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Application of Nuclear Power Plant Simulator for High School Student Training

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1. Introduction

Until now, many simulator trainings have been performed to foreign operator candidates in developing countries. However, there has been no education for Korean high school students who will take the leading part in nuclear power industry. Especially in the case of Meister high school, students directly enter nuclear companies after graduation. In this situation, it is needed to show and teach them how a nuclear power plant works. In this context, two lectures on nuclear power plant simulator and practical training were provided to high school students in 2014.

The education contents were composed of two parts: the micro-physics simulator and the macro-physics simulator. The micro-physics simulator treats only in-core phenomena, whereas the macro-physics simulator describes whole system of a nuclear power plant but it considers a reactor core as a point. The high school students showed strong interests caused by the fact that they operated the simulation by themselves. This abstract reports the training detail and evaluation of the effectiveness of the training.

2. Nuclear Power Plant Simulator

2.1 Micro-physics Simulator

The Micro-physics simulator [1] developed at Nuclear Engineering Ltd (NEL) in Japan is used for the training. Figure 1 shows the micro-physics simulator execution screen. There are three modes: transient analysis mode, fuel rod performance analysis mode, and thermal-hydraulics analysis mode. In the transient analysis, the power maneuvering, control rod drop, abnormal withdrawal at hot zero power were simulated. In the fuel rod performance analysis, the variation so f stress-strain, internal pressure, and oxide film thickness as a function of time are expressed as trend graphs. In the thermal-hydraulics analysis, coolant temperature, void fraction, critical heat flux, departure from nucleate boiling ratio according to time are expressed as trend graphs as well. Before the practical training, the students learned about basic concepts in nuclear reactor theory.

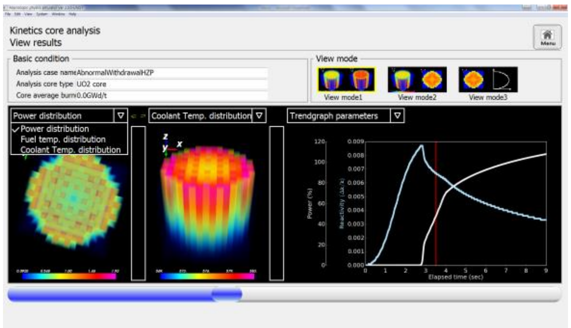


Fig. 1. Micro-physics simulator execution screen

2.2 Macro-physics Simulator

MARS-ViSA [2] that had been provided to IAEA was used for practical exercise. Figure 2 shows the macro-physics simulator execution screen. Five operational transient scenarios are used for training: reactor power increase/decrease, reactor trip, a single reactor coolant pump trip, large break loss of coolant accident, and station black-out with D.C. power loss. Before the practice of the scenarios, students are taught about concepts and brief theories about nuclear power plant accidents.

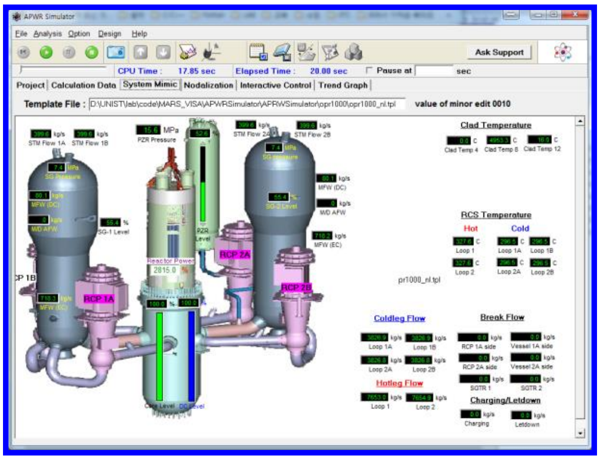


Fig. 2. Macro-physics simulator execution screen.

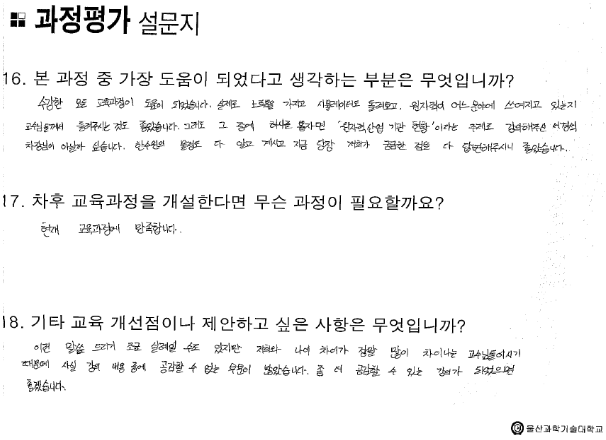
3. Education Evaluation

There were two education programs at Ulsan in 2014. One is for Ulsan Energy High School students in January, and the other is for Ulsan Meister High School students in February. Figures 3 and 4 show the classrooms of education at Ulsan Meister High School and Ulsan Energy High School, respectively.

Fig. 3. Classroom at Ulsan Meister High School.

Fig. 4. Classroom at Ulsan Energy High School.

After education, the students responded to the question investigation. Figure 5 shows the survey results at Ulsan Meister High School. The students' evaluation of the training course are as follows: 'Simulation helped to understand about nuclear power plants', 'It is useful to comprehend several emergencies in a nuclear power plant', and 'By directly seeing phenomena through simulation, I was interested in nuclear theory'. The survey results show that the education was of help for the high school students to get interest in a nuclear power plant and made them learn principles on nuclear engineering easier through the simulators. This education program, a kind of communications with next generation, will have a beneficial influence on public perception about the nuclear power generation.



과정평가 설문지

16. 본 과정 중 가장 도움이 되었다고 생각하는 부분은 무엇입니까?

수강한 모든 교육과정이 도움이 되었습니다. 실제로 노트북을 가지고 시뮬레이터도 돌려보고, 원자력이 어느 분야에 쓰여지고 있는지 교수님들께서 들려주시는 것도 좋았습니다. 그래도 그 중에 하나를 뽑자면 '원자력산업 기관 현황'이라는 주제로 강의해주신 서정석 차장님이 아닐까 싶습니다. 한수원의 물정도 다 알고 계시고 지금 당장 저희가 궁금한 점을 다 답변해주시니 좋았습니다.

17. 차후 교육과정을 개설한다면 무슨 과정이 필요할까요?

현재 교육과정에 만족합니다.

18. 기타 교육 개선점이나 제안하고 싶은 사항은 무엇입니까?

이런 말씀 드리기 조금 실례일 수도 있지만 저희와 나이 차이가 정말 많이 차이나는 교수님들이시기 때문에 사실 강의 내용 중에 공감할 수 없는 부분이 많았습니다. 좀 더 공감할 수 있는 강의가 되었으면 좋겠습니다.

울산과학기술대학교

Fig. 5. Survey result at Ulsan Meister High School.

4. Conclusions

Lectures on nuclear power plant simulator and practical exercises were performed at Ulsan Energy High School and Ulsan Meister High School. Two simulators were used: the macro- and micro-physics simulator. Using the macro-physics simulator, the following five simulations were performed: reactor power increase/decrease, reactor trip, single reactor coolant pump trip, large break loss of coolant accident, and station black-out with D.C. power loss. Using the micro-physics simulator, the following three analyses were performed: the transient analysis, fuel rod performance analysis, and thermal-hydraulics analysis. The students at both high schools showed interest and strong support for the simulator-based training. After the training, the students showed passionate responses that the education was of help for them to get interest in a nuclear power plant. Through the training, it is expected that next generation are more familiar with the nuclear power generation and public perception gets better.

Acknowledgment

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