Contribution ID: **8** Type: **Oral Presentation**

#8-8 SAIGA: a highly innovative instrumented in-pile experiment dedicated to measuring the events occurring during an Unprotected Loss Of FLow-type severe accident in a Sodium Fast Reactor

Thursday, June 12, 2025 2:20 PM (20 minutes)

In case of a severe accident in a Sodium Fast Reactor (SFR), several successive physical phenomena, such as temperature rise, sodium boiling, in-vessel pressure increase, relocation of UO2 molten core and neutron fluxes evolution, are coupled. These phenomena can lead to power excursions. In order to inhibit potential power excursions in SFR core in the case of a hypothetical severe accident, in-core mitigation devices have been designed. One of these devices is the discharge tube, whose aim is to relocate core molten materials towards a core-catcher placed in the bottom part of the reactor vessel, and thus prevent prompt criticality. Among the three main possible severe accident scenarios, CEA decided to focus on the Unprotected Loss Of Flow (ULOF). Even if large number of experiments have already been conducted in CABRI reactor through SCARABEE tests program, several gaps in experimental knowledge were identified.

In that context, CEA and NNC-RK are jointly preparing an in-pile test under the SAIGA (Severe Accident In-pile experiments for Gen-IV reactors and the Astrid prototype) program. The goal is to study the degradation of the SFR fuel sub-assemblies during the ULOF phase in the case of multi-sector test. Two fuel sub-assemblies composed of 16 fuel pins with different enrichments allow getting two different powers, while one sector filled with sodium (without fuel) corresponds to a corium discharge tube. The test device currently under construction will be hosted within the Impulse Graphite Reactor (IGR) operated by NNC-RK in Kazakhstan, and is scheduled for experimental testing by the end of 2025. A sodium loop will be connected to the in-pile device to bring sodium flow inside the in-pile test device. The main objectives of this SAIGA experiment are:

- to improve our understanding of mitigation strategy in case of degradation of the SFR fuel during the ULOF phase;
- to enrich the experimental database needed to validate the mechanistic scientific computational tool named SIMMER-V within the SEASON platform dedicated to the simulation of SFR core degradation during severe accidents.

From the experimental point of view, the SAIGA test will be carried out in two phases: a first phase which aims to reach a nominal steady state of SFR, followed by a second one corresponding to the ULOF event. While the liquid sodium is circulating at 400°C within the test section, the IGR will quickly reach its nominal power in order to bring the test section into a thermal equilibrium representative of SFR nominal thermal hydraulics conditions. This first phase during which steady state is reached is estimated to last about 10 seconds. While maintaining reactor power, the sodium flow rate will be progressively reduced, leading rather quickly to sodium boiling (estimated to occur less than 10 seconds after starting the progressive shutdown of sodium pumps). The degradation of the fuel, before the breakthrough of walls between fuel sub-assemblies and discharge tube, is estimated to occur between 5 and 10 seconds later.

In order to record the various physico-chemical events occurring at a rather high frequency and collect precious experimental data, special attention is being paid to the instrumentation of the SAIGA test section. Despite very strong constraints in terms of pressure, temperature, tightness and available space, the SAIGA test section will include a large number of different types of sensors, which will be detailed in this article. Some of these, such as the Optical Fiber Bragg Grating sensors helically wounded around the fuel pins in place of the spacer wire, are highly innovative and exposed to high levels of radiations never experienced

before. The introduction of each type of sensor is also justified in terms of events predicted by the SIMMER-V code.

Primary author: Dr CHAROLLAIS, François (CEA, DES, IRESNE, DTN, Cadarache, F-13108 St Paul Lez Durance, France)

Co-authors: Dr DE IZARRA, Grégoire (CEA, DES, IRESNE, DER, Cadarache, F-13108 St Paul Lez Durance, France); Mr BLEVIN, Gwendal (CEA, DES, IRESNE, DTN, Cadarache, F-13108 St Paul Lez Durance, France); Dr MICHEL, Frédéric (CEA, DES, IRESNE, DTN, Cadarache, F-13108 St Paul Lez Durance, France); Dr DUFOUR, Emmanuelle (CEA, DES, IRESNE, DER, Cadarache, F-13108 St Paul Lez Durance, France); Dr TROTIGNON, Laurent (CEA, DES, IRESNE, DTN, Cadarache, F-13108 St Paul Lez Durance, France); Dr GUBERNATIS, Pierre (CEA, DES, IRESNE, DTN, Cadarache, F-13108 St Paul Lez Durance, France); Dr LEJEAIL, Yves (CEA, DES, IRESNE, DTN, Cadarache, F-13108 St Paul Lez Durance, France); Dr QUAINI, Andrea (CEA, DES, IRESNE, DER, Cadarache, F-13108 St Paul Lez Durance, France); Dr MAURIN, Laurent (Université Paris-Saclay, CEA, LIST, F-91120 Palaiseau, France); Dr BLANCHET, Thomas (Université Paris-Saclay, CEA, LIST, F-91120 Palaiseau, France); Dr BATYRBEKOV, Erlan (NNC-RK, Kurchatov, Kazakhstan); Dr VURIM, Alexandr (NNC-RK, Kurchatov, Kazakhstan); Dr PAKHNITS, Alexandr (NNC-RK, Kurchatov, Kazakhstan); Dr BAKLANOV, Viktor (NNC-RK, Kurchatov, Kazakhstan)

Presenter: Dr CHAROLLAIS, François (CEA, DES, IRESNE, DTN, Cadarache, F-13108 St Paul Lez Durance, France)

Session Classification: #08 - Severe Accident Monitoring

Track Classification: 08 Severe Accident Monitoring