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#05-32 The analysis of different physical mechanisms during cladding failure evolution and detection in sodium cooled fast reactors

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To keep the dependability of Sodium Cooled Fast Reactor, the "clean sodium concept"is demanded, which means that the sodium is free from contamination. The release of fission products is searched for by a contamination measuring system. We need to have a comprehensive description of cladding failures and the detection of contamination, including the failure occurrence on the fuel pin, the transfer process through the sodium and cover gas, the measurement efficiency, etc. We aim to identify the important parameters of physical phenomena, with modelling and simulations based on the return of experiments from past reactors such as Phenix. There have been a total of 15 open pin failures in Phenix reactor. Through studying these detected signals, we can get a better physical explanation and description of the evolution of failures.

The detection system is related to different stages of the evolution of fuel pin, with different types of fission products, various release mechanism and physical properties. During the evolution of the failed fuel pin, gaseous fission products is released on the first stage of failure followed with other fission fragments including delayed neutron precursors. There are two main parts of the whole detection system. DRG (Détection des Ruptures de Gaine) system is functioned for detecting the crack of the cladding, with only gaseous fission products release. DND (Détection des Neutrons Différés) system is functioned for ruptures with solid fission products leakage.

We propose a block diagram that identify the physical phenomena occurring at each stage of the detection system, and have a focus on two parts for illustration. For gas signal, we propose a qualitative modeling of transfer function to describe the time broadening of the gas release from the fuel pin to the detector. The result matches well with Phenix experiment data, with the same order of magnitude of the time broadening and the same shape of exponential decreasing. For delayed neutron measurement, we study the complex evolution inside the fuel pin to interpret the different release mechanism and neutron signal variation.

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