Development of Information Display System for Operator Support in Severe Accident

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1. Introduction

Severe accident is an accident than can release radioactive products into the environments caused by significant damage to reactor fuel. After the severe accident of Fukushima Daiichi Nuclear Power Electric Power the importance of severe accident management was increased. When the severe accident occurs, the technical support center (TSC) performs the mitigation strategy with severe accident management guidelines (SAMG) and communicates with main control room (MCR) operators to obtain information of plant's status. In such circumstances, the importance of an information display for severe accident is increased. Therefore an information display system dedicated to severe accident conditions is required to secure the plant information, to provide the necessary information to MCR operators and TSC operators, and to support the decision using these information [1]

We setup the design concept of severe accident information display system (SIDS) in the previous study and defined its requirements of function and performance [1]. In this paper we describes the identification of the severe accident-related information and the implementation of SIDS screen.

2. Development of SIDS

In this section we describes the implementation details of SIDS. We have developed the SIDS prototype with the following sub-sections.

2.1 Requirement analysis

First we setup the design concepts of SIDS and established the requirements in the previous study and we defined the classifications of SIDS as Safety Class 'NNS (non-nuclear safety)', Quality class 'T', Seismic class 'I', Electrical class 'Non-1E' and Software class 'ITS (important to safety)'. SIDS have following functions:

1) Critical function monitoring function
2) Post-accident monitoring function
3) Alarm functions
4) Information display functions for operator support
5) Data validation functions
6) Information Display functions in MCR, remote shutdown room(RSR), TSC, and EOF

2.2 Identification of the Severe Accident-related Information

Secondly, to identify the related information of severe accident for SMART MCR operators, we performed the following procedures:

1) Review laws, regulations and policies against the severe accidents of NPPS in Korea and USA.
2) Review the design requirements of SMART critical function monitoring system to identify the critical function and related instrumentations of SMART and the results of SSAR chapter 19 to identify the scenarios and mitigation system/function for severe accidents.
3) Identify the critical function and instrumentations for each severe accident scenarios.
   - Display window of the monitoring parameter for severe accident
   - Monitoring parameter and instrumentation for critical function
   - Critical function and parameter during severe accident

For example, we identified the monitoring variables of core heat removal to reactor water level and core exit temperature as shown in Figure 2. Also we identified their instruments of detectors.

2.3 Implementation of SIDS

We implemented the critical function monitoring and alarm function as described in section 2.1. The critical function monitoring system (CFMS) function displays the instrument information that can quickly diagnose and monitor the safety status of the plant operator during normal and abnormal operation. CFMS monitors the state of the following critical functions:

- Core Reactivity Control
- Core Heat Removal
- RCS Inventory Control
- RCS Pressure Control
- RCS Heat Removal
- Containment Pressure/Temperature Control
- Containment Isolation
- Radioactive Emissions Control
- Maintenance of Vital Auxiliaries

We implemented the 24 CFMS screens for above critical function including the main screen (Fig. 1). For alarm functions, a visual and audible alarm is provided to MCR operators in the SIDS when any function of CFMS is not maintained.

We implemented that the main screen of SIDS displays the overall information of plant status and navigation menu. The reactor vessel water level screen (Fig. 3) will be displayed by clicking the corresponding sub-menu of core heat removal in main screen of SIDS.

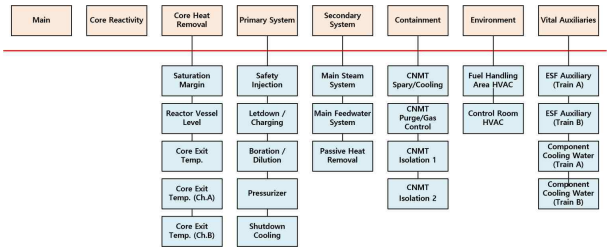

Fig. 1. CFMS Navigation Hierarchy of SIDS.

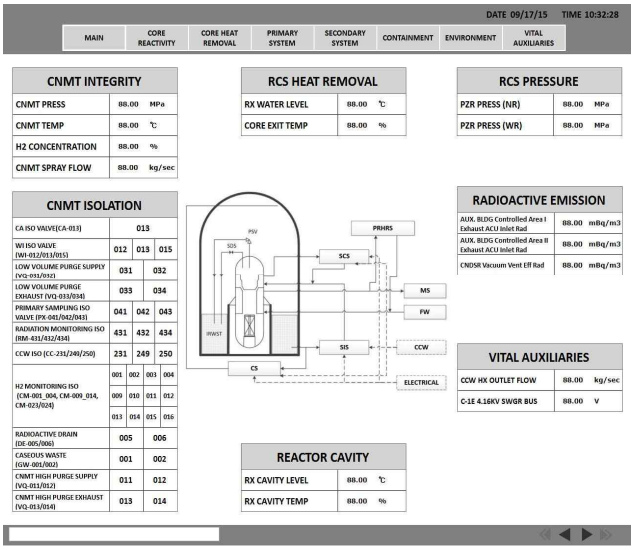

Fig. 2. Main Screen of SIDS

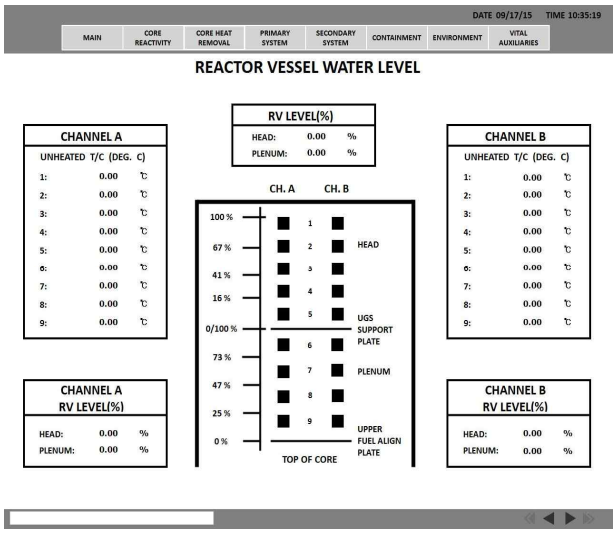

Fig. 3. Reactor Vessel Water Level Screen of SIDS

3. Conclusions

This paper describes the process, results of the identification of the severe accident information for MCR operator and the implementation of SIDS. Further implementation on post-accident monitoring function and data validation function for severe accidents will be accomplished in the future.

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MEST) (No. 2012M2A8A4025979)

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