Nondeterministic method to the analysis of the aging effects in PWR power plant components

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This report presents a methodology focusing on the analysis of the aging process of the Containment Spray Injection System [1]. This form of analysis is significant because it is capable of generating important data for the security of an installation and characterizing the components that should receive more attention during the operating time of a system.

Some nuclear power plants around the world have an advanced operating time. Within the operating time of 40 years, these plants should be subject to the decommissioning process. This process implies a considerable investment and the loss of an important source of energy. In addition to the issues of safety involved, this work is one of the pioneers in the search for methodologies that can ensure that the supervision, maintenance and replacement of components which are more sensitive to the "aging process" result in increased safety of an installation, and consequently, in the guarantee that it can extend its operating time.

The Spray System in conjunction with the ventilation system (Fan Cooler System) comprise a third and last barrier level safety system. Besides being responsible for temperature containment and control, these systems are connected to the pressure control (see WASH–1400 [2]). The Spray Containment System offers a mixture of cold water and boron through sprays from the Refueling Water Storage Tank (RWST) [3].

The first stage of the application of the methodology of the aging study of the Containment Spray Injection System consists in the cut sets selection that have greater importance to the system unavailability (89.87% of the system unavailability). The second stage of the aging analysis consists in attributing multipliers to the failure probability of these events and calculations of the system unavailability, allowing for the obtainment of a graph that shows the system unavailability progression due to the susceptibility of each of its components to the aging process (Fig.1).

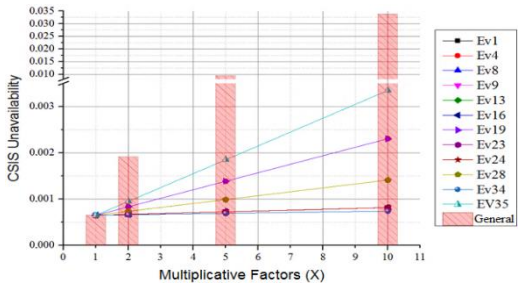

Figure 1: Behavior of CSIS Unavailability.

A simple way to analyze the effect of the aging on CSIS is to convert the failure probabilities of the cut sets which have greater importance to the system unavailability to percentage. Fig. 2 shows a graph with the variation percentage (based on the multipliers 2x, 5x, 10x) of failure probability of the components of the Containment Spray System which are most sensitive to aging.

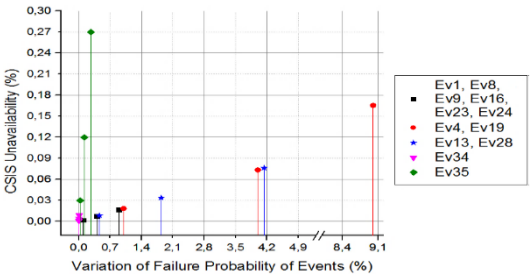

Figure 2: Progression Percentage of Unavailability of the CSIS.

With the method described it was possible to obtain functions, through non-linear regression methods, which govern the system behavior due to the variation percentage of the most sensitive components to the aging process, as well as to allow the use of the time factor as an implicit variable of a probabilistic safety analysis.

References

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