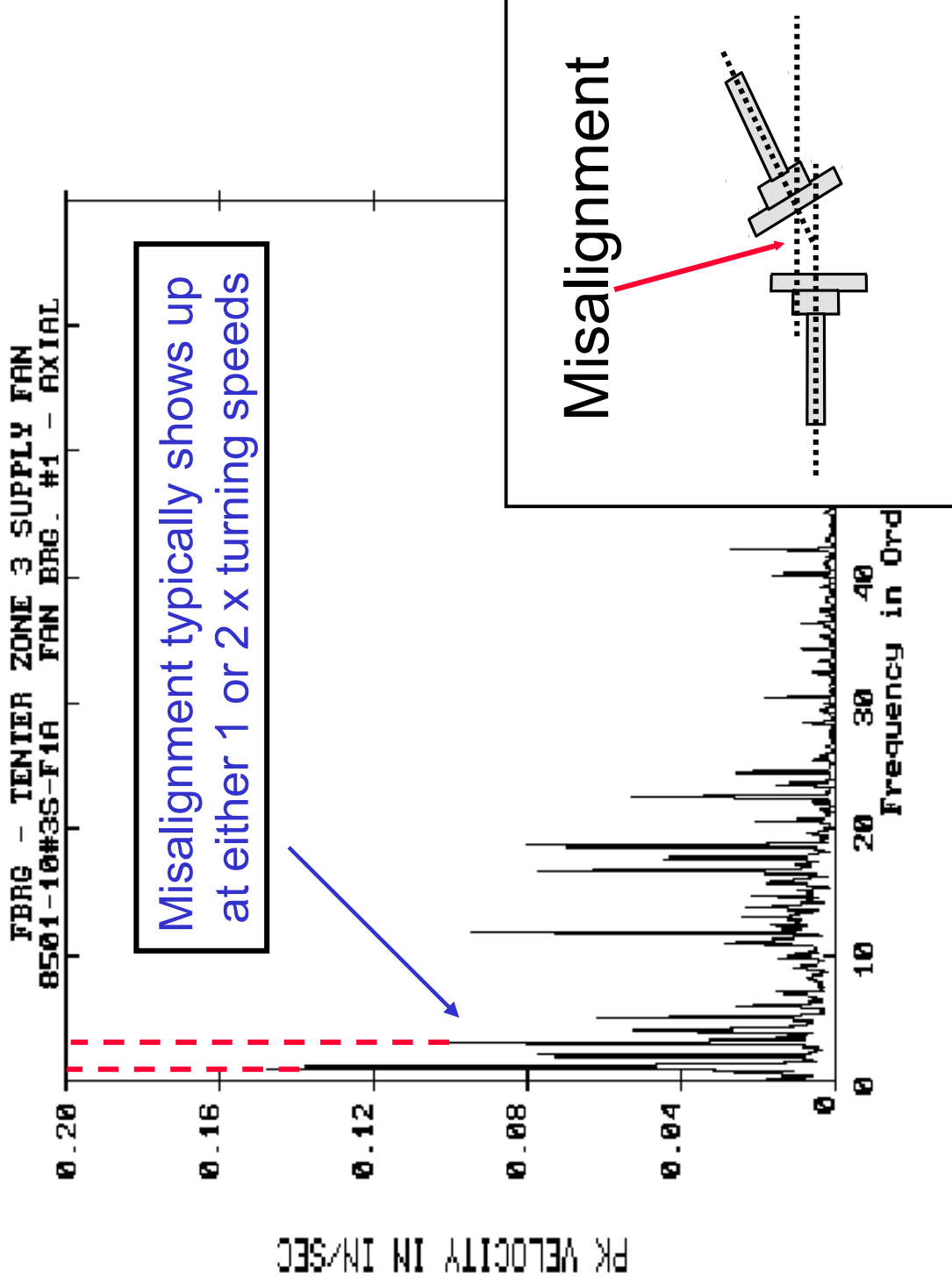
Offset - Radial vibration at 2X or 3X RPM

Harmonics (3X-10X) generates as severity increases.

If the 2X amplitude more than 50% of 1X then coupling damage starts.

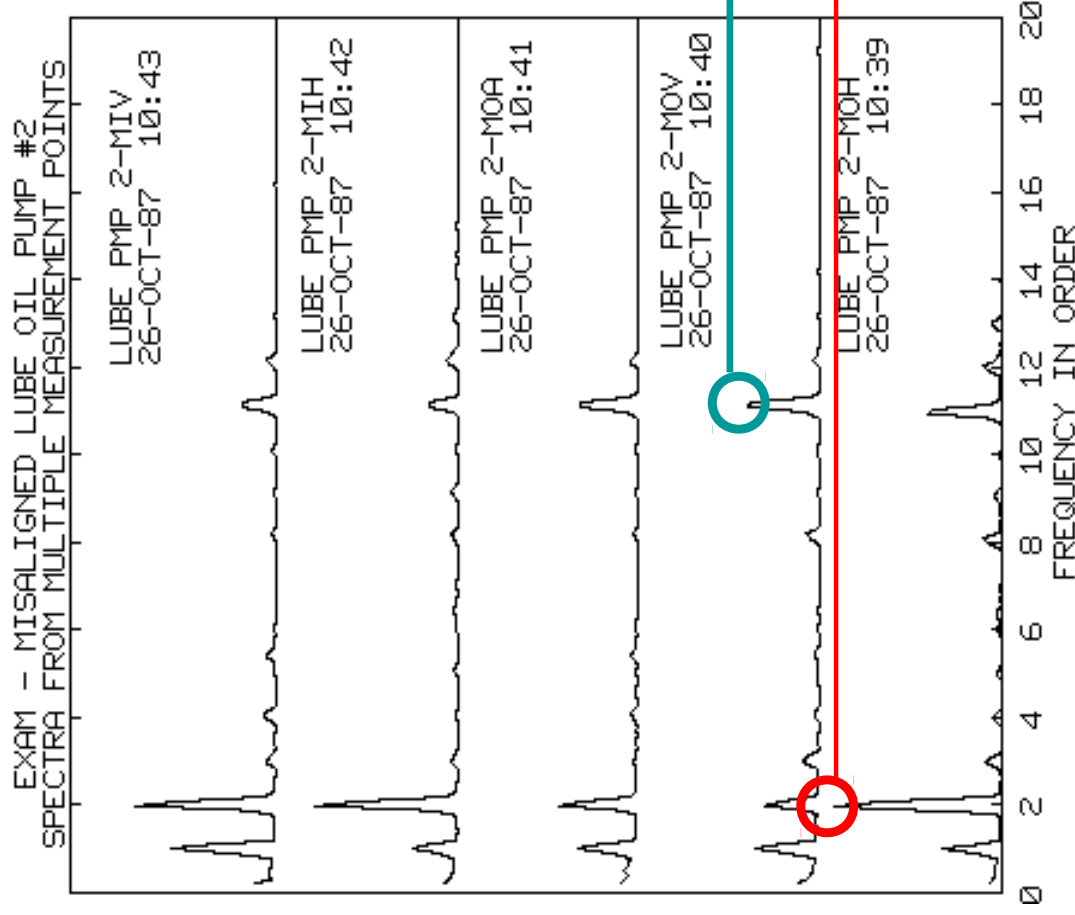
If the 2X amplitude more than 150% of 1X then machine should be stopped for correction.

Misalignment



Misalignment

- 2X shaft RPM is dominant location of vibration
- Vane pass is due to 11 blade pump impeller



Mechanical Looseness

Causes

- **It alone can not create vibration but in the influence of Unbalance, Misalignment, Bearing problems it amplify the amplitude.**
- **It should be corrected first.**

Types of Looseness

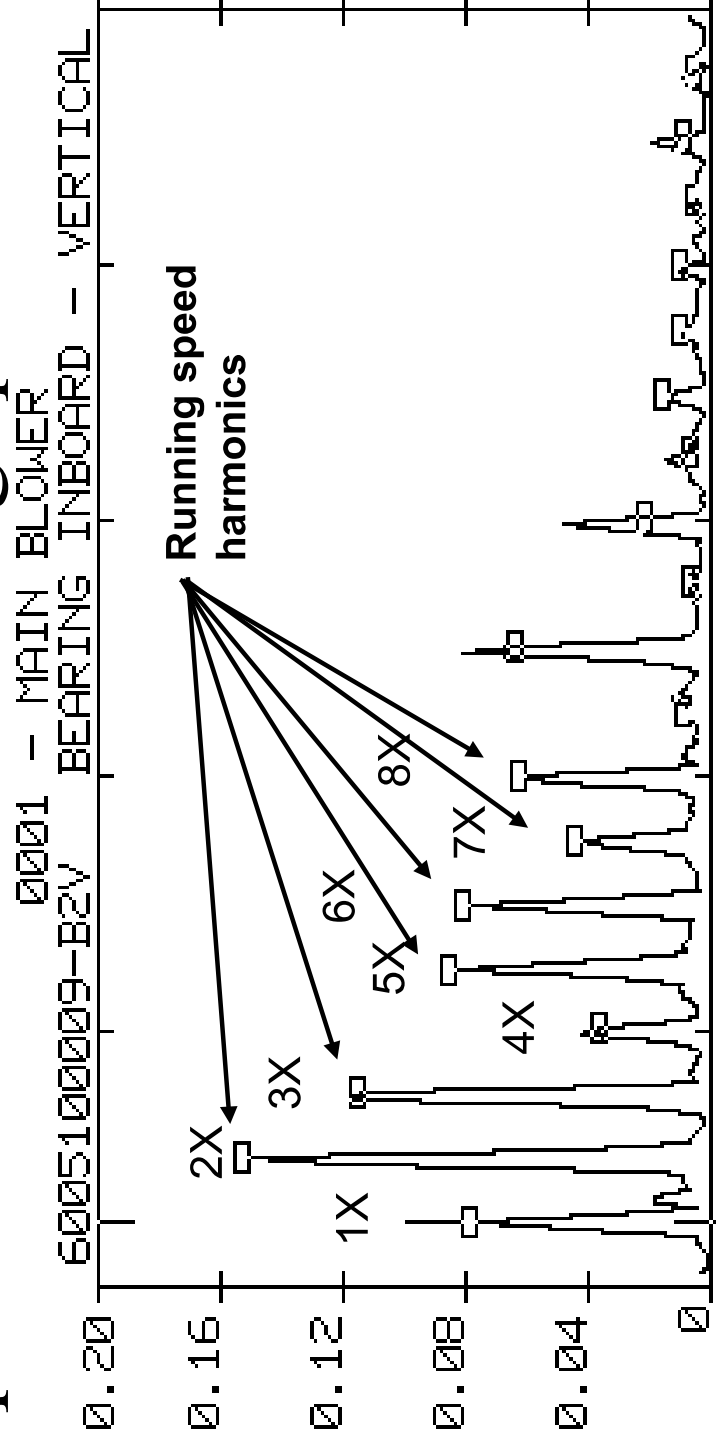
- Structural Looseness
 - Base mount
 - Split Casings
 - Bearing caps
 - Bearing supports
- Rotating Element Looseness
 - Impellers
 - Fans
 - Bearings
 - Couplings

Characteristics of Looseness

- Many Harmonics of running speed
- Directional in nature; horizontal and vertical amplitudes may differ greatly
- Occasional half-harmonics
- Random, non-periodic time waveform
- Broad based skirts on peaks in the Spectrum, possible elevated floor also

Mechanical Looseness

- Multiple harmonics of running speed



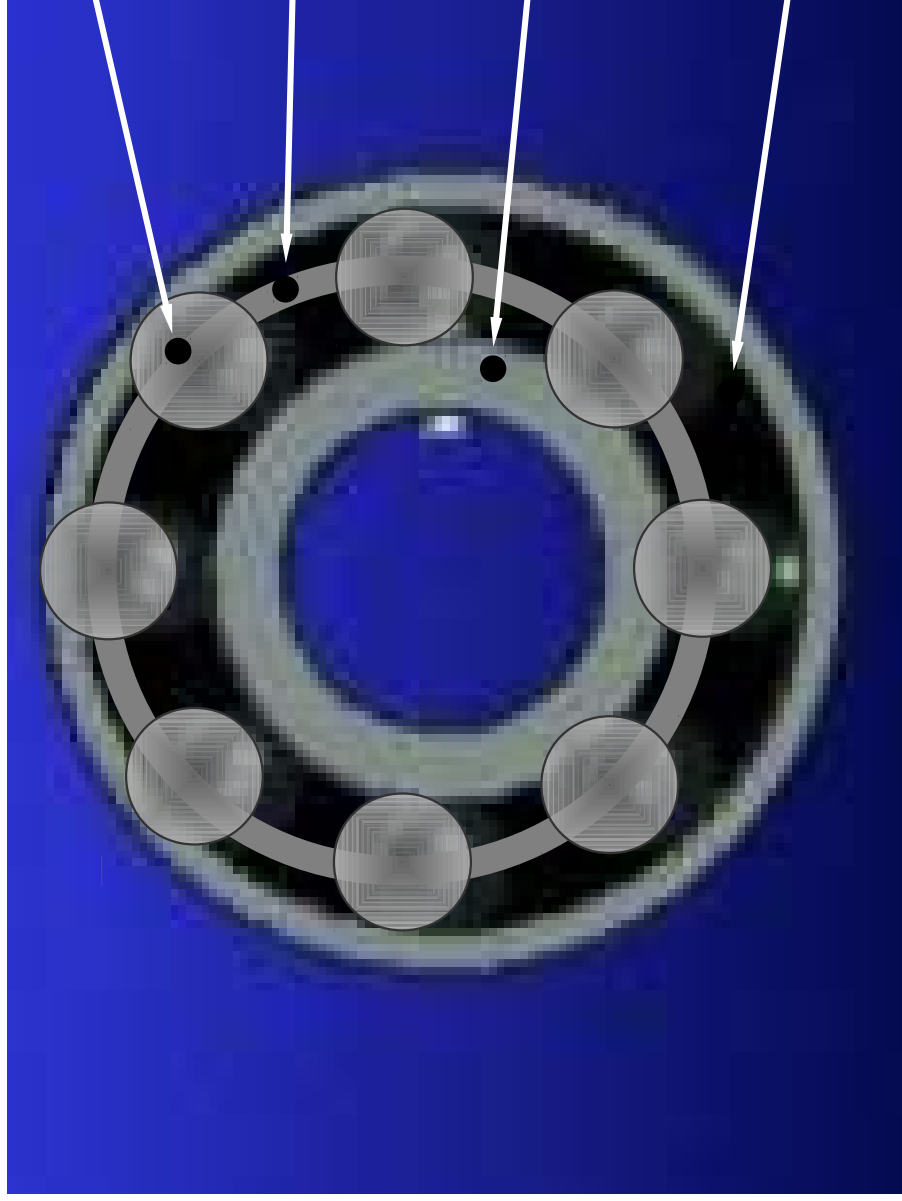
Rolling Element Bearing

Why Does Bearing Fail?

- 1. Improper lubrication**
- 2. Contaminated lubrication**
- 3. Heavier loading from
unbalance,
misalignment, bent shaft etc.**
- 4. Improper handling or
installation.**
- 5. Old age (Surface fatigue) .**

Anti-friction Bearing Faults

Four different bearing frequencies



Ball Spin Frequency
(BSF)

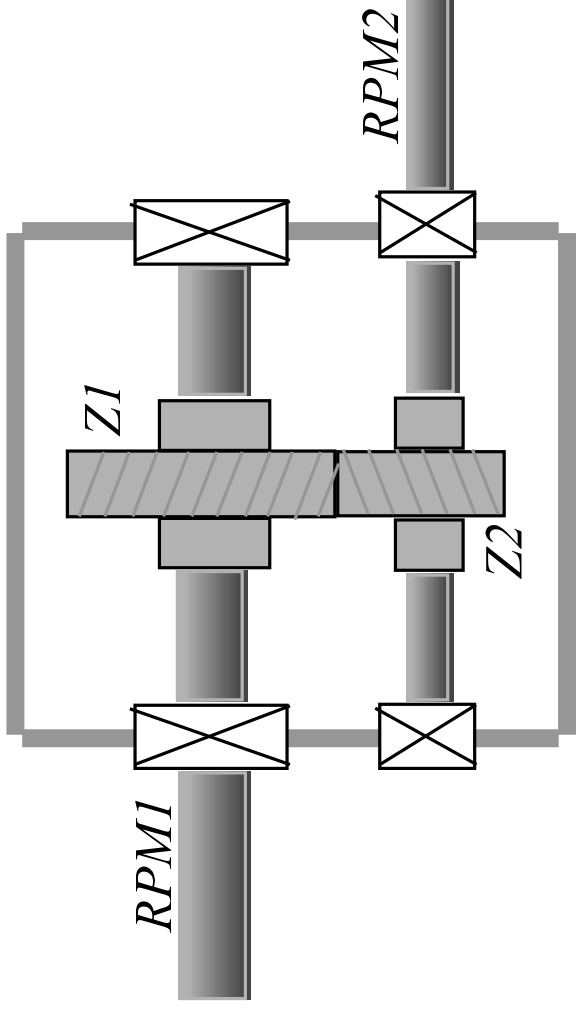
Fundamental Train
Frequency
(FTF)

Ball Pass Frequency
Inner Race
(BPFI)

Ball Pass Frequency
Outer Race
(BPFO)

Gear Box

Gear box



GMF (Gear Mesh Frequency)

$$Z1 \cdot RPM1 = Z2 \cdot RPM2$$

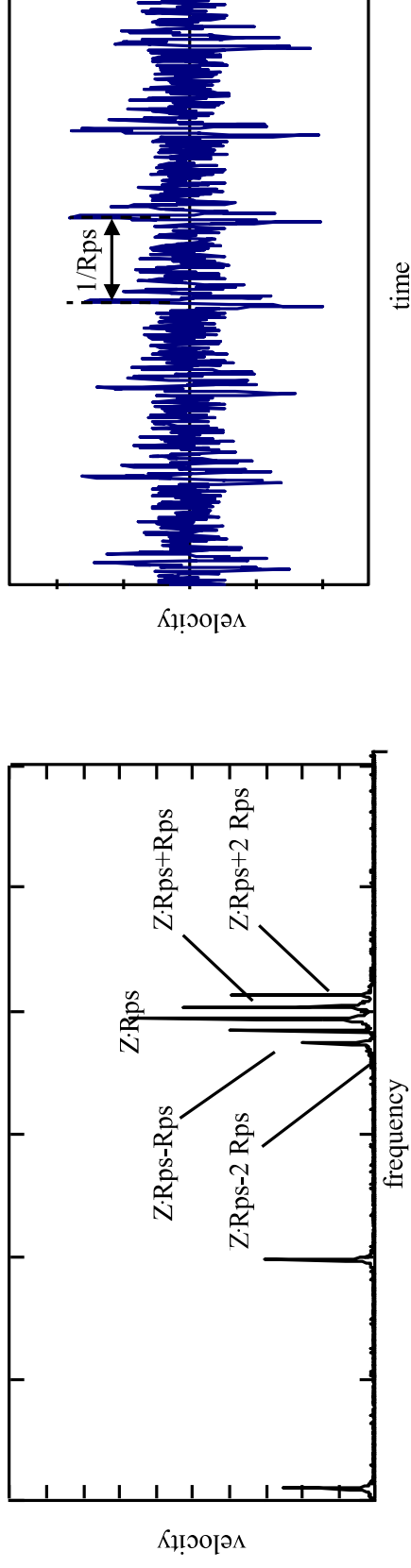
where Z = no. of teeth and RPM shaft speed

Mating gears produce only one ‘Gear Mesh Frequency’

Gear Box Defects

- Tooth wear
- Gear eccentricity & backlash
- Gear misalignment
- Cracked or broken tooth
- Hunting tooth

Gear box

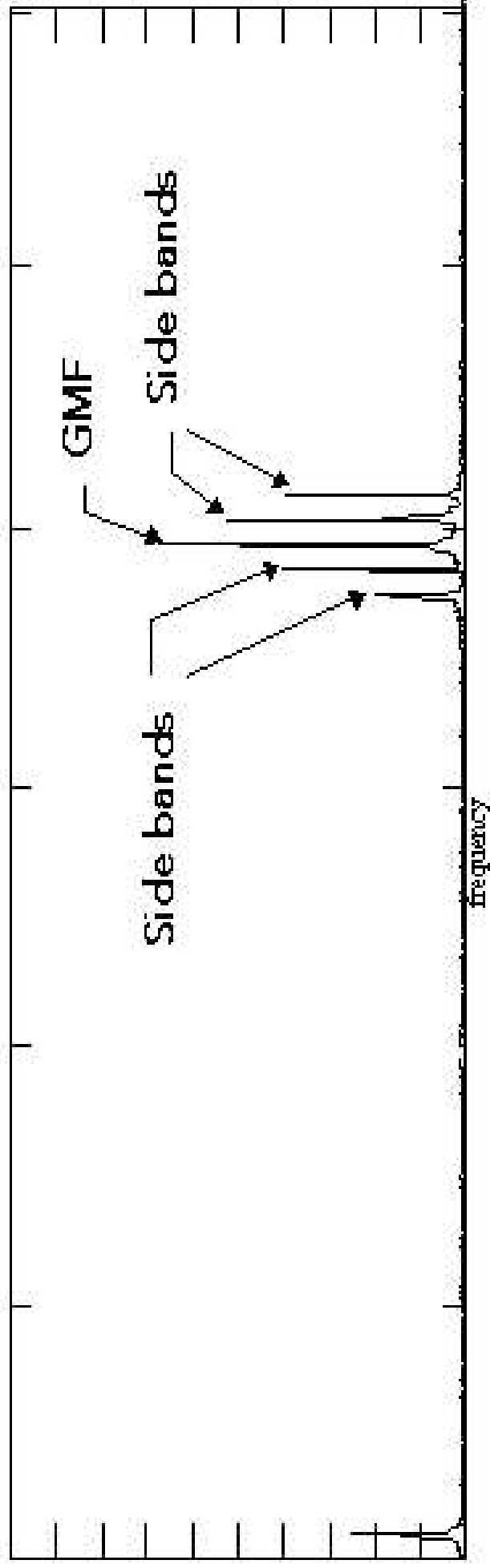


Spur gear produce vibration in radial direction and helical gear produce in radial & axial directions.

Sideband spacing reveals the defective gear or pinion.

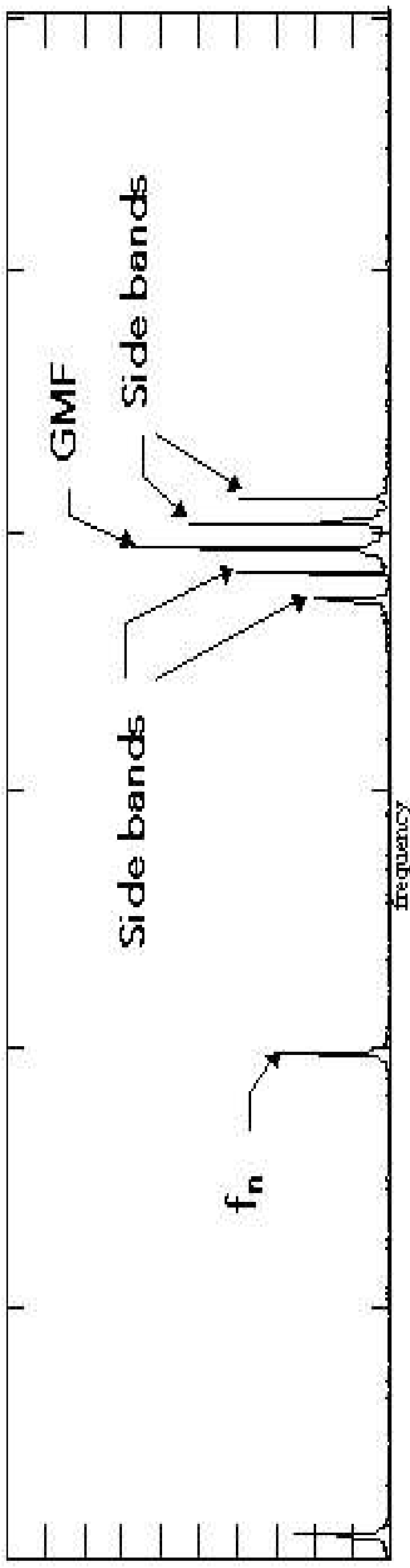
All analysis should be done at maximum load.

Normal Spectrum



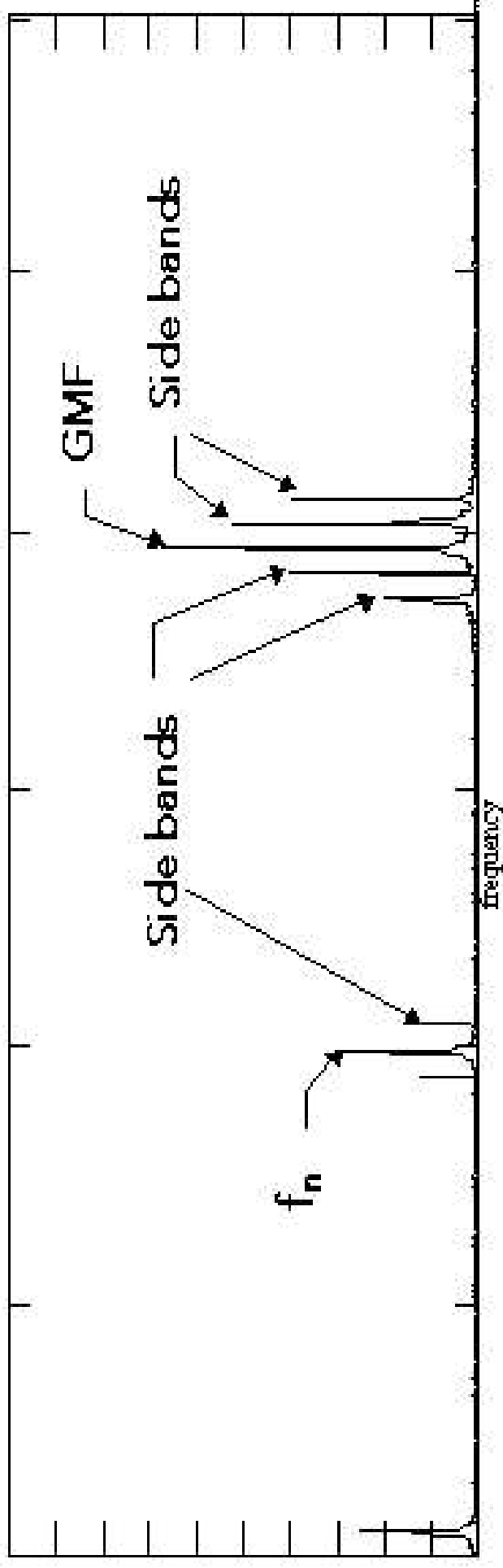
- All peaks are of low amplitudes
- No natural frequency of gear excited

Tooth Wear



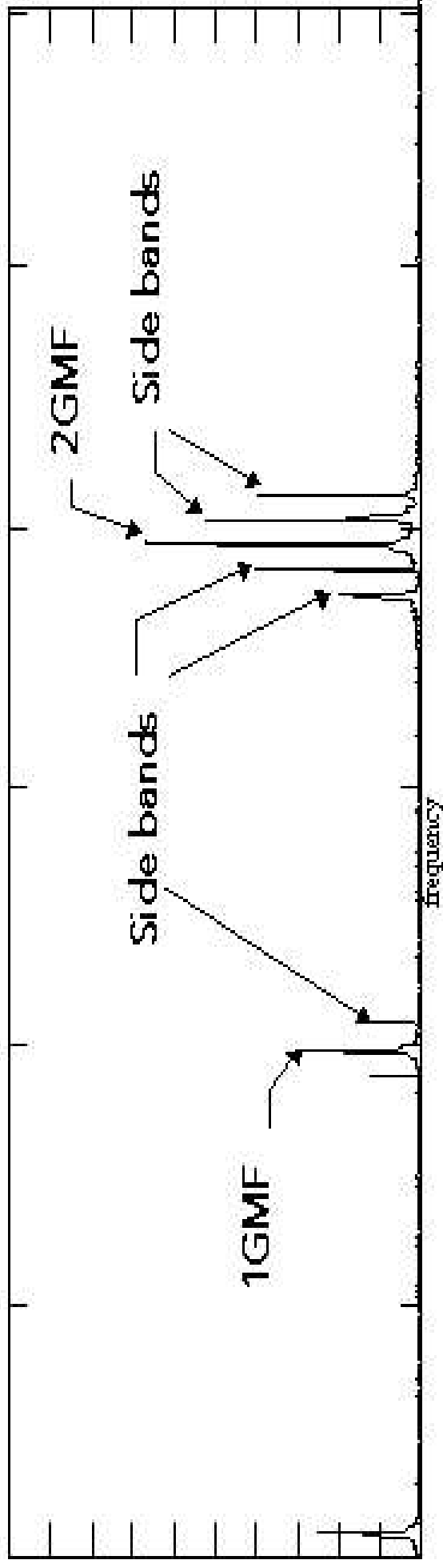
- GMF may not change
- High amplitudes of side bands
- Presence of natural frequency of gear (f_n)

Gear Eccentricity & Backlash



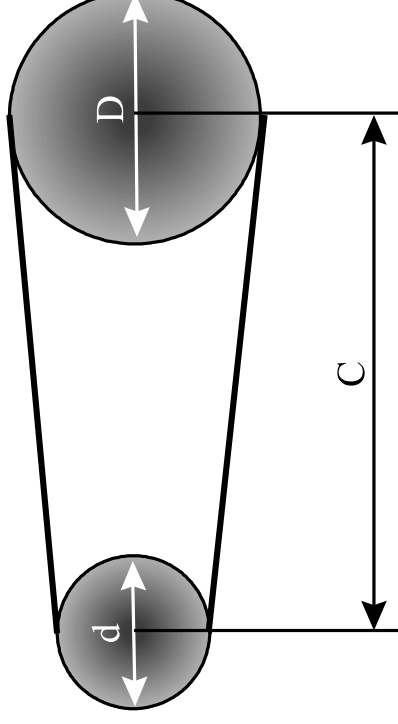
- Excites GMF, f_n & their side bands
- High amplitudes of side bands
- Sideband spacing reveals the defective gear or pinion.

Gear Misalignment



- Excites harmonics of GMF with side bands
- Amplitudes 2GMF or 3GMF higher than 1GMF

Belt Drive



$$\text{BF (Belt Frequency)} = \text{Rps} \cdot \pi \cdot D / L$$

BF is the rotational frequency of the belt. Worn or mismatched belts will produce radial vibration at BF and its harmonics. 2·BF is often dominant with 2 sheaves in the system. BF is a subsynchronous vibration (below 1X).

$$L \approx 2C + 1.57(D + d) + \frac{(D - d)^2}{4C}$$