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COURSE BROCHURE

# Metallurgy for Non-Metallurgists in Oil and Gas Training Course

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Registered in the United Kingdom and Saudi Arabia

# Metallurgy for Non-Metallurgists in Oil and Gas Training Course

Metallurgy for Non-Metallurgists in Oil and Gas is a 1-week training course for engineers, inspectors and technicians without a materials background, and each participant leaves with an Equipment Material Fact Sheet for one item of plant they look after. Ageing pipework, vessels and rotating parts increasingly fail through mechanisms that only make sense once grain structure, heat treatment and weld zones are understood. Jupiter Prime Training runs this course.

## Why Metallurgy for Non-Metallurgists Matters Now

Three pressures make metal behaviour everyone's concern on hydrocarbon sites: life extension of equipment beyond its original design years, sourcing of replacement parts from a wider set of mills and fabricators, and sour or high-temperature service that punishes the wrong alloy choice. Teams that can read a mill certificate, question a weld procedure or recognise a brittle fracture surface catch problems early and talk usefully with specialists. Teams that cannot often accept substitutes blindly or misread failures. The course builds on the iron-carbon phase diagram, standard mechanical tests and the material grades used across petroleum, power and chemical plants.

## Who Gains Most from Metallurgy for Non-Metallurgists

- Staff who inspect vessels, piping and tanks and interpret thickness and crack indications
- Staff who approve repairs, weld procedures and replacement parts
- Staff who buy pipe, plate, forgings and fasteners and check certificates
- Staff who investigate equipment breakdowns and write failure reports
- Staff who run or maintain rotating equipment exposed to wear and fatigue

An inspection or maintenance engineering section gains most when several members attend together and share one vocabulary for materials questions raised with specialists.

## Metallurgy for Non-Metallurgists Capabilities

Participants connect what happens inside a metal’s microstructure to what they see on a fracture face, a hardness reading or a certificate.

- Assess whether a carbon, low-alloy or stainless grade suits a given temperature and fluid — the materials engineer
- Specify heat treatment requirements such as normalising or post-weld stress relief — the fabrication contractor
- Test mill certificates against purchase specifications for chemistry and mechanical properties — the procurement officer
- Weigh hardness, impact and tensile results when accepting a repair — the inspection authority
- Apply fracture surface reading to separate fatigue, overload, creep and hydrogen cracking — the failure investigator
- Communicate material condition and remaining-life concerns in plain terms — the plant manager

## Key Metallurgy for Non-Metallurgists Terms

- Microstructure — the arrangement of grains and phases inside a metal, visible under a microscope, that governs strength and toughness.
- Heat-affected zone — the band of base metal beside a weld whose structure and properties change because of welding heat.
- Charpy impact test — a notched-bar test measuring the energy a sample absorbs on fracture, indicating toughness at a set temperature.
- Martensite — a hard, brittle steel structure formed by rapid cooling, often softened later by tempering.
- Creep — slow, permanent deformation of metal held under stress at high temperature over long periods.
- Hydrogen embrittlement — loss of ductility when atomic hydrogen enters steel, leading to cracking under load.

## Metallurgy for Non-Metallurgists Day by Day

## Day 1: Inside the Metal

- Crystal Lattices and Grain Boundaries — Why Metals Bend Before Breaking
- Iron-Carbon Phase Diagram — Reading Steel Behaviour From Composition and Temperature
- Alloying Elements Such as Chromium and Molybdenum — Strength and Resistance Choices
- Ferrite, Pearlite and Austenite Structures — Linking Microstructure to Properties
- Carbon, Low-Alloy and Stainless Grades — Matching Families to Plant Duty

## Day 2: Shaping Properties With Heat

- Annealing, Normalising and Quench-and-Temper Cycles — Specifying the Right Treatment
- Hardenability and Cooling Rate — Thick Sections Versus Thin Components
- Post-Weld Heat Treatment — Residual Stress and Hardness Control
- Surface Hardening by Nitriding and Carburising — Wear Parts on Pumps and Compressors
- Cast, Forged and Rolled Products — Selecting a Manufacturing Route

## Day 3: Welding Metallurgy and Testing

- Fusion Zone and Heat-Affected Zone — Where Weld Failures Begin
- Preheat, Interpass Temperature and Filler Selection — Avoiding Cold Cracking
- Tensile, Hardness and Charpy Tests — Accepting or Rejecting Material
- Mill Certificates and Positive Material Identification — Catching Wrong Grades
- Dissimilar Metal Welds — Joining Stainless to Carbon Steel Safely

## Day 4: How Plant Metals Fail

- Fatigue Crack Growth and Beach Marks — Rotating Shafts and Vibrating Piping
- Creep and Stress Rupture — Furnace Tubes and Hot Headers
- Hydrogen Embrittlement and Sulphide Stress Cracking — Sour Service Choices
- Corrosion Forms From Pitting to Galvanic Attack — Linking Environment to Alloy
- Brittle and Ductile Fracture Surfaces — First Reading in a Failure Investigation

## Day 5: Practising the Equipment Material Fact Sheet

- Grade Selection Exercise for a Sour Gas Line — Applying Day 1 Families
- Heat Treatment and Weld Repair Review — Applying Day 2 and Day 3 Rules
- Fracture Photograph Interpretation Session — Applying Day 4 Failure Modes
- Remaining-Life Questions for Specialists — Framing an Expert Referral
- Equipment Material Fact Sheet Drafting — Grade, Treatment, Threats and Checks

## Applying Metallurgy for Non-Metallurgists After the Course

- Audit the mill certificates for one recent purchase order against its specification and log any gaps.
- Lead a short fracture-reading session for colleagues using photographs of a past failure on site.

## Metallurgy for Non-Metallurgists Questions FAQ

### What is metallurgy for non-metallurgists and why does it matter now?

It is a practical grounding in how metals are structured, treated, welded and tested, and how they fail. It matters now because ageing plant and wider sourcing of parts put material decisions in the hands of engineers who never studied metallurgy.

### Which roles gain most from metallurgy for non-metallurgists in oil and gas?

Inspectors, maintenance and reliability engineers, buyers of metal products and failure investigators gain most, along with technicians who handle repairs.

## How does metallurgy for non-metallurgists differ from a damage mechanisms course?

It teaches the underlying science of structure, heat treatment and welding first. A damage mechanisms course catalogues specific degradation threats by process unit; this subject explains why those threats arise so non-specialists can ask better questions.

## What do you bring back from metallurgy for non-metallurgists training?

You bring back an Equipment Material Fact Sheet for one item of plant, stating its grade, treatment, likely threats and the checks that confirm its condition.

## Metallurgy for Non-Metallurgists: The Way Forward

The Equipment Material Fact Sheet first informs whether a proposed replacement part or repair procedure suits the duty of that equipment. Inspectors, maintenance engineers and buyers use it when approving substitutes. After its first use, revisit the threats listed against new inspection findings to see whether the original grade and treatment still fit current operating conditions.