

## CERTIFICATION EXAM REFERENCE MATERIAL (認證考試參考資料)

$$T = T_s \times N = \frac{N}{F_s} = \frac{N}{2.56 \times F_{max}} = \frac{\text{lines}}{F_{max}}$$

T = Time required to collect the waveform (總量測時間)

Ts = Time between each sample (每個取樣的時間間距)

Fs = Sampling rate (取樣率) = Samples per second (每秒取樣數)

N = Number of samples (取樣數量) (1024, 2048, 4096, etc.)

$$\text{Resolution} = \frac{F_{max}}{\text{lines}}$$

$$\text{Bandwidth} = \text{Resolution} \times \text{Window factor}$$

Window factor = 1 (no window/uniform/rectangular) or 1.5 (Hanning window)  
(窗函數因子) (無窗函數/均勻/矩形) (漢寧窗函數)

Separating frequency  $\geq 2 \times$  Bandwidth  $\geq 2 \times$  Resolution \* Window Factor  
(分離的頻率差) (頻帶寬度) (頻率解析度) (窗函數因子)

Required spectral lines  $\geq 2 \times$  Window factor  $\times$  Fmax / Separating frequency  
(分離的頻率差)

Accuracy of frequency (at peak) =  $\pm \frac{1}{2} \times$  Resolution  
頻率的準確度(在峰值) (頻率解析度)

Prime numbers: 1, 2, 3, 5, 7, 11, 13, 17, 19...  
(質數)

1 inch = 25.4 mm

1mm = 0.039 inches

**Trial weight calculation (試重塊計算):**

$$W = \frac{F}{K \times R \times N^2}$$

F = 10% of rotor mass divided by the number of bearings in kg

K = 0.011 (10%轉子質量除以軸承數量, kg)

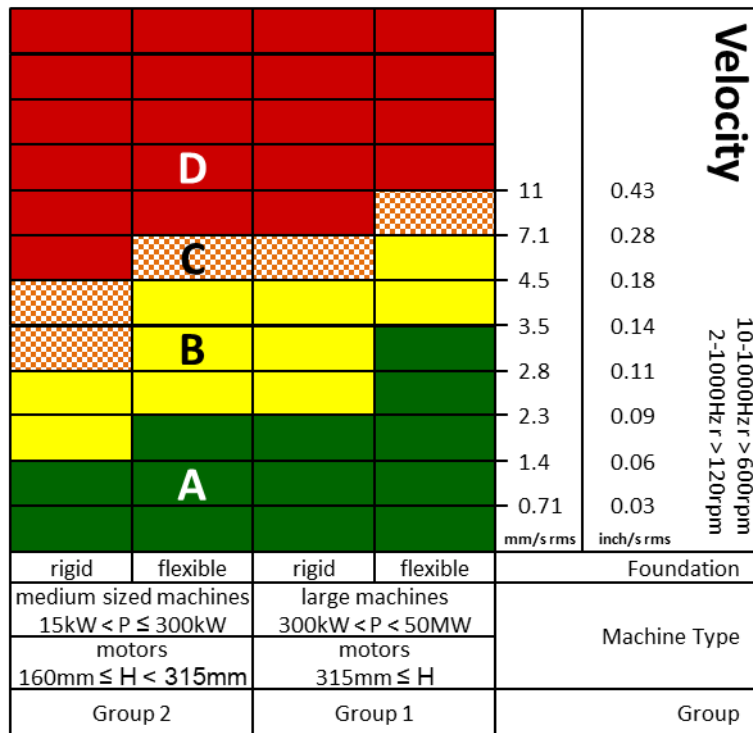
N = RPM/1000

R = Radius in cm

### Unit Conversions

$D_{pk-pk} = \frac{19098 V_{pk}}{f_{cpm}} \quad V_{pk} = \frac{5217 A_{rms}}{f_{cpm}}$	$D_{pk-pk} = \frac{27009 V_{rms}}{f_{cpm}} \quad V_{rms} = \frac{93712 A_{rms}}{f_{cpm}}$
$D_{pk-pk} = \frac{9.958 \times 10^7 A_{rms}}{f_{cpm}^2} \quad A_{rms} = \frac{f_{cpm} V_{pk}}{5217}$	$D_{pk-pk} = \frac{2.53 \times 10^9 A_{rms}}{f_{cpm}^2} \quad A_{rms} = \frac{f_{cpm} V_{rms}}{93712}$
$V_{pk} = \frac{f_{cpm} D_{pk-pk}}{19098} \quad A_{rms} = \frac{f_{cpm}^2 D_{pk-pk}}{9.958 \times 10^7}$	$V_{rms} = \frac{f_{cpm} D_{pk-pk}}{27009} \quad A_{rms} = \frac{f_{cpm}^2 D_{pk-pk}}{2.53 \times 10^9}$
<b>D = Displacement:</b> mils pk-pk <b>V = Velocity:</b> in/sec pk <b>A = Acceleration:</b> g rms <b>F = Frequency:</b> CPM	<b>D = Displacement:</b> micron pk-pk <b>V = Velocity:</b> mm/sec rms <b>A = Acceleration:</b> g rms <b>F = Frequency:</b> CPM <b>1g rms = 9.8m/sec<sup>2</sup></b>

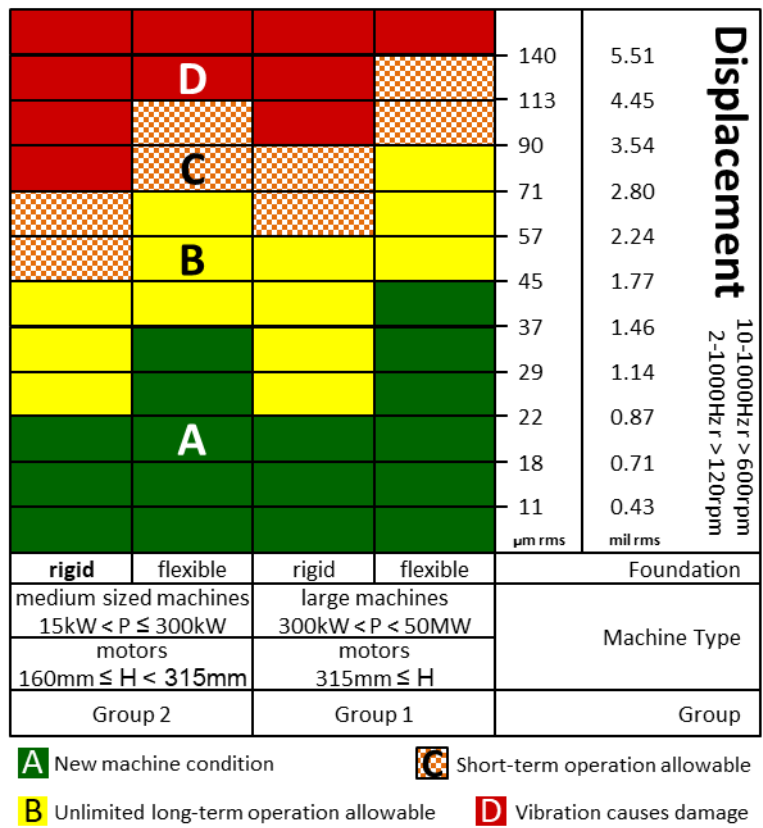
### ISO 10816-3 Vibration Severity Chart



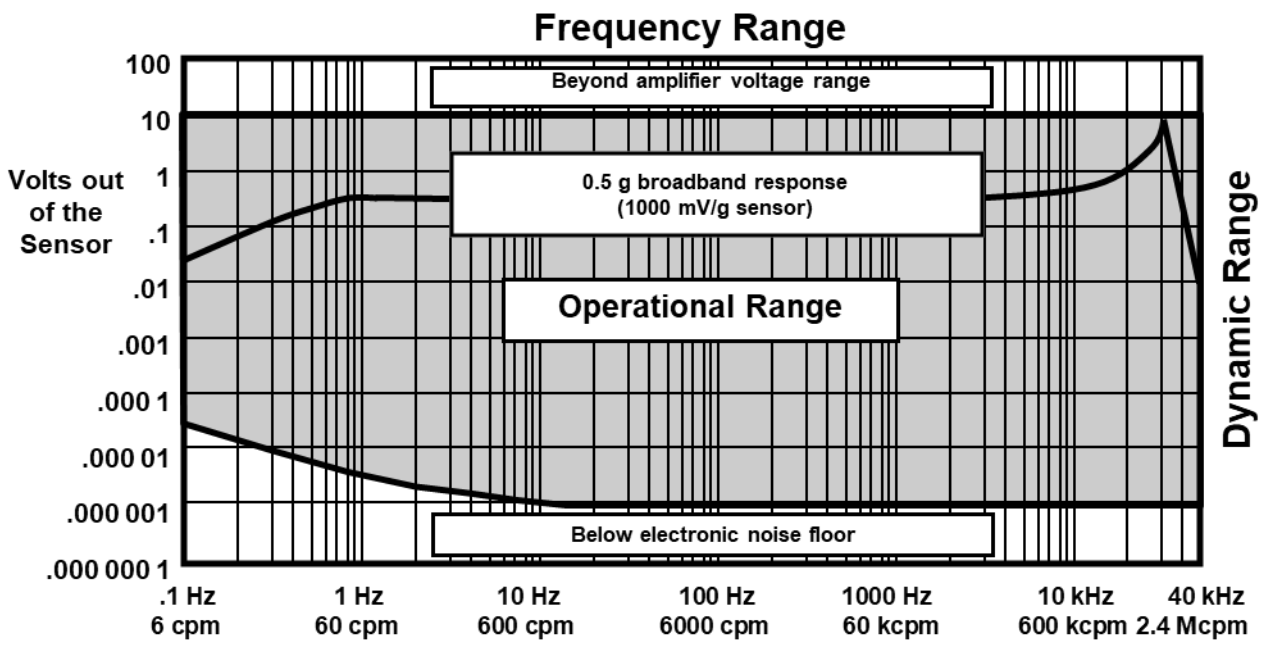
- A** New machine condition
- B** Unlimited long-term operation allowable
- C** Short-term operation allowable
- D** Vibration causes damage

If the lowest natural frequency of the combined machine and support system in the direction of measurement is higher than its main excitation frequency (this is in most cases the rotational frequency) by at least 25 %, then the support system may be considered rigid in that direction. All other support systems may be considered flexible.

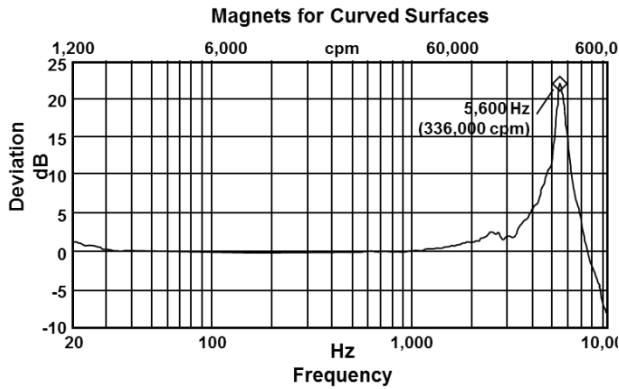
# ISO 10816-3 Vibration Severity Chart



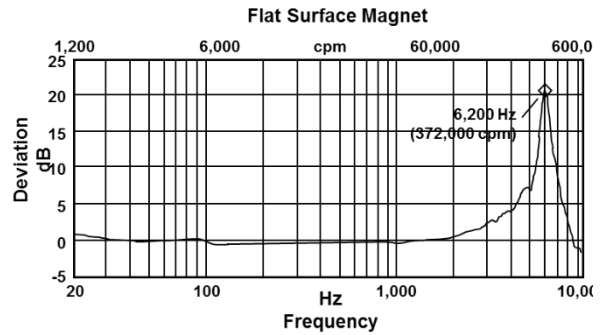
# Transducer Operating Regions



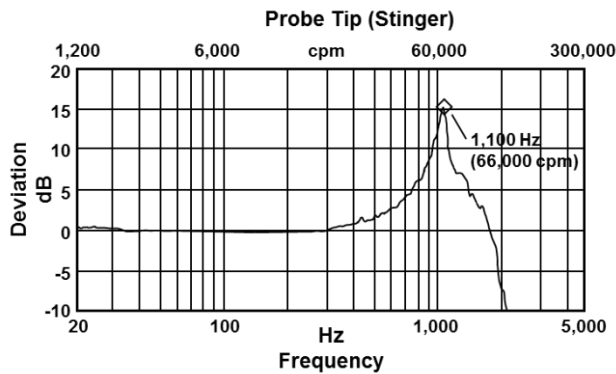
**Transducer Frequency Response - Magnets on Curved Surfaces**



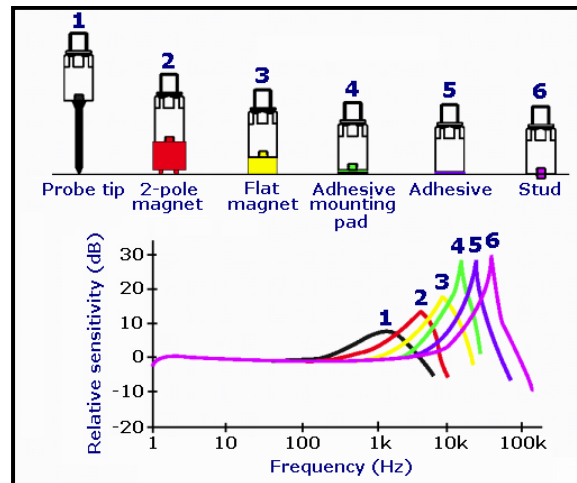
**Transducer Frequency Response - Magnets on Flat Surfaces**



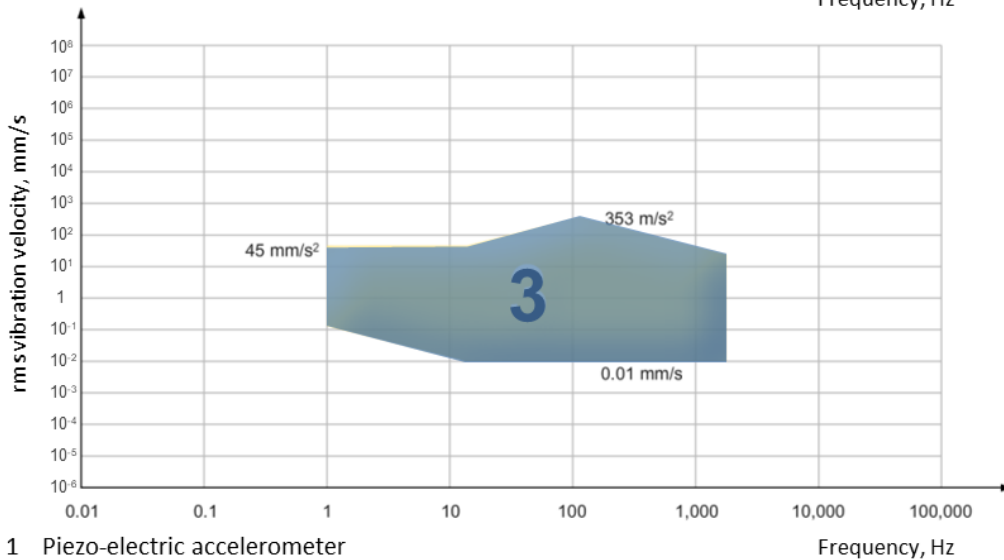
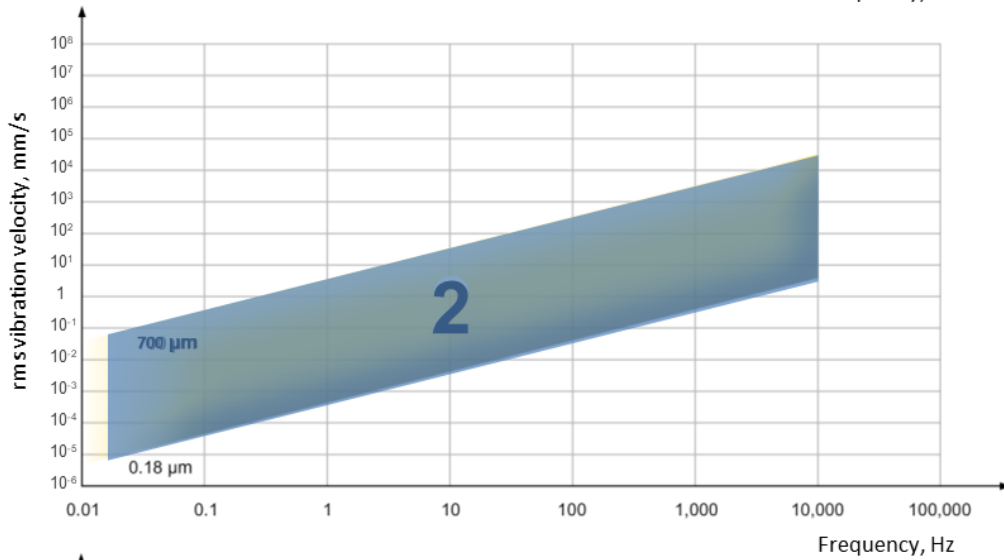
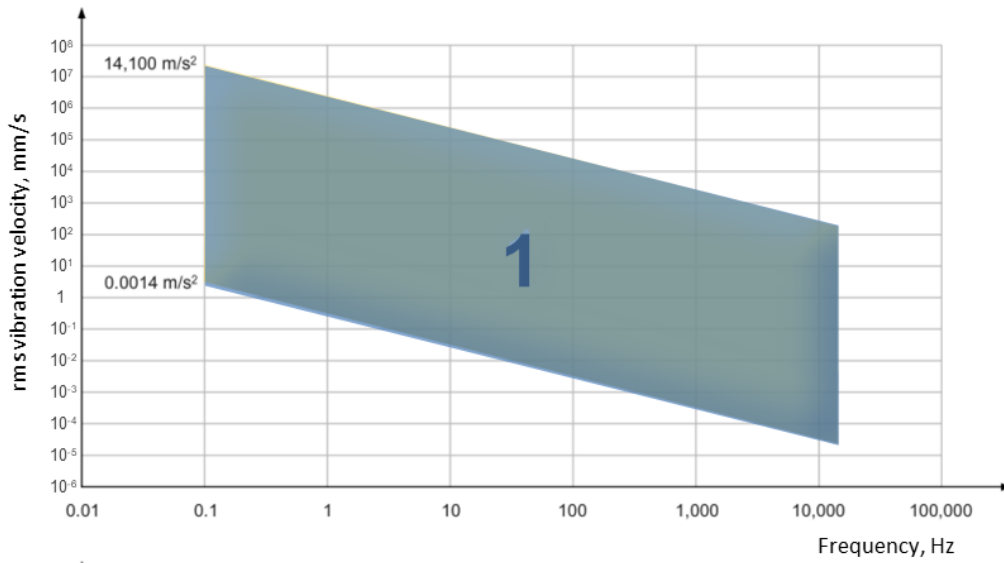
**Transducer Frequency Response - Stingers or Hand Held Probes**



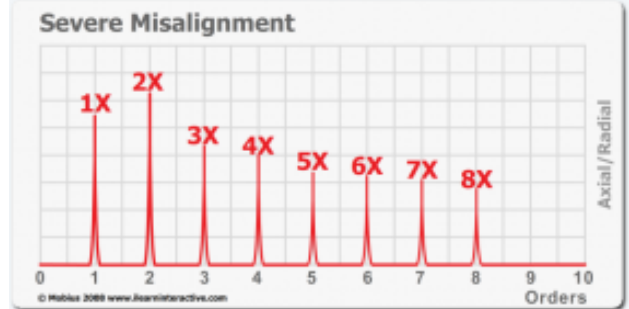
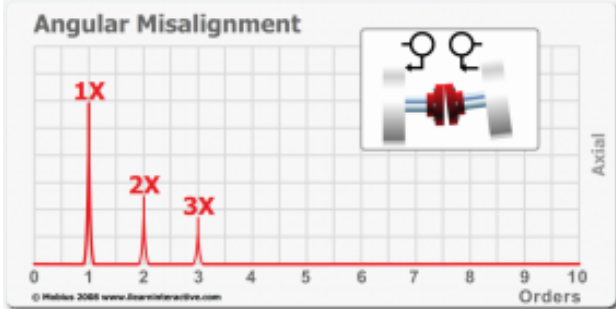
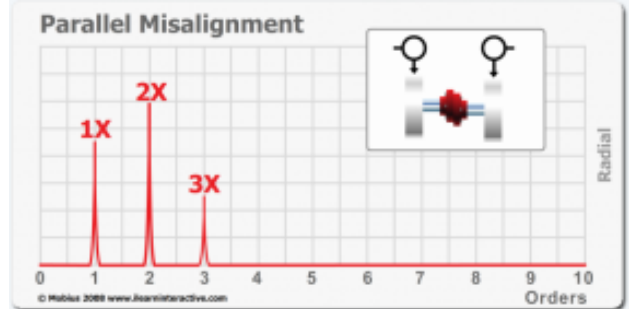
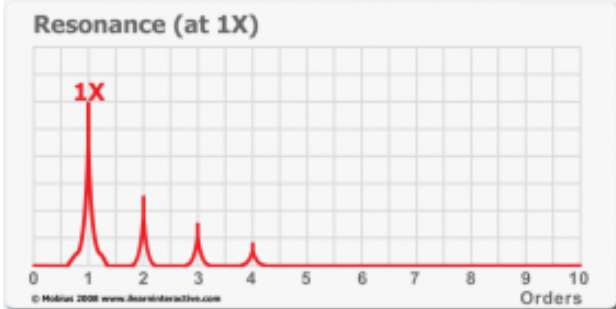
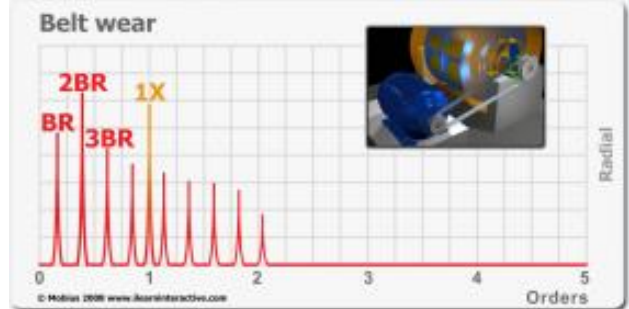
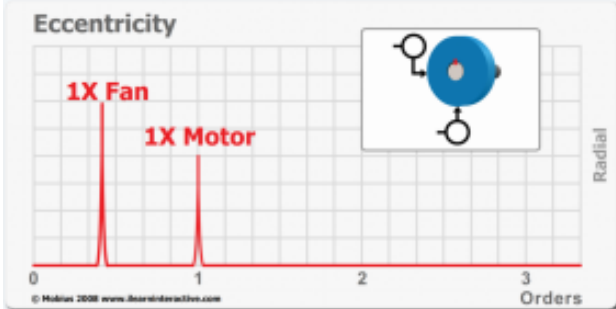
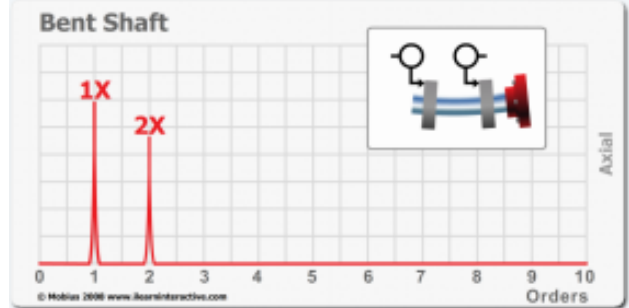
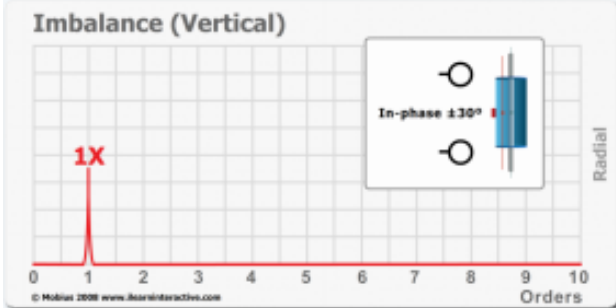
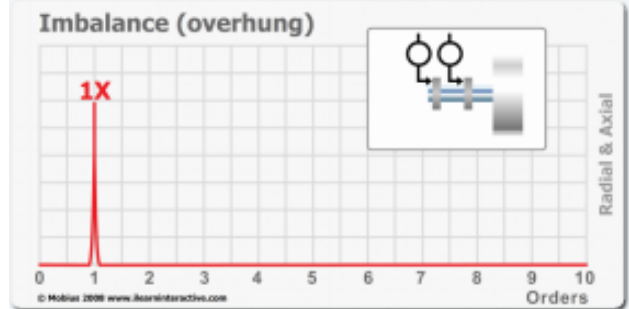
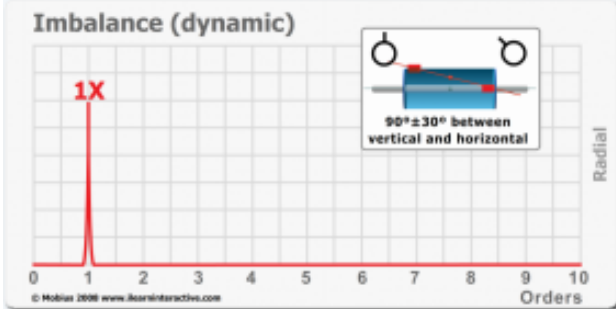
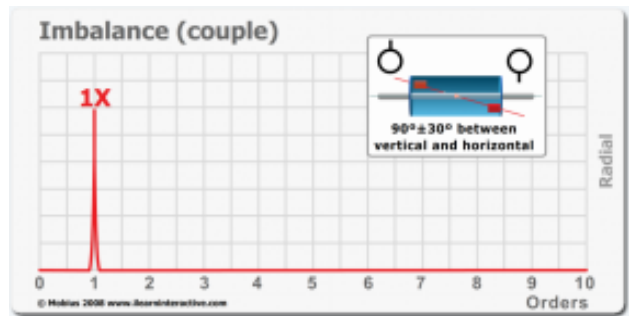
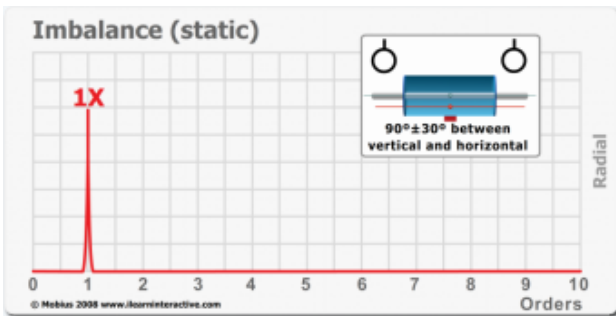
**Transducer Frequency Response Curves**

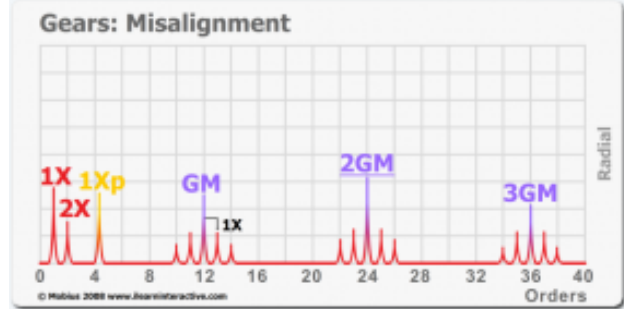
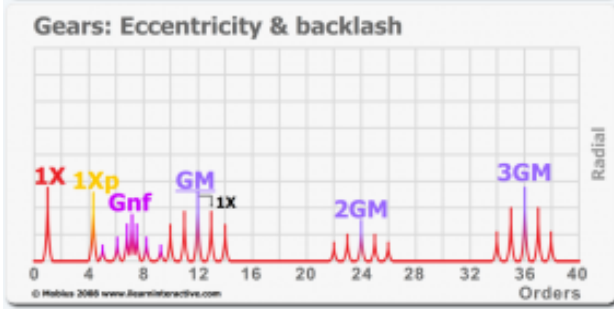
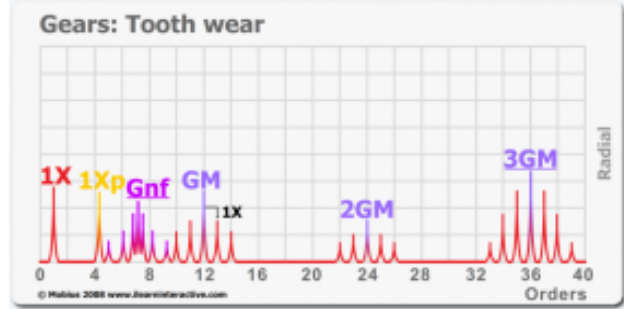
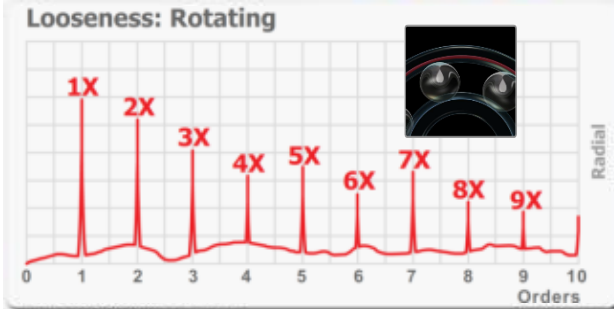
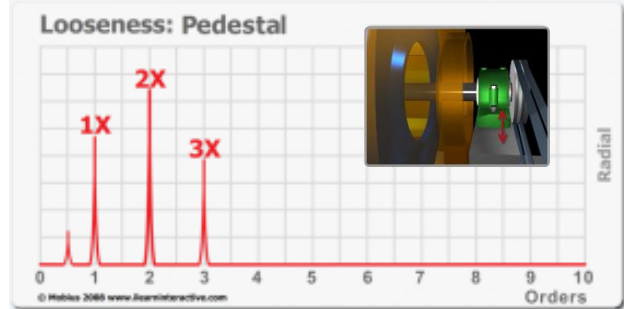
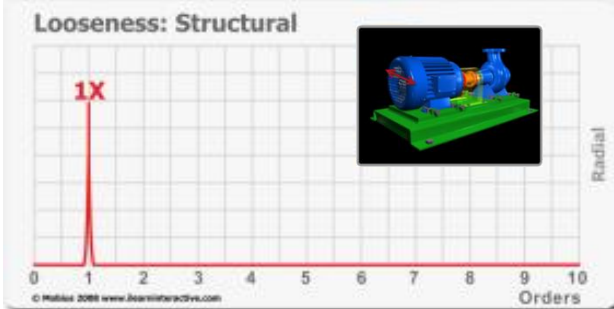
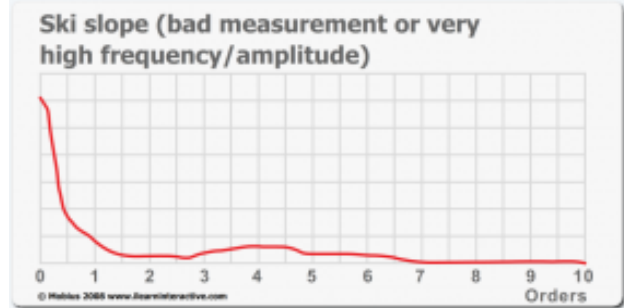
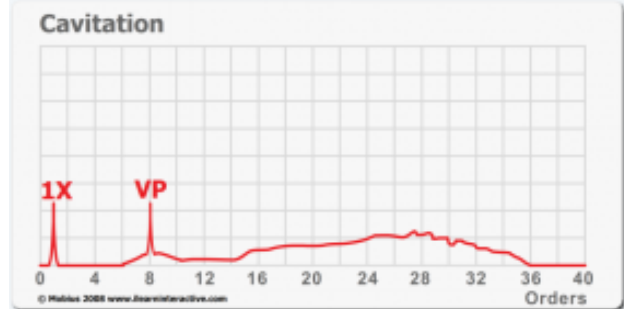
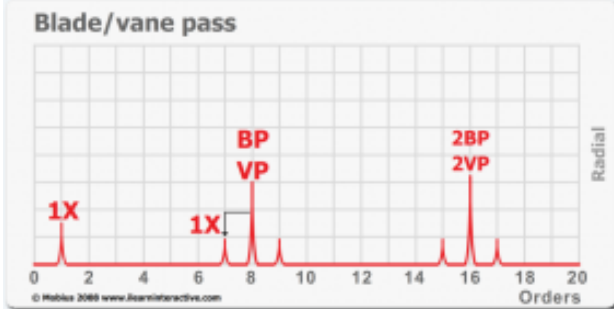
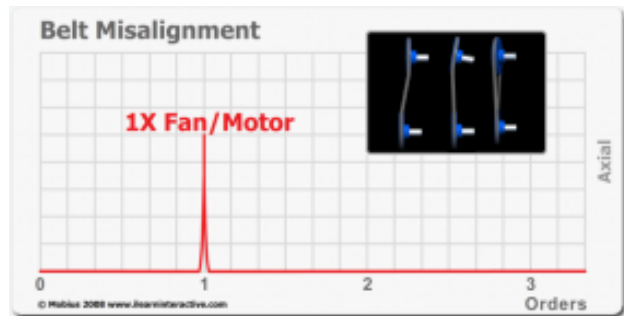
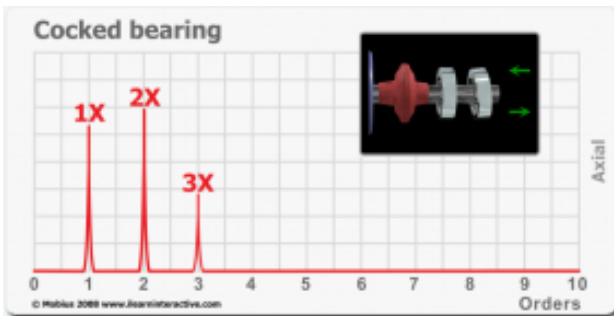


# Transducer Effectiveness Regions

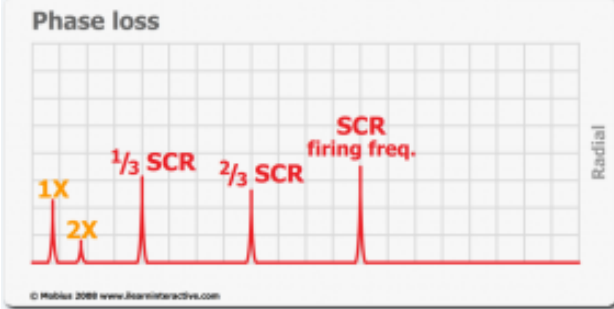
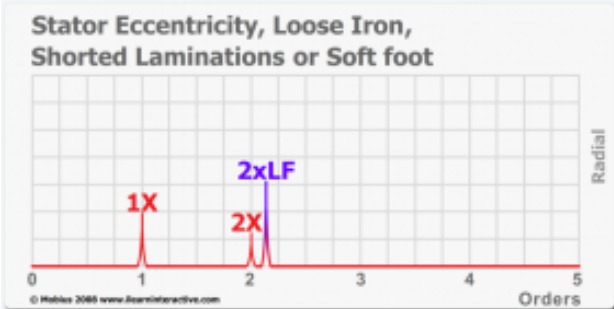
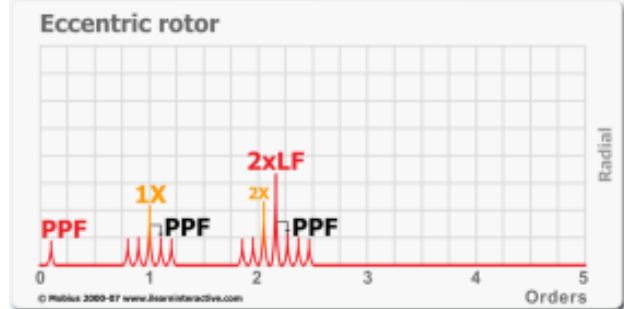
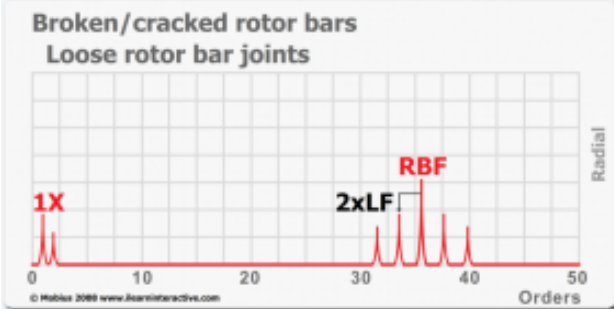
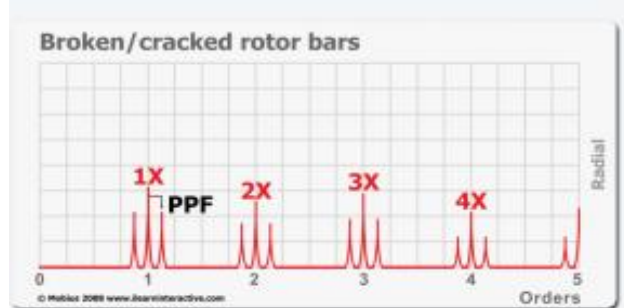
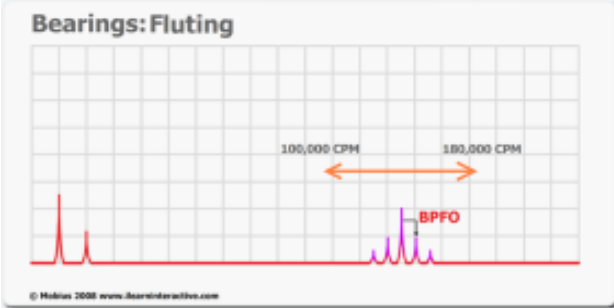
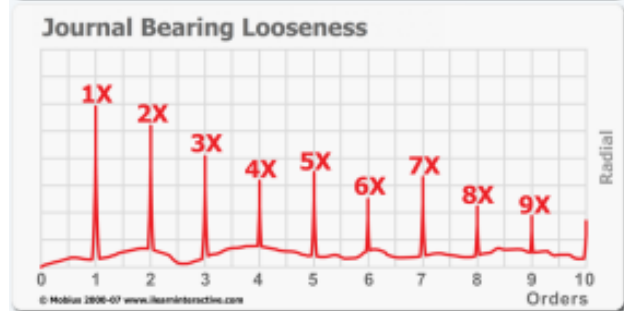
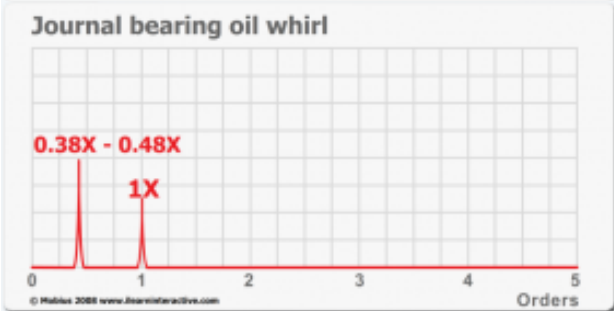
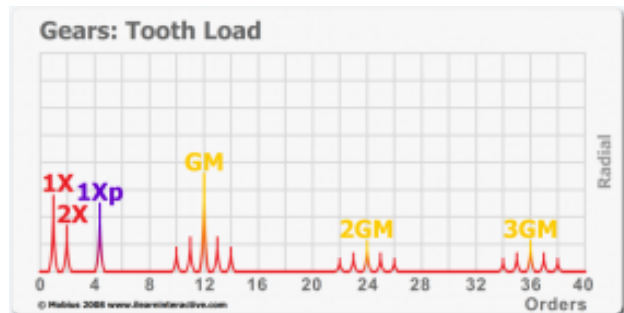
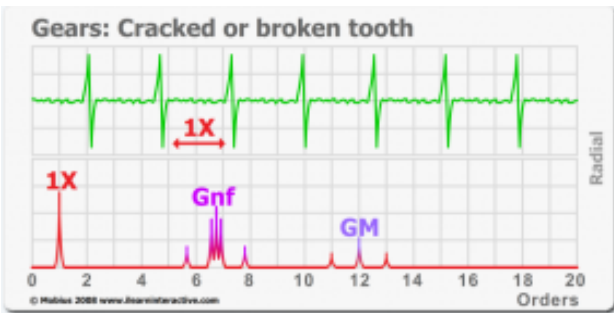


- 1 Piezo-electric accelerometer
- 2 Eddy-current proximity probe
- 3 Electro-mechanical velocity transducer

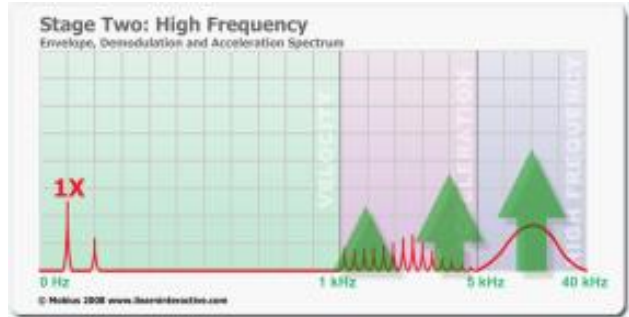
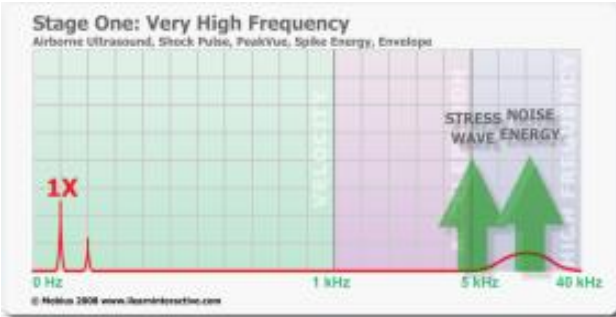
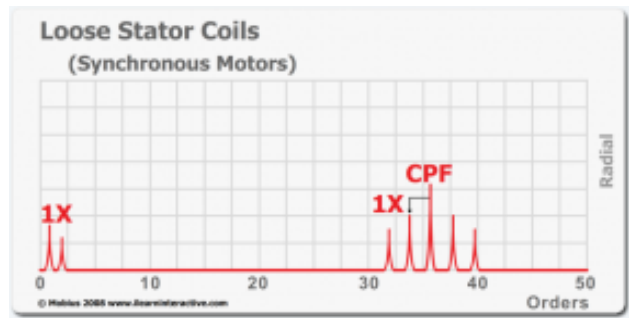
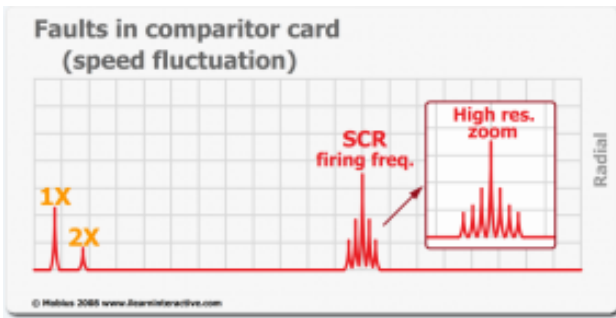






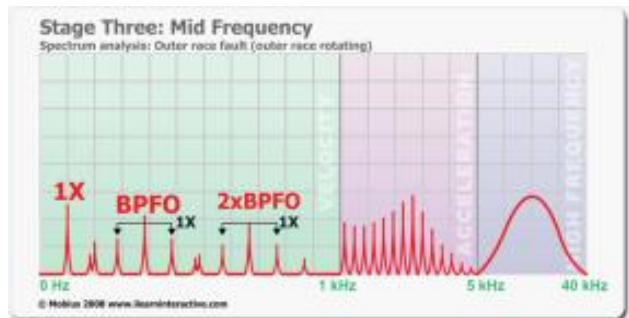
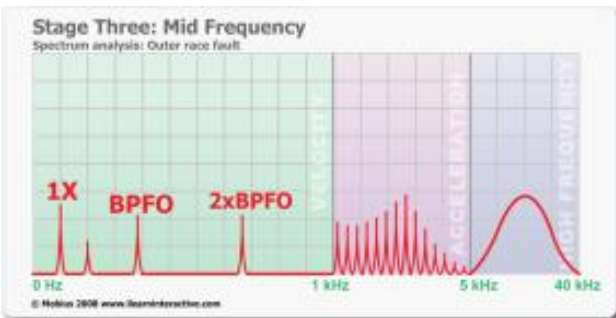






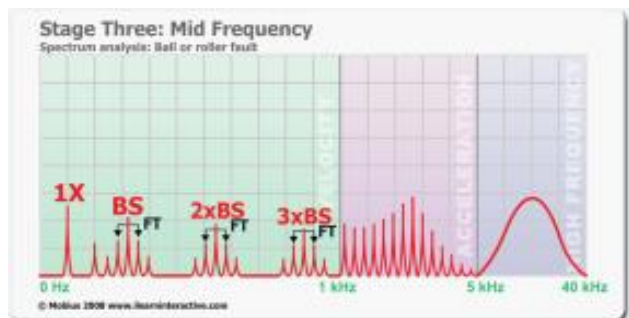
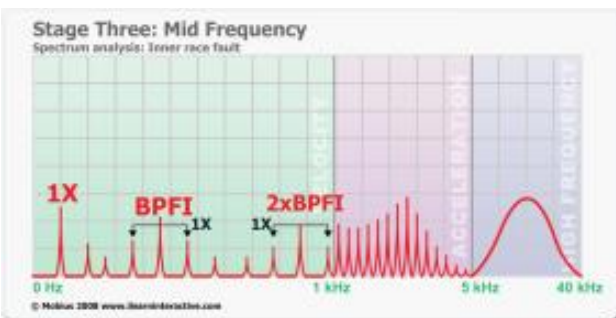
Stage One: Airborne Ultrasound, Shock Pulse, PeakVue, Spike Energy, Envelope

Stage Two: Envelope, Demodulation and Acceleration Spectrum



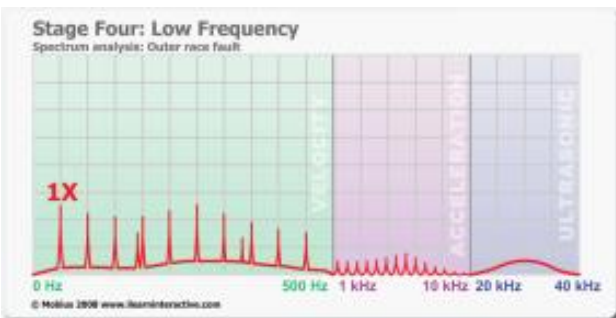
Stage Three: Outer race fault (inner race rotating)

Stage Three: Outer race fault (outer race rotating)



Stage Three: Inner race fault (inner race rotating)

Stage Three: Ball or roller fault (inner race rotating)



Stage Four

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