

# 2025 Nuclear Global Internship Job Description

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## 1. Basic Information

- Expected Internship duration: *6 months (or more)*
- Internship Area/Topic: *Thermal-Hydraulics, CFD simulation, applied to PWR core*
- Division/Department Placement: *CEA - IRESNE/DTN/STCP/LTHC at CEA-Cadarache center*
- Supervisor's contact information: *Fabrice FRANCOIS, [fabrice.francois@cea.fr](mailto:fabrice.francois@cea.fr)*

## 2. Responsibilities

- 1) Main Purpose: *Modeling boiling flow for PWR thermalhydraulic conditions - A new approach using a 4 equations local time-averaged mixture balance model*

*For some incidental conditions, boiling may occur in PWR reactors and can lead to boiling crisis phenomenon. Classical approach for predicting the critical heat flux for which boiling crisis triggers uses correlations whose inlet parameters are area-averaged quantities like the thermodynamic quality, the mass flux...*

*In order to improve the accuracy of those correlations but also to extend their validity ranges, CEA and eDF are developing a novel approach called the Predictive Local Approach (PLA). It consists in replacing correlations using area-averaged variables by correlations built using local thermal hydraulic parameter, at CFD scale. However, to be successful, this method requires a highly validated CFD tool, especially for the involved thermal-hydraulic conditions e.g. high pressure and high temperature. The reference numerical tool is the well-known two-fluid model (3 balance equations written for each phase plus additional equation for interfacial area concentration transport) that can be encountered in many CFD tools (Fluent®, CFX®...). But despite being developed for several decades, this model is still far from being validated for the aforementioned thermal hydraulic conditions. Some closure relations (turbulence, interfacial heat and mass transfer...) are still questionable. Since several years, CEA started to develop an alternative methodology by replacing the two-fluid model by a simpler model, which is based on 4 balance equations written for the mixture. This new model (Kledy et al., 2021) is an extension to a 3D formulation of the very well-known 1D Drift Flux model.*

*Kledy et al., 2021 : Kledy M., François F., Djéridi H. et al., 2021, Toward a local drift flux model for high-pressure, subcooled convective boiling flows, Int. J. Heat and Mass Transf., Vol. 177, pp.167-177*

### 2) Tasks/ Key Results Expected

*The proposed research work in this internship can be divided into three different parts: The first one will be devoted to develop an optimized numerical modeling of the proposed physical model. Some versions of the computational model already exist but the numerical scheme needs some optimizations to decrease the time duration of the calculations. Once it is done, the second part of the job will be devoted to the development and the implementation of new closure laws in the model in order to improve the quality of its predictions. In order to develop such physical models, the candidate will use experimental datasets obtained at CEA (DEBORA facility: Garnier et al., 2001). Finally, the*

*intern will perform some comparisons between numerical calculations and experimental results in order to check the consistency of the new closure relationships.*

*Garnier et al., 2001: Garnier J., Manon E., Cubizolles G., 2001, Local measurements on flow boiling of refrigerant 12 in a vertical tube, Multiphase Science and Technology, Vol. 13, pp. 1-111*

- *Developing an optimized numerical tool (using compiled languages e.g. C, Fortran or Julia) from scratch*
- *Development of new physical models*
- *Implementation in the aforementioned numerical tool*

### **3) Knowledge, Skills and Abilities**

- *Thermal-hydraulics*
- *Heat Transfer*
- *Numerical methods for PDE solving*

## **3. Qualifications (Education)**

- ☐ (1) Bachelor degree (3<sup>rd</sup> year ☐, 4<sup>th</sup> year ☐)
- ☒ (2) Master degree (or candidate)
- ☒ (3) Ph. D. degree (or candidate)
- ☐ (4) Does NOT matter

## **4. Required documents**

- ☒ Resume / Curriculum Vitae
- ☒ Cover letter
- ☒ Academic transcript
- ☒ Recommendation letter written by academic supervisor
- ☒ English Test score (TOEFL, TOEIC, IELTS, etc.)
- ☐ Others ( )

## **5. Is the host organization providing any additional financial support in addition to the funding from KONICOF?**

- ☒ Yes
  - The amount of stipend: EUR 700 per month /~~week~~
  - Purpose of the stipend: *assist housing, required minimum wage, etc.*
- ☐ No



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