

## Discussion of ISV Scenario Scope with Operating Process Element

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### 1. Introduction

Human factor verification and validation (HF V&V) is required to evaluate human system interfaces (HSIs) in nuclear power plant and an integrated system validation (ISV) is one of validation method for HF V&V. The ISV validates HSIs with expected operational conditions. NUREG-0711 identifies the sampling dimension of operational conditions which includes normal operation, I&C and HSI failures, transient, and accidents [1]. Because of practical limitation of sampling, ISV scenarios do not include every expected operational condition. To develop a scenario for the ISV, it requires much time and efforts. It takes about 1 month with 3 operating crew team for 7 scenarios for the ISV. Therefore, operational conditions are screened out for integration to scenario.

### 2. Complexity of Scenario

Even though it has been screened out, each type of operation should be included according the requirement. As a result, an ISV scenario tends to be collection of each type of operational condition such as normal operation, abnormal operation, emergency operation and operation with I&C and HSI failures. Specially, safety-related operator actions such as emergency operating procedure execution and important human actions should be included in ISV scenario. Therefore the sequence of operation in one scenario can be complicated. For example, normal operational suddenly changes to the middle of emergency operation. If the scenario is too complicate, it is difficult to evaluate the operation. Because the operator mental model is not ready to fit for different operational condition in a limited time. The measurement of workload also is affected by the complexity of scenario. The workload is measured by questionnaires after the scenario, and operator may feel high workload for the complex scenario. Therefore, the number of scenario and the complexity of scenario should be decided according to the benefit of each screening objects.

### 3. Evaluation for Screened out operational condition

After the proper screening, there may exist important operational conditions which are not included in ISV scenario. Those operational conditions can be verified by task support verification a (TSV) and an operational

walkthrough. For example, some sets of emergency operating procedure (EOP) that are not included in ISV scenario, can be verified through TSV.

Operational walkthrough may be applied when a EOP is developing or when the EOP is tested. However, it should be demonstrate that the evaluation of representative subset of operational condition in ISV scenario can be expended to the rest of operational scenario in TSV and operational walkthrough.

### 4. TSV and Operational Walkthrough

A TSV has less limitation than ISV, because TSV can be performed by table top analysis by subject matter expert. Operational conditions which are not included in ISV scenario can be verified by TSV with TSV process. However, difference between TSV and ISV, for example, TSV cannot validate integrated control room. Thus, additional operational walkthrough is considered to review that is not included in ISV. Table 1 shows the characteristics of TSV, ISV, and operational walkthrough according to operating process element. Operating process elements consist of monitoring and detection, situation awareness, response planning, response implementation, team work, and check the result of operation. The ISV validates all of the operating process for the selected scenario. The operating process which is not included in the selected ISV scenario can be evaluated by operational walkthrough and TSV. For example of the monitoring, if ISV validates that the operator can monitor plant status with displays in the operator workstation The same type of monitoring can be evaluated and validate with operational walkthrough. Operational walkthrough assumes that the secondary task for monitoring is identical with ISV. The content of each display can be evaluated using TSV, which verifies that the required information is included in the display.

**Table 1 Operating process element and validation**

Operating Process Element	Task Support Verification	Integrated System Validation	Operational Walkthrough
Monitoring and detection	Verify that a HSI provides required information (display and alarm) to the operator	Validate that operator receive the provided information	Validate that the use of representative HSI can evaluate the use of other HSI
Situation awareness	There is no direct verification.	Validate whether the operator aware the situation	Validate that the operator aware the situation with provided information, procedure, and training by using representative evaluation result
Response planning	There is no direct verification.	Validate that the operator have response planning from procedure or knowledge	- Operational condition with procedure : Validate that procedure provides response activity - Operational condition without procedure : Walkthrough with operation expert
Response implementation	Verify that a HSI provides required control means to the operator.	Validate that operator can control the plant with provided control means	Validate that the use of representative HSI can evaluate the use of other HSI
Team work (eg. communication)	There is no direct verification.	Validate that there are expected communication and team work	Walkthrough with operation expert
Check the result of operation (Plant status)	There is no direct verification.	Validate that the primary operation goal is met	Walkthrough with simulator

#### 4. Discussion

TSV can be used for the evaluation of monitoring, detection, and response implementation about the inventory of information and control. However, validity of operational walkthrough for other operating process element needs to be discussed. For the situation awareness, the general acceptance check list can be derived from the result of representative scenario set of ISV. The check list may contain the number of information, type of information, level of procedure and training program. For the response planning, procedure can be used for evaluation. For team work, operation expert evaluation can be used, and the checking the result of operation can be evaluated by using full-scope simulator.

#### REFERENCES

- [1] NUREG-0711, Revision 3, "Human Factors Engineering Program Review Model," US NRC, November 2012.