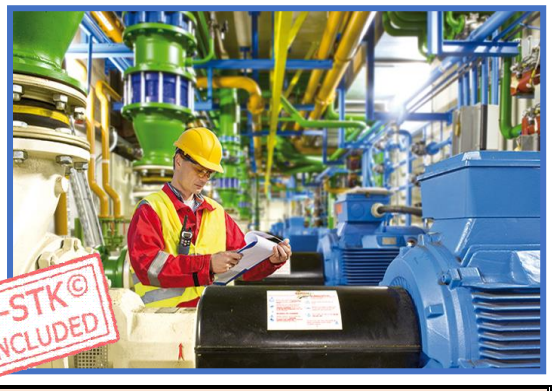
COURSE OVERVIEW RE0761-4D
Rotating Equipment Selection, Operation, Troubleshooting & Effective Predictive Maintenance

Course Title
Rotating Equipment Selection, Operation, Troubleshooting & Effective Predictive Maintenance



Course Reference
RE0761-4D

Course Duration/Credits
Four days/2.4 CEUs/24 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	February 05-08, 2024	Ajman Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE
2	May 13-16, 2024	Al Aziziya Hall, The Proud Hotel Al Khobar, Al Khobar, KSA
3	August 26-29, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
4	December 19-12, 2024	Business Center, Concorde Hotel Doha, Doha, Qatar

Course Description

This practical and highly-interactive course includes real-life case studies and exercises where participants will be engaged in a series of interactive small groups and class workshops.

This course is designed to cover the selection, operation, maintenance, inspection and troubleshooting of the various types of plant rotating equipment such as compressors, pumps, motors, turbines, turbo-expanders, gears and transmission equipment. The course will feature a unique blend of practical application experience and basic analysis methods. Its aim is to convey a thorough understanding of machinery operating principles, equipment troubleshooting and effective predictive maintenance.

The course will cover the principal machines represented at a large number of plants. There will be a thorough examination of basic operating concepts, application ranges, selection criteria, maintenance, inspection, troubleshooting and vulnerabilities of certain types of equipment. The course will also cover the equipment failure patterns, bearings, lubrication, shafting, couplings, belts/chain drives and gears.

Upon the successful completion of this course, participants will have gained an understanding of the 12 principal types of machinery used in industry. They will understand the differences between electric motors, design peculiarities, advantages and disadvantages of different types of gears, operating principles of gas turbines and reciprocating gas engines.

The course will convey an understanding of impulse vs. reaction turbines, insights into application ranges, limitations, maintenance and operability constraints for different kinds of pumps, compressors and dynamic gas machinery such as turbo-machinery as opposed to displacement machinery.

The course will discuss the root cause failure analysis (RCFA) and its various approaches and processes, the proper procedure for troubleshooting faults and carrying out the corrective actions including the various troubleshooting and testing tools and instruments. Predictive maintenance will be discussed in details including vibration analysis, oil particle and wear debris analysis, thermography and ultrasonics performance evaluation.

The course includes a comprehensive e-book entitled *"Engineers' Guide to Rotating Equipment: The Pocket Reference",* published by Wiley, which will be given to the participants to help them appreciate the principles presented in the course.

Course Objectives

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

- Select, operate and troubleshoot rotating equipment and implement an effective predictive maintenance program
- Identify the various plant rotating equipments and their components, how equipment works and define the maintenance educational component (MEC) term
- Discuss electric motors, gears & transmission equipment, gas turbines & engines, steam turbines and expanders
- Select and use centrifugal pumps, positive displacement and vacuum pumps, turbo-compressors, fans, blowers and displacement compressors
- Apply the principles of equipment failure patterns and review the common reasons for equipment failure
- Troubleshoot, repair and maintain the major components of rotating equipment including bearings, lubrication, shafting, shaft couplings, V-belts, positive-drive belts, chain drives, gears, gearing and housing
- Use the concept of root cause failure analysis (RCFA) including the various types and approaches used in rotating equipments
- Troubleshoot all possible faults and failures of the rotating equipment and identify the various approaches to be considered in applying corrective actions
- Employ the various predictive maintenance techniques and strategies used for rotating equipment
- Determine the various types of conditioning monitoring techniques and recognize their importance in troubleshooting plant rotating equipment and their major role in predictive maintenance

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 provides an overview of all significant aspects and considerations of mechanical and rotating equipment at industrial plants, utilities, production oil/gas field, or manufacturing facilities for those who are involved in the selection, operation, maintenance, inspection and troubleshooting of rotating equipment and carrying out effective predictive maintenance. General maintenance personnel and engineers will find this course extremely useful as well as for those who are coming from a wide variety of industries, skill-levels, company sizes and job titles.

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

Abu Dhabi	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day
Al Khobar	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Dubai	**US$ 4,500** 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$ 5,500** per Delegate. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

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

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

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 **2.4 CEUs** (Continuing Education Units) or **24 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.

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. Karl Thanasis, PEng, MSc, MBA, BSc, is **Senior Mechanical & Maintenance Engineer** with over **45 years** of extensive industrial experience. His wide expertise includes **Piping & Pipeline**, Maintenance, Repair, **Shutdown**, **Turnaround & Outages**, **Maintenance & Reliability** Management, **Mechanical Maintenance** Planning, Scheduling & Work Control, Advanced Techniques in **Maintenance** Management, **Predictive & Preventive** Maintenance, **Maintenance & Operation Cost Reduction** Techniques, Reliability Centered Maintenance (**RCM**), **Machinery Failure** Analysis, **Rotating Equipment Reliability** Optimization & Continuous Improvement, **Material Cataloguing**, **Mechanical & Rotating Equipment** Troubleshooting & Maintenance, **Root Cause Analysis & Reliability** Improvement, **Condition** Monitoring, **Root Cause Failure Analysis** (RCFA), **Steam Generation**, **Steam Turbines**, **Power Generator Plants**, **Gas Turbines**, **Combined Cycle Plants**, **Boilers**, **Process Fired Heaters**, Air Preheaters, Induced Draft Fans, All Heaters Piping Work, Refractory Casting, Heater Fabrication, Thermal & Fired Heater Design, **Heat Exchangers**, Heat Transfer, Coolers, **Power Plant** Performance, Efficiency & Optimization, **Storage Tank** Design & Fabrication, **Thermal Power Plant** Management, **Boiler & Steam** System Management, **Pump** Operation & Maintenance, **Chiller & Chiller Plant** Design & Installation, **Pressure Vessel**, **Safety Relief Valve** Sizing & Selection, **Valve** Disassembling & Repair, Pressure Relief Devices (**PSV**), **Hydraulic & Pneumatic** Maintenance, Advanced **Valve** Technology, **Pressure Vessel** Design & Fabrication, **Pumps**, Turbo-Generator, Turbine **Shaft Alignment**, **Lubrication**, Mechanical **Seals**, Packing, **Blowers**, **Bearing** Installation, **Couplings**, **Clutches** and **Gears**. Further, he is also versed in **Wastewater Treatment** Technology, **Networking** System, **Water Network Design**, Industrial **Water Treatment** in Refineries & Petrochemical Plants, **Piping** System, Water Movement, Water Filtering, Mud Pumping, **Sludge Treatment** and **Drying**, **Aerobic Process** of **Water Treatment** that includes **Aeration**, **Sedimentation** and **Chlorination Tanks**. His strong background also includes **Design** and **Sizing** of all **Waste Water Treatment Plant Associated Equipment** such as **Sludge Pumps**, **Filters**, **Metering Pumps**, **Aerators** and **Sludge Decanters**.

Mr. Thanasis has acquired his thorough and practical experience as the **Project Manager**, **Plant Manager**, **Area Manager - Equipment Construction**, **Construction Superintendent**, **Project Engineer** and **Design Engineer**. His duties covered **Plant Preliminary Design**, **Plant Operation**, **Write-up** of **Capital Proposal**, **Investment Approval**, **Bid Evaluation**, **Technical Contract Write-up**, **Construction** and **Sub-contractor Follow up**, **Lab Analysis**, **Sludge Drying** and **Management** of **Sludge Odor** and **Removal**. He has worked in various companies worldwide in the **USA**, **Germany**, **England** and **Greece**.

Mr. Thanasis is a **Registered Professional Engineer** in the **USA** and **Greece** and has **Master** and **Bachelor** degrees in **Mechanical Engineering** with **Honours** from the **Purdue University** and **SIU** in **USA** respectively as well as an **MBA** from the **University of Phoenix** in **USA**. Further, he is a **Certified Internal Verifier/Trainer/Assessor** by the **Institute of Leadership & Management** (**ILM**) a **Certified Instructor/Trainer** and has delivered numerous trainings, courses, seminars, workshops and conferences worldwide.

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	***Introduction*** *Overview of Rotating Equipment ● What is Common to All Types of Equipment? ● Understanding How Equipment Works ● The Maintenance Educational Component (MEC)*
0930 – 0945	*Break*
0945 – 1030	***Electric Motors*** *Design ● Controls ● Wiring Systems ● Standard Motors ● Special Designs ● Major Components ● The Motor as Part of a System ● Adjustable Frequency Motors*
1030 – 1130	***Gears & Transmission Equipment*** *Types of Gears ● Applications Constraints ● Maintenance*
1130 - 1230	***Gas Turbines & Engines*** *Simple Cycle ● Heat Recovery Cycles ● Type Selection ● Maintenance ● Two & Four Cycle Gas Engines ● Gas Engine Compressor Auxiliary Systems*
1230 – 1245	*Break*
1245 – 1330	***Steam Turbines & Expanders*** *Impulse Turbines ● Reaction Turbines ● Application Ranges ● Turbine Configurations ● Applications Constraints ● Maintenance ● Turbo-expander Construction Features ● Applications ● Operation*
1330 – 1420	***Centrifugal Pumps*** *Configurations & Styles ● Application Ranges & Constraints ● Construction Features & Options ● Pump Auxiliaries ● Wear Components ● Canned Motor & Magnetic Drive Pumps ● High Speed/Low Flow Pumps ● Servicing & Condition Monitoring*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***Positive Displacement & Vacuum Pumps*** *Reciprocating Steam & Power Pumps ● Diaphragm Pumps ● Plunger Pumps ● Gear Screw & Progressive Cavity Pumps ● Peristaltic Pumps ● Conventional & Special Vacuum Pumps ● Liquid Jet & Liquid Ring Pumps ● Combination & Staged Vacuum Pumps*
0930 – 0945	*Break*
0945 – 1045	***Turbo-compressors*** *Types, Styles & Configurations of Centrifugal & Axial Compressors ● Construction Features ● Mode of Operation ● Compressor Auxiliaries & Support Systems ● Condition Monitoring ● Application Criteria ● Performance Capabilities & Limitations ● Maintenance*

1045 – 1130	***Fans & Blowers*** *Types & Configurations ● Performance & System Effects ● Performance Correction ● Capacity Control Options*
1130 - 1230	***Displacement Compressors*** *Classification ● Reciprocating Compressors vs. Rotary Screw Compressors ● Application Ranges & Limitations ● Compression Processes ● Construction Features & Components ● Capacity Control*
1230 – 1245	*Break*
1245 - 1315	***Equipment Failure Patterns*** *Distinguishing between Repairable & Non-Repairable Equipment ● Types of Equipment Failure ● Review Why Equipment Fails ● Areas of the Bath-Tub Curve ● Actual Equipment Failure Patterns ● Actions to Minimize Failure Effect ● Discussions ● How does Most of Your Equipment Fail?*
1315 - 1420	***Bearings & Lubrication*** *Anti Friction ● Plain ● Importance of Lubrication ● Types of Lubrication ● What Needs to be Lubricated ● How & When to Lubricate*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Shafting & Shaft Couplings*** *Types of Shafts ● Types of Couplings ● Uses & Applications*
0930 – 0945	*Break*
0945 - 1030	***V-Belts, Positive-Drive Belts & Chain Drives*** *Component Overview ● Uses for Equipment ● Failure Modes*
1030 – 1130	***Gears, Gearing & Housing*** *Gear Types & Mechanisms ● Removing the Mysteries ● Repair & Maintenance of Gears ● Types of Housing*
1130 – 1230	***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*
1230 – 1245	*Break*
1245 – 1315	***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*
1315 – 1420	***Troubleshooting Faults & Corrective Action*** *Vibration Analysis ● Fast Fault Finding ● Acoustical Troubleshooting ● Infra-red Inspection*
1420 - 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Three*

Day 4

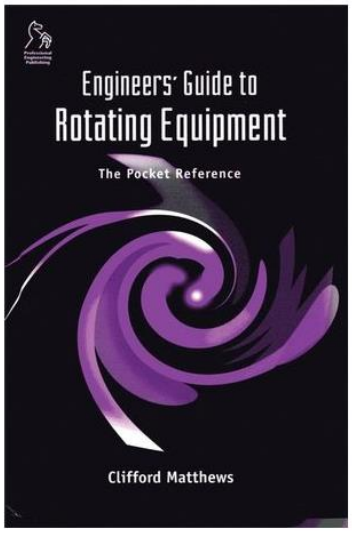
0730 – 0930	***Troubleshooting Faults & Corrective Action (cont'd)*** *Oil Analysis ● Motors ● Megger Testing ● Pumps, Blowers & Fans ● Other Rotating Equipment*
0930 – 0945	*Break*
0945 – 1100	***Predictive Maintenance Overview*** *Classification of Plant Machinery ● Maintenance Strategies as Adopted to Each Class of Machinery ● Identification of Critical Machinery & Adoption of CBM ● Principles of Predictive Maintenance ● Detection & Diagnosis*
1100 – 1230	***Predictive Maintenance Techniques*** *Vibration Analysis ● Oil particle & Wear Debris Analysis ● Thermography ● Ultrasonics ● Performance Evaluation*
1230 – 1245	*Break*
1245 – 1345	***Predictive Maintenance: Condition-Based Monitoring*** *Types of Condition-Based Monitoring ● Vibration Monitoring ● Pump Monitoring Frequency ● Temperature Based Monitoring ● Infrared Monitoring ● Lube Oil Analysis• Discussion ● Analytical- Base Tools ● Data Analysis ● Weibul Analysis ● Discussions ● What Kind of Analysis is Done?*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Practical Sessions

This practical and highly-interactive course includes real-life case studies and exercises:

Book(s)

As part of the course kit, the following e-book will be given to all participants:



Title : Engineers' Guide to Rotating Equipment: The Pocket Reference
ISBN : 9781860583445
Author : Clifford Matthews
Publisher : Wiley

Course Coordinator

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