User Requirements for Technical Specifications Operator Support System

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1. Introduction

Technical Specification (TS) is a document that establishes requirements for the prevention of accidents and minimization of damage caused by the operation of nuclear power plants [1]. The Limiting Conditions for Operation (LCO) of the TS that identify the lowest functional capability of equipment required for safe operation for the facility must be monitored, and if LCO is not met, the operators are required to take actions related to the LCO within completion time [2]. But operators in MCR have difficulty in monitoring LCOs because there are many LCOs that must be monitored, as well as types of monitoring parameters [3]. To solve these problems, Technical specifications Operator Support System (TOSS) has been developed and applied at domain nuclear power plant (NPP) [4]. In this paper, we introduce user requirements and results through a site survey conducted to derive enhancement items for TOSS. The derived functional enhancement items will be reflected in major functional updates of TOSS in the future.

2. Nuclear Power Plant Site Survey

In this section, the user requirements and results based on site survey including the typical reactor types such as OPR1000, APR1400, Framatome, WestingHouse, CANDU are described [5].

2.1 Site Survey Overview

Table I shows the overall schedule of domain nuclear power plants site survey including Shin-Wolsong 1,2 units at which TOSS is operated.

The site survey included a general explanation of TOSS and sharing of key monitoring results of the system, followed by a survey with operators. If additional questions were necessary based on the operator's survey comments, individual interviews were conducted. Over 130 operators attended the TOSS presentation, and 94 of them, who hold licenses for each power plant and have experience in the main control room, participated in the survey. The survey period spanned approximately one year, considering the schedule of each nuclear power plant.

Table I: Site Survey Schedule

Date	Domain NPP	Reactor Type
23.12.26~27	Shin-Wolsong 1,2	OPR1000
23.3.6~7	Saeul 3,4	APR1400
23.4.13~14	Saeul 1,2	APR1400
23.9.7~8	Shin-Hanul 1,2	APR1400
23.9.13~14	Shin-Kori 1,2	OPR1000
23.9.14~15	Hanul 1,2	Framatome
23.10.30~31	Hanbit 1,2	WestingHouse
23.11.6~7	Hanul 3,4, 5, 6	OPR1000
23.11.13~14	Hanbit 3,4,5, 6	OPR1000
23.12.27~28	Wolsong 3,4	CANDU

2.2 Operator Survey Questionnaire

The survey consisted of 13 scale(5-point) questions, including the first impressions of TOSS, and 4 open-ended questions including functional enhancement items they would like to see added to TOSS. Table II & III present the survey questions and scale results.

Table II: Survey questionnaire (Scale)

Questions	Results
1. First impressions of TOSS	4.44
Retrieval Function	
2-1. Overall structure	4.67
2-2. Sorting	4.65
2-3. Relevant documents	4.73
2-4. LCO DB based on function location	4.64
2-5. Synonym	4.51
Monitoring Function	
3-1. Overall structure	4.55
3-2. Monitoring start page	4.56
3-3. Monitoring system page	4.56
3-4. Detection Logic page	4.46
3-5. Evaluation Logic page	4.44
Overall questions	
1. Has the TOSS appropriately reflected tasks related to TS?	4.52
2. Will TOSS be beneficial in tasks related to TS?	4.60

Table III: Survey questionnaire (open-ended)

Questions
1. Difficulties in performing tasks related to TS
2. functional enhancement items they would like to see added to TOSS
3. The need for enhanced monitoring logic through design change about pi system.
4. Additional comments

2.3 Survey Results

In the scale questions, the first impressions of the TOSS received a relatively low score of 4.4 points, which appears to reflect the difficulty in TS tasks rather than an evaluation of the system itself. Furthermore, questions regarding the appropriate reflection of tasks related to TS and whether TOSS will be beneficial when applied to the NPP recorded scores of 4.52 and 4.60 respectively. This indicates an overall high satisfaction with the system. The key findings for open-ended question 1 include the ambiguity of TS, difficulty in understanding the mutual impact among multiple TS, and the diversity in monitoring LCOs and types due to changes in plant conditions. Table IV shows the summary of the operator's comments.

Table IV: The summary of the operator's comments

Operator's comments
1. The ambiguity in the TS and backgrounds
2. There are variations in interpretation among individuals.
3. The changes in LCO items that need monitoring based on the alterations in the power plant condition.
4. The difficulty in applying 'Section 3.0' and the 'Safety Functions Determination Program'
5. The difficulty in retrieving for similar cases for 'Entry-into Actions of LCO' cases.
6. Analyzing information that requires determination of whether LCO is met or not met through graphs or similar visuals takes a considerable amount of time.
7. The difficulty in determining due to the mixing of various guidelines.

And the diverse opinions for Question 2 were gathered, including the need for segmentation of the blocking function, strengthening the user interface, enhancing user-customizable features for periodic notifications, and specifying the simulation mode. For questions 3, there was generally consensus, especially in power plants with relatively low 'pi' signals, regarding the need for advanced monitoring logic through design changes. Finally, additional comments included concerns about increased workload related to STA tasks, and concerns about potential decline in operator's skills due to the introduction of TOSS.

2.4 User Requirements

Based on the responses from operators to the scale and open-ended questions, the user requirements have been derived as outlined in the following table V.

Table V: User Requirements

User Requirements
● Resolution of ambiguity whether LCO is met or not met.
● Enhancing awareness of various monitoring types for LCO.
● Pre-alarm feature for LCO dissatisfaction.
● Enhancing the retrieval function for existing the 'Entry-into Actions of LCO' cases.
● Minimizing administrative burdens resulting from the introduction of the system.
● Enhancing accessibility to other NPP.
● Incorporating elements from 'Section 3.0' and 'Safety Functions Determination Program'

3. Conclusions

In this paper, a survey was conducted targeting operators of domestic NPPs to derive improvements for the current TOSS functionalities. And the results of the survey are presented. The survey revealed that operators were having difficulty performing tasks related to LCO of technical specifications and user requirements were derived to address these difficulties.

TOSS is scheduled to be further improved to reflect user requirements, and nuclear power plant safety is expected to be greatly improved due to the introduction of the improved TOSS.

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