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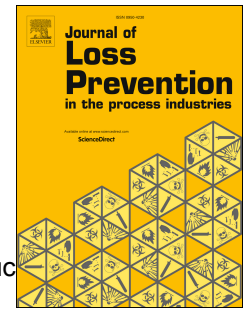

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Developing a Framework for Dynamic Risk Assessment Using Bayesian Networks and Reliability Data

Rym Kanes[a] and Clementina Ramirez-Marengo[b], Hazem Abdel-Moati[a*], Jack Cranefield[a] and Luc Véchot[b]

[a]ExxonMobil Research Qatar Science and Technology Park, PO Box 22500, Doha, Qatar
[b]Mary Kay O'Connor Process Safety Center at Qatar, Texas A&M University at Qatar, PO Box 27874, Doha, Qatar
*Corresponding author: hazemm.abdelmoati@exxonmobil.com

Abstract

Process Safety in the oil and gas industry is managed through a robust Process Safety Management (PSM) system that involves the assessment of the risks associated with a facility in all steps of its life cycle. Risk levels tend to fluctuate throughout the life cycle of many processes due to several time varying risk factors (performances of the safety barriers, equipment conditions, staff competence, incidents history, etc.). While current practices for quantitative risk assessments (e.g. Bow-tie analysis (BT), Layer of protection analysis (LOPA) etc.) have brought significant improvements in the management of major hazards, they are static in nature and do not fully take into account the dynamic nature of risk and how it improves risk-based decision making.

In an attempt to continually enhance the risk management in process facilities, the oil and gas industry has put in very significant efforts over the last decade toward the development of process safety key performance indicators (KPI or parameters to be observed) to continuously measure or gauge the efficiency of safety management systems and reduce the risks of major incidents. This has increased the sources of information that are used to assess risks in real-time. The use of such KPIs has proved to be a major step forward in the improvement of process safety in major hazards facilities. Looking toward the future, there appears to be an opportunity to use the multiple KPIs measured at a process plant to assess the quantitative measure of risk levels at the facility on a time-variant basis.

ExxonMobil Research Qatar (EMRQ) has partnered with the Mary Kay O'Connor Process Safety Center – Qatar (MKOPSC-Q) to develop a tool that monitors, in real time, the potential increases in risk levels as a result of pre-identified risk factors and process safety related data, using Bayesian Belief Networks (BN). The development of the tool involved two phases: 1) Development of a methodology that establishes the framework for the tool and 2) Development of the tool itself with the use of JAVA programming language. The overall tool is to be called PULSE, which stands for Process Unit Life Safety Evaluation.

In this context, the paper presents a case study of the quantitative risk assessment of a process unit using BN. The different steps of the development of the BN are detailed, including: translation of a Bowtie into a skeletal BN, modification of the skeletal BN to incorporate reliability data, and insertion of equipment failure evidence into the BN for dynamic modeling. In addition, an overview of PULSE is presented. The outcomes of the dynamic modeling of the BN with real time insertion of evidence are discussed and recommendation for the framework for a dynamic risk assessment tool are made.