DEVELOPMENT AND APPLICATION OF WWER1000 PC BASED SIMULATORS FOR EDUCATION AND TRAINING IN NRNU MEPHI

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Abstract

The computer based informational and educational tools of different type are very attractive for students, useful and effective for education in Universities. Two WWER1000 reactor PC Based simulators for education are presented in the paper. Basic Principle WWER1000 PC Based Simulator is used for informational and educational purposes, while WWER1000 PC Based Analyzer can be used in steady state and transient analysis in education and research.

1. SYNOPSIS OF PAPER

The WWER1000 PC Based Simulator is a part of IAEA collection of PC Based Simulators for education. Simulator provides insight of the design as well as a clear understanding of the operational characteristics of WWER1000 reactor and demonstrates main physical phenomena in WWER1000 reactor (Fig. 1). The WWER1000 PC Based Simulator can be used as an introductory educational tool as well as a tool for developing of nuclear engineering courses.

The WWER1000 PC Based Simulator was originally developed for personnel training. It is executed on a personal computer in real time and provides a dynamic response with sufficient fidelity. After reducing the scope of modelling to the systems essential for overall correct response and fidelity and cutting out a number of auxiliary systems the Simulator becomes suitable for educational and information purposes. Application of Simulator is limited to providing general response characteristics of WWER1000 reactor. The WWER1000 PC based simulator is not intended for using for plant specific purposes such as design, safety evaluation, licensing or operators training.
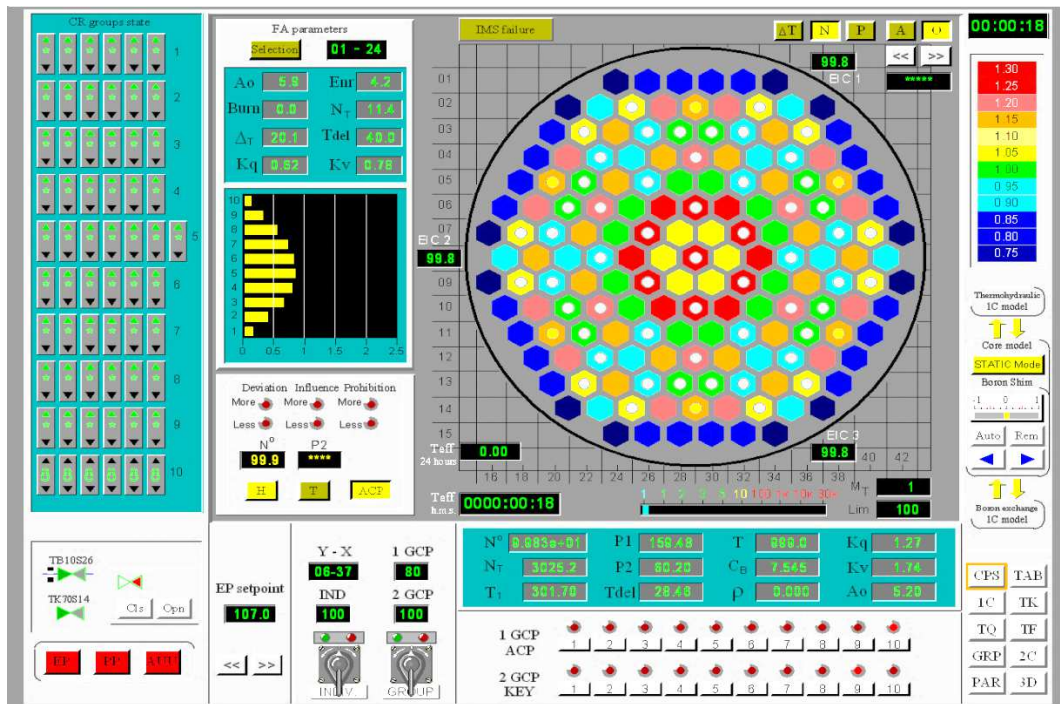

FIG. 1. WWER1000 PC based simulator graphical user interface.

Scope of modelling covers reactor, primary circuit, pressurizer and primary circuit pressure compensating system, primary circuit feed and bleed system, including boron regulation, secondary circuit steam lines and feedwater pipelines, control and protection system and safety systems.

Scope of simulation covers normal operational conditions, including reactor startup, working at rated power level, reactor shutdown and abnormal operational conditions like reactor cooling pump trip, valves closure etc. If malfunction can be removed it's possible to come back to normal operational conditions.

Main physical phenomena simulated into reactor core are transients on prompt and delayed neutrons, xenon transients coursed by changes of reactor power level, xenon radial and axial power distribution oscillations, samarium poisoning, fuel burnup (without core refuelling) and residual heat.

The WWER1000 PC based simulator training tasks give Simulator user practical skills of Simulator control, help to become familiar with reactor construction and operational experience and demonstrate main physical phenomena in the reactor and reactor core. Simulator workshop materials provide description of every training task that gives learning objectives, sequence of actions to be performed by Simulator user and reference to the corresponded Simulator display pages outputs and controls.

The WWER1000 Reactor Department Multi Functional Analyzer (MFA–RD) is an upgraded and extended modern analogue of WWER1000 Reactor Department Simulator. MFA–RD was benchmarked against a wide range of WWER1000 experimental and calculated data and it was certified for WWER1000 type reactors computations by the State Atomic Inspection of Russia. As a result of MFA–RD specific adaptation to solution of numerous educational problems in the field of neutron physics, thermal hydraulics and control of nuclear power plants, the Educational and Research (E&R) Laboratory 'Reactor Physics, Control and Safe Operation of WWER type NPP' was developed [1].

The WWER1000 PC Based Simulator gives an understanding of the reactor construction and operational characteristics while E&R Laboratory can be used for WWER1000 reactor steady state and transients' analysis.

Currently Educational and Research Laboratory Reactor Physics, Control and Safe Operation of WWER type NPP is used for educational purposes in the National Research Nuclear University MEPhI, Russian Federation, Moscow; in the Belorussian State University (BSU) and in the Belorussian State University of Informatics and Radio electronics (BSUIR), Minsk; in the State Engineering University of Armenia (SEUA), Yerevan. E&R Laboratory was installed in BSU, BSUIR and SEUA under IAEA's Technical Cooperation projects.

The WWER1000 PC Based Simulator is used for IAEA Training Courses; last two courses took place in Jordan Atomic Energy Commission (JAEC), Amman, Jordan, 22–26 November 2015 and in Arab Atomic Energy Agency (AAEA), Tunis, Tunisia, 11–15 July 2016. WWER1000 PC Based Simulator is distributed free of charge among IAEA member states institutions.

The NRNU MEPhI experience in WWER1000 PC Based Simulators and corresponded educational and training courses development and application [2] demonstrates high efficiency of learning by doing methodology in human resource development for nuclear industry in different countries and different institutions.

REFERENCES

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