



## Advanced Troubleshooting Of Rotating Equipment

Training program



### Introduction:

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This aims to convey the latest thinking and best practice of machinery vibration monitoring and analysis via lectures, case studies, video films, and friendly software and course activities. The course gives a detailed advanced treatment of the detection, location and diagnosis of faults in rotating and reciprocating machinery, using vibration analysis. Industrial case study examples are used throughout the course to emphasize key points and to underline the relevance and applicability of the topics being addressed. The course will provide a refreshment of knowledge for existing condition monitoring practitioners, and it will provide a solid foundation for technologists moving into a machine monitoring and diagnostic role.

### Who Should Attend?

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Mechanical Engineers, Schedule and Planning Engineers, Engineers and Technicians working in application and management of predictive maintenance, Designers and Production Managers and Engineers working in technical and design modification roles within industries, Maintenance, engineering and operations personnel involved in troubleshooting reliability, analysis, condition monitoring, and maintainability of rotating equipment and related systems

## Course Objectives:

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### At the end of this seminar participants will:

- Have a detailed understanding of advanced time and frequency analysis techniques
- Have the knowledge to assess accurately machinery condition
- Have acquired a knowledge of accurate diagnosis of anti friction bearings
- Have acquired a knowledge of accurate evaluation of gear problems
- Have acquired a knowledge of structural troubleshooting
- Have acquired a knowledge of predicting remaining machine life

## Course Outline:

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### Vibration Signal Processing and Assessing Condition

- Sampling, aliasing, digitizing
- Time, frequency and modal domains
- Time and frequency representation
- Frequency domain instrumentation
- Fast Fourier transforms
- Windowing
- Filtering
- Averaging
- Amplitude scales
- Transmission path effects
- Harmonic, periodic, random motion
- Generated and excited frequencies

- Frequencies caused by electronic phenomena
- Relationship between velocity, displacement and acceleration
- Band selectable analysis and real time bandwidth
- Speed and load adjusted sensitivity
- Identifying imbalance bent shaft soft foot looseness horizontal, vertical, offset, and angular misalignment noise resonance rubs oil whirl
- Case studies

### Advanced Analytical Techniques

- Principles of the envelope
- Pulse trains and line spectra
- Loaded element modulation
- Definitions of the cepstrum
- The autocorrelation function and coding the cepstrum
- Comparison with spectrum and phase sensitivity.
- Transmission path effects.
- Zoom cepstra and noise level effects.
- Dynamic range limitations and the effect of filter bandwidth
- Other demodulation techniques
- Use of phase in diagnostics
- Case studies

### Advanced Troubleshooting of Antifriction Bearings

- Data collection and transducer selection
- Frequency calculation
- Identifying (inner and outer race multiple defects defect severity nature of defect deep fatigue spalls shallow flaking frosting acid etching/corrosion fluting) defects
- Defects on balls/rollers and cage
- Inadequate lubrication

- Looseness excessive internal clearance turning on the shaft loose in the housing
- Case studies

### **Advanced Troubleshooting of Gearboxes**

- Transducer selection
- Gear vibration theory
- Gearmesh frequency harmonics and sub harmonics
- Hunting tooth frequency
- Planetary gears
- Gear life expectancy
- Identifying eccentric gears out of round bent shaft loose worn misaligned backlash problems oscillating gears broken, cracked or chipped teeth
- Case studies

### **Advanced Diagnostics and Structural Troubleshooting**

- Vibration control (transmissibility, excitation, design charts)
- Fundamentals of isolator selection/damping applications
- Structural supports considerations
- Critical shaft speeds
- Vibration in ducts
- Vibrational control via structural modification
- Electric motor analysis out of magnetic center broken rotor bars turn to turn shorts siren effect
- Steam turbines
- Pumps, starvation and cavitation
- Special tests startup/coast down bump tests noise recording
- Dual channel impact testing
- Modal analysis (natural frequency/mode shape/damping)
- Startup/coast down testing
- Critical speeds/damping

## Best Technology Solutions **(BTS)**

## Training Program

- Operational deflection shapes
- Case studies