



Quantitative Risk Assessment (QRA): Consequence Modelling, F-N Curves and Facility Siting



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Introduction:

Quantitative risk assessment QRA turns loss of containment scenarios into numbers that decide plant layout, building locations and which safeguards are worth funding. Too often these numbers arrive in a consultant report that nobody on the owner side can check: inventories are guessed, ignition assumptions are hidden and F-N curves are accepted without challenge. This Core Concept course takes engineers through the full calculation chain, from source term and consequence modelling to frequency analysis, individual risk contours and societal risk. Participants build a Simplified QRA and Risk-Reduction Options Report for a case facility.

Course Objectives:

- Define the scope, study basis and representative release scenarios of a QRA and position it against HAZID, HAZOP, LOPA and bow-tie outputs
- Calculate release rates and interpret dispersion, fire, explosion and toxic consequence results produced by consequence modelling software
- Derive scenario frequencies from generic leak data, event trees and ignition probability models
- Compute individual risk contours, location-specific risk and F-N curves and compare them with risk criteria and ALARP expectations
- Apply QRA results to facility siting, layout separation, occupied buildings and escape route decisions
- Review a consultant QRA report for input traceability, model validity, sensitivity and uncertainty, and rank risk-reduction options

Target Audience:

- Process safety engineers who define release scenarios and own the input data for quantified risk studies
 - Technical safety and loss prevention engineers who use consequence and risk results to set layout and separation
 - Risk engineers who run consequence and risk modelling packages or check the runs of others
 - HSE managers who commission QRA studies and must accept or challenge their conclusions
 - Project and design engineering managers responsible for siting new units, control rooms and occupied buildings
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Course Outline:

Day 1: QRA Purpose, Study Basis and Release Scenario Definition

- QRA Position Relative to HAZID, HAZOP, LOPA and Bow-Tie Outputs
- Risk Triplet: Scenario, Frequency and Consequence Summation
- QRA Study Basis Document: Objectives, Boundaries, Receptors and Assumptions
- Isolatable Section Definition and Inventory Estimation From P&IDs and Heat and Material Balances
- Representative Release Scenario Selection: Hole Size Categories and Release Orientation

Day 2: Source Term and Consequence Modelling Methods

- Release Rate Calculation: Liquid, Gas and Two-Phase Discharge With Flashing and Rainout
- Dense Gas and Passive Dispersion Modelling: Weather Categories and Surface Roughness
- Jet Fire and Pool Fire Radiation Models: Flame Geometry and Surface Emissive Power
- BLEVE Fireball, Fragment Projection and Congestion-Based Vapour Cloud Explosion Overpressure
- Toxic Dose, Probit Functions and Vulnerability Endpoints at Overview

Day 3: Frequency Analysis, Individual Risk and Societal Risk

- Generic Leak Frequency Data and the Equipment Parts-Count Method
- Event Tree Construction: Isolation, Blowdown and Immediate Versus Delayed Ignition
- Ignition Probability Models: Release Rate Correlations and Ignition Source Density
- Individual Risk Contours and Location-Specific Individual Risk Calculation
- Societal Risk: Population Data, Occupancy Factors, F-N Curve Plotting and Potential Loss of Life

Day 4: Risk Criteria, Siting Decisions, Report Review and Uncertainty

- Risk Criteria Comparison and ALARP Cost-Benefit Evaluation of Safeguards
- Facility Siting and Layout Separation Driven by Consequence and Risk Results
- Occupied Building Exposure and Escape Route Impairment Assessment
- Consultant QRA Report Review Checklist: Input Traceability and Model Validity
- QRA Uncertainty Sources, Sensitivity Runs and Known Method Limitations

Day 5: Modelling Build: Simplified QRA for a Case Facility

- Case Facility Scenario List and Inventory Build for a Gas Processing and Storage Site
 - Consequence Distance Table From PHAST-Type Consequence Package Output
 - Frequency and Event Tree Spreadsheet Build With Individual Risk and F-N Results
 - Risk-Reduction Option Evaluation: Inventory Reduction, Faster Isolation and Layout Change
 - Simplified QRA Report Presentation and Peer Challenge
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Skills You Will Gain:

- Release Scenario Definition
- Source Term Calculation
- Consequence Modelling Interpretation
- Event Tree Frequency Analysis
- Individual Risk Contour Mapping
- Societal Risk and F-N Analysis
- Facility Siting Assessment
- QRA Report Verification

Why Attend This Course:

- Leave with a Simplified QRA and Risk-Reduction Options Report built for a case facility and adaptable to your own site
- Question consultant inventories, ignition assumptions and F-N curves with your own check calculations
- Place control rooms, occupied buildings and muster areas on the basis of risk numbers you understand
- Show which safeguards buy the largest reduction in individual and societal risk before capital is committed

Conclusion:

A quantitative risk assessment is only as sound as its scenarios, source terms, frequencies and population data. The course moves from QRA scope and release scenario definition, through release rate and consequence modelling, to leak frequency, event trees and ignition probability, then individual risk, societal risk and F-N curves, criteria, siting, occupied buildings, report review and uncertainty. The final day brings these steps together in a modelling build that produces a Simplified QRA and Risk-Reduction Options Report ready for technical review.
