## Maintenance & Inspection of Static Equipment

**Overview**

**LEVEL**
Knowledge

**PURPOSE**
This course aims to acquire a comprehensive and practical knowledge of static equipment inspection in order to efficiently contribute to the entire scope of duties performed by an inspection department of an Oil & Gas company.

**LEARNING OBJECTIVES**
Upon completion of the course, participants will be able to:
- use and explain pressure vessels international rules and regulations,
- identify materials comprising equipment, their composition, their mechanical characteristics and select the most appropriated material for a given Oil & Gas application,
- describe the various welding processes and their limits,
- identify most appropriate non-destructive or destructive testing for the different modes of degradation and perform several simple non-destructive testing,
- list the main characteristics and types of corrosion of metallic materials used in the Oil & Gas industries, describe protection means against each type of corrosion and implement associated monitoring.

**WAYS AND MEANS**
Numerous industrial case studies and practical exercises.

**LEARNING ASSESSMENT**
Written test upon training course completion.

**PREREQUISITES**
No prerequisites for this course.

### Agenda

**MODULE 1: INSPECTOR OCCUPATION & STATUTORY REGULATIONS RELATING TO PRESSURE VESSELS**
- Introduction to production facilities inspection:
- Impact on safety, pressure vessel integrity, accident analysis.
- Inspector occupation:
- Duties and organization of inspection services: inspector role and responsibilities.
- Inspection plan: definition, set-up, implementation.
- Inspection report. Interaction with the other departments.
- Statutory regulations applicable to pressure vessels:
  - Main regulatory texts. Area of application and regulatory context of pressure vessels.
  - Roles and responsibilities of various parties. Managing feedback and lessons learnt.

**MODULE 2: METALLURGY & MATERIALS, WELDING**
- Metallurgy:
Ferrous and non-ferrous metals.
Structures and behavior of metals and alloys at service conditions for static equipment.
Evaluation of the mechanical characteristics required for predictable behavior at service conditions.
Most widely used metals and metal alloys in production facilities: steels, their composition, structure and behavior at service conditions.
Steels: HIC-resistant, CRA resistant, cupronickel, aluminium bronze.
Effect of heating and cooling on steels: current heat treatments resulting from welding or deliberately applied.
Common defects in steels.
Boilermaking - Welding:
Current cutting, forming and welding processes; impact on metals structure.
Post-welding heat treatment.
Identification of welding defects in welded assemblies using non-destructive checks and destructive tests on weld test pieces.
Qualification of welding procedures and welders.
Technique for the permanent assembly of heat exchanger bundle tubes and tube plates: roll and mechanical expansion.
Case study.

MODULE 3: CONSTRUCTIVE TECHNOLOGY, NON DESTRUCTIVE & DESTRUCTIVE TESTING

Equipment construction technology:
General information on static equipment.
Type of pressure vessels and pressurized accessories.
Drawings: reminder on PFD, P&ID, Isometrics reading.
Introduction to construction codes and standards:
Rules and regulations application areas, standards, harmonized standards, professional guides.
Notions of materials strength and pressure vessel shells calculations. Safety and welding margins.
Construction monitoring, destructive and non-destructive testing.
Notions of strength test.
Introduction to relevant codes and standards (ASME).
Techniques for non-destructive and destructive testing:
Standard faults in external and internal walls.
Principles, possibilities and areas of application of main NDTs: visual, sweating, magnetic crack detection, ultrasound, X-ray, sealing, acoustic emission.
Review of innovative NDTs: digital radio, phased array, TOFD, IRIS, MFL, intelligent pigging, ROVs, drones, reinforced visual inspection.
Implementation in equipment inspection: on base materials and components, during production, on acceptance, in operation.
Principles, possibilities and areas of application of destructive test methods.

MODULE 4: CORROSION PREVENTION IN PRODUCTION FACILITIES

Definition and mechanisms of corrosion:
Wet corrosion, dry corrosion.
Elements of electrochemistry.
Cost of corrosion: both financial and human, impact on safety.
Common types of corrosion: origin and development process, possible methods of prevention.
Types of corrosion encountered in the Oil & Gas industry:
Case studies of corrosion observed in Oil & Gas installations: identification of the types of corrosion and suggested remedial treatments.
Corrosion prevention:
Design of equipment; choice of materials; corrosion inhibitors; anti-corrosion coatings and systems.
Cathodic protection with sacrificial anodes or imposed current.
Methodology and control of processes. Control of process and environmental parameters.
Corrosion monitoring:
Corrosion coupons and probes; non-destructive testing of wall condition.
Corrosion monitoring plan.