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Alternative Method for Classification of Structures, Systems and Components for Dedication in Research Reactors

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1. Introduction

In 2020 more than 200 nuclear research reactors are in operation globally with a wide variety of designs, power levels and diverse purposes [1]. Unlike power reactors, the task of safety classification of Structures, Systems and Components (SSC) of research reactors is not simple [2]. Many countries, including Brazil, do not have clear regulations that set the criteria and discipline the classification process regarding research reactor safety. This lack of regulation causes designers to use the regulation of power reactors but given their peculiar characteristics, this alternative is often not suitable. The mission characteristic of research reactor operation, i.e, the fact that they are operated continuously only for short periods of days or weeks, makes safety requirements of power reactors very conservative, oversized and, in the end, costly when moving to the stage of manufacturing and acquiring the SSCs and building the research reactor. The SSC qualification process burdens the project to the point of making it financially unfeasible and often very difficult to implement.

Regarding SSC safety classification, the two most important safety conditions for a nuclear reactor are the ability to shut down the reactor at any time and keep the nuclear plant in a safe condition even after an accident has occurred. In order to meet these two conditions, all SSCs are classified according to their importance for reactor safety or significance for safety functions. The classification procedure must follow a clear and objective approach that allows a correlation with technical and quality standards [1-6]. The correct classification of SSCs is essential, as it defines its quality, design, manufacturing and testing requirements. Therefore, the safety rating is also directly related to project costs and schedules.

2. Alternative method for SSCs classification and possible dedication of commercial items for safety functions

The present work proposes an SSC classification method (see Figure 1) that allows the reactor designer generating the technical requirements necessary for both qualification and dedication of commercial items for use in reactor safety functions. Dedication is a process standardized in the USA and widely applied in the replacement of power reactor spare parts. The use of the dedication process has allowed savings of up to 80% in cost and 50% in delivery time for safety systems [5,6].

Figure 1 shows, in the first column, 7 steps to be taken by the reactor designer from the reactor design

phase to the implementation of the SSCs in the reactor plant. In the second column, support activities are associated, such as technical evaluations, simulations and necessary laboratory tests. Finally, the last column presents the technical requirements generated in each step of the process. Such requirements can be applied in a dedication process or even for qualification of the SSC studied in the specific context of the reactor.

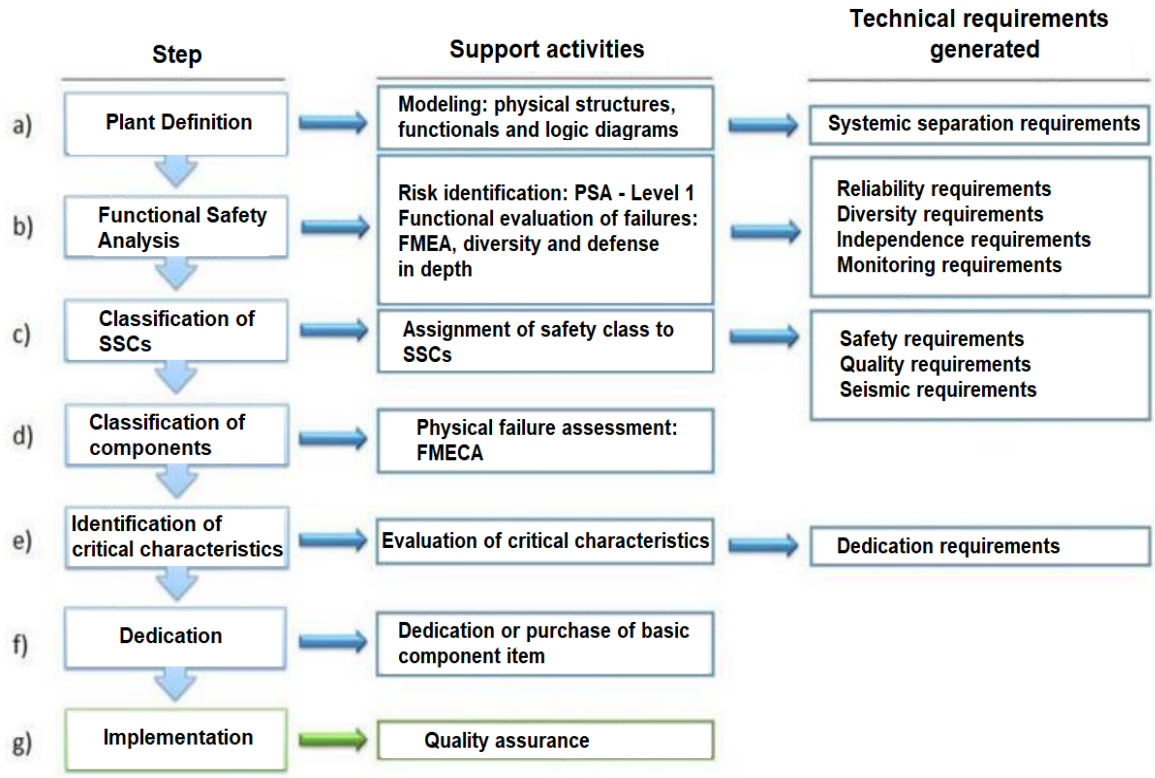

Figure 1 – Method for classification and generation of technical requirements for structures, systems and components (SSC).

The proposed safety classification method is thus concerned with demonstrating the origin of the technical requirements, and with showing the logical structure of the proposed method within the project up to the implementation stage. Consequently, it shows the possibility of using the dedication procedure to ensure the safety of SSCs due to less rigid characteristics for research reactors, in particular operation by time of short limited mission.

3. Conclusion

The task of safety classification of structures, systems and components of research reactors is not strictly defined and nuclear regulators recommend designers to adopt power reactors safety regulations to complement it. This procedure is often expensive, not practical and does improve safety due to the research reactors' much smaller power levels and short-term operation periods, when compared to power reactors. This alternative method for classification of safety related SSCs allows identifying technical requirements based on the mission characteristics and actual safety issues of research reactors. In addition, it makes possible the dedication of commercial items to perform safety functions, which

substantially reduces the cost of the project without compromising the safety of workers, public and the environment.

References

[1] KIM, T-R. Safety Classification of Systems, Structures, and Components for Pool-Type Research Reactors. Nuclear Engineering and Technology 48 (2016) 1015-1021, 2016.

[2] IAEA-RDS-2/37. Nuclear Power Reactors in the World. IAEA, Reference data Series N° 2, Vienna, Austria, 2017.

[3] VICENTE, S. M. G; PRINJA, N.; GALIARDI, M.; ROVERE, S.; PERRAULT D.; TAYLOR, N. Safety classification of mechanical components for fusion application. Fusion Engineering and Design 136 (2018) 1237-1241, 2018.

[4] KIM, I. S.; CHEON, S. W.; KIM, M. C. Nuclear equipment parts classification: a functional modeling approach. Annals of Nuclear Energy 30 (2003), 1677-1690, 2003.

[5] EPRI-NP-5652. ELECTRIC POWER RESEARCH INSTITUTE. EPRI NP-5652 and TR-102260. Plant Engineering: Guideline for the Acceptance of Commercial-Grade Items in Nuclear Safety Related Applications: Technical Report 2014. EPRI: Palo Alto, California, 2014.

[6] BUSSE, A. L.; MOREIRA, J. M. L.; OZEKI, T. Y. B.; SILVA, L. G. G. Avaliação sistêmica de tolerância a falhas em sistemas de proteção de reatores nucleares. Revista Tecnologia e Sociedade, v. 16, n. 42, p. 58-74, 2020.