



COURSE OVERVIEW IE0103

Flow Measurement and Custody Transfer

Course Title

Flow Measurement and Custody Transfer

Course Date/Venue

November 09-13, 2025/The Victoria Meeting Room, The H Hotel, Sheikh Zayed Road Trade Centre, Dubai, UAE

Course Reference

IE0103

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 Flow Measurement and Custody Transfer. It covers the basic fluid mechanics, gas properties and flow measurement principles; the types of flow measurement devices, installation requirements and meter run design; the international standards, regulatory requirements and differential pressure meters; the orifice plate installation and maintenance, venturi, nozzle and cone meters; the turbine flow meters, flow conditioning, metering accuracy, performance monitoring and error detection; and the ultrasonic flow meter fundamentals, ultrasonic meter installation and calibration.



During this interactive course, participants will learn the coriolis flow meters, vortex flow meters, comparison of metering technologies and digital and smart flow measurement; the calibration, meter proving and verification; the temperature, pressure and density measurement; the gas composition and energy measurement, uncertainty and error analysis, data validation and reconciliation; the custody transfer standards and codes, metering systems and station design; the flow computers and data management, metering audits and verification reports; and the discrepancy management procedures, arbitration and resolution mechanisms.



Course Objectives

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

- Apply and gain an advanced knowledge on flow measurement and custody transfer
- Discuss gas flow measurement, basic fluid mechanics, gas properties and flow measurement principles
- Identify types of flow measurement devices, installation requirements and meter run design
- Recognize international standards and regulatory requirements and differential pressure meters
- Apply orifice plate installation and maintenance and describe venturi, nozzle, and cone meters including turbine flow meters
- Illustrate flow conditioning and metering accuracy, performance monitoring and error detection
- Discuss ultrasonic flow meter fundamentals and apply ultrasonic meter installation and calibration
- Recognize coriolis flow meters, vortex flow meters, comparison of metering technologies and digital and smart flow measurement
- Carryout calibration fundamentals, meter proving and verification as well as temperature, pressure and density measurement
- Employ gas composition and energy measurement, uncertainty and error analysis, data validation and reconciliation
- Discuss custody transfer standards and codes, metering systems and station design
- Apply flow computers and data management covering flow computer functions and algorithms, correction factors and standard volume calculations, real-time data transmission to SCADA, audit trail and data integrity management
- Implement metering audits and verification reports, discrepancy management procedures and arbitration and resolution mechanisms

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 flow measurement and custody transfer for instrumentation, inspection, control, custody, metering and process engineers and other technical staff. Further, the course is suitable for senior automation engineers, piping engineers, pipelines engineers, mechanical engineers, operations engineers, maintenance engineers, plant/field supervisors & foreman and loss control coordinators.

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

Haward's 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**. Haward's certificates are internationally recognized and accredited by the British Accreditation Council (BAC). 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\$ 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 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. Ahmed El-Sayed, PhD, MSc, BSc, is a **Senior Electrical & Instrumentation Engineer** with over **30 years** of extensive experience in the **Oil, Gas, Power, Petroleum, Petrochemical** and **Water & Utilities**. He specializes in **Fire Fighting System Instrumentations, Fire Protection System, Fire & Gas Detection & Alarm System, Instrumentation Protection Devices Maintenance & Testing, Protection Devices Troubleshooting, Water Meter Calibration, Liquid & Gas Flowmetering & Meter Calibration, Testing & Calibration of Energy Meters, DCS & ESD System Architecture, Distributed Control System, DCS & SCADA, Distributed Control System (DCS) Selection & Troubleshooting, Advanced DCS Yokogawa, Yokogawa CENTUM VP DCS, Modern**

Distributed Control System (DCS) & Process Instrumentation, Cyber Security of Industrial System, DCS System (Honeywell), DCS Experion System, DCS Siemens Teleperm XP, Relay Coordination Using ETAP Software, Power System Study on ETAP, ETAP-Power System Analysis, Flow Measurement Foundation, Hydrocarbon Measurement & Sampling, Gas Dosiers Preparation, Gas/Liquid Fuel Measurement, Instrumentation Measurement & Control System, Flow Measurement, Pressure Measurement, Level & Temperature Measurement, Measurement Devices & Control System, Instrumentation & Control Systems, Control System Orientation, Uninterruptible Power Supply (UPS) Battery Charger, Industrial UPS Systems Construction & Operation, Test Lead-Acid & Ni-cad Battery Systems, Hazards & Safe Work Practices, Transformer Operational Principles, Selection & Troubleshooting; HV & LV Transformers, Control Valves & Actuators, Electrical Safety, Protection Relay Application, Maintenance & Testing, NEC (National Electrical Code), NESC (National Electrical Safety Code), Electrical Safety, Electrical Hazards Assessment, Electrical Equipment, Personal Protective Equipment, Lock-Out & Tag-Out (LOTO), Confined Workspaces, Alerting Techniques, Electrical Transient Analysis Program (ETAP), Power Quality, Power Network, Power Distribution, Distribution Systems, Power Systems Control, Power Systems Security, Power Electronics, Electrical Substations, UPS & Battery System, Earthing & Grounding, Load Forecasting, Power Generation, Protective Systems, Electrical Generators, Power & Distribution Transformers, Electrical Motors, Switchgears, Transformers, AC & DC Drives, Variable Speed Drives & Generators, Generator Protection, GE Gas Turbines, PLC, SCADA, DCS, Process Control, Control Systems & Data Communications, Instrumentation, Automation, Valve Tuning, SIS, SIL, ESD, Alarm Management Systems, Energy Management System, Engine Management System, Bearing & Rotating Machine, Fieldbus Systems and Fiber Optics Technology. He is currently the **Systems Control Manager of Siemens where he is in-charge of Security & Control of **Power Transmission Distribution & High Voltage** Systems and he further takes part in the Load Records Evaluation & Transmission Services Pricing.**

During his career life, Dr. Ahmed has been actively involved in different Power System Activities including Roles in Power System Planning, Analysis, Engineering, **HV Substation Design**, Electrical Service Pricing, Evaluations & Tariffs, Project Management, Teaching and Consulting. His vast industrial experience was honed greatly when he joined many International and National Companies such as **Siemens, Electricity Authority** and **ACETO** industries as the **Instrumentation & Electrical Service Project Manager, Instrumentation & Control Engineer, Fire Protection Engineer, Energy Management Engineer, Department Head, Assistant Professor, Instrumentation & Control Instructor, Project Coordinator, Project Assistant and Managing Board Member** where he focused more on dealing with Technology Transfer, System Integration Process and Improving Localization. He was further greatly involved in manufacturing some of **Power System** and **Control & Instrumentation Components** such as Series of Digital Protection **Relays, MV VFD, PLC** and **SCADA** System with intelligent features.

Dr. Ahmed is well-versed in different electrical and instrumentation fields like **ETAP**, Load Management Concepts, **PLC** Programming, Installation, Operation and Troubleshooting, **AC Drives** Theory, Application and Troubleshooting, [Industrial Power Systems Analysis](#), **AC & DC Motors**, Electric Motor **Protection, DCS SCADA, Control** and Maintenance Techniques, Industrial Intelligent Control System, **Power Quality** Standards, Power Generators and Voltage Regulators, Circuit Breaker and Switchgear Application and Testing Techniques, **Transformer** and **Switchgear** Application, Grounding for Industrial and Commercial Assets, Power Quality and **Harmonics, Protective Relays** (O/C Protection, Line Differential, Bus Bar Protection and **Breaker Failure Relay**) and Project Management Basics (PMB).

Dr. Ahmed has **PhD, Master's & Bachelor's** degree in **Electrical Engineering** from the **University of Wisconsin Madison, USA** and **Ain Shams University**, respectively. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/ Assessor/Trainer** by the **Institute of Leadership and Management (ILM)**, an active member of **IEEE** and **ISA** as well as numerous technical and scientific papers published internationally in the areas of Power Quality, Superconductive Magnetic Energy Storage, SMES role in Power Systems, Power System **Blackout** Analysis, and Intelligent Load Shedding Techniques for preventing Power System Blackouts, **HV Substation Automation** and Power System Stability.



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, 09th of November 2025

0730 – 0800	Registration & Coffee
0800 – 0815	Welcome & Introduction
0815 – 0830	PRE-TEST
0830 – 0930	Introduction to Gas Flow Measurement Overview of Gas Metering in Oil & Gas Industry • Importance of Accurate Flow Measurement • Legal and Fiscal Implications of Measurement Errors • Overview of Metering Station Components
0930 – 0945	Break
0945 – 1030	Basic Fluid Mechanics & Gas Properties Gas Laws (Boyle's, Charles's, Ideal Gas Law) • Compressibility and Real Gas Behavior • Flow Regimes (Laminar, Turbulent, Transitional) • Reynolds Number and Flow Profiles
1030 – 1130	Flow Measurement Principles Differential Pressure (DP) Principles • Velocity-Based Flow Measurement Concepts • Volumetric versus Mass Flow Measurement • Conversion Between Standard and Actual Flow
1130 – 1215	Types of Flow Measurement Devices Differential Pressure Meters (Orifice, Cone, Venturi) • Turbine and Ultrasonic Meters • Coriolis and Vortex Meters • Emerging Technologies in Gas Metering
1215 – 1230	Break
1230 – 1330	Installation Requirements & Meter Run Design Straight Pipe Lengths and Flow Conditioners • Effects of Bends, Valves, and Fittings • Meter Orientation and Support Design • Piping Material and Surface Finish Considerations
1330 – 1420	International Standards & Regulatory Requirements ISO 5167, ISO 9951, AGA, API Standards Overview • OIML and ASTM Standards for Custody Transfer • National and Local Regulations in UAE (ADNOC, Dolphin Energy) • Role of Metrological Authorities
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, 10th of November 2025

0730 – 0830	Differential Pressure Meters Principle of Operation • Orifice Plate Design and Types (Concentric, Eccentric, Quadrant) • Flow Coefficient and Beta Ratio Selection • Calculation of Flow Using DP
0830 – 0930	Orifice Plate Installation & Maintenance Orifice Plate Installation and Alignment • Inspection, Cleaning, and Wear Considerations • Effects of Erosion and Deposits on Accuracy • Calibration and Verification Methods
0930 – 0945	Break
0945 – 1100	Venturi, Nozzle, & Cone Meters Comparative Design and Advantages • Pressure Recovery Characteristics • Typical Applications in Gas Systems • Maintenance and Calibration Aspects
1100 – 1215	Turbine Flow Meters Mechanical Design and Principle of Operation • Bearing Selection and Rotor Dynamics • Signal Conditioning and Pulse Output • Error Sources and Correction Factors
1215 – 1230	Break
1230 – 1330	Flow Conditioning & Metering Accuracy Flow Disturbances and Swirl Effects • Flow Straighteners and Conditioners • Meter Run Length Optimization • Uncertainty Analysis
1330 – 1420	Performance Monitoring & Error Detection Detecting Mechanical Wear and Fouling • Comparing Meter Outputs • Trending and Diagnostics • Predictive Maintenance Using Digital Tools
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, 11th of November 2025

0730 – 0830	Ultrasonic Flow Meter Fundamentals Transit-Time and Doppler Measurement Principles • Path Configurations (1, 4, 6, 8 Paths) • Signal Processing and Sound Velocity Corrections • Influence of Gas Composition and Temperature
0830 – 0930	Ultrasonic Meter Installation & Calibration Installation Geometry and Acoustic Path Alignment • Factory and Field Calibration Procedures • Effects of Contamination and Condensation • Verification Using Reference Meters
0930 – 0945	Break
0945 – 1100	Coriolis Flow Meters Operating Principle and Sensor Design • Mass versus Volume Measurement in Gas Flow • Temperature and Pressure Compensation • Calibration and Accuracy Considerations
1100 – 1215	Vortex Flow Meters Principle of Kármán Vortex Shedding • Signal Amplification and Filtering • Rangeability and Gas Composition Effects • Advantages and Limitations
1215 – 1230	Break



1230 – 1330	Comparison of Metering Technologies <i>Accuracy and Repeatability Differences • Pressure Drop and Maintenance Requirements • Suitability by Gas Type and Pressure Conditions • Cost-Benefit Analysis for Field Applications</i>
1330 – 1420	Digital & Smart Flow Measurement <i>Integration with SCADA and DCS Systems • Diagnostics and Self-Monitoring Functions • Digital Twins for Metering Stations • Data Transmission and Cybersecurity</i>
1420 – 1430	Recap <i>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</i>
1430	<i>Lunch & End of Day Three</i>

Day 4: Wednesday, 12th of November 2025

0730 – 0830	Calibration Fundamentals <i>Primary versus Secondary Calibration Standards • Traceability and Reference Systems • Flow Calibration Facilities (Prover, Gravimetric, Bell Prover) • Uncertainty Budget and Error Propagation</i>
0830 – 0930	Meter Proving & Verification <i>Working Principle of Gas Provers • Field Proving and Verification Intervals • Use of Master Meters and Transfer Standards • Calibration Documentation and Reporting</i>
0930 – 0945	<i>Break</i>
0945 – 1100	Temperature, Pressure & Density Measurement <i>Measurement Instrumentation Types • RTD versus Thermocouple Accuracy • Pressure Transmitter Selection and Calibration • Density Measurement and Gas Compressibility Correction</i>
1100 – 1215	Gas Composition & Energy Measurement <i>Chromatograph Operation and Sampling Systems • Calculation of Energy Content (BTU, kWh, Joules) • Use of AGA-8 and ISO 6976 for Gas Properties • Impact of Composition on Metering Accuracy</i>
1215 – 1230	<i>Break</i>
1230 – 1330	Uncertainty & Error Analysis <i>Statistical Treatment of Uncertainty • Sources of Systematic and Random Errors • Combined Uncertainty Budget Development • Reporting and Traceability Requirements</i>
1330 – 1420	Data Validation & Reconciliation <i>Validation of Metering Data • Reconciliation Between Meters and Balance Points • Handling Discrepancies and Adjustments • Reporting in Custody Transfer Systems</i>
1420 – 1430	Recap <i>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</i>
1430	<i>Lunch & End of Day Four</i>



Day 5: Thursday, 13th of November 2025

0730 – 0830	Basics of Custody Transfer <i>Legal and Commercial Importance • Buyer-Seller Agreements and Metering Clauses • Allocation and Balancing Concepts • Contractual Tolerance Limits</i>
0830 – 0930	Custody Transfer Standards & Codes <i>AGA 3, AGA 7, AGA 9, AGA 11 Overview • API MPMS (Manual of Petroleum Measurement Standards) • ISO 6976, ISO 5167, ISO 17089 References • Regional Metrology and Audit Standards</i>
0930 – 0945	<i>Break</i>
0945 – 1100	Metering Systems & Station Design <i>Metering Skid Configuration • Instrumentation and Auxiliary Systems • Bypass Lines and Isolation Valves • Gas Chromatograph and Flow Computer Integration</i>
1100 – 1215	Flow Computers & Data Management <i>Flow Computer Functions and Algorithms • Correction Factors and Standard Volume Calculations • Real-Time Data Transmission to SCADA • Audit Trail and Data Integrity Management</i>
1215 – 1230	<i>Break</i>
1230 – 1300	Custody Transfer Auditing & Dispute Resolution <i>Metering Audits and Verification Reports • Discrepancy Management Procedures • Arbitration and Resolution Mechanisms • Role of Third-Party Inspectors and Certifiers</i>
1300 – 1345	Case Studies & Best Practices <i>Dolphin Energy Gas Metering Systems • Lessons Learned from Field Audits • Preventive Maintenance Strategies • Emerging Technologies in Metering and Transfer</i>
1345 – 1400	Course Conclusion <i>Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course</i>
1400 – 1415	POST-TEST
1415 – 1430	<i>Presentation of Course Certificates</i>
1430	<i>Lunch & End of Course</i>

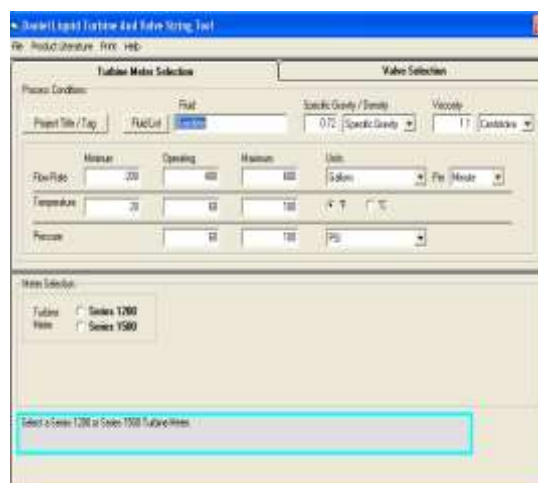


Simulators (Hands-on Practical Sessions)

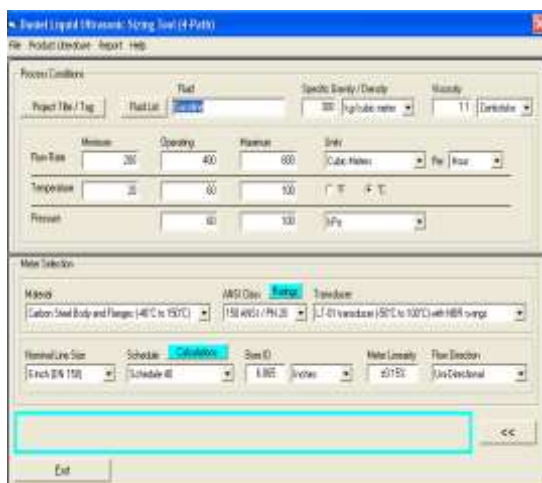
Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using our state-of-the-art “Gas Ultrasonic Meter Sizing Tool”, “Liquid Turbine Meter and Control Valve Sizing Tool”, “Liquid Ultrasonic Meter Sizing Tool” and “Orifice Flow Calculator” simulators.



Gas Ultrasonic Meter (USM) Sizing Tool Simulator



Liquid Turbine Meter and Control Valve Sizing Tool Simulator



Liquid Ultrasonic Meter Sizing Tool Simulator



Orifice Flow Calculator Simulator

Course Coordinator

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