Improvement of abnormal phenomenon attributable to fallen individual control rod for UAE BNPP Simulator

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1. Introduction

Two UAE BNPP(Barakah Nuclear Power Plant) simulators have been developed and installed as a part of the contract of UAE Nuclear power plant. It is the first time to export the Full Scope Simulator(FSS) in Korea.

APR1400 simulator which is exported to UAE is designed according to Shin-Kori nuclear power plant 3&4 as the reference plant. APR1400 is the first peculiar nuclear power plant made by KHNP which applied to have not conventional hardware control concept, but software control concept using mouse on the screen including integrated information and alarm design.

UAE BNPP simulators are designed and manufactured according to the international standard, ANSI/ANS 3.5 and tested many times on site. Simulators are used as Integrated System Validation facility to validate the nuclear power plant MMI design, and also for training MCR operators and acquiring RO/SRO certificate, etc.

After the simulators are installed in Barakah, warranty is being proceeded for two years to solve the problem while using the simulators.

2. Methods and Results

In this section, major constitutions of simulator development for UAE BNPP are described. UAE BNPP simulator consists of mainly software and hardware.

2.1 Main specification

UAE BNPP simulator is designed by KHNP. It is accurately replicate the actual control room equipment, remote shutdown and local panels, and simulate the systems so that an operator will not discern differences between simulator operation and reference unit operation, over the normal and abnormal ranges.[1]

2.2 Software

UAE BNPP simulator for development utilizes the environment simulator tool which has the function of the real-time executive and modeling system. This tool is capable of simulating all aspects of power plant fluid dynamic, electrical distribution, and logic and control systems.
In addition to the environment simulator tool, it uses the RELAP5 for reactor thermal-hydraulics and NESTLE for reactor neutronics modeling of the reactor systems.

2.3 Hardware

UAE BNPP simulator hardware made up for operator consoles manufactured after Shin-Kori 3. The compositions of hardware are as follows.

- Large display panel
- Operator console(SS, STA, RO, TO, EO)
- Safety console
- Remote shutdown console
- Instructor console
- Maintenance and Test Cabinet

2.4 Phenomenon of simulator trouble

The troubles which are happened during the operating the simulator is named Discrepancy Reports. UAE BNPP simulator also made the troubles when using the simulator and generates the discrepancy reports. These are being managed and solved by development institute.
The fields of discrepancy reports are mainly core/thermal hydraulic, system interface, MMIS, BOP and hardware.

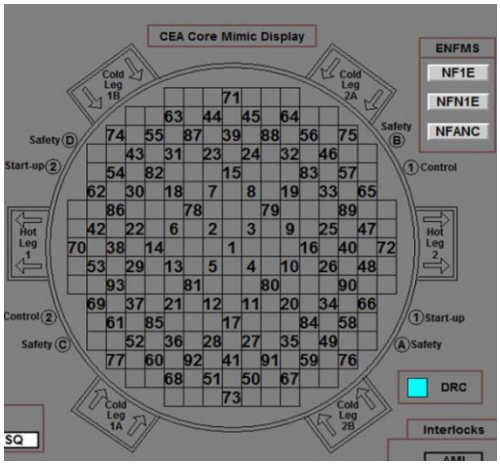

Fig 1. Arrangement of control rod for UAE BNPP simulator

Among the theses fields, this paper deals with the system interface issue. Arrangement of control rod is shown in Fig 1.

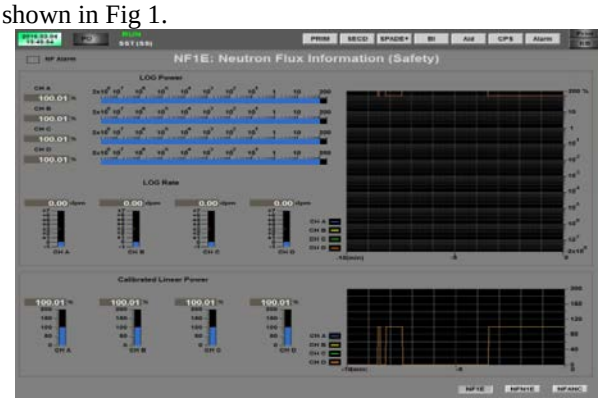

Fig 2. Calibrated Linear Power HMI display

The phenomenon of discrepancy report is that the temperature of hot leg 1 adjacent to the fallen control rod is not decreased when individual control rod dropped at quadrant two of core and calibrated Linear Power of channel C and D are not decreased in Fig 2.[2] Normally, the temperature and power should be decreased .

3. Trouble and improvement

The temperature of hot leg close to the fallen control rod should be going down because control rod absorbs the neutrons and control power should be declined.

To reproduce the symptom of this discrepancy report, let the individual control rod fall at each quadrant of core. Then check the temperature change of hot leg and power of safety channel.

In order to modify the problem, check the control rod position information of each quadrant. First, make a couple of control rods which located in the same quadrant dropped and check the change of hot leg temperature and reactor power. Then, after rotate the position of control rod in the assign file, check the change of hot leg temperature and reactor power.

The problem is solved by turning the control rod position - 90 degree using the assign file. The modified assign text file is shown in Fig. 3.

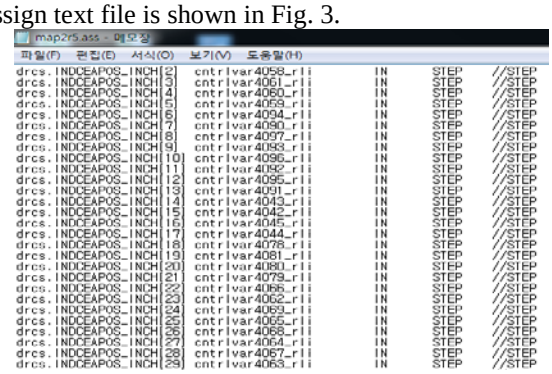

Fig 3. Assign text file of control rods

4. Conclusions

Wrong assignment of the control rod position causes the bad phenomenon of hot leg temperature and reactor power. Simulator is complex and it is composed of many devices. If design data should be rechecked and validated in the initial stage of simulator development, simulator will be more stable and reliable.

REFERENCES

[1] WSC O&M, “Simulator Overview”, WSC, 2015
[2] WSC UAE BNPP FSS DR System, 2016