Integrated Performance Validation Facility for KNICS MMIS

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1. Introduction

Recently digital I&C systems are widely adopted for the instrumentation and control(I&C) systems of nuclear power plants(NPPs). For the application of new digital control and monitoring systems in nuclear power plants(NPPs), it is required to satisfy the proven technology requirements.

It, EPRI-URD, requests the 'proven technology' which should have at least three years experience of documented, satisfactory service as modules of subsystems in the NPP or other plant applications similar to that of NPP [1].

Because the digital control and monitoring systems of Korea Nuclear Instrumentation & Control System (KNICS) has no application experience in any NPPs as well as industrial and fossil power plants, KNICS R&D center chose the another option to verify their performance, operability and reliability according by EPRI-URD's another option, satisfactorily completing a 'well defined program of prototype testing' to verify its performance by using the stimulated full scope simulator [2].

2. Full scope simulator for integrated test bed

The full scope simulators(FSSs) are used as a integration test bed to verify and validate(V&V) before applying new digitalized I&C technology for replacing and/or upgrading old control systems of operating NPPs, and for constructing of advanced MMIS of new constructing NPPs.

The Table-1 shows the some of cases of the full scope simulator(FSS) use for validation test and/or operator training before application of the new digital control system to NPPs.

Table 1. DCS V&V using FSS

Unit	Type	Utility	I&C
Sizewell B	PWR	British Energy	Upgrading
Leningrad	RBMK	Rosenergoatom	Upgrading
Paks	VVER	MVM	Upgrading
Chooz B	PWR	EDF	Upgrading
Lungmen1&2	ABWR	TPC	Constructing
SKN3	PWR	KHNP	Constructing

The Shin Kori-3 nuclear power plant(NPP), the first APR1400 NPP, is also designed with the fully digitalized control system by using foreign vendor DCS.

U.S. NRC requests to do verification & validation (V&V) that the new design or MMI system conform to perform successfully their tasks for achieving plant safety and other operational goals.[3] The integrated system validation which is using a full scope simulator is the part of this activity and can provide evidence that the integrated design and system remains within acceptable performance envelopes. Generally speaking the full scope simulator is build for the operator training purpose and its requirements is ANSI/ANS 3.5.[4]

Though it has been discussing to revise to insert the standard for Distributed Control System (DCS) V&V, it is expected no big changing in near future.

Korea Electric Power Research Institute (KEPRI) is developing the integrated performance validation Facility to validate the integrated performance design of Man-Machine Interface System(MMIS) of APR1400 main control room(MCR).[5] One of major parts of the system, full scope simulator, is considerably designed too simulate the specific phenomena of the APR1400 dynamics by using the real-time best estimated thermal-hydraulic (TH) simulation code, RELAP-RT, and new emulated Distributed Control System(DCS) & Computerized Procedure System(CPS).

3. Integrated Performance Test Bed for KNICS

KEPRI and Doosan Heavy Industry (DHI) are developing together the KNICS Integrated Performance Validation Facility (IPVF) which could show performance of the newly developed control and protection system, KNICS MMIS system.

With the well defined V&V program using the facility could KNICS system satisfy the requirements of the user's requirements (KURD). Figure 1 shows the overview of its architecture.
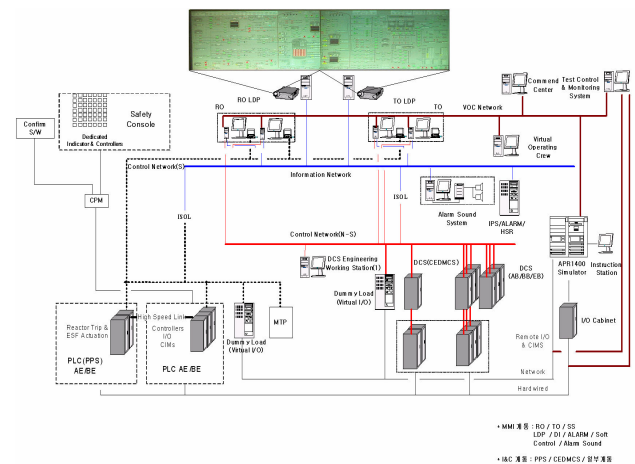

Figure 1. Overview of KNICS IPVF Architecture

IPVF should have some of interfaces between the simulator and its other subsystems, KNICS MMIS systems, Test Commander (TC), Virtual Operating Crew (VOC) & other Human System Interface (HSI) system.

The IPVF has the stimulated control system with the Programmable Logic Controller (PLC) and DCS developed by KNICS which has the actual control logics and MMI of real NPP. For each PLC & DCS the actual I/O interface and its own network communication are needed and TCP/IP communication will be used for other subsystems. Figure 2 shows the interface between the KNICS MMIS and the simulator.
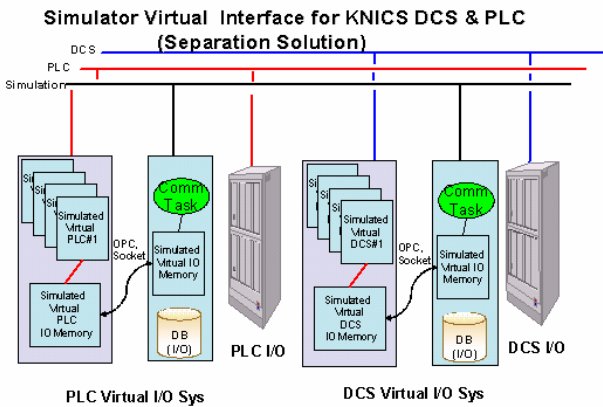

Figure 2. Interface between KNICS MMIS and simulator

Fist of all Reactor Protection System (RPS) and Plant Power Control System (PCS) of APR1400 are selected and developed to develop IPVF by modifying the simulation model from emulation to stimulation and integrating actual KNICS MMIS and simulator in the first year of this project. Figure 3 shows simulation diagram of Reactor Power Cutback System (RPCS) of PCS in the simulator.
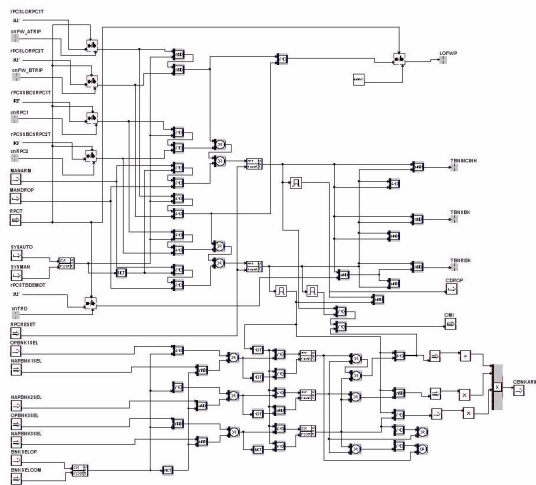

Figure 3. Simulation diagram of RPCS

The versatile featured I/O testing system which is consisted of I/O testing, data acquisition module and network testing module is designed and used for interfacing KNICS MMIS and the simulator. The proto type stimulated simulator of the RPS&PCS for IPVF is designed and done non-integrated standalone test.

It will be integrated with the actual KNICS RPS&PCS system which is made of KNICS PLC&DCS and the scope will be expanded for full scale integration test for KNICS MMIS validation.

4. Conclusion

An integrated performance testing facility (IPVF) for KNICS MMIS design validation is under development by KEPRI and DHI.

The proto type stimulated simulator of the RPS&PCS for IPVF is designed and interface methodology is developed and tested for this facility.

It will be integrated with the actual KNICS RPS&PCS system which is made of KNICS PLC&DCS and the scope will be expanded for full scale integration test for KNICS MMIS validation.

This system will be useful for applying new digital control and monitoring systems, like KNICS MMIS, to nuclear power plants (NPPs) to satisfy the proven technology requirements.

ACKNOWLEDGMENT

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