



# Charisma Education Pvt. Ltd.

## Training on

## **Fitness for Service of Equipment and Piping per API 579 and ASME FFS1**

Vadodara, India, 5 Days, Year 2023

Training Program on **Fitness for Service of Equipment and Piping per API 579 and ASME FFS1** will be held in Vadodara organized by Charisma Education Pvt Ltd. CEPL is a Scientific and Technical Consultancy involved in the Design of Process Equipment, Technical Troubleshooting Process Plants, Failure Analysis of Equipment of Piping System etc. We also provide correspondence courses for Process Equipment and Pressure Vessel Design, Piping Technology.

### **OBJECTIVE:**

This Training program covers understanding of damages which may happen to equipment and connected piping while it is under fabrication, handling, erection and in prolonged service. Service exposures for a longer duration pose challenges to equipment safety and integrity. The damaged and defects are detected during regular inspection at different stages.

Fitness-For- Service (FFS) assessments are required through engineering analysis to demonstrate the structural integrity of components containing flaw or damages. The guidelines provided in API 579/ ASME FFS-1 are used to make run-repair-replace decisions of pressurised components after inspection, if they can continue to operate safely. Recommended practice as presented supplement and augment requirements and decisions while implementing inspections as per API 510, API 570 and API 653. The course will cover situations encountered in pressure vessels, heat exchangers, tanks and connected piping in refining and petrochemical industry.

### **Benefit and Importance:**

The orientation during training program shall prove beneficial to participants and their employing company through;

- Understanding bad impact on safety due to defects and damages detected during inspection
- Field case histories discussions to provide lead to understanding failures relevant to process equipment in service, remedial action in at proper stage, estimation of remaining safe life
- Help experienced professionals who wish to brush up their knowledge and stay abreast with the latest design and integrity evaluation procedures
- Basic orientation to Engineers and Technologists and fresher from varied technical background interested in learning more about **equipment damages, detection and evaluation of acceptance levels of defects and damages.**

**For Whom:** Equipment Design Engineers / Managers, Safety Engineers, Inspection and Quality Control Specialists, Technical Supervisory Personnel responsible for operating plants, Operation Engineers, Maintenance engineers

### **COVERAGE OUTLINES:**

Handout shall be provided which will cover all the topics as listed.



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## Day 1:

Introductory Test/ Evaluation

### Session 1: Understanding of Process Plant System under Analysis

- 1.1 Original Equipment and System Design Data
- 1.2 Maintenance and Operational History
- 1.3 Inspection Techniques for detection of flaws and Damages
- 1.4 Assessment Techniques, Acceptance Criteria and Remediation
- 1.5 Remaining Safe Life Assessment, In-service Monitoring

### Session 2: General Flaw and Damage Mechanism

- 2.1 Introduction to Broad Grades of Damages and Mechanism
- 2.2 Types of Damages
  - \* Thinning, Corrosion
  - \* Cracking, Brittle Fracture, Propagation, Fatigue, Creep
  - \* Mechanical Damages, Dents, Distortions,
  - \* Weld assisted Damages, Metallurgical Damages

### Session 3: Assessment of Equipment and Piping for Brittle Fracture

- 3.1 Brittle Fracture:
  - \* Mode of fracture
  - \* Toughness Issues
  - \* Effect of Temperature
  - \* Role of Crack size
- 3.2 Assessment Techniques and Acceptance Criteria
  - \* Pressure Vessels
  - \* Piping Systems
  - \* Storage Tanks
- 3.3 Remaining Life Assessment and Acceptability for continued service
- 3.4 Remediation, In-service Monitoring

### Session 4: Assessment of General Metal Loss

- 4.1 In-service Monitoring and Inspection of components affected
- 4.2 Required Measurements and Data for FFS Assessment
- 4.3 Inspection Techniques and Sizing Requirements
- 4.4 Assessment and Acceptance Criteria
- 4.5 Remaining Life Assessment and Remediation

## Day 2:

### Session 5: Assessment of Local Metal Loss

- 5.1 Acceptability and Limitation:
  - \* Types of Flaws
  - \* Geometry
- 5.2 Required Measurements and Data for FFS Assessment
- 5.3 Inspection Techniques and Sizing Requirements
- 5.4 Assessment and Acceptance Criteria
- 5.5 Remaining Life Assessment and Remediation

### Session 6: Assessment of Pitting Corrosion

- 6.1 Acceptability and Limitation
  - \* Definitions of Types of Pitting
  - \* Cross sectional shapes of pits
- 6.2 Required Measurements and Data for FFS Assessment
- 6.3 Inspection Techniques and Sizing Requirements
- 6.4 Assessment and Acceptance Criteria
- 6.5 Remaining Life Assessment and Remediation



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## **Session 7: Assessment of Blisters and Laminations**

- 7.1 Acceptability and Limitation
  - \* Geometry and shapes of Blisters
- 7.2 Required Measurements and Data for FFS Assessment
- 7.3 Inspection Techniques and Sizing Requirements
- 7.4 Assessment and Acceptance Criteria
- 7.5 Remaining Life Assessment and Remediation

## **Session 8: Assessment of Weld Misalignment and Shell Distortions**

- 8.1 Acceptability and Limitation
  - \* Categories and definition of weld distortions and shell distortions
- 8.2 Required Measurements and Data for FFS Assessment
- 8.3 Inspection Techniques and Sizing Requirements
- 8.4 Assessment and Acceptance Criteria
- 8.5 Remaining Life Assessment and Remediation

### **Day 3:**

## **Session 9: Assessment of Crack-Like Flaws (Part 1)**

- 9.1 Definition of Crack-Like Flaws
- 9.2 Acceptability and Limitation
- 9.3 Maintenance and Operating History
- 9.4 Required Measurements and Data for FFS Assessment
  - \* Loads and Stresses
  - \* Material Properties
  - \* Flaw characterization
- 9.5 Inspection Techniques and Sizing Requirements

## **Session 10: Assessment of Crack-Like Flaws (Part 2)**

- 10.1 Assessment and Acceptance Criteria
- 10.2 Remaining Life Assessment
  - \* Subcritical Crack Growth
  - \* Analysis for growing cracks
  - \* Leak before Break Analysis
- 10.3 Remediation

## **Session 11: Assessment of Fire Damage**

- 11.1 Acceptability and Limitation
- 11.2 Required Measurements and Data for FFS Assessment
  - \* Collect fire damage data as practically possible
  - \* Try to get video of incident, if available
  - \* Identify heat exposed area of equipment, piping and structures
- 11.3 Inspection Techniques and Sizing Requirements
  - \* Record degradations observed in heat exposure zones
  - \* Dimensional, metallurgical and mechanical test of heat exposed zones
  - \* Extensive in-situ metallography as conducted shall be recorded
  - \* Non-destructive examinations
- 11.4 Assessment and Acceptance Criteria
- 11.5 Remaining Life Assessment and Remediation

## **Session 12: Thickness, MAWP, Stress Evaluation for FFS Assessment**

- 12.1 Calculation of Minimum Required Wall Thickness: Pressure Vessels and Tanks under internal pressure
  - \* Shell, Head, Nozzle and Reinforcement area,
- 12.2 Calculation of Minimum Required Wall Thickness: Pressure Vessels under external pressure



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\* Shell, Head, Stiffening rings

12.3 Calculation of Minimum Required Wall Thickness: Piping under internal pressure

\* Pipes, Bends

12.4 MAWP (Calculation of Maximum Allowable Working Pressure) of Vessel & Piping



## Day 4:

### Session 13: Stress Analysis for FFS Assessment (Part 1)

13.1 Role in establishing structural integrity

13.2 Linear Elastic Stress Analysis and Acceptance

\* Basic Stress Intensity Categories

13.3 Establishing Allowable Stress Intensity

13.4 Non-linear Elastic-Plastic Stress Analysis

\* Limit Loads

\* Plastic Collapse Load

\* Stress Analysis with a flaw

13.5 Assessment of Structural Stability

### Session 14: Stress Analysis for FFS Assessment (Part 2)

14.1 Assessment of Structural Stability

14.2 Methods for Fatigue Evaluation

14.3 FFS Assessment using Finite Element Analysis

### Session 15: Residual Stresses in FFS Evaluation (Part 1)

15.1 Weld Locations with Residual Stress Distribution

\* Full Penetration Welds

\* Fillet Welds

\* Repair Welds

15.2 Variables which affect residual stresses



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- 15.3 Residual stresses in Cylindrical shells and Piping
- 15.4 Residual Stresses in spherical shell and vessel heads

## **Session 16: Residual Stresses in FFS Evaluation (Part 2)**

- 16.1 Residual stresses in storage tanks
- 16.2 Residual stresses at nozzles and piping branch connections
- 16.3 Residual stresses at Tee joints
- 16.4 Residual stresses in repair welds

### **Day 5:**

## **Session 17: Material Properties for FFS Assessment**

- 17.1 Yield and Tensile Strength
- 17.2 Flow Stress
- 17.3 Fracture Toughness, Fracture Toughness Parameters
- 17.4 Fracture Toughness Testing
- 17.5 Assessing Fracture Toughness from Charpy V-notch Data
- 17.6 Fracture Toughness after in-service degradation
- 17.7 Fracture Toughness of Austenitic Stainless Steel

## **Session 18: Crack Growth Types and Evaluation**

- 18.1 Categories of Crack Growth
- 18.2 Fatigue Crack Growth
- 18.3 Stress Corrosion Crack Growth
- 18.4 Fatigue Strength of Welded Components
- 18.5 Creep Rupture and Creep Crack Growth

## **Session 19: Overview on Deterioration and Failure Modes**

- 19.1 Pre-service Deficiencies
- 19.2 In-service Deterioration and Damage

## **Session 20: Discussion on plant damage case histories and Mock Examination**

The training package includes

1. Comprehensive course material of 200+ pages to each participant & exposure to Operating Plant Piping conditions, Inspection and fitness.
2. Lectures by renowned experts of 30+ years of experience in the Industry

Our clientele include Oman Refinery , Qatar Petroleum, Oman Gas, STS Oman, PDO, L&T, ABB, TCE, EIL, GAIL, IFFCO, GSFC, IOC, RELIANCE, ALSTOM-POWER, LINDE, REAL, BHEL, TRANSPEK, ONGC, PRAJ, Tecnimont ICB, MECON, Chennai Petroleum, PTTEP Thailand & many others who have benefited from program conducted regularly by us.

### **METHODOLOGY**

1. Technical Sessions
2. Problem Solving Sessions
3. Case Studies

### **DATE & TIME**

Place- Conference Room CEPL, Vadodara

Date/ Duration- **5 Days, Year 2022 (Batch may start on demand)**

Time: 10.00 AM- 5 PM

Note: **Program can be conducted Online** as well, which may require your self study of course materials. This may take around 100 hours of your time. Your queries will be sent to



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us through emails, and clarifications submitted by us through email. We may also use video conferencing at a prescheduled time and durations.

## VENUE

CEPL Conference Room, 302 Sunsilver Aptt, Productivity Road, Vadodara

## REGISTRATION

The Registration fees (India):

**Rs. 56000 per delegate**

The fee may be sent to us in the form of a Cheque drawn in favour of **Charisma Education Pvt. Ltd.**, payable at Vadodara. Online Bank Transfer of the Fee may also be done and details will be provided on request.

Request for nominations can be sent on the organization letter-head along with the fee as cheque.

The Registration fees (Foreign):

**US \$ 700 per delegate**

The fee may be sent to us in our bank account in favour of **Charisma Education Pvt. Ltd.**, payable at Vadodara. Online Bank Transfer of the Fee may also be done and details will be provided on request.

Request for nominations can be sent on the organization letter-head or through email along with the fee as online bank transfer.

## CONTACT India:

**Charisma Education Pvt Ltd.**

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Website: [www.charismacareer.com](http://www.charismacareer.com)

## Biodata of Expert Faculty:



### **Narendra Kumar Roy**

Born on February 4, 1948, he graduated in Mechanical Engineering at Bihar Institute of Technology, Sindri, Ranchi University, India (Year 1966). He completed his Master of Engineering with specialization in Mechanical Machine Design at University of Roorkee; India (Year 1968).

He is working as **Director** on the board of Charisma Careers Pvt. Ltd, Charisma Education Pvt Ltd Vadodara, India and is Advisor to Charisma Global Networks Ltd, Auckland, New Zealand.



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He had worked as Advisor to Gramya Research since inception of the organization (since Year 1984).

Number of process plant design, and inspection training programs were conducted by him for the benefit of engineers & supervisors in India and abroad (Oman, Qatar, Malaysia, Indonesia, New Zealand).

He had worked as **General Manager**, Humphreys & Glasgow Consultants Ltd. (A Project Engineering Consultant and Associate of Jacobs Engineering, UK / USA), Vadodara Regional Office, Gujarat, India guiding and heading all function of Project Management and Engineering as regional head during 1994-1996.

He worked as **General Manager** (Technical), VXL India Ltd., Saurashtra Chemicals, Porbandar, Gujarat, India during 1991-1993. Planned and established scientific Predictive Maintenance systems, Nondestructive Testing Laboratory, established systems for life assessment of pipelines, equipment and boilers including corrosion monitoring.

He worked as Dy. Chief Engineer / **Project Manager** / **Chief Engineer** with Projects & Development India Ltd, Vadodara, Gujarat, India in their Design/ Engineering and Project Management Group during 1982-1991.

He has to his credit **120+ papers** published in various National and International Technical Journals and Proceedings of the seminars and conferences. Main subjects covered related to pressure vessels, pumps and piping, pipeline designs & Inspection as per ASME and API Code.

He has co-authored three books as published in the past;

**Engineering Manual of Valves**

**Thermal Insulation**

**Project Management in Indian Scenario**

He is the Honorary Editor of the **Journal for Process Equipment & Piping Technology** (J-PEP), published by Charisma Careers Pvt. Ltd (Gramya Research Analysis Institute), Vadodara, India.

He guided and organized **100+ training programs** of national and international level on Technical and Management topics under the banner of Gramya Research Analysis Institute and Charisma Careers Pvt Ltd, Vadodara and Charisma Global Network Ltd Auckland, New Zealand.

## List of recent training programs conducted:

1. Piping design & inspections, 2 days, In-house Training program at Gujarat Gas Company Ltd., LPG Division, Rajkot, India (1996)
2. Design, Selection & Inspection of Machinery Piping Systems, 4 days, In-house Training Program at Nuclear Power Corporation Ltd, Kakrapar, Gujarat, India (1998)
3. Piping Technology: Design and Analysis, Inspection (3 days), In-house Training Program at Birla Cellulosics, Kharach, Bharuch, India (2000)
4. Piping Design and Analysis, Inspection & Erection (5 days) at Rusayl Institute, Rusayl (Muscat), Oman (2002)
5. Piping Inspection as per API 570 (5 days) at Rusayl Institute, Rusayl, Oman, (2003), Doha, Qatar, (July 2005)
6. Piping Technology/ Piping design as per ASME B31.3 programs, conducted 2-3 times every year in India at Vadodara, Delhi, Mumbai (4-5 days) starting year 2000 onwards.
7. Pipeline Inspection and Maintenance Training Program for Oman Gas Ltd, Oman through Rusayl Institute; 5 Modules (Nov. 2004 till Sept. 2005)



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8. Pipeline Right-of-Way Inspection and Maintenance Training Program for Oman Gas Ltd, Oman through Rusayl Institute; 3 Modules (Nov. 2004 till Sept. 2005)
9. Piping Technology, (6 Days), PT South Pacific Viscose, Purvakarta, Java, Indonesia, April 2007
10. Piping Design and Orientation to software application, (4 Days), Tata Chemicals Ltd Mithapur, Gujarat, India; October 2007
11. Piping Design and Pipeline integrity, (2 days), COMFORI Kuala Lumpur, Malaysia, December 2008
12. Piping Design and Stress analysis using Software, (2 days), CGNL Auckland., New Zealand, October 2010
13. Piping and Pipeline Design, Inspection, Repairs and Maintenance; (5 Days), GTChennai/ QTPC Doha Qatar, November 2010
14. Piping Systems and Pipeline Integrity Management, (3 Days), QTPC Doha, Qatar, December 2010
15. Piping Design and Stress Analysis, Dow Corning India, Chennai, January 2011, (3Days)
16. Inspection and NDT in Fertilizer Industry, IFFCO, Kalol Unit, India, August 2011, (2 Days)
17. Selection of Machineries, Piping and Equipment and their Maintenance, Zuari Industries Goa, India, January 2012, (3 Days)
18. Pipeline Integrity Management, (5 Days), QTPC Doha, Qatar, March 2012
19. Piping Systems and Pipeline Integrity Management, (3 Days), CapSource, Maputo Mozambique, January 2015
19. Piping Systems and Pipeline Integrity Management, (3 Days), CapSource, Lagos Nigeria, April 2015
20. Defect Assessment and Evaluation for Pipeline Fitness for Service, (3Days), CapSource, Lagos Nigeria, Apr 2016
21. Piping Integrity and Corrosion Control, (3Days), YF- Asia, Bangkok Thailand, August 2016
22. Fitness for Service of Equipment and Piping of Oil & Gas Sector (5Days), YF Asia/ PTTEP Bangkok Thailand, December 2017
23. Fitness for Service of Equipment and Piping of Oil & Gas Sector (5Days), Vadodara India, September 2019/ January 2020

He had visited Federal Republic of Germany, University of Stuttgart, July 1971 to attend International Conference/Workshop on Engineering Fracture Mechanics.

He visited Denmark; Haldor Topsoe A/S, Copenhagen, July/August 1985 for Project Coordination activities of Ammonia Project, National Fertilisers Ltd Vijaipur (Guna) Project, and IFFCO Aonla.

Visited Oman (Muscat), 2002+

Visited Qatar (Doha), 2002+, 2010, 2012

Visited USA, Portland (Oregon), San Francisco (CA), Los Angeles (CA) and Vancouver (Washington), 2006/ 2014/2016

Visited Indonesia, Purvakarta, Java, 2007

Visited Malaysia, Kuala Lumpur, 2009,13, 14

Visited New Zealand, Auckland, 2010/ 2016/ 2017

Visited Mozambique, Maputo, January 2015

Visited Nigeria, Lagos, 2015/ 2016

Visited Thailand, Bangkok, 2016/ 2017





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**NK Roy is Professional Member of:**

American Society of Mechanical Engineers (ASME), USA;

American Water Works Association (AWWA), USA;

Indian Institute of Metals, Calcutta;

Society of Piping Engineers and Designers, USA

Project Management Institute, USA

Listed in Who is Who in the World