

## Highlights of Safety Enhancements of Research reactors Based on Safety Reassessments following the Fukushima-Daiichi Accident

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Following the Fukushima-Daiichi NPP accident which occurred on 11 March 2011, specific safety reassessments (called Complementary Safety Assessments or Stress Tests) were initiated in many countries for research reactors on requests of the regulatory bodies or decisions of the operating organizations. Their main objective was to take into account the feedback and preliminary lessons learned from this accident, which cover technical and organizational aspects, including in particular the design of the facilities against extreme hazards associated with the site, the emergency preparedness and the regulatory oversight.

The focus of the specific safety reassessments was mainly to evaluate the robustness of the research reactor facilities against extreme but credible hazards which are more severe than those adopted for the design, and to address the defense in depth, the performance of the basic safety functions as well as the continuity of the facility monitoring function in such conditions. The methodology established by the IAEA for performing post Fukushima safety reassessments of research reactors was aimed at ensuring consistency and avoiding non justified discrepancies in the approaches adopted in different Member States. This methodology is based on a deterministic approach and consideration of combination of events and possible interactions with other facilities at the site.

The paper will present, on the basis of available information at the international level, a general overview on the safety reassessments performed for research reactors with a main focus on safety enhancements, including:

- Modifications of the facilities to enhance their robustness against extreme external hazards, such as the reinforcement of reactor buildings against earthquakes, implementation of additional monitoring instrumentation including seismic detectors with associated action to shut down the reactor, implementation of an emergency control room from which it will be possible to shut down the reactor, to monitor important safety parameters and to control the operation of important safety systems in case of non-availability or non-accessibility of the main control room, provision of portable electrical power supply systems to operate items important to safety in case of a total blackout, implementation or improvement of emergency cooling systems to prevent potential fuel damage in case of a LOCA;
- Consideration of Design Extension Conditions in the safety analyses and improvement of the consistency of analyses related to site specific extreme hazards;
- Emergency plan and associated equipment and procedures for mitigation of severe accident consequences.

The paper will present the above elements in detailed manner and include considerations on the use of a graded approach in performing the post Fukushima safety reassessments and on the follow up of implementation of the resulting safety enhancements.

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