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Seminarium Zakładu Energetyki Jądrowej i Analiz Środowiska (UZ3) Departament Badań Układów Złożonych (DUZ)

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dr inż. Karol Kowal

Integration of heterogeneous reliability data for DEMO-Oriented Neutron Source

Abstract:

The need for the qualification of materials to be used in fusion power reactors has been recognized for many years as an important part of the safety assessment and licensing process. The DONES facility (DEMO-Oriented Neutron Source) is being designed to operate an accelerator-based D-Li neutron source of sufficient intensity and irradiation volume to simulate the neutron flux and spectrum of the fusion reactors, thus creating the required conditions for materials testing. One of the main challenges of the DONES design development is reaching the high reliability and availability goals. This, in turn, requires overcoming the problem of heterogeneity of the existing databases containing information about the failure frequency of the fusion-specific components.

Usually, the component failure frequency is estimated by the data extracted from several sources of different content, structure, and accuracy. This is because the reliability databases are developed and shared by various organizations operating different types of facilities within various industry areas. Moreover, the data providers are in different geographical regions with specific regulations, cultures, and environmental conditions. Consequently, it influences the analysts, who must rely on their own judgment of how well the data correspond to reality and which source is to be preferred.

Under this work, a comprehensive method has been established to integrate the heterogeneous reliability data for fusion-specific components of the DONES facility. It makes use of several data sources of different content and structures developed independently by various organizations. The algorithm is based on the Monte Carlo method. The random sampling of reliability data coming from different sources is preceded by the selection of the relevant inputs, that can be reached automatically or by the expert's verdict. The sampling process proceeds with respect to the within-source and between-source uncertainty of the input data. As a result, the empirical probability distributions are generated for the failure rates of the relevant components that can be used in safety and reliability studies of DONES.

The analysis has been done by using the Fusion Component Failure Rate Database (FCFRDB) developed by Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA). This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom Research and Training Programme 2014-2018 and 2019-2020 under grant agreement No 633053. This project was co-financed by the program of the Polish Minister of Science and Higher Education entitled "PMW" in 2020; contract number 5119/H2020-Euratom/2020/2.

Serdecznie zapraszamy
M. Dąbrowski, T. Kwiatkowski
<http://www.phd4gen.pl>