COURSE OVERVIEW ME0015-4D
Centrifugal Compressor & Steam Turbine Design, Performance, Operation, Maintenance & Troubleshooting

Course Title
Centrifugal Compressor & Steam Turbine Design, Performance, Operation, Maintenance & Troubleshooting

Course Reference
ME0015-4D

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

Course Date/Venue
Please refer to page 3

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.

Centrifugal Compressors and Mechanical Drive Steam Turbines are used extensively in the process industries. There are many types with widely varying configurations and applications. Compressors and steam turbines represent a significant part of the capital and operating costs of most plants, and optimizing their selection is therefore, of major economic importance.

The course deals with design features, efficiencies, operating characteristics, reliability and maintenance implications of centrifugal compressors and their steam turbine drivers.

The course will cover the operating principles of centrifugal compressors and steam turbines, specifications, their design, thermodynamics, effects of efficiency on operating costs, energy usage, and effect on plant costs, materials of construction, selection, troubleshooting and maintenance.
The course will also cover plant run-length extension surveys, organizing for successful turnarounds and on-going reliability improvement, and preventive vs. predictive maintenance strategy decisions.

The course will provide the participant with a basic as well as advanced centrifugal compressor and steam turbine technology knowledge inventory required to successfully select, apply, operate, troubleshoot and maintain compression and steam turbine equipment.

Upon completion of this course, participants will have gained a thorough understanding of the various centrifugal compressor and steam turbine configurations available to most industrial users, including mechanical design features, sizing and application criteria, maintainability, reliability, vulnerability and troubleshooting issues. Participants will learn simple techniques and short-cut methods of machinery sizing and selection. This replaces tedious hand or other methods of calculation and will serve as a fast way to arrive at sensitivity or influence of parameter changes on equipment performance.

Participants will be able to determine the most appropriate and efficient matching of steam turbine drivers to compressors. Participants will also acquire knowledge of operating and maintenance issues by getting to know mechanical design, machinery components, connecting piping design as well as proven approaches to monitoring, troubleshooting and maintaining compressor installations.

Course Objectives

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

- Apply a comprehensive knowledge in the mechanical design, performance, operation, maintenance and troubleshooting of centrifugal compressor and steam turbine
- Illustrate the different alignment techniques and support criteria for centrifugal compressor and steam turbines
- Describe parameters of thermodynamics, capacity, power, efficiency, gas properties and intercooling for turbocompressors
- Select centrifugal process compressors by utilizing calculation methods, characteristic curves and stability criteria
- Employ the proper procedure for compressor train inspection, maintenance, overhaul and repair
- Explain in detail the mechanical design, configurations, application ranges and constraints for steam turbines
- Identify the different turbine components which include turbine rotors, balancing, rotor dynamics, casings, bearings, shaft sealing devices and lube oil management
- Perform the selection and sizing of steam turbines for compressor drives and recognize the operation and maintenance of steam turbines
- Emphasize approaches to machinery troubleshooting, cite examples from recent failure incidents attributed to design defects and maintenance deficiencies
- Explain the difference between predictive and preventive maintenance techniques and determine which method to use
- Carryout machinery reliability audits and reviews as well as recognize the importance of reliability enhancement efforts

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 centrifugal compressor & steam turbine for those directly involved in the design, performance, operation, maintenance and troubleshooting of such equipment. This course is also intended for rotating equipment and machinery engineers, plant and maintenance engineers and other technical staff involved in turbomachinery management, operation and maintenance. Further, it is suitable for operations, process and process unit contact, mechanical and project engineers.

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 Date/Venue

Session(s)	Date	Venue
1	January 22-25, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
2	January 29-February 01, 2024	Al Aziziya Hall, The Proud Hotel Al Khobar, Al Khobar, KSA
3	February 05-08, 2024	Club B Meeting Room, Ramada Plaza by Wyndham Istanbul City Center, Istanbul, Turkey
4	March 04-07, 2024	Boardroom, Warwick Hotel Doha, Doha, Qatar
5	April 22-25, 2024	Club B Meeting Room, Ramada Plaza by Wyndham Istanbul City Center, Istanbul, Turkey
	July 01-04, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
	October 07-10, 2024	Ajman Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE

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. Manuel Dalas, MSc, BSc, is a **Senior Mechanical & Maintenance Engineer** with over **25 years** of industrial experience in **Oil**, **Gas**, **Refinery**, **Petrochemical**, **Power** and **Nuclear** industries. His wide expertise includes **Root Cause Failure Analysis**, Rotating Equipment Maintenance & **Failure Analysis**, **Failure Analysis Methodologies** for Mechanical Engineers, **Reliability Centered Maintenance & Root Cause Failure Analysis**, **Machinery Failure Analysis**, Prevention & Troubleshooting, **Machinery** Failure Analysis, Machinery Root Cause Failure Analysis **(RCFA)**, **Machinery Diagnostics & Root Cause Failure** Analysis, **Water Well**, **Transfer & Network Systems** Operation, **Water Network Systems & Pumping** Stations, **Instrument**, **Control & Protection** Systems, Plumbing **Network Systems** & Building, **Water Distribution & Pump** Station, **Boiler** Operation & Water Treatment, **Pipe Stress Analysis** using **CAESAR II**, **CAESAR II** Application, **Piping Dynamic**, **Static & Other Special Analysis** using **CAESAR II**, **Expansion Joints** Design & Analysis, **Impact Load** Analysis, **Piping** Systems, **Piping Codes** Used in **CAESAR II**, **RFP Pipe** Maintenance & Repair, **Relief Valve** Analysis, Safety **Relief Valve**, **Tanks & Tank Farms**, **Seismic Loads**, **Tank Shell**, **Tank Failure**, **Vacuum Tanks**, **Tank Design & Engineering**, **Tank Contractions**, **Material Cataloguing**, **Maintenance Planning & Scheduling**, Reliability Centered Maintenance (**RCM**), **Reliability Maintenance**, **Condition Based Maintenance & Condition Monitoring**, **Asset & Risk** Management, **Vibration Condition Monitoring & Diagnostics** of Machines, **Vibration & Predictive** Maintenance, Reliability Improvement & Vibration Analysis for Rotating Machinery, Effective Maintenance **Shutdown & Turnaround** Management, **Engineering Codes & Standards**, **Rotating Equipment** Maintenance, **Mechanical** Troubleshooting, **Static Mechanical Equipment** Maintenance, **Plant Reliability & Maintenance** Strategies, **Pumps** Maintenance & Troubleshooting, **Fans**, **Blowers & Compressors**, **Process Control Valves**, Piping Systems & Process Equipment, **Gas Turbines & Compressors** Troubleshooting, Advanced **Valve** Technology, **Pressure Vessel** Design & Analysis, **Steam & Gas Turbine**, **High Pressure Boiler** Operation, **FRP Pipe** Maintenance & Repair, **Centrifugal & Positive Displacement Pump** Technology Troubleshooting & Maintenance, **Rotating Machinery** Best Practices, **PD Compressor & Gas Engine** Operation & Troubleshooting, **Hydraulic Tools & Fitting**, **Mass & Material BalanceTank Farm & Tank Termin**al Safety & Integrity Management, **Process Piping** Design, Construction & **Mechanical Integrity**, **Stack & Noise** Monitoring, **HVAC & Refrigeration** Systems, BPV Code, Section VIII, Division 2, **Facility Planning & Energy** Management, Hoist - Remote & Basic **Rigging & Slinging**, **Mobile Equipment** Operation & Inspection, **Heat Exchanger**, **Safety Relief Valve**, **PRV & POPRV/PORV**, **Bearing & Lubrication**, **Voith Coupling** Overhaul, **Pump & Valve** Technology, **Lubrication** Inspection, **Process Plant** Optimization, Rehabilitation, Revamping & Debottlenecking, Engineering Problem Solving and **Process Plant** Performance & Efficiency. Currently, he is the **Technical Consultant** of the **Association of Local Authorities of Greater Thessaloniki** where he is in charge of the mechanical engineering services for piping, pressure vessels fabrications and ironwork.

During his career life, Mr. Dalas has gained his practical and field experience through his various significant positions and dedication as the **Technical Manager**, **Project Engineer**, **Safety Engineer**, **Deputy Officer**, **Instructor**, **Construction Manager**, **Construction Engineer**, **Consultant Engineer**, **Water Network Systems Engineer**, **Maintenance Engineer** and **Mechanical Engineer** and **CAESAR II Application Consultant** for numerous multi-billion companies including the **Biological Recycling Unit** and the **Department of Supplies** of **Greece**, **Alpha Bank Group**, **EMKE S.A**, **ASTE LLC** and **Polytechnic College of Evosmos**.

Mr. Dalas has a **Master's** degree in **Energy System** from the **International Hellenic University, School of Science & Technology** and a **Bachelor's** degree in **Mechanical Engineering** from the **Mechanical Engineering Technical University of Greece** along with a **Diploma** in **Management & Production Engineering** from the **Technical University of Crete**. Further, he is a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership and Management** (**ILM**), a **Certified Project Manager Professional** (**PMI-PMP**), a **Certified Instructor/Trainer**, a **Certified Energy Auditor** for **Buildings**, **Heating & Climate Systems**, a **Member** of the **Hellenic Valuation Institute** and the **Association of Greek Valuers** and a **Licensed Expert Valuer Consultant** of the **Ministry of Development and Competitiveness**. He has further delivered numerous trainings, courses, seminars, conferences and workshops internationally.

Course Fee

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.
Istanbul	**US$ 5,000** per Delegate + **VAT**. This rate includes Participants Pack (Folder, Manual, Hand-outs, etc.), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
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
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.

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 to Compressor Types*** *Centrifugal • Axial • Reciprocating • Helical Screw • Ranges of Application and Limitations*
0930 – 0945	*Break*
0945 – 1100	***Mechanical Design of Centrifugal Compressors*** *Compressor Side Streams • Rotors • Balancing*
1100 – 1215	***Mechanical Design of Centrifugal Compressors (cont'd)*** *Rotor Dynamics • Impellers • Casings*
1215 – 1230	*Break*
1230 – 1330	***Mechanical Design of Centrifugal Compressors (cont'd)*** *Bearings • Seals • Couplings • Controls*
1330 - 1420	***Alignment Techniques & Support Criteria*** *Review of Dial Indicator Methods • Laser Optic Cold Alignment • On-Stream (Hot) Alignment Verification Techniques*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 - 0930	***Basic Compressor Parameters*** *Thermodynamics • Capacity • Power • Efficiencies • Gas Properties • Intercooling*
0930 – 0945	*Break*
0945 – 1100	***Selection of Centrifugal Process Compressors*** *Calculation Methods • Characteristic Curves • Stability*

1100 – 1215	***Compressor Train Inspection, Maintenance, Overhaul & Repair–IMO&R*** *IMO&R Planning • Execution • Documentation*
1215 – 1230	*Break*
1230 – 1330	***Compressor Train Inspection, Maintenance, Overhaul & Repair–IMO&R*** *IMO&R Planning • Execution • Documentation*
1330 - 1420	***Compressor Train Inspection, Maintenance, Overhaul & Repair–IMO&R (cont'd)*** *IMO&R • Q & As • Troubleshooting*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Steam Turbines*** *Operating Principles & Mechanical Design • Impulse Turbines • Reaction Turbines*
0930 – 0945	*Break*
0945 – 1100	***Steam Turbines (cont'd)*** *Application Ranges • Configurations • Application Constraints*
1100 – 1215	***Turbine Components*** *Turbine Rotors • Blading • Diaphragms • Nozzles • Steam Chests • Glands & Gland Systems • Bearings*
1215 – 1230	*Break*
1230 – 1330	***Turbine Components (cont'd)*** *Balancing • Rotor Dynamics • Governing Systems • Lube Oil Management*
1330 - 1420	***Selection & Sizing of Steam Turbines for Compressor Drives*** *Steam (Water) Rates • Condensing and Backpressure Turbines • Single and Multistage Types • Process Considerations*
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*

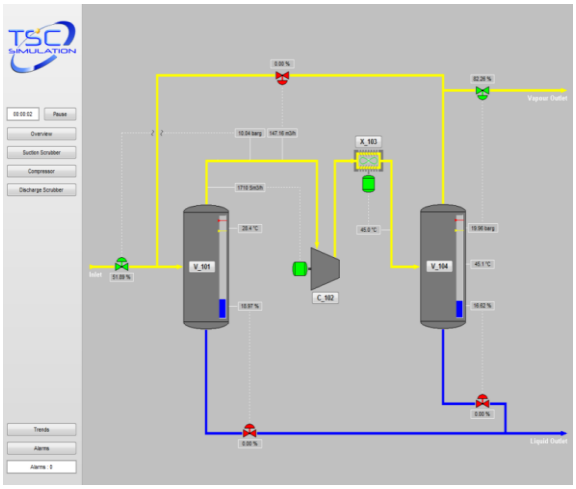
Day 4

0730 – 0930	***Operation & Maintenance of Steam Turbines*** *Commissioning • Startup • Run-In & Shut-down • Surveillance & Health Monitoring • Performance Measurement • Monitoring and Tracking*
0930 – 0945	*Break*
0945 – 1100	***Operation & Maintenance of Steam Turbines (cont'd)*** *Steam Turbine Washing • Steam Turbine Inspection • Maintenance Overhaul & Repair (IMO&R)*
1100 – 1215	***Basic Approaches to Machinery Troubleshooting*** *Examples from Recent Failure Incidents Attributed to Design Defects • Processing & Manufacturing Deficiencies • Assembly Errors • Off-Design or Unintended Service Conditions • Maintenance Deficiencies, etc.*
1215 – 1230	*Break*
1230 – 1300	***Predictive vs. Preventive Maintenance Techniques*** *Determination of Which Method to Use*

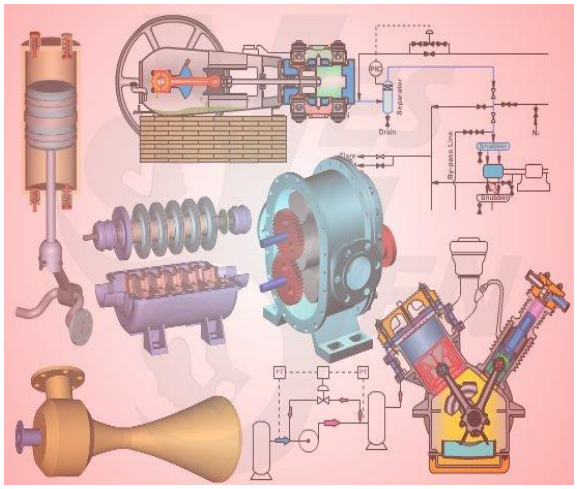
1300 - 1345	***Machinery Reliability Audits & Reviews*** *Overview • Reliability Impact on Plants*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course*
1400 – 1415	***POST TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulator (Hands-on Practical Sessions)

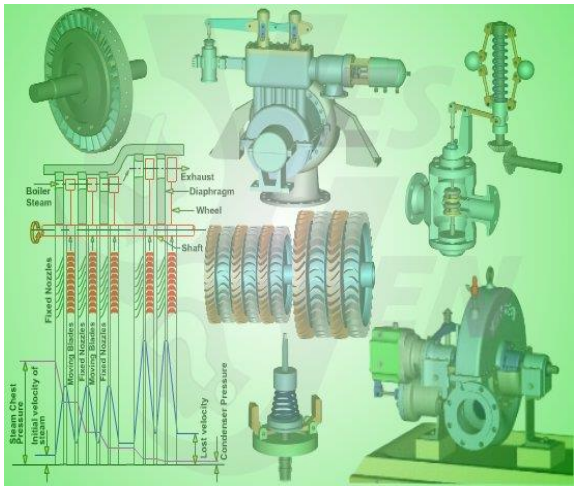
Practical session will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using the state-of-the-art simulators "SIM 3300 Centrifugal Compressor", "CBT on Compressors" and "Steam Turbines & Governing System CBT".



SIM 3300 Centrifugal Compressor Simulator



CBT on Compressors



Steam Turbines & Governing System CBT

Course Coordinator

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