

Advanced Vibration Analysis

Maximize Performance of Your Equipments and Achieve Greatest Cost Savings
Using State-of-the-Art Condition Monitoring Techniques

JW Marriott Hotel, Kuala Lumpur, Malaysia • 18th – 20th June 2008



Course Facilitator:

Dr. Robert Badgley
Owner
Emcon Systems

Supporting Organization:



Media Partner:



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Hear What Other People Said About Dr. Badgley

'Very good, balanced course for petrochem engineers'

– Texaco Inc.

'Case studies related well to my machinery problems'

– M.W. Kellogg

'Analysis methods and techniques were helpful in understanding my motor and pump problems'

– Dow Chemical

Capitalize On The Expert Knowledge To Gain Maximum Value On These Vital Issues

- ❖ **GET** a deeper and stronger understanding of vibration and more effective controlling methods
- ❖ **BUILD** practical problem solving techniques through case studies and best practices illustrations
- ❖ **GARNER** knowledge about new, advanced practices and relevant special specifications
- ❖ **DEVELOP** a systematic thinking process to identify root cause of vibration problems from the analysis of a variety of symptoms
- ❖ **APPLY** test-and-proven techniques for reducing vibration of your rotating equipments and prevent vibration problems
- ❖ **EXAMINE** critical elements for effective vibration prevention and monitoring system design

UNI training courses are thoroughly researched and carefully structured to provide practical and exclusive training applicable to your organization.

Benefits include:

- Thorough and customized programmes to address current market concerns
- Illustrations of real life case studies
- Comprehensive course documentation
- Strictly limited numbers

Workshop Overview

For industry like power generation, petrochemical and other processing industries, vibration analysis has been the technique of choice for monitoring the condition of large, critical pieces of rotating equipment and has proven economic benefits. Great savings are realized by improving the performance of the machines so that they can last longer, require less downtime, consume less power and improve plant productivity.

Together with leading expert in vibration analysis, **Dr. Robert Badgley**, you will learn how to use your vibration tools to assess machinery condition, identify and correct the root causes of problems and move away from 'find and fix' vibration analysis strategies. This three-day practical course will offer you the opportunity to learn more about various aspects of vibration including vibration measurement, interpretation and modeling. Advanced vibration concepts are presented with a practical approach in mind. The learning will be accentuated through discussion of case studies and industry best practices.

Facilitated discussion and hands-on exercises will allow you to share your challenges and opinion. Delegates can immediately apply the knowledge gained from the workshop to improve and analyze the mechanical condition of rotating equipments. After this course, you will depart with a set of more advanced tools to improve your machinery performance and bring last changes to your organization.

DAY1 | 18th June 2008

PART 1 – INTRODUCTION

- ❖ Course objectives
- ❖ Description of course content by part
- ❖ Basic terminology

PART 2 – MACHINERY VIBRATION FUNDAMENTALS

- ❖ Key concepts – mass, stiffness, damping
- ❖ Mechanical resonance
- ❖ Undamped free vibration
- ❖ Damped free vibration
- ❖ Damped force vibration

PART 3 – LATERAL VIBRATION CHARACTERISTICS

- ❖ Rigid-Body vibrations
- ❖ Flexible shaft vibrations
- ❖ Mode shapes and critical speeds of general motor bearing systems

PART 4 – JOURNAL AND THRUST BEARINGS

- ❖ Types of fluid film bearings
- ❖ Selection of bearing type
- ❖ Selection of bearing dimensions
- ❖ Self-acting thrust bearings
- ❖ Design data for tilting-pad thrust bearings
- ❖ Calculated thrust bearing stiffness & damping

PART 5 – BALL BEARINGS

- ❖ Bearing design factors
- ❖ Fatigue life
- ❖ Bearing lubrication
- ❖ Dynamics of ball bearings

DAY2 | 19th June 2008

PART 6 – ROTOR BEARING SYSTEM DYNAMICS

- ❖ Spring and damping coefficients
- ❖ Rotor response analysis
- ❖ Rotor dynamics for a typical machine

PART 7 – ROTOR RESPONSE TO VARIOUS FORCES

- ❖ Types of forces
- ❖ Response to unbalance
- ❖ Response to other forces

PART 8 – ROTOR BEARING SYSTEM INSTABILITY

- ❖ Dynamic instability in rigid-body systems
- ❖ Complicating factors
- ❖ Control of rotor instability

PART 9 – ROTOR AND SHAFT BALANCING

- ❖ Balancing of rotors and shafts
- ❖ Single plane balancing
- ❖ Balancing in a commercial balance machine
- ❖ In place rotor and shaft balancing

DAY3 | 20th June 2008

PART 10 – TORSIONAL VIBRATION

- ❖ Modeling
- ❖ Sources of torsional excitation
- ❖ Transient response
- ❖ Damping
- ❖ Interpretation of analysis

PART 11 – VIBRATION ANALYSIS

- ❖ Analytical methods for calculating vibration amplitudes
- ❖ Troubleshooting analysis
- ❖ Diagnostic procedures
- ❖ Machinery faults and vibration frequencies
- ❖ Vibration at running speed
- ❖ Shaft surface defects and proximity probe readings
- ❖ Vibration analysis
- ❖ Vibration amplitude jump phenomenon
- ❖ Beating of two adjacent frequencies
- ❖ Harmonics
- ❖ Sub-synchronous vibrations
- ❖ Modulation
- ❖ Vibration of ball and roller bearings

PRE-COURSE QUESTIONNAIRE

To ensure that you gain maximum value from this course, a detailed questionnaire will be forwarded to you upon registration to establish your exact training needs and issues of concern. Your completed questionnaire will be analysed by the course trainer prior to the event and addressed during the event. You will receive a comprehensive set of course documentation to enable you to digest the subject matter in your own time.

PART 12 – VIBRATION DATA INTERPRETATION AND PROBLEM

- ❖ Acquiring data to define the problem
- ❖ Long-term history of machine
- ❖ Field measurement data acquisition
- ❖ Field measurement data assessment
- ❖ Field measurement data interpretation

SIMULATION AND DELEGATE CASE STUDIES

Dr. Badgley will share with all delegates modeling of various machines using rotordynamics software, together with results and interpretation. Delegates are also encouraged to bring your challenges/issues to the workshop for discussion

CASE STUDIES

- ❖ Dr. Badgley will also use the following case studies to demonstrate key principle and applications of vibration analysis:
 - ◆ Blower – Petrochemical
 - ◆ Drive Motor – Chemicals
 - ◆ Large Blower – Work Area Ventilation
 - ◆ Speed Reducer Gearbox Drive – Chemical
 - ◆ LM2500 Gas Turbine Engine – Power Generation

Why You Should Attend

This is a highly impactful workshop to provide you with a solid and comprehensive understanding of vibration analysis as a tool for quickly identifying and correcting the root causes of machinery problems, achieving precise tolerance and improving machinery performance beyond what is expected for a new machine. Dr. Badgley will share with you some advanced knowledge and solutions for problems resulting from unbalance, misalignment and many other machinery defects. This is a course developed based on proven methodology and Dr. Badgley's over 40 years of experience in vibration. Through a series of practical illustrations and real life case studies, you will return with a whole new set of perspective and practical tools.

Who Should Attend?

This training program is uniquely designed to provide valuable insight for:

- ◆ Head of Maintenance or Operations
- ◆ Rotating Equipment Engineers
- ◆ Reliability Engineers
- ◆ Instrumentation and Control Engineers
- ◆ Vibration Monitoring Engineers
- ◆ Mechanical Engineers
- ◆ Equipment Specialists
- ◆ Technical Managers/Engineers
- ◆ Process Engineers
- ◆ Production Engineers
- ◆ Project Engineers
- ◆ Plant Engineers
- ◆ Lubrication Managers
- ◆ Facilities Managers

About Your Course Facilitator

Dr. Robert Badgley is owner of **Emcon Systems**, which offers a range of professional technical consulting services (motor vibration analysis, vibration failure analysis, vibration control, vibration monitoring, root cause failure analysis, vibration damping, vibration testing and predictive maintenance) for machinery of many types and sizes (compressors, turbines, bearings, generators, marine equipment etc.)

At Emcon Systems, Dr. Badgley currently provides expert technical consulting services and training to a range of firms at US and international locations. The focal point of Dr. Badgley's services is forensic engineering, directed at understanding and resolving machinery failure problems, sometimes catastrophic, in various types of plant machinery, including fans, blowers, motors, generators, compressors and turbines

When Dr. Badgley was at Mechanical Technology Inc., over a 15-year period, he has presented Advanced Vibration Analysis course to over 1,500 engineers on a worldwide basis. All major US companies, including **Mobil, Shell, Exxon, Texaco**, etc. Others come from Canada, Venezuela and Japan. Before he formed Emcon Systems, he also served as Executive Vice President of Dynamic Science Inc. and Director of Engineering at TECO-Westinghouse Motor Company.

With over 40 years of experience, Dr. Badgley has built up a wealth of practical experience with organizations throughout the world. He has undertaken successful projects in Canada, Europe, the Middle East, and Asia, as well as extensively in the US. His partial client list includes:

- ◆ ExxonMobil
- ◆ ChevronTexoco
- ◆ BP
- ◆ Syncrude
- ◆ Suncor
- ◆ Global Santa Fe
- ◆ Pemex
- ◆ ARCO Dubai
- ◆ PetroCanada
- ◆ ADMA-OPCO
- ◆ General Electrics
- ◆ Rolls Royce Inc.
- ◆ Seagate Technology
- ◆ Singapore Air Force
- ◆ US Army

Dr. Badgley is registered as a Professional Engineer in the State of New York, and is a Life member of the American Society of Mechanical Engineers. He has authored or co-authored 43 technical publications. He received the Master of Science degree in Nuclear Engineering from Massachusetts Institute of Technology and Ph.D. in Mechanical Engineering from Cornell University.

Program Schedule

(Day 1 & Day 2 & Day 3)

08:30	Registration
09:00	Morning Session Begins
10:40 - 11:00	Refreshments & Networking Break
12:45	Luncheon
14:00	Afternoon Session begins
15:30 - 15:50	Refreshments & Networking Break
17:00	Course Ends