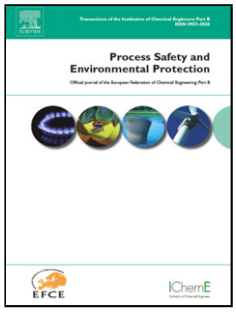

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A method for facility layout optimisation including stochastic risk assessment

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Highlights

- A framework integrating QRA and layout optimisation is presented.
- Stochastic risk assessment technique is described for uncertainty propagation.
- An approach for reducing escalation event risk is discussed.
- Global optimality is induced by a MILP formulation.
- Optimised layout is influenced by the designer's risk tolerance.

Abstract

Facility siting and layout configuration are essential factors during design and expansion of any industrial installation. In the recent past, cost-driven layout arrangements and the proximity of chemical facilities to densely populated areas, among other factors, have also contributed to the severity and propagation of various chemical incidents. Although several studies have been reported to address such problems, there is still a need for incorporating safety into the facility layout problem (FLP); especially for a method combining quantitative risk assessment (QRA) and layout reformulation. Based on that, the objective of this study is to develop a framework integrating layout formulation with a quantitative risk assessment method to support risk-based decisions throughout the lifecycle of process facilities. The proposed methodology is divided into three steps: risk calculation, determination of safety distances, and layout optimisation. In the first stage, an in-house code has been developed to quantify risks associated with loss of human life and structural damage stochastically. Subsequently, minimum separation distances between process units are obtained to prevent escalation events. In the last stage, risk maps and safety distances are accounted in a mixed-integer linear programming (MILP) for layout optimisation. The application of the proposed methodology is demonstrated through a case study. Sensitivity analysis is performed by varying risk values, safe distances, and risk acceptance criteria. Even though different layout options are generated, a trend is observed towards placing the equipment by its type.

Keywords: Layout Optimisation, quantitative risk assessment (QRA), uncertainty, escalation events.

Nomenclature List