HSI for monitoring the critical safety function status of a NPP

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Introduction

Critical safety function (CSF) is the most significant design concept for prioritize operator actions based on the potential threat to the three barriers (fuel cladding, primary coolant system boundary, and containment) and allows the operator to respond to these threats prior to event diagnosis.

The CSF has a hierarchical information structure that organizes the system variables affecting the plant safety in terms of goal-means relations. It is important that the operator should be aware of various success paths associated with each CSF in order to respond to unanticipated system failures quickly.

When an emergency occurs in NPPs, the operator should monitor CSFs periodically and identify possible success paths as necessary, and try to stabilize or safely shut down the plant using emergency operating procedure (EOP) that includes steps to check the CSFs. This implies that safety function status check may become a cognitively burdensome task that needs to be supported by proper information display. The advanced human-system interface (HSI) in nuclear power plants provides an information environment that supports the operators' burdensome cognitive tasks.

This work describes the CFST interface designed [1] to support the operator's tasks to monitor and to identify the associated success path for a Westinghouse 3-loops NPP.

Methodologies

The Critical Function Status Tree (CFST) main screen, is shown in the Fig. 1, summarizes the status of each one of other six more detailed screens, each one representing one of CFST. Within the CFST main screen, the operator is able to check if the current status is satisfactory (SAT), as well as if there is any abnormal situation on the system. In case of non-satisfactory status, the operator will be able to check which of CFST is not in satisfactory condition, as well as quickly identifies which operation procedure needs to be followed in order to try bringing the system back to the satisfactory condition

Fig. 1, for example, shows that every CSFTs are in satisfactory condition with exception to the *Core Cooling* CFST, which is in FRCC-3 state. This is a low priority condition, as pointed by the CFST main screen.

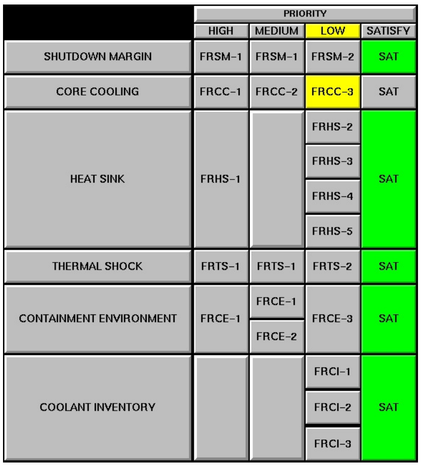

Fig. 1 - CFST main screen.

The operator may click on the *Core Cooling* button to enter the Core Cooling CFST screen, as shown in the Fig. 2. This screen shows why the plant entered in the FRCC-3 low priority (yellow) non-satisfactory state.

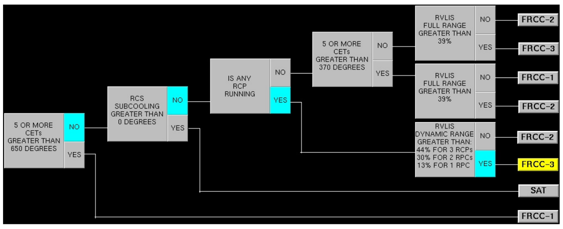

Fig. 2 - Core cooling critical function status tree.

Results and Discussion

Currently this project is in an advanced status of development. All screens were built, and the software that keeps track of each CFST screen status was written, in C language, and is already working. This software is capable of reading the simulator's shared memory every 2 seconds in order to calculate the state in which each CFST is at a given moment, as well as to maintain the CFST main screen updated.

As the future work, we will perform tests to the CFST operator aid system presented in this report. Afterwards, we will develop a Field Programmable Gate Arrays (FPGA) application for implementation of the CSFs status tree logic for a Westinghouse 3-loops NPP simulator.

References

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