COURSE OVERVIEW RE0141
Certified Machinery Failure Analysis, Vibration & Predictive Maintenance: Machinery Diagnostics & Root Cause Failure Analysis to Improve Equipment Performance

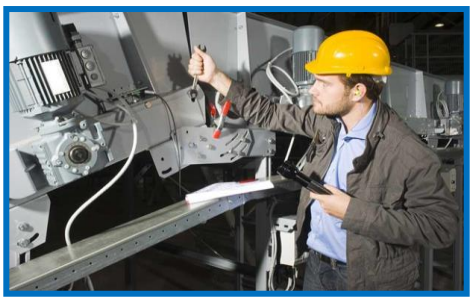
Course Title
Certified Machinery Failure Analysis, Vibration & Predictive Maintenance: Machinery Diagnostics & Root Cause Failure Analysis to Improve Equipment Performance

Course Date/Venue
Session 1: July 21-25, 2024/Plaza 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
Session 2: October 27-31, 2024/Oryx Meeting Room, Double Tree by Hilton Al Saad, Doha, Qatar

Course Reference
RE0141

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Description



This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.

The course presents a systematic approach to fault diagnosis and failure prevention in a broad range of machinery used in the Oil/Gas, Petrochemical and other process industries. The key approaches to preventive maintenance are demonstrated through both overview and the study of examples in metallurgical failure analysis, vibration analysis and a sequential approach to machinery troubleshooting and problem solving.

Equipment failure events will be reviewed and participants are encouraged to bring to the course relevant assembly drawings or such components as failed bearings, gears, mechanical seals and similar machine elements for failure analysis and discussion.

The course explores a systematic approach to successful failure analysis and troubleshooting, including the determination of goals, use of checklists and setting up a failure analysis team. By reference to specific case studies, especially dealing with centrifugal pumps, it will be shown that such a systematic program can lead to significant failure reductions in many types of machinery.

Through examples dealing with pumps and compressors, guidance is given on vendor selection and methods for reliability review.

A matrix approach to machinery troubleshooting uses illustrative examples in pumps, centrifugal compressors, blowers and fans, reciprocating compressors, engines and gas turbines. Next, a systematic approach to generalized machinery problem-solving is described in terms of situation analysis, cause analysis, action generation, decision making and planning for change. Finally, a highly effective root cause failure analysis (RCFA) method is explained in detail.

At the end of the course, participants will gain an understanding of structured, results-oriented root cause failure analysis methods for all types of machine components and entire machinery systems. Participants will also learn how parts fail, why they fail in a given mode and how to prevent failures. Participants will acquire a thorough understanding of making the best possible use of available failure statistics and how these can be used in a conscientiously applied comprehensive program of specifying, purchasing, installing, commissioning and operating machinery.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply systematic techniques on machinery failure analysis, vibration and predictive maintenance
- Recognize machinery failure patterns covering the nature of failure, the types of equipment failures and its classifications
- Employ machinery diagnostic testing, metallurgical failure analysis methodology, machinery component analysis and reliability improvement
- Carryout machinery troubleshooting and root cause failure analysis (RCFA)
- Analyze vibration signal for different faults and machineries
- Report formalized failure as a teaching tool and examine failed components
- Illustrate process, mechanical and technical interaction
- Evaluate machine condition and implement predictive maintenance and condition-based monitoring
- Improve reliability through optimizing lubrication for pumps and electric motors

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials, sample video clips of the instructor's actual lectures & practical sessions during the course conveniently saved in a **Tablet PC**.*

Who Should Attend

This course covers systematic techniques and methodologies in machinery failure analysis, prevention and troubleshooting for those who work with mechanical and rotating equipment at industrial plants, utilities, production oil/gas field or manufacturing facilities. General maintenance personnel, engineers and other technical staff from a wide variety of industries, skill-levels, company sizes and job titles will also find this course extremely useful.

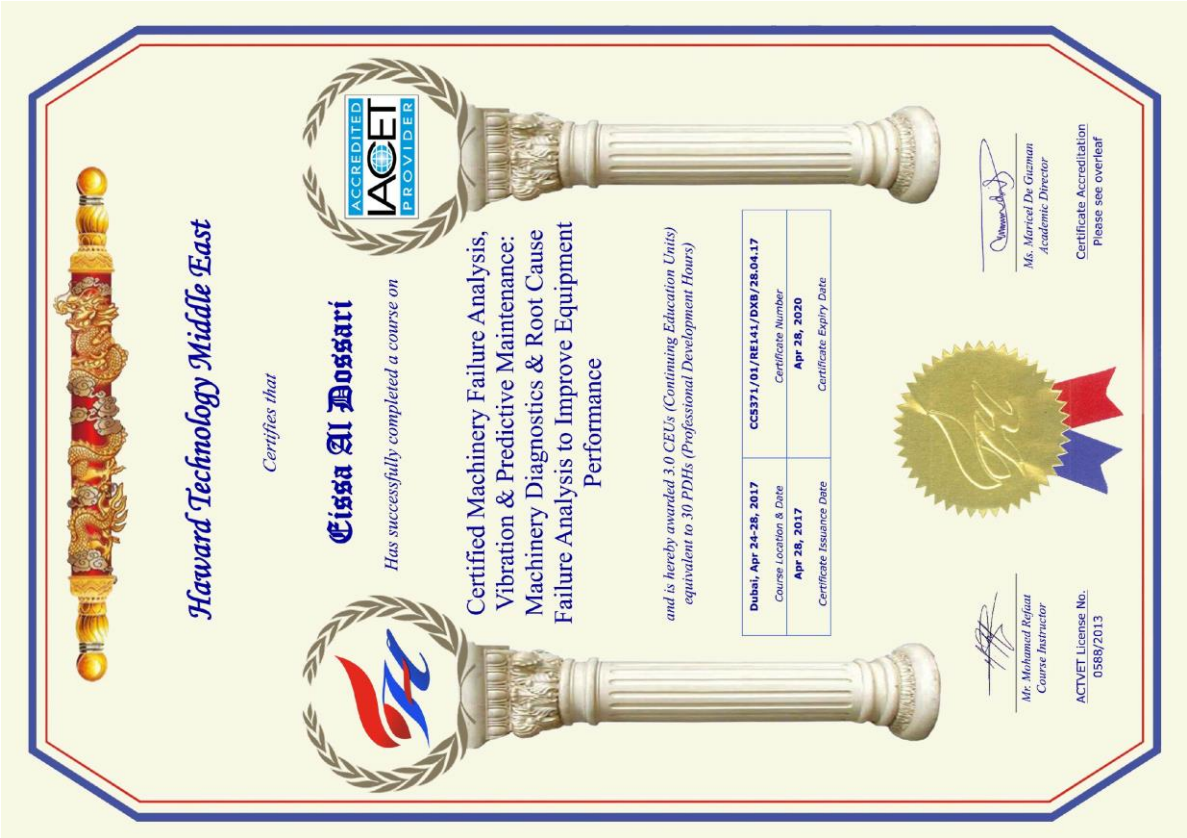
Course Certificate(s)

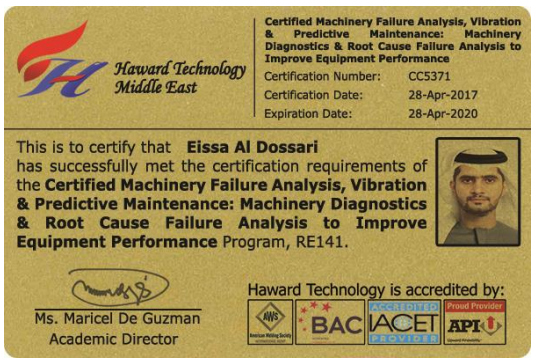
Internationally recognized Competency Certificates and Plastic Wallet Cards will be issued to participants who completed a minimum of 80% of the total tuition hours and successfully passed the exam at the end of the course. Certificates are valid for 5 years.

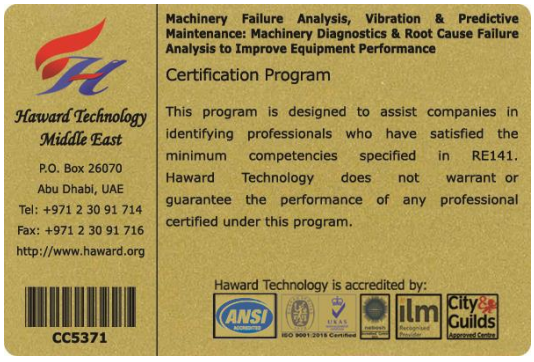
Recertification is FOC for a Lifetime.

Sample of Certificates

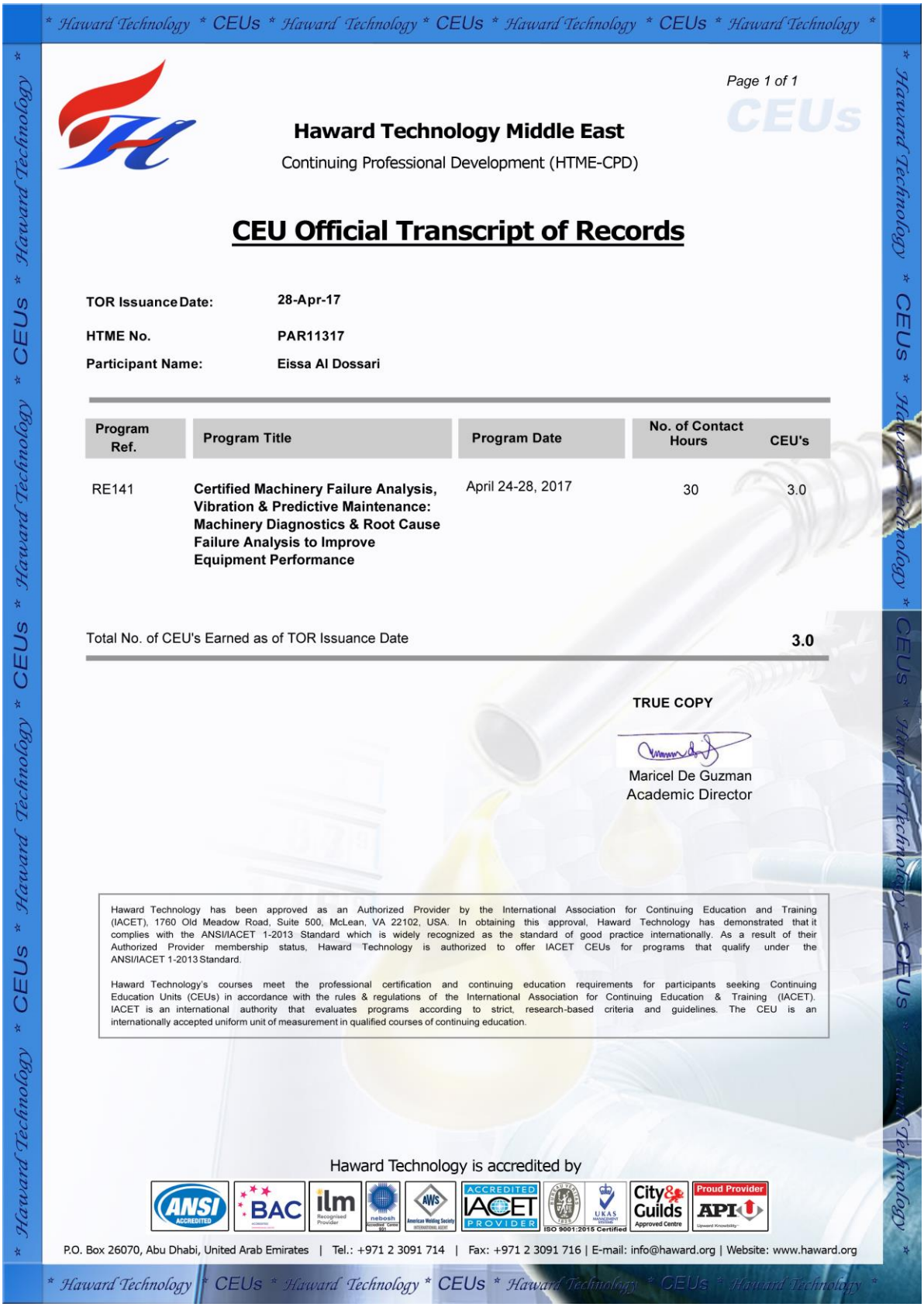
The following are samples of the certificates that will be awarded to course participants: -







(2) Official Transcript of Records will be provided to the successful delegates with the equivalent number of ANSI/IACET accredited Continuing Education Units (CEUs) earned during the course.



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Haward Technology Middle East

Continuing Professional Development (HTME-CPD)

CEU Official Transcript of Records

TOR Issuance Date: 28-Apr-17

HTME No. PAR11317

Participant Name: Eissa Al Dossari

Program Ref.	Program Title	Program Date	No. of Contact Hours	CEU's
RE141	**Certified Machinery Failure Analysis, Vibration & Predictive Maintenance: Machinery Diagnostics & Root Cause Failure Analysis to Improve Equipment Performance**	April 24-28, 2017	30	3.0

Total No. of CEU's Earned as of TOR Issuance Date **3.0**

TRUE COPY

Maricel De Guzman
Academic Director

Haward Technology has been approved as an Authorized Provider by the International Association for Continuing Education and Training (IACET), 1760 Old Meadow Road, Suite 500, McLean, VA 22102, USA. In obtaining this approval, Haward Technology has demonstrated that it complies with the ANSI/IACET 1-2013 Standard which is widely recognized as the standard of good practice internationally. As a result of their Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for programs that qualify under the ANSI/IACET 1-2013 Standard.

Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking Continuing Education Units (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

Haward Technology is accredited by

P.O. Box 26070, Abu Dhabi, United Arab Emirates | Tel.: +971 2 3091 714 | Fax: +971 2 3091 716 | E-mail: info@haward.org | Website: www.haward.org

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations:-

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Mr. Rod Larmour (**UK**), PE, MSc, BSc, is a **Senior Mechanical Engineer** with over **40 years** of **Onshore & Offshore** practical experience within the **Power**, **Petrochemical**, **Oil & Gas** industries. His expertise greatly covers the application of **Stress Analysis**, **Thermodynamics**, **Fluid Mechanics**, **Heat Transfer Engineering**, **Air Conditioning & Refrigeration Technology**, **Gas & Steam Turbines**, **Centrifugal Compressor & Pumps**, the **design**, **failure investigation**, and **maintenance** of **Atmospheric Storage Tanks & Tank Farms** and **Bolted Flanges & Joints**.

Currently, Mr. Larmour is working with Transnet overseeing the performance and safety of several **fuel pipelines** including **pumping stations** and **inland tank farms** locally. He also takes lead in the **planning** of detailed design of a **fuel gas supply system** from a site to the **proposed new power station**, the **management** of an **EPC booster gas compressor station** including an **overland piping**, and **spearheads** the **commercial & contractual management** within the **Ilitha Process Group**.

Throughout Mr. Larmour's lengthy career, he has worked with **several international companies** like **Mobil**, **Mossgas**, **Stewarts & Lloyds** and **Ilitha** with prime positions such as **Operations Manager**, **Principal Project Manager**, **Senior Mechanical Engineer**, **Offshore Projects Manager**, **Design Manager**, **Quality Assurance Manager** and **Project Engineer**.

Mr. Larmour's experience was not only confined to the industry alone. He was also able to largely contribute his expertise and impart his knowledge in the academe. He has engaged himself with **researches** and **lectures** in for several **universities** and **companies** and has held numerous **training courses** on **Thermomechanics** & **Fluid mechanics**, **Engineering Design**, **Refrigeration & Air Conditioning** and **Heat Transfer**.

Mr. Larmour has **Master** & **Bachelor** degrees in **Mechanical Engineering** and has further gained a **Diploma** in **Nuclear Science**.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Fee

Dubai	**US$ 5,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Doha	**US$ 6,000** per Delegate. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Machinery Failure Patterns*** *Understand the Nature of Failures • Types of Equipment Failures • Failure Classifications & Failure Patterns • Why Equipment Fails • Failure analysis & Root Cause • How Does Most of Your Equipment Fail?*
0930 – 0945	*Break*
0945 – 1100	***Machinery Diagnostic Testing*** *Diagnostic Objectives • Mechanical Inspection • Test Plan Development • Data Acquisition & Processing • Data Interpretation • Conclusions & Recommendations • Corrective Action Plan*
1100 – 1215	***Metallurgical Failure Analysis Methodology*** *Failure Analysis of Bolted Joints • Shaft Failures & their Origins • Ductile vs. Brittle Failures of Shafts • Stress Raisers in Shafts*
1215 – 1230	*Break*
1230 – 1420	***Machinery Component Analysis & Reliability Improvement*** *Redesign Opportunities ● Analyzing Wear Failures ● Bearings in Distress ● Rolling Element Bearing (AFB) & Bearing Failure Analysis ● Journal & Tilt-Thrust Bearings ● Gear Failure Analysis*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***Machinery Component Analysis & Reliability Improvement (cont'd)*** *Coupling Failure Avoidance ● Determining the Cause of Mechanical Seal Distress ● Mechanical Seal Selection Strategies ● O-Ring Failures & their Causes*
0930 – 0945	*Break*
0945 – 1100	***Machinery Troubleshooting*** *The Matrix Approach to Machinery Troubleshooting ● Pumps ● Centrifugal Compressors ● Blowers & Fans ● Reciprocating Compressors ● Engines ● Gas Turbines & Others*

1100 – 1215	***Machinery Root Cause Failure Analysis (RCFA)*** *Structured Problem Solving & RCFA ● Cause Analysis ● Two-Track Approach ● Failure Types ● The Three Levels of Cause ● Collecting Failure Data ● Parts & Position ● The Analysis Process*
1215 – 1230	*Break*
1230 – 1420	***Machinery Root Cause Failure Analysis(RCFA) (cont'd)*** *Describing the Process ● Data Analysis I ● Data Analysis II ● Data Analysis III ● Another Way ● Human Root Causes ● Solutions ● Stewardship of RCFA Results*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Vibration Analysis – A Management Overview*** *Specific Machinery Problems • Monitoring & Analysis Methods • Future Outlook*
0930 – 0945	*Break*
0945 – 1100	***Machinery Vibrations*** *Equipment & Processes Typically Monitored by Vibration Analysis • Typical Vibration Problems & their Approximate Percentage of Occurrence • Rotary Mechanical Vibrations • Other Mechanical Vibrations • Non-Mechanical Vibration Problems • Spring-Mass-Damper Model of Vibration • Simplest Form of Vibrating System • Real-world System • Peak vs RMS vs Peak to Peak-to-Peak*
1100 – 1215	***Machinery Vibrations (cont'd)*** *Frequency • Phase Measurement • Phase Relationship • Measurement Relationships • Vibration Measurement • Vibration Data Type & Formats • Frequency Domain vs Time Domain • Low, Medium & High Frequency Ranges • Excitation Frequencies • Natural Frequencies & Mode Shapes*
1215 – 1230	*Break*
1230 – 1420	***Vibration Signal Analysis for Different Faults*** *Gear Boxes • Electric Motors • Flow-related Problems Pumps, Fans & Compressors • Vibration Frequencies Related to Machinery Faults*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4

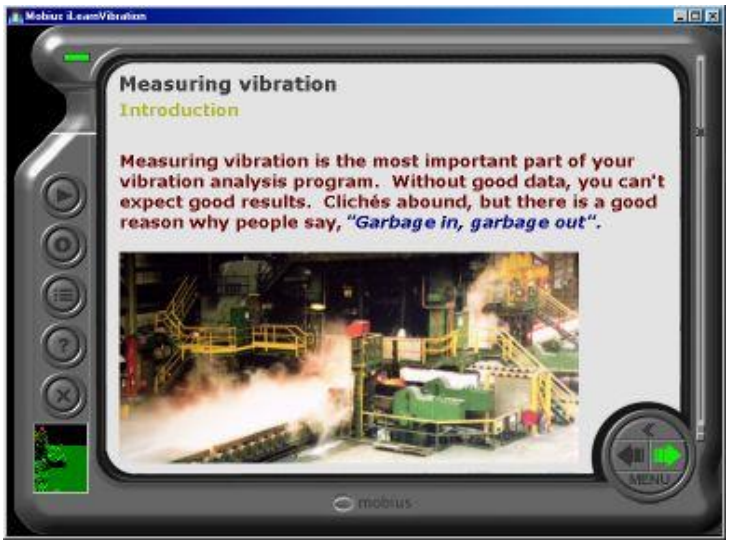
0730 – 0930	***Formalized Failure Reporting as a Teaching Tool*** *Actual Cases Cited & Explained in Detail ● High Speed Pump Failure & Bearing Failures*
0930 – 0945	*Break*
0945 – 1100	***Examination of Failed Components*** *Bearings ● Gears ● Mechanical Seals & Others*
1100 – 1215	***Process/Mechanical/Technical Interaction*** *How PMT Teams Work ● Turnaround Management ● Preventive vs. Predictive Maintenance Concepts*
1215 – 1230	*Break*
1230 – 1420	***Process/Mechanical/Technical Interaction*** *Integrated vs. Separate Maintenance ● Centrifugal Pump Failure Reduction Programs*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

Day 5

0730 – 0930	***Machine Condition Evaluation*** *Vibration Severity Limits • Shaft Vibration • Bearing Vibration • Casing Vibration • Standards • ISO 2372 Chart • ISO 10816 Chart • The IRD General Machinery Vibration Severity Chart*
0930 – 0945	*Break*
0945 – 1100	***Predictive Maintenance & Condition-Based Monitoring*** *Types of Condition Based Monitoring ● Vibration Monitoring ● Pump Monitoring Frequency ● Infrared Thermography ● Physical Effects Monitoring*
1100 – 1215	***Predictive Maintenance & Condition-Based Monitoring (cont'd)*** *Lube Oil Analysis ● What Kinds of Monitoring are Being Used Today? ● Has the Monitoring Program Been Effective? ● Is the Monitoring Scheduled Being Adhered to?*
1215 – 1230	*Break*
1230 – 1300	***Continuous Reliability Improvement*** *Optimized Lubrication for Pumps & Electric Motors ● Economics of Dry Sump Oil Mist Lubrication ● Lubrication Considerations for Pump & Electric Motors ● Major Machinery Lubrication Management*
1300 – 1315	***Course Conclusion***
1315 – 1415	***COMPETENCY EXAM***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulator (Hands-on Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using the "iLearnVibration" simulator.



iLearnVibration Simulator

Course Coordinator

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