Establishment of Vital Digital Assets Verification Environment Design Base

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1. Introduction

As cyber-attacks continue to occur at nuclear facilities, the importance of cyber security to nuclear facilities is getting higher. In this situation, there is also a growing need to establish cyber security measures against electronic infringement and establish a fundamental defense system for the nuclear facilities. Therefore, it is possible to establish a verification environment for vital digital assets (VDA) that are directly related to the nuclear accidents including fuel damage among the critical digital assets (CDA). In this paper, we discuss what to consider when designing the VDA verification environment.

2. Test Requirements of VDA Verification Environment

2.1 General Requirements

To be used as VDA verification environment, the requirements of ANSI/ANS 3.5(2009) "Nuclear power plant simulators for use in operator training and examination" must be satisfied. After establishing the VDA verification environment, we should test the items required for comprehensive operating status, abnormal operation, safety status, and transient status according to ANSI/ANS 3.5 in order to verify that the analysis environment operates correctly.

2.2 Comprehensive Operating Status

3.1.3.2 Normal Evolutions of ANSI/ANS 3.5 requires testing to include at least the following in order to test the overall operating condition.

- Power plant startup from cold shutdown to rated power conditions
- Power shutdown from rated power to cold shutdown conditions
- Power operation and load changes
- Surveillance testing performed by the driver on safety-related equipment or systems.

2.3 Abnormal Operation

3.1.4 Malfunctions of ANSI/ANS 3.5 require testing to include 24 malfunction points to test for abnormal operating conditions.

2.4 Safety Status

ANSI / ANS 3.5 Appendix B B.1.1 The Steady-State Test requires the following to test the steady state: In this test, an acceptable steady-state response is tested by comparing the parameters between the simulator and the existing plant. The thermal balance data should be compared against three distinct output levels over at least 50% of the available operating range. Therefore, it may be considered to perform the following test in such a state.

- 100% output steady state
- 75% output steady state
- 50% output steady state
- 25% output steady state

2.5 Transient Status

ANSI/ANS 3.5 Appendix B B.3.2 the Transient Performance Test requires tests to include 11 malfunction statements to test transient conditions.

3. Details on Test of VDA Verification Environments

In order to construct the VDA verification environment, the following data and environment should be prepared.

Table 1. Data List for VDA Verification Environments

Data for Development of Process Model	P&ID (Piping and Instrument Diagram), System Operation Diagram ,Control & Instrument Diagram, Control Logic Diagram, General Arrangement Drawing, Single Line Diagram, Schematic Diagram, Component List, Component Technical Specification & Component Data, Board Elevation Drawing, Data from Turbine, S/G, PZR, RCP, RX, Condenser, MSR etc. ,Core Input Deck, Fuel Assembly Map, Neutron Instrument Locations, Fuel Geometry, Reactor Vessel Geometry, Primary Loop Piping, Pressurizer Geometry, Steam Generator Geometry, Reactor Coolant Pump Parameters, Detail Drawing of Reactor Vessel Internals,
Data for Development of Plant Process Computer	Turbine Control System Control Logic & HMI, CPC/ENFMS algorithm and HMI Design Report, PAS algorithm and HMI Design Report, PMS algorithm and HMI Design Report. etc.
Data for Detail Environments	System Function Description, Set-Point List, Controller Gain & Constant, Instrument Range
Data for Development for self-test and test procedure	FSAR, Operating Procedure, Operation Data by Output

In order to construct the VDA analysis environment, the following equipment should be prepared.

Table 2. Hardware and Software for establishing VDA Verification Environments

Hardware	Main Server, Computer for Instructor, Engineering Work Station, Plant Process Computer, Network Equipment
Software	Simulation Environment, Core Program, Development tool

4. Conclusion

We have discussed what needs to be considered to design the VDA verification environment and what materials need to be prepared. Each data for the VDA verification environment could be produced by a variety of organizations such as system designers, software designers, manufacturers, licensees and operators. Further research on VDA verification environment should be studied for effective regulation and in-depth cyber security and it is expected that cyber security for nuclear facilities will be strengthened by developing regulatory technology.

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