

A Study on Virtual Operating Crew and Test Commander For the Experience Accumulating Test of Unproven MMIS Technology

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1. Introduction

New MMIS (Man Machine Interface System) technology is rapidly advanced as digital technology provides opportunity for more functionality and better cost effectiveness. Also, NPP (Nuclear Power Plant) operators are inclined to use the new technology for the construction of new plant and for the upgrade of existing plants. However, this new technology may include risks at the same time. These risks are mainly due to the poor reliability of newly developed technology. According to the user requirement (KURD: Korean Utility Requirement Document), advanced MMIS technology may be applied if it could be apparently needed to obtain a defined gain in simplicity or performance.

For applying new MMIS technology, reliability needs to be verified on the basis of the requirements of proven technology. KURD suggests two methods for verifying satisfaction of the requirement of proven technology.

These methods are to verify whether or not unproven MMIS technology has adequate reliability. First method is that it has at least three years of documented, satisfactory service as modules of subsystems in power plant applications similar to that in LWRs or in other than power plant applications which are similar to the use in the APR1400 M-MIS. Second method is that it has satisfactorily completed a defined program of prototype testing which has been designed to verify its performance in the APR1400 M-MIS application.

But, new MMIS technology had not yet opportunity to apply in the Nuclear Power Plant. Therefore, we think that second method is the effective method to demonstrate reliability and performance of new technology through the experience accumulation test. In here, Experience accumulation test means that we emulate the process of nuclear power plant such as installation after shipping, trial operation, operation, and maintenance with MMIS facility and verify reliability and performance through various test method under the circumstance of emulation and if any problem occurs, systematic process such as feedback of problem, correction of problem and retest leads to enhance the reliability of unproven technology and this repetitive test enables new MMIS technology to accumulate experience of at least three operating years.

This experience accumulation test needs much efforts and time to repeatedly test for accumulating experience. We suggest system to efficiently perform the experience accumulation test in this paper.

2. System Overview and Function

Introduction of proposed system such as Test Commander (TC), Virtual Operating Crew (VOC) and Test Control and Monitoring System (TCMS) enable new MMIS technology to perform efficiently experience accumulation test. TC substitutes for role of tester and VOC substitutes for role of operators and TCMS is in charge of controlling and monitoring failure or error state.

System configuration for experience accumulation test through integrated validation facility is described below:

- A. Test Commander (Proposed System) including Test Control and Monitoring System (Proposed System)
- B. Virtual Operating Crew (Proposed System)
- C. Simulator
- D. New MMIS technology (for example, DCS or PLC)

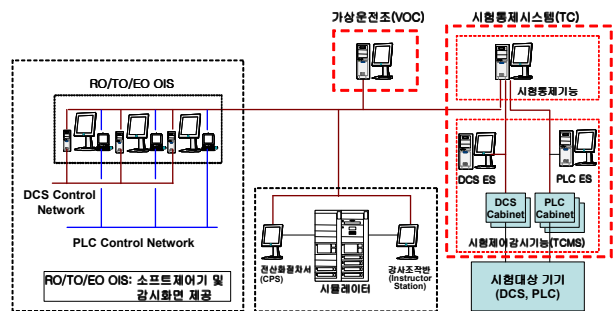


Figure1. Configuration of Integrated Validation Facility for Experience Accumulation Test.

2.1 Test Commander

TC provides the function which develops test scenario and analyzes test results and adjust test mode. TC consists of TC scheduler function and TC

commander/logger function. TC scheduler function provides sequential test scenario with time tag. Start time and frequency of the test scenario are also defined in the TC scheduler. TC commander/logger functions divide two parts. TC logger has the function to record operation scenarios generated from basic log function of the simulator. Logged operation scenarios are finally included in the test scenarios in accordance with various kinds of test. TC commander has the function to command test related system (VOC, Simulator, Test System) to perform the necessary function of the system which includes procedure or control action of VOC and make up of simulation environment through the instructor station in the simulator and make up of failure environment through the TCMS.

Also, TC includes the function of TCMS which controls failure or error condition and monitor failure or error state. In other words, TCMS injects test data (failure or error generating signal) into the test facility (including new MMIS technology) and then monitors system status and if failure or error occurs, reports test results with the failure or error. This system is implemented with the system (new MMIS technology) of the same kind that we would apply.

2.2 Virtual Operating Crew

VOC performs operation of the plant implemented with the simulator as if real operators would operate the plant, that is, control valve, pump or process and monitor the feedback value of control and plant state according to the procedure. Also, VOC evaluates the success or fail of the procedure. This VOC emulates such control and monitoring action as operator's control action.

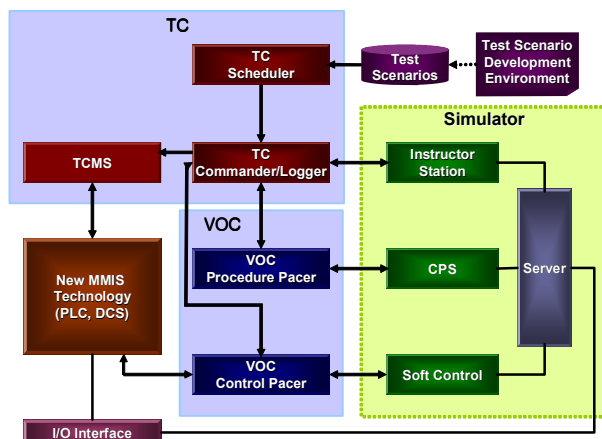


Figure 2. Function Block indicates relation among the systems

2.3 Simulator

Simulator performs control function (Start/Stop/Freeze/Reset) of simulator and the function of computerized procedure system and soft control function included in the simulator. Simulator emulates

the nuclear power plants and has the function of event injection and event report. Initial plant operation scenario is generated from the internal function of the simulator. This operation scenario is applied for making up test scenario including operation scenario.

3. Emulation Requirements for Practical Experience Accumulation Test

Experience accumulation test should be performed through integrated validation facility including TC and VOC satisfying following conditions to emulate condition of installation/pre-operation/operation/maintenance of plant within the process of detection/reporting/correction of the failure.

- A. Main process emulation of such construction and operation as installation/pre-operation/operation/maintenance of NPP: Reliability and performance of new MMIS technology should be tested and verified in the main process of construction project.
- B. Process emulation of detection/reporting/correction of the failure and problem: This process provides the opportunity to enhance the reliability and robustness.
- C. Environment emulation of Test facility: temperature, moisture, system stall and initialization, power loss etc could be emulated.
- D. Physical process emulation of NPP: Physical process of NPP could be emulated through the simulator.
- E. Event emulation of NPP: Normal/abnormal/emergency event and operation could be emulated.

4. Conclusion

Currently, we developed the conceptual design of the proposed system (Test Commander and Virtual Operating Crew) for experience accumulation test. But, we have to focus on detailed and efficient upgrade plan of the reliability through TC/VOC. Also, we try to make this proposed system practically applicable. We hope that this system would help all of utility and supplier to apply new MMIS technology.

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