Hands on training on NPP simulations: achieving steady state conditions and conducting the simulation of thermal hydraulic phenomenology

RELAP5, TRACE, RELAP/SCDAPSIM, MARS-KS training course
The training organized last year was a success with 14 participants from 6 different countries: South Korea, People’s Republic of China, South Africa, Republic of Congo, Switzerland and Czech Republic.

Overview

For the third consecutive year, the training “Advanced Simulation of Thermal Hydraulic Phenomenology with system codes” has been held at the Technical University of Catalonia (Barcelona). In this sense, we are really proud to see how the course has become consolidated during this time. In 2017, we hosted 14 people from 6 different countries: South Korea, People’s Republic of China, South Africa, Republic of Congo, Switzerland and Czech Republic. Participants came from a 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 covering both: local phenomena and system behavior, it was subdivided in two parts.

In the first one, we focused on the simulation of a test facility to simulate a particular phenomenon. The participants had to build a model from scratch. The exercise was useful to compare the capabilities of the different system codes in predicting the void fraction in a fuel bundle.

In the second part, a full model of a generic power plant was distributed. Firstly the participants learnt how to adjust the different control systems in order to bring the plant to stable conditions and later they configured an accidental scenario and studied the thermal hydraulic response of the system.

June 2017
In this course you will learn how to stabilize a full model of a generic Nuclear Power Plant. The final objective is to transfer knowledge on best practices in system code modeling.

Objective of the course:

The ‘Advanced Simulation of Thermal Hydraulic Phenomenology with System Codes’ aims at a transfer of advanced knowledge and best practices in system code modeling for nuclear power plants. In addition to general modeling technique for nuclear power plant systems, the course will provide a hands-on training on how to implement proper operation actions to achieve steady-state conditions by using control components of system codes. 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:

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| June 25 (Mon) | - Registration  
- Introduction to the course and thermal hydraulics  
- NPP modelling  
  - Introduction and familiarization  
  - Hydraulic components, modeling |
| June 26 (Tue) | - Achieving the steady state  
  - Control systems  
  - Discussion and trouble shooting |
| June 27 (Wed) | - Scaling principles  
- Control system for achieving a steady state  
- Achieving a steady state (continuation) |
| June 28 (Thu) | - Accident analysis  
  - Configuring transients  
  - Understanding transient phenomenology  
  - Specific development and special processes |
| June 29 (Fri) | - Accident analysis  
  - Discussion and trouble shooting  
- Wrap-up |
The PWR session will be focused in the simulation of a full power plant model. The main goals will be stabilization and control of full plant nodalizations and configuring transient scenarios.

**PWR session (June 25-29):**

- **Nuclear Power Plant problem**
  - Developing a nodalization
  - Qualifying a nodalization

- **Improvements to plant nodalization**
  - Hydrodynamic improvements
  - Steady-state improvement
  - Control implementation

- **Transient analysis 1**
  - Understanding transient scenario
  - Specific development
  - Executing base case
  - Extracting results

- **Transient analysis 2**
  - Executing and analyzing base case
  - Sensitivity analysis on case 2

- **Working with user supplied input models**
  - Understanding transient scenario
  - Plans of use
  - Executing calculation

Learning how to control and stabilize your system

Assessment of local phenomena and system behavior during Design Basis Accidents
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.freixaterradas@upc.edu)

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.

Individual course extension, customized training and tutoring (July 2-6)

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.freixaterradas@upc.edu)

Lecturers:

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. Marina Pérez has 13 years of experience in the use of TH system codes. In 2009 she started working part-time at Innovative Systems Software as an external consultant providing support in RELAP5 trainings and code development.

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.

Dr. Raimon Pericas recently finished his thesis on Thermalhydraulics-Neutron kinetics coupled codes, and uncertainties calculations. He also holds experience on Severe Accident analysis. He has 8 years of experience in the use of TH system codes.
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 analyze 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, RELAP-5 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.
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.

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
Organizing committee

Prof. Dr. Taewan Kim
Dr. Jordi Freixa
Dr. Víctor Martínez-Quiroga
Prof. Francesc Reventós

Registration page:

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

Registration Fee:

Before April 30: 1500€ per participant
After April 30: 1750€ per participant

Feel free to contact us at:

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