Reliability study of the auxiliary feed-water system of a pressurized water reactor by faults tree and bayesian network

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This paper aims to present a study of the reliability of the Auxiliary Feed-water System (AFWS) through the methods of Fault Tree and Bayesian Network. Therefore, the paper consists of a literature review of the history of nuclear energy and the methodologies used [1]. The AFWS is responsible for providing water system to cool the secondary circuit of nuclear reactors of the PWR type when normal feeding water system failure. How this system operates only when the primary system fails, it is expected that the AFWS failure probability is very low. The AFWS failure probability is divided into two cases: the first is the probability of failure in the first eight hours of operation and the second is the probability of failure after eight hours of operation, considering that the system has not failed within the first eight hours. The calculation of the probability of failure of the second case was made through the use of Fault Tree and Bayesian Network, that it was constructed from the Fault Tree. The results of the failure probability obtained were very close and also very low, on the order of 10^{-3}.

Figure 1: is a simplified diagram of the Auxiliary Feed-water System. Due to the need for AFWS, the three pumps, two electric and one turbine, can be started automatically or manually. This work made possible the study of two methodologies that are widely used today because of their ease of understanding and precision of results and, finally, they are applied to the Auxiliary Feed-water System.

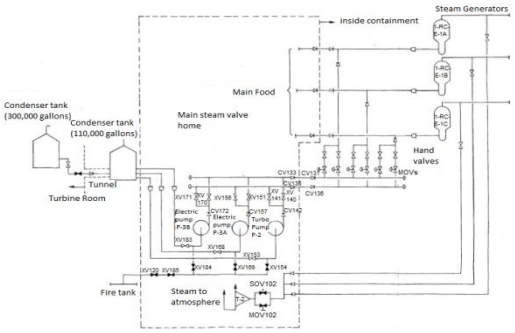

Figure 1. AFWS Simplified Diagram (Source: Nureg-75/01)

Figure 2 presents the Tree of the first case generated by SAPHIRE computational code.

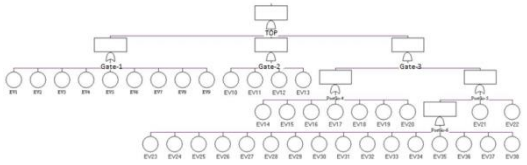

Figure 2. AFWS Fault Tree (first 8 hours of operation)

It has been confirmed that it is possible to obtain a Bayesian Network (BN) equivalent to the Fault Tree (FT), provided that the corresponding probability tables are constructed for each corresponding logical gate. It was verified that both the Fault Tree and the Bayesian Network presented very close results, differing only in the fourth decimal place of the probability of failure of the system in question. FT presented as a result that the system failure probability is 1.155×10^{-3}, whereas BN presented as a result 1.2×10^{-3}.

References

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