Nuclear Human Resources Development Program using Educational Core Simulator

Yu Sun Choi[*] and Soon Kwan Hong
KHNP-CRI, 70 Yuseongdaero 1312beon-gil, Yuseong-gu, Daejeon 34101, Korea
[*]*Corresponding author: yschoi5577@khnp.co.kr*

1. Introduction

KHNP-CRI(Korea Hydro & Nuclear Power Co.-Central Research Institute) has redesigned the existing Core Simulator(CoSi) used as a sort of training tools for reactor engineers in operating nuclear power plant to support Nuclear Human Resources Development (NHRD) Program focusing on the nuclear department of Dalat university in Vietnam. This program has been supported by MOTIE in Korea and cooperated with KNA(Korea Nuclear Association for International Cooperation) and HYU(Hanyang University) for enhancing the nuclear human resources of potential country in consideration with Korean Nuclear Power Plant as a next candidate energy sources.

2. Development of Core Simulators

2.1 Core Simulator(CoSi)

Originally, Core Simulator(CoSi) has been developed to enhance the reactor engineer's proficiency for Low Power Physics Test(LPPT) of OPR1000 and APR1400 by KHNP-CRI. CoSi consists of three parts as illustrated in figure 1. RAST-K is a calculating engine for the neutron physics in a core, Input Interface Modules treat control rod movement, boron concentration change and temperature feedback in coolant as an input data for RAST-K core calculation. Output Interface Modules handle the output data generated from RAST-K, which used to produce trend chart containing reactor power, coolant temperature, boron concentration and reactivity in a core. The 2D or 3D power distributions are displayed and selected by user's option. Output Interface Modules can also generate the major reactivity parameters into reactivity computer.[ref.1]
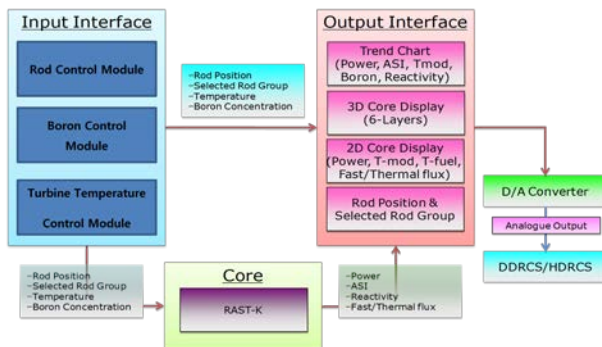

Fig. 1 Schematic Diagram of CoSi

CoSi has a function of generating neutron flux signal similar with that of neutron signal from Ex-core detector, and provides neutron detector signal into the reactivity computer that calculates and analyzes the core reactivity in real time base.

CoSi includes four monitoring panels of rod position and main core parameters in Main Control Room of OPR1000(Fig.2). CoSi's panels show fuel assembly and control rod bank position, reactor power(%), average moderator temperature(℃), boron concentration(ppm), boration and dilution information which handle moderator makeup water rate(liter/min) and boron makeup flow rate(liter/min), moderator heating/cooling rate(℃/min), vertical position of control bank and digital display of control bank position. CoSi is able to be connected with reactivity computer and print on strip chart. CoSi provides real time chart for reactor core parameters.[ref.1]

Fig. 2 CoSi Hardware

2.2 Educational Core Simulator(Edu-CoSi)

The CoSi is re-designated for educational purpose, and it became a suitable form for undergraduate students. Some features such a function of generating neutron signal, connecting with reactivity computer and generating signal to strip chart have been removed. To record the testing data from 3D core calculation, additionally Edu-CoSi has a function of logging the core parameters as a text format in hardware drive in every second. Edu-CoSi hardware consists of Two(2) TV monitors, Two(2) LED monitors, HP Workstation that easily can be bought at the market.

Fig. 2 Educational Core Simulator(Edu-CoSi)

3. NHRD Programs

3.1 Domestic Classes

The 3 days course on The Zero Power Physics Test using CoSi of OPR1000 or APR14000 consists of class lecture and hands-on training on Initial Criticality Test and measurement of reactor physics parameters during Physics Tests in Nuclear Power Plant. This course is conducted for three or four times a year since 2012 only for KHNP reactor engineers. A Job Qualification Certificates will be issued to reactor engineer who has completely passed all performance tests without severe and repeated faults.

Fig. 3 ZPPT Performance Test in KHNP

3.2 Training Classes for Vietnamese

Edu-CoSi was delivered to Dalat University in Vietnam in November of last year by airplane. Training course for next lecturer was held last January and July. The following items are touched and measured at this classes using plant test procedure.
 - Approach to critical
 - Determination of test range (POAH)
 - Boron End Point (BEP)
 - Isothermal Temperature Coefficient (ITC)
 - Bank worth measurement by boron swap
 - Bank worth measurement by rod swap

 - Dynamic control rod measurement (DCRM)

Test procedure for every measurement test consists of following items by ANSI/ANS formation.
 - Introduction
 - Test Objectives
 - Test Purpose
 - Initial Conditions
 - Test Method
 - Test Procedure
 - Evaluation

By Nuclear Human Resources Development in Vietnam, five(5) lecturers have received the course certificate on ZPPT and four(4) students participated in demonstration training class for 6 days.

4. Conclusion

KHNP-CRI has provided Edu-CoSi to Dalat University in Vietnam in order to support Nuclear Human Resources Development Program in Vietnam. Edu-CoSi software is clarified as a nuclear strategic item by KINAC in Korea. Job Qualification Certificates Program in KHNP is utilized to design a training course for Vietnamese faculty and student of Dalat University. Successfully, knowhow on lecturing the ZPPT performance, training and maintaining Edu-CoSi hardware are transferred by several training courses which KHNP-CRI provides.

Reference

[1] Y.S. Choi et al, "Zero Power Physics Test by using Core Simulator(CoSi) for OPR1000," Trans. Of KNS Spring Meeting, Jeju, May 17-18, 2012
[2] KHNP SWN, "Initial Fuel Loading," 9S-L-422-01, Test Procedure. 2012.
[3] KHNP SWN, "Low Power Physics Test," 9S-L-422-02, Test Procedure. 2012.