Navigating Uncertainties: Strategies for a Robust Hydrogen QRA

Both the EU and Sweden have announced strategies for incorporating hydrogen in their solution for decarbonizing industries and reducing their dependence on fossil fuels. Liquid Wind is a company attempting to decarbonize an industry, they are a developer of sustainable electro-fuel production facilities with a vision to reduce the world's dependence on fossil fuels.

When developers like Liquid Wind build facilities to produce green hydrogen, certain risks need to be assessed. Hydrogen Quantitative Risk Analysis (QRA) is typically done conservatively, using worst-case scenarios and point estimates. While this approach ensures safety, it can also overestimate risks, leading to exaggerated measures that might slow down the green transition, increase costs, and prolong the approval process.

This thesis explores ways to improve QRA by better managing uncertainties and strengthening the knowledge base. The goal is to develop more accurate and reliable risk assessments. To achieve this, the study uses an iterative process to continuously refine the QRA with new data and Monte Carlo simulations.

Three methods were identified to enhance the strength of knowledge and reduce uncertainties: a semi-quantitative method, assumption deviation risk analysis, and Monte Carlo simulation. These methods were applied in four iterations focusing on frequency generation.

1. **Iteration 1:** Replaced the base frequency for event trees.
2. **Iteration 2:** Modified ignition probabilities to include data from multiple sources.
3. **Iteration 3:** Used similar approaches to incorporate various data sources through distributions.
4. **Iteration 4:** Combined all previous changes with additional refinements.

The results showed that while the strength of knowledge increased, not all parameters required complex distributions, as some changes had negligible effects. However, applying this refined approach to an entire case study could significantly improve the robustness and accuracy of QRA, which is crucial as facilities scale up from pilot plants to commercial operations.