LNG Liquefaction Plant Operations: Refrigeration Cycles, Cryogenic Equipment and Train Start-Up

1 – 12 February 2027
Paris - Right Bank business hotel



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Ref: 707_19023 **Date:** 1 – 12 February 2027 **Location:** Paris - Right Bank business hotel **Fees:** 42300 SAR

Introduction:

LNG liquefaction plant operations fail quietly before they fail loudly: a drifting mixed refrigerant composition, a warm-end pinch in the main cryogenic exchanger or a rushed cool-down cuts production, raises specific power and can crack cold equipment. This Core Concept course takes engineers inside the liquefaction train, from feed gas pre-treatment and refrigeration cycles through spiral-wound and plate-fin exchangers, compressors, tanks and boil-off gas, to cool-down, start-up, trips and hazards. Participants produce a Train Start-Up and Performance Review Plan for a case LNG plant.

Course Objectives:

- Interpret LNG cooling curves, flash behaviour and feed gas composition to set the operating basis of a liquefaction train
- Verify that acid gas, water, mercury and heavy hydrocarbon removal meets the limits that prevent freeze-out and exchanger damage
- Compare propane-precooled mixed refrigerant, cascade, single mixed refrigerant and expander cycles on specific power, turndown and equipment count
- Diagnose exchanger pinch points, refrigerant composition drift and compressor operating point problems from plant data
- Plan cool-down, start-up, shutdown and trip response steps that protect cryogenic materials, tanks and personnel from LNG hazards
- Produce a Train Start-Up and Performance Review Plan with efficiency and reliability KPIs for a case LNG plant

Target Audience:

- Process engineers accountable for liquefaction train heat and material balance and refrigerant performance
- Operations engineers and shift leads who run cool-down, start-up, rundown and shutdown of LNG trains
- Mechanical and rotating equipment engineers responsible for refrigerant compressors, drivers and cryogenic exchangers
- HSE and process safety engineers who assess cryogenic spill, rollover and vapour cloud scenarios at liquefaction sites
- Reliability engineers who track train availability, trips and bad actors on cold section equipment

Course Outline:

Day 1: LNG Properties, Cryogenic Behaviour and Liquefaction Train Basis

- Methane-Rich LNG Composition, Minus 162 Degree Boiling Point and Density Behaviour
- Temperature-Enthalpy Cooling Curves for Precooling, Liquefaction and Subcooling Zones
- Joule-Thomson Expansion, Flash Gas and End Flash Nitrogen Rejection
- Feed Gas Composition Envelope: Lean, Rich and Nitrogen-Bearing Cases
- Liquefaction Train Block Flow Diagram from Inlet Receiving to Rundown

Day 2: Feed Gas Pre-Treatment for the Cold Section

- Amine Acid Gas Removal Unit and CO2 Slip Limits That Prevent Freeze-Out
- Molecular Sieve Dehydration Bed Cycle, Regeneration Gas and Breakthrough Signs
- Mercury Guard Bed Duty and Protection of Brazed Aluminium Equipment
- Scrub Column and NGL Extraction to Remove Heavy Hydrocarbons and Benzene
- Cold Section Entry Gas Specification Sheet

Day 3: Liquefaction Refrigeration Cycle Families

- Propane-Precooled Mixed Refrigerant Cycle Flow Scheme and Pressure Levels
- Pure-Component Cascade Cycle with Propane, Ethylene and Methane Loops
- Single Mixed Refrigerant Cycle for Mid-Scale and Modular Trains
- Nitrogen and Methane Expander Cycles for Small-Scale and Floating Units
- Cycle Selection Matrix: Specific Power, Equipment Count and Turndown

Day 4: Cryogenic Heat Exchangers, Refrigerant Compressors and Train Control

- Spiral-Wound Main Cryogenic Exchanger Bundles, Shell-Side Distribution and Warm-End Approach
- Brazed Aluminium Plate-Fin Cores: Thermal Stress Limits and Core Leak Detection
- Refrigerant Compressor Maps, Anti-Surge Control and Gas Turbine or Electric Motor Drivers
- Mixed Refrigerant Make-Up, Composition Trimming and Light-to-Heavy Ratio Control
- Advanced Process Control of LNG Rundown Temperature and Production Rate

Day 5: Week-One Case: Refrigeration Loop Diagnosis on a Case Train

- Case Train Data Pack: Heat and Material Balance, Cooling Curves and Compressor Logs
- Cooling Curve Gap Analysis to Locate Exchanger Pinch Points
- Mixed Refrigerant Composition Correction from Sample Chromatograph Results
- Compressor Operating Point Plot Against Surge and Stonewall Lines
- Week-One Diagnosis Memo and Peer Challenge

Day 6: LNG Storage Tanks, Boil-Off Gas Recovery and Loading Interface

- Full-Containment Tank: Nickel Steel Inner Tank, Prestressed Concrete Wall and Suspended Deck
- Membrane Tank Corrugated Stainless Liner and Insulation Panel System
- Tank Heat Leak, Boil-Off Rate Estimation and Stratification Monitoring
- Boil-Off Gas Compressor, Fuel Gas Header and Reliquefaction Return Routes
- Jetty Loading Arm Sequence, Vapour Return Balancing and Ship-Shore ESD Link

Day 7: LNG Hazards, Process Safety and Safeguards

- Tank Rollover Mechanism, Density Layering and Mixing Countermeasures
- Rapid Phase Transition on LNG Contact with Water and Spill Direction Channels
- Vapour Cloud Dispersion, Pool Fire Radiation and Impoundment Basins
- Cryogenic Burns, Asphyxiation Risk and Cold-Work Protective Equipment
- Emergency Shutdown Hierarchy, Fire and Gas Detection and Cause and Effect Review

Day 8: Cryogenic Materials, Cool-Down, Start-Up and Shutdown Sequences

- Cryogenic Materials: Austenitic Stainless, Nickel Steel and Aluminium Alloys
- Piping Thermal Contraction, Cold Spring and Support Movement Checks
- Controlled Cool-Down Rate Procedures for Exchangers, Piping and Tanks
- Train Start-Up Sequence from Refrigerant Charging to First LNG Rundown
- Planned Shutdown, Warm-Up, Deriming and Shift Handover Communication

Day 9: Trip Response, Troubleshooting and Liquefaction Performance KPIs

- Compressor Trip, Driver Loss and Exchanger Flow Maldistribution Scenarios
- Freeze-Out, Hydrate and Fouling Diagnosis from Differential Pressure Trends
- Specific Power Consumption and Refrigeration Efficiency Tracking
- Train Availability, Production Uptime and Flaring Loss KPIs
- Reliability Bad Actor Ranking and Root Cause Analysis Records

Day 10: Capstone: Train Start-Up and Performance Review Plan

- Capstone Brief: Case LNG Plant Train Data, Constraints and Outage History
- Start-Up Plan Drafting: Cool-Down Steps, Hold Points and Permissives
- Performance Review Section: KPI Baselines, Targets and Efficiency Actions
- Hazard Safeguard and Trip Response Annex for the Case Train
- Plan Presentation to a Peer Panel and Revision Log

Skills You Will Gain:

- Cooling Curve Interpretation
- Pre-Treatment Specification Checking
- Refrigeration Cycle Comparison
- Mixed Refrigerant Composition Control
- Cryogenic Exchanger Diagnostics
- Cool-Down Procedure Planning
- Cryogenic Hazard Safeguarding
- Liquefaction Performance Benchmarking

Why Attend This Course:

- Return with a Train Start-Up and Performance Review Plan built on a case LNG plant and challenged by a peer panel
- Read compressor maps, exchanger temperature profiles and refrigerant samples together to find lost production
- Run cool-down and restart after a trip without thermal shock to spiral-wound bundles, plate-fin cores or cold piping
- Compare liquefaction practice with process, rotating equipment and safety engineers from other trains and operators

Conclusion:

Steady LNG rundown depends on clean feed gas, a well-tuned refrigerant loop, healthy cryogenic exchangers and compressors, and disciplined cool-down and restart. Week one covers LNG properties, pre-treatment, refrigeration cycle families, exchangers, compressors and control, then tests them on a case train. Week two adds tanks and boil-off gas, the loading interface, cryogenic hazards, materials, start-up and shutdown sequences, trip troubleshooting and performance KPIs. The final day produces a Train Start-Up and Performance Review Plan for a case LNG plant.