

# Post doctorate position proposal

## PERSUR project of GIS S3GS University of Technology of Troyes, Charles Delaunay Institute French Atomic Energy Commission CEA, DER/SESI/LCFR - Cadarache

### Project leaders

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**Location :** University of Technology of Troyes, some travels and stays to Cadarache.

### PERSUR project presentation

Within the framework of the design of GEN IV nuclear reactors, the insertion of safety systems based on passive function (gravity, natural convection, conduction...) is strongly encouraged. For a passive system, its priming and then the execution of its mission depend on the state on its components but also on the characteristics on the moving fluid and on the state of the environment. In this context, the tools and methods developed for the analysis of behaviour and performances of active systems are not anymore adequate and different works have been carried out in order to propose more adapted methodologies:

- RMPS project (*Reliability Methods for Passive Systems*) of the 5th European Framework Programme, coordinated by the CEA/LCFR ;
- A similar methodology by MIT/CANES ;
- APSRA approach by the BARC Institute in India.

One of the tools used in the safety demonstration is the Probabilistic Safety Assessment (PSA). The current standard of level 1 PSA (associated with the risk of reactor core damage) is a Boolean approach based on an analysis of scenarios (represented by event trees) and failure analysis of components (Modelled by fault trees). As part of the nuclear systems of the 4<sup>th</sup> generation, the use of passive systems is envisaged for some accidental sequences upon the occurrence of an initiating event. In this case, the current standard model has limitations:

- The need to model the degraded performance of a thermal-hydraulic passive system may involve introducing nodes in the event tree with many branches (more than 5), which can lead to a combinatorial explosion of possible sequences;
- An alternative is to consider a single event in the event tree accounting for all possible scenarios up to core damage. That is to change the modelling difficulty in the PSA into an analysis of uncertainty propagation in a system code modelling the behaviour of the nuclear reactor. Given the complexity of these codes and the large number of uncertainties sources, such analysis is seldom workable.

So a methodology remains to be built for these situations. A promising hint is the field of dynamic reliability. In recent years, the theoretical foundations of the dynamic reliability have been elaborated, the first software tools appear and assessment of this methodology on industrial examples is conceivable.

As part of building a comprehensive methodology for assessing the impact of thermal hydraulic passive systems on safety, the PERSUR project proposes to answer the following questions (work of postdoctoral researcher with its support):

- Improve the RMPS methodology, enriching it with points of the methodologies developed by MIT and the BARC;
- Assess the applicability and relevance of dynamic reliability in PSA.

A first version of the Probabilistic Safety Assessment was conducted by the CEA/LCFR, and a set of data for thermal-hydraulic CATHARE code is available. To perform this work, postdoctoral researcher will be trained to the CATHARE code and to the Spectrum Risk Software in Cadarache (CEA / LCFR).

### **Candidate background**

Knowledge in dependability (even on Probabilistic Safety Assessment) is necessary to participate to this project. Practicing probabilistic approaches and statistical tools will also be very useful. Skills in mechanical / thermal (hydraulic) or general physics (or engineering processes) will be appreciated but not mandatory. A practice of numerical simulation is also necessary in order to be able to analyze results at best during the work.

### **Selection process**

Curriculum vitae should be sent to the contact indicated below. After receipt, additional items may be required (recommendations). A first selection will be made on the basis of this information. An audition of the best candidates will be held at the UTT videoconferencing with CEA / LCFR.

### **Salary**

1800 Euros (possibility of 2135 Euros for foreigners)

### **Contact**

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