

A Method of Building Multi-MCR in One Validation Facility

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1. Introduction

In designing digital main control rooms, a validation facility is used essentially for HFE V&V (verification and validation), which contributes to design optimization of MCR. For high reliability of validating an MCR, a validation facility should represent the characteristics of the specific MCR as precisely as possible. KHNP CRI has a validation facility by the name of 'APR-MCR@CRI', which played a role of supporting MCR design and HFE validation for APR1400-type plants. Though all the plants are adapted for the same APR1400-type MCR, there are design differences between the plants. Therefore APR-MCR@CRI should be adapted appropriately to validate respectively according to MCR designs of the specific plants (e.g. SKN3&4 or SHN1&2). This paper describes the method of building multiple specific MCRs into APR-MCR@CRI including the configuration structure.

2. Methods and Results

Constructing nuclear power plants since Shin-kori unit 3&4(SKN3&4) have been designed and built on the basis of digital main control room. For finally installing digital MCR in a plant, many times of validation tests for design verification and human factors engineering validation are performed in the validation facility and the simulator for training. Design changes or design decision are done through the results from the validation tests. Since design validation using the simulator for training is mostly performed at the phase of almost decided design and just before installing MCR in the plant, it is difficult to validate the design through the simulator during the early phase or the continuous phase of the design. Therefore the validation facility is used to repeatedly validate, change, and confirm the design in the continuous phase of construction projects. The validation facility has a similar structure to the simulator with a plant emulation type, which consists of application servers, database, operator's consoles, soft-control, LDP (large display panel) and so on. But the validation facility is far more flexible to change and validate the design than the simulator, so the design validation results through the validation facility contributes to the simulator design as well as the MCR design optimization.

KHNP CRI has a validation facility (APR-MCR@CRI) for APR1400-type MCR. Generally,

though the each plant adapts to the same type MCR, there are differences in MCR design of each plant because the latter plant design can be improved compared to the former plant. Shin-hanul 1&2, the latter model, has some differences in MCR design from Shin-kori 3&4, the first APR1400 model, even though the two plants adapted to the same APR1400-type MCR. Therefore it needs each validation environment corresponding to each plant MCR in order to improve reliance and accuracy of the design validation. However, it is not easy to build each MCR environment in one validation facility. This paper is describing the method of building multiple specific MCRs into a validation facility through the case of APR-MCR@CRI. Currently, APR-MCR@CRI is available to use two model plant MCRs' environments such as SKN3&4 and SHN1&2, and SKN 5&6 model is under construction.

2.1 Validation Facility "APR-MCR@CRI"

APR-MCR@CRI in KHNP CRI is a full scope simulator for limited purpose of validation in Human Factors Engineering and MMI display design. So it has some differences with real site plant's actual MMI components. For example, MMI system of SHN1&2 is using a platform "ARIDES" that is supplied by Doosan Heavy Industry but CRI's APR-MCR@CRI uses "ProcSee" display platform developed by HRP (Halden Reactor Project).

APR-MCR@CRI physically consists of one LDP, five operator workstations, and a safety console. Each operator workstation has four FPDs and four ESCMs respectively and in addition SS and STA have two QIAS(qualified indication and alarm system)-N FPDs as shown in figure 1 [1].

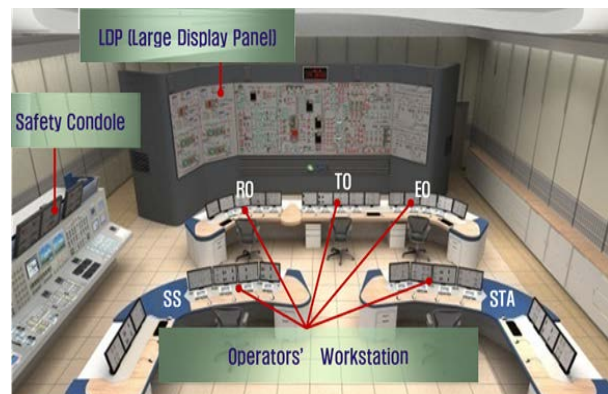


Fig. 1. Validation facility 'APR-MCR@CRI' in KHNP CRI

APR-MCR@CRI has also an instructor station which plays roles of providing various operating situations for validation or training, and managing other functions such as CPS (computerized procedure system), alarm, system powers and so on.

2.2 Configuration for Building Multi- MCR

Each plant model(SKN3&4, SHN1&2, SKN5&6) has some differences in design but it is possible to build the models into one validation facility because the models are on the basis of APR1400-type and have same characteristics plentifully. Nevertheless, the each model can have specific characteristics such as different MMI platform, different variable tag names, new components, or new variables. Therefore, for building multi-MCR, it needs to integrate various characteristics into a common database. APR-MCR@CRI has independent plant model servers corresponding to the each plant as figure 3 and a common DB for multi-MCR. The common database includes the specific characteristics separated according to the plants. The plant models were made of “3Keymaster” which is a tool for making plant simulation.

For example, if SKN3&4 environment is needed in the validation facility, user only needs to select “SKN3&4” button in user’s interface. Then the data related to SKN3&4 are called in common DB and sent to the validation facility, finally SKN3&4 MCR is built as figure 2.

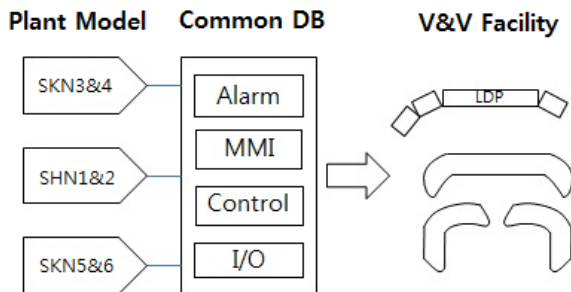


Fig. 2. The basic configuration for building multi-MCR

2.3 Network Structure of APR-MCR@CRI

As figure 3, APR-MCR@CRI has two networks that one is IPS network for sharing operating information and the other is I/O network for controlling I/O systems such as safety console switches and ESCM confirm switches [2]. The link between IPS network and I/O network is performed by VTBP(virtual terminal box protocol) [3]. The instructor station is for the manager of APR-MCR@CRI or for the instructor controlling operation scenarios. The instructor station can manage all functions related to validation of MCR such as change of multi-MCR, control of all facilities powers, start/stop of system functions including alarm, CPS, and

etc. as well as injection of mal-functions in scenarios for operation training.

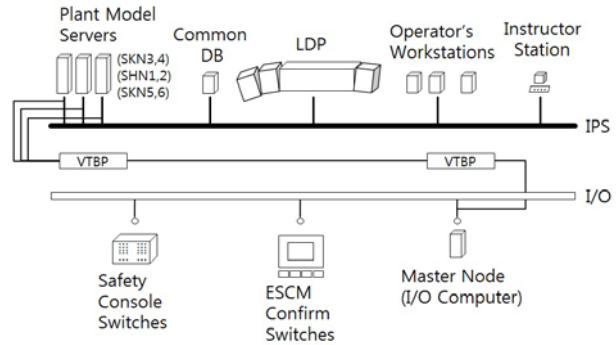


Fig. 3. APR-MCR@CRI network structure

3. Conclusions

Design validation and HFE verification of digital MCR are continuously performed from the early phase to the final phase of design. The validation of design before design decision is mainly fulfilled in the validation facility, it is essential to build the validation facility corresponding to the specific MCR. APR-MCR@CRI is a validation facility for APR1400-type MCR and has been upgraded to easily accept the characteristics of multiple MCR environments [4]. The facility will be used to validate SKN5&6 and SHN3&4, and to train operators. Also, the facility is expected to usefully apply to validation of the former plants in design changes.

REFERENCES

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