COURSE OVERVIEW PE0322
Refrigeration System Commissioning, Operation and troubleshooting

Course Title
Refrigeration System Commissioning, Operation and troubleshooting

Course Reference
PE0322

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

Course Date/Venue

Session(s)	Date	Venue
1	May 04-08, 2025	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
2	July 06-10, 2025	
3	November 02-06, 2025	

Course Description

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

Refrigeration systems are common in the natural gas processing industry and processes related to the petroleum refining, petrochemical, and chemical industries. Several applications for refrigeration include NGL recovery, LPG recovery, hydrocarbon dew point control, reflux condensation for light hydrocarbon fractionators and LNG plants.

Selection of a refrigerant is generally based upon temperature requirements, availability, economics and previous experience. For instance, in a natural gas processing plant, ethane and propane may be at hand; whereas in an olefins plant, ethylene and propylene are readily available. Propane or propylene may not be suitable in an ammonia plant because of the risk of contamination, while ammonia may very well serve the purpose. Halocarbons have been used extensively because of their non-flammable characteristics.

This course is designed to provide participants with a detailed and up-to-date overview of refrigeration system commissioning, operation and troubleshooting. It covers the discuss mechanical refrigeration, refrigeration stages and condensing temperature, carryout horsepower and condenser duty estimation as well as design and operating considerations, apply considerations for vacuum refrigeration systems and identify the types of compressors, recognize mixed refrigerants, chillers an system controls as well as recognize absorption refrigeration and carryout principles of refrigeration processes.

During this interactive course, participants will learn the illustrating of cryogenic processes and constant – temperature refrigeration processes, identifying the need for refrigerant including optimum mixture composition, natural gas liquefaction process and cooling and liquefaction of air and its constituents, employing proper troubleshooting and problem solving processes, implementing the rules of thumb for troubleshooting and problem solving skills, applying gathering skills and interpersonal skills.

Course Objectives

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

- Apply systematic techniques on refrigeration commissioning, operation and troubleshooting
- Discuss mechanical refrigeration, refrigeration stages and condensing temperature
- Carryout horsepower and condenser duty estimation as well as design and operating considerations
- Apply various considerations for vacuum refrigeration systems and identify the types of compressors
- Recognize mixed refrigerants, chillers and system controls as well as recognize absorption refrigeration and carryout principles of refrigeration processes
- Illustrate of cryogenic processes and constant – temperature refrigeration processes
- Identify the need for refrigerant including optimum mixture composition, natural gas liquefaction process and cooling and liquefaction of air and its constituents
- Employ proper troubleshooting and initial problem solving processes
- Implement the rules of thumb for troubleshooting and problem solving skills
- Apply gathering skills and interpersonal skills

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 a complete and up-to-date overview of refrigeration system commissioning, operation and troubleshooting for process engineers, production engineers, operations engineers and other technical staff.

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:

Mr. Karl Thanasis, PEng, MSc, MBA, BSc, is a **Senior Engineer** with over **30 years** of practical experience within the **Oil**, **Gas**, **Refinery** and **Petrochemical** industries. His wide expertise includes **Process Plant** Optimization Technology & Continuous Improvement, **Process Engineering Calculations**, **Process Plant** Start Up & Commissioning, Applied **Process Engineering** Elements**,** **Coke Cooler**, **Process Plant** Start-up & Commissioning, **Process Plant** Troubleshooting, **Operations Abnormalities & Plant Upset**, **Process Equipment** Applications & Troubleshooting, **Process Plant Performance & Efficiency**, **Gas Sweetening & Sulphur Recovery**, **Distillation-Column** Control & Troubleshooting, **Oil Movement & Troubleshooting**, **Process Plant Operations & Control**, **Process Equipment** Operation, **Fired Heaters & Air Coolers** Maintenance, **Heat Exchangers**, **Pumps & Compressors**, **Crude Desalter**, **Pressure Vessels & Valves**, **Steam Trapping & Control**, **Pumps & Valve** Maintenance & Troubleshooting, **Turbomachinery**, **Mechanical Alignment**, **Rotating Equipments**, **Diesel Generators**, **Lubrication** Technology, **Bearing**, **Predictive & Preventive** Maintenance, **Root Cause Analysis**, **Boilers**, **Oil Field** Operation, **Production** Operation, Plant Operation & Commissioning, **Crude Oil De Salting** Process, **Gas Conditioning**, **NGL Recovery & NGL Fractionation**, **Flare** System, **Storage Tanks**, **Oil Recovery** System and **Chemical Injection**.

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 a **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**) and a **Certified Instructor/Trainer**.

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.

Accommodation

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

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 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 – 1030	***Mechanical Refrigeration*** *Refrigeration Cycle ● Expansion Step ● Evaporation Step ● Compression Step ● Condensation Step ● System Pressure Drop*
1030 – 1045	*Break*
1045 – 1115	***Refrigeration Stages*** *One-Stage System ● Two-Stage System ● Three-Stage System ● System Configuration*
1115 – 1215	***Condensing Temperature*** *Refrigerant Subcooling ● Refrigerant Cascading ● Refrigerant Properties*
1215 – 1315	***Horsepower & Condenser Duty Estimation*** *One-Stage System ● Two-Stage System ● Three-Stage System*
1315 – 1330	*Break*
1330 – 1420	***Design & Operating Considerations*** *Oil Removal ● Liquid Surge & Storage ● Vacuum Systems*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***Considerations for Vacuum Refrigeration Systems*** *Materials of Construction ● Refrigerant Purity ● Seal Gas & Lube Oil System*
0930 – 1030	***Types of Compressors*** *Centrifugal Compressors ● Reciprocating Compressors ● Screw Compressors (Operation & Upkeep) ● Rotary Compressors*
1030 – 1045	*Break*
1045 – 1145	***Mixed Refrigerants***
1145 - 1245	***Chillers*** *Kettle Type Chiller ● Plate-Fin Chillers*

1245 - 1300	*Break*
1300 - 1420	***System Controls*** *Level Controls ● Pressure Controls ● Evaporator Temperature ● Low Ambient Controls ● Control of Refrigerant Losses*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Absorption Refrigeration Processes*** *Lithium Bromide-Water Systems ● Aqueous Ammonia System ● Reliability ● Design Flexibility ● Applications*
0930 – 1100	***Principles of Refrigeration Processes*** *Applications ● Sign Convention ● Ideal Refrigeration & Liquefaction ● Processes ● Exergy ● Exergy Loss & Exergy Efficiency ● Exergy Efficiency of Processes without any Work Interaction ● Performance of an Ideal Gas Cooler Operating with a Non-Ideal Expander ● Precooled Ideal Liquefaction Process ● Linde-Hampson Refrigerators & Liquefiers ● Joule-Thomson Coefficient ● Exergy Efficiency of a Linde-Hampson Liquefier ● Temperature Profiles in Heat Exchangers Operating with Single Phase Fluids ● Heat Exchanger Effectiveness ● Exergy Efficiency of the Solvay & Linde-Hampson Liquefaction Processes ● The Kapitza Liquefaction Process & its Variants ● Pinch Points ● Types of Refrigerant Mixtures ● Function & Maintenance of Purge Unit in Propane Refrigerant Plant*
1100 – 1115	*Break*
1115 – 1215	***Simulation of Cryogenic Processes*** *Sequential Modular Simulators ● Equation-Oriented Simulators ● Simultaneous Modular Simulators ● Simulation of Heat Exchangers with Pinch Points ● Optimization of a Kapitza Nitrogen Liquefier*
1215 – 1315	***Constant-Temperature Refrigeration Processes*** *Gas Refrigerant Supply & Liquid Refrigerant Supply (GRS/LRS) Process ● Linde-Hampson Refrigerators Operating with Refrigerant Mixtures ● Mixed Refrigerant Linde-Hampson Refrigerator Operating at 90 K in GRS Mode ● Mixed Refrigerant Linde-Hampson Refrigerator Operating at 100 K in LRS Mode ● Effect of the Addition of Neon or Helium ● Effect Precooling ● Mixed Refrigerant Process Refrigerator with a Phase Separator ● Mixed Refrigerant Process Refrigerators with Multiple Phase Separators*
1315 – 1330	*Break*
1330 – 1420	***Need for Refrigerant Mixtures*** *Refrigeration Systems ● Exergy Efficiency of Ideal Linde-Hampson Refrigeration Operating with Refrigerant Mixtures ●Cooling of Gases using mixed Refrigerant Process ● Linde Gas Cooler Operating with Mixtures ● Liquefaction of Natural Gas*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4

0730 – 0830	***Optimum Mixture Composition*** *Choice of Mixture Constituents • Optimization of Mixture Composition for Refrigeration Processes • Example: Linde-Hampson Refrigerator Operating in GRS Mode at 80 K • Comparison of Performance of a Linde-Hampson Refrigerator Operating in GRS Mode at 92 K with Mixtures Obtained Using the Method of Dobak et al. & the Present Method • Optimization of Mixture Composition & Operating Pressures of Liquefaction Processes*
0830 – 1000	***Natural Gas Liquefaction Processes*** *Classification of Natural Gas Liquefaction Processes • Classical Cascade Processes • Assumptions • Single-Stage Mixed Refrigerant LNG Process without Phase Separators • Precooled LNG Process without Phase Separators • LNG Processes with a Phase Separator • Precooled LNG Process with a Phase Separator • Propane Precooled Phase Separator (C3-MR) Process • Mixed Refrigerant Precooled Phase Separator (DMR) Processes • Cascade Liquefaction Process Operating with Mixtures • LNG Processes with Turbines*
1000 – 1015	*Break*
1015 – 1115	***Cooling & Liquefaction of Air & its Constituents*** *Single-Stage Processes for the Sensible Cooling of a Pure Fluid such as Nitrogen • Single-Stage Process for the Liquefaction of Pure Fluids such as Nitrogen • Mixed Refrigerant Precooled Linde-Hampson Liquefaction Process • Mixed Refrigerant Precooled Kapitza Liquefaction Process • Liquefaction of Nitrogen using the Kleemenko Process • Other Liquefaction Processes & Refrigerants*
1115 – 1215	***What is Troubleshooting?*** *Characteristics of a Trouble-Shooting Problem • Characteristics of the Process Used to Solve Trouble-Shooting Problems • Routine Maintenance & Troubleshooting • Hands On Practice • Safety*
1215 – 1230	*Break*
1230 – 1330	***Self-Assessment & Case Studies***
1330 – 1420	***The Mental Problem-Solving Process*** *Problem Solving • Troubleshooting • Mechanical Integrity Testing & Pre-Commissioning • Performance Trials & Design Specifications • Efficient Operation of the System • Overall Summary of Major Skills & a Worksheet • Example Use of the Trouble-Shooter's Worksheet*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

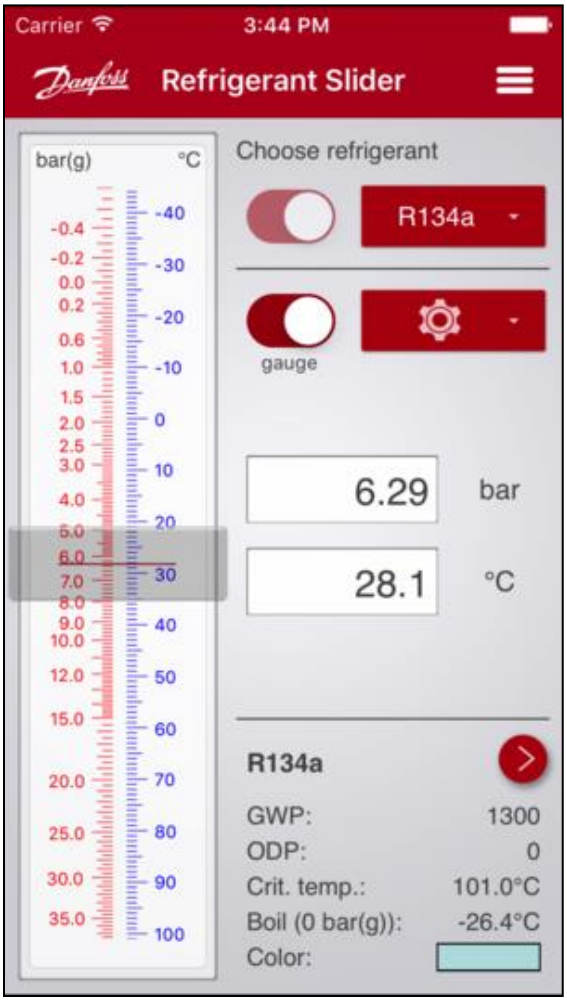
Day 5

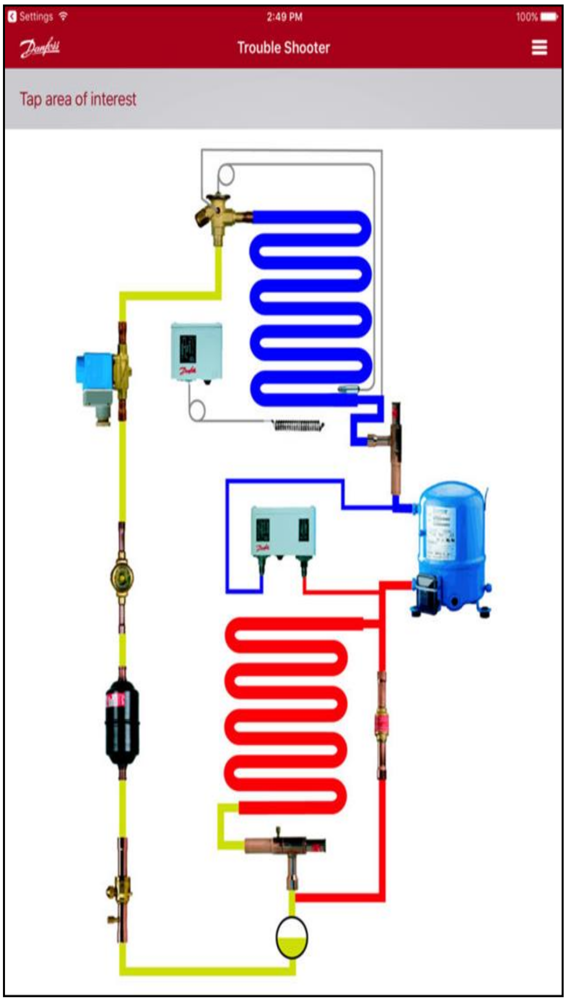
0730 – 0830	***Rules of Thumb for Troubleshooting*** *Overall • Transportation Problems • Energy Exchange • Homogenous Separation • Heterogenous Separations • Reactor Problems • Mixing Problems • Size-Decrease Problems • Size Enlargement • Vessels, Bins, Hoppers & Storage Tanks • Electrical Panel & Automation • Instrument & Controls • "Systems" Thinking • Health, Fire & Stability*
0830 – 0930	***Case Study Observation***
0930 – 0945	*Break*
0945 – 1045	***Problem Solving Skills*** *Developing Awareness of the Problem-Solving Process • Strategies • Exploring the "Context": What is the Real Problem? • Creativity • Self-Assessment*

1045 – 1145	***Data Gathering Skills*** *How to Select Valid Diagnostic Actions ● Consistency: Definitions, Cause-Effect & Fundamentals ● Classification ● Recognizing Patterns ● Reasoning*
1145 – 1200	*Break*
1200 – 1300	***Interpersonal Skills*** *Interpersonal Skills ● Factors that Affect Personal Performance ● The Environment*
1300 – 1345	***Case Studies - Working in Groups*** *Case Study chosen from a list by the class*
1345 – 1400	***Course Conclusion***
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

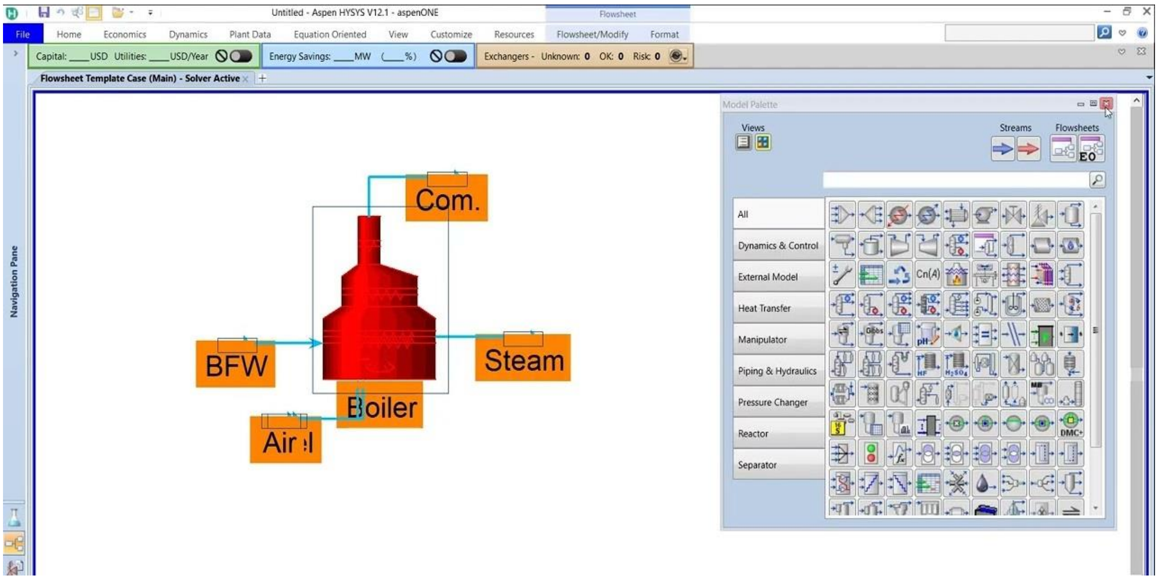
Simulator (Hands-on Practical Sessions)

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 simulator “Danfoss Refrigerant Slider App”, “Danfoss Trouble Shooter App” and “ASPEN HYSYS” simulator.





Danfoss Refrigerant Slider App **Danfoss Troubleshooter App**



ASPEN HYSYS V12.1 Simulator

Course Coordinator
Mari Nakintu, Tel: +971 2 30 91 714, Email: mari1@haward.org