IDC
Training House Sdn Bhd

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API 579/ASME FFS-1 FITNESS FOR SERVICE

PART 1 (LEVEL 1 & 2)

COURSE DURATION: 5 DAYS

COURSE DESCRIPTION

Fitness-For-Service (FFS) is essential guideline for a run-repair-replace decision making process to help determine if pressurized equipment containing flaws that have been identified by inspection can continue to operate safely for certain period of time. The methods covered by FFS are suitable, compatible and in some cases required with and from major inspection codes and standards (i.e. ASME, API). Applicable to most types of pressurized equipment, piping and piping systems and storage tanks where flaws and damage/ degradation has been detected or identified.

Detailed understanding of FFS will help you competently and confidently discuss any issue with the integrity consultants or authorities.

This 5-days advanced course provides guidance for conducting FFS assessments using methodologies as covered in the de-facto industry standard API 579/ASME FFS-1, applicable to the pressurized equipment. The course has been adopted and revised to correspond to the latest edition of the code (June 2016), and covers both the main code body of knowledge (API 579-1/ASME FFS-1 -Fitness-For-Service) as well as illustrative implementation examples as given in API 579-2/ASME FFS-2 - Fitness-For-Service Example Problem Manual.

Detailed knowledge and understanding of the design and inspection codes is pre-requisite for attendance to this course. Such as ASME Sec. VIII Div. 1, ASME Sec. VIII Div. 2, ASME Sec. I, ASME B31.1, ASME B31.3, API 650, API 620.

COURSE OBJECTIVE

- This training course covers API 579-1/ASME FFS-1 with a focus on the Level 1 & 2 assessment procedures and their practical implementation and introduction into Level 3 assessments. The students should be able to complete by themselves in a confident manner at least Level 2 assessments; coupled with strong design code knowledge and inspection experience.
- Discussion on damage mechanisms and the importance of identification, inspection techniques for flaw characterization, remaining life considerations, remediation methods and methods for life extension of damaged equipment.
- Students should understand background and logic behind assessment procedures and work out the selected examples from the API 579- 2/ASME FFS-2 Example Problem Manuals in a guided manner.
- The course will cover the assessment of all major problems covered in the FFS-1 and FFS-2 document - brittle fracture, general and local metal loss including pitting, crack-like flaws and blisters/HIC, creep, as well as fire and mechanical damage.

WHO SHOULD ATTEND

- Design Engineers interested in design verification using Fitness for Service assessment procedures
- Maintenance personnel, operations supervisors, and process specialists who are expected to make decisions regarding the suitability of equipment for continued service;
- Plant Inspection Engineers responsible for evaluation of inspection results and overall plant safety and reliability
- Plant Inspectors responsible for managing the integrity of ageing process equipment, pipelines, boilers and storage tanks;
- Refining and Petrochemical Engineers, Mechanical Engineers, Process Engineers interested in Fitness-for-Service as a tool to better understand the overall plant state and effects of the operation on the equipment state.

COURSE OUTLINE

DAY 1

Module 1: Introduction

- Construction Codes and Fitness-For-Service
- Fitness-For-Service Definition
- Scope and basic key definitions and links
- Organization and Use, responsibilities and qualifications
- Definition of selected terms and key references

Module 2: Fitness-for-Service Engineering Assessment Procedures

- Fitness-For-Service and Continued Operation
- Organization by Flaw Type and Damage Mechanism
- FFS Assessment Procedure
- Applicability and Limitations of the FFS Assessment Procedures
- Introduction into level 1, 2, 3 Assessments
- Remaining Life Assessment - Remaining Life and Guidance on Remaining Life Determination
- Documentation

Module 2a: Fitness-for-Service engineering assessment procedure background skills and knowledge

- Damage Mechanisms
- Thickness, MAWP And Stress Equations for a FFS Assessment
- Stress Analysis Overview for a FFS Assessment
- Practical guidance on background skills application – worked examples

Module 3: Assessment of Equipment for Brittle Fracture

- Evaluation of Resistance to BF and Avoidance of Catastrophic BF
- Critical Exposure Temperature (CET) and Minimum Allowable Temperature (MAT)
- Applicability and Limitations of the Procedure;
- Level 1 & 2 for different systems; alternative methods, introduction into level 3
- Remaining Life Assessment and Remediation; In-Service Monitoring; Documentation

Module 3a: Assessment of Existing Equipment for Brittle Fracture – Particle examples

- Pressure vessel in caustic service, Level 1
- Piping example, Level 2
- Own example(s) Levels 1, 2 decide when to apply

DAY 2

Module 4: Assessment of General Metal Loss

- Assessment Procedures for General Metal Loss
- Level 1 & 2 assessment procedures, introduction into level 3
- Remaining Life Assessment – thickness approach
- Remaining Life Assessment – MAWP Approach
- Remediation and In–Service Monitoring; Documentation

Module 5: Assessment of Local Metal Loss

- Assessment Procedures for Local Metal Loss; localized or general choice; Pitting Damage; Applicability and limitations of the procedure
- Limitations Based on Flaw Type;
- Level 1 & 2 assessment procedures, introduction into level 3
- Assessment of Blend Ground Areas for Crack-Like Flaw Removal
- Remaining life assessment - thickness approach
- Remaining life assessment - MAWP Approach
- Remediation and in-service monitoring; Documentation

Note:
Detailed knowledge and understanding of the design and inspection codes is pre-requisite for attendance to this course.

(ASME VIII Div. 1, ASME VIII Div. 2, ASME I, ASME B31.1, ASME B31.3, API 650, API 620)

Module 6: Assessment of Pitting Corrosion

- Assessment of Pitting Corrosion; Assessment of Blister Arrays
- Limitations Based on Flaw Type and Limitations Based on Temperature
- Level 1 & 2 assessment procedures, introduction into level 3
- Remaining life assessment – MAWP approach
- MAWP Procedure for Remaining Life Determination
- Remediation and in-service monitoring; Documentation

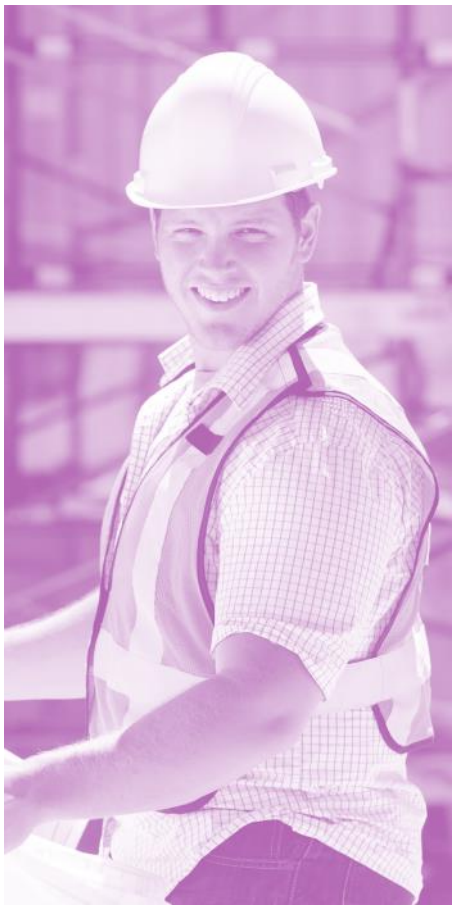
Module 6a: Assessment of Metal Loss – Practical Examples

- General Corrosion - Heat exchanger level 1
- General Corrosion - Pressure vessel level 1 and 2
- General Corrosion - Piping level 1 and 2
- General Corrosion-Own example(s); determine necessary level(s)
- Pressure vessel single localized corrosion area, level 1
- Pressure vessel with groove like flaws, level 1 and 2
- Atmospheric tank with localized corrosion, levels 1 and 2
- Elbow with localized corrosion, levels 2
- Piping with pitting example, level 1 and level 2
- Pressure vessel with pitting at the bottom, level 2

DAY 3

Module 7: Assessment of hydrogen blisters and hydrogen damage associated with HIC and SOHIC

- Assessment Procedures for Hydrogen Blisters, HIC and SOHIC
- HIC and SOHIC Definition; Hydrogen Blistering Definition
- HIC, SOHIC and Blistering Distinct Damage Types
- Level 1 & 2 assessment procedures, introduction into level 3
- Remaining life assessment - HIC and SOHIC Growth Rates; Blister Growth
- Remediation - Elimination of Hydrogen Charging; Controlling Hydrogen Charging; Venting of Blisters; Blend Grinding; Repair and Replacement of Damaged Material; NACE Standard SP0296-10
- In-service monitoring -Monitoring for Hydrogen Charging; Inspection Methods for Monitoring; Detection of HIC, SOHIC, or Blister Damage Growth; Documentation



COURSE DURATION

- 5 Days Training

DAILY SCHEDULE

- 8:30am - 5:30pm (Workshop)

ITEMS TO BRING

- Lots of Questions
- A "CAN-DO" Attitude
- Codes / Standards (in soft / hard copy)
  - **API 579 / ASME FFS-1**
  - **API 579 / ASME FFS-2**

Stationeries such as pen and highlighter will be provided.

Module 8: Assessment of weld misalignment and shell distortions

- Evaluation of Weld Misalignment and Shell Distortions; ASME Sec. VIII Div. 2
- Level 1 & 2 assessment procedures, introduction into level 3
- Remaining life assessment - Categories – Metal Loss, Cyclic Loading, High Temperature Operation
- Special requirements for a Level 3 Assessment
- Remediation - Addition of Reinforcement; Correction of Tolerances by Mechanical Means
- In-service monitoring and Groove-Like and Crack-Like Flaws; Documentation
- Practical examples

Module 9: Assessment of Crack-like Flaws

- Assessment Procedures for Crack-Like Flaws; ASME Sec. VIII Div. 2
- Use of Assessment Procedures to Evaluate Brittle Fracture
- Level 1 & 2 Assessment Procedures, introduction into level 3
- Remaining life assessment - Subcritical Crack Growth and Leak-Before-Break Analysis
- In-Service Monitoring - Monitoring of Subcritical Crack Growth; Validation of Monitoring Method
- Documentation – General; Assessment Procedure; Remediation Methods; In-Service Monitoring
- Compendium of Stress Intensity Factor Solutions
- Compendium of Reference Stress Solutions for Crack-Like Flaw

Module 9a: Assessment of hydrogen blisters, weld misalignment and shell distortions and Crack-like Flaws – Practical examples

- Worked example: pressure vessel with blisters inside and outside; levels 1, 2
- Worked example: Piping with peaking at the long seam weld; levels 1 and 2
- Worked example: Pressure vessel with crack-like flaw; level 1
- Worked example: Spherical pressure vessel with crack-like flaw; level 1
- Worked example: Cylindrical pressure vessel with crack-like flaw; level 1 and 2
- Worked example: piping with crack-like flaw on circumferential seam; level 1 and 2

DAY 4

Module 10: Assessment of Components Operating in the Creep Range

- FFS Procedures and Temperature Limits; Remaining Life of Components with and without Crack-Like Flaws
- Assessment Techniques and Acceptance Criteria – Overview; Level 1, 2 assessment
- Remaining Life Assessment – Overview; Creep Rupture Life ; Creep -Fatigue Interaction
- Creep Crack Growth; Creep Buckling; Creep-Fatigue Assessment of Dissimilar Weld Joints
- In-Service Monitoring
- Documentation – General; Documentation for Life Assessment

Module 11: Assessment of Fire Damage

- Assessment of Fire Damage; Assessment of Process Upsets; Guidelines and Assessment Flowchart
- Recommendations for Inspection Techniques and Sizing Requirements
- Assessment Techniques and Acceptance Criteria – Overview; Level 1, 2 assessment
- Remaining Life Assessment - Thinning and Crack-Like Flaw Damage; Creep Damage
- Remediation – Techniques; Need for Repair or Replacement
- In-Service Monitoring
- Documentation – General; Heat Exposure Zones; Record Retention

Module 12: Assessment of Dents, Gouges, & Dent-Gouge Combinations

- Assessment Procedures for Dents, Gouges and Dent-Gouge Combinations
- Assessment Procedures for LTAs, Grooves and Other Shell Distortions
- Level 1 & 2 assessment procedures, introduction into level 3
- Remaining Life Assessment - Categories of Remaining Life Assessment; Requirements for a Level 3 Assessment
- Remediation - Flaw Severity and Evaluation of Material Condition; Reinforcement of Dents, Gouges and Dent-Gouge Combinations; Use of General Corrosion Remediation Methods
- In-Service Monitoring - Requirements for In-Service Monitoring;
- Documentation

Module 13 – Assessment of Laminations

- Assessment Procedures for Laminations; Definition of Laminations; Laminations in Hydrogen Charging Service
- Recommendations for Inspection Technique and Sizing Requirements
- Assessment Techniques and Acceptance Criteria- Overview; Level 1, 2 and 3 Assessment
- In-Service Monitoring
- Documentation

Module 14 – Assessment of Fatigue Damage

- Assessment Procedures for Fatigue Damage
- ASME Sec. VIII Div. 2; Use of Fatigue Curves in Performing Assessments
- Level 1 & 2 Assessment Procedures, introduction into level 3
- Remaining Life Assessment - Included in Level 2 and Level 3 Assessments; Loading Time History
- In-Service Monitoring
- Documentation

DAY 5

Module 14a: Practical Examples Creep, Fire Damage, Dents, Gouges, and Dent-Gouge Combinations, Lamination and Fatigue Damage

- Practical example: Creep Damage - Short-term overheating of pressure vessel; level 1
- Practical example: Creep Damage - boiler / heater tubing overheating; level 1 and level 2
- Practical example: Creep Damage - crack-like flaw; creep crack growth; level 2
- Practical example: Fire Damage - Partially fire exposed vessel damage; level 1
- Practical example: Fire Damage - Partially fire exposed vessel damage; level 2
- Practical example: Dent damage – pipeline; level 1 and level 2
- Practical example: Gouge damage – pipeline; level 1 and level 2
- Practical example: Lamination damage – pressure vessel shell lamination; level 1and level 2
- Practical example: Fatigue damage assessment – remaining life assessment based on operation data and cycle counting; Level 1
- Practical example: Fatigue damage – assessment of fatigue crack growth; level 1 and level 2

Module 15: Repetitorium

- 2-hour repetitorium of covered modules
- Exam preparation

Final Exam

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TRAINER'S PROFILE

DR.-ING. ANDREAS KLENK

MSc in Mechanical Engineering with the specialization in Materials Testing, Materials Technology and Strength Design, PhD in Dynamic Fracture Mechanics.

More than 30 years of work in research and industrial projects, as well as training activities especially in materials testing, high temperature materials, non-destructive testing and inspection with focus on power plants and refining industry. Participated or led numerous EU or German funded research projects and participated in a number of national projects in the area of material research and education.

In these projects, a vast understanding and knowledge about materials, material degradation mechanisms, inspection methods, risk assessment and fitness for service assessment has been accumulated. His main focus areas are application oriented research and development for power plant manufacturers, utilities and process plant industries: Characterization of short and long term behavior of materials and weldments, numerical simulation and development of constitutive equations for high temperature applications, design and lifetime assessment of power plant components.

In the area of remaining life assessment, materials behavior and fitness for service he is active last 30 years. Dr. Klenk has worked in various national and EU technical committees especially in the high-temperature area.

Dr. Klenk has long standing teaching history (more than 30 years) at the University of Stuttgart as well as various other institutions abroad (Japan, India, UK, South Africa).

Dr. Klenk has led the department of High Temperature Materials at Material Testing Institute (MPA) Stuttgart for almost 20 years and is currently deputy director of the Institute.