Reliability analysis in research reactors

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Fault trees and event trees are widely used in industry to model and to evaluate the reliability of safety systems. Detailed analyzes in nuclear installations require the combination of these two techniques. This dissertation uses the methods of fault tree (FT) and event tree (ET) to perform the Probabilistic Safety Assessment (PSA) in research reactors. According to IAEA (International Atomic Energy Agency), PSA is divided into Level 1, Level 2 and level 3. At Level 1, conceptually security systems perform to prevent the accident. At Level 2, the accident occurred and seeked to minimize the consequences, known as stage management of the accident, and at Level 3 consequences are determined. This thesis focuses on Level 1 studies, and searches through the acquisition of knowledge, the consolidation of methodologies for future reliability studies. The Greek Research Reactor, GRR – 1 was employed as a case example [1][2]. The LOCA (Loss of Coolant Accident) was chosen as the initiating event and from LOCA, it was being developed possible accidental sequences, using ET, which could lead damage to the core. Furthermore, for each of affected systems, the possible accidental sequences were performed and evaluated the probability of each event tops of FT. Estimates of importance measures for basic events are present. The studies were conducted using a commercial computational tool SAPHIRE.

We can note in the Figure 1 that the sequences of accidents that lead to damage to the core is 2 - 4 and 6 - 17. The results presented in the Table 1 refer to the top event of each system.

In this thesis, each accidental sequence analyzed, it consisted of the same event initiator, LOCA which is followed by failure or success of systems. All sequences were treated as accidental sequences, using Boolean Laws for results and information about the importance and the contribution of basic events for each affected system, and therefore they could cause damage to the core. The obtainable results were considered satisfactory either for performance or failure of systems.

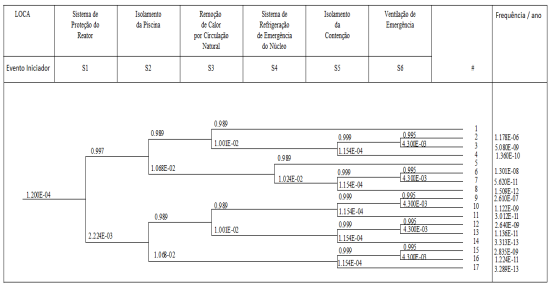

Figure 1. Event tree for the LOCA event initiator.

Table 1. Top event results

SAFETY SYSTEM	PROBABILITY
Reactor Protection System	2.227E-03
Pool Isolatio	1.068E-02
Heat Removal by Natural Circulation	1.001E-02
Emergency Core Cooling System	1.024E-02
Containment Isolation	1.154E-04
No Emergency Ventilation	4.300E-03

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