

Barcelona July 1– 5, 2019



Hands on training on NPP simulations: Building up a full model of an SMR

RELAP5, TRACE, RELAP/SCDAPSIM,
MARS-KS training course



UNIVERSITAT POLITÈCNICA
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The training organized last year had 16 participants from 5 different countries: South Korea, United Arab Emirates, Finland, Switzerland and Czech Republic.

Overview of 2018 edition of the training on system codes

For the fourth consecutive year, the training “Advanced Simulation of Thermal Hydraulic Phenomenology with system codes” was held at the Technical University of Catalonia (Barcelona, Spain). In this sense, we are really proud to see how the course has become consolidated during this time. In 2018, we hosted 16 people from 5 different countries: South Korea, United Arab Emirates, Finland, Switzerland and Czech Republic. Participants came from diverse origins of the Nuclear Thermal-Hydraulics community: regulatory bodies, research institutes, universities and companies devoted to safety analysis. The training dealt with the simulation of thermal hydraulic phenomenology related to the simulation of Pressurized Water Reactor systems.

In the first part of the training we focused on the achievement of a steady state for a pressurized water reactor. A full model of a generic power plant was distributed. The participants learnt how to adjust the different control systems in order to bring the plant to stable conditions

In the second part of the training, the participants adjusted different accidental situations. The related phenomenology and the thermal hydraulic response of the system was studied and discussed.

June 2018



In this course you will learn how to build up a full model for an SMR. The final objective is to transfer knowledge on best practices in system code modeling

Objective of the 2019 edition:

In 2019, The 'Hands on training on NPP simulations: building up a full model of an SMR' aims at a transfer of advanced knowledge and best practices in system code modeling for nuclear power plants. The 2019 edition focuses on the simulation of an SMR. A simplified model of a light water pressurized SMR will be developed from scratch. The participants will be guided through the process starting by the review of the limited information that can be found on the literature. During the first part of the exercise the core of the reactor will be nodalized and tested. Afterwards the full primary and secondary systems will be developed.

In the last part of the course, an transient scenario will be configured and the capacity of the necessary safety systems will be evaluated.

In order to enhance the modeling skills of participants, information on important physical phenomena and the best practices in modeling will be given and discussed during the course.

Target of the course:

The course is recommended to users:

- who can make a simple model for a system code analysis,
- who can modify the existing input by him/herself,
- who want to analyze an integral behavior of nuclear power plant system based on TH system code analyses.
- who need to develop the logic and the control of a supplied NPP/facility input deck

Codes:

The exercises of the course can be performed with any of the following thermal hydraulic codes:

- TRACE
- RELAP5
- RELAP/SCDAPSIM
- MARS-KS

Participants will be expected to bring a laptop computer with their preferred TH code installed.

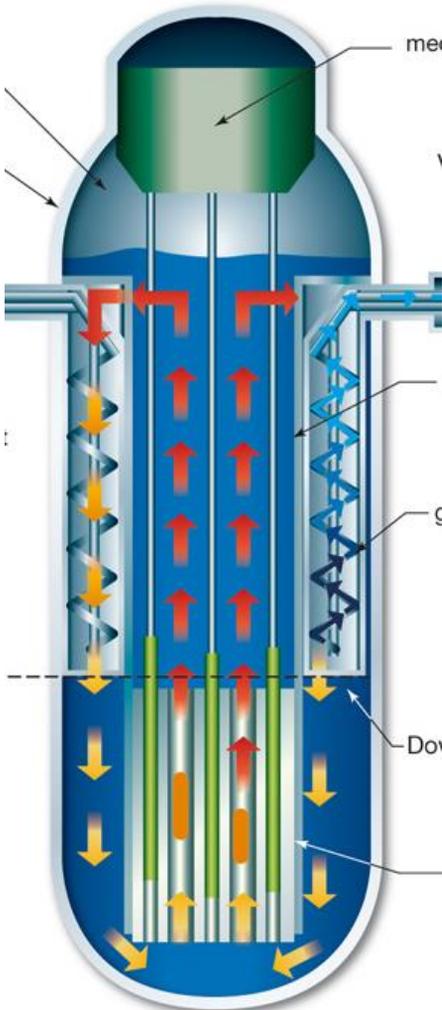
Schedule:

Date	Contents
July 1 (Mon)	<ul style="list-style-type: none">• Registration• Introduction to the course and thermal hydraulics• SMR modelling· Analysis of the available data· building up of the core
July 2 (Tue)	<ul style="list-style-type: none">• Scaling principles• Testing the core· Control systems· Discussion and trouble shooting
July 3 (Wed)	<ul style="list-style-type: none">• Building up the rest of the SMR system• Achieving a steady state
July 4 (Thu)	<ul style="list-style-type: none">• Testing the steady state• SBLOCA accident· Configuring transients· Understanding transient phenomenology· Specific development and special processes
July 5 (Fri)	<ul style="list-style-type: none">• Accident analysis· Discussion and trouble shooting• Wrap-up

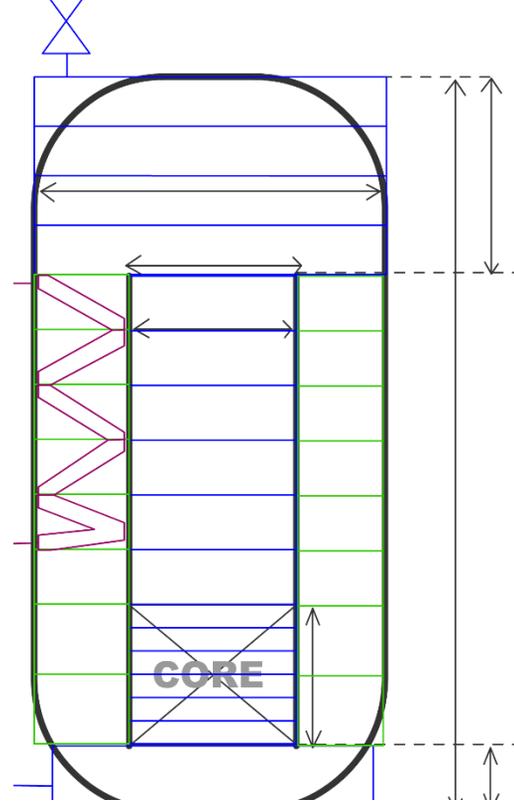


Methodology

The teaching methodology of the training focuses on a learning-by-doing approach. The participants will be provided with the necessary tools, design information and other background theoretical background. With this information the participants will build a TH model. Expert tutors will be available to provide continuous support.



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Specific Lectures

- **State of the art of system codes**
 - Description of the 6 equation models used in system codes
 - Limitations and requirements for the simulation of LW-SMR
- **Small modular reactors**
 - Current SMR designs
 - Passive safety systems
- **Scaling of thermal hydraulic complex systems**
 - Basic principles in the scaling of TH complex systems
 - Integral Test Facilities
 - Benchmarking and the use of ITF data
- **Phenomenology of thermal hydraulic systems**
 - Phenomenology during accidental conditions for LWR
 - Passive safety systems

Most of the time of the training will be devoted to “Learning-by-doing”, but a limited number of theoretical lectures will be provided. Above is the list of presentations. Additional topics can be discussed upon demand.

Registration Fee: 1500€ per participant

The course will be held at The Barcelona School of Industrial Engineering (ETSEIB) which is part of the Technical University of Catalonia - BarcelonaTech (UPC), a public institution dedicated to higher education and research, specialized in the fields of engineering, architecture and science.

The School is located in Barcelona and is well connected with the airport and the city center.

The course is organized by the Advanced Nuclear Technologies group (ANT) from the Technical University of Catalonia. ANT has a long experience in R&D and teaching in Nuclear Engineering, principally nuclear reactors technology, thermal-hydraulic analysis and safety for both fission and fusion reactors.

For more information, please visit our website:

<https://ant.upc.edu>

The seminar is open to vendors, utilities, regulatory bodies, national laboratories, consulting companies and universities. There will be at least one lecturer for every 5 participants. A maximum of 20 participants will be accepted.



Lecturers and instructors:



Prof. Reventós was Responsible of Plant Dynamic Analysis in the utility organization operating Ascó and Vandellòs NPPs (1985-2001). He has more than 30 years of experience in the preparation and qualification of TH models for NPPs as well as its use in fields like operation support, PSA, training, licensing and fuel management.



Prof. Taewan Kim has about 20 years of experience in nuclear TH system code. His specialty includes uncertainty evaluation in TH analyses for nuclear power plant, and the assessment and improvement of TH system codes.



Dr. Jordi Freixa has about 15 years of experience in the use of TH system codes. During this time, he has developed or worked with more than 10 full plant models. His main areas of research are the validation and application of best estimate thermal hydraulic codes for LWRs.



Dr. Victor Martinez-Quiroga participated as TH analyst in several OECD/NEA projects since 2006. His expertise includes scaling and Deterministic Safety Assessment. In his Thesis, Victor developed the SCUP methodology, a systematic approach for qualifying NPP nodalizations with experimental facilities database.



Max Casamor has an experience of 6 years in training NPP operators including full scope control room simulators at Tecnomat S.A. He also participates in the research activities at UPC. Mainly consisting on coupling CTF subchannel code and RELAP5 system code.

Individual course extension, customized training and tutoring (July 8-12)

In this training we offer the possibility of extending courses for one week. In such extensions, the participant will have the opportunity to broaden the knowledge acquired in a course under the supervision of dedicated ANT instructors. The cost for one week will be 2000€. For longer trainings the cost will be agreed by both partners in the form of a collaboration agreement. For more information, please contact Dr Jordi Freixa (jordi.freixa-terradas@upc.edu)

Each code has its own particularities, understanding the assets and limitations of each code is essential to perform qualified thermal hydraulic simulations. In this training you will be able to sense what makes each code different

RELAP5

The RELAP5/MOD3.3Patch05 code has been developed for best-estimate transient simulation of light water reactor coolant systems during postulated accidents. The code models the coupled behavior of the reactor coolant system and the core for loss-of-coolant accidents and operational transients such as anticipated transient without scram, loss of offsite power, loss of feedwater, and loss of flow. A generic modeling approach is used that permits simulating a variety of thermal hydraulic systems. Control system and secondary system components are included to permit modeling of plant controls, turbines, condensers, and secondary feedwater systems.

TRACE

TRACE (TRAC/RELAP Advanced Computational Engine) is the latest best-estimate system codes developed by the US NRC for analyzing steady-state and transient neutronic/thermal-hydraulic behaviour of Light Water Reactors (LWRs). The TRACE code is designed to analyse reactor transients and accidents up to the point of significant fuel damage. The code is a product of a consolidation of the capabilities of the main system codes of US NRC, such as TRAC-PF1, TRAC-BF1, RELAP5 and RAMONA.

TRACE includes models for multidimensional two-phase flow, non-equilibrium thermodynamics, generalized heat transfer, reflood, level tracking, and reactor kinetics. A two-fluid model is used to evaluate the gas-liquid flow.

RELAP/SCDAPSIM

RELAP/SCDAPSIM, designed to predict the behavior of reactor systems during normal and accident conditions, is being developed at Innovative Systems Software (ISS) as part of the international SCDAP Development and Training Program (SDTP). In addition to the typical RELAP features, the SCDAP models calculate the behavior of the core and vessel structures under normal and accident conditions. The SCDAP portion of the code also includes models to treat the later stages of a severe accident including debris and molten pool formation, debris/vessel interactions, and the structural failure (creep rupture) of vessel structures.

MARS-KS

Korea Advanced Energy Research Institute (KAERI) conceived and started the development of MARS-KS code with the main objective of producing a state-of-the-art realistic thermal hydraulic systems analysis code with multi-dimensional analysis capability. MARS-KS achieves this objective by very tightly integrating the one dimensional RELAP5/MOD3 with the multi-dimensional COBRA-TF codes. The method of integration of the two codes is based on the dynamic link library techniques, and the system pressure equation matrices of both codes are implicitly integrated and solved simultaneously. In addition, the Equation-Of-State (EOS) for the light water was unified by replacing the EOS of COBRA-TF by that of the RELAP5.

Training available online

Because we know that it is hard for you to find a time window to come to the training, we offer the possibility to follow the course materials online whenever you want.

The online course lasts 4 weeks instead of one week. In this way you can combine your daily work with the exercises. You can decide the starting week.

The materials will be similar to the ones of the on-site course but can be complemented or modified to better suit your level.

The lectures will be recorded and available online. In this way you can buy the course material and perform the exercises whenever you want.



Whenever you want

The total estimated time to complete the training is 40h.

You will have access to a platform where the exercise material will be posted. Each exercise will have a chat room where questions can be posted and answered.

There will be 1,5h of personalized video conference per week per person. In total 6 hours. This time is equivalent to the time dedicated to a person attending the course on-site.

In addition, you will have access to a platform where the exercise material will be posted. Each exercise will have a chat room where questions can be posted and answered.

1500€ per participant

NEW YORK

LONDON

MOSCOW



Advanced Nuclear
Technologies

Organizing committee

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Dr. Jordi Freixa
Dr. Víctor Martínez-Quiroga
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Our website: <https://ant.upc.edu>

Registration page:

<https://ant.upc.edu/en/activities/>

Registration Fee:

Before April 30:

1500€ per participant*

1250€ students

(limited to 4 spots)

After April 30:

1750€ per participant*

* The total number of participants is limited to 20



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