V4 nuclear training course

Program

12 -16 April 2021

	Monday *12. 4. 2021*	Tuesday *13. 4. 2021*	Wendesday *14. 4. 2021*	Thursday *15. 4. 2021*	Friday *16. 4. 2021*
9:00 - 9:50	**Opening Session**	**Group A** **Experimental training at VR-1 Reactor** *(CTU)* **Group B** **Simulation workshop** *(STU)*	**Group A** **Simulation workshop** *(STU)* **Group B** **Experimental training at VR-1 Reactor** *(CTU)*		**Legislative for Reactor Operation** Miroslav Šváb *(IAEA)*
	Introduction lecture *(BUTE)*			9:30-10:30 **Virtual Visit of NPP Temelin** Petr Šuleř *(CEZ)*	
9:50 - 10:10	*Break*				*Break*
10:10 - 11:00	**Introduction lecture** *(BUTE)*			*Break*	**Safe Operation of NPP** Miroslav Šváb *(IAEA)*
11:00 - 11:10	*Break*			10:45 - 12:00 **New Nuclear Source in Czech Republic** Petr Závodský *(CEZ)*	*Break*
11:10 - 12:00	**Methods in Neutron Detection and Spectroscopy** Agnieszka Korgul *(UW)*				**Severe accidents, phenomenology and source term evaluation** Petr Vokáč *(ÚJV Řež)*
12:00 - 13:30	*Lunch*	*Lunch*	*Lunch*	*Lunch*	*Lunch*
13:30 - 14:20	**Nuclear Data – Measurements and Theory** Andrej Trkov	**Fuel Cycle Core Reload Analysis of US LWRs** Ivan Maldonado *(UTK)*	**Nuclear Fuels for LWRs** Martin Ševeček *(ALVEL)*	**Presentation of experimental/ calculation results**	**SAMGs and severe accident mitigation** Miroslav Kotouč *(ÚJV Řež)*
14:20 - 14:30	*Break*	*Break*	*Break*	*Break*	*Break*
14:30 - 15:20	**Nuclear Data – Evaluations and Libraries** Andrej Trkov	**Defence in Depth in Design of Existing and New Nuclear Power Plants** Jozef Mišák *(ÚJV Řež)*		**Presentation of experimental/ calculation results**	**Closing Session**
15:20 - 15:40	*Break*	*Break*	*Break*		
15:40 - 16:30	***Theory for Simulation Workshop*** *(STU)*	***Nuclear Forensics*** George M. Moore *(MIIS)*	***Nuclear Weapons*** George M. Moore *(MIIS)*		

Organisation part of training
Theoretical part of training
Practical part of training
Technical visit

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1. Introduction lecture

(BUTE)

This first introduction lecture will help to unify student's knowledge. The main discussed topics are neutron balance in the system, diffusion and transportation equation, kinetic and dynamic of the reactor.

2. Methods in Neutron Detection and Spectroscopy

Agnieszka Korgul (UW)

The aim of the lecture will be to present different methods of neutron detection and neutron energy measurements.

3. Nuclear Data - Measurement and Theory

Andrej Trkov

The lecture is focused on the introduction to the nuclear data processing and evaluated data libraries that are used in numerous fields of nuclear engineering. First part is devoted to issues related to neutrons cross section measurement and EXFOR library of experimental data, nuclear reaction models with used model codes (EMPIRE, TALYS) and RIPL library of model parameters.

4. Nuclear Data - Evaluation and Libraries

Andrej Trkov

The second part of Nuclear Data section is focused on the evaluation of neutron cross sections like basic principles of evaluation, traditional evaluation method and total Monte Carlo evaluation method. Also Evaluated nuclear data libraries and major issues in nuclear data will be discussed.

5. Theory for Simulation Workshop

(STU)

Theoretical preparation for simulation workshop. This lecture provide the basic theory necessary for successful completion of the workshop. The content of the workshop is related to tailoring the evaluated data to specific systems and applications, where different requirements between deterministic and stochastic codes as well as between continuous energy and multi-group cross-section libraries are emphasized. Special attention is given to the calculation of sensitivity profiles by deterministic and stochastic methods, propagation of uncertainties induced by nuclear data to the integral results of nuclear simulations and application of cross-section adjustment methods for similarity assessment of nuclear systems.

6. Experimental training

(CTU)

Training at the VR-1 reactor – hands on experience with measurement at the reactor. Training is focussed on approach to critical state, discussion of different states of reactor and its dynamics.

7. Simulation workshop

(STU)

The simulation workshop is focused on the two main topics: sensitivity, uncertainty and similarity assessment. Students will study the target nuclear system during the workshop by utilization of multiple codes. The application of perturbation theory and cross-section adjustment method with SBJ_V2019 cross-section libraries will be utilized in parallel with cross-section processing code TRANSXSBJ and

deterministic solvers such as DIF3D and PARTISN to demonstrate the difficulties related to the two main topics. Each simulation step will be accompanied with the short theory lecture which will be then demonstrated by the use of appropriate code. The inputs for the workshop will be partially prepared in advance for students to increase the effectiveness of proposed exercises.

8. Fuel Cycle Core Reload Analysis of US LWRs

Ivan Maldonado (UTK)

Key aspects of reactor operation will be discussed during this lecture - design and optimization of fuel batch and calculation of reactor parameters.

9. Defence in depth in design of existing and new nuclear power plants

Jozef Mišák (ÚJV Řež)

The lecture will present key principles of defence in depth as a hierarchical deployment of different levels of equipment and procedures to protect integrity of barriers against radioactive releases to the environment. The principles will be illustrated by examples of mechanisms challenging the barriers, and of the ways for ensuring compliance with as well as deviations from the principles of defence in depth.

10. Nuclear Forensics

George M. Moore (MIIS)

The lecture will provide an introduction to the subject and cover the age dating (chronometry) used for nuclear materials. It will also expose the student to the procedures for analysis using an actual incident.

11. Nuclear Fuels for LWRs

Martin Ševeček (ALVEL)

This lecture will provide a short overview of fuel assembly design and construction with a focus on PWR and VVER fuel systems. The response of a nuclear fuel system during accidental scenarios is the main limiting factor for nuclear reactor design and construction. Industrial and R&D state-of-art such as advanced or accident tolerant fuels will be introduced.

12. Nuclear Weapons

George M. Moore (MIIS)

The lecture will cover the basic unclassified concepts of nuclear weapons and their effects. It will also point out the differences between the neutronics of a nuclear weapons and nuclear reactors.

13. Virtual Visit of NPP

Petr Šuleř (ČEZ)

Online tour through NPP Temelin.

14. New Nuclear Source in Czech Republic

Petr Závodský (ČEZ)

This lecture provide the main information about installation of new nuclear source in Czech Republic and also gives overview about all issue connected with project preparation and approval procedure.

15. Legislative for reactor operation

Miroslav Šváb (IAEA)

In this lecture, the role of individual key players will be discussed – government, regulatory body and operator. Also the role of international organization that provides support for use of nuclear energy will be covered in the lecture, specially International Atomic Energy Agency (IAEA). In second part of lecture, students get information about work of IAEA, which kind of support IAEA provide and about documents that are published by IAEA.

16. Safe operation of NPP

Miroslav Šváb (IAEA)

To ensure safe operation of the reactor/NPP it is necessary to implement several basic principles into operation. In this lecture will be discussed life cycle of NPP, 3S principle and basic safety principles used for decrease probability of accident (diversification, redundancy, physical separation). In the second part of lecture, the defence in depth principle will be discussed.

17. Severe accidents, phenomenology and source term evaluation

Petr Vokáč (ÚJV Řež)

Introduction to severe accident phenomenology, fission product release and transport. Methods for the source term evaluation.

18. SAMGs and severe accident mitigation

Miroslav Kotouč (ÚJV Řež)

The keynote tackles the fundamentals of the origin, basic concepts and principles, and the implementation of severe accident (SA) management guidelines (SAMG), complementing the overview with some most common SA management strategies. Moreover, SA mitigation through SAMGs application is illustrated on concrete examples of computed SA courses at the Czech NPP Temelin (VVER-1000) using the integral code MELCOR.

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