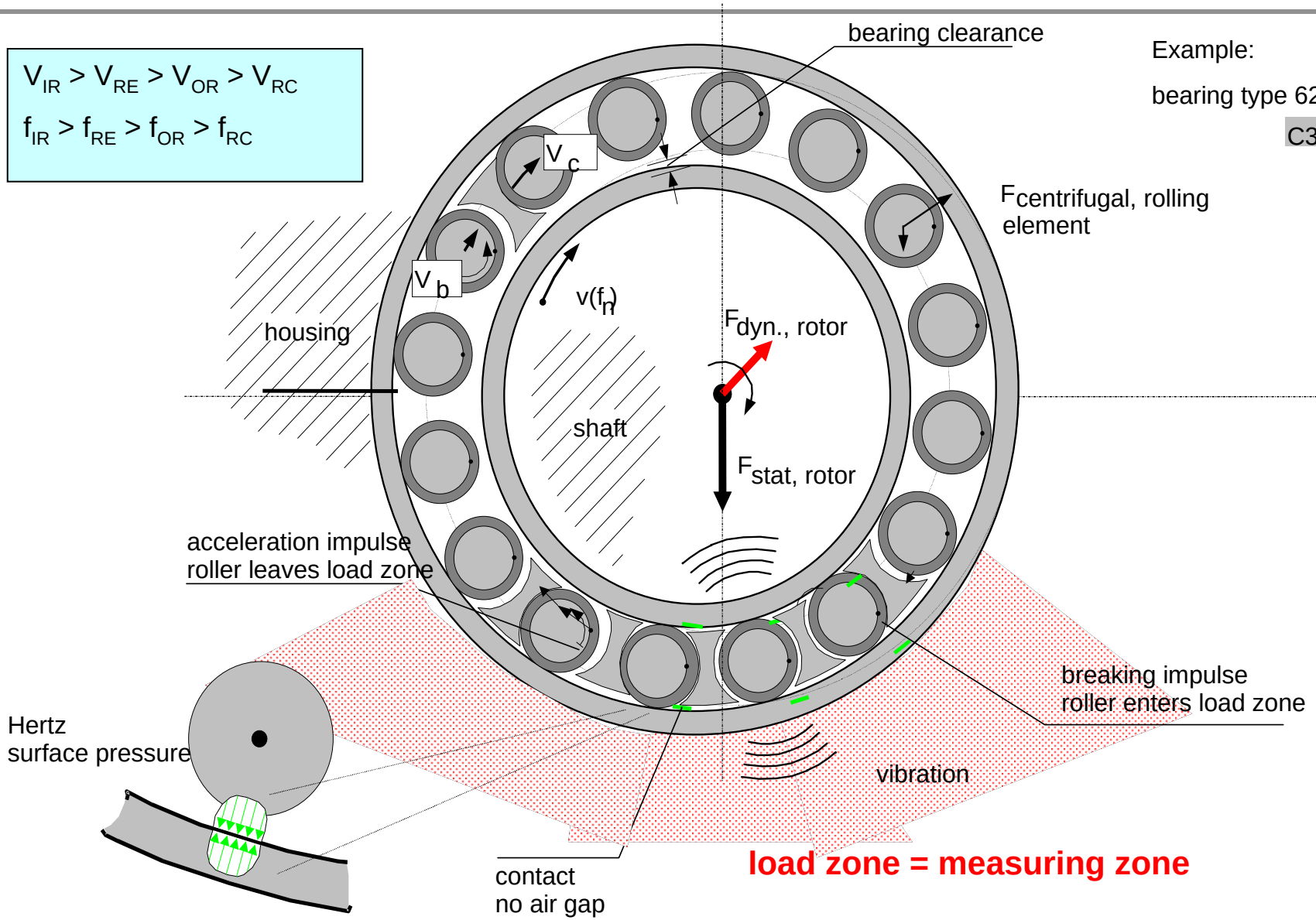
Forces and Motions in Rolling Bearings

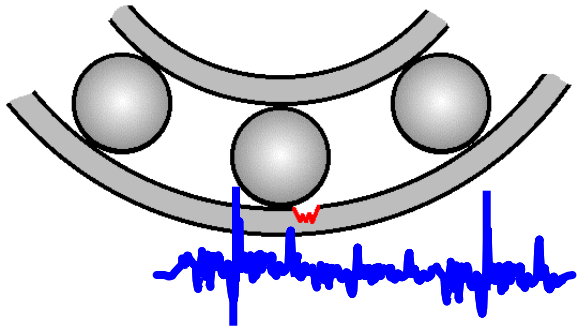
$V_{IR} > V_{RE} > V_{OR} > V_{RC}$

$f_{IR} > f_{RE} > f_{OR} > f_{RC}$



Overall values for Bearing condition

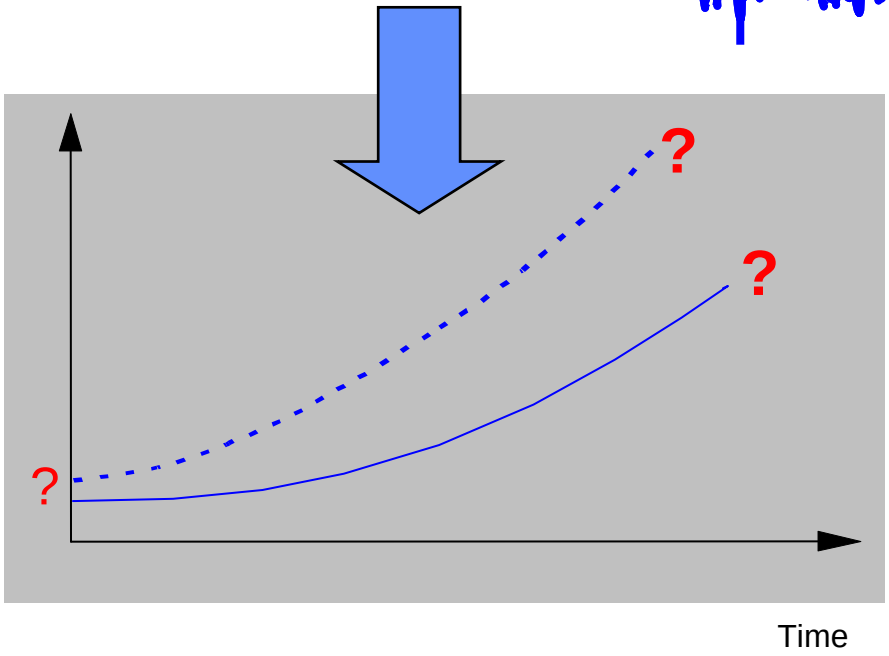
Acceleration - Crest Factor
Spike Energy Value
BCU - Value
Kurtosis Factor
gSE - Value
SEE - Value

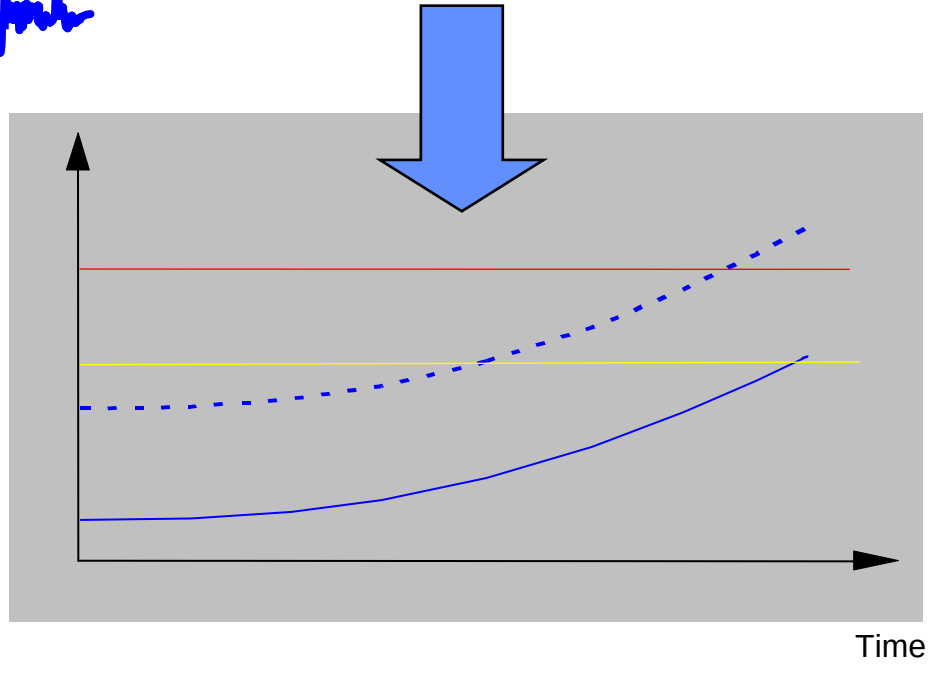


Shock Pulse Measurement

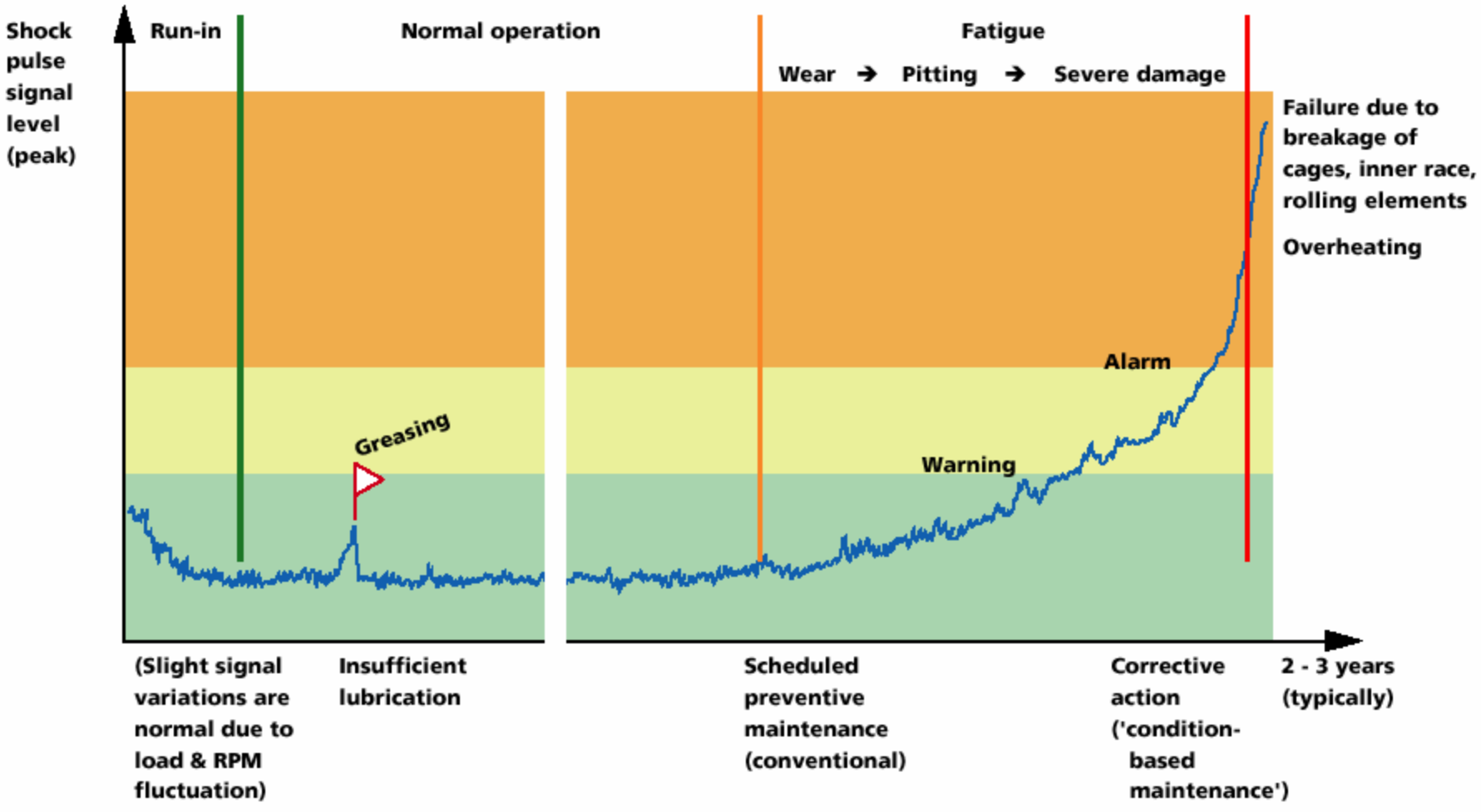
Normalising with…

- **Shaft speed (rpm)**
- **Shaft Diameter (Bearing Size)**





A Typical Bearing Life Cycle

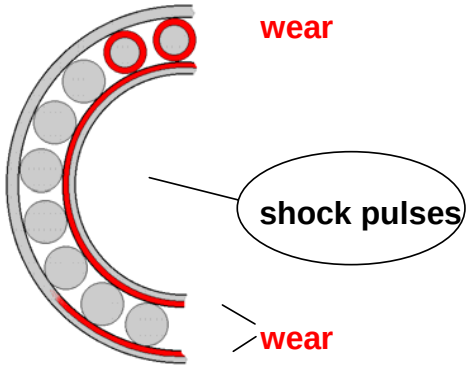


Types of Rolling Bearing Damages (1)

Damages types/ Causes

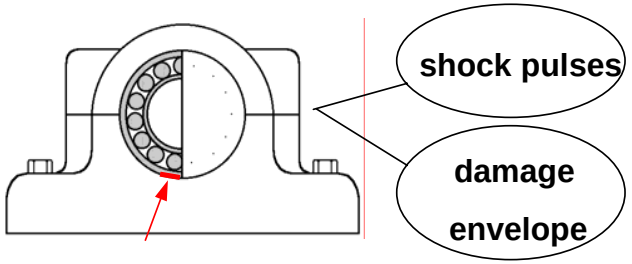
1 Wear

- lifetime expired
- overloading
- assembly / manufacturing error
- greasing deficiency



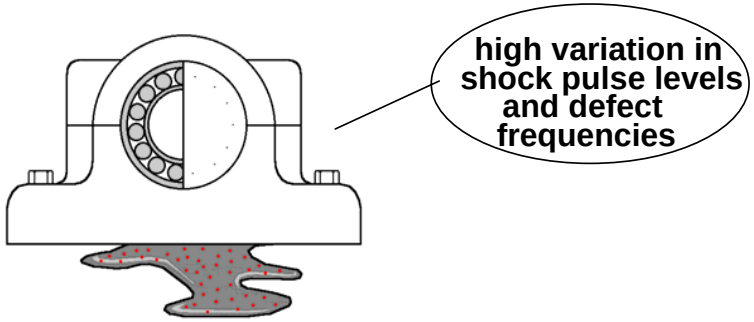
2 Damage to rolling track

- lifetime expired
- bearing overloaded
- bearing under-loaded
- greasing deficiency



3 Contaminated lubricant

- Damaged rolling track
- damaged sealing
- contaminated lubricant

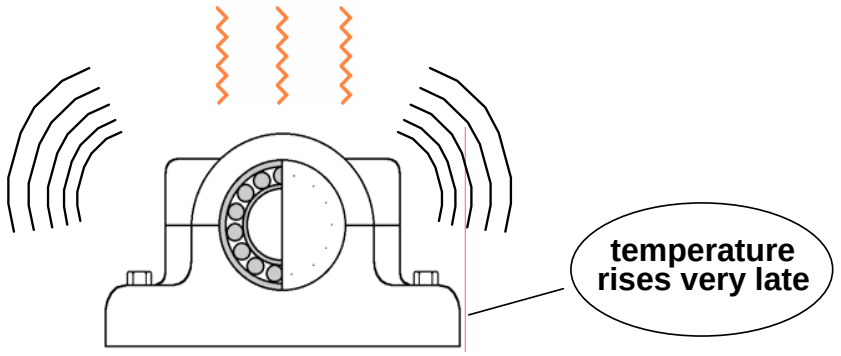


Types of Rolling Bearing Damages (2)

Damages types/ Causes

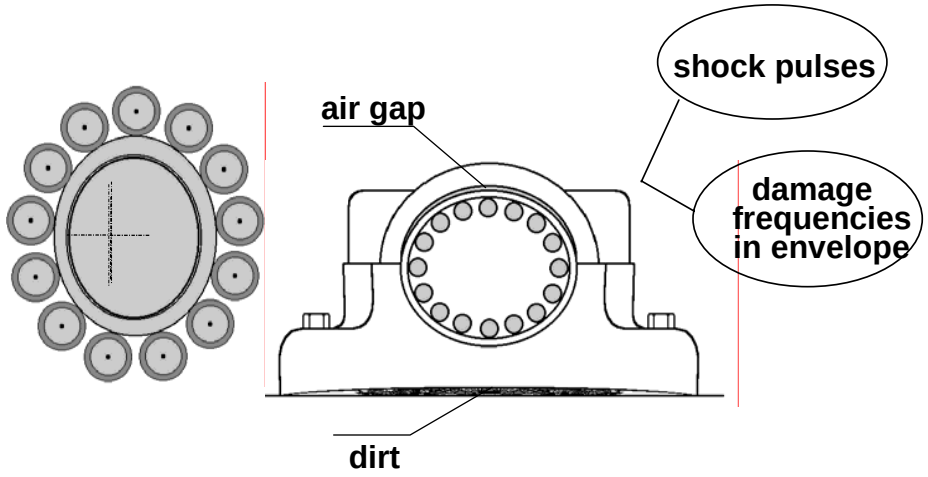
4 Greasing deficiency

- greasing deficiency
- Under-loading



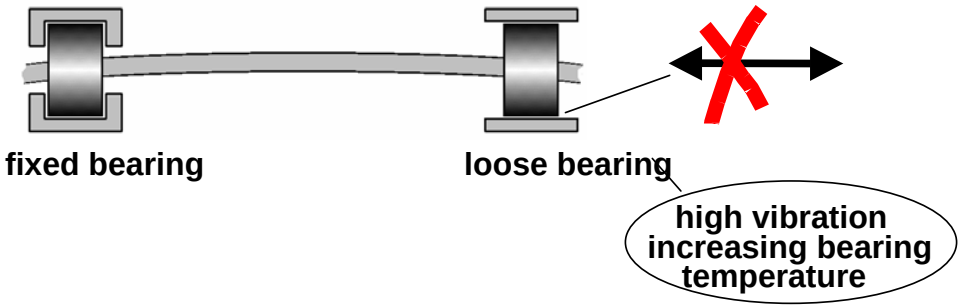
5 Unround deformation of bearing race

- assembly error
- manufacturing defect in shaft or bearing housing



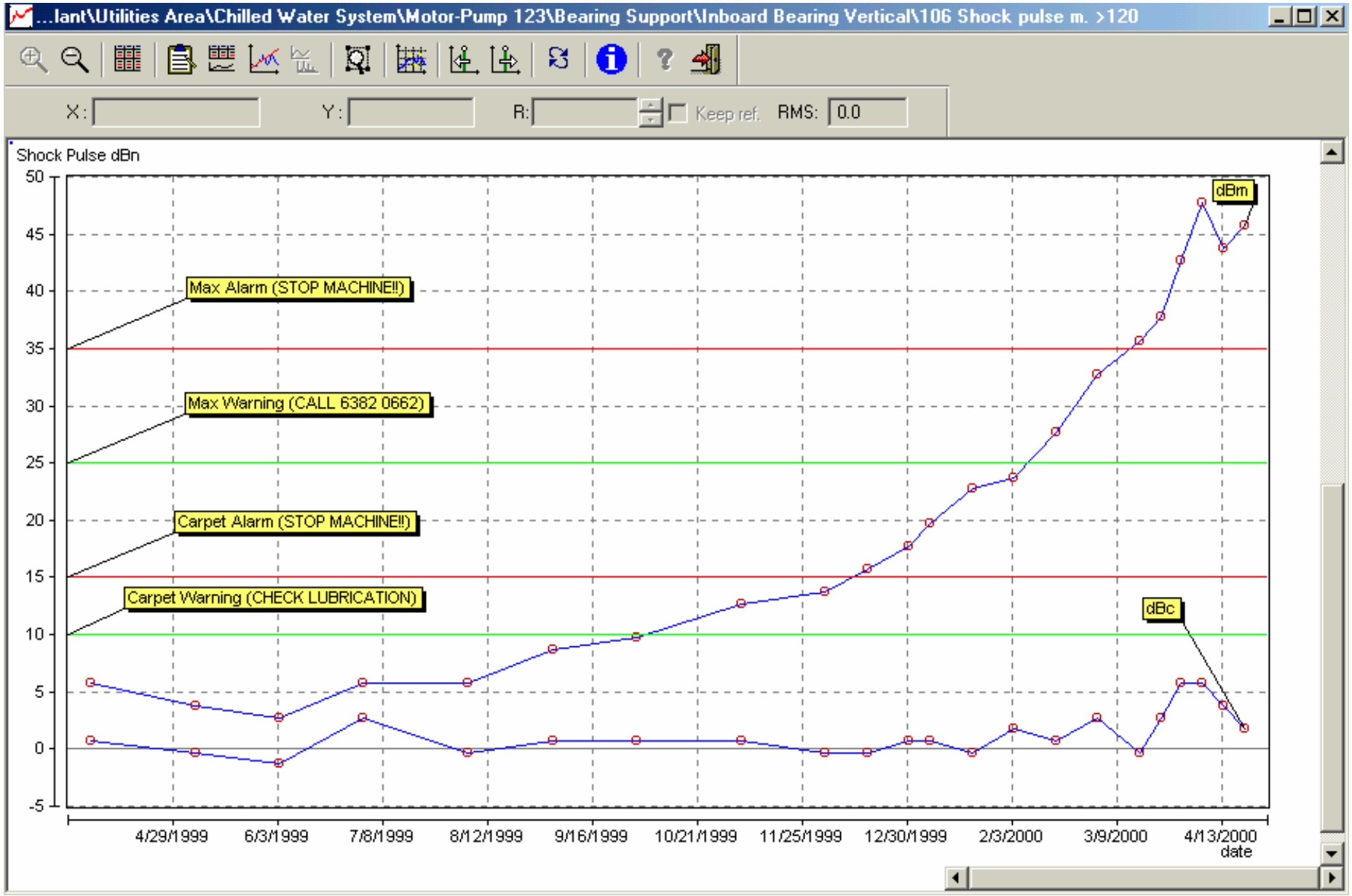
6 Jammed loose bearing

- in bearing housing (sliding fit)
- mis-calculation of housing design

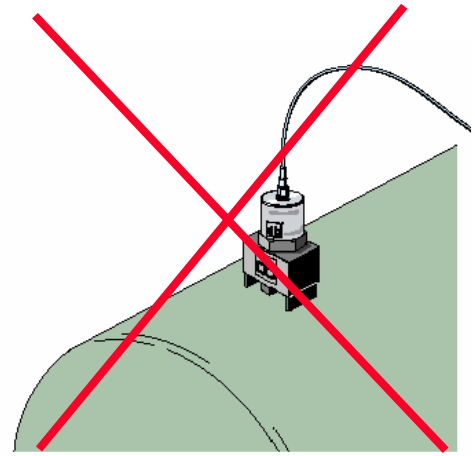


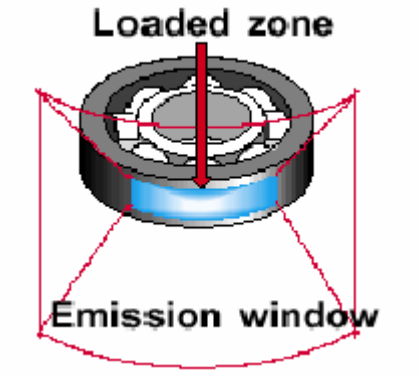
VIBSCANNER® Bearing Condition Measurement

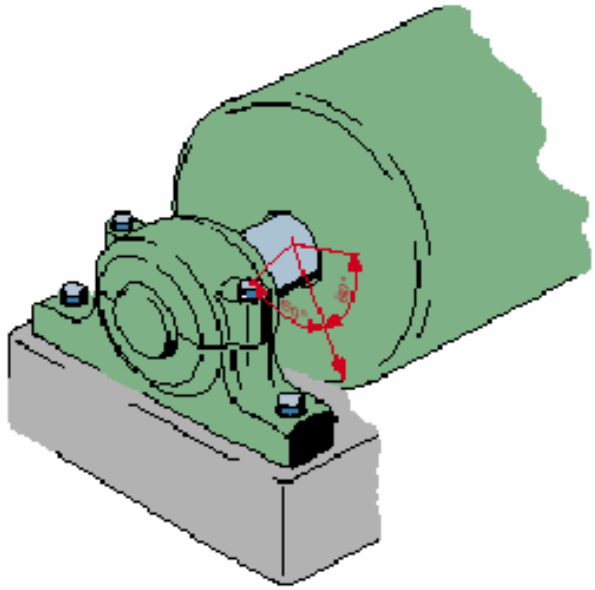
Normalising of Shock Pulse Measurements



Bearing Condition : Location & Preparation

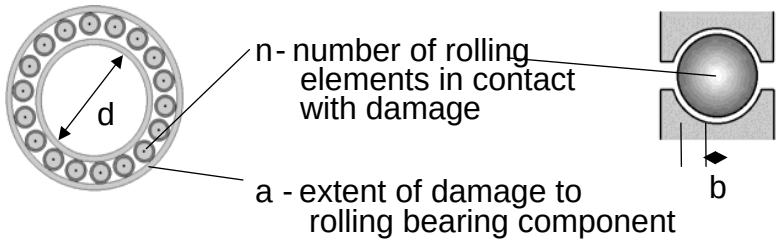


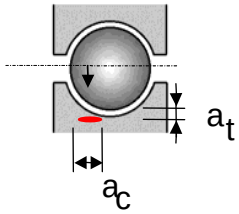




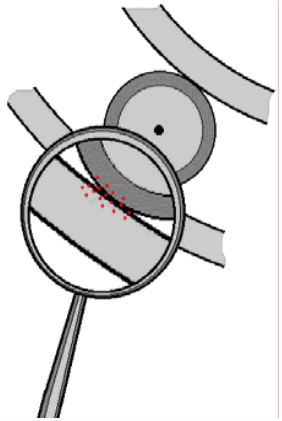
Extent of rolling bearing surface damage

0 good



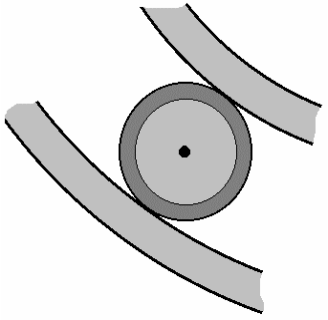


1 very small



- small material defects
- several pitting
- defect frequencies are visible in envelope spectrum

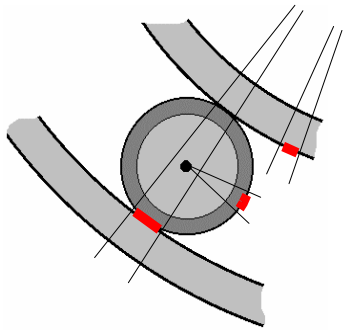
2 small



- slight material splintering
- Max values of shock pulses begin to rise when rolling element passes over defect

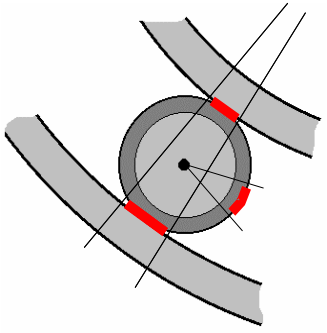
Extent of rolling bearing surface damage

3 medium



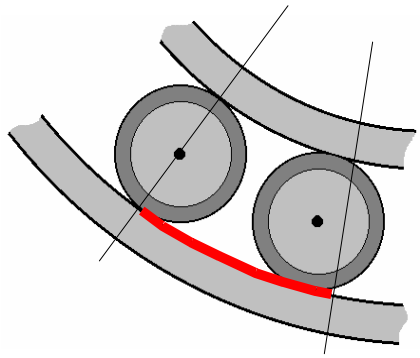
- one roller drops into slight depression caused by damage to rolling track
- maximum values rise perceptibly

4 large



- one or more rollers drop into large depression by damage to rolling track
- maximum values rise dramatically carpet values rise continuously

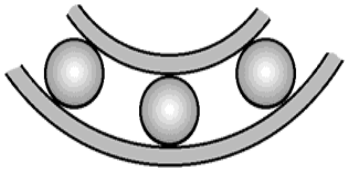
5 very large



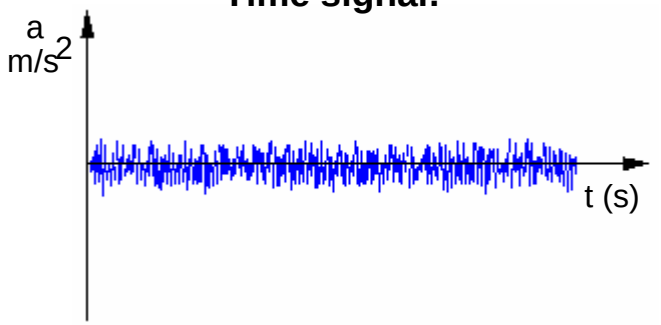
- carpet values rise substantially
- bearing approaching crash
- components may break
- increasing machine vibrations
- rotor drops into very large depression
- several rollers drop into severe

Envelope Analysis – Rolling Bearings Fault Detection

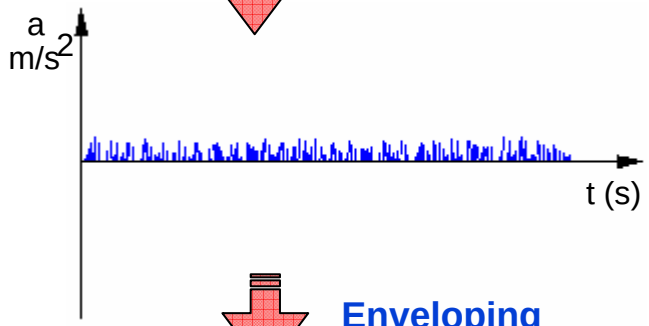
No rolling track defect:



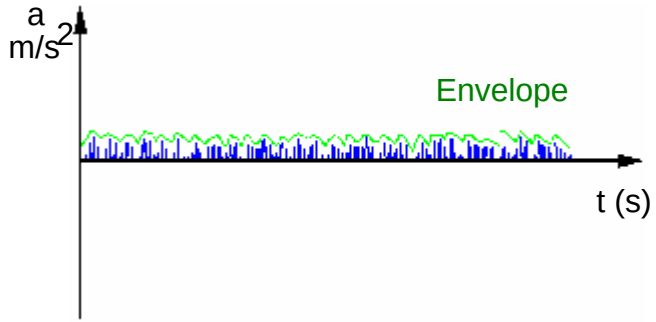
Time signal:



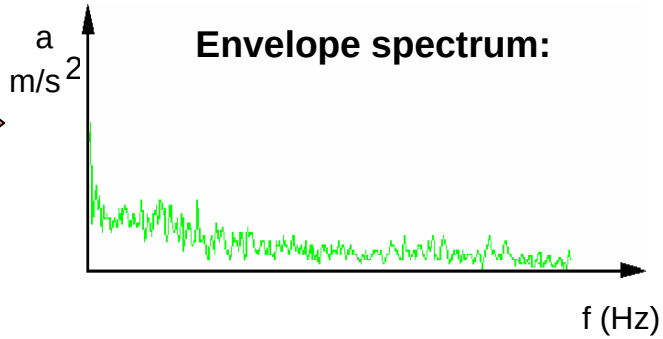
Rectification



Enveloping

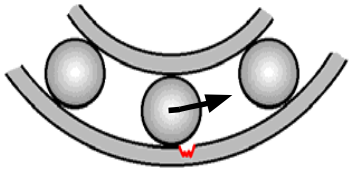


Envelope spectrum:

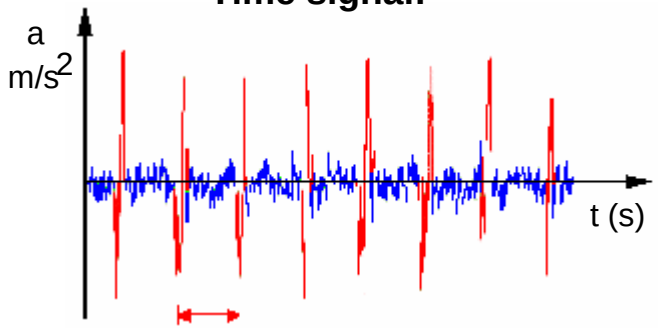


Envelope Analysis – Rolling Bearings Fault Detection

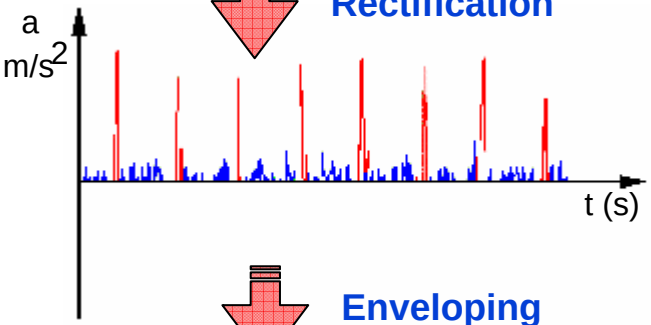
Rolling track defect:



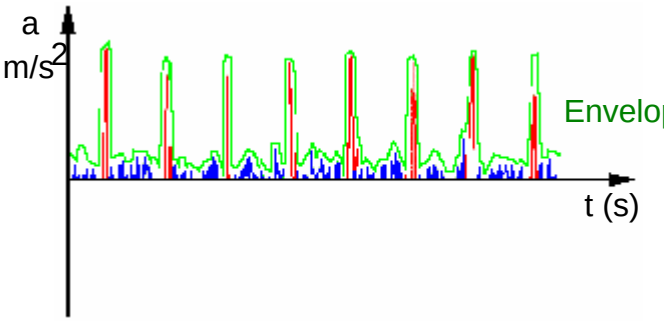
Time signal:



Rectification

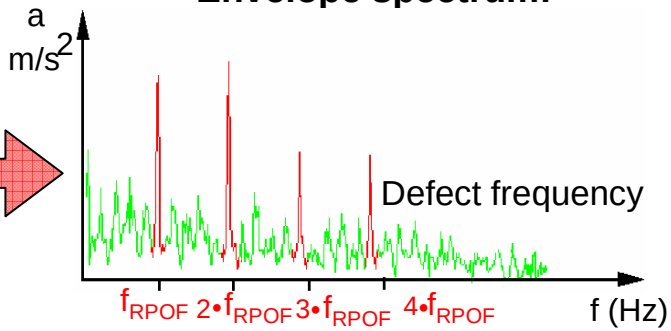


Enveloping



Envelope

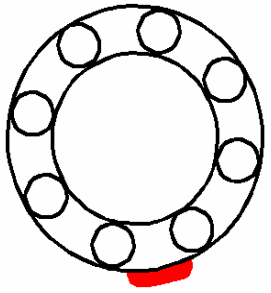
Envelope spectrum:

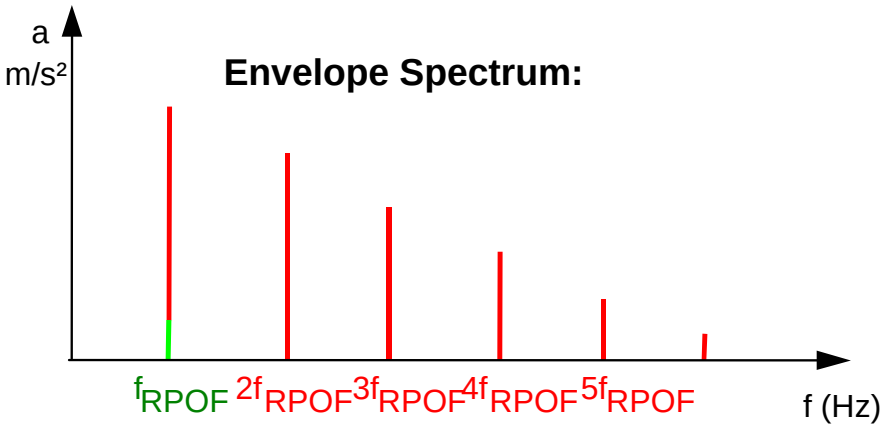


- $f_{RPOF\ (Hz)} = \frac{1}{T_{RPOF}}$

Roller Bearing Race Track Defects

Outer Race Defect:

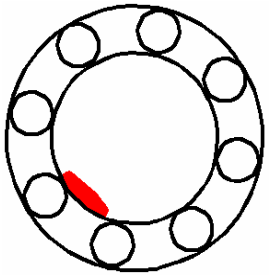


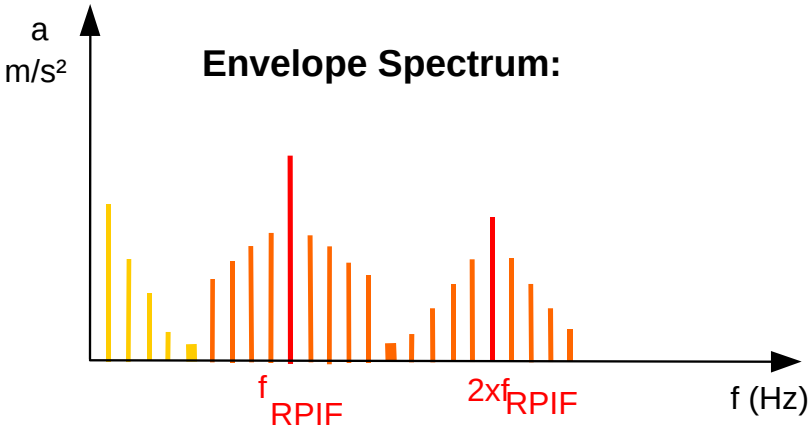


Rolling element pass outer race f_{RPOF} and harmonics clearly visible

- if only f_{RPOF} appears, then it can also be an unround deformation of the outer race track
- In the case of very big unbalance, side bands with interval f_n appear because of periodic load changes (in the load zone modulation with f_n as the unbalance runs periodically through the load zone)

Inner Race Defect:



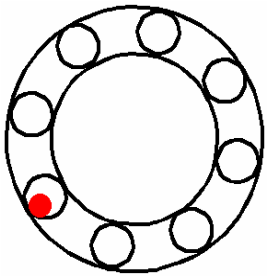


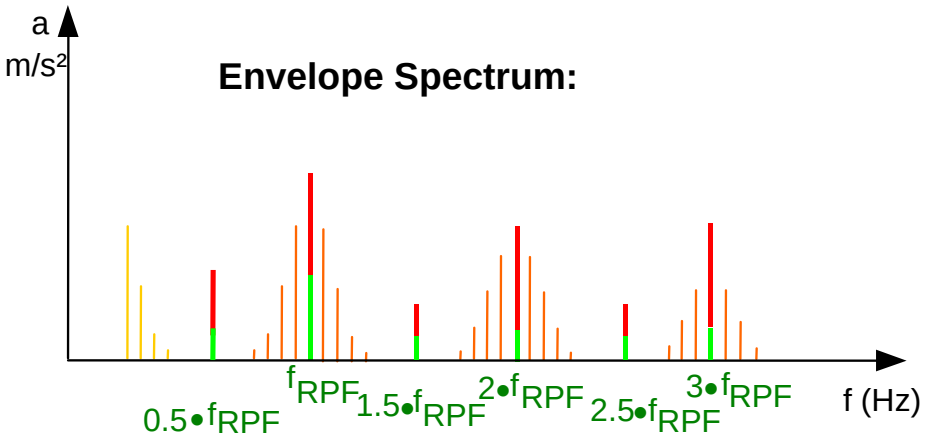
Rolling element pass inner race frequency f_{RPIF} and many side bands with interval f_n

- Modulated with the fundamental frequency f_n as the inner race defect runs periodically through the load zone with f_n
- Fundamental modulation frequency f_n and harmonics are visible

Roller Bearing Defects – Part 3

Rolling element defect:

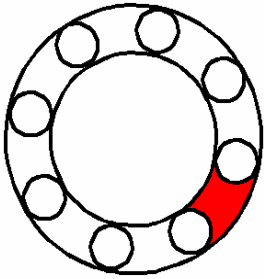


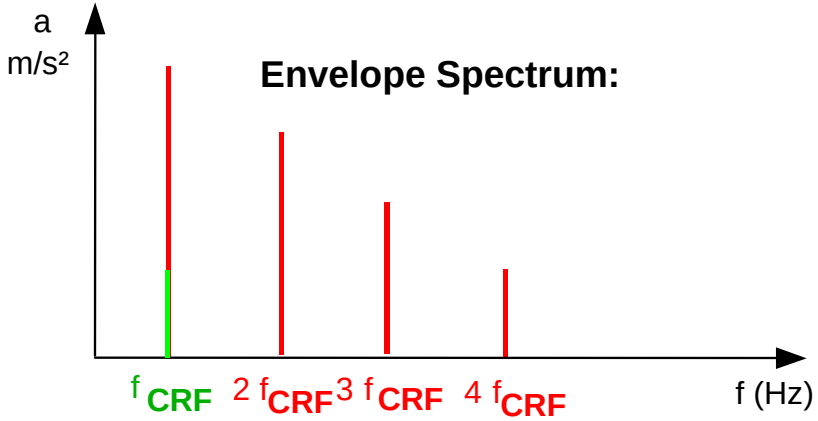


Rolling element pass frequency f_{RPF} with harmonics
And side bands with interval f_{CRF}

- f_{RPF} can be also visible because of too small bearing clearance or insufficient lubrication
- Modulation with cage rotational speed f_{CRF} , as the rolling element runs periodically through the load zone with f_{CRF}
- Sub-harmonics of f_{RPF} exist always with the harmonics, because the pulse on outer race gives a higher level as pulses on the inner race
- Fundamental modulation frequency f_{CRF} and harmonics are visible

Cage Defect:





Cage rotational frequency f_{CRF} and harmonics visible

- f_{CRF} cage rotational frequency is cage defect frequency
- coming out of the load zone: the rolling element is accelerated and slides on the cage defect
- or coming into the load zone: the rolling element is braked and slides on the cage defect