

## **Post-doctoral subject on:**

# **Processing of aleatory and epistemic uncertainties in nuclear safety applications**

## **ISSUES**

Nuclear safety analyses are partly based on statistical computations giving in particular confidence intervals on safety margins, probabilities of exceeding safety criteria or the importance of the input uncertain parameters through sensitivity analyzes. The input uncertainties involved in these studies can be classified into two broad categories: the aleatory uncertainties, which represent the intrinsic randomness of a phenomenon, irreducible in nature and the epistemic uncertainties, which are reducible uncertainties resulting from a lack of knowledge.

Hitherto, in these safety studies, the two types of uncertainties are usually not distinguished, and they are all processed within the same probabilistic framework involving their modeling by probability density functions and their propagation by random sampling techniques. However, if the choice of probabilistic framework is justified for aleatory uncertainties for which sufficient data enable their modeling by probability density functions, it can be questioned for epistemic uncertainties, for which their characterization is only based on the expert opinion. For these epistemic variables, a more suitable framework, corresponding to the non-probabilistic concepts, should be investigated.

## **WORK CONTENT**

The objective of the work will be to implement extra-probabilistic methods such as, interval analysis, p-boxes modeling, possibility theory or Dempster-Shafer theory of evidence, for processing epistemic uncertainty in the context of nuclear safety numerical models. It will consist, in the one hand to define a satisfactory modeling for these epistemic uncertainties, and in another hand to develop an effective methodology to propagate both these epistemic uncertainties and the aleatory uncertainties. Two major difficulties are present and justify a post-doctoral work:

- The high cpu-time cost of the numerical model, that makes the sampling step difficult (only several hundreds of model evaluations are possible),
- The large number of the epistemic uncertain variables (several tens).

The final objective will be to obtain a relevant characterization of the quantities of interest (typically a 95%-quantile) for decision-making in nuclear safety analyzes.

The main application case will concern a loss-of-coolant accident (LOCA) in a pressurized water nuclear reactor. Other possible applications may concern severe accident situations analyzes and Probabilistic Safety Assessment of new fast sodium cooled reactors.

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