Best Technology Solutions (BTS)

# Carbon & Low Alloy Steel Materials for Sour Service (NACE MR0175ISO 15156NACE MR0103) Training program

## Introduction:

This comprehensive course will enable the candidates gain an understanding of general principles for selection of cracking-resistant materials used in H2S-containing environments in oil and gas production where the failure of such equipment could pose a risk to the health and safety of the public and personnel or to the environment as described in NACE MR0175/ISO 15156 and for refineries as described in NACE MR0103. This will be achieved by clarifying the responsibilities of the equipment user, manufacturer, and supplier as defined in NACE MR0175/ISO 15156 and NACE MR0103 aided by studying basic steel metallurgy, H2S related damage mechanisms, hardness test methods, steel standards. To assist with these objectives, a brief introduction to H2S-environment cracking test methods NACE TM0177 and TM0284 will be covered.

## Who Should Attend?

Engineers, testing lab technologists and technicians, inspectors, equipment designers, steel manufacturers, distributors, and maintenance personnel who are involved in designing, fabricating, manufacturing, supplying, operating, maintaining, repairing, and inspecting oil field and refinery equipment in sour service by using NACE MR0175/ISO 15156 and MR0103. This course will assist personnel performing API 579 and API 581 evaluations



# Course Objectives:

**By the end of this course delegates will be able to:**

- Learn about NACE MR0175, ISO 15156 & NACE MR0103 standards and fully comprehend the basic principles

# Course Outline:

**General Introduction**

- Introduction to NACE Material Requirements Standards
- History of MR0175 development
- Overview of MR0175/ISO 15156 Parts 1, 2, and 3, MR0103, TM0177, TM0284, and how they work together.

**NACE MR0175/ISO 15156 Part 1**

- Overview of Part 1 - General Principles for Selection of Cracking-Resistant Materials
- Evaluation of definition of service conditions
- Listed (pre-qualified) materials

**Introduction to Carbon and Alloy Steel Metallurgy**

- Introduction to carbon steel metallurgy, including terms and definitions in ASTM A941
- Using the Fe-Fe3C phase diagram in practical terms
- Using continuous cooling transformation diagrams to predict undesirable steel conditions for sour service
- Common heat treatments for carbon and alloy steels
- Classification of steels - UNS, ASTM, ASME, SAE (AISI), API, EN, and how they are used within NACE MR0175/ISO 15156



- Detailed discussion of the misnomers and slang terms used to described steels
- Review of several commonly used ASTM steel standards, such as A105, A106, A333, A516, and others
- Chemical compositions
- Mechanical properties
- Heat treatments
- Hardness requirements
- Supplementary requirements
- Material test reports
- Review of sample A105, A106, A333, and A516 material test reports
- Understanding the importance of material test report data and evaluation for meeting NACE MR0175/ISO 15156 and MR0103
- Using material test reports to make critical purchasing decisions
- Brief introduction to the weldability of carbon and alloy steels for wet H2S service
- Defining the weld in metallurgical terms
- Understanding the weld heat affected zones (HAZs)
- Use of carbon equivalence formulas

**H2S Related Damage Mechanisms**

- Introduction to H2S cracking mechanisms addressed in NACE MR0175/ISO 15156
- Sulfide stress cracking, stress corrosion cracking, hydrogen-induced cracking
- Stepwise cracking, stress-oriented hydrogen induced cracking, soft zone cracking and galvanically induced hydrogen stress cracking
- Description of affected materials, critical factors, affected units or equipment appearance
- Morphology of damage, prevention/mitigation, inspection and monitoring

**NACE MR0175/ISO 15156 Part 2**

- Qualification and selection of carbon and alloy steels for sour service
- Defining sour service environment (H2S partial pressure vs. pH)
- Regions of environmental sensitivity (Figure 1 in MR0175/ISO 15156 Part 2)
- Determination of H2S partial pressure and pH (Annex C and D)
- Overview of Annex A
- SSC-resistant carbon and alloy steels



- Maximum acceptable hardness values
- Applications to specific product forms (pipe, plate, fittings, bolting, etc.)
- Purchasing Materials for Sour Service
- Information to be supplied for material purchasing (Part 2 Annex E)
- Material test reports (MTRs) - what they really mean and how they should be used to qualify and purchase steels within MR0175/ISO 15156

**Hardness Test Methods and Related ASTM and ISO Standards**

- Bench hardness testing
- ASTM E10 and ISO 6506-1 (Brinell)
- ASTM E18 and ISO 6508-1 (Rockwell)
- ASTM E384 and ISO 6507-1 (Vickers)
- ASTM E110 (Portable Hardness Testers)
- ASTM E384 (Microindentation)
- Portable hardness testing:
- A833 (Telebrineller)
- A956 (Leeb, Equotip, others)
- A1038 (Microdur - MIC)
- Converting hardness test values to other scales: ASTM E140 and EN ISO 18265

**NACE MR0175/ISO 15156 Part 3**

- Part 3 and CRAs will not be covered in this course

**NACE Test Methods for Sour Service**

- Overview of NACE TM0177 and TM0284
- SCC laboratory testing for sour service (Part 2 Tables B.1, B.2, and B.3)
- Example test reports and applications of both test methods will be discussed

**CSA and API Codes**

- Review of sour service requirements for pipeline steels covered in CSA Z662 and API 5L specifications



**NACE MR0103**

- Roadmap to MR0103 (Table 1)
- Carbon, alloy, and stainless steel material requirements, including P-No. hardness
- Nonferrous material requirements
- Fabrication requirements (welding, cladding, stamping, threading)
- Bolting requirements
- Plating, coating and diffusion processes
- Special component requirements (bearings, springs, instrumentation, etc.)
- Valve requirements
- Compressor and pump requirements

**Limitations of MR0175/ISO 15156 and MR0103**

- Discussion of why hardness testing, laboratory testing, and NACE MR0175/ISO 15156 may not be sufficient to predict suitable application of materials for the intended sour service conditions