

Background

University courses in nuclear reactor physics at the universities consist of a theoretical description of the physics and technology of nuclear reactors. In order to demonstrate the basic concepts in reactor physics, training exercises in nuclear reactor installations are also desirable. Since the number of reactor facilities is however strongly decreasing in Europe, it becomes difficult to offer to students a means for demonstrating the basic concepts in reactor physics by performing training exercises in nuclear installations. Universities do not generally possess the capabilities for performing training exercises. Therefore, SCK•CEN offers universities the possibility to perform (on a commercial basis) training exercises at its infrastructure consisting of two research reactors (BR1 and VENUS).

Besides the organisation of training exercises in the framework of university courses, SCK•CEN also organizes theoretical courses in reactor physics for the education and training of nuclear reactor operators. It is indeed a very important subject to guarantee the safe operation of present and future nuclear reactors. In this framework, an understanding of the fundamental principles of nuclear reactor physics is also necessary for reactor operators. Therefore, the organisation of a basic "Nuclear reactor physics" course at the level of reactor operators in the initial and continuous training of reactor operators has proven to be indispensable. In most countries, such training also results from the direct request from the safety authorities to assure the high level of competence of the staff in nuclear reactors.

Objectives

- To provide training & education activities in reactor physics for university students
- To organise courses in nuclear reactor physics for reactor operators

Principal results

The aim of the training exercises in "Nuclear Reactor Physics" is to allow university students to familiarize with the basic concepts of nuclear reactors in practice.

Depending on the request, one-day, two-day or even a week course can be given. The following topics can be covered:

- Subcritical approach
- Control rod worth determination
- Reactor kinetics analysis
- Axial fission-rate distribution and axial buckling measurement
- Prompt Jump analysis
- Noise methods: Rossi-alpha measurement
- Control rod calibration
- Temperature coefficient measurement
- Measurement of diffusion length and coefficient
- Measurement of the Fermi-Age
- Fission chamber calibration
- Reactor dosimetry
- BR2 visit and explanation,
- Hot-cells visit and explanation

Such training exercises are currently routinely performed at SCK•CEN for the Belgian universities, the BNEN interuniversity programme and KTH Stockholm University.

The aim of the basic course "Nuclear Reactor Physics for reactor operators" is to provide the reactor operators with a basic understanding of the main concepts relevant to nuclear reactors. In this course, mathematics and physics are at a level adapted to the trainee.



Depending on the request, several modules can be given. One is more focussed on the description of the reactor physics in stationary (critical) conditions, whereas the second course treats the kinetic aspects of reactor operation.

A one-day course on "Nuclear Reactor Statics for reactor operators" covers the following subjects:

- Concept of nuclear fission and energy production
- Nuclear chain reaction
- Fissile fuel and absorbers
- Energy distribution of neutrons in the reactor
- Simplified derivation of diffusion equations
- Spatial power distribution in the reactor

A one-day course on "Nuclear Reactor Kinetics for reactor operators" covers the following subjects:

- The concept of prompt and delayed neutrons
- Neutron multiplication constant
- Simplified derivation of point kinetics
- Kinetics and control of a nuclear reactor
- Temperature feedback effects
- Effect of poisoning by fission products on the reactor operation

In addition to the theoretical courses, training exercises on the BR1 and VENUS research reactors can be followed covering some of the topics as mentioned in the first paragraph.

At present, SCK•CEN organizes such a course for the reactor operators of the BR2-reactor (MTR) at the SCK•CEN site and for the reactor operators and operation team heads of the PWR's situated at the DOEL-site (Belgium).

The courses can be given in three languages: Dutch, French and English. Also the course material (course text, slides used during the course) is available in these languages.

Future developments

Since the set-up of these courses is very modular, it is our intention to respond even more custom-made to future requests from industry. Also, an integration with other courses provided at SCK•CEN will even enlarge the scope for possible interested parties.

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Main reference

Course content and material is available on a commercial basis.