



## **INSC Project MC3.01/13**

EC Contract N° NSI/2014/343-969

**“Training and Tutoring for experts of the NRAs and their TSOs for developing or strengthening their regulatory and technical capabilities”**

### **TASK 2**

#### **Tutoring Module**

**on**

**“NPP mechanical systems, components and safety requirements”**

November 9<sup>th</sup> 2015 – January 1<sup>st</sup> 2016

c/o ITER-Consult (Pisa)

#### **Tutoring Programme**

draft

*October 2015*



**INSC Project MC3.01/13  
EC Contract N° NSI/2014/343-969**

**Tutoring Module on “NPP mechanical systems components and safety requirements”**

**Tutoring Programme**

*Final Draft*

**Duration: 2 months – 09.11.2015 – 01.01.2016**

**Venue: ITER-Consult – Italy**

**Tutoring Coordinator: Davide Mazzini, e-mail: [d.mazzini@iter-consult.it](mailto:d.mazzini@iter-consult.it)**

The tutoring activity has been conceived as “on the job training” at ITER-Consult in the area of NPP mechanical systems structural analysis and safety requirements. It will contribute to a practical “build-up” of knowledge allowing a sustainable transfer of approaches and methods on the topic.

**Tutoring objective**

The safety aspects and safety requirements of the NPP mechanical systems structural analysis and codes for independent assessment.

**Tutoring content**

The tutoring course (8 weeks organized for 2 tutees) is planned back to back to the one week EU training course in Rome on the same topic.

The tutoring course will address the evaluation of conceptual design of mechanical structure, piping and main components of a NPP and their safety and functional requirements.

It will include: the basis for safety and seismic classification, the associated design and operational requirements, the seismic design and design under dynamic loads during accident conditions, introduction to and application of codes for an independent assessment of the safety related SSCs behavior in normal, transient and accident conditions.

Attention will also be given to the safety requirement of environmental and dynamic qualification of safety related equipment.

Familiarization with applicable standards will be faced too.

The primary focus of the tutoring is for regulatory requirements and regulatory approach in review-evaluating the content of safety analysis.

<b>Expected achievements</b>
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Consolidate knowledge of safety requirements and design of main components, mechanical systems, equipment and piping. Familiarization with regulatory review approach and available computer codes for regulatory independent assessment.

### WEEKLY PROGRAM

*(changes can be introduced in the timing and adding new topics according to the progress of activities)*

Week	Topic	Tutor
I.	<ul style="list-style-type: none"> <li>- Introduction to regulatory approach for establishing requirements mechanical structures and components in a NPP</li> <li>- Design safety requirements associated to safety classes and seismic classes</li> <li>- Regulatory requirements for the Content of SAR</li> </ul>	D. Mazzini Giovanni Pino F. Zambardi
II.	Numerical tools for the stress analysis with reference to PTS events/scenarios: <ul style="list-style-type: none"> <li>- use of RELAP CODE - Main instructions and exercises</li> <li>- use of CATIA CODE - Main instructions and exercises</li> <li>- use of FLUENT CODE - Main instructions and exercises</li> <li>- use of ANSYS WORKBENCH and ANSYS APDL- Main instructions and exercises</li> </ul>	D. Mazzini W. Giannotti
III.	Design safety: <ul style="list-style-type: none"> <li>- Fundamentals on selection of loading sequences, assumptions for the analysis and loads from thermal-hydraulic analysis.</li> <li>- Main concepts and investigation of the thermal exchange between the structure and fluid by the use of the RELAP code</li> </ul> Review of Content of SAR Chapter for mechanical structures for typical PWR	D. Mazzini W. Giannotti Giovanni Pino
IV.	Design safety:	D. Mazzini

Week	Topic	Tutor
	<ul style="list-style-type: none"> <li>- Fundamentals of the CFD analysis of the thermal exchange between fluid and pressure wall;</li> <li>- Main concepts and investigation of the thermal exchange between the RPV structure and the cooling fluid by the use of the FLUENT code</li> </ul> <p>Review of Content of SAR Chapter for mechanical structures for typical PWR.</p>	
V.	<p>Main concepts of structural and Fracture mechanics analyses:</p> <ul style="list-style-type: none"> <li>- Static strength and High and Low-Cycle Fatigue at room temperature</li> <li>- Seismic analysis</li> <li>- Fracture Mechanics</li> <li>- Linear Elastic Fracture Mechanics</li> </ul> <p>Approach for independent assessment using SAR data and applicable assumptions and requirements</p>	<p>D. Mazzini Giuseppe Pino A. Pasculli</p>
VI.	<p>Finite Element analysis (ANSYS Apdl/ ANSYS Workbench)</p> <ul style="list-style-type: none"> <li>- Material models: linear elastic/ elastic-plastic</li> <li>- Submodeling technique</li> <li>- Thermomechanical analysis</li> </ul> <p>Review of SAR content for critical components in a passive PWR</p>	<p>D. Mazzini Giovanni Pino</p>
VII.	<p>Fracture Mechanics with Finite Element analysis</p> <ul style="list-style-type: none"> <li>- Different calculation techniques</li> <li>- Semi-elliptical crack modelling</li> <li>- Submodeling 3D crack</li> </ul> <p>Environmental and seismic qualification for mechanical components (e.g. safety valves)</p>	<p>D. Mazzini F. Zambardi A. Madonna</p>
VIII.	<p>Review of content of SAR for Environmental and seismic qualification</p> <p>Analysis of a SSC for a selected loading condition</p> <p>Reporting</p>	<p>F. Zambardi A. Madonna</p>



## Reporting

At the end of the Tutoring Module the Tutees will elaborate a common Report containing the following sections:

- **INTRODUCTION**
- **TUTORING OBJECTIVE**
- **TUTORING PROGRAM**
- **ACTIVITIES PERFORMED**
- **MAIN RESULTS**
- **CONCLUSIONS**

The Tutees Report will be approved by the tutoring coordinator.