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Preliminary Probabilistic Safety Assessment of Tokamak-type Fusion Power Plants In Conceptual Design Stage

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Owing to their inherent safety features and lacking of high level long-lived radioactive waste, fusion power plants have long been expected to be a safe, clean and ultimate solution for human energy crisis. Among all the fusion reactors, the tokamak-type fusion power plant (FPP) with deuterium and tritium fuels is considered to be one of the most promising fusion energy systems. However, there has been no probabilistic safety assessment for severe accidents of this type of FPP. Then how is the radiation risk of a tokamak-type fusion power plant in the viewpoint of severe accidents? This paper is such an effort to assess its radiation risk under the conditions of severe accidents in a risk way.

Since there is no reactor core in fusion power plants, core damage frequency concept from fission nuclear power plants cannot be adopted as the risk metric for fusion power plants. But the frequency of large off-site release of radioactive material could be a possible effective risk metric, as there will also be specific radioactive material release in the accidents of a fusion power plant. According to the recommendations of international atomic energy agency, a large release of radioactive material can be specified in a way as a specified dose to the most exposed person off the site. Therefore, a large release concept could be defined for fusion power plants.

On the basis of this large release concept, preliminary probabilistic safety assessment was applied to the safety design concept of a typical FPP based on the European fusion power plant conceptual study. This complex assessment work is finished with the assistance of reliability and probabilistic safety assessment program RiskA developed by FDS Team. Not only the total large release frequency of a fusion power plant was calculated, but also representative large release accident sequences initiated from specific accident types of a fusion power plant were identified. And their characteristics in happening frequencies, radioactive material release fractions, releasing time were analyzed and compared. Results showed that fusion power plants were not so safe as public's imagination. There are still accident sequences which would arise significant radiation risk, although inherent safety features exist in the tokamak-type FPP.

Eligible for student paper award?

No

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