2021 International Nuclear Atlantic Conference – INAC 2021
Virtual meeting, Brazil, November 29 – December 2, 2021

ISBN: 978-65-594-1256-3

Methods, Approaches and Tools for Development and Application of Level 2 PSA for LPS

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1. Introduction

The use of Probabilistic Safety Assessment (PSA) to support the design, licensing and supervision of reactors is growing. Requirements are established in nuclear international recommendations. The Probabilistic Safety Assessment (PSA) is an effective tool to improve safety and refine nuclear plant operations. It must be executed in three levels and it is implemented in over two hundred nuclear plants around the world. PSA can be used to explore the significance of risk associated to many aspects of plant design or its operations, explore the impact on the risk due to design changes and to evaluate abnormal events that may occur inside the plant [1].

After the two most significant nuclear accidents in history, the Chernobyl Reactor Four explosion in Ukraine (1986) and the Fukushima Daiichi accident in Japan (2011), the United States Nuclear Regulatory Commission and other countries have included in the Final Safety Analysis Report (FSAR), a new chapter (19) dedicated to the Probabilistic Safety Assessment (PSA) and Severe Accident Analysis (SAA) with significant damage to the reactor core. The Safety Analysis Report (SAR) is the most important document used by a regulatory body to assess the adequacy of plant safety at all stages of the lifetime of a Nuclear Power Plant (NPP), and presents the licensing basis of a plant [2].

PSA aims to identify and delineate event combinations that may lead to severe accidents, the estimated probability of each final stage related to each event combination and the evaluation of consequences related. To execute this task, a PSA methodology integrates information on plant projects, operational practices, operation history, component reliability, human behavior, accident phenomenology and possible health and environmental effects.

A level 2 PSA added to a level 1 PSA also covers accident with damage to the reactor phenomena, as well as the containment response for possible loadings and transport of radioactive material from the damaged core to the environment. Those analyses provide information on the probability of accidental radioactive releases. Analysis can show the relative importance of events in terms of main concerns related to safety concerning possible radioactive release to the environment and allow the identification of important measures to be taken to mitigate the consequences of an accident [3].

Within the life stages of a nuclear plant, the low power and shutdown stages (LPS) have, according to studies, the equivalent level of associated risk to full potency stage risk. Therefore, specific attention must be paid to these two stages while executing a PSA.

An PSA for LPS has the following objectives: a) locate plant vulnerability during the specific plant stages and analyze risk impact on possible changes and improvements; b) analyze and provide feedback on maintenance shutdown or reactor fuel changes, and c) make recommendations for improvement of accident related procedures, maintenance and operations. Within the past several years the results of nuclear power plant operating experience and performance of PSAs for LPS operating modes have revealed that the risk from operating modes other than full power may contribute significantly to the overall risk from plant operations. These results have led to an increased focus on safety during low power and shutdown operating modes and to an increased interest in performing shutdown and low power PSAs. [4].

It is important to share information and content related to the nuclear sector, in order to acquire knowledge about the world scenario, understanding the challenges, recommendations and actions taken that may affect the future of Brazilian nuclear projects.

The scope of this paper is talk about the development and application of level 2 Probabilistic Safety Assessment for Nuclear Power Plants. It describes some methods and some tools that could be applied on the development and application of level 2 PSA for LPS stages.

References

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