

Training Title

**Piping Fitness for Service, Pressure Vessel FFS, FFS for Inspectors**

Training Duration

5 days

Training Certificate

Define Management Consultants Certificate of course completion will be issued to all attendees.

Training Fees

- 3300 US\$ per participant for Public Training includes Materials/Handouts, tea/coffee breaks, refreshments & Buffet Lunch

Description

The design codes and standards for piping and pressure vessels provide rules for design, fabrication, inspection and testing of new systems. Piping and pressure vessels do degrade while in-service due to deficiencies from original fabrication or due to different causes of degradation. Fitness-for-Service (FFS) assessments are quantitative engineering evaluation performed to determine the structural integrity of an in-service systems containing a flaw or damage. The FFS help engineers to make run-repair-replace decisions to help ensure that the system in-service can continue to operate safely.

Fitness-for-Service intends to ensure safety of plant personnel and public while older equipment continues to operate, to provide technically sound fitness-for-service assessment procedure to ensure that different service provide furnish consist life prediction, and to help optimize maintenance and operation of existing facilities.

FFS is an integration of three disciplines; these are materials, inspection, and mechanical analysis.

The course will discuss the three technological triad required for fitness-for-service assessment, and apply that on the piping and pressure vessels systems. All of the above will be presented in connection with the related codes and standards.

Examples will be presented using the known methods and programs. Delegates are asked to bring with them their own laptops to practice some of such exercises

Course Objectives

- The participant will learn the importance of FFS for piping systems and pressure vessels

- The participant will learn the principles of FFS, and how to apply it on Piping system and Pressure vessels.
- The participant will learn where to find and how to calculate data necessary for FFS application
- The participant will learn how to use the results of FFS to take right decision concerning the operation, shutdown, interval of inspection, repair of the existing in-service piping
- The participant will learn how to evaluate the integrity and remaining life of piping systems and pressure vessels.
- The participant will have a chance to practice some the FFS assessment methods during the course.

### **Who Should Attend**

Mechanical engineers, process plant and piping / pressure vessels engineers and inspectors responsible for design, installation, operation, integrity and maintenance of piping systems and pressure vessels are encouraged to attend this course.

### **Course Outline**

#### ***Ch 1 Piping and Pressure Vessels Deterioration and Failure Modes***

Pre-Service Deficiencies

In-Service deterioration and damage

General Metal Loss due to Corrosion and/or Erosion

Localized Metal Loss due to Corrosion and/or Erosion

Surface Connected Cracking

Subsurface Cracking and Microfissuring/Microvoid Formation

Metallurgical Changes

#### ***Ch 2 Material Properties for FFS assessment***

Strength Parameters

Yield and Tensile strength

Flow Stress

Stress-Strain relationship

Physical properties

Elastic Modulus

Poisson's Ratio

Coefficient of Thermal expansion

Fatigue Toughness

Fracture Toughness Parameters

- Low bound fracture Toughness
- Charpy V-Notch data
- Fracture Toughness for in-service materials
- Temper Embrittlement
- Crack Growth
  - Categories of Crack Growth
  - Fatigue Crack Growth Calculation
- Fatigue Curves
  - Smooth Bar test Specimens
  - Welded test specimens
- Creep Rupture
  - Creep Strain-Rate Data
  - Crack Initiation
  - Creep Crack Growth

### ***Ch 3 Stress Analysis for FFS Assessment***

- Stress Analysis Methods for a FFS
- Linear Elastic Stress Analysis Methods and Acceptance Criteria
- Nonlinear Elastic Plastic Stress analysis Methods and Acceptance Criteria
- Methods of Structural Stability
- Methods of Fatigue Evaluation
- FFS Assessment Using Finite Element Analysis

### ***Ch 4 Thickness, MAWP and Membrane Stress Equation for a FFS Assessment***

- Calculation of Minimum Thickness
- Calculation of MAWP (MFH)
- Calculation of Membrane Stress
- Piping Components
- Pressure vessels Components

### ***Ch 5 Fitness-For-Service Assessment***

- FFS Engineering Assessment Procedure
  - Date Requirement
  - Assessment Techniques
  - Acceptance Criteria
  - Remaining Life Evaluation
  - Remediation
  - In-Service Monitoring

Types of assessment

- Assessment for Brittle Fracture
- Assessment of General Metal Loss
- Assessment of Local Metal Loss
- Assessment of Pitting Corrosion
- Assessment of Blisters and Laminations
- Assessment of Crack-Like Flaws

Case Studies

Last Day Review, Discussions will be carried out

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