

# ROTATING EQUIPMENT

MAINTENANCE & RELIABILITY EXCELLENCE

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26 to 29 April 2011, Kuala Lumpur



Expert Course Faculty Leader

## **Mike Sondalini**

Maintenance management professional with over 30 years of practitioner experience. Previous head of technical services and maintenance manager for Coogee Chemicals.

ORGANISED By

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# ROTATING EQUIPMENT MAINTENANCE & RELIABILITY EXCELLENCE

26<sup>th</sup> to 29<sup>th</sup> APRIL 2011, Kuala Lumpur

## Course Overview

### More than 60% of maintenance costs are spent on equipment wear & tear

The above fact was provided to us based on interviews and discussions with leading maintenance engineers across Asia. Predictably, continuous improvement of reliability by optimising predictive maintenance for rotating equipment is one of the most important challenges maintenance professionals face today. To assist rotating engineers and maintenance professionals improve their equipment serviceability, there are numerous innovative condition monitoring techniques and proven reliability based maintenance techniques.

Maintenance & Reliability Excellence for Rotating equipment consolidates successful best practices and techniques. This 4 day training course will concentrate on the problems and solutions surrounding equipment failures, diagnostics and effective methods to prevent them.

## Course Objectives

- Identify the most common causes of shafts, bearings and seals fatigue and failures based with actual case studies
- Understand the fundamentals of PPM (precision/preventive maintenance) for rotating equipment through hands-on exercises
- Examine and understand the various condition monitoring techniques
- Uncover Best Practices in conducting RCFA (Root Cause Failure Analysis) practically in the workplace to prevent repeated equipment failures
- Optimise reliability of rotating equipment through applying best practices

## Who Should Attend

Condition monitoring professionals • Electrical engineers • Equipment Engineers • Equipment support maintenance • Machinery engineer • Mechanical engineering managers/superintendents/ supervisors • Machinist/ Machine Operator • Maintenance managers/ superintendents/ supervisors • Mechanical managers/ superintendents/ supervisors • Operations supervisors • Plant Maintenance Superintendent • Plant Operator/ Engineer • Predictive Maintenance Engineer • Production managers/ supervisors • Reliability engineers • Rotating equipment managers/ superintendents /Engineers • Technical services professionals

## Unique Features of this Training Course

- Pre-Course Questionnaire to help us focus on your learning objectives
- Detailed Course & Reference Manual for Continuous Learning and Sharing
- Practical Exercises & Case Examples to better understand the principles
- Limited class size to ensure One-to-One Interactivity
- Assessment at the end of the course to help you develop a Personal Action Plan

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## Course Outline

### DAY 1

#### True Cost Of Failure

- Defect and Failure True Costs
- Understanding Risk and its Consequences
- Preventing Defects and Failure

#### Know The Process, Physical, Chemical Properties And Characteristics

- Effects of Process Condition Disruption
- Corrosion, Erosion and Wear
- Effects of Equipment Internal Changes
- Activity 1 – Designing Rotating Equipment and Selecting Materials

#### Supporting Structure, Foundations, Strength, Rigidity

- Vibration Basis
- Attenuation of Vibration
- Dissipating Loads and Forces
- Preventing Equipment Deformation
- Activity 2 – Soft-foot removal case study

#### Fatigue And Failure Modes

- Causes of Shaft Failure
- Causes of Bearing Failure
- Causes of Seal Failure

#### Bearing Failures

- Effects of Fluctuating Loads and Forces
- Lubrication Condition
- Tell-tale Bearing Failure Signs

#### Reliability, Availability, Maintainability, Safety (RAMS)

- Equipment Degradation Cycle
- Impact of Special and Common Cause Variation
- Precision Maintenance for Rotating Equipment
- Accuracy Controlled Procedures
- Afternoon tea
- Activity 3 – Develop an ACE 3T Procedure
- Activity 3 report back and wrap-up

### DAY 2

#### Balanced Rotors, Balancing Standards

- Causes of Out-of-Balance
- Balancing Standards
- Rotating Equipment Balancing
- Activity 1 – Balancing Case Study

#### Shaft Alignment

- Effects of Shaft Misalignment
- Accuracy and Limits for Alignment
- Practice Precision Shaft Alignment
- Activity 2 – Shaft Alignment Case Study

#### Rotating Equipment Vibration

- Allowable Vibration Severity
- Bearing Vibration Causes
- Machinery Vibration Prevention and Isolation

#### Condition Monitoring Methods For Rotating Equipment

- Range and Choice of Condition Monitoring Methods
- Vibratory Condition Based Monitoring
- Vibration Signatures and Analysis
- Activity 3 – Vibration Signature Case Study
- Tribology and Lubrication Analysis
- Wear particle analysis
- Properties of lubricants
- Sustaining lubricant health
- Thermography
- Temperature Signature Analysis
- Mechanical Equipment
- Electrical Equipment
- Rotating Equipment Non-Destructive Testing

#### Maintenance Strategy Mix

- Component and System Reliability Basics
- Rotating Equipment PM - PdM - Breakdown mix
- TPM and Operator Driven Reliability
- Measuring Maintenance Outcomes and KPIs
- Maintenance Quality Systems for RAMS
- Using Visual Management to Control Performance
- Activity 4 – RE Maintenance Strategy Mix
- Activity 4 report back and wrap-up

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### **DAY 3**

#### **Lubrication Best Practice**

- Properties of Lubricants and Additives
- Lubricant Operating Environment
- Lubricant Life-extension – Lubrication Management

#### **Shaft Seals – Methods, Types, Designs, Process Effects**

- Seal Design Overview
- Seal Failure Modes
- Long-life Conditions
- Seal Selection

#### **Vibration Prevention and Isolation**

- Basics of Spring/Damper Systems
- Natural Frequency
- Machinery Vibration Isolation
- Activity 1 – Vibration Isolation Calculation

#### **Strength of Materials for Shafts and Rotors**

- Metallurgy - Stress and Stress Raisers
- Metal Fatigue
- Bending and Deflection of Shafts

#### **Horizontal Shaft Design, Vertical Shaft Design**

- Axial and Radial Loads
- Shaft and Equipment Expansion Considerations
- Shaft Manufacture, Diameter and Tolerances
- Activity 2 – Design a Shaft with Bearings and Housings

#### **Bearing Design and Selection, Radial and Axial Bearings**

- Bearing Loads – Max and min
- Roller Bearings and Plain Bearings – Uses and Limitations of Each
- Bearing Lubrication and Selection
- Bearing Housings and Construction
- Activity 3 – Select a Bearing for the Shaft Exercise

### **DAY 4**

#### **Risk Reduction Strategies in Rotating Equipment Design and Operation**

- Understanding and Measuring Risk
- Chance vs. Consequence Risk Reduction Methods
- Applying Risk Reduction During Design

#### **Design, Operation and Cost Total Optimisation Review**

- Life Cycle Operating Costs
- -Failure Cost Impact Calculations
- Design Review and Optimisation

#### **Lifting Lifetime Reliability**

- Equipment Reliability Overview
- Measuring Reliability for Components – Weibull
- Measuring Reliability for Systems - Crow/AMSAA
- RCM/FMEA Fundamentals
- Activity 1 – FMEA Exercise

#### **Rotating Equipment Root Cause Failure Analysis (RCFA)**

- RCFA Fundamentals
- The RCFA Process
- Developing and Implementing Solutions

#### **Finding the Evidence and Proof**

- Operating and maintenance records analysis
- Creative disassembly
- Importance of keeping accurate records and history and how to do it

#### **Applying RCFA in the Workplace**

- Cross-Functional Teams
- The 5 Whys Method
- Operator and Maintainer Buy-in for Improvement
- Activity 2 – RCFA Exercise

#### **Rotating Equipment Integrity Management**

- Statutory, Safety, Operating and Maintenance Standards
- Documentation and Record Keeping requirements
- Auditing and Analysis of operating management systems

#### **Rotating Equipment Reliability Improvement Strategy**

- Setting Equipment Performance Specifications
- Selecting best practice methods to achieve the performance objectives

## **Mike Sondalini**



Mike Sondalini's 30 years in maintenance spans from mechanical engineering, strategic asset management to rotating equipment. He was previously a mechanical engineer with the State energy commission of Australia, where he conducted equipment failure investigations and constructed improvement plans. He was then the maintenance manager for the Swan Brewery, responsible for overall plant reliability and project engineering. Mike then spent over 10 years as maintenance manager and head of engineering services for Coogee Chemicals. In this role, he successfully introduced condition monitoring and maintenance strategies that reduced production down time and maintenance costs. An achievement was reducing bearing failures from 3 a month to 3 a year. As a maintenance manager, Mike also successfully initiated and trained other reliability centered techniques focused towards rotating equipment, including vibration analysis, particle analysis, thermography, equipment criticality analysis, root cause analysis reviews.

As a current maintenance and reliability consultant, Mike continues to assist organisations such as BHP, Smorgon Steel and State Energy Commission in improving equipment reliability. He is also reputed publisher of numerous online technical white papers and training materials that are widely sought after by maintenance professionals. Mike is also a past Chairman of the WA Chapter of (MESA) the Maintenance Engineering Society of Australia

### **Testimonials from past participants from these companies:**

Very good mix of theory and company applications

- **Engineering Manager, Chevron Corporation**

Excellent presentations on diverse subjects

- **Maintenance Manager, Premier Oil**

### **Some key achievements from Mike's career as a maintenance manager:**

- Introduced preventative maintenance of bearings that reduced bearings failures from 4 per month to 4 per year on bulk materials handling equipment.
- Championed and trained engineers on the use of shaft laser alignment that saw mechanical seal failures drop from 20 per year to 3 per year.
- Improved equipment design that boosted plant reliability from 85% to 98% and made the operation profitable.

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PRICING	Early Bird	Normal	Savings
<b>Rotating Equipment Maintenance &amp; Reliability Excellence</b> <b>4 – Days</b>	<b>SGD \$3359</b>	<b>SGD \$3559</b>	<b>SGD \$200</b>

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