Transactions of the Korean Nuclear Society Autumn Meeting
PyeongChang, Korea, October 25-26, 2007

Strategy for Modernization of Main Control Rooms

Yeonsub Jung, Jaesung Lee , Hojong Yoo
Korea Hydro Nuclear Power Company, ysjung@khnp.co.kr

1. Introduction

Lifetime of most information devices spans 5 years at most. Both memory capacity and CPU performance nearly double every 2 years. A new operating system is released every year. New information technology appears rapidly and disappears. Even though there is time delay, this phenomena is observed in I&C (instrument and control) devices in nuclear power plants. It is assumed that lifetime of I&C is about 20 years. At that time, spare parts are difficult to purchase. However, main control rooms in nuclear power plant have not changed dramatically. Once MCR is built, it stays almost forever.

Why do the operators in NPP insist using the old and traditional devices? Traditional MCR has some advantage over advanced MCR. For example tradition MCR provides operators panoramic view, and dedicated and strong devices. On the other hand, advanced MCR provide them powerful presentation and information. When new power plants are built, advanced MCR is preferred. But when old MCR is modernized, most operators still insist the old style.

This is because the transition from traditional MCR to advanced MCR is not clear and has challenges to overcome. This paper will explain the challenges and provide a strategy to overcome.

2. Experience from Modernization of MCR

2.1 Kori 1 MCR

Kori 1 has been operated since 1978, now it is stopped to evaluate its systems for life extension. MCR is partially improved in 2007. LED indicators will replace needle type indicators. Paperless recorders will be introduced. SPDS and plant computer is combined. The MCR will be further improved in 2011. The isolated electric control panels are merged into the main area. BISI indicators will be introduced.

I&C systems of Kori1 was improved in 1998. There is no further improvement this time. After thorough discussions, the endpoint view of MCR is determined to be a hybrid type, which is combination of traditional MCR and advanced MCR. The local I&C expert and operator prefers the hybrid type because advanced MCR is not running right now in Korea. They are also afraid of difficulty while maintaining the advanced MCR.

In addition, without purchase of additional I&C system, it is difficult to introduce electronic control panel (e-panel) in 2007

2.2 KSNP

KSNP I&C and MCR will be upgraded gradually beginning from 2015. End point view of MCR and master plan for I&C is being developed. Upgraded KSNP MCR and I&C are trying to utilize the products of KNICS, such as DCS and PLC. DCS will be used for non safety system, whereas PLC is for safety. Data can be transferred between DCS and PLC. Recent advanced PLC and DCS can simplify I&C architecture, so that various control systems can be unified with standard platform.

By evaluating reliability, economic factors, and obsolescence factors, I&C system for upgrade are being selected.

3. Upgrade Strategy

The upgrade normally occurs during the outage of nuclear power plants. Outage duration is about 20 days. Therefore the upgrade demands multiple outages. Initially control and monitoring network is supposed to be built. Gradually old and obsolescent I&C system will be replaced and connected to the backbone of communication. Current KSNP I&C provide plant computer system for monitoring, but not for control. The upgrade KSNP plant computer system will provide control capability.

Current MCR devices such as handswitch or PID controller are connected to ILS (Interposing Logic System). When the ILS is replaced with both DCS and PLC, the same architecture can remain if traditional MMI devices are used. But there will be challenges when traditional MMI devices are removed or new control panel are built.

According to human factor engineering program such as NUREG-0711, there are twelve elements to consider when modifying the MCR. The elements are required from design to implementation. Some of them are procedure revision, training, modification of simulator. These are tremendous and time consuming tasks. Furthermore KSNP operators can not afford to adapt themselves to the rapidly changing MCR. Unfortunately there are no experiences in this matter in the world. How can we avoid this problem?

This paper proposes an elegant strategy to change from traditional MCR to advanced or hybrid MCR. In this strategy, operator burden to follow the rapidly varying MCR is dramatically reduced.

The key point of this strategy is to minimize the apparent change of MCR until the last stage. The indicators and controls of MCR are replaced with similar ones when I&C system are upgraded. The operators will experience the same interactions with new devices as the old devices. This kind of design and replacement are not difficult to achieve.

The second point of this strategy is to reinforce the capability of plant computer system whenever I&C system is upgraded. The plant computer system will be equipped with not only for monitoring function, but also for control function at the time. But the control function of PCS is not allowed until the last stage as depicted in Fig.1. PCS will be installed in e-panel. This constraint is introduced to avoid control conflict between traditional control panel and e-panel, and to avoid operator's confusion. Even though operator can not control actuators with e-panel, operators become accustomed to both monitoring and control function in e-panel during normal operation.

When the last stage approaches, e-panel's control capability is released to work as Fig.1. Simultaneously number of traditional control panels will be minimized, and arrangement of device in traditional control panel will be revised. Because operators will have been used to the e-panel during the I&C upgrade period, the transition would be smooth. From this time operators would like to control the plant devices through e-panels.

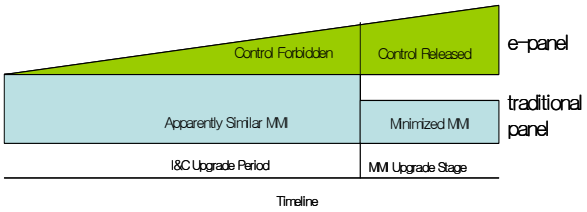

Fig 1 Strategy for MCR modernization

In view of NUREG-0711, this strategy can minimize a lot of time consuming tasks. Procedures and simulators can be revised at the last stage. Training can be performed only once.

4. The functionality of plant computer system

The transition from traditional panel to e-panel is explained previously. But e-panel capability will surpass the capability of traditional panel. Traditional panels have limited indicators and controls, whereas e-panels have powerful presentation and control capability. A lot of attributes of a single device can be combined in a single symbol. For example, device flow status, alarm status, and trouble can be combined in a symbol. Because this function has been demonstrated in APR1400 design, KSNP MCR will adapt the same functionalities.

In addition, KSNP MCR will provide more powerful functionalities such as surveillance test. Additional features can be introduced after thorough analysis of operator's tasks.

The prototype of KSNP MCR is being developed using PC based platforms. For example, simulator will be developed and be running in PC. Control logic will be implemented in PC. Their communication is achieved with TCP/IP. Everything is emulated in PC. MMI of e-panel is drawn with PROSEE software developed in OECD/HRP. Minimum numbers of KNICS PLC and DCS will be used in the prototype if necessary. This architecture seems enough for validating KSNP MCR

5. Reference

1.NUREG-0700, Human System Interface Design Review Guidelines, 2002
2.Human Factors Guidance for Hybrid Control Rooms and Digital I&C Systems (EPRI-1010042), 2005