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Unifying Fragmented Risk Assessments: A Full-Facility Bowtie Approach for Hydrogen Production Safety

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ABSTRACT

Decarbonisation projects are accelerating globally, yet maintaining strong process safety performance during this transition remains challenging. Recent developments in hydrogen production highlight this complexity: facilities are often assembled from multiple globally sourced OEM packages, each designed to different international standards and supported by risk assessments of varying quality and methodology. While these assessments may be sound in isolation, they rarely reflect how equipment is actually installed, integrated, and operated on a specific site. Nor do they capture the combined risk profile that emerges when diverse packages function together within a single process. The result can be a fragmented collection of disconnected studies that makes consistent process safety management and acheiving SFAIRP difficult.

To address this gap on a recent project, a full-facility bowtie risk assessment was undertaken to unify the process safety understanding across the installation. The bowtie approach consolidated OEM risk assessments (QRAs, HAZOPs and SIL Assessments), balance-of-plant (BOP) studies, and the outcomes of project risk reviews—while also incorporating design modifications made after procurement and learnings from commissioning, early operations, and observed initial system behaviour. This integration revealed several important lessons. Key risks identified through the bowties differed from those highlighted in individual OEM assessments, particularly where design or installation changes had rendered earlier studies outdated. Having OEM representatives directly involved in the bowtie workshops proved essential to avoid overestimating risks, ensure accurate understanding of equipment design intent, and draw on learnings from their other installations. The process also highlighted the importance of consequence modelling and quantitative risk assessment to contextualise occupancy, ignition probability, and fire and gas system performance. Insights from other hydrogen projects—especially those involving containerised electrolysers—were incorporated to strengthen the assessment further and support SFAIRP discussions.

The resulting bowties delivered a clear, visual, and site-specific understanding of MAE risks and the controls needed to manage them. They highlighted safety critical barriers, supported troubleshooting and operational decision-making, and demonstrated how fragmented risk assessments can be consolidated into a coherent facility-wide safety understanding.

This work shows that even in complex decarbonisation projects with diverse global equipment, structured bowtie assessments can reveal previously unrecognised hazards and support safe, reliable hydrogen facility operation.

KEY WORDS

Bowtie, Process Safety, Decarbonisation, Hydrogen, SFAIRP

BIOGRAPHY

Tharanga is a chemical engineer with 8 years of experience across the oil and gas, mining, and renewable energy sectors, with the past five years dedicated to process safety management. She is currently a Risk Consultant at GPA, where she has spent the last four years working extensively on hydrogen and future fuels projects across Australia. Her work spans design engineering, risk assessments, advisory services, commissioning support, and participation in functional safety assessments and audits.

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