Layers of Protection Analysis LOPA Practical Training Course

OGT-1101 · 5 days · 15 CPD hours · English

OVERVIEW

Layers of Protection Analysis (LOPA) is a structured, semi-quantitative risk assessment methodology used to evaluate hazardous process scenarios, estimate risk levels and determine whether existing safeguards provide adequate protection against major process incidents. In the oil and gas industry, where process hazards can lead to catastrophic consequences, LOPA plays a vital role in supporting systematic risk reduction, process safety decisions and the implementation of effective protective measures.

The **Layers of Protection Analysis LOPA Practical Training Course** offered by the Oil & Gas Training Institute is designed to equip professionals with the knowledge and practical skills required to conduct, review and apply LOPA studies across process facilities, production operations, refineries, petrochemical plants and other hazardous industrial environments. As part of the **Process Safety Management for Oil & Gas** category, this programme explores the principles of LOPA, scenario development, initiating event frequency estimation, risk tolerance criteria and the identification and evaluation of independent protection layers.

Participants will develop an understanding of how LOPA builds upon hazard identification and process hazard analysis techniques, such as Hazard and Operability Studies (HAZOP), to assess the effectiveness of existing safeguards and identify additional risk reduction requirements. The course also examines the relationship between LOPA and Safety Integrity Level (SIL) determination, helping professionals understand when a Safety Instrumented Function (SIF) may be required and how its target integrity level can be established through structured risk assessment.

Through practical exercises, worked examples, technical discussions and industry-based case studies, participants will learn to assess initiating events, evaluate safeguard effectiveness, calculate scenario risk, identify gaps in protection and document LOPA findings. The programme emphasises practical application, analytical consistency and sound engineering judgement, enabling professionals to make informed process safety decisions and support the implementation of reliable risk reduction measures.

The Oil & Gas Training Institute delivers this course with a practical, industry-oriented approach, helping participants strengthen their technical capabilities in process risk assessment, safeguard evaluation and process safety management.

OBJECTIVES

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

- Explain the principles, purpose, methodology and applications of Layers of Protection Analysis in oil and gas process safety management.

- Identify hazardous scenarios, initiating events, consequences and escalation pathways relevant to LOPA studies.
- Estimate initiating event frequencies and evaluate the assumptions, data sources and uncertainties associated with frequency assessment.
- Identify, assess and validate independent protection layers based on independence, effectiveness, reliability and other relevant criteria.
- Apply risk tolerance criteria, consequence severity classifications and risk reduction requirements to process safety scenarios.
- Perform structured LOPA calculations to determine scenario risk and the required risk reduction.
- Interpret LOPA results and understand their relationship with Safety Integrity Level (SIL) determination and Safety Instrumented Functions (SIFs).
- Evaluate existing safeguards, identify protection gaps and recommend appropriate additional risk reduction measures.
- Prepare, review and document LOPA studies using consistent assumptions, calculation methods and technical justifications.
- Facilitate or contribute effectively to LOPA workshops and support the integration of LOPA findings into process safety improvement initiatives.

TRAINING METHODOLOGY

The course adopts a practical, interactive and technically focused training methodology designed to develop participants' analytical skills and their ability to apply LOPA in real industrial environments.

- **Instructor-Led Presentations:** Structured presentations introduce LOPA principles, terminology, methodology, risk assessment frameworks and the relationship between LOPA, HAZOP, SIL determination and process safety management.
- **Technical Discussions:** Participants explore real process safety challenges, discuss risk assessment decisions and examine the limitations and assumptions associated with LOPA calculations.
- **Practical LOPA Workshops:** Hands-on exercises enable participants to develop scenarios, identify initiating events, assess safeguards, determine risk reduction requirements and complete LOPA worksheets.

- **Industry Case Studies:** Realistic oil and gas scenarios involving pressure systems, hydrocarbon processing, storage facilities, pipelines and process equipment are used to demonstrate the practical application of LOPA.
- **Scenario-Based Exercises:** Participants analyse hypothetical process incidents, assess initiating event frequencies, evaluate independent protection layers and determine whether additional safeguards are required.
- **Collaborative Group Activities:** Teams work together to conduct selected LOPA assessments, challenge assumptions, compare analytical approaches and develop technically justified conclusions.
- **Worked Calculation Exercises:** Step-by-step calculations reinforce understanding of consequence severity, initiating event frequencies, IPL probabilities of failure, risk reduction factors and residual risk.
- **Knowledge Sharing and Feedback:** Facilitated discussions encourage participants to share operational experiences, explore common LOPA challenges and receive feedback on their assessment approaches.

This combination of technical instruction, collaborative learning and practical exercises helps participants translate theoretical understanding into workplace application.

ORGANISATIONAL IMPACT

Implementing effective Layers of Protection Analysis practices can strengthen process safety performance and help organisations manage major accident risks more systematically. This training course supports organisational development by improving the quality, consistency and reliability of risk assessment decisions.

- **Improved Process Risk Management:** Organisations can strengthen their process hazard assessment practices by systematically evaluating hazardous scenarios, initiating events and existing safeguards.
- **More Effective Safeguard Evaluation:** Participants develop the capability to assess the effectiveness of independent protection layers, identify weaknesses in protection systems and recommend appropriate improvements.
- **Better Safety Instrumented System Decisions:** Understanding the relationship between LOPA and SIL determination supports informed decisions about the need for Safety Instrumented Functions and their required risk reduction performance.
- **Strengthened Risk-Based Decision-Making:** LOPA provides a structured basis for evaluating residual risk, prioritising risk reduction measures and supporting engineering decisions.
- **Enhanced Operational Reliability:** Better safeguard assessment and risk reduction planning can help organisations improve the reliability of protective systems and reduce the likelihood of hazardous events.

- **Improved Process Safety Documentation:** Consistent LOPA methodologies, assumptions and calculation records support traceability, technical review and future reassessment.
- **More Effective HAZOP and Risk Assessment Integration:** Organisations can improve the connection between hazard identification, scenario evaluation, safeguard analysis and risk reduction planning.
- **Greater Technical Collaboration:** LOPA workshops encourage cooperation among process engineers, instrumentation specialists, operations personnel, safety professionals and engineering teams.
- **Support for Process Safety Management:** The course reinforces risk-based approaches to safeguard management, safety system planning and process safety improvement initiatives.

PERSONAL IMPACT

Attending the Layers of Protection Analysis LOPA Practical Training Course can help participants strengthen their technical expertise and confidence in managing process safety risk assessment responsibilities.

- **Advanced LOPA Knowledge:** Participants gain a structured understanding of LOPA methodology, terminology, calculations and practical assessment techniques.
- **Improved Risk Assessment Skills:** They develop the ability to analyse hazardous scenarios, evaluate initiating events and assess risk reduction requirements.
- **Greater Confidence in Safeguard Evaluation:** Participants learn how to critically examine independent protection layers and determine whether safeguards meet the requirements of a LOPA assessment.
- **Enhanced SIL Determination Understanding:** They gain practical insight into how LOPA can support SIL determination and the identification of Safety Instrumented Functions.
- **Stronger Analytical and Problem-Solving Capabilities:** Practical exercises improve their ability to interpret process hazards, assess assumptions, compare protection strategies and make technically justified recommendations.
- **Improved Technical Communication:** Participants develop the ability to explain LOPA findings, document risk assessment decisions and communicate safeguard requirements to multidisciplinary teams.
- **Better Workshop Participation and Facilitation:** They gain confidence in contributing to LOPA workshops, challenging assumptions constructively and supporting structured technical discussions.

- **Greater Professional Competence:** The course strengthens their capabilities in process safety engineering, risk management and industrial safety assessment.

- **Career Development:** Participants can build knowledge relevant to professional responsibilities involving process safety, hazard analysis, safety systems, risk assessment and engineering consultancy.

WHO SHOULD ATTEND

This course is designed for professionals involved in process safety, hazard assessment, risk management, engineering design and operational safety in oil and gas and other process industries.

- **Process Safety Engineers:** To strengthen their capability to conduct, review and manage LOPA studies and process hazard assessments.

- **Safety Engineers and HSE Professionals:** To improve their understanding of risk reduction requirements, safeguard effectiveness and process safety decision-making.

- **Process Engineers:** To evaluate hazardous scenarios, initiating events, existing protection measures and additional risk reduction requirements.

- **Instrumentation and Control Engineers:** To understand LOPA's role in SIL determination, Safety Instrumented Functions and safety system design requirements.

- **Reliability Engineers:** To evaluate safeguard reliability, protection layer performance and risk reduction considerations.

- **Operations and Production Engineers:** To understand process hazards, operational safeguards and the role of LOPA in maintaining safe plant operations.

- **Engineering Managers and Technical Managers:** To support risk-based engineering decisions, safeguard prioritisation and process safety improvement programmes.

- **Plant Managers and Operations Supervisors:** To improve their understanding of LOPA findings and their implications for operational risk management.

- **Project Engineers and Design Engineers:** To incorporate risk reduction requirements and appropriate protection layers into facility design, modification and project planning.

- **Loss Prevention Specialists:** To develop their expertise in process hazard analysis, risk assessment methodologies and safeguard evaluation.

- **Process Safety Consultants and Risk Assessment Practitioners:** To enhance their technical knowledge and practical application of LOPA assessment methods.
- **HAZOP Team Leaders and Facilitators:** To understand how LOPA can extend HAZOP findings into structured risk evaluation and protection layer analysis.

COURSE OUTLINE

Fundamentals of Layers of Protection Analysis and Process Safety Risk Assessment

- Introduction to process safety management in oil and gas industries
- Major accident hazards and the importance of risk reduction
- Principles, purpose and scope of Layers of Protection Analysis
- LOPA as a semi-quantitative risk assessment methodology
- Relationship between LOPA, HAZID, HAZOP, Bowtie Analysis and Quantitative Risk Assessment
- Risk-based approaches to process safety decision-making
- Understanding hazardous scenarios and accident pathways
- Consequence severity classifications and risk tolerance criteria
- Introduction to risk matrices, frequency categories and tolerable risk
- LOPA terminology, assessment boundaries and study assumptions
- Selecting suitable scenarios for LOPA assessment
- Overview of the LOPA workflow and documentation requirements

Scenario Development, Initiating Events and Frequency Assessment

- Developing well-defined LOPA scenarios from HAZOP findings
- Identifying hazardous events, initiating events and potential consequences
- Understanding initiating event frequency and its role in LOPA

- Common initiating events in oil and gas process facilities
- Equipment failures, human errors and process deviations
- Initiating event frequency estimation methodologies
- Sources of initiating event frequency data
- Historical data, industry databases and engineering judgement
- Understanding frequency modifiers and conditional probabilities
- Occupancy, ignition, exposure and other relevant consequence modifiers
- Avoiding double-counting and inconsistent assumptions
- Evaluating uncertainty in initiating event frequency estimates
- Establishing scenario-specific assessment assumptions
- Preparing initiating event analysis records

Independent Protection Layers and Safeguard Evaluation

- Introduction to independent protection layers (IPLs)
- IPL criteria and qualification requirements
- Understanding independence, effectiveness, reliability and auditability
- Identifying potential IPLs within process safety scenarios
- Process design features and inherent safety measures
- Basic process control systems and their limitations as protection layers
- Alarms, operator response and human reliability considerations
- Pressure relief systems and mechanical protection
- Safety Instrumented Functions and emergency shutdown systems

- Fire and gas detection and mitigation systems
- Evaluating IPL probability of failure on demand
- Understanding IPL effectiveness and risk reduction factors
- Common IPL assessment errors and limitations
- Independence requirements and common-cause failure considerations
- Safeguard documentation and evidence requirements

LOPA Calculations, Risk Reduction and SIL Determination

- LOPA calculation methodology and assessment workflow
- Establishing scenario risk and consequence severity
- Combining initiating event frequency with relevant conditional modifiers
- Applying IPL probability of failure values
- Calculating mitigated scenario frequency
- Understanding risk reduction factors and protection layer contribution
- Determining residual risk and comparing it with risk tolerance criteria
- Identifying risk gaps and required risk reduction
- Evaluating the need for additional independent protection layers
- Introduction to Safety Integrity Levels (SIL 1, SIL 2, SIL 3 and SIL 4)
- Understanding SIL targets and probability of failure on demand
- Relationship between LOPA risk reduction requirements and SIL determination
- Identifying Safety Instrumented Functions
- Understanding the role of Safety Instrumented Systems (SIS)

- Introduction to SIF design, implementation and lifecycle considerations
- Common calculation errors, assumptions and sensitivity considerations
- Technical review and validation of LOPA results

LOPA Study Facilitation, Documentation and Practical Implementation

- Planning and preparation for a LOPA workshop
- Defining LOPA study objectives, scope and boundaries
- Selecting scenarios and preparing assessment inputs
- Facilitating structured LOPA discussions
- Managing assumptions, disagreements and technical challenges
- Reviewing initiating event frequencies and IPL data
- Ensuring consistency across LOPA scenarios
- LOPA worksheets, assessment records and documentation standards
- Recording risk reduction requirements and recommendations
- Integrating LOPA findings with HAZOP recommendations
- Communicating LOPA findings to engineering, operations and management teams
- Implementing additional safeguards and risk reduction measures
- Integrating LOPA outcomes into Safety Instrumented System lifecycle activities
- Management of change and reassessment of LOPA scenarios
- Maintaining and reviewing LOPA studies throughout facility lifecycle
- Common LOPA implementation challenges and lessons learned

- Final review of course concepts and practical application

SCHEDULED DATES

Dates	Venue	Format	Fee
04 - 08 Jan 2027	Abu Dhabi, United Arab Emirates	In person	On request
04 - 08 Jan 2027	Abuja, Nigeria	In person	On request
04 - 08 Jan 2027	Accra, Ghana	In person	On request
04 - 08 Jan 2027	Addis Ababa, Ethiopia	In person	On request
04 - 08 Jan 2027	Al Ain, United Arab Emirates	In person	On request
04 - 08 Jan 2027	Al Khobar, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Alberta, Canada	In person	On request
04 - 08 Jan 2027	AlUla, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Amman, Jordan	In person	On request
04 - 08 Jan 2027	Amsterdam, The Netherlands	In person	On request
04 - 08 Jan 2027	Athens, Greece	In person	On request
04 - 08 Jan 2027	Baku, Azerbaijan	In person	On request
04 - 08 Jan 2027	Barcelona, Spain	In person	On request
04 - 08 Jan 2027	Berlin, Germany	In person	On request
04 - 08 Jan 2027	Boston, USA	In person	On request
04 - 08 Jan 2027	Brussels, Belgium	In person	On request
04 - 08 Jan 2027	Budapest, Hungary	In person	On request
04 - 08 Jan 2027	Cairo, Egypt	In person	On request
04 - 08 Jan 2027	Cape Town, South Africa	In person	On request
04 - 08 Jan 2027	Casablanca, Morocco	In person	On request
04 - 08 Jan 2027	Dammam, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Dhahran, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Doha, Qatar	In person	On request

Dates	Venue	Format	Fee
04 - 08 Jan 2027	Dubai, United Arab Emirates	In person	On request
04 - 08 Jan 2027	Edinburgh, United Kingdom	In person	On request
04 - 08 Jan 2027	Edmonton, Canada	In person	On request
04 - 08 Jan 2027	Frankfurt, Germany	In person	On request
04 - 08 Jan 2027	Geneva, Switzerland	In person	On request
04 - 08 Jan 2027	Houston, USA	In person	On request
04 - 08 Jan 2027	Istanbul, Turkey	In person	On request
04 - 08 Jan 2027	Jakarta, Indonesia	In person	On request
04 - 08 Jan 2027	Jeddah, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Jubail, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Khamis Mushait, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Kigali, Rwanda	In person	On request
04 - 08 Jan 2027	Kuala Lumpur, Malaysia	In person	On request
04 - 08 Jan 2027	Lisbon, Portugal	In person	On request
04 - 08 Jan 2027	Liverpool, United Kingdom	In person	On request
04 - 08 Jan 2027	London, United Kingdom	In person	On request
04 - 08 Jan 2027	Los Angeles, USA	In person	On request
04 - 08 Jan 2027	Luanda, Angola	In person	On request
04 - 08 Jan 2027	Madrid, Spain	In person	On request
04 - 08 Jan 2027	Manama, Bahrain	In person	On request
04 - 08 Jan 2027	Marbella, Spain	In person	On request
04 - 08 Jan 2027	Marrakech, Morocco	In person	On request
04 - 08 Jan 2027	Miami, USA	In person	On request
04 - 08 Jan 2027	Milan, Italy	In person	On request
04 - 08 Jan 2027	Munich, Germany	In person	On request
04 - 08 Jan 2027	Muscat, Oman	In person	On request

Dates	Venue	Format	Fee
04 - 08 Jan 2027	Nairobi, Kenya	In person	On request
04 - 08 Jan 2027	New York, USA	In person	On request
04 - 08 Jan 2027	Nice, France	In person	On request
04 - 08 Jan 2027	Oslo, Norway	In person	On request
04 - 08 Jan 2027	Paris, France	In person	On request
04 - 08 Jan 2027	Port Louis, Mauritius	In person	On request
04 - 08 Jan 2027	Prague, Czech Republic	In person	On request
04 - 08 Jan 2027	Pretoria, South Africa	In person	On request
04 - 08 Jan 2027	Riyadh, Saudi Arabia	In person	On request
04 - 08 Jan 2027	Rome, Italy	In person	On request
04 - 08 Jan 2027	Sarajevo, Bosnia and Herzegovina	In person	On request
04 - 08 Jan 2027	Sharm El Sheikh, Egypt	In person	On request
04 - 08 Jan 2027	Singapore, Singapore	In person	On request
04 - 08 Jan 2027	Stockholm, Sweden	In person	On request
04 - 08 Jan 2027	Tokyo, Japan	In person	On request
04 - 08 Jan 2027	Toronto, Canada	In person	On request
04 - 08 Jan 2027	Tromso, Norway	In person	On request
04 - 08 Jan 2027	Vienna, Austria	In person	On request
04 - 08 Jan 2027	Zagreb, Croatia	In person	On request
04 - 08 Jan 2027	Zurich, Switzerland	In person	On request
04 - 08 Jan 2027	Online, Virtual	Online	On request

CERTIFICATE