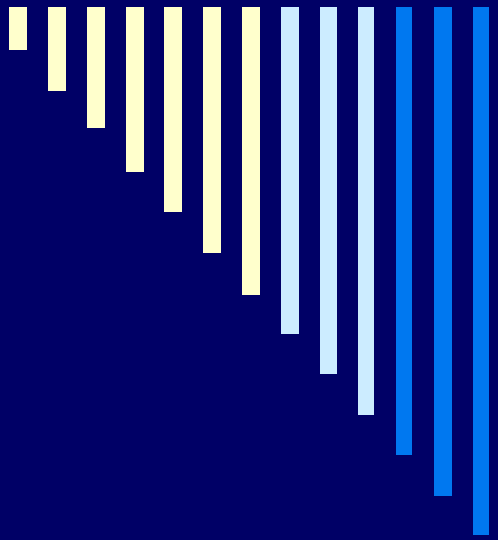


Motor Electrical Fluting

Using Vibration Analysis to Detect & Prevent

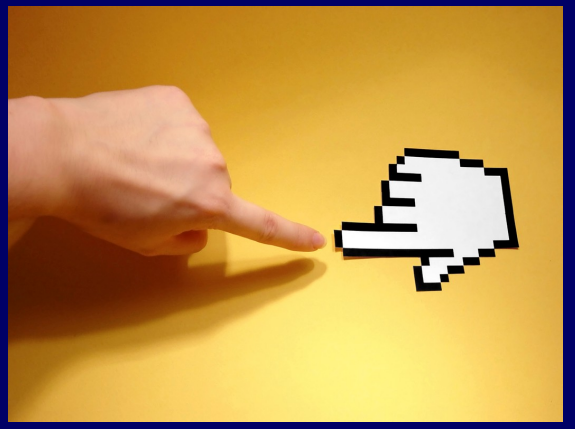
Outline

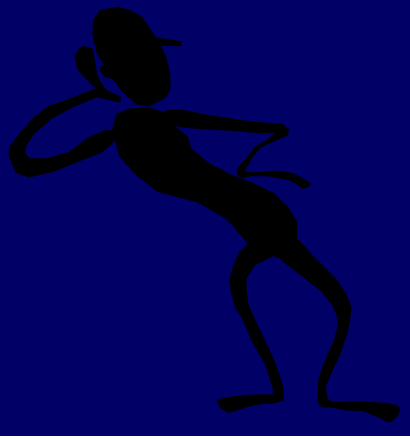
- Introduction
- Cause & Effect
- Identifying the Problem
- Bearing life
- Bearing examples
- Protection Methods

Janelle Hammes

- Electric Motor and Repair, Inc
- West Columbia, SC
- Originally from Rockford, IL
- In the motor business for 2 years

Vibration Description



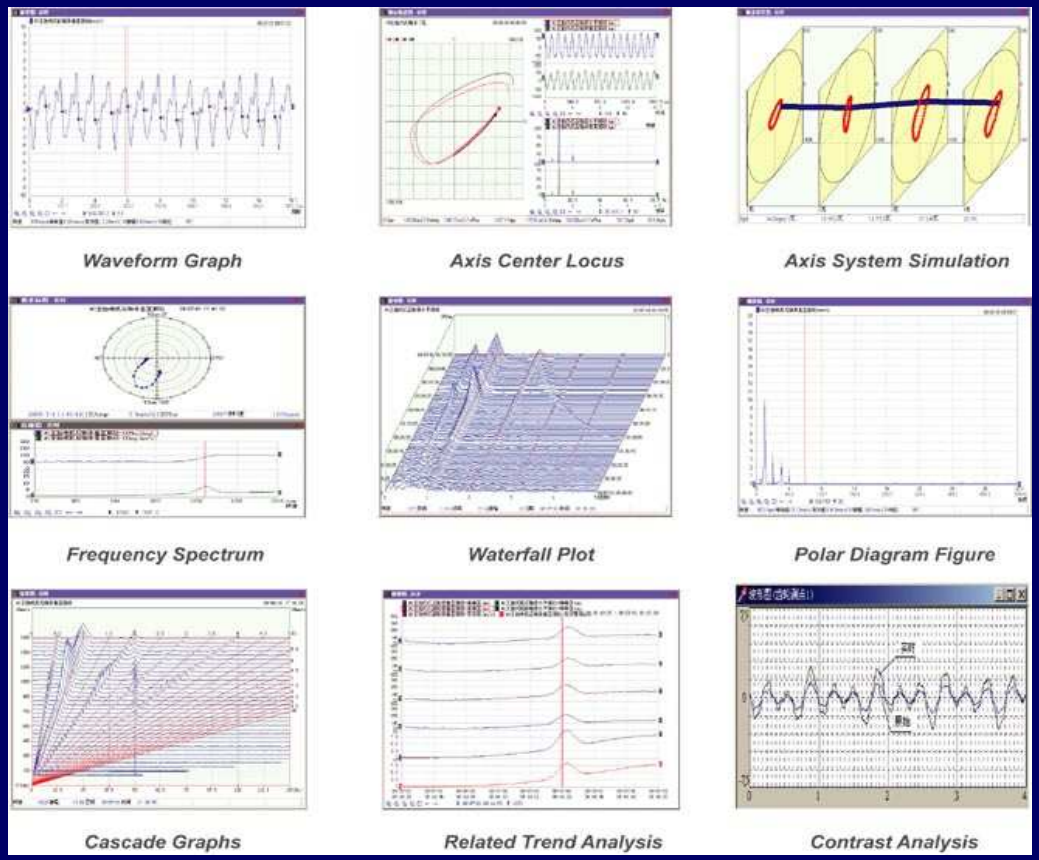


Cause & Effect

VFD Induced Shaft Voltage	Bearing Damage
Higher Carrier Frequency	Insulation & Bearing Damage
Constant Speed Operation	Bearing Damage
Inadequate Grounding	Bearing Damage
Excessive Loads/Over Heating	Bearing Damage

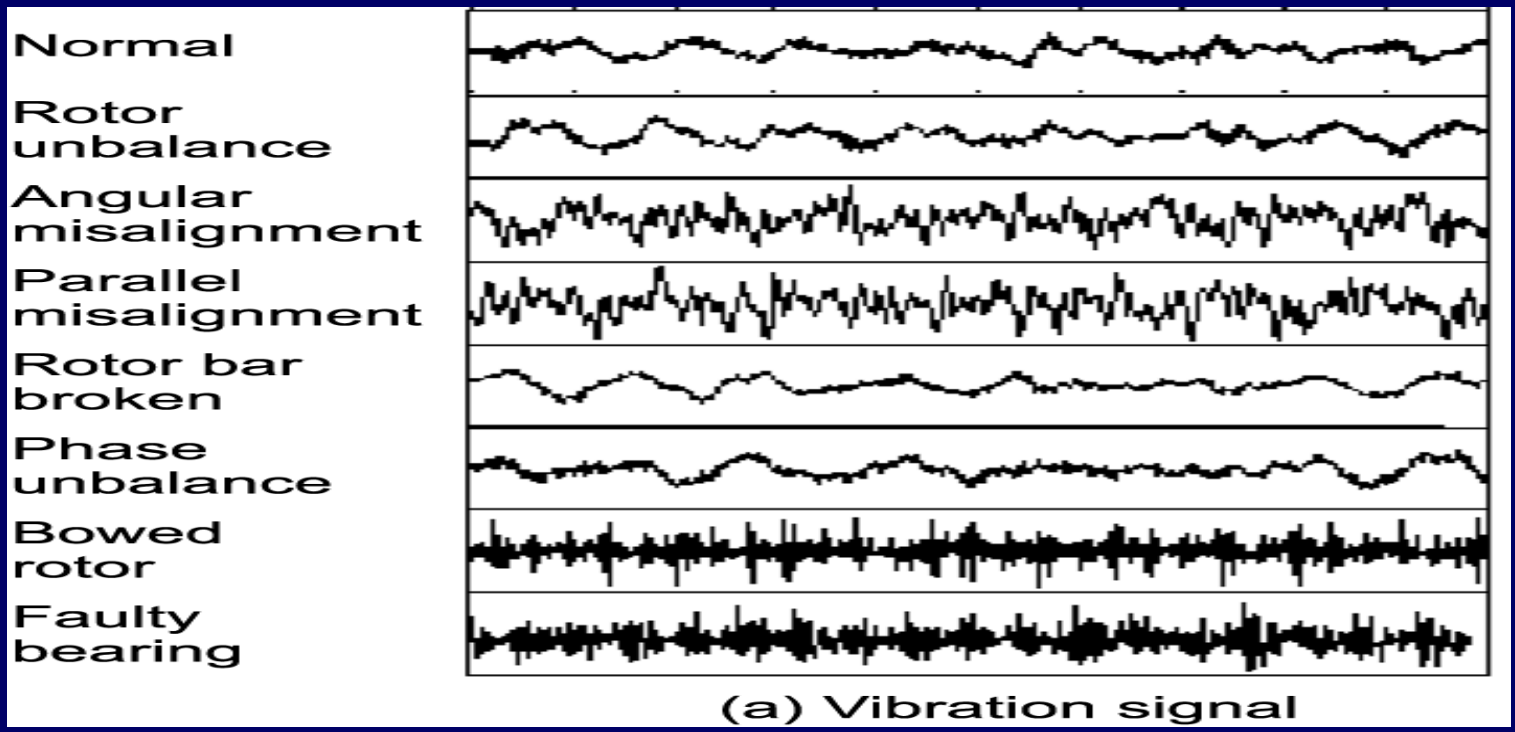
Identifying the Problems cont.

Identifying the Problems



- Vibration Analysis helpful in confirming bearing fluting (damage)
- Continuous monitoring/testing from installation on is recommended
- P.M is key

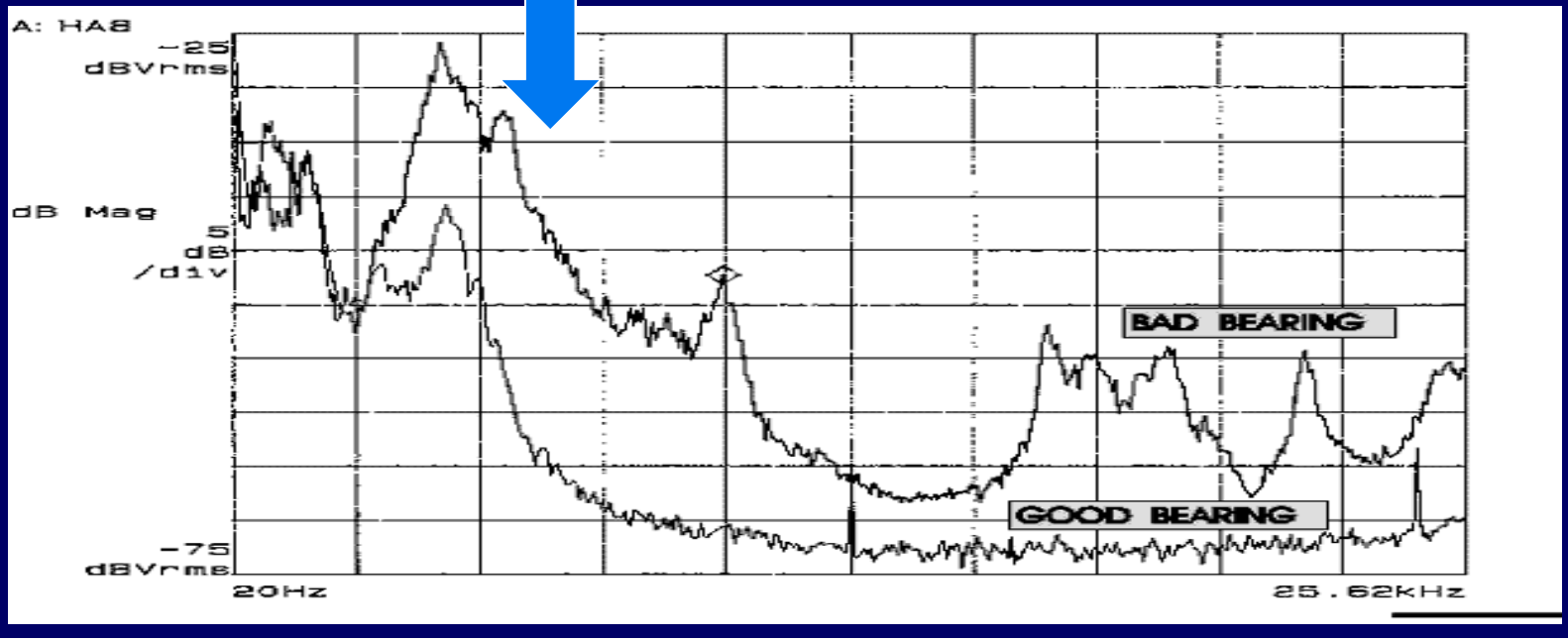
Identifying the Problems cont.



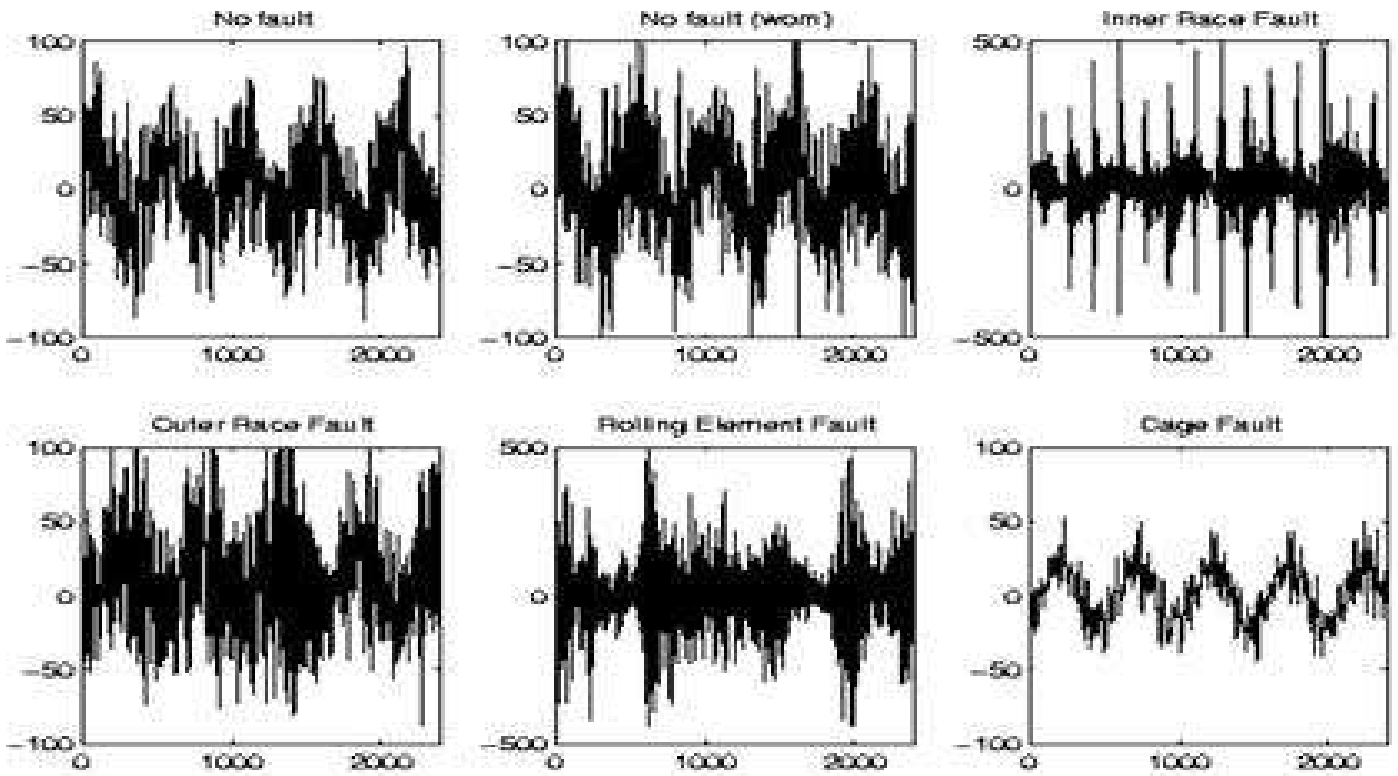
- Here are some examples of what to look for when you are performing a vibration analysis.

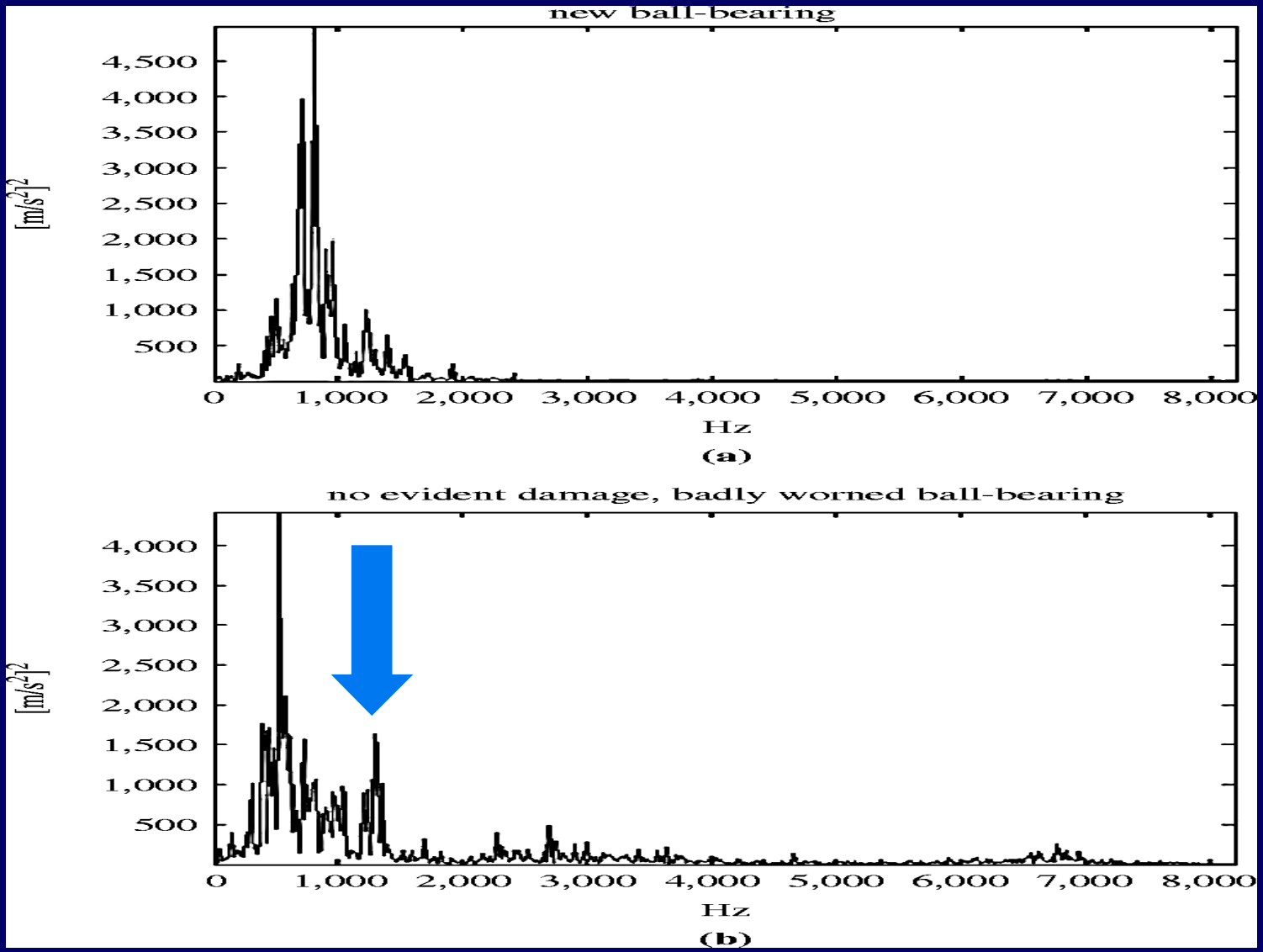
Identifying the Problems cont.

- Here is a good comparison of the good bearing vs the bad bearing. The difference is quite obvious.



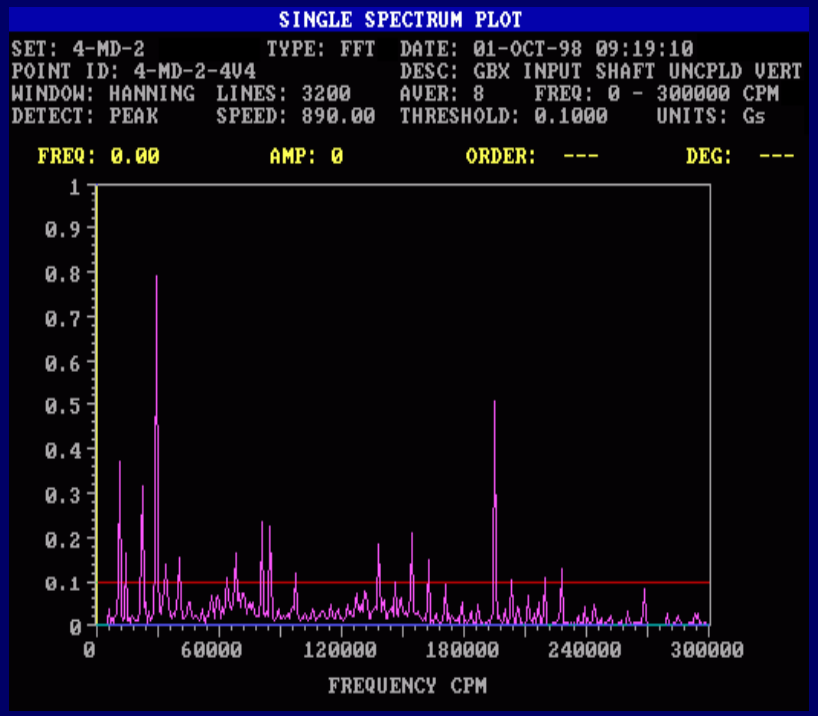
Identifying the Problems cont.



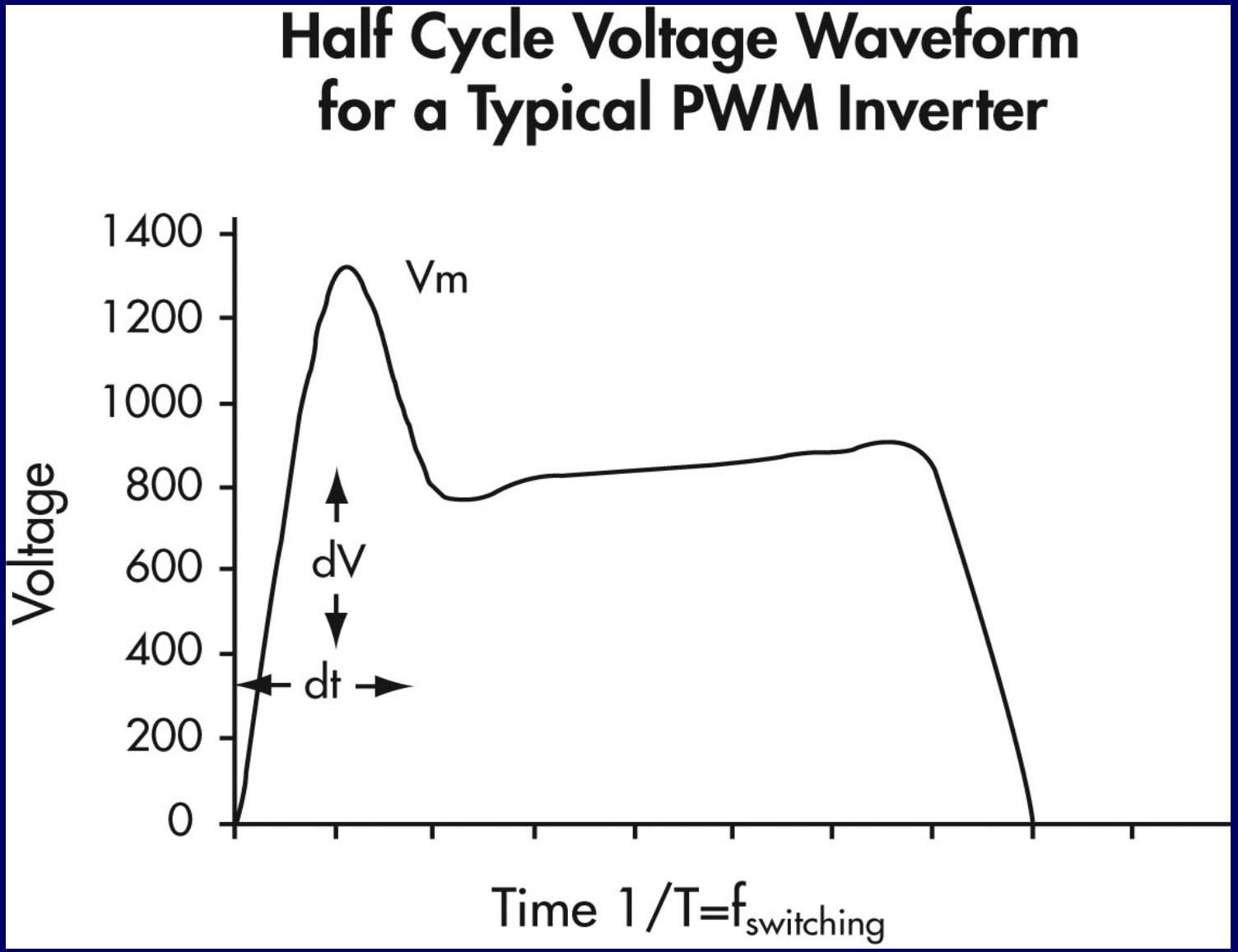

new ball-bearing
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
[m/s²]²
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
Hz
(a)
no evident damage, badly worned ball-bearing
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
[m/s²]²
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
Hz
(b)

Identifying the Problems cont.

- Voltage Analysis can be used to determine the likelihood of damage
- This method is not an exact science, however it is helpful



Half Cycle Voltage Waveform for a Typical PWM Inverter



Identifying the Problem cont.

- SKF Electrical Discharge Detector Pen
- Does not tell you what the problem is only a tool to assist in detection

Bearing life

$$L_{10} = \frac{16700}{rpm} \times \left[\frac{\text{dynamic capacity x load rating}}{\text{force}}\right]^3$$

= hours of life

$$B_{10h} = \frac{1000000}{60 \times RPM} \times \left(\frac{C}{P}\right)^p$$

Where

B_{10h} = life of bearing in hours

C = dynamic load rating (load at which at least 90% of identical bearings complete one million revolutions)

P = equivalent dynamic bearing load

p = exponent = (3 for ball bearing; 10/3 for roller bearing)

RPM = revolutions per minute

Bearing Life

New Bearing Race

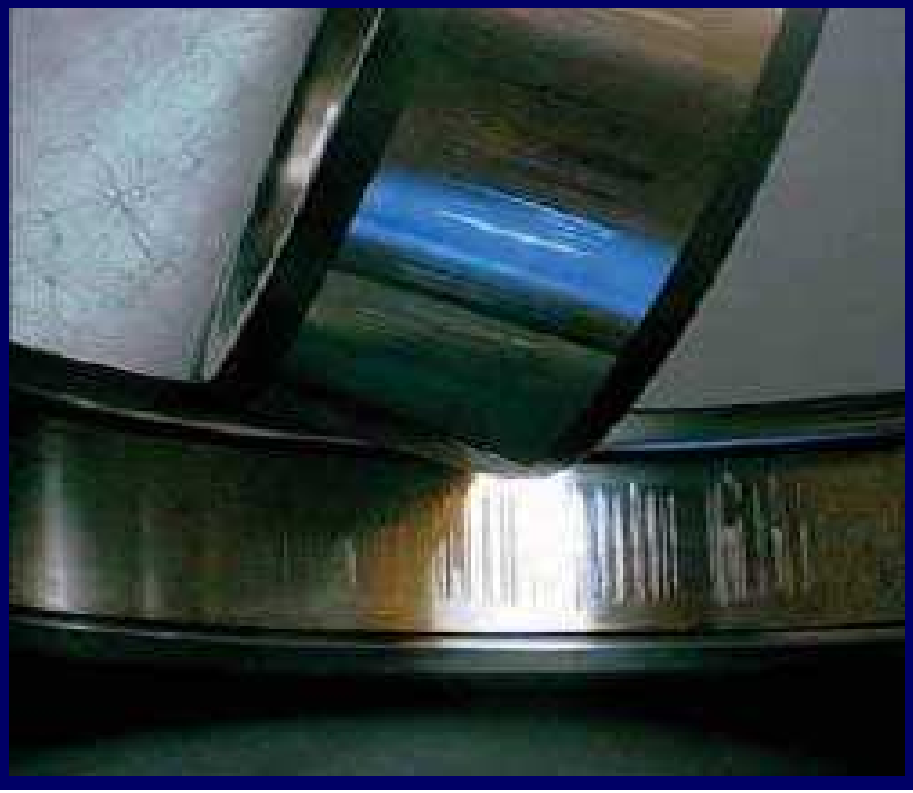
- New bearing race will be smooth
- Track will eventually form

Bearing Damage

- Pitting
- Early damage

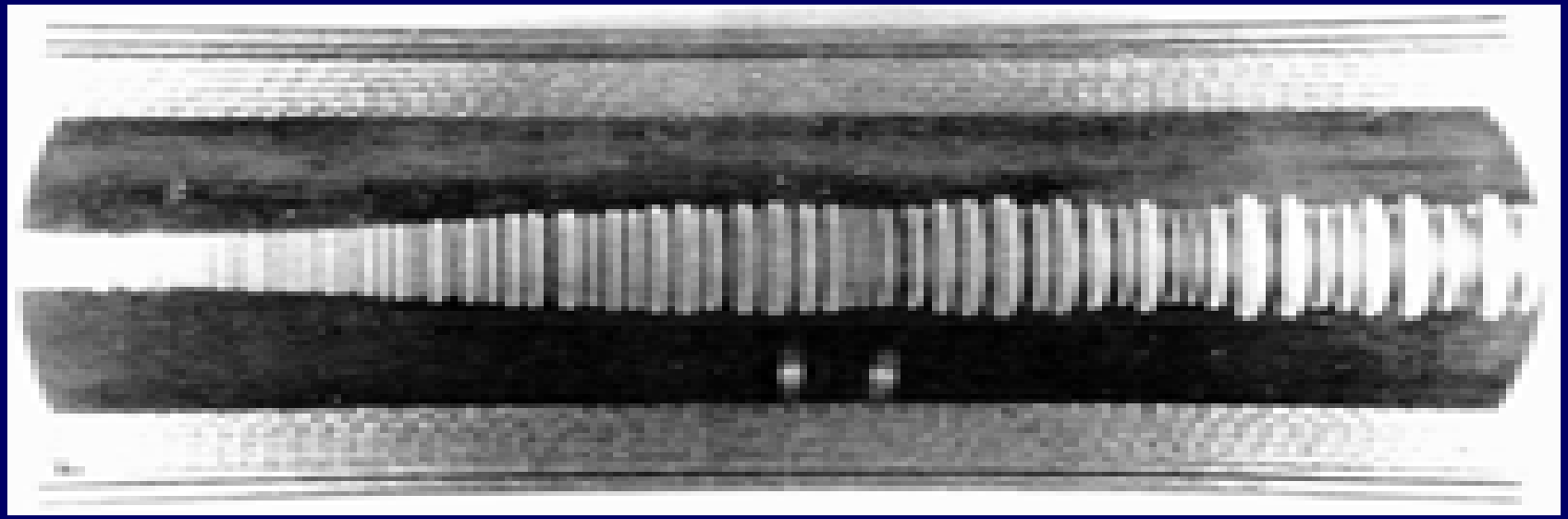
Bearing Damage Cont.

- Birnelling



Bearing Damage cont.

- Fluting: “washboard” pattern.
- Vibration
- Noise



Bearing Damage cont.

- Rust damage / corrosion

Bearing Damage Cont.

- Excessive load / Overheating
- Brinelling and Discoloration

Protection Methods

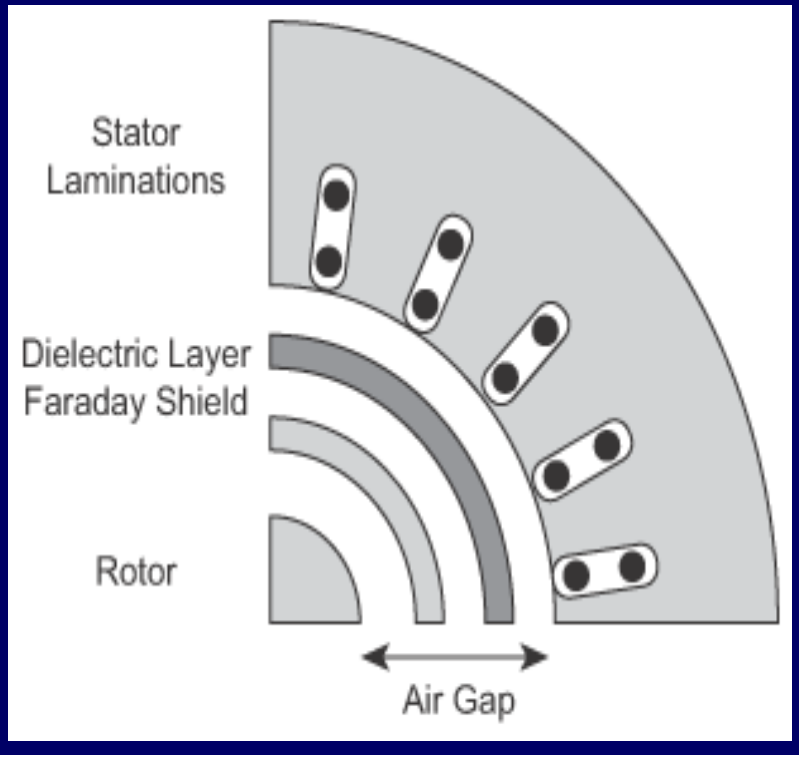
- Shaft grounding

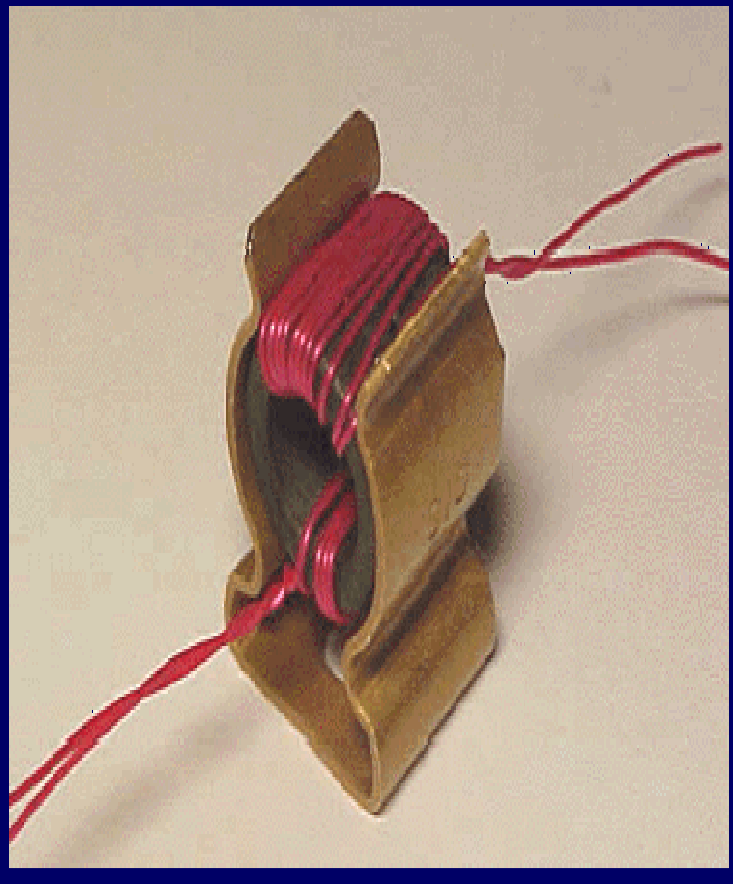
Protection Methods cont.

- Insulated/ceramic bearings or insulating the bearings

Protection Methods cont.

- Faraday Shield





Protection Methods cont.

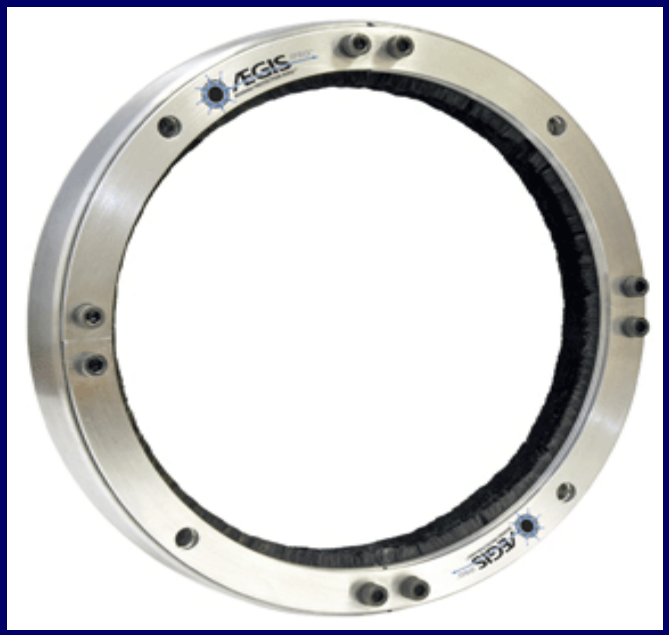
- Sine wave filter
- Or DV/DT filter

Protection Methods cont.

- Conductive grease
- Can interfere with the performance of the shaft protector

Protection Methods cont.

- Bearing Protection Ring (SGR)



Bearing Installation Tips

- Handle with care
- Inspect shaft & housing
- Avoid overheating
- Use the same bearing that is replaced
- Use correct tools
- Pay attention
- Verify bearing ring & bearing seat
- Don’t clean new bearings
- Proper lubrication
- Rotate idle bearings
- Look for danger signs
- Find the cause of failure

Thank you