COURSE OVERVIEW FE0570
API 579-1/ASME FFS-1: *Fitness-for-Service (FFS) of Process Plant Equipment, Pressure Vessels, Piping & Storage Facilities*

Course Title
API 579-1/ASME FFS-1: Fitness-for-Service (FFS) of Process Plant Equipment, Pressure Vessels, Piping & Storage Facilities

Course Reference
FE0570

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

Course Date/Venue

Session(s)	Date	Venue
1	January 21-25, 2024	Jubail Hall, Signature Al Khobar Hotel, Al Khobar, KSA
2	April 21-25, 2024	Business Center, Concorde Hotel Doha, Doha Qatar
3	July 28-August 01, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
4	October 28-November 01, 2024	Ajman Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE

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 fitness-for-service (FFS) of process plant equipment, pressure vessels, piping and storage facilities in accordance with API 579-1/ASME FFS-1. It covers the API 579 and ASME FFS-1 standards; the fitness-for-service assessment procedure; the concept of remaining strength factor (RSF); the FFS and degradation mechanisms; the brittle fracture, pitting corrosion, blisters, HIC, SOHIC, distortion, crack-like flaws, creep, dent and gouges, laminations, wall thinning, cracking, embrittlement and mechanical damage; the FFS procedures and level of assessment; and the ASME FFS-1/API-579 procedure, API/ASME FFS levels of assessment, general FFS assessment procedure and failure prevention.

Further, the course will also discuss the piping codes B31, boiler and pressure vessel code sections, storage tanks, other codes and standards, post-construction codes and design margin piping systems; the FFS pipeline, piping, PV and tank; the systematic assessment of existing equipment for brittle fracture; and the brittle fracture features, brittle fracture and material behavior, brittle fracture risk factors and safeguards against brittle fracture.

During this interactive course, participants will learn the measurement of toughness visually; the critical exposure temperature, applicability and limitations of the procedure and data requirements; the assessment techniques and acceptance criteria; the remaining life assessment acceptability for continued service; the assessment of general metal loss and its applicability, limitations and inspection data/thickness measurements; the UT measurements, burst prevention, NDE data mapping and visual examination; the assessment of local thin area; the thickness readings, stress analysis and piping assessment; the proper assessment of pitting corrosion, laminations, weld misalignment, shell distortion, dents, gouges, crack-like flaws, creep and fire damage; the fitness for service assessment for a drilling platform structure and piping following fire damage; the assessment of hydrogen blisters and hydrogen damage as well as fatigue and API 574 piping inspection; and the risk-based inspection, inspection planning and equipment screening.

Course Objectives

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

- Apply and gain an in-depth knowledge on fitness-for-service (FFS) of process plant equipment, pressure vessels, piping and storage facilities in accordance with the latest API 579-1/ASME FFS-1 standard
- Discuss API 579-1 and ASME FFS-1 standards
- Carryout fitness-for-service assessment procedure and explain the concept of remaining strength factor (RSF)
- Determine FFS and degradation mechanisms, brittle fracture, pitting corrosion, blisters, HIC, SOHIC, distortion, crack-like flaws, creep, dent and gouges, laminations, wall thinning, cracking, embrittlement and mechanical damage
- Employ FFS procedures and level of assessment covering ASME FFS-1/API-579 procedure, API/ASME FFS levels of assessment, general FFS assessment procedure and failure prevention
- Review piping codes B31, boiler and pressure vessel code sections, storage tanks, other codes and standards, post-construction codes and design margin piping systems
- Discuss FFS of pipeline, piping, PV and tank
- Apply systematic assessment of existing equipment for brittle fracture
- Identify brittle fracture features, brittle fracture and material behavior, brittle fracture risk factors and safeguards against brittle fracture
- Measure toughness visually and discuss critical exposure temperature, applicability and limitations of the procedure and data requirements
- Carryout assessment techniques and acceptance criteria as well as remaining life assessment acceptability for continued service
- Assess general metal loss and recognize its applicability, limitations and inspection data/thickness measurements
- Apply UT measurements, check burst prevention and perform NDE data mapping and visual examination
- Assess local thin area as well as apply thickness readings, stress analysis and piping assessment
- Employ proper assessment of pitting corrosion, laminations, weld misalignment, shell distortion, dents, gouges, crack-like flaws, creep and fire damage

- Carryout fitness for service assessment for a drilling platform structure and piping following fire damage
- Perform assessment of hydrogen blisters and hydrogen damage as well as fatigue and API 574 piping inspection
- Employ risk-based inspection, inspection planning and equipment screening

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 fitness-for-service (FFS) of process plant equipment, pressure vessels, piping and storage facilities in accordance with API 579-1/ASME FFS-1 standard. Integrity assessment engineers, maintenance engineers, specialists, site inspection engineers, piping engineers, mechanical engineers, plant engineers, engineers and other technical staff will benefit from the practical approach of this course. The course will also be very useful to those who are responsible in maintaining the integrity of process plant equipment and piping.

Course Fee

Al Khobar	**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.
Doha	**US$ 5,500** per Delegate. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Dubai	**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.
Abu Dhabi	**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.

Training Methodology

This interactive training course includes the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Workshops & Work Presentations
30% Case Studies & Practical Exercises
20% Software, Simulators & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

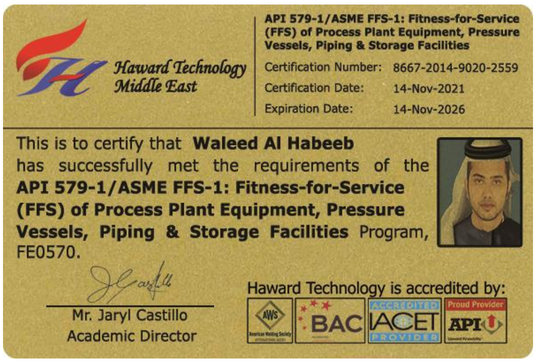
Course Certificate(s)

(1) Internationally recognized Wall Competency Certificates and Plastic Wallet Card Certificates will be issued to participants who completed a minimum of 80% of the total tuition hours and successfully passed the exam at the end of the course. Certificates are valid for 5 years.

Recertification is FOC for a Lifetime.

Sample of Certificates

The following are samples of the certificates that will be awarded to course participants:-



(2) Official Transcript of Records will be provided to the successful delegates with the equivalent number of ANSI/IACET accredited Continuing Education Units (CEUs) earned during the course.

* Haward Technology * CEUs * Haward Technology * CEUs * Haward Technology * CEUs * Haward Technology *

Haward Technology Middle East

Continuing Professional Development (HTME-CPD)

CEUs

CEU Official Transcript of Records

TOR Issuance Date: **14-Nov-21**

HTME No. **8667-2014-9020-2559**

Participant Name: **Waleed Al Habeeb**

Program Ref.	Program Title	Program Date	No. of Contact Hours	CEU's
FE0570	API 579-1/ASME FFS-1: Fitness-for-Service (FFS) of Process Plant Equipment, Pressure Vessels, Piping & Storage Facilities	November 10-14, 2021	28	2.8

Total No. of CEU's Earned as of TOR Issuance Date **2.8**

TRUE COPY

Jaryl Castillo
Academic Director

Haward Technology has been approved as an Authorized Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this approval, Haward Technology has demonstrated that it complies with the ANSI/IACET 1-2013 Standard which is widely recognized as the standard of good practice internationally. As a result of their Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for programs that qualify under the ANSI/IACET 1-2013 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 Association 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 is accredited by

P.O. Box 26070, Abu Dhabi, United Arab Emirates | Tel.: +971 2 3091 714 | Fax: +971 2 3091 716 | E-mail: info@haward.org | Website: www.haward.org

* Haward Technology * CEUs * Haward Technology * CEUs * Haward Technology * CEUs * Haward Technology *

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 **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.

- 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.

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. Steve Magalios, CEng, PGDip (on-going), MSc, BSc, is a **Senior Welding & Pipeline Engineer** with almost **40 years** of extensive **On-shore/Offshore** experience in the **Oil & Gas**, **Construction**, **Refinery** and **Petrochemical** industries. His expertise widely covers in the areas of **ASME Post Construction Code**, **Inspection Planning**, **Fitness-for-Service** (**FFS**) (**API 579**), **Repair Techniques**, **Assessment & Repair of Pressure Equipment & Piping**, Risk-Based Inspection (**RBI**), **API 650: Welded Tanks for Oil Storage**, **Welding Technology**, **Welding & Fabrication**, **Welding Inspection**, **Pipeline** Operation & Maintenance, **Pipeline** Design & Construction, **Pipeline** Repair Methods, **Pipeline** Engineering, Pipeline Integrity Management System (**PIMS**), **Pipeline** Pigging, Piping & Pipe Support Systems, **Piping** Systems & Process Equipment, **Piping** System Repair & Maintenance, **Piping** Integrity Management, Computer Aided Design (**CAD**), **Building & Road** Design Skills, **Civil Engineering Design**, **Structural Reliability** Engineering, **Road** Construction & Maintenance, **Concrete Structures & Building Rehabilitation**, **Reinforced Concrete Structures Protection**, **Geosynthetics & Ground Improvement Methods**, **Blueprint** Reading & Interpretation, **Blue Print** Documentation, Mechanical **Drawings**, **P&ID**, **Flow Diagram** Symbols and **Land Surveying** & Property Evaluation. He is also well-versed in Lean & Sour Gas, Condensate, **Compressors**, **Pumps**, Flare Knockout Drum, Block **Valve** Stations, New Slug Catcher, Natural **Gas Pipeline** & Network, Scraper Traps, Burn Pits, Risk Assessment, HSE Plan & Procedures, Quality Plan & Procedures, Safety & Compliance Management, Permit-to-Work Issuer, ASME, API, ANSI, ASTM, BS, NACE, ARAMCO & KOC Standards, MS Office tools, **AutoCAD**, **STAAD-PRO**, GIS, ArcInfo, ArcView, Autodesk Map and various programming languages such as FORTRAN, BASIC and AUTOLISP. Currently, he is the **Chartered Professional Surveyor Engineer & Urban-Regional Planner** wherein he is deeply involved in providing exact data, measurements and determining properly boundaries. He is also responsible in preparing and maintaining sketches, maps, reports and legal description of surveys.

During his career, Mr. Magalios has gained his expertise and thorough practical experience through challenging positions such as a **Project Site Construction Manager**, **Construction Site Manager**, **Project Manager**, **Deputy PMS Manager**, **Head of the Public Project Inspection Field Team**, **Technical Consultant**, **Senior Consultant**, **Consultant/Lecturer**, **Construction Team Leader**, **Lead Pipeline Engineer**, **Project Construction Lead Supervising Engineer**, **Lead Site Engineer**, **Senior Site Engineer, Welding Engineer, Lead Engineer**, **Senior Site Engineer**, **R.O.W. Coordinator**, **Site Representative**, **Supervision Head** and **Contractor** for international Companies such as the Penspen International Limited, Eptista Servicios de Ingeneria S.I., J/V ILF Pantec TH. Papaioannou & Co. – Emenergy Engineering, J/V Karaylannis S.A. – Intracom Constructions S.A., Ergaz Ltd., Alkyonis 7, Palaeo Faliro, Piraeus, Elpet Valkaniki S.A., Asprofos S.A., J/V Depa S.A. just to name a few.

Mr. Magalios is a **Registered Chartered Engineer** and has a **Master's** and **Bachelor's** degree in **Surveying Engineering** from the **University of New Brunswick**, **Canada** and the **National Technical University of Athens**, **Greece**, respectively. Further, he is currently enrolled for **Post-graduate** in **Quality Assurance** from the **Hellenic Open University**, **Greece**. He has further obtained a Level 4B Certificates in Project Management from the National & Kapodistrian University of Athens, Greece and Environmental Auditing from the Environmental Auditors Registration Association (EARA). Moreover, he is a **Certified Instructor/Trainer**, a **Chartered Engineer** of Technical Chamber of Greece and has delivered numerous trainings, workshops, seminars, courses 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 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	***API 579-1 & ASME FFS-1 Standards*** *API/ASME Standard API 579-1/ASME FFS-1 • ASME B31 Codes • ASME 331.3 Process Piping Code • Is fitness-for-service a code? • Standard • The Inspection Drive Mechanisms • Why use a Fitness for Service Assessment? • Failure Conditions and Types of Flaws • Multidisciplinary Nature of FFS Assessment • Fitness-for-Service Assessment Procedure • Levels of Assessment • Evaluation Methodology • Typical Level 1 Limitations • Level 2 Assessment • Acceptance Criteria • Concept of Remaining Strength Factor (RSF) • Calculation of RSF for Corroded Cantilever Pipes with Increasing Corrosion Levels • Acceptance Criteria*
0930 – 0945	*Break*
0945 – 1100	***FFS & Degradation Mechanisms*** *Benefits • Matching between Degradation Mechanisms and FFS Parts • Contents of ASME FFS-1/API 579 • ASME FFS-1/API 579 Contents • Brittle Fracture • General Metal Loss (GML) • Local Thin Area (LTA) • Pitting Corrosion • Blisters, HIC and SOHIC • Distortion • Crack-Like Flaws • Creep • Post-Fire • Dent and Gouges • Laminations • Annexes to ASME FFS-1 / API 579 • Plant Engineer Perspective • Wall Thinning • Cracking • Embrittlement • Mechanical Damage*
1100 – 1200	***FFS Procedures & Level of Assessment*** *ASME FFS-1/API-579 Procedure • API/ASME FFS Levels of Assessment • General FFS Assessment Procedure • Conditions of Applicability • Design Margins for Each FFS Evaluation Level • Failure Prevention • Piping Codes B31 • Boiler & Pressure Vessel Code Sections • Storage Tanks • Other Codes and Standards • Post-Construction Codes • Design Margin Piping Systems • Case Study -1 • B31.3 Piping System • Parameters • Minimum Wall Thickness by Code (ASME B31.3) • Example • Next Three Steps • Design Margins in Piping Systems • Design Margin Pipelines • Design Margins Pressure Vessels (ASME B&PV)*
1200 – 1215	*Break*
1215 – 1300	***FFS of Pipeline, Piping, PV & Tank*** *ASME B&PV Section II Part D • ASME II Part D • Case Study - 2: ASME VIII Div.1 • Minimum Wall Thickness by Code • Design Margins Tanks API 620-650 • Design Margins – Tanks • Case Study – 3 • Example • Weight Stress • Longitudinal Stress Equation • Weight Stress • Example: 10 in. NPS, sch.40 • Bending Stress Due to Sag • Review • The Inspector's Calc's • Exercises • Who is involved in Fitness-For-Service? • Objectives of FFS Assessment • Advantages of FFS Assessment • CSWIP Plant Inspection Programme – Level 1, 2 and 3 • Resource Documents of FFS Standard*

1300 – 1420	***Assessment of Existing Equipment for Brittle Fracture*** *Brittle Fracture ● Level 1 Assessment – Applicability and Limitations ● What is Brittle Fracture? ● What is Brittle Failure ● Identifying Brittle Fracture Features ● Brittle Fracture and Material Behavior ● Brittle Fracture Risk Factors ● Safeguards Against Brittle Fracture ● Repairs ● Figure 3.1 Overall Brittle Assessment Procedure for Pressure Vessels and Piping (API RP 579) ● Figure 3.2 Brittle Fracture Assessment for Storage Tanks (API 579) ● Compare to Ductile Fracture ● Characteristics of a Brittle Fracture ● Toughness ASTM A 370 ● Toughness of CS vs. SS ● BCC Ferrite vs. FCC Austenite ● C Content ● Movement of Dislocations: Ductile ● Carbon Atom Pins the Dislocation ● Drop Weight Tear Test (DWTT) - ASTM E 436 (or API RP 5LR)*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0900	***Assessment of Existing Equipment for Brittle Fracture (cont'd)*** *Toughness Measured Visually ● CET - Critical Exposure Temperature ● Applicability and Limitations of the Procedure ● Data Requirements ● Assessment Techniques and Acceptance Criteria ● Remaining Life Assessment Acceptability for Continued Service ● Toughness and Hardness ● Requirements for Low Temperature Toughness Tests – Case Study 3-1 ● Solution to Case Study 3-1 Assignment of Materials to Curves in Fig. 3.3 ● Notes to Curves in Fig. 3.3 ● Solution 3-1 ● Solution to Case Study 3-1 Material Groups Table – ASME B&PV Code, Section IX ● Solution to Case Study 3-1 T-Reduction vs. Stress Ratio (API RP 579) ● Notes ● Case Study 3-2 ● Case Study 3-3 ● Case Study 3-4 ● High-Pressure Purge Vessel ● Process Separator Vessel ● Part 3 - Brittle Fracture Assessment ● Class Quiz*
0900 – 0915	*Break*
0915 – 1100	***Assessment of General Metal Loss (GML)*** *Two Failure Modes: Leak or Burst ● Part 4 General Metal Loss ● ASME - Three Levels for FFS ● Applicability and Limitations ● Inspection Data/Thickness Measurements ● Point Thickness Readings Technique (API 579) ● Critical Thickness Profile (CTP)Technique ● Spacing of UT Point Readings ● Case Study - Storage Tank ● Tank Data ● ASTM A 283 C ● Shell External Corrosion ● Shell Inspection ● Corrosion in the Tank Shell ● Meridional and Circ. Insp. Planes ● Inspection Grid ● Major Structural Discontinuity ● Thickness Measurements (in): 1" x 1" Grid ● Future Corrosion Allowance (FCA) ● Corrosion Rates: Rule of Thumb ● Applicability of GML Part 4 ● Conclusion ● Case Study – Pressure Vessel ● Case Study COV > 10% ● Vessel Data*
1100 - 1215	***Assessment of General Metal Loss (GML) (cont'd)*** *UT Measurements ● UT Measurements at 1" Spacing ● Check Burst Prevention ● Assignment ● NDE Data ● Mapping ● Screening ● FFS Reports ● Caution: Discontinuities ● Caution: Buckling ● Level 3 Analysis ● Assignment ● Input Data ● UT Readings are 2 in. Apart ● Review ● Heat Exchanger Tube Bundle ● HX Data ● Inspection Planning ● Risk-Based Inspection Sample ● Inspection Sampling ● Inspection Techniques ● Visual examination ● When to plug ● Replacement Practice ● FFS Assessment ● Review*

1215 – 1230	Break
1215 – 1315	***Assessment of Local Thin Area (LTA)*** *Local Thin Areas (LTA's) ● Starting Point ASME B31G ● B31G Table ● Folias' Formula ● Three Assumptions ● Case Study 1 ● Case Study 2 – Evaluate Level 1 ● Conclusions and Options ● Supplemental Case Study: SS-Lined Tank ● Level 3 - Section of Vacuum Tower*
1315 – 1420	***Assessment of Local Thin Area (LTA) (cont'd)*** *Thickness Readings ● Description ● Stress-Strain Curve at 350° F ● Stress Analysis of Vacuum Tower ● Assignment ● Review Quiz ● Piping Assessment ● Stress Analysis ● Level 1 Assessment*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0900	***Assessment of Pitting Corrosion*** *Assessment of Pitting Corrosion ● The 8 Standard Templates of Pitting Grades ● Selection of Pitting Colonies ● AP1579-1/ASME-FFS- 1 ● Level 1 Assessment ● Determination of RSF using Pitting Grades Templates ● Results of Level 1 Assessment ● Case Study 1 ● Question to be Resolved ● Lowest Pit Density Chart ● Highest Pit Density Chart ● Interpolate for RSF ● Conclusion ● Level 2 Assessment ● Determination of Pitting Couples ● Results of Level 2 Assessment ● Applicability of Level 2 ● Level 3 Assessment (Nonlinear FEA) ● FE Modelling for Pitted Pipe ● Von-Mises Stress Distributions from FEA ● Distributions of Radial Deformation from FEA ● Limit Pressures for Pitted Pipes by TES Method ● Comparison between the Results Obtained using FEA and Part 6 of API-579/ASME-FFS-1 ● Case Study 2 ● Input Parameters ● Conclusions and Recommendations ● Review*
0900 – 0915	*Break*
0915 – 0945	***Assessment of Laminations*** *Causes of Laminations ● Case Study – Separator and Downstream Reactor ● Lamination ● General Approach ● Detection of Laminations ● Forecasting Equipment Failure ● Acoustic Emission (AE) Testing ● What is Acoustic Emission (AE) Testing?*
0945 – 1045	***Assessment of Weld Misalignment & Shell Distortion*** *Dent ● Weld Misalignment ● Level I Assessment ● ASME B31.3 ● Fabrication Tolerance API 650 and 620 ● Level 2 ● Case Study 1 ● Assignment ● Level 1 - B31.4 Oil Pipelines ● Level 3 – FEA ● Review*
1045 – 1145	***Assessment of Dents & Gouges*** *Definition of a Dent ● Example of Dent ● Pipeline Issue: Large PD/2t ● Installation of Pipeline ● Types of Dents ● Kinked Dent ● The Significance of Dents ● ASME B31.8: Must Repair if ● Dents on Weld Seams ● Burst Strength of Dented Welds ● Braga Noronha et. al. (Petrobras) ● Measurements for a FFS Assessment ● Fatigue Life of Dented Welds ● Fatigue Check ● Rebound Fatigue Test ● Significance of Dents in Pipelines ● Gouge ● Gouge – Dent Combination ● Recommendations for the Assessment of Dents ● Assignment ● Level 3 FEM*

1145 – 1230	***Assessment of Crack-like Flaws*** *Crack-Like: Incomplete Penetration ● Fabrication Flaws ● Crack-Like: Corrosion Cracking ● Crack-Like: Fatigue Crack ● Fatigue Crack ● Fatigue Crack at Intersection ● Fatigue Testing of Pipe Fittings ● Crack-like Flaws ● Cycles to Failure (Markl Tests) ● Actual Failure vs. B31.3 Markl Limit SA ● ASME B&PV Design Fatigue Curves (CS in air) ● API 579 Fatigue Curves ● Running Crack? ● Introduction to Fracture Mechanics ● Crack Opening Displacement (COD) ● 1st Condition of Crack Stability ● 2nd Condition of Crack Stability ● Three Modes of Fracture ● Stress Intensity – General Form ● How to Obtain KIC (the stress intensity limit to start a crack in mode I)? ● Three Assessment Levels ● Complex Geometry ● Crack from Expansion-Contraction ● Liquid Penetrant Test (PT) of Crack ● Case Study 9-1 ● Corrosion Crack*
1230 – 1245	*Break*
1245 – 1400	***Assessment of Crack-like Flaws (cont'd)*** *Class Exercise 9-2 ● Case Study 9-3 ● Pipeline ● Stress Ratio Lr ● Stress Intensity K ● Approximate Mode I Stress Intensity Factor at the Crack (KIC) ● Lower Bound Ferritic Steels ● Calculate Reference Temperature (Tref) ● Figure 3.4 (API RP 579, 2007) ● Example: Stress Intensification Factor, Mode I (KIC) ● Stress Intensity Ratio Kr ● Failure Assessment Diagram (FAD) ● How will the Crack Size Progress? ● Increment of Crack Growth for a Given Cycle (da/dN) ● da/dN, but ΔK is complex ● Computational Fluid Dynamics (CFD) Simulation ● Experimental Benchmark ● Reactor Vessel Penetrations PWSCC ● Control Rod Drive Mechanism (CRDM) Penetration ● Stress Growth Velocity (da/dt) ● Level 2 – Complete Analysis ● Serious Complications for the Analysis ● Leak-before-Break ● Crack Stability Analysis ● Level 3 - High Pressure Fitting ● FFS of Down-Comer Flaws Increasing Crack Depth (a) ● Review*
1400 – 1420	***Assessment of Creep*** *What is Creep? ● Creep Characteristics ● The Three Creep Stages ● Creep Mechanism ● Assessment of Creep Damage ● Understanding the Effects of Creep…● Creep Strain at Constant Pressure ● Creep Voids ● Burst of Longitudinal Seam ● Mohave Power Station, 1985:30 in. 600 psi @ 1000º F ● Mohave Power Station, 1985 – Laughlin, Nevada ● Δ Life vs. Δ Temperature ● Temperature Profile is Critical ● Remaining Life Assessment ● Level 1 - Creep Assessment Procedure ● Level 1 Assessment ● Level 2 Assessment ● Furnace Tube Example ● Case Study 10-1 ● Material ● Measurement ● Larson-Miller Parameter (LMP) ● API 530 Larson-Miller Parameter (LMP) ● Remaining Life*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4

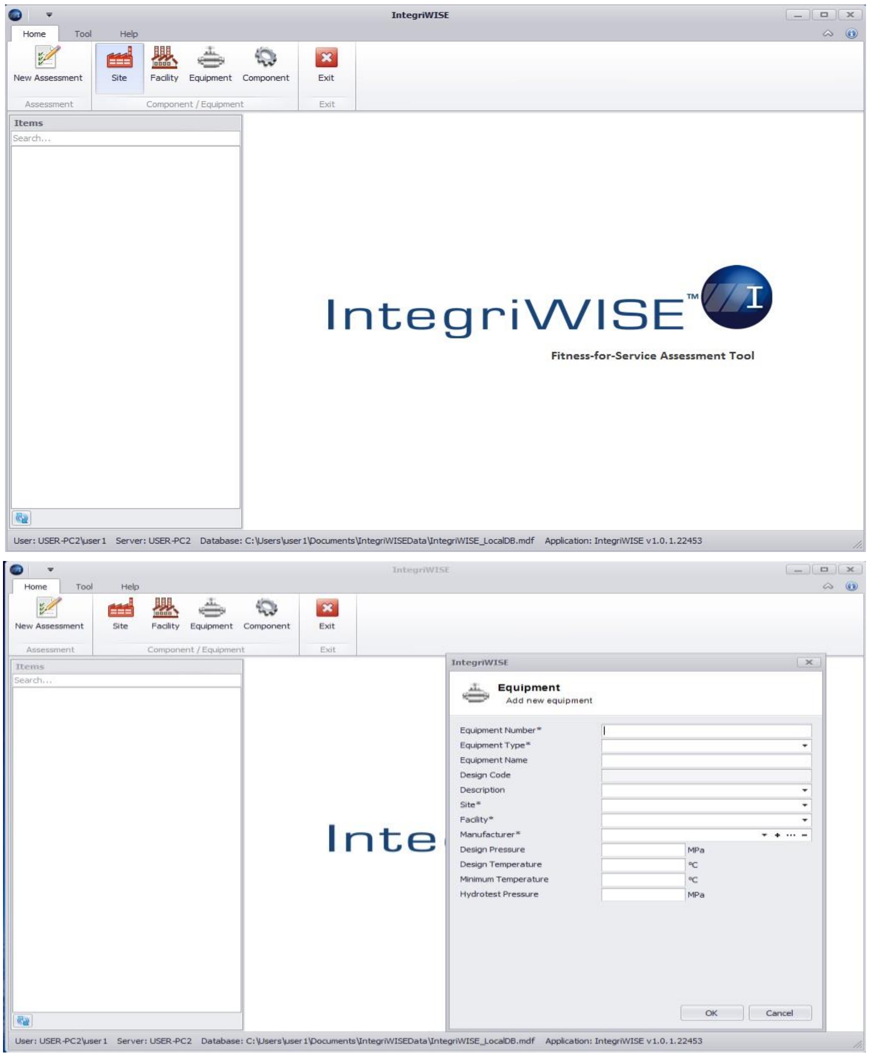
0730 – 0830	***Assessment of Creep (cont'd)*** *Replication ● Weld-O-Let Connections and Creep Damage ● Creep Failures ● Comparison of Creep Stresses at 10,000 Hours for Various Special Alloys used in High-Temperature Service ● What is Creep? ● Larson-Miller Parameter ● MPC Omega Method ● Modeling Creep Behavior ● Why Do Creep Life Assessment? ● Inputs for Heater Tube Assessment ● API 579-1 / ASME FFS-1 Creep Life Assessment ● Example: Remaining Life Results ● Why Do Creep Testing? ● Guidelines for Tube Removal ● Coker Heaters ● Case Study: Background ● Case Study: Omega vs. LMP ● Other Damage Mechanisms ● Carburization ● Sigma Phase Embrittlement ● External Oxidation ● Erosion ● Challenges Predicting Life ● Review Quiz*
0830 – 0900	***Assessment of Fire Damage*** *Fire Damage ● Data Requirements ● Data Required for Assessment ● Degradation Associated with HEZ ● General Approach ● Heat Exposure ● Heat Exposure Zone ● Inspection Techniques ● Measurements ● Assessment Techniques ● Level I Assessment Repairs – Replacements ● Case Study ● Observations from Fire ● Conclusions ● Actions*
0900 - 0915	*Break*
0915 – 1000	***Fitness for Service Assessment for a Drilling Platform Structure and Piping Following Fire Damage*** *Introduction ● Fig.1. Consequences of Fire Damage ● Fig.2. Identification of the 6 Heat Exposure Zones Level-1 Assessment ● The Three Levels of Assessment of Fire Damage ● Specifications of Features of the 6 Fire Zones ● Level-2 Assessment ● Hardness Survey on Fire-Affected Piping ● Results of FFS Assessment ● Pressure De-Rating of Heat Affected Piping ● Outcomes of FFS Assessment of Fire Damage*
1000 – 1100	***Assessment of Hydrogen Blisters & Hydrogen Damage*** *Stress-Oriented Hydrogen Induced Cracking ● Assessment of Blisters and Hydrogen Induced Cracking ● Surface Bulging Due to Blisters ● Detection, Characterization, and Sizing ● Detection, Characterization, and Sizing of Blister Damage ● Detection and Sizing of HIC Damage ● Level I Acceptable if …● Case Study 1 ● Assignment Level 1 – Same Vessel ● How to Prevent Hydrogen Blistering*
1100 – 1200	***Fatigue Assessment*** *Fatigue Assessment ● Level 1 Fatigue Assessment–Screening ● Level 2 Fatigue Assessment ● Level 2 Fatigue Assessment Method C ● Level 3 Fatigue Assessment*
1200 – 1215	*Break*
1215 – 1420	***API 574 Piping Inspection*** *Piping Inspection Introduction ● Basic Piping Inspection Program Goals ● Pressure Vessel Stress Areas ● Basic Piping Inspection ● Basic Piping Inspection for Corrosion*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

Day 5

0730 – 0815	***API 574 Piping Inspection (cont'd)*** *Selecting Corrosion Monitoring Locations ● Remote Corrosion Monitoring System ● Basic Piping Inspection ● Piping Injection Point Example ● Piping Injection Point Example 2*
0815 – 0930	***Risk-Based Inspection*** *Inspection Plan ● Inspection Techniques ● Visual Examination ● Magnetic Particles Testing (MT) ● Yoke and Fluorescent MT ● MT: Advantages and Limitations ● Liquid Penetrant Testing (PT) ● PT: Advantages and Limitations ● 4. Replication ● Radiographic Testing (RT) ● RT: Advantages and Limitations ● RT Through Insulation ● Digital Radiography ● Ultrasonic Testing (UT) ● Through-transmission Shear waves (angle beam)*
0930 – 0945	*Break*
0945 – 1100	***Risk-Based Inspection (cont'd)*** *Classic Shear Wave Angle Beam ● Phased-Array ● Long Range Guided Wave (Ultrasound) ● Guided Wave Transducers ● Corroded Sphere Support Legs ● Inspections ● Results ● Eddy Current Testing (EC) ● Eddy Current Testing ● Pulsed Eddy Current ● Magnetic Flux Leakage ● Infrared Thermography ● Acoustic Emission Testing (AE) ● AE: Advantages and Limitations ● AE Controls ● Laser Mapping*
1100 – 1200	***Inspection Planning*** *What is RBI? ● Objectives of RBI ● RBI Benefits and Limitations ● Outcome of an RBI? ● International Standards ● Type of RBI Assessment ● RBI Planning Process Overview ● Data Collection ● Identification of Damage Mechanisms ● Probability of Failure ● Consequence of Failure ● Risk Analysis ● Inspection Planning ● Mitigation ● Reassessment and Updating RBI Assessments ● RBI Softwares ● RISKWISE ● System Overview ● RBI Example – Quantitative Assessment of a Boiler ● Application Selection ● Current Table ● Item Proposal ● Item Properties ● Risk Factors ● Risk Analysis ● Level 1 Assessment ● Home ● Unit Proposal ● Unit Analysis ● RBI Process ● Risk = Likelihood x Consequence ● Qualitative Approach ● CUI Likelihood ● RBI Team ● Likelihood = Corrosion Loops ● Consequence = Contents + Environment*
1200 – 1215	*Break*
1215 – 1300	***Equipment Screen*** *Fluid Screen ● History Screen ● Scenarios Screen ● Actions Screen ● Mitigation Plan ● Likelihood = A (low) to E (high) Consequence = I (low) to IV (high) ● Risk-based Inspection Intervals ● Effective RBI Program ● Review*
1300 – 1315	***Course Conclusion***
1315 - 1415	***COMPETENCY EXAM***
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 "IntegriWISE^{TM}".



IntegriWISE^{TM}

Course Coordinator

Kamel Ghanem, Tel: +971 2 30 91 714, Email: kamel@haward.org