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Benefits and limitations of vibration monitoring at turbine generators

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Why Condition Monitoring?

• To prevent catastrophic damage
• To evaluate progress of damage
• To assist in planning an overhaul or other corrective action
• To prevent unplanned outage
Why monitor Turbo Machinery?
(and not all)
Why monitor turbomachinery?

- Critical to plant processes
- Typically no capital spares in stock or readily available
- Often extremely high financial impact in case of long shutdowns
- Large horsepower, high performance
- Large thermal growth
- Operates above resonance and/or critical speed
- Runs on fluid film bearings
What is Condition Monitoring

• Observation of machine parameter like oil pressures, bearing temperatures, vibrations, noise, leakage, efficiency etc.

• Combine these parameters in order to make a condition assessment of the machine.
Vibration monitoring

• Term often used wrong, vibration monitoring is only observing the amplitude of the machine vibration level

• Can be done by measuring shaft vibration (called relative vibration measurement) using Eddy current probes or by absolute vibration measurement using accelerometers
Relative vibration measurement

Rotor Unbalance Simulation

View from drive end of the shaft
Absolute vibration measurement

To generate a useful output signal, the sensors rely on the piezoelectric effect. ("Piezo" is a greek term which means "to squeeze.") When the piezoelectric elements are strained by an external force, displaced electrical charge accumulates on opposing surfaces.
What to choose

• Relative vibration measurement systems are more expensive, more complex and require some more calibration. In combination with a key phasor and dedicated equipment excellent vibration analysis can be done.

• Absolute vibration measurement is less expensive, simple, reliable and offers sufficient machine protection. Vibration analysis is limited.
Relative Vibration Analysis

• Requires specific signal processing equipment and software
• Requires a key phasor for optimum result
• Requires experience and understanding of the machine being analyzed.
Relative Vibration Analysis Spectrum
Relative Vibration Analysis Bode Plot
Relative Vibration Analysis Shaft Centerline
Relative vibration Analysis Waveform
Relative Vibration Analysis Orbit
Condition monitoring benefits

• Helps to identify causes of failure in an early stage
• When all parameters are combined and interpreted correctly a reliable picture of the machine status can be achieved.
Condition Monitoring Limitations

• It can’t predict damage, predictive maintenance does not exist.
• The symptoms seldom fit the “textbook”, understanding of the machine and experience is a must to make a solid judgement. Even then care should be taken not to jump to conclusions.
Extending maintenance or overhaul intervals

• Typically vibrations are not the critical factor, in most cases it’s OK or NOK.

• Other factors affecting the possibility of longer maintenance intervals are: water in oil entry, oil varnish settlement in bearings and journals, shaft seal leakage, inspection of safety devices, leaking control valves etc, etc. Condition monitoring is only a small part of this consideration, the importance should not be exaggerated. A skilled and experienced operator often identifies issues in an earlier state then on-line systems do.
Design issues
Design issues

Mode No = 1  STABLE MIXED (4% F, 96% B) Whirl
Shaft Rotational Speed = 5000 rpm
Whirl Speed (Damped Natural Freq) = 8198 rpm, Log. Decrement = 0.3272
Example of trouble shooting

Customer had shutdowns on high vibrations measured at gearbox at reduced load.

First step: 
Talked with operators, they mentioned a high pitch noise originating from the gearbox

Second step: reproduce this operating condition and carry out vibration measurements.
Example of trouble shooting

Third step:
Analyze the data and propose inspection plan

Fourth step:
Inspection of the machine, identify the problem and take corrective action.

Fifth step:
Verify the problem is solved.
Example of trouble shooting
Example of trouble shooting
Example of trouble shooting

• No match with gear frequency, imbalance, bearing damage, alignment etc.
• Only a worn gear fitted the symptoms
Example of trouble shooting
Example of trouble shooting
Example of trouble shooting
Not Diagnosed
Not Diagnosed
Not Diagnosed
Not diagnosed
Not diagnosed