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FTP/P7-27: Analysis of Consequences in the Loss-Of-Coolant Accident in Wendelstein 7-X Experimental Nuclear Fusion Facility

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Fusion is the energy production technology, which could potentially solve problems with growing energy demand of population in the future. Starting 2007, Lithuanian energy institute (LEI) is a member of European Fusion Development Agreement (EFDA) organization. LEI is cooperating with Max Planck Institute for Plasma Physics (IPP, Germany) in the frames of EFDA project by performing safety analysis of fusion device W7-X. Wendelstein 7-X (W7-X) is an experimental stellarator facility currently being built in Greifswald, Germany, which shall demonstrate that in the future energy could be produced in such type of fusion reactors. The W7-X facility divertor cooling system consists of two coolant circuits: the main cooling circuit and the so-called "baking"circuit. Before plasma operation, the divertor and other in-vessel components must be heated up in order to "clean"the surfaces by thermal desorption and the subsequent pumping out of the released volatile molecules. The rupture of pipe, providing water for the divertor targets during the "baking" regime is one of the critical failure events, since primary and secondary steam production leads to a rapid increase of the inner pressure in the plasma (vacuum) vessel. Such initiating event could lead to the loss of vacuum condition up to overpressure of the plasma vessel, damage of in-vessel components and bellows of the ports. In this paper the safety analysis of 40 mm inner diameter coolant pipe rupture in cooling circuit and discharge of steam –water mixture through the leak into plasma vessel during the W7-X no-plasma "baking" operation mode is presented. For the analysis the model of W7-X cooling system (pumps, valves, pipes, hydro-accumulators, and heat exchangers) and plasma vessel was developed by employing system thermal-hydraulic state-of-the-art RELAP5 Mod3.3 code. This paper demonstrated, that the developed RELAP5 model allows to analyze the processes in divertor cooling system and plasma vessel. The results of analysis demonstrated that proposed burst disk, connecting the plasma vessel with torus hall, opens and pressure inside plasma vessel do not exceed the limiting 1100 kPa absolute pressure. Thus, the plasma vessel remains intact after loss-of-coolant accident during no-plasma operation of Wendelstein 7-X experimental nuclear fusion facility.

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