Development and Operation of the Nuclear Safety Academic-Industry Education Program

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1. Introduction

According to the World Meteorological Organization (WMO), global natural disasters resulting from climate change, such as extreme weather events and water shortages, are on the rise. In response to these challenges, the issue of carbon neutrality has emerged, and nuclear energy is gaining attention as a realistic alternative for low-carbon energy supply. Consequently, the demand for the development of future innovative technologies, such as Small Modular Reactors (SMRs) and nextgeneration reactors, is increasing, along with a growing need for training professionals in this field. It is now essential to strengthen education aimed at cultivating interdisciplinary talents who possess a broad understanding and inclusivity in various fields, based on nuclear engineering knowledge.

In response to these needs, the Education Center of the Korea Atomic Energy Research Institute (KAERI) aims to develop and operate academic-industry education programs that utilize the institute's large-scale research infrastructure and top-tier research personnel, resources that are often difficult for universities to provide. These programs, based on the institute's core technologies (such as research reactors, small modular reactors, nuclear safety technologies, and radiation fusion technologies), will be tailored to the educational needs of undergraduate and graduate students, with the goal of cultivating future nuclear experts.

2. Research Methodology

This study aims to operate a nuclear safety KAERI academic-industry education program utilizing the research facilities, equipment, and top experts of the KAERI for domestic university (graduate and undergraduate) students in the field of nuclear energy. The implementation strategy consists of conducting a demand survey for education, designing and developing the curriculum, creating teaching materials and content, developing evaluation tools, operating the education program, and conducting survey assessments. The implementation framework is shown in Figure 1.

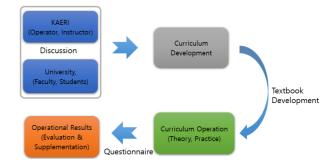


Fig. 1 Implementation System

2.1 Educational Needs Survey

We conducted a survey on the educational needs of nuclear-related undergraduate and graduate students interested in participating in the program. Based on the results, we categorized them into undergraduate, master's, and doctoral levels and developed programs that cater to the high-demand areas for each group.

2.2 Design, Development, and Improvement of Educational Programs

The Nuclear Safety Research Laboratory Training Program consists of the following:

First, at the KAERI Nuclear Education Center, we offered courses developed and operated under the existing project, "Specialized Nuclear Safety Training Using KAERI Research Facilities (2018–2021)." These courses included "Nuclear Power Plant Material Degradation Assessment," "Practical Radiation Safety Management," "Graphical-Based Nuclear Power Plant Simulation Operation," and "Personal Radiation Dose Measurement and Evaluation." After conducting the training sessions, we performed survey evaluations, analyzed the feedback, and incorporated the suggestions into course improvements. Additionally, we consulted with the instructors to refine certain aspects of the course content and training materials.

Second, we developed a new course titled "Prediction and Response Techniques for Severe Nuclear Accidents(Course 7)." This course aims to enhance participants' understanding of response strategies, facility conditions during severe nuclear accidents, and measures to improve nuclear power plant safety.

Table I: Total Number of Trainees

Course Name	Nuclear Power Plant Simulation Operation	Nuclear Power Plant Material Degradation Assessment	Practical Radiation Safety Management	Personal Radiation Dose Measurement and Evaluation	Prediction and Response to Severe Nuclear Accidents	Nuclear Research Field Experience	Total
Number of Training Sessions	3	2	2	1	1	1	10
Participating Universities	8	12	14	8	4	4	19*
Undergraduate Students	8	20	8	4	16	2	58
Graduate Students	29	16	37	22	2	6	112

Table II: Improvement Rate of Learning Level Before and After Training

No.	Training Course	Graduates (Number)	Before Training	After Training	Improvement Point
1	Nuclear Power Plant Material Degradation Assessment	14	33	70	37
2	Nuclear Research Field Experience	8	41	82	<mark>41</mark>
3	Practical Radiation Safety Management	23	52	81	29
4	Nuclear Power Plant Simulation Operation I	10	48	87	<mark>39</mark>
5	Nuclear Power Plant Simulation Operation II	11	37	87	<mark>50</mark>
6	Personal Radiation Dose Measurement and Evaluation	26	52	89	37
7	Prediction and Response to Severe Nuclear Accidents	18	42	72	30
8	Nuclear Power Plant Simulation Operation III	16	38	81	<mark>43</mark>
9	Nuclear Power Plant Material Degradation Assessment	22	47	80	33
10	Practical Radiation Safety Management	22	59	85	26

3. Operation of the Academic-Industry Research Education Program and Course Evaluation Results

Trainees were selected, and the course design report and implementation plan were prepared and approved. After conducting the training sessions, a training implementation report was compiled. A survey evaluation was then conducted, followed by the preparation of a final training outcome report. Additionally, survey questionnaires were developed or refined to align with each field's training program. The collected survey responses from participants were analyzed to identify areas for future improvement.

3. Results

Table I shows the overall results of the training operation. As shown in Table II, an analysis of learning achievement point before and after the training revealed that the improvement point were highest in Courses 2, 4, 5 and 8. However, course 10 showed the lowest learning improvement rate, indicating the need for future adjustments in lecture difficulty.

According to Fig. 2 and Table III, the overall satisfaction score (out of 5) indicates that graduate

students generally had equal or higher satisfaction levels compared to undergraduate students.

Table III: Training Satisfaction

Satisfaction	Overall	Graduate Students	Undergradua -te Students
Expectation	4.6	4.6	4.7
Satisfaction	4.6	4.4	4.7
Acquisition of New Knowledge/Skills	4.6	4.4	4.8
Willingness to Recommend to Others	4.7	4.7	5.0
Instructor/Lecture Content	4.7	4.9	4.9
Learning Environment	4.6	4.7	4.8

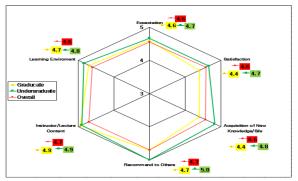


Fig. 2. Training Satisfaction Chart

4. Conclusions

Analyzing the overall training survey results, it was found that graduate students expressed higher satisfaction with the hands-on training, suggesting that it contributed to the enhancement of the expertise level of highly educated nuclear engineering students. In the future, we aim to address the shortcomings identified during the development and implementation of the training programs, with the goal of strengthening the capabilities of nuclear professionals and contributing to the activation of the nuclear safety research field.

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