N.IN.E. NUCLEAR AND INDUSTRIAL ENGINEERING

WHO WE ARE

NINE Nuclear and Industrial Engineering is a private company founded in 2011 by a group of nuclear and aerospace engineers, having in common a PhD in Nuclear and Industrial Safety and an extensive background experience in the area of Nuclear Reactor Safety Analysis.

The company benefits from a technical expertise in the field of Nuclear Fission power plant technology and our services include Licensing, Safety Analysis, Computer Codes development and validation, NPP design and optimization, Test facilities Design and Consulting.

NINE EXPERIENCE

- ✔ Support to IAEA SAET (Safety Assessment and Education Training) in development and conduction of competence building program for embarking countries since 2009 for Poland, Vietnam, Malaysia, Jordan, Bangladesh and Turkey
- ✔ Twice a year since 2014 Inspector and plant walkdown trainings under the guidance of US NRC inspectors at abandoned NPP at Zwentendorf, Austria



For further information, please visit: www.nineeng.com

N.IN.E. NUCLEAR AND INDUSTRIAL ENGINEERING

COMPETENCE BUILDING PROGRAM FOR EMBARKING COUNTRIES

Sustainable and successful nuclear energy programme demands a technical infrastructure including a workforce of highly specialized and well-educated professionals. Due to complexity of the required skills and knowledge intensive training ranging from several months up to few years under the guidance of experienced trainers has to be undertaken.

NINE offers a variety of services to help the embarking countries in development of the competence building including:

- ✔ **Review of the existing infrastructure and gap analysis**
- ✔ **Familiarization of the Government and other stakeholders of a national nuclear programme with the key components of the technical infrastructure**
- ✔ **Development of the competence building program**
- ✔ **Delivery of the competence building program**
- ✔ **Assessment of the progress and advice in development of the long-term sustainable national training program**

APPROACH

NINE competence building program is based on the modular approach allowing for flexibility in training structure depending on the current situation in the country. It consists of all essential elements of the nuclear safety including:

- ✔ Essential nuclear safety knowledge
- ✔ Assessment of engineering aspects important to safety
- ✔ Deterministic safety assessment
- ✔ Probabilistic safety assessment
- ✔ Plant inspection

NINE - Nuclear and Industrial Engineering
Via della Chiesa XXXII, 759 - 55100 Lucca - Italy

Syllabus for Essential Knowledge

- Introduction to Safety Assessment
  1. Fundamental Safety Principles and overview of IAEA Safety Standards
  2. Basic Safety Concepts
  3. Scope of Safety Assessment
- Basic Nuclear Technology Courses
  1. Reactor Physics
  2. Thermal Hydraulics
  3. Nuclear Power Reactor Designs
- Fundamentals of Safety Analysis
  1. Scope of safety analysis
  2. Preparing for safety analysis
  3. Criteria for Judging Safety and Acceptance Criteria
  4. Scope and Overview of Deterministic Safety Analysis Methods
  5. Scope and Overview of Probabilistic Safety Analysis Methods
  6. Use of Computer Codes
  7. Integrate Risk Informed Decision Making
  8. Overview SA Applications (Licensing Analyses, Development of EOPs and SAMGs, ...)

Syllabus for Assessment of Engineering Aspects Important to Safety

- Crosscutting Topics
  1. Implementation of defence in depth
  2. Operational experience
  3. Radiation protection
  4. Classification of structures systems and components
  5. Equipment qualification
  6. Aging and wear-out mechanisms
  7. Human factors in NPP design and operation
  8. Protection against internal fire and explosions
  9. Protection against internal hazards other than fire and explosions
  10. Protection against earthquakes
  11. Protection against external events excluding earthquakes
- Site Evaluation
  1. General aspects of the site evaluation
  2. Impact of the site on the installation
  3. Site characteristics and the potential effects of the nuclear installation in the region
  4. Monitoring of hazards
- Safety Assessment of the Design of the Main Systems
  1. Reactor Core
  2. Reactor coolant system and associated systems
  3. Reactor containment systems
  4. Emergency power systems
  5. Fuel handling and storage systems
  6. Supporting and auxiliary systems
  7. Instrumentation and control systems

Syllabus for Deterministic Safety Assessment

- Deterministic Analysis
  1. Deterministic Safety Assessment
  2. Scope of Deterministic Analysis
  3. Deterministic Analysis:Overview of Codes
  4. Fundamentals of Nuclear System Modelling
- Beyond Design Basis Analysis
  1. Intro to Beyond Design Basis Analysis
  2. Intro to BDBA Experimental Data Base
  3. Primary Circuit Analysis
  4. Containment Analysis
  5. Fission Product Release & Dispersion Analysis
  6. Interpretation and Use of Results
- Design Basis Analysis
  1. Intro to Design Basis Analysis
  2. Basic Code Modelling
  3. Code Verification and Validation
  4. Separate Effects Tests Modelling
  5. Integral Effects Tests Modelling
  6. Sensitivity Analysis
  7. Fundamentals of Conservative vs. Best Estimate Analysis
  8. Nuclear Power Plant Modelling
  9. Accident Analysis, Uncertainty Evaluation and Interpretation of Results

Syllabus for Probabilistic Safety Assessment

- Probabilistic Safety Assessment
  1. Basic Concepts
  2. System Modeling and Analyses
- Level 1 PSA
  1. Intro to Lv. 1 PSAs
  2. Exercises in Lv. 1 PSAs
  3. Safety Assessment & Verif. with Lv.1 PSAs
  4. Risk Monitors
- Level 2 PSA
  1. Intro to Lv. 2 PSAs
  2. Exercises in Lv. 2 PSAs
  3. Safety Assessment and Verification with Lv. 2 PSAs
- Level 3 PSA
  1. Intro to Lv. 3 PSAs
  2. Exercises in Lv. 3 PSAs
  3. Safety Assessment and Verification with Lv. 3 PSAs

Syllabus for Plant Inspection

- Introduction to Plant Safety
  1. Personnel safety and Equipment
  2. Radiological Safety and Equipment
  3. Fire Protection
  4. Security
  5. Emergency Preparedness
  6. Housekeeping
  7. Plant Status, Systems and Equipment
- Plant Design and Operation
  1. Basic NPP designs and operations
  2. Plant Tour
- Plant Walk-down
  1. Planning a Walk-down
  2. Preparing for a Walk-down
  3. Detailed Plant a Walk-down of the designated Areas
  4. Evaluation of Issues
- Plant Inspection
  1. Fundamentals of Inspection
  2. Plant Operation & Documentation Familiarization
  3. Conduct of Inspection
  4. Evaluation of Inspection
  5. Reporting

Syllabus for Developing Thermal-Hydraulics Code Skills

- General Aspects
  1. Introduction to Deterministic Safety Analysis
  2. Features and Limitations of System-Thermal-Hydraulic codes (SYS-TH)
  3. Conservative and BE Approach
  4. Validation of system computer codes by Integral Test Facility (ITF)
- Code Syntax
  1. Overview of the RELAP5 code architecture
  2. Minor & Major Edits and Time Step Controls
  3. Hydrodynamic Components in RELAP5
  4. Heat Structure Components in RELAP5
  5. Special Components in RELAP5
  6. Logic Trips and Control Variables in RELAP5
- Physical Code Models
  1. The Hydrodynamic and the Heat Transfer Models
  2. Closure Relationships
  3. Other Special Models
- Code Numerics
  1. Numerical Methods and RELAP5 Equation
  2. Solution Algorithms in RELAP5
  3. Numerical Effects in RELAP5 Applications
- Hands-on Training
  1. Familiarization with plotting tools (APT plot, etc..)
  2. Modeling a simple pipe
  3. Edwards Pipe Problem
  4. Valve Sizing
  5. Blow-Down Problem
  6. Steam Generator & Pressurizer Models
  7. Boiling Channel Problem
  8. Effect of Time Step and Spatial Discretization
- Qualification Procedures for SYS-TH Calculations
  1. Procedure for Developing and Qualifying Nodalizations
  2. Procedure for Nodalization Qualification
  3. Quantification of Accuracy of a Code Calculation
  4. Origin of Uncertainties in SYS-TH Calculations
  5. Approaches to perform Uncertainty Analysis
- Advanced Hands-on Training
  1. Achievement of Steady State
  2. Developing an ITF Nodalization
  3. Qualification of a System Code Calculation of a ITF
  4. Developing a NPP Nodalization
  5. Qualification of a System Code Calculation of a NPP: The Kv Scaled Calculation
  6. Identifying Simple and Complex Input Error

Syllabus for Developing Reactor Physics Code Skills

- General Aspects
  1. Features and Limitations of nodal core simulator codes
  2. Procedures and codes for cross-section generation
  3. Nodal cross-section requirements for static, transient and depletion analysis
  4. Overview of the diffusion code models; input and output files
- Code Syntax
  1. Nodal cross-section generation
  2. PAMXS and table formats
  3. PARCS Syntax
- Hands-on Training
  1. Modeling of static core with internal feedback
  2. Generating PMAXS cross-sections
  3. Modeling of transient PWR core
  4. Using PMAXS
  5. Coupling to RELAP5
  7. Coupling PARCS to RELAP5 PWR model
  8. Coupling to TRACE
  9. Coupling PARCS to TRACE PWR model
  10. Using PMAXS for coupled calculations (Control Rod Ejection)
  11. Fuel cycle analysis capabilities of the PARCS
  12. Using PMAXS for depletion calculation (Core Loading Analysis)