Uncertainty delimitation and reduction for improved overall mishap probability prediction: application to level control of distillation unit

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Abstract

At all levels, the understanding of uncertainty associated with risk of major chemical industrial hazards should be enhanced. Here we perform a quantitative risk assessment (QRA) for a knockout drum in distillation unit of a refinery process, and then apply probabilistic uncertainty analysis for this QRA. In this study, a fault tree was developed to analyze the probability distribution of flammable liquid released from overfilling of knockout drum. Bayesian estimation was used to update failure rates of the equipment, combining generic reliability information in available databases and scarce data in form of plant specific testing data to enhance our knowledge on component reliability. Using Monte Carlo simulation, the distribution of top event probability was presented to characterize the uncertainty of the result. It was found that the uncertainty of basic event probabilities has significant impact on the top event probability distribution; and the top event probability prediction uncertainty profile shows that our risk estimation was improved by reducing uncertainty though Bayesian updating on the basic event probabilities. The whole distribution of top event probability replaces point value in a risk matrix to guide decisions employing all of the available information rather than only point mean values using input mean values as in the conventional approach. The resulting uncertainty guides where more information or reduction of uncertainties is needed the most to avoid overlap with intolerable risk levels.