

# Internship and Thesis Projects at Tractebel

**Treatment of time interdependencies in a modern static PSA model by means of explicit time reliability convolution**

## Probabilistic Safety Assessment

**Business line:** Nuclear – Nuclear Engineering Department – Probabilistic Safety Assessment

**Duration:** ≈ 4 months

**Period:** June – December 2023

**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 company. 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 PSA team which is responsible for the Probabilistic Safety Analysis of the Belgian Nuclear Power Plants. The group also performs reliability analyses for other industrial applications.

## What will you be working on?

### Context

In the current challenging economic and political climate, new nuclear builds will often be challenged by regulators and stakeholders to demonstrate risk level well below those obtained by the current operating reactors while able to produce power at a cost per MWh that is similarly lower. The quantification methods applied within PSA have to evolve and be improved to be able to support such goals, by reducing conservatisms inherent in the quantification approaches.

Time interdependencies between events in PSA models are part of the conservatisms of the PSA quantification and they are not easy to assess. These are either treated via time-phased event trees, via dynamic event trees or most commonly not at all. In the latter case component failures are conservatively considered to occur at time zero in independent manner. This can however lead to non-negligible conservatisms, in particular for systems that are paired with long mission times (e.g., spent fuel pool cooling, external hazard conditions, etc.).

This internship proposal aims to provide guidance and produce required software tools to reduce one such source of potential conservatism, namely treatment of time dependencies.

### Description of the work

The internship proposal relates to the creation of a framework procedure and post-processing tools to reduce conservatisms related to time interdependencies in PSA models without the need to alter existing models, change current modelling practice or transition to new quantification software. The post-processing program is aimed to be developed to be independent of the risk quantification software used for the initial quantification.

### Scope

- Get familiarized with RiskSpectrum® and the way it produces, and it quantifies the Minimal Cut Sets (minimal combinations of events leading to fuel/core melt).
- Identify situations where explicitly performing convolution of time reliability functions for components will help to reduce conservatism in the results with a noticeable impact.
- Develop an expanded framework and guidance on the computation of recovery factors (to reduce the Minimal Cut Sets frequencies) for time dependant failures (mathematical background).
- Develop a post-processing tool for PSA results to facilitate the application of the developed guidance.

- Run simulations to demonstrate the beneficial effect of the developed guidance.
- Writing 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 estimation.
- You have programming skills (e.g., Python).
- You have an analytical mind.
- You are autonomous, rigorous, systematic, willing to listen and learn.
- 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 teacher or send an e-mail to [FEDERICO.AGOSTI@TRACTEBEL.ENGIE.COM](mailto:FEDERICO.AGOSTI@TRACTEBEL.ENGIE.COM) with your CV and a few lines of motivation.

We hope to see you soon!