Course on "Operation and safety of PWRs" (3 ECTS)

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Units and LO Statements		
Unit 1 –Principles of a nuclear reactor (6 hours)	**Responsibility / Autonomy**	
	Architecture and related operation of a PWR (EQF=7)	
	Skills	**Knowledge**
Reactor principle and systems • Neutron interaction, Cross section, Fission • Reactor principle, Reactor systems **The neutron kinetics** • Equations of kinetics • Sub- and Super-critical states **Thermal hydraulics**. • Energy balance and fuel temperature • Pressure drops and coolant flow rate • Thermal and hydraulic design	• Integrate and apply theory and kinetics of nuclear reactors. • Apply reactor thermal hydraulics. • Approach and manage the reactor operation. • Explain physics underlying the reactor operation.	• Basic nuclear interaction in a reactor core • Main core elements • Reason for moderating neutrons • Reason for core stability • Reactivity variation and management • Core thermal hydraulics and heat transfer main characteristics
Unit 2 – Operation under normal conditions (12 hours)	**Responsibility / Autonomy**	
	Architecture and related operation of a PWR (EQF=7)	
	Skills	**Knowledge**

• Core physics and thermal-hydraulics basics
• Architecture and functional analysis of PWRs (primary and secondary components, containment building, auxiliary systems)
• PWR normal operation
  ○ base load operation
  ○ start-up procedures
  ○ shutdown procedures
• PWR control aspects
  ○ load-follow operation
  ○ performance of control modes
• Safety in operation
  ○ regulation
  ○ protection systems and procedures
  ○ typical operational transients
• PWR core and fuel management
• Practicals on PWR simulator and training reactor.
	• Understand basic principles of PWRs operation
	• Be able to connect safety equipment with their function
	• Understand the needs of safety regulation
	• Link the safety needs to their related equipment
		• Core physics and thermal-hydraulics basics
		• Architecture and functional analysis of PWRs (primary and secondary components, containment building, auxiliary systems)
		• PWR normal operation
		  ○ base load operation
		  ○ start-up procedures
		  ○ shutdown procedures
		• PWR control aspects
		  ○ load-follow operation
		  ○ performance of control modes
		• Safety in operation
		  ○ regulation
		  ○ protection systems and procedures
		  ○ typical operational transients
		• PWR core and fuel management
		• Practicals on PWR simulator and training reactor.

Unit 2 – Safety in accidental conditions (12 hours)	**Responsibility / Autonomy**	
	Safety approach; Management of transient and accident operation (EQF=7)	
	Skills	**Knowledge**

• PWR safety approach
  ○ Deterministic approach
  ○ Probabilistic approach
  ○ Calculation tools
	• Make safety study while referring to safety regulation	• Safety study rules.
		• Safety methodologies.
		• In situ analysis of reactor control.
		• Realistic operational transients.

• Practicals on PWR simulator and training reactor.
• PWR safety systems
• Accidental scenarios
  ○ Loss Of Coolant Accidents (LOCA)
  ○ Steam Generator Tube Ruptures (SGTR)
  ○ Steam Line Secondary Break
  ○ Reactivity Initiated Accidents (RIA).
• Post-accident management (state-oriented approach)
• Innovative tracks of LWRs
  ○ burn-up, conversion ratio, materials and fuels
	• Use the most appropriate safety approach
	• Get familiar with realistic PWR complex operation
	• Understand the main accident sequences and the role of operators
		• Main accident sequences of a PWR.
		  ○ Loss Of Coolant Accidents (LOCA).
		  ○ Steam Generator Tube Ruptures (SGTR).
		  ○ Steam Line Secondary Break.
		  ○ Reactivity Initiated Accidents (RIA).
		• The TMI-2 accident.
		  ○ Initiators.
		  ○ Development.
		  ○ Consequences.
		• Innovative designs.
		• Practicals on PWR simulator

Assessment criteria = to demonstrate mastery of basic nuclear reactor physics and operation		
Recommended assessment methods: Written test and/or oral face to face interview		

Course applicable (in part) for the following job profiles:

- 1.0.01: Nuclear Safety Manager
- 1.0.02: Safety Assessment Specialist
- 1.0.10: Safety Design Engineer
- 1.2.01: Design Manager
- 1.2.09. System Design Engineer
- 1.4.07. Licensing Manager
- 2.1.06. Engineering Manager
- 2.1.07. Operation Manager
- 2.2.01. Shift Engineer
- 2.2.02. Senior Reactor Operator/CRO
- 2.6.01. Safety and Security Manager