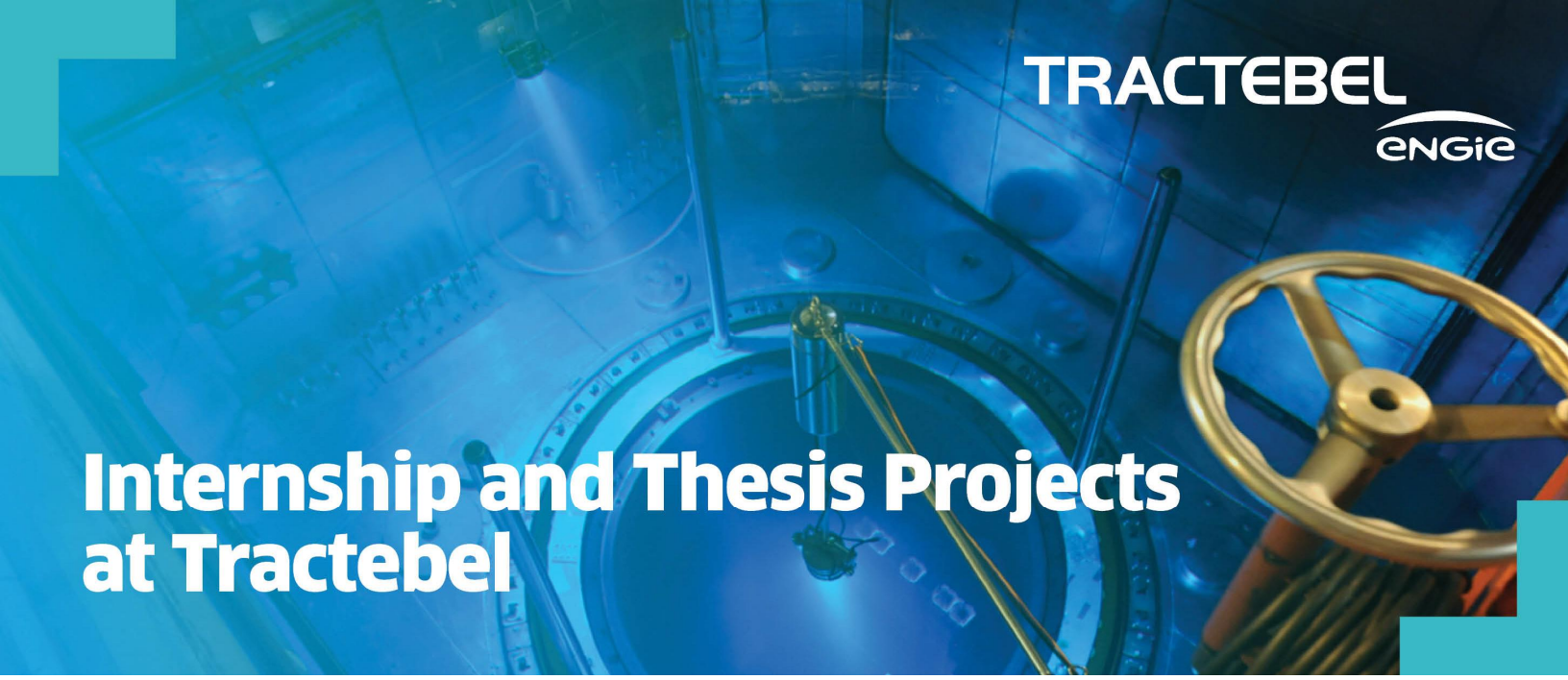

Internship and Thesis Projects at Tractebel

Dynamic PSA applied on Small Modular Reactors

Probabilistic Safety Assessment

Business line: Nuclear – Nuclear Safety and Engineering – Probabilistic Safety Assessment

Duration: from 2 to 6 months

Period: January – December 2024

Site: Brussels Engie Tower

Who is Tractebel?

Tractebel, part of the Engie group, has over 150 years of experience and is one of the world's largest engineering companies. Tractebel offers its customers multidisciplinary solutions in the fields of energy, nuclear, hydraulic and infrastructure. Our teams are involved in all phases of a project, from feasibility studies to implementation.

With who will you be working with?

You will work with the Level 1 Probabilistic Safety Assessment (PSA) team which is responsible for the PSA of the Belgian Nuclear Power Plants. The group also performs reliability analyses for other industrial applications.

What will you be working on?

Context

PSA is a method for analyzing and evaluating risks associated with complex systems, where consequences are expressed and ranked numerically. Currently, in the Level 1 PSA, an Event Tree (ET) analysis method coupled with Fault Tree (FT) analysis is employed. This method uses forward logic, with development beginning at a certain pre-determined failure (or Initiating Event, IE) and proceeding through set of branching events in order to trace possible outcomes. However, this “static modelling” could lead to incomplete results or added conservatisms: time independency, Boolean component states (i.e., working or failed), predefinition of failure events by the analyst, uncertainties and sensitivities hard to be accurately quantified, etc.

One technique that can reduce or sometime even remove the conservatisms of PSA studies whilst better capturing the scenarios’ peculiarities, is the Dynamic PSA (DPSA). DPSA is a technique which couples a time dependent system model (such as a deterministic study) with usually time independent PSA model. In doing this, the sequencing of events is no longer pre-determined by the analyst, but instead it emerges from the solution of the system model as the system evolves over time. In general terms, DPSA offers many benefits which would help enhance PSA studies: better handling of both aleatory (due to the stochastic nature of events) and epistemic (due to lack of knowledge about the system processes) uncertainties, intrinsic time dependency, better representation of what occurs during an accident (components repairability, human errors, etc.), modelling of partial failures, more accurate integration of passive systems reliability through the consideration of degraded states (above all for Small Modular Reactors, SMRs, whose smaller size should make easier the DPSA model development and quantification), identification of new failure pathways, reduced conservatisms, etc.

Because of the combination of a time-dependent deterministic model with a time-independent PSA model, one common major downside of the various DPSA methods is the large number of calculations, and thus the high calculation time needed to perform the studies.

The PSA team of Tractebel has launched an R&D project dedicated to the development of a methodology for the industrial application of DPSA techniques on SMRs. This internship fits in this context.

Description of the work

This internship proposal aims at developing a simple test case (demonstrator) to assess the feasibility of the application of a given DPSA method on a simple accident scenario for an SMR design. The DPSA method to be used for the demonstrator is the Dynamic Event Tree (DET) technique.. The results obtained will help to identify the added value of the chosen approach compared to traditional PSA techniques. Moreover, the limits of the approach, to be addressed for future improvements, will be listed.

The duration of this internship can be tailored to the needs of the student: its scope/content/level of detail can be adapted to fit in the academic calendar.

Scope

- Get familiarized with the literature review on the subject already performed at Tractebel.
- Get familiarized with the DPSA method proposed by Tractebel.
- Get familiarized with commercial PSA tools and the way Minimal Cut Sets (minimal combinations of events leading to fuel/core melt) are produced and quantified.
- Get familiarized with the chosen deterministic tool supporting the DPSA.
- Test the chosen DPSA method on a simple SMR accident scenario to demonstrate the feasibility of the application and its beneficial effect on the standard PSA results.
- Identify the limits of the approach for further improvements.
- Write a summary report.

Who are we looking for?

- You have a particular interest in PSA and reliability/availability analyses.
- You have a good knowledge of reliability and availability estimations.
- You have programming skills (e.g., Python).
- You have an analytical mind.
- You are autonomous, rigorous, systematic, willing to listen and learn.
- You are not afraid to ask questions and to look for support.
- You are creative, seek solutions and propose ideas.
- You have a good team spirit.

What do we offer?

- An interesting internship in a multilingual environment, with a good work-life balance.
- The opportunity to meet industry experts and work in a team of experienced professionals.
- Familiarity with an environment that allows you to strengthen your professional and technical skills.
- An opportunity to experience the ways of working in a design office.

How to apply?

Do you think Tractebel is the ideal solution for your internship?

Contact your professor and send an e-mail to FEDERICO.AGOSTI@TRACTEBEL.ENGIE.COM with your CV and a concise motivation message.

We hope to see you soon!