

# Nuclear Academy

Courses in Nuclear Probabilistic Safety Assessment



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Lloyd's Register Nuclear Academy offers a comprehensive training programme in Probabilistic Safety Assessment (PSA) targeting professionals in risk management. The programme includes an introductory course, an advanced course, and a range of specialised PSA training modules.

Our instructors are chosen on the basis of their areas of expertise, industry experience and proven results. As specialists in their respective fields, they have confronted and resolved many of the problems you are facing on a daily basis. Training modules combine theory with practical examples from industry (BWRs and PWRs) and provide an overview of international best practice. Participants will also benefit from interactive sessions and hands-on practice using RiskSpectrum® PSA software.

In addition to our scheduled courses, we offer customised training to fit your needs - held at your premises if requested.



*“An investment in  
knowledge pays the  
best interest.”*

Benjamin Franklin

# PSA courses

- PSA Part 1
- PSA Part 2

## PSA Part 1 (3 days)

### Level 1 PSA - Internal Events

The purpose of this course is to give participants both a broad overview and a detailed introduction to PSA and its various elements. The focus is on Level 1 PSA and internal events analysis. The course is designed for individuals with little or no experience in PSA. The lectures combine simple theory with interesting practical examples from industry (BWRs and PWRs). These are followed by hands-on practice using RiskSpectrum® PSA software. An overview of the most widely used international references (IAEA, USNRC, CSNI etc.) will be provided for each stage of the internal events analyses.

### Contents

**Introduction** to PSA, History, Aim and Scope

**Overview** Level 1, 2 and 3 PSA

**Standards**, Guidelines and Requirements from Regulators  
Introduction to IAEA Safety Guide SSG-3 on Level 1 PSA

**Level 1 PSA**, Internal Events

- Initiating events analysis
- Sequence analysis
- Success criteria
- Systems analysis
- Human reliability analysis (HRA)
- Data analysis
- Quantification
- Results presentation and interpretation
- Dependencies

**Hands-on** Practice using RiskSpectrum® PSA

- Introduction to RiskSpectrum
- Systems analysis (Fault trees)
- Sequence analysis (Event trees)
- Interpretation of results

## PSA Part 2 (4 days)

### Low Power and Shutdown Level 1 PSA, Internal and External hazards, Level 2 and 3 PSA

The purpose of this course is to give participants an introduction to specific PSA topics such as low power and shutdown PSA, internal hazards, external hazards, Level 2 and Level 3 PSA. The course is tailored to individuals with some experience in PSA (PSA Part 1 or working experience). The lectures combine theory with practical examples, and there are exercises using RiskSpectrum® PSA.

### Contents

**Plant** Operating States

**Low** Power and Shutdown PSA

**Internal** Hazards PSA, Fire, Flooding, Dropped Loads and Turbine Missiles

**External** hazards PSA, Seismic, Aircraft Crash, High Winds and External Flooding Analysis

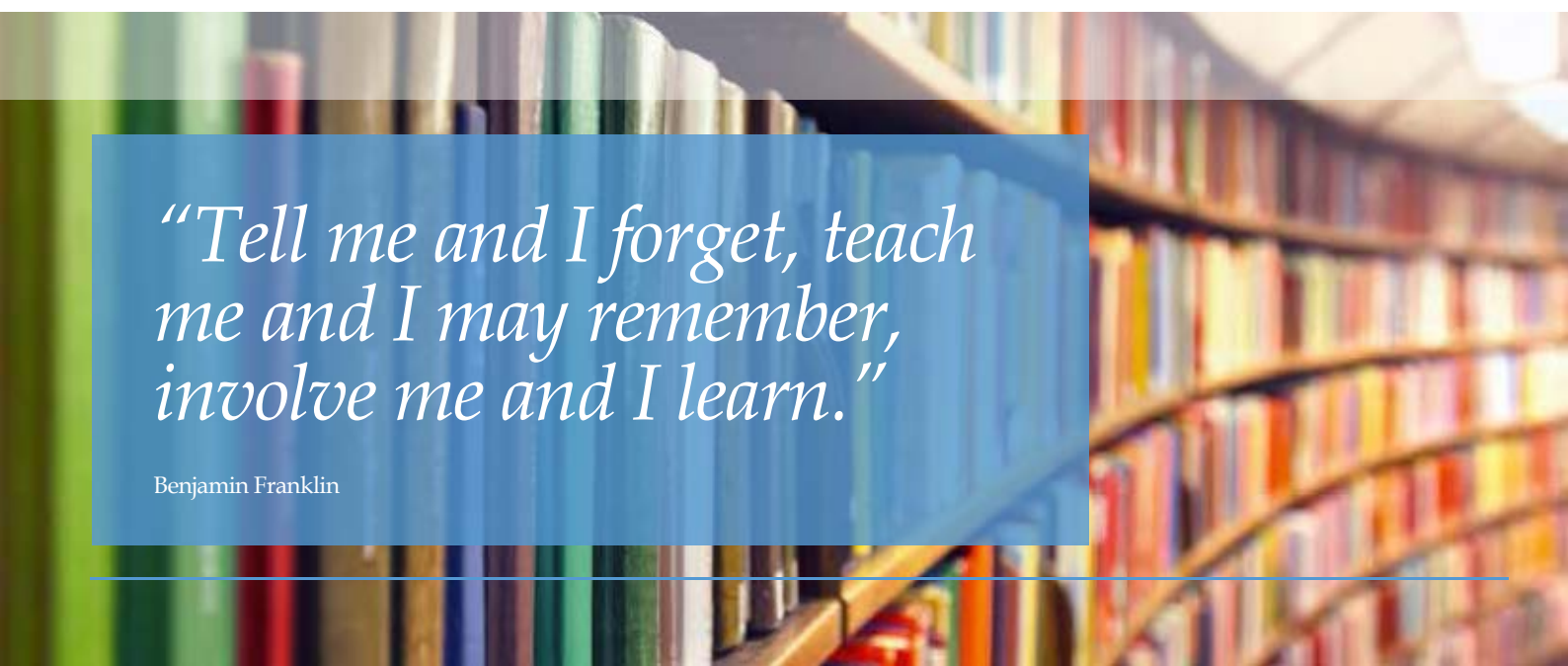
**Level 2 PSA**

- Interface Level 1 and 2 PSA
- Plant damage states
- Accident progression analysis (containment event trees)
- Containment failure modes and performance
- Phenomena during severe accidents
- Release categories and source terms
- Quantification of large early release frequency (LERF/LRF)

**Hands-on** Practice using RiskSpectrum® PSA


- Shutdown PSA modelling vs. full power PSA modelling
- Integrated Level 1 and 2 PSA modelling
- Internal and external hazards
- Containment event trees and release categories

**Overview** of Level 3 PSA



*“Tell me and I forget, teach me and I may remember, involve me and I learn.”*

Benjamin Franklin



*“I never learn anything talking. I only learn things when I ask questions.”*

Lou Holtz

# Specialised PSA courses

## Level 2 PSA (2 days)

**Interface** between Level 1 and Level 2 PSA

**Plant** Damage States (PDS)

- PDS characteristics and attributes
- PDS quantification

**Accident** Progression Analysis

- Containment failure modes
- Containment performance analysis
- Containment event trees

**Phenomena** during Severe Accidents

- Physics, modelling and quantification

**Release** Categories and Source Terms

**System** Functions and Operator Actions

**Quantification** of Large Early Release Frequency (LERF) and Large Release Frequency (LRF)

**Hands-on** Practice using RiskSpectrum® PSA

- Development of containment event trees

**Quantification** and Interpretation of Results

- Level 2 PSA
- Human Reliability Analysis
- PSA Applications
- Seismic PSA
- Internal Fire PSA
- Internal Flooding PSA
- Data Analysis, Analysis of Dependencies and CCF

## Human Reliability Analysis (HRA) (2 days)

**Overview of HRA in PSA**

**Categories** of Human Failure Events

- Pre-initiators
- Initiators
- Post-initiators

**First-generation** HRA Methods (THERP, ASEP, HEART, SPAR-H)

**Second-generation** HRA Methods (ATHEANA)

**Hands-on** Practice using RiskSpectrum® HRA

## PSA applications (3 days)

**Overview** of PSA Applications

**Introduction** to ASME PRA Standard and PSA Capability Categories

**Introduction** to IAEA-TECDOC-1511 (Determining the Quality of PSA for Applications)

**Overview** of PSA Parameters (Risk Metrics/Measures used in Applications)

**Risk-informed** Decision-making

**Probabilistic** Evaluation and Rating of Operational Events

**Support** NPP Upgrades, Back-fitting Activities

**Risk-informed** Technical Specifications Optimisation

**Risk-based** Configuration Control/Risk Monitors

**Risk-informed** Categorisation of Structures, Systems and Components (SSCs)

**Risk Follow-up** (Evaluation of Occurred Operational Events)

## Seismic PSA (3 days)

**Introduction** to Seismic PSA

**Seismic** PSA vs. Internal Events PSA

**Seismic** PSA Methodology

**Modelling** of Seismically Induced Initiators and Accident Sequences

**Probabilistic** Seismic Hazard Analysis

**Seismic** Fragility Analysis, Screening, Accident Sequence and Systems Logic Modelling

**System** Modelling in Seismic Accident Sequences

**Seismic** Risk Quantification with Characterisation of Uncertainties

**Hands-on** Practice deriving Seismic Input Data and using RiskSpectrum® PSA

- Screening process
- Derivation of seismic fragilities
- Use of fragility data
- Implementation of seismic hazard and fragilities into the PSA model
- Implementation of modified HEPs for seismic scenarios
- Development of seismic event trees
- Quantifications and results interpretation

## Internal Fire PSA (3 days)

**Introduction** to fire PSA

**Steps** Involved in Performing Fire PSA

- Plant boundary partitioning
- Component and cable selection
- Qualitative screening
- Fire ignition frequencies
- Quantitative screening
- Scoping fire modelling
- Circuit failure analysis and detailed fire modelling
- Human reliability analysis
- Quantification

**Hands-on** Practice using RiskSpectrum® PSA

- Modification of internal events PSA model for fire PSA
- Creation of internal fire event trees
- Implementation of modified human error probabilities (HEPs) for fire scenarios
- Quantification and results interpretation

## Internal Flooding PSA (3 days)

**Introduction** to Flooding PSA

**Tasks** Involved in Performing Internal Flooding PSA

- Selection of flood areas and systems, components and structures
- Identification of flood sources
- Qualitative screening
- Characterisation of flood scenarios
- Flood initiating event frequency estimation
- Flood consequence analysis
- Flood mitigation – Human reliability analysis
- Modelling of retained flood scenarios
- Quantification and results interpretation

**Hands-on** Practice using RiskSpectrum® PSA

- Modification of internal events PSA model for flooding PSA
- Creation of internal flooding event trees
- Implementation of modified HEPs for flooding scenarios
- Quantification and results interpretation





*“Wisdom... comes not from age, but from education and learning.”*

Anton Chekhov

## Data Analysis, Analysis of Dependencies and CCF (2 days)

### Data Analysis

- Component failure modes and reliability models
- Component boundaries
- Choosing appropriate generic data source for each component
- Overview of data analysis (theory and best practice)
- Plant-specific data analysis and Bayesian analysis
- Passive components (simple Bayes and composite modelling)
- Active components (two-stage Bayes)

### Analysis of Dependent Failures

- Physical and functional dependencies, basic definitions
- Dependency defences against dependencies

### Common Cause Failure (CCF) Analysis

- Examples of CCFs faced by industry, including more susceptible components
- General overview of the alpha, beta and MGL models
- International data references for CCF data and CCF parameters
- Modelling aspects in software and limitations

### Hands-on Practice using RiskSpectrum® PSA

- Reliability models and reliability parameters
- Modelling of CCFs in RiskSpectrum®
- Modelling of maintenance

## How to register

### When

Course dates are announced on <http://info.lr.org/nuclear-academy-training> and [www.riskspectrum.com](http://www.riskspectrum.com)

### Where

Lloyd's Register, Stockholm, Sweden or at client premises on request

### Language

English

### Price

On request excl. VAT, incl. handouts, lunch, and a course dinner

### Contact

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