

Mr Vincent Roux CEA France Findings and results of safety reassessments and safety improvements on the ORPHEE research reactor

The Orphée reactor is a 14 MWth research reactor located at the CEA center in Saclay, France. The main function of the reactor is to supply neutron beams for fundamental research. The reactor first went critical on December 19th, 1980. Periodic safety review (PSR) and post-Fukushima stress tests have been conducted on the reactor over the past few years. Since the commissioning of the reactor, the Orphée reactor has gained experience in conducting PSRs and implementing safety improvements. The second PSR was released in 2009. The on-going third PSR will be submitted to the ASN in 2019. The safety reassessments are realized to verify that the reactor is operated with a good level of safety, meaning that the reactor is in conformity and that the safety cases still meet the requirements even after the evolution of regulation and safety analysis standards. For the Orphée reactor, the findings from the conformity analysis and the safety reassessments have resulted in the implementation of both operational improvements and safety related equipment. After the Fukushima accident, in respect with the regulatory requirements, the safety margins to reach and maintain safe state have been evaluated for extreme external hazards and relevant cumulative losses. For the Orphée reactor, a hard core of robust equipment has been defined for the monitoring of a safe state in extreme situation. The robust design of the Orphee reactor enables to withstand long time loss of heat sink or loss of electrical power thanks to passive residual heat removal design and important inertia of the water capacities. Regarding external hazards, the site of Saclay has a low seismicity risk. The safety improvements mainly consisted in the implementation of reactor emergency shutdown on seismic signal, implemented to strengthen the control rods drop in case of extreme seism. An ultimate emergency control panel with the report of minimal information for the monitoring of safe state has been installed in a local with sufficient seismic margins. This paper will describe the relevant findings from the periodic safety reassessment and post-Fukushima stress tests, and safety improvements that were implemented on Orphee reactor to fulfill the requirements of safety levels from the regulatory body.

Mr Gilbert Rouviere CEA France Identification and implementation of a hardened core in a research reactor in light of the lessons learned from the Fukushima Daiichi accident.

The JHR case. The JHR reactor is a new high performance MTR (Material Testing Reactor) working as an International User Facility in support to Nuclear Industry, Public Bodies and Research Institutes. This new facility of a maximum power of 100 MWth will allow to reproduce on a small scale real power plant conditions and in some cases, more severe conditions for Material screening (comparison of materials tested under representative conditions), Material characterisation (behaviour of one material in a wide range of operating conditions, up to off-normal and severe conditions) and fuel element qualification (test of one / several fuel rods (clad+fuel)). Its construction began in 2009 after getting the authorization by French Regulatory Body (ASN) with the best safety design specifications of the moment. Following the Fukushima Daiichi accident as a consequence of the earthquake and tsunami occurred on 2011 March 11th, the French government asked all French nuclear facilities to perform complementary safety assessments to meet objectives under extreme situations exceeding licensing basis (with focus on "cliff-edge" effect prevention). JHR, which was under construction, provided its report on 2011 September 15th. Conclusion JHR, the new high

performance MHR under construction in France has taken into account the lessons learned from Fukushima Daiichi accident. After stress test evaluation, a Hardened Core of material dispositions was decided by ASN based on a CEA proposal, constituted by already designed SSC and new SSC. New methodologies have been defined to guarantee Hardened Core SSC operation in post Fukushima situation preventing a severe accident or limiting its progression, limiting large-scale releases in the event of an accident which is not possible to control, enabling the licensee to perform its emergency management duties. The completion of Hardened Core implementation on JHR will be performed without start up schedule modification.

Mr Jean-Sebastien Zampa CEA France Safety Reassessment of OSIRIS Reactor in the light of Fukushima Daiichi Accident

A safety reassessment was carried out on the OSIRIS reactor, immediately following the Fukushima Daiichi accident. The margins were evaluated for severe external events such as earthquakes or flooding. The additional effects of the loss of electrical supply and of the ultimate heat sink were also analyzed. On the basis of these evaluations improvements were chosen to reinforce potential weak points and avoid cliff-edge effects. These improvements were technical and organizational, including procedures, human resources, emergency response organization or use of external resources. Most modifications were implemented during the years 2013 and 2014. A further periodic safety reassessment is under preparation. It will include an analysis of the lessons learnt from past operations, conformity analyses and new safety studies to comply with new safety standards and new French regulations and requirements. The reassessed safety demonstration will also take into consideration the diminution of nuclear risks after OSIRIS reactor was definitively shut down at the end of the year 2015 and will include those related to the preparation of dismantlement activities.