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# French Post-Fukushima Complementary Assessments –General Approach and Resulting Safety Improvements for the High Flux Reactor located in Grenoble

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Following the accident that occurred on the Fukushima Daiichi nuclear power plant on the 11th March 2011, the French Prime minister asked the national nuclear safety authority (ASN) to engage a targeted reassessment of the safety of every basic nuclear facility with the aim of evaluating their capacity to withstand extreme situations beyond design basis assumptions. These specific reassessments, called Complementary Safety Assessments (CSAs), were mainly carried out by operators in 2011 on the basis of the specifications for the stress tests requested by the European Council. In France these evaluations included all nuclear power plants in operation but also nuclear cycle facilities and research reactors.
The CSAs have been carried out with the purpose of analyzing the robustness of the nuclear facilities regarding :
• natural hazards more severe that ones retained for its design;
• specific situations such as long-term loss of cooling and loss of electrical power supplies.
The paper will present the analysis performed by french operators in the framework of CSAs and the opinion of the Institute of Radioprotection and Nuclear Safety (IRSN) which has been largely involved in the reviewing of the CSAs carried out by licensees. In particular the paper will present the opinion of the IRSN on the assessment of the robustness of facilities by operators.
Then, the paper will introduce the concept of "hardened safety core"firstly defined by IRSN on the basis of the conclusions of its CSAs critical review. The "hardened safety core"is a set of structures and equipment identified to withstand natural extreme hazards as earthquake and flooding, completed by crisis management measures. The identification of provisions to be included in "hardened safety core"must be done with respect to the "defence in-depth"principle considering the prevention of the occurrence of accident situations, whilst assuming they may still occur, thus envisaging the implementation of appropriate systems to manage them including provisions for crisis management actions. For research reactors, the definition of a "hardened safety core"must consider the potential of danger of each facility (graduated approach).
Finally the paper will present a concrete application of the a "hardened safety core"based on the example of the High Flux Reactor (RHF) research reactor, operated by the Laue-Langevin Institute, at Grenoble (France). The RHF is an interesting example firstly because the reactor is located in a strong natural hazards area (high earthquake and flooding risks) and secondly because of the relative proximity of the ILL site from urbanized zones. The paper will focus on the modifications suggested by the operator and the conclusions of the review of these propositions done by IRSN between 2012 and 2014. The improvements already achieved in the facility and those that are still in progress will be presented, showing how these improvements answer to the objective of controlling the main vital safety functions (cooling of the reactor, confinement of radioactive materials, crisis management) in exceptional - but nonetheless conceivable - situations.

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