Development of V&V System for the KNICS

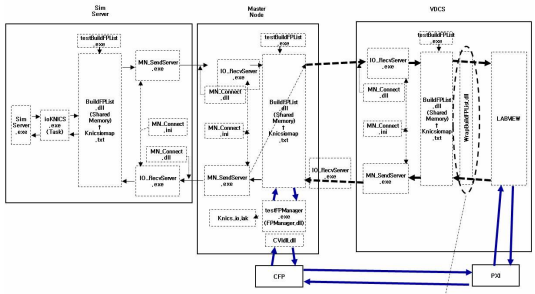
JinHyuk Hong, MyeongSoo Lee, SeungHo Lee, JungKwan Suh, DoHyun Hwang
KEPRI, Nuclear Power Laboratory, Munji-Dong, Yuseong-Gu, Daejeon,
jhhong@kepri.re.kr, fiatlux@kepri.re.kr, kepco99@kepri.re.kr, jksuh@kepri.re.kr, whitepeach@kepri.re.kr

1. Introduction

It is required to satisfy the proven technology requirement for application of new digital control and monitoring systems in nuclear power plants. At least three years of documented, satisfactory service in other plant applications which are similar to the use in NPP(EPRI-URD's first option)[1]. A well defined program using IPVF (Integrated Performance Validation Facility) for prototype testing has been prepared to verify their performance, operability and reliability according to EPRI-URD's second option. Using this facility, the newly developed control systems of KNICS will be proven for its application. The stimulated approach via hardware I/O points representing physical status of NPP is adopted [2] and has been being tested for the validation of the KNICS with a test bed (V&V system) which is based on the APR1400 simulator. Along with this, KEPRI is implementing the emulated PLC/DCS by using the commercial tool (LABVIEW^{TM}) and interfacing the V&V system for testing the integrity of the test bed. The purpose of this paper is to report the current state of the development of the V&V system for the KNICS.

1. KEPRI Integrated Performance Validation Facility

KEPRI is developing the KNICS IPVF which could verify the performance of the newly developed control and protection system. As for the KNICS, the stimulated approach via hardware I/O points representing physical status of NPP is adopted for the validation test of the KNICS. To fully test and evaluate the integrity of the KNICS, the IPVF that could work actually as the real plant is quite necessary. For the IPVF, KEPRI is developing the IPVF, called KEPIPVF. The KEPIPVF (KEPRI IPVF) has the emulated control system with the Programmable Logic Controller (PLC) and DCS developed by the commercial tool (LABVIEW^{TM} 8.5). For each PLC and DCS, the actual I/O interface and its own network communication are needed and TCP/IP communication will be used for dummy load (virtual I/O). Figure 1 shows the configuration of the KEPIPVF I/O system.



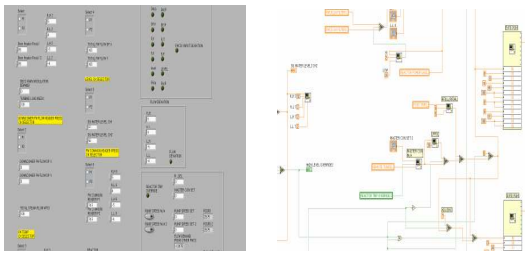
[Fig.1] Configuration of the KEPIPVF I/O System

2. Developed Systems for the KEPIPVF

A commercial tool (LABVIEW^{TM} 8.5) is adopted for simulation of the PLC and DCS of the KEPIPVF. As with the real KNICS, the following systems are already developed :

- NPCS (Nuclear Process Control System) consisting of FWCS (Feedwater Control System), SBCS (Steam Bypass Control System), CVCS (Chemical Volume and Control System), BDAS (Boron Dilution and Alarm System), PPCS (Pressurizer Pressure Control System) and PLCS (Pressurizer Level Control System).
- PCS (Power Control System) made up by RRS (Reactor Regulating System), RPCS (Reactor Power Cutback System) and CEDMCS (Control Element Drive Mechanism and Control System)

For the simulator server to run in coincidence with the models in the Labview, a class with which the response traits of the filter can be made is developed and applied to the overall systems in the Labview.



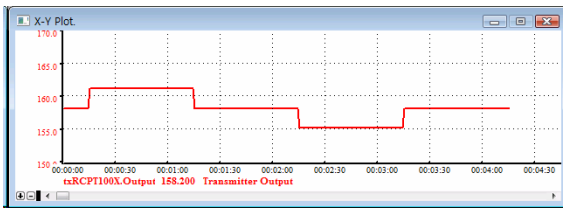
[Fig.2] FWCS (Feedwater Control System) in Labview

3. NIST (Non-Integration System Test)

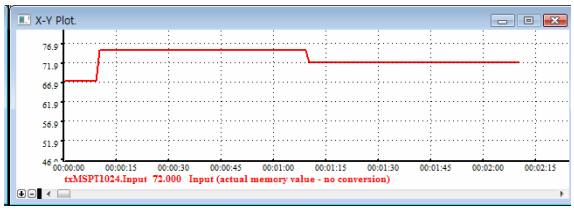
This section shows the NIST for parts of the developed systems for the KEPIPVF.

3.1 SBCS (Steam Bypass Control System)

Due to abrupt load rejection by SBCS (Steam Bypass Control System), some tests are made for the focus on whether the change of the header pressure of the main steam and the pressure of the pressurizer can be made and whether the turbine bypass valve could act in the normal manner. Fig 3 to 4 shows the result of the SBCS NIST.



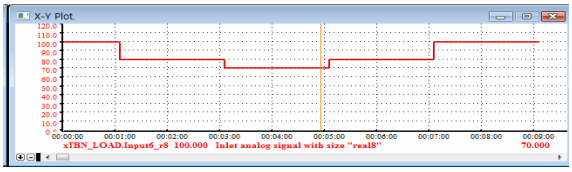
[Fig.3] Pressurizer pressure



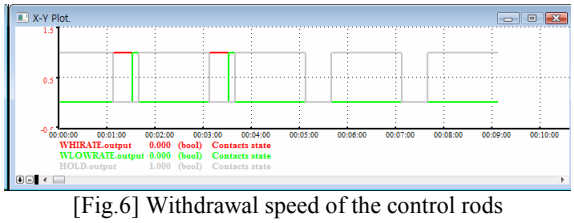
[Fig.4] Main steam header pressure

3.2 RRS (Reactor Regulating System)

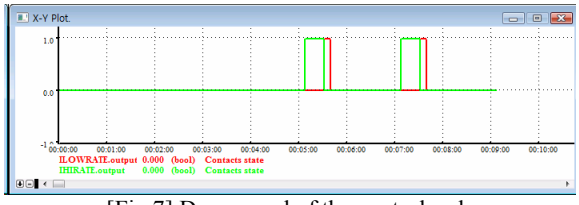
Due to the change of the turbine load and RCS temperature, some tests are made for the focus on the speed and direction of the control rods, and the generation of the automatic withdrawal inhibit (AWI) signal for the CEDMCS (Control Element Drive Mechanism Control System) and SBCS. Fig 5 to 7 shows the result of the RRS NIST.



[Fig.5] Change of the turbine load



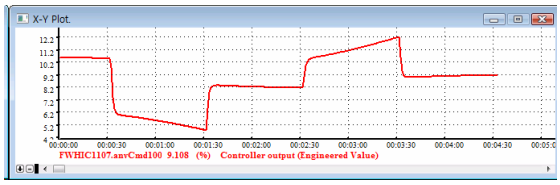
[Fig.6] Withdrawal speed of the control rods



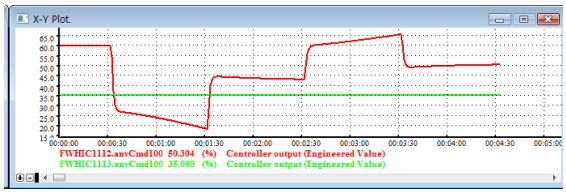
[Fig.7] Drop speed of the control rods

3.3 FWCS (FeedWater Control System)

For the integrity of the FWCS, some tests are made from the points of view that the opening of the main feedwater valve and the speed control for main feed pumps are normally operated in the normal and abnormal states of the main feedwater control system. Fig 8 to 9 shows the result of the SBCS NIST.



[Fig.8] Speed of main feed pump A



[Fig.9] Opening of the Economizer/Downcomer Valve

4. Conclusions and Furthers

The KEPIPVF for the KNICS is under development by the KEPRI. The emulated systems of the PCS and NPCS are designed and tested with good results. Also, the scope will be expanded for full scale test for the integrity of the KEPIPVF.

REFERENCES

[1] EPRI-URD Chapter 11-10-3.2.1, Criteria for Proven Technology

[2] Myeong-Soo Lee et al., "Integrated Performance Validation Facility for KNICS MMIS," the Korean Nuclear Society Spring Meeting, 2007.