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Design and Development of a Severe Accident Training System

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1. Introduction

The nuclear plants' severe accidents have two big characteristics. One is that they are very rare accidents, and the other is that they bring extreme conditions such as the high pressure and temperature in their process. It is, therefore, very hard to get the severe accident data, without inquiring that the data should be real or experimental. In fact, most of severe accident analyses rely on the simulation codes where almost all severe accident knowledge is contained. These codes are, however, programmed by the fortran language, so that their output are typical text files which are very complicated. To avoid this kind of difficulty in understanding the code output data, several kinds of graphic user interface (GUI) programs could be developed. In this paper, we will introduce a GUI system for severe accident management and training, partly developed and partly in design stage.

2. Description of Works

In this section some of the development process including the system design and its architecture is described.

2.1 Design Objectives

Because nuclear plant severe accidents are very rare, members in MCR and TSC are not familiar with their phenomena and mitigation procedures. Also it is not difficult to imagine their psychological pressure in an emergency. From this point of view, the first objective of our GUI system is set to help operators understanding the severe accidents phenomena and their processes by providing several graphical displays.

Another objective is to provide a training tool for the severe accident mitigation strategies practices, imitating the technical support center (TSC) and main control room (MCR) activities at real accident situations.

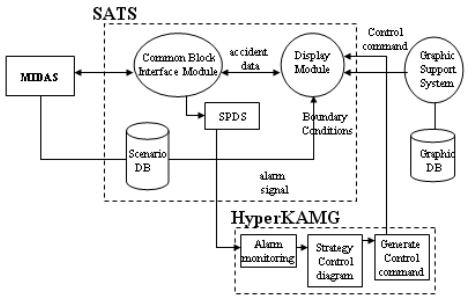
2.2 Description of Subsystems

SATS is a severe accident training simulator, developed to provide a multi-purpose tool for severe accident analyses and training. It aimed to have two main functions: one is to provide graphic displays to represent severe accident phenomena and the other is to process interactive user inputs. SATS simulates nuclear plant behavior using MIDAS code as its engine, and provides graphical displays of plant behaviors. Moreover SATS has the real-time control function so that every important valves and pumps are controllable by interactive mouse operations without changing scenario inputs.

HyperKAMG, the severe accident guidance module, has full contents of the severe accident management guidelines in the hypertext format [2]. Whenever an alarm in the safety parameter display system (SPDS) of SATS appears, operators in MCR and TSC staffs can follow the severe accident mitigation steps.

2.3 Overall Structure

As shown in Fig. 1, the SATS accesses the MIDAS data block via common block interface module, and displays the current plant status data on the graphic display screens. The SPDS module is the accident variable monitoring module, drawing variables graphs and generating alarms according to the safety criteria of the guidance. The generated alarm signals go to the HyperKAMG module and set of alarm signals are processed according to the strategy control diagram to produce a proper control command for the SATS. The generated commands are sent to the display module of SATS again, and the corresponding valves and pumps of SATS are controlled automatically.



- Performs graphical simulation on the basis of MELCOR simulation results
- Use SL-GMS graphic animation function
- Has multi-processing architecture on IBM PC

Figure 1. Overall structure of the training system

2.4 Developments

The strategy control diagram, which is the core logic of the SAMG is implemented as a subsystem as shown in Fig. 2. It uses the seven parameter values generated from the SATS simulator as the system input for the alarm generation. In the Fig. 2, seven alarm icons are prepared for mitigation strategy execution. These seven alarm icon colors vary from white to red as their own related parameter violates the predefined range of the SAMG. Whenever an icon color becomes red, the strategy control diagram module generates and sends a corresponding alarm signal to the HyperKAMG module to process mitigation strategy execution.

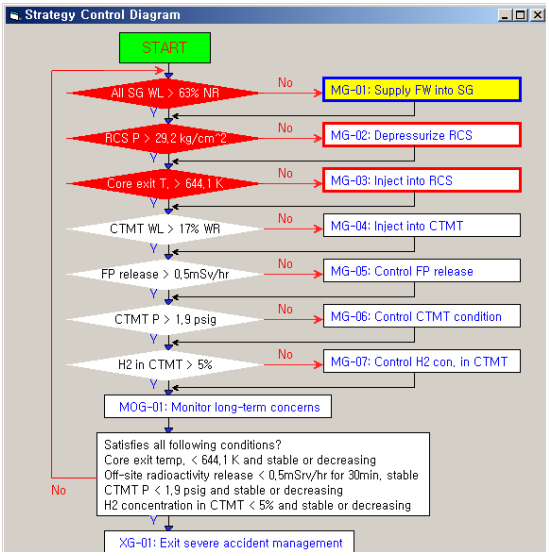


Figure 2. The strategy control diagram module

The HyperKAMG module has the interface for the operators' decision making process for a mitigation strategy execution. Currently the mitigation strategy processes are partly implemented for automation. Following a decision-making made by the HyperKAMG, several control commands, for example SDS valve operation or aux-feed pump operation, are sent to the SATS together with the operation reservation time.

3. Conclusion

This paper presents an integrated severe accident training system which consists of the HyperKAMG, the SATS training simulator using MIDAS code as its engine, the SPDS module and the strategy control diagram module. The idea of combining the SAMG logic and SATS control capabilities to mimic the severe accident management procedures in a real plant was realized through a successful integration of the these subsystems. We expect that the proposed system will be an excellent tool for a severe accident management and training purposes.

REFERENCES

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