COURSE OVERVIEW FE0121

API 660: Shell & Tube Heat Exchangers

Design, Welding, Fabrication, Inspection, Testing, Operation, Maintenance & Troubleshooting

Course Title

API 660: Shell & Tube Heat Exchangers: *Design, Welding, Fabrication, Inspection, Testing, Operation, Maintenance & Troubleshooting*

Course Reference

FE0121

Course Duration/Credits

Five days/3.0 CEUs/30 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	April 13-17, 2025	Tamra Meeting Room, Al Bandar Rotana Creek, Dubai UAE
2	July 20-24, 2025	
3	November 16-20, 2025	

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.

This course is designed to provide participants with a detailed and up-to-date overview of API 660: Shell & Tube Heat Exchangers: Design, Welding, Fabrication, Inspection, Testing, Operation, Maintenance & Troubleshooting. It covers the importance role of API 660 in the process industry; the fundamentals of heat exchanger including the general scope and key terminologies used in API 660; the operating conditions and process requirements; the thermal and mechanical design considerations and fluid properties and their impact on design; selecting materials for shell, tubes and baffles; and the key components of a shell-and-tube heat exchanger.

Further, the course will also discuss the design codes and standards, mechanical design aspects and tube sheet and tube bundle design; the baffles and support structures, nozzles and flanges design and welding and fabrication requirements; the API 660 inspection criteria, third-party inspection requirements and common non-conformities in heat exchangers; the non-destructive testing (NDT) methods, hydrostatic and pneumatic testing and tube integrity testing; and the quality assurance and documentation, factory acceptance testing (FAT) and site acceptance testing (SAT).

During this interactive course, participants will learn the startup and shutdown procedures, operating parameter monitoring and efficiency optimization techniques; the fouling and scaling issues, tube-side and shell-side corrosion, vibration and mechanical damage and gasket leaks and sealing problems; the cleaning and maintenance procedures, performance monitoring and optimization and retrofitting and upgrades; the systematic troubleshooting approach, identifying root causes of exchanger failures and corrective actions and long-term solutions; the advanced heat transfer enhancements, special service heat exchangers and economic and environmental considerations; preparing for API 660 compliance audits; and common audit findings, corrective actions and documentation and record-keeping best practices.

Course Objectives

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

- Apply and gain an in-depth knowledge on the design, welding, fabrication, inspection, testing, operation, maintenance and troubleshooting of shell and tube heat exchangers in accordance with API 660 standards
- Discuss the importance role of API 660 in the process industry
- Explain the fundamentals of heat exchanger including the general scope and key terminologies used in API 660
- Recognize the operating conditions and process requirements as well as thermal and mechanical design considerations and fluid properties and their impact on design
- Select materials for shell, tubes and baffles and identify the key components of a shell-and-tube heat exchanger
- Discuss design codes and standards, mechanical design aspects and tube sheet and tube bundle design
- Describe baffles and support structures, nozzles and flanges design and welding and fabrication requirements
- Recognize API 660 inspection criteria, third-party inspection requirements and common non-conformities in heat exchangers
- Apply non-destructive testing (NDT) methods, hydrostatic and pneumatic testing and tube integrity testing
- Carryout quality assurance and documentation, factory acceptance testing (FAT) and site acceptance testing (SAT)
- Employ startup and shutdown procedures, operating parameter monitoring and efficiency optimization techniques
- Identify and troubleshoot fouling and scaling issues, tube-side and shell-side corrosion, vibration and mechanical damage and gasket leaks and sealing problems
- Apply cleaning and maintenance procedures, performance monitoring and optimization and retrofitting and upgrades
- Carryout systematic troubleshooting approach, identify root causes of exchanger failures and apply corrective actions and long-term solutions

- Recognize advanced heat transfer enhancements, special service heat exchangers and economic and environmental considerations
- Prepare for API 660 compliance audits and apply common audit findings, and corrective actions and documentation and record-keeping best practices

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 conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of the design, welding, fabrication, inspection, testing, operation, maintenance and troubleshooting of shell and tube heat exchanger in accordance with API 660 standards for engineers and technical professionals, inspection and quality control personnel, operations and maintenance personnel, project and procurement professionals, fabricators and manufacturers and other technical staff.

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.

Accommodation

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

Course Fee

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.

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: -

- 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.

- 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.

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:

Dr. Tony Dimitry, PhD, MSc, BSc, is a **Senior Mechanical Engineer** with over **30 years** of industrial experience. His expertise covers **Pumps, Compressors, Turbines & Troubleshooting**, **Centrifugal Pumps**, Maintenance of **Gas Compressors**, **Compressor & Steam Turbine**, **Pressure Safety Relief Valve** Repair & Recalibration, **PSV/PRV** Troubleshooting, **PRV** Testing & Repair, **Valve** Testing & Inspection, **Valve** Sealing, **Valve** Calibration, **Process Equipment**, **Vibration Analysis**, **Heat Exchanger**, **Siemens Steam Turbine Maintenance**, **Electromechanical Maintenance**, **Machinery Alignment**, **Lubrication Technology**, **Compressors**, **HVAC & Refrigeration Systems**, **Piping System**, **Blower & Fan**, **Shaft Repair**, **Control Valve & Actuator**, **Safety Relief Valves**, **Pipelines**, **Piping Vibration Analysis**, **Pressure Vessels**, **Dry Gas Seal**, **Process Equipment**, **Diesel Engine & Crane Maintenance**, **Maintenance Management** (**Preventive**, **Predictive**, **Breakdown**), **Reliability Management**, **Condition-Based Monitoring**, **Rotating Equipment**, **Tanks & Tank Farms**, **Pneumatic System**, **Static Equipment**, **Failure Analysis**, **FMEA**, **Corrosion**, **Metallurgy**, Planning, Scheduling, Cost Control, Preventive and Predictive Maintenance. Currently, he is the Maintenance Manager of the PPC Incorporation wherein he is responsible for the maintenance and upgrade of all plant components, monitoring the thermal stresses and the remaining life of steam pipes, turbine casing, mills, fans and pumps. He is in-charge of the metallurgical failure analysis and the usage of fracture mechanics for determining crack propagation in impellers of turbines, assessing all alterations and developments for upgrading the plant.

During his career life, Dr. Dimitry was a **Senior Engineer** in **Chloride Silent** (**UK**) wherein he was responsible for the mechanical, thermal and electrical modelling of battery problems for electric vehicles and satellites as well as an **Operations Engineer** of the **National Nuclear Corporation** (**UK**) wherein he was responsible for the optimization of the plant. Prior to this, he was a **Professor** at the **Technical University of Crete** and an Assistant **Professor** of the **University of Manchester** (**UK**).

Dr. Dimitry has **PhD**, **Master** and **Bachelor** degrees in **Mechanical Engineering** from the **Victory University of Manchester** and the **University of Newcastle**, **UK** respectively. Further, he is a **Certified Instructor/Trainer,** a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**) and an associate member of the American Society of Mechanical Engineers (**ASME**) and Institution of Mechanical Engineers (**IMechE**). He has further delivered various trainings, seminars, courses, workshops and conferences internationally.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the workshop 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 API Standard 660*** *Overview of API Standards and Their Importance • Role of API 660 in the Process Industry • Relationship with other Industry Standards (ASME, TEMA, etc.) • Key Objectives and Learning Outcomes of the Course*
0930 – 0945	*Break*
0945 – 1030	***Heat Exchanger Fundamentals*** *Types of Heat Exchangers and Their Applications • Basics of Heat Transfer and Thermodynamics • Shell-and-Tube Heat Exchanger (STHE) Working Principle • Selection Criteria for Heat Exchangers*
1030 – 1130	***API 660 Scope & Definitions*** *General Scope of API 660 • Key Terminologies Used in API 660 • Roles of Manufacturers, Purchasers and Engineering Companies • Applicability and Limitations of API 660*
1130 – 1215	***Design Considerations & Service Conditions*** *Operating Conditions and Process Requirements • Thermal and Mechanical Design Considerations • Fluid Properties and their Impact on Design • Pressure Drop and Efficiency Calculations*
1215 – 1230	*Break*
1230 – 1330	***Materials of Construction*** *Selection of Materials for Shell, Tubes and Baffles • Corrosion Resistance and Material Compatibility • API 660 Material Standards and Compliance • Special Materials for High-Temperature and Corrosive Applications*
1330 – 1420	***Key Components of a Shell-&-Tube Heat Exchanger*** *Shell and Tube Bundle Configuration • Tube Sheets, Baffles and Nozzles • Expansion Joints and Floating Heads • Gasket Materials and Sealing Mechanisms*
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 – 0830	***Design Codes & Standards*** *API 660 versus ASME Section VIII • TEMA Classifications and their Relevance • Compliance with PED and other International Codes • Case Studies on Design Standard Conflicts*
0830 – 0930	***Mechanical Design Aspects*** *Pressure and Temperature Limits • Stress Analysis and Fatigue Considerations • Thermal Expansion and Design Allowances • Mechanical Load Calculations*
0930 – 0945	*Break*

0945 – 1100	***Tube Sheet & Tube Bundle Design*** *Fixed versus Floating Tube Sheet Designs • Tube Expansion and Welding Methods • Tube Bundle Extraction and Maintenance Considerations • Material Selection for Tube Sheets and Corrosion Prevention*
1100 – 1215	***Baffles & Support Structures*** *Role of Baffles in Heat Transfer Enhancement • Types of Baffles and their Spacing Guidelines • Flow-Induced Vibration and Mitigation Techniques • Support Structures for Mechanical Stability*
1215 – 1230	*Break*
1230 – 1330	***Nozzles & Flanges Design*** *Nozzle Orientation and Connection Types • Stress Analysis on Nozzle Loads • Flange Types and Gasket Selection • API 660 Requirements for Nozzle Reinforcement*
1330 – 1420	***Welding & Fabrication Requirements*** *API 660 Welding Specifications • Qualification of Weld Procedures and Welders • Common Welding Defects and Inspection Methods • Case Studies on Welding Failures*
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 – 0830	***Inspection & Testing Overview*** *Purpose and Importance of Inspection • API 660 Inspection Criteria • Third-Party Inspection Requirements • Common Non-Conformities in Heat Exchangers*
0830 – 0930	***Non-Destructive Testing (NDT) Methods*** *Radiographic Testing (RT) of Welds • Ultrasonic Testing (UT) for Thickness Measurement • Magnetic Particle Testing (MPT) for Crack Detection • Dye Penetrant Testing (DPT) for Surface Defects*
0930 – 0945	*Break*
0945 – 1100	***Hydrostatic & Pneumatic Testing*** *Hydrostatic Pressure Test Procedures • Pneumatic Pressure test Requirements • Leak Detection Methods and Acceptance Criteria • Safety Precautions during Testing*
1100 – 1215	***Tube Integrity Testing*** *Eddy Current Testing (ECT) for Tube Condition Assessment • Pressure Decay Testing for Tube Leaks • Plugging and Repair Strategies • Case Studies on Tube Failure Detection*
1215 – 1230	*Break*
1230 – 1330	***Quality Assurance & Documentation*** *Manufacturer's Quality Control Procedures • Material Traceability and Certification • API 660 Documentation Requirements • Audit and Compliance Checks*

1330 – 1420	***Factory Acceptance Testing (FAT) & Site Acceptance Testing (SAT)*** *FAT Procedure and Checklist • SAT Requirements and Site Verification • Common Issues during Acceptance Tests • Client Involvement in Testing processes*
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 – 0830	***Heat Exchanger Operational Considerations*** *Startup and Shutdown Procedures • Operating Parameter Monitoring • Efficiency Optimization Techniques • Impact of Process Changes on Performance*
0830 – 0930	***Common Heat Exchanger Failures*** *Fouling and Scaling Issues • Tube-Side and Shell-Side Corrosion • Vibration and Mechanical Damage • Gasket Leaks and Sealing Problems*
0930 – 0945	*Break*
0945 – 1100	***Cleaning & Maintenance Procedures*** *Online versus Offline Cleaning Methods • Chemical Cleaning and its Effectiveness • Mechanical Cleaning Techniques (Rodding, Hydro-Jetting) • Preventive Maintenance Scheduling*
1100 – 1215	***Performance Monitoring & Optimization*** *Key Performance Indicators (KPIs) for Heat Exchangers • Monitoring Heat Transfer Efficiency • Identifying and Resolving Performance Drops • Energy-Saving Techniques and Case Studies*
1215 – 1230	*Break*
1230 – 1330	***Retrofitting & Upgrades*** *When to Consider a Heat Exchanger Upgrade • Changes in Process Conditions and Design Modifications • Using Enhanced Tubes for Efficiency Improvement • Upgrading Materials for Extended Service Life*
1330 – 1420	***Troubleshooting & Root Cause Analysis*** *Systematic Troubleshooting Approach • Identifying Root Causes of Exchanger Failures • Corrective Actions and Long-Term Solutions • Case Studies on Exchanger Failures and Corrective Actions*
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 Four*

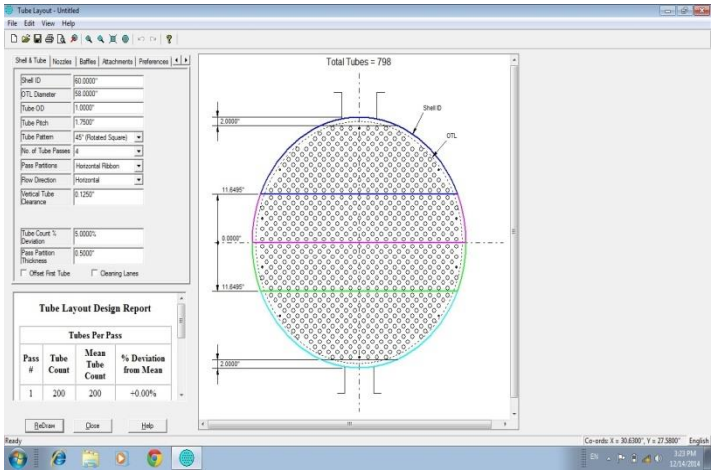
Day 5

0730 – 0830	***Advanced Heat Transfer Enhancements*** *Use of Extended Surface Tubes • Helix Baffles and Other Innovative Designs • Computational Fluid Dynamics (CFD) in Design • Case Studies on Heat Transfer Improvements*
0830 – 0930	***Special Service Heat Exchangers*** *Heat Exchangers for Cryogenic Applications • High-Pressure and High-Temperature Exchangers • Offshore and Marine Heat Exchanger Applications • API 660 Compliance for Specialized Services*
0930 – 0945	*Break*

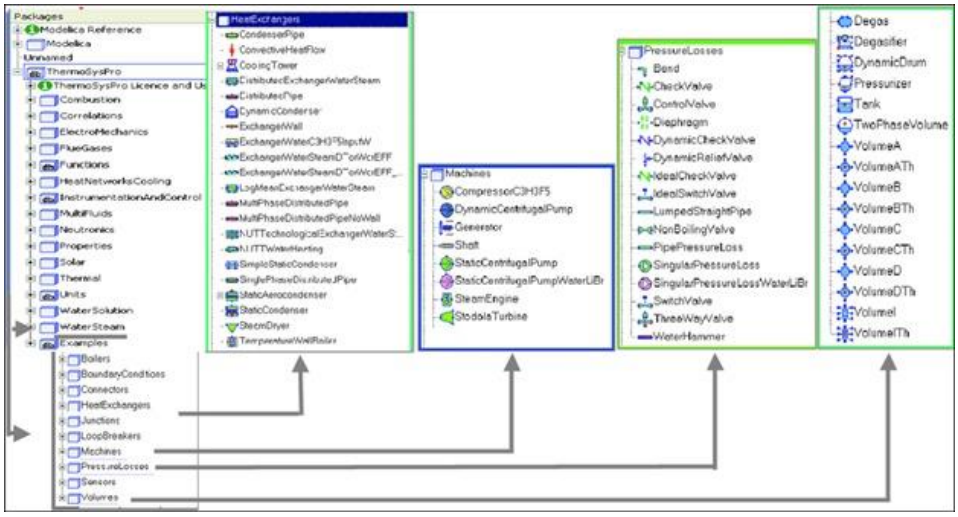
0945 – 1100	***Economic & Environmental Considerations*** *Lifecycle Cost Analysis of Heat Exchangers • Energy Efficiency and Emission Reduction Strategies • Sustainable Materials for Heat Exchanger Construction • Green Engineering Practices in Heat Exchanger Design*
1100 – 1215	***API 660 Compliance Audits*** *Preparing for API 660 Compliance Audits • Common Audit Findings and Corrective Actions • Documentation and Record-Keeping Best Practices • Case Studies on API Compliance Failures*
1215 – 1230	*Break*
1230 – 1345	***Case Studies & Real-World Applications*** *Analysis of Failed and Successful Exchanger Designs • API 660 Implementation in Major Industries • Lessons Learned from Past Failures • Interactive Group Discussions on Case Studies*
1330 – 1345	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about t Topics that were Covered During the Course*
1345 – 1415	***POST-TEST***
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 simulator "Heat Exchanger Tube Layout" and "ThermoSysPro".



Heat Exchanger Tube Layout Simulator



ThermoSysPro

Course Coordinator

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