



Nuclear Power Plant Technology and Operations Course: PWR, BWR, Safety Functions and SMRs



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Introduction:

Nuclear power plant technology and operations, covering PWR, BWR, safety functions and SMRs, is a 10-day course for engineering, project and utility staff joining civil nuclear power programmes, ending with a Plant Technology and Operations Readiness Plan for a case organisation. New programmes stall when owner teams cannot read reactor system descriptions, judge vendor design claims or plan outages. Nominees already work as engineers or technical staff in power or process plants and learn through case studies built on reactor data, heat balances and transient sequences. CoreConcept Training Center delivers this nuclear power plant technology course.

Course Objectives:

- Explain fission, neutron moderation, reactivity feedback and decay heat when reading reactor core and plant system descriptions
- Trace the primary and secondary circuits of PWR and BWR plants and identify the function of each major component
- Map defence in depth levels, physical barriers and the three fundamental safety functions onto a given reactor design
- Compare integral PWR, BWR-based and non-water small modular reactor designs on cooling, passive safety and deployment features
- Describe the nuclear fuel cycle, refuelling outage sequence and operating experience feedback process used by an operating plant
- Prepare a Plant Technology and Operations Readiness Plan that sets reactor choice, safety function coverage and operations arrangements for a case organisation

Target Audience:

- Staff responsible for mechanical, electrical, instrumentation and civil engineering work packages on nuclear new-build projects
 - Staff responsible for owner-side technical review of reactor vendor documentation and system design descriptions
 - Staff responsible for preparing future plant operations, shift organisation and operator training arrangements
 - Staff responsible for maintenance, outage and reliability planning in utilities moving into nuclear generation
 - Staff responsible for project coordination and interfaces between reactor, turbine and balance-of-plant packages
 - Staff transferring from thermal, process or grid plants who will support nuclear plant commissioning and operation
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Course Outline:

Day 1: Fission, Reactor Physics and Nuclear Plant Layout

- Neutron Fission, Chain Reaction and Critical Mass Basics
- Neutron Moderation, Absorption and the Multiplication Factor
- Reactivity Coefficients Including Negative Temperature Feedback Behaviour
- Decay Heat Generation After Shutdown and Removal Demands
- Nuclear Plant Layout From Reactor Building to Turbine Hall

Day 2: Defence in Depth and Fundamental Safety Functions

- Five Defence in Depth Levels Mapped to Plant Barriers
- Fuel Cladding, Primary Boundary and Containment Barrier Roles
- Reactivity Control, Core Heat Removal and Confinement Functions
- Redundancy, Diversity and Single Failure Criterion in Design
- Safety Significance Grading of Plant Systems and Components

Day 3: Pressurised Water Reactor Primary Circuit

- Reactor Pressure Vessel, Core Internals and Fuel Assemblies
- Reactor Coolant Pumps and Primary Loop Flow Paths
- Pressuriser Heaters, Spray and Relief Valve Pressure Control
- U-Tube Steam Generators Separating Primary and Secondary Water
- Control Rod Drives and Boric Acid Volume Control

Day 4: Boiling Water Reactor Design and Secondary Plant Systems

- BWR Direct Cycle With Boiling Inside the Core
- Recirculation Pumps, Jet Pumps and Flow-Based Power Control
- Steam Separators, Dryers and Bottom-Entry Control Blades
- Turbine, Condenser and Feedwater Train in Secondary Plant
- Plant Computer, Process Instrumentation and Control Room Displays

Day 5: Guided Case Study Tracing Heat From Core to Grid

- Case PWR Heat Balance From Core to Generator
 - Case BWR Comparison of Circuits, Barriers and Controls
 - Case Reactor Trip Sequence and Decay Heat Path
 - Case Safety Function Status Tree for a Transient
 - Week-One System Description Note and Terminology Check
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Day 6: Small Modular Reactors and Advanced Reactor Designs

- Integral PWR Small Modular Reactors With In-Vessel Steam Generators
- BWR-Based Small Modular Reactors Using Natural Circulation Cooling
- High-Temperature Gas-Cooled, Molten Salt and Fast Reactor Concepts
- Passive Decay Heat Removal and Reduced Core Inventory Features
- Factory-Built Modules, Multi-Module Plants and Microreactor Uses

Day 7: Emergency Cooling, Accident Management and Safety Analysis

- Emergency Core Cooling Systems for Loss-of-Coolant Accidents
- Containment Spray, Suppression Pool and Hydrogen Control Methods
- Design Basis Accidents Versus Severe Accident Management Guidelines
- Probabilistic Safety Assessment Fault Trees and Event Trees
- Technical Specifications, Operating Limits and Surveillance Testing Routines

Day 8: Nuclear Fuel Cycle, Shift Operations and Human Performance

- Fuel Cycle Front End From Mining to Enrichment
- Fuel Pellet, Rod and Assembly Fabrication Quality Checks
- Spent Fuel Pool Cooling and Dry Cask Storage Transfer
- Shift Crew Structure, Turnover and Control Room Communication
- Human Performance Tools Including Three-Way Communication and Peer Checks

Day 9: Refuelling Outages, Maintenance and Operating Experience

- Refuelling Outage Critical Path and Core Reload Pattern
- Shutdown Safety Function Monitoring During Outage Configurations
- Reliability-Centred Maintenance and Ageing Management of Components
- Operating Experience Feedback, Event Screening and Corrective Actions
- Plant Performance Indicators Including Capability Factor and Unplanned Scrams

Day 10: Capstone Case Study and Plant Readiness Plan

- Case Organisation Brief on Reactor Choice and Programme Stage
 - Reactor Technology Comparison Matrix Using PWR, BWR and SMR Data
 - Safety Function and Barrier Map for the Selected Design
 - Outage and Operating Experience Arrangements for First Fuel Cycle
 - Plant Technology and Operations Readiness Plan Completion and Presentation
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Skills You Will Gain:

- Reactor Physics Literacy
- Primary Circuit System Tracing
- Defence in Depth Mapping
- Safety Function Analysis
- Small Modular Reactor Evaluation
- Fuel Cycle Planning Awareness
- Refuelling Outage Planning
- Operating Experience Screening

Why Attend This Course:

- Deliver a Plant Technology and Operations Readiness Plan to the programme director and technical lead of the case organisation for use in reactor option and operations planning
- Judge whether a vendor system description covers reactivity control, core heat removal and confinement before the owner team accepts it
- Avoid late design queries, outage overruns and repeated events caused by owner staff who cannot read reactor system and safety function documentation
- Brief engineering and project colleagues on PWR, BWR and SMR differences using the course heat balances, barrier maps and comparison matrix

Conclusion:

Back at work, the participant hands the programme director and technical lead a Plant Technology and Operations Readiness Plan for the case organisation. Engineering teams use its reactor comparison matrix and safety function map when reviewing vendor submissions, and operations planners use its outage and operating experience arrangements to shape shift, maintenance and training preparation for the first fuel cycle. After its first use in a design review or operations planning round, the unit should check which safety functions or outage assumptions drew queries and update the plan accordingly.

Frequently Asked Questions FAQ:

What should participants know before the nuclear power plant technology and operations course?

Participants should have an engineering or technical plant background and be comfortable with basic thermodynamics, heat transfer and plant diagrams. No prior nuclear experience is needed. Bringing a system description or heat balance from a thermal or process plant helps with the case studies.

How does nuclear power plant technology and operations training differ from a nuclear licensing or power sector course?

This course covers reactor physics, plant systems, safety functions, fuel cycle, outages and operating experience. Licensing courses cover nuclear law, authorisations and regulatory submissions, and power sector courses cover grids, tariffs and markets; both appear here only where they touch plant engineering.

How do small modular reactors differ from large PWR and BWR nuclear power plants?

Small modular reactors are smaller units, often with the steam generator and pressuriser inside one vessel, passive natural-circulation cooling and factory-built modules. Large PWR and BWR plants rely more on pumped circuits and active safety systems and are built largely on site.

What do participants take back from the nuclear power plant technology and operations course?

Participants take back a Plant Technology and Operations Readiness Plan for a case organisation, with a reactor comparison matrix, a safety function and barrier map, and outage and operating experience arrangements ready to adapt to their own programme.
