IVMR

In-Vessel Melt Retention Severe Accident Management Strategy for Existing and Future NPPs

OBJECTIVES

The stabilization of molten corium is necessary to reach a safe and stable state following a severe accident. Among the possible options, In-Vessel Melt Retention (IVR) appears as an attractive solution that would minimize the risks of containment failure (less Hydrogen produced, no corium-concrete interaction), if it can be proved to be feasible. Current approaches for reactors with relatively small power, such as VVER 440 or AP600, use conservative assumptions. However, for higher power reactors (around 1000 MWe), it is necessary to evaluate the IVR strategy with best-estimate methods in order to address the uncertainties associated with the involved phenomena. Additional R&D is needed to ensure and demonstrate adequate safety margins, including identification of efficient technical solutions for the external cooling of the vessel and performing best-estimate evaluation of relevant scenarios. The goal of the project is an analysis of the applicability and technical feasibility of the IVMR strategy to high power reactors, both for existing ones (e.g. VVER 1000 type 320 units) as well as for future reactors of different types (PWR or BWR). The main outcomes of the project will be new experimental data to justify relevant assumptions and scenarios to estimate the maximum heat load on the vessel wall. Additional outcomes will be improved numerical tools for the analysis of IVR issues and a harmonized methodology on the IVR strategy.

DESCRIPTION OF WORK

The strategy is already adopted for the VVER-440 type 213 based on thorough research work for the Finnish Loviisa NPP and eastern Europe NPPs in Slovakia, Hungary and Czech Republic. It is also included in the design of some new Gen III reactors like AP-1000, APR1400 and Chinese CPR-1000. It has also been studied in the past for other reactor concepts like KERENA (BWR) or VVER-640.

The scope is to provide a common approach to analyze the safety margins of IVR of all types of reactors and to establish a harmonized methodology to make easier the analyses made by safety authorities or their technical support organizations

MAIN RESULTS / HIGHLIGHTS

Considering the benefits of an efficient IVR strategy, it is now important to review the concept at the light of recent knowledge gained about corium behavior and about new technologies or devices that could improve the efficiency of IVR (like a simultaneous in-vessel injection of water, or a passive system to delay the arrival of molten corium or technological modifications to increase the CHF). This work should be beneficial for different reactor designs, taking advantage of the fact that the principle is the same and only few differences exist (mass inventory of the molten corium, shape of the vessel, presence of vessel penetrations, etc.). This work should also be usable by different end-users thanks to the establishment of a harmonized approach and the development of common models in codes used for safety studies.

- New experimental data from prototypic material, small-scale, stratified pool experiment
- New experimental data from large scale experiments of stratified pool with simulant materials
- New experimental data about external cooling of a full-scale semi-elliptical vessel
- Improved models for codes
- Harmonized and improved methodology

DURATION

1 June 2015 – 31 May 2019
4 years

PARTNERS

IRSN / UJV/ JRC / CEA / KTH / KIT / CEA / AREVA / / EDF / GRS / HZDR / FORTUM / VTT / MTA-EK / NUBIKI / IVS / ENEA / LEI / TRACTEBEL / Imperial College/ NRG / INRNE / CVR / NCBJ

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This project has received funding from the Euratom Research & Training programme 2014-2018 under grant agreement N°662157.