

## Quantitative Risk Assessment (QRA) in Process Safety: A Comprehensive Approach to Identifying, Analyzing, and Mitigating Risks

### Course general description:

**Quantitative Risk Assessment (QRA)** is a cornerstone of process safety management, enabling organizations to systematically evaluate potential risks associated with industrial processes. This course is designed to equip participants with the knowledge and skills necessary to conduct QRAs effectively, ensuring compliance with regulatory standards while enhancing safety and operational efficiency. Through a blend of theoretical insights, practical case studies, and hands-on exercises, participants will learn how to quantify risks, interpret results, and implement risk mitigation strategies.

### Audience:

**This course is intended for:**

- Process safety engineers and managers
- Risk analysts and consultants
- HSE (Health, Safety, and Environment) professionals
- Plant operators and maintenance personnel
- Regulatory compliance officers
- Anyone involved in designing, operating, or managing industrial processes

### Course objectives:

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

- Understand the principles and methodologies of Quantitative Risk Assessment (QRA).
- Identify hazards and assess their potential consequences in industrial processes.
- Apply statistical and probabilistic techniques to estimate risk levels.
- Develop risk mitigation strategies based on QRA findings.
- Interpret QRA results to support decision-making in process safety management.
- Comply with international standards and best practices for QRA implementation.

### Course duration:

5 days

### Course location:

Dubai

### Course contents:

#### **Day-1: Introduction to QRA and Hazard Identification**

- Pretest to assess participants' baseline understanding of QRA principles.
- Overview of Quantitative Risk Assessment (QRA) and its role in process safety.
- Key regulatory frameworks and industry standards (ISO 31000, API RP 754).
- Hazard identification techniques: HAZID, HAZOP, FMEA, and risk terminology.
- Group activity on hazard identification and real-world case study analysis.

#### **Day-2: Consequence Modeling and Risk Estimation**

- Fundamentals of consequence modeling for fire, explosion, and toxic releases.
- Probabilistic risk estimation using fault trees, event trees, and Bayesian networks.
- Introduction to software tools like PHAST and SAFETI for consequence modeling.
- Hands-on tutorials for building fault trees and analyzing chemical spill scenarios.
- Quiz on consequence modeling and risk estimation concepts.

#### **Day-3: Risk Quantification and Uncertainty Analysis**

- Techniques for quantifying risk: frequency analysis, exposure assessment.
- Risk matrices and the ALARP (As Low As Reasonably Practicable) principle.
- Addressing uncertainties in QRA with sensitivity analysis and Monte Carlo simulations.
- Practical exercise on using risk matrices and evaluating pipeline failure uncertainty.
- Quiz on risk quantification and uncertainty analysis.

#### **Day-4: Risk Mitigation and Decision-Making**

- Strategies for risk reduction: engineering controls, administrative measures, PPE.
- Cost-benefit analysis in risk mitigation decision-making.
- Effective communication of QRA results to stakeholders.
- Group discussion on prioritizing risk mitigation measures in a refinery.
- Quiz on risk mitigation strategies and stakeholder communication.

#### **Day 5: Advanced Topics and Final Assessment**

- Emerging trends in QRA: AI, machine learning, and digital twins.
- Integration of QRA with other safety management systems.
- Review of key concepts, lessons learned, and best practices.
- Final written test covering all topics from the course.
- Post-course feedback session and posttest evaluation of learning outcomes.

#### **Methodology:**

- 50% lectures & concepts
- 10% Videos
- 10% Case studies
- 10% Exercises
- 10% Discussions

#### **Assessment and Certification:**

Upon successful completion, participants will receive a **Quantitative Risk Assessment (QRA) in Process Safety**, demonstrating their capability to implement quantitative risk assessment studies for process industry systems.

**Course code: (THSE013)**