

## On-Line Maintenance Scheduling and Risk Management - The EOOS Monitor<sup>®</sup> Approach

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**Abstract:** *It is known that Probabilistic Safety Assessment (PSA) can provide safety status information for a plant during different configurations; but additional effort is needed to do this in real time for on-line operation. This paper describes an approach to use PRA to achieve these goals.*

*Equipment Out Of Service (EOOS) tool was developed to monitor nuclear power plant safety from the probabilistic point of view. EOOS is using model developed from a full-scope PRA, and incorporates a user friendly program interface approach.*

*Results from EOOS can be used by planners or operations to effectively manage the level of risk by controlling the actual plant configuration.*

**Keywords:** Probabilistic Safety Assessment, on-line risk monitoring, maintenance

This paper will present approach used for development of the On-Line Risk Model for the Seabrook NPP inside the Equipment Out of Service (EOOS) Monitor software tool, and discuss obtained results and special EOOS Monitor capabilities.

The EOOS Monitor is a PC based tool, providing accurate and fast calculations of risk, in order to monitor nuclear power plant safety from the probabilistic point of view. The EOOS Monitor is designed for three types of users with separate distinct needs. Scheduler: user concerned with scheduling equipment outages, Operator: user concerned with current plant status, and Probabilistic Safety Assessment (PSA) Analyst: risk assessment analyst whose mission is to support scheduler and operator.

The EOOS software is developed by Science Application International Corporation (SAIC) to use and integrate available modules from EPRI's Risk and Reliability Workstation. PSA results could be included through minimal cut sets representation, complete model or a combination of these two approaches.

An advantage of EOOS is the easy transformation from an initial PSA model to an EOOS environment. EOOS can support different approaches in PSA: small event trees with big fault trees, or big/moderate event trees with small fault trees (support state approach). This means that all fault tree formats are supported (e.g., CAFTA, Riskman, Grafter, etc.). For the big fault tree approach, EOOS is designed to easily build the initial model, and to do recalculation directly. EOOS can also receive and include operational and scheduling information (i.e., events and activities).

Basically EOOS model is constructed from hierarchically structured data base relationships between different plant items. Types of items are: activity, test, system, train, clearance, component, and basic event. This is the base for evaluating a specific plant event with PSA model.

Figures included in this paper presents some important EOOS capabilities. Figure 1 shows EOOS screen for operators. With this safety panel EOOS can help operators to focus on safety. Operators panel shows: a numerical measure of plant safety that reflects changes in equipment status; the maximum time allowed in a particular plant configuration based on the plant safety value; the status of plant systems affected by various test and maintenance activities (i.e., provides "defence-in-depth" information); a list of current activities.

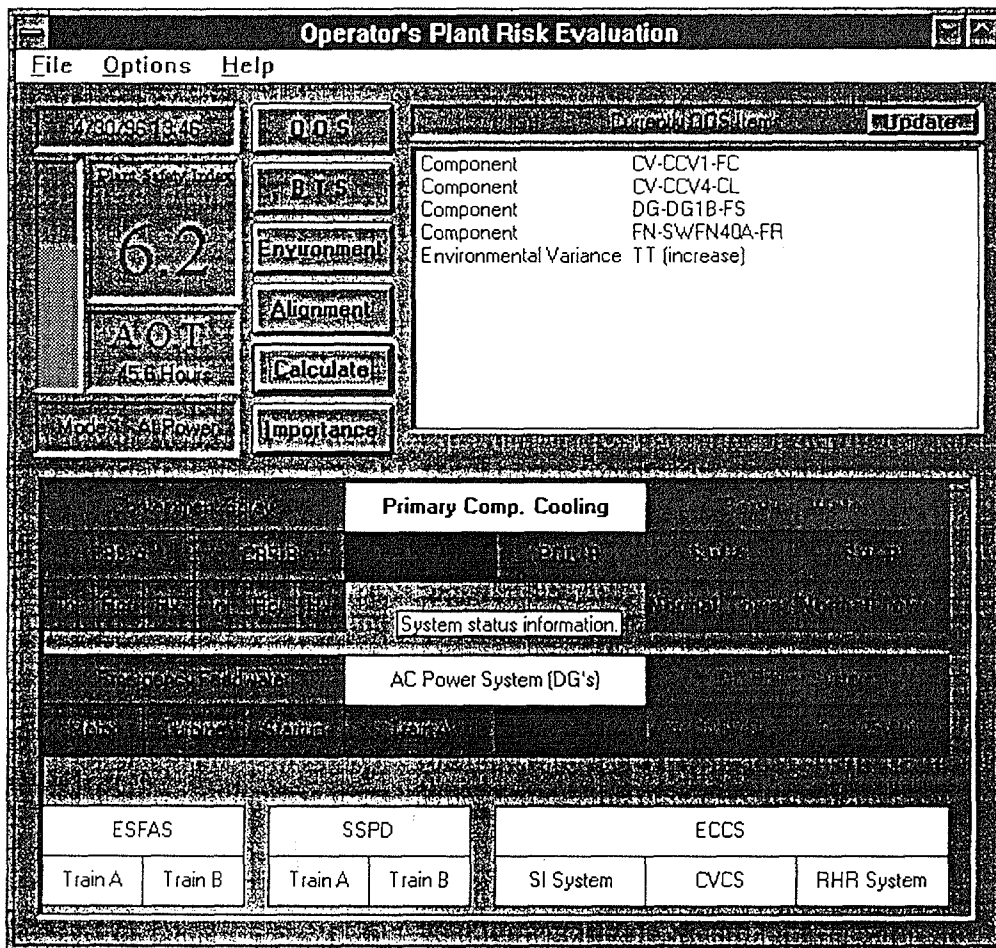


Figure 1. EOOS Screen for Operators.

Figure 2 shows how user can see more informations about components currently out of service. This graphical interface works also for entering informations about components out of service during operations.

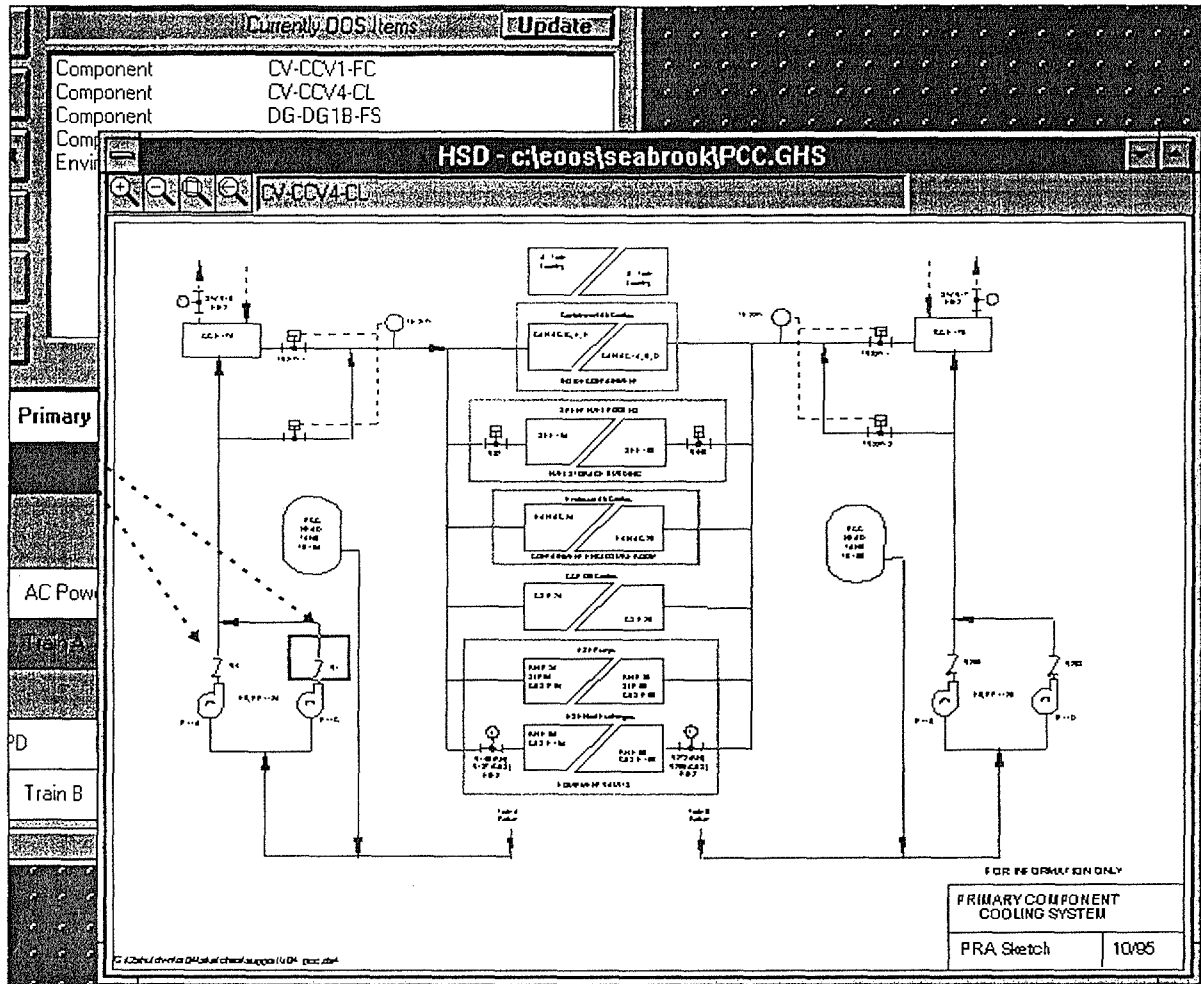


Figure 2. Connection between HotSpot P&ID and Operators Panel.

Results from proposed schedule of test and maintenance activities are visible on separate screen. Figure 3 shows all informations from schedule activities and influence to the plant safety. User can see proposed schedule of activities, separate impact of these activities to the plant systems, and final impact on the plant safety.

All these EOOS capabilities have serious request regarding effort for model preparation. We were able to transfer complete PSA model results for the Seabrook NPP to EOOS model. This includes following group of activities: initial PSA model changing, mapping database tables building, connecting P&ID with relevant basic events and fault trees gates, creating specific fault tree added for the operator panel purposes.

For the scheduling part it is also needed to make additional PSA model changes and build relevant mapping database tables (that is, activities, testing).

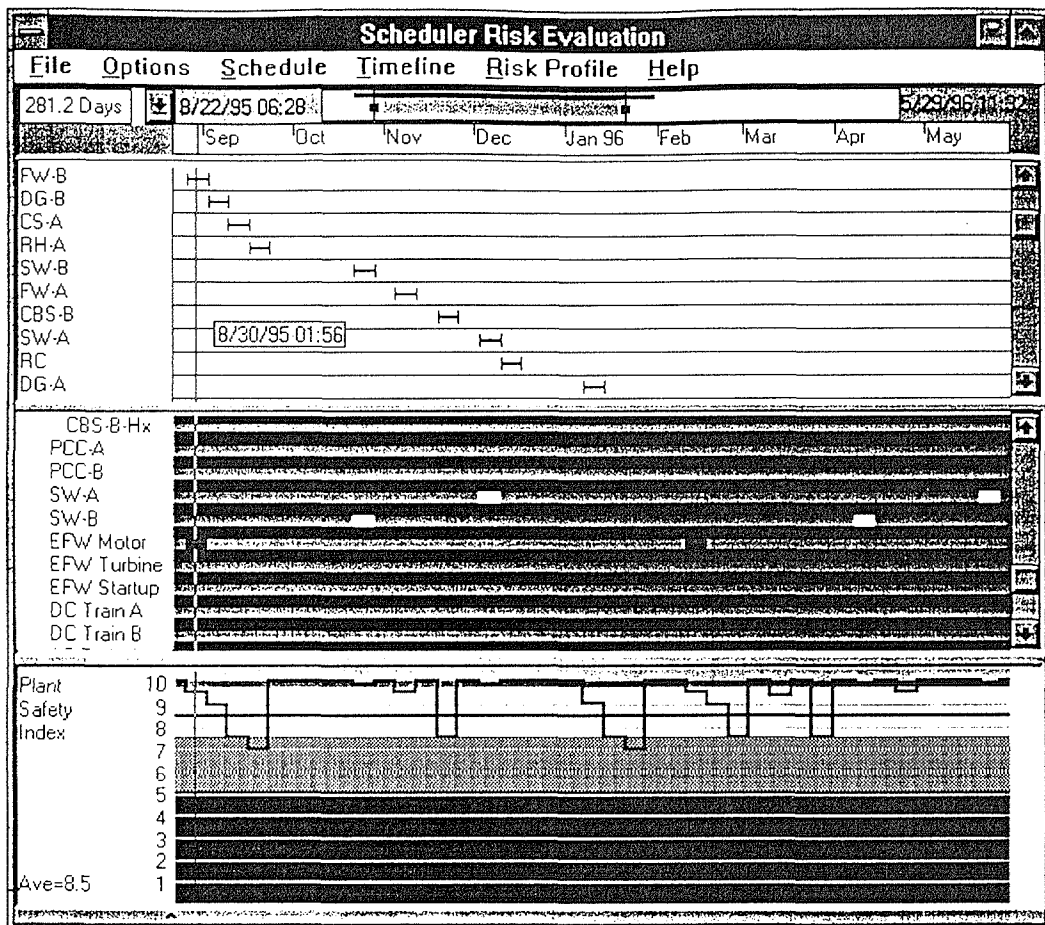


Figure 3. EOOS Scheduler's Display

Experience with EOOS is continuing with more complete model preparation and results testing. First results are promising.

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