COURSE OVERVIEW RE0957
Troubleshooting Techniques

Course Title
Troubleshooting Techniques

Course Date/Venue
July 06-10, 2025/Meeting Plus 9, City Centre Rotana, Doha, Qatar

Course Reference
RE0957

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.

This course is designed to provide participants with a detailed and up-to-date overview of process equipment maintenance and troubleshooting. It covers the basics of rotating equipment; the categories of pumps; the theory of operation of centrifugal pumps; the types of compressors and performance management; the positive displacement, reciprocating, trunk piston, sliding crosshead piston, diaphragm, bellows, rotary, screw, and lobe type air compressors; and the operation and characteristics of centrifugal and axial compressors.

During this interactive course, participants will learn the performance characteristics of turbines; the types and major turbine components of turbines; the gas turbine cycles; the configuration of fans and blowers; the performance correction and capacity control on fans and blowers; the mechanical seals, bearings and lubrication; the proper maintenance, re-rerating, retrofitting and troubleshooting of rotating equipment; the static equipment basics, pressure vessels (drums, columns, reactors), heat exchangers, non pressure components, storage tanks, boilers and burners, piping system, valves and static equipment failure modes; and the maintenance of mechanical equipment and troubleshooting of failure analysis.

Course Objectives

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

- Apply systematic techniques on process equipment maintenance and troubleshooting
- Discuss the basics of rotating equipment covering pumps, compressors, turbines, fans/blowers, flow diagram and operation of rotating equipment
- Recognize the categories of pumps that include dynamic and displacement, reciprocating and rotary
- Discuss the theory of operation of centrifugal pumps as well as describe radial thrust, axial thrust and hydrostatic pressure tests
- Identify the types of compressors and carryout performance management
- Differentiate positive displacement, reciprocating, trunk piston, sliding crosshead piston, diaphragm, bellows, rotary, screw, lobe type air compressors and etc.
- Discuss the operation and characteristics of centrifugal and axial compressors
- Describe the performance characteristics of turbines and identify types and major components of turbines
- Illustrate the gas turbine cycles covering reversible cycles with ideal gases, combustion processes and stoichiometric
- Configure fans and blowers as well as review performance and system effects
- Carryout performance correction and capacity control on fans and blowers
- Recognize mechanical seals, bearings and lubrication
- Carryout proper maintenance, re-rerate and retrofit of rotating equipment and troubleshoot rotating equipment in a professional manner
- Discuss static equipment basics and identify pressure vessels (drums, columns, reactors), heat exchangers, non pressure components, storage tanks, boilers and burners, piping system, valves and static equipment failure modes
- Employ systematic maintenance of mechanical equipment and troubleshoot extension of failure analysis

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 covers systematic techniques on process equipment maintenance and troubleshooting for mechanical engineers, rotating equipment engineers, supervisors and other technical staff. Further, the course is also beneficial to those who are involved in the selection, sizing, applications, operation, testing, troubleshooting, maintenance and failure analysis of pumps, compressors, turbines and motors.

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 Fee

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

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. Andrew Ladwig is a **Senior Process & Mechanical Maintenance Engineer** with over **25 years** of extensive experience within the **Oil & Gas**, **Refinery**, **Petrochemical & Power** industries. His expertise widely covers in the areas of **Ammonia Manufacturing & Process Troubleshooting**, **Distillation Towers**, **Crude Oil Distillation**, **Ammonia Storage & Loading** Systems, **Operational Excellence** in **Ammonia Plants**, **Fertilizer Storage** Management (Ammonia & Urea), **Fertilizer Manufacturing** Process Technology, **Sulphur Recovery**, Phenol Recovery & Extraction, **Refining Process & Petroleum Products**, **Refinery Planning & Economics**, **Hydrotreating & Hydro-processing**, **Separators** in **Oil & Gas** Industry, **Gas Testing & Energy** Isolations, **Industrial Liquid Mixing**, **Extractors**, **Fractionation**, **Water Purification**, **Water Transport** & Distribution, **Environmental Emission Control**, **Process Plant** Troubleshooting & Engineering Problem Solving, **Process Plant Performance**, **Plant Startup & Shutdown**, **Process Troubleshooting** Techniques and Oil & Gas Operation/Surface Facilities. Further, he is also well-versed in **Rotating Machinery** (**BRM**), **Rotating Equipment** Operation & Troubleshooting, Root Cause Analysis (**RCA**), **Process Plant** Shutdown, Turnaround & Troubleshooting, Planning & Scheduling **Shutdowns & Turnarounds**, Optimizing **Equipment Maintenance** & Replacement Decisions, **Maintenance Planning & Scheduling**, **Material Cataloguing**, Maintenance, Reliability & Asset Management Best Practices, **Storage Tanks Operations** & Measurements, **Tank** Inspection & Maintenance, **Pressure Vessel** Operation, **Flare & Relief** System, **Flaring System** Operation, **PSV** Inspection & Maintenance, **Centrifugal & Reciprocating Compressor**, **Screw Compressor** Troubleshooting, **Heat Exchanger** Overhaul & Testing, **Pipe Stress** Analysis, **Control Valves & Actuators**, **Vent & Relief System**, **Centrifugal & Reciprocating Pump** Installation & Repair, **Heat Exchanger** Troubleshooting & Maintenance, **Steam Trapping & Control**, **Control & ESD** System and Detailed Engineering Drawings, Codes & Standards.

During his career life, Mr. Ladwig has gained his practical experience through his various significant positions and dedication as the **Mechanical Engineer**, **Project Engineer**, **Reliability & Maintenance Engineer**, **Maintenance Support Engineer**, **Process Engineer**, **HSE Supervisor**, **Warehouse Manager**, **Quality Manager**, **Business Analyst**, **Senior Process Controller**, **Process Controller**, **Safety Officer**, **Mechanical Technician**, **Senior Lecturer** and **Senior Consultant/Trainer** for various companies such as the Sasol Ltd., Sasol Wax, Sasol Synfuels, just to name a few.

Mr. Ladwig has a **Bachelor's** degree in **Chemical Engineering** and a **Diploma** in **Mechanical Engineering**. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**) and has delivered various trainings, workshops, seminars, courses and conferences internationally.

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: ***Sunday, 06th of July 2025***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Rotating Equipment Basics*** *Types of Equipment • Pumps • Compressors • Turbines • Fans/Blowers • Flow Diagram of Rotating Equipment • Operation of Rotating Equipment*
0930 – 0945	*Break*
0945 – 1030	***Pumps*** *Definition & Categories: Dynamic & Displacement, Reciprocating & Rotary • Centrifugal Pumps: Theory of Operation, Casings & Diffusers, Radial Thrust, Hydrostatic Pressure Tests*
1030 – 1130	***Pumps (cont'd)*** *Impeller, Axial Thrust, Axial Thrust in Multistage Pumps, Hydraulic Balancing Devices, Balancing Drums, Balancing Disks*
1130 – 1230	***Pumps (cont'd)*** *Mechanical Seals, Bearings, Couplings, Bedplates, Minimum Flow Requirement • Centrifugal Pumps General Performance Characteristics, Cavitation, Net Positive Suction Head*
1230 – 1245	*Break*
1245 – 1330	***Compressors*** *Compressor Types & Performance Measurement • Positive Displacement Compressors, Reciprocating Compressors, Trunk Piston Compressors, Sliding Crosshead Piston Compressors, Diaphragm Compressors, Bellows Compressors*
1330 – 1420	***Compressors (cont'd)*** *Rotary Compressors, Rotary Screw Compressor, Lobe Type Air Compressor, Sliding Vane Compressors, Liquid Ring Compressors • Dynamic Compressors, Centrifugal Compressors, Axial Compressors • Air Receivers, Compressor Control, Unloading System • Intercoolers & Aftercoolers, Filters & Air Intake Screens • Preventive Maintenance & Housekeeping*
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: **Monday, 07th of July 2025**

0730 – 0830	***Centrifugal & Axial Compressors*** *Operation & Characteristics • Surging, Choking, Bleed Valves, Variable Stator Vanes, Inlet Guide Vanes*
0830 – 0930	***Turbines*** *Types of Turbines • Industrial Heavy Duty Gas Turbines • Major Turbine Components*
0930 – 0945	*Break*
0945 – 1030	***Turbines (cont'd)*** *Performance Characteristics • Performance Calculations*
1030 – 1130	***Gas Turbine Cycles*** *Reversible Cycles with Ideal Gases • Combustion Processes • Stiochiometric*
1130 – 1230	***Fans & Blowers*** *Types & Configurations • Performance & System Effects*
1230 – 1245	*Break*
1245 – 1330	***Fans & Blowers (cont'd)*** *Performance Correction • Capacity Control Options*
1330 – 1420	***Mechanical Seals*** *Basic Components, Temperature Control, Seal Lubrication/Leakage, Typical Single Inside Pusher Seal • Recommended Maintenance, Vibration Analysis, Equipment Condition*
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: **Tuesday, 08th of July 2025**

0730 – 0830	***Bearings*** *Types of Bearings, Ball & Roller Bearings, Stresses during Rolling Contacts • Statistical Nature of Bearing Life, Materials & Finish, Sizes of Bearings, Types of Rolling Bearings, Thrust Bearings*
0830 – 0930	***Lubrication*** *Viscosity of Lubricants, Flow Through Pipes, Variation of Viscosity with Temperature & Pressure, Viscosity Index • Non-Newtonian Fluids, Greases, VI Improved Oils, Variation of Lubricant Viscosity with Use, Oxidation Reactions, Physical Reactions, Housing & Lubrication, Lubrication of Antifriction Bearings • Oil Analysis: Lube Oil Sampling Technique, Test Description & Significance, Visual & Sensory Inspections, Chemical & Physical Tests, Water Content, Viscosity, Emission Spectrographic Analysis, Infrared Analysis, Total Base Number (TBN), Total Acid Number (TAN), Particle Count*
0930 – 0945	*Break*
0945 – 1030	***Maintenance, Re-rate & Retrofit of Rotating Equipment*** *Case Gasket • Checking for Wear Clearance • Oil Change • Storage • Impeller Cut • NPSH • De-Staging • Electric Motor Sizing • Viscosity Changes*
1030 – 1130	***Troubleshooting of Rotating Equipment*** *Bearing Failures • Bearing Housing Oil Leakage • Cavitation Noise & Damage • Impeller Cavitation/Erosion • Vibration • Cracked Volute Tongues • NPSH • Viscosity Effects*

1130 – 1230	***Static Equipment Basics*** *Types of Equipment • Materials, Welding • Non Destructive Examination • Painting & Protective Coating • Flow Diagrams of Static Equipment • Operation of Static Equipment: Drums, Columns, Reactors, Storage Tanks, Heat Exchangers, Boilers, Pressure Vessels & Piping System • Understanding Static Equipment Drawings: Drafting Exercises*
1230 – 1245	*Break*
1245 – 1330	***Pressure Vessels (Drums, Columns, Reactors)*** *Introduction • Internal Pressure, External Pressure • Nozzle: WRC 107 & 297 for Local Loads • Pressure Vessels Internals (Most Typical) • Fabrication & Erection of Pressure Vessels • Fitness for Purpose of Pressure Vessels (ASME FFS/API 579) • Repairs of Pressure Vessels with ASME PCC2 • Heat Exchangers*
1330 – 1420	***Heat Exchangers*** *Introduction & Definition of Heat Transfer Coefficients • Types of Heat Exchangers • Workshop Practical Session • Industrial Features & Additional Information • Heat Exchanger Analysis in Detail*
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: ***Wednesday, 09th of July 2025***

0730 – 0830	***Heat Exchanger (cont'd)*** *Counter Flow, Cross Flow & Multipass Heat Exchangers • Shell & Tube Heat Exchangers • Heat Exchanger Maintenance (Planning, Precaution Required, Plugging, Ferruling) • Heat Exchanger Maintenance (Sleeving, Shell Side Repairs) • Heat Exchanger Maintenance (Re-Tubing)*
0830 – 0930	***Non Pressure Components*** *Introduction • Loads (Wind & Seismic) • Skirt Calculations • Base Ring & Anchor Bolts • Tall Towers Maintenance*
0930 – 0945	*Break*
0945 – 1030	***Storage Tanks*** *Introduction • Roof Types • API 650 & API 620 • Fabrication of Storage Tanks • Fitness for Service of Storage Tanks*
1030 – 1130	***Boilers & Burners*** *Types of Boilers • Configurations & Characteristics of Each Type • Circulation of Boiler Water • Boiler Fluid Flow Paths*
1130 – 1230	***Boilers & Burners (cont'd)*** *Feedwater • Steam or Hot Water • Gas Burners • Oil Burners • Combination Gas/Oil Burners • Boiler Maintenance & Protection*
1230 – 1245	*Break*
1245 – 1330	***Piping System*** *Introduction to Piping • Piping Components • Piping Materials • Fabrication & Installation of Piping*

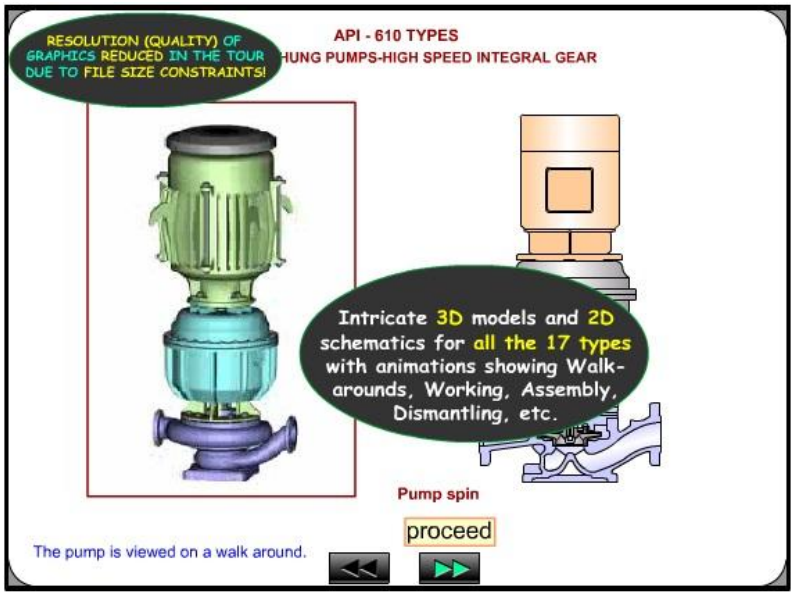
1330 – 1420	***Piping System (cont'd)*** *Bolted Joints • Piping Layout • Piping Supports • Pressure & Leak Testing of Piping Systems*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Four*

Day 5: Thursday, 10th of July 2025

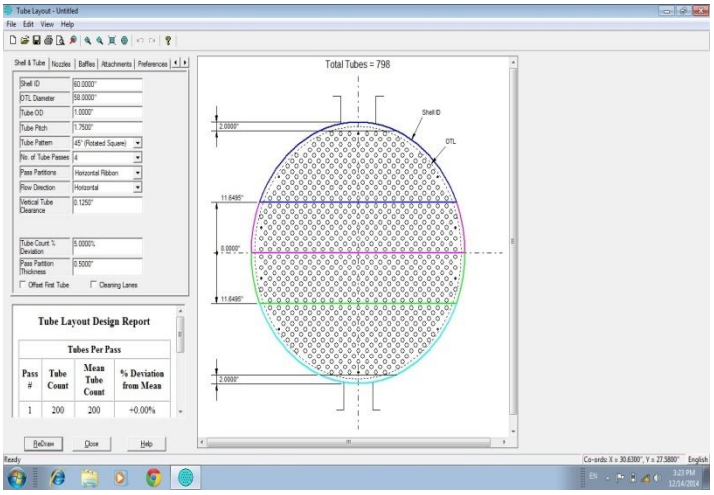
0730 – 0830	***Valves*** *Valve Theory • Valve Types • Applications • Functions • Operations • Maintenance • Troubleshooting • Control Valves & Actuators*
0830 – 0930	***Static Equipment Failure Modes*** *How to Determine What Failure Modes Each Technology can Detect • How Identify the Common Traps of Each Technology • How to Build a Stationary Asset Health Matrix*
0930 – 0945	*Break*
0945 – 1030	***Static Equipment Failure Modes (cont'd)*** *How to Balance Workflow Maturity with Coverage • How to Apply Benchmark Data & Asset Criticality to "Design the Coverage" Model*
1030 – 1130	***Maintenance of Mechanical Equipment*** *Selecting Maintenance Approaches • Inspection Regimes • Analytical On-Line Condition Monitoring*
1130 – 1230	***Troubleshooting as an Extension of Failure Analysis*** *Causes of Machine Failures • The "7-Cause Category Approach" to Root Cause Failure Analysis • Techniques • The Matrix Approach • The Cause & Effect Principle*
1230 – 1345	*Break*
1230 – 1345	***Troubleshooting as an Extension of Failure Analysis (cont'd)*** *Bearings • Journal & Tilt-Pad Thrust Bearings • Patterns of Load Paths & their Meaning in Bearing Damage • Noise Signature Recordings • Action Planning & Decision-Making*
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)

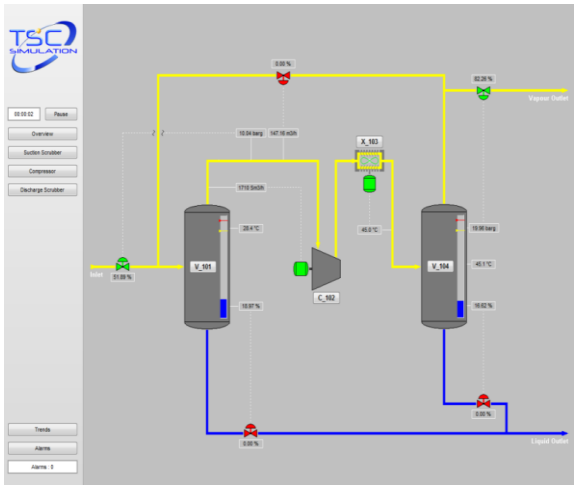
Hands-on practical sessions will be arranged for all participants throughout the course duration using "Centrifugal Pumps and Troubleshooting Guide 3.0", "Heat Exchanger Tube layout Simulator", "SIM 3300 Centrifugal Compressor Simulator", "CBT on Compressors", "Steam Turbines & Governing System CBT", "Win Boiler Sim", "Valve Sizing Software", "Valve Software 3.0", "Valvestar 7.2 Software" and "PRV2SIZE Software" and "iLearnVibration Simulator", "MTBF Calculator" and "ManWinWin Express CMMS Software".



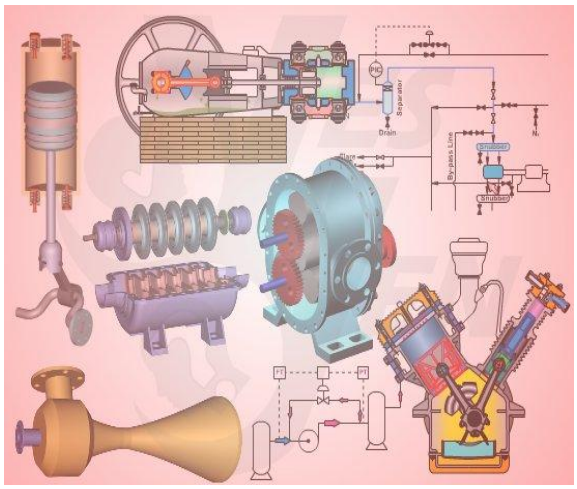
Centrifugal Pumps and Troubleshooting Guide 3.0



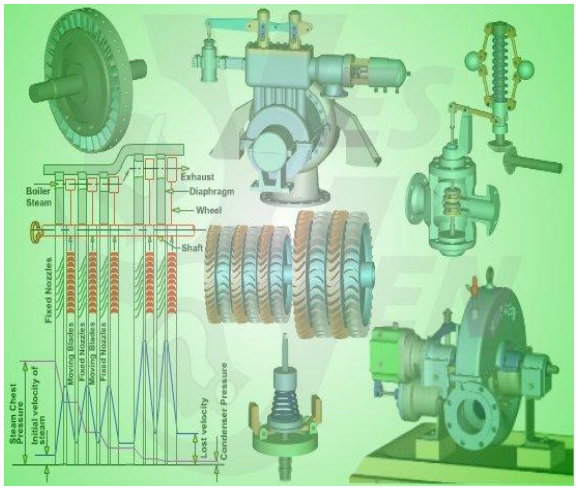
Heat Exchanger Tube Layout Simulator



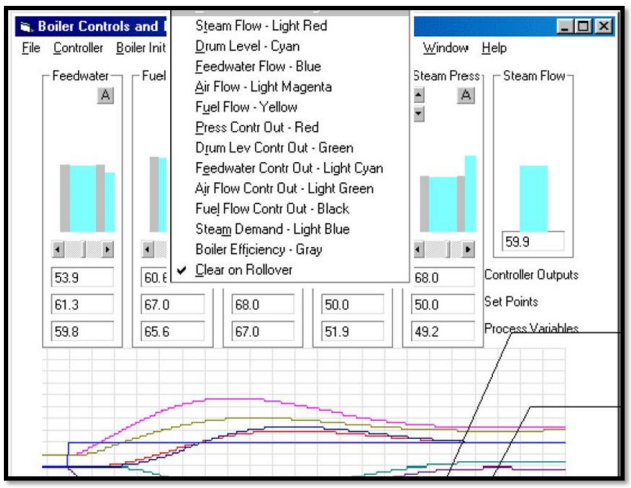
SIM 3300 Centrifugal Compressor Simulator



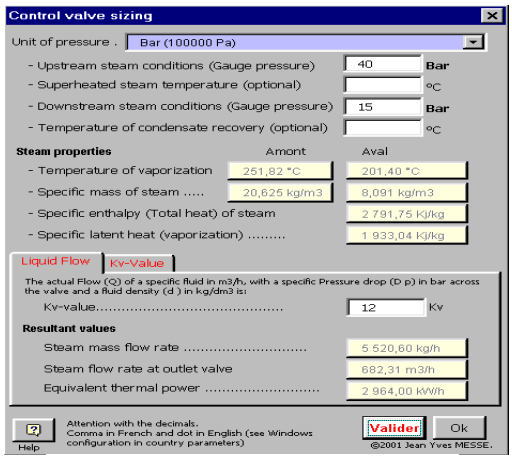
CBT on Compressors



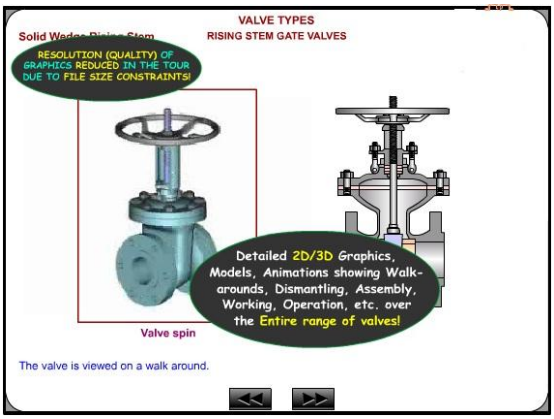
Steam Turbines & Governing System CBT



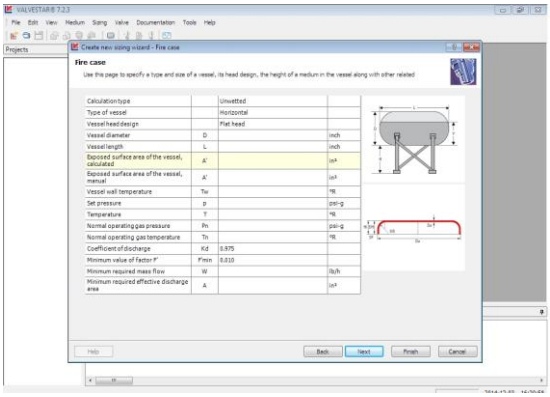
Win Boiler Sim



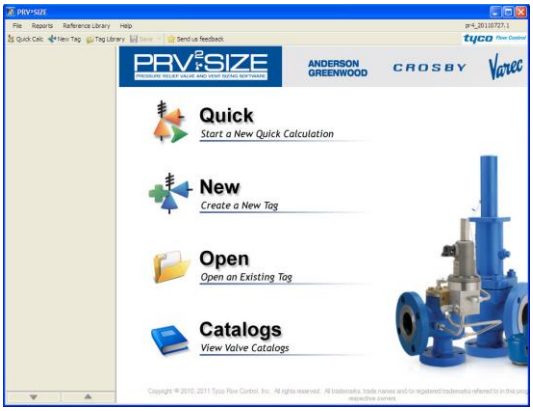
Valve Sizing Software



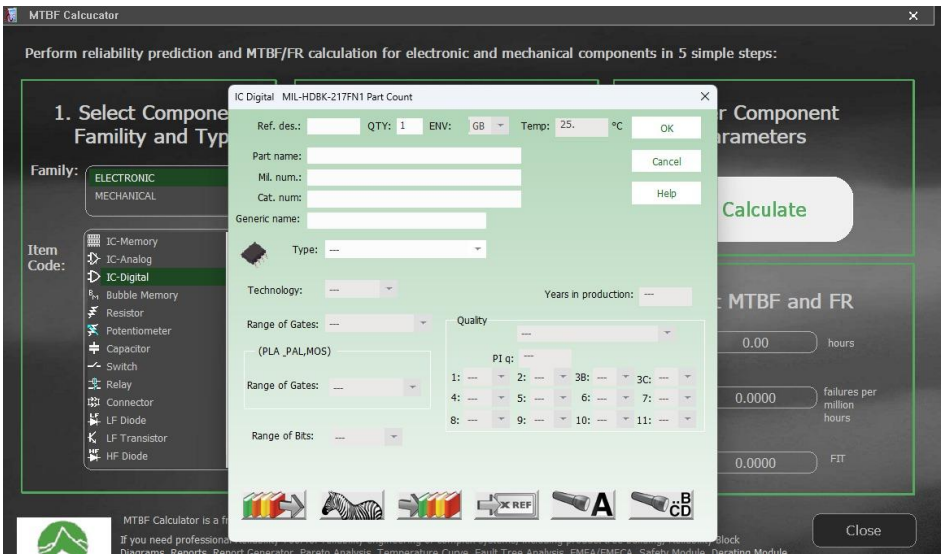
Valve Software 3.0



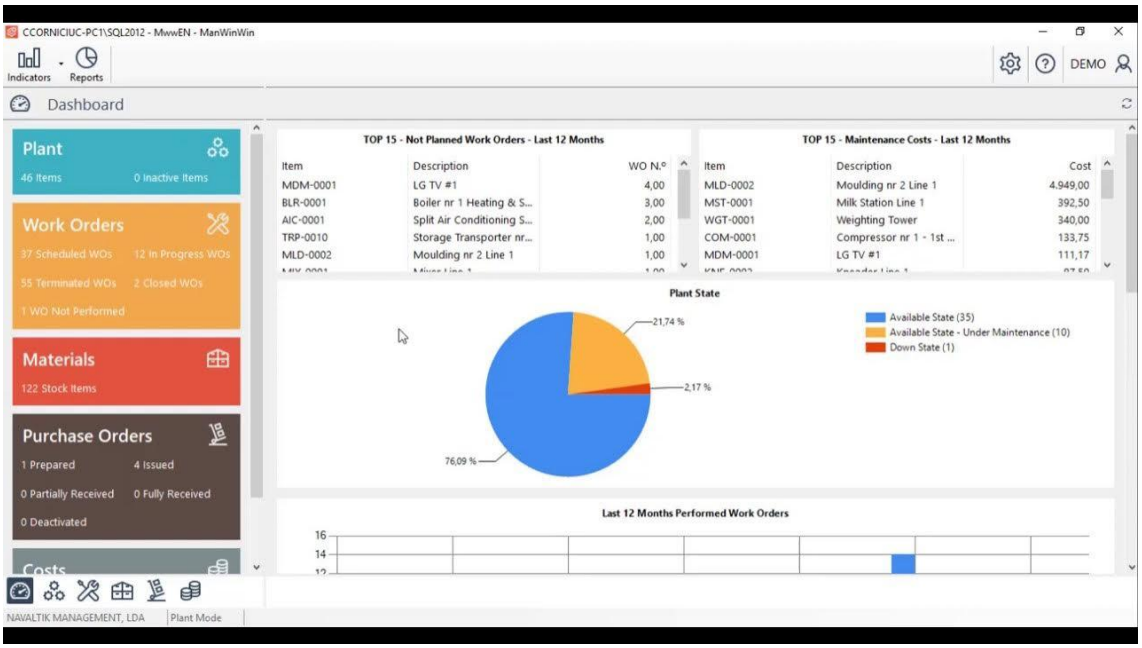
Valvestar 7.2 Software



PRV²SIZE Software



MTBF Calculator



ManWinWin Express CMMS Software

Course Coordinator

Reem Dergham, Tel: +974 4423 1327, Email: reem@haward.org