Expanding System Boundaries: Multi-Risk Approaches for Decision Support in Process Safety

Abstract

Process safety is undergoing a significant evolution driven by increasing system complexity, digitalisation and stronger interdependencies between technological assets, human and organisational performance, cyber infrastructures and the surrounding territory. As industrial systems become more interconnected and exposed to compound disturbances, the limitations of traditional plant-centred and single-hazard approaches in supporting effective decision-making are becoming increasingly evident.

This keynote traces the evolution of risk assessment in process safety from plant-bounded analyses towards system-oriented and decision-supporting multi-risk approaches. It discusses how the explicit representation of interactions among hazards, exposed assets and vulnerabilities has progressively improved the understanding of escalation mechanisms and cascading effects in cyber-physical systems, including disruptions of instrumentation, control and organisational functions.

The keynote further reflects on how the integration of Human and Organisational Factors and cybersecurity has emerged as a necessary step in this evolution, reshaping the way accident scenarios are interpreted and safety barriers are assessed. Within this context, recent research results illustrate how collaborative intelligence and AI-based approaches are increasingly supporting this transition by combining data-driven insights, expert knowledge and organisational context. Rather than replacing human judgement, these approaches strengthen the capability to identify weak signals, interpret complex situations and inform safety-related decisions.

Overall, the keynote contributes to the consolidation of an ongoing shift towards integrated, system-level multi-risk governance, highlighting implications for safety, security and resilience in process and power industries.