Assessment of an Accidental Liquified Petroleum Gas Release at a Petrochemical Site: a Case Study

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Abstract

The Oil and Gas industry is currently undergoing major changes in technology, and as a result of the increasing demand for energy, it is still a major source of risk, and therefore risk assessment of this type of industry is crucial to ensure the safety of people, equipment and the environment protection. This assessment contributes to better management by reducing these risks and implementing an adequate prevention and protection strategy to achieve the objectives of the HSE (health, safety and environment) management system.

This study consists of a quantitative assessment of the risks associated with an LPG storage and distribution station, by proposing a risk assessment approach that allows the analysis of the various accidental sequences that may occur following an accidental release of LPG and the modelling of their consequences. We would like to specify that the initiating event is a complete and instantaneous rupture of the line, and thus a loss of containment of an important quantity of liquefied gas. Smaller, medium and large leaks are also studied. It was found that the main failure modes for the lines are: external leakage, plugging and deformation or corrosion (without leakage or plugging). The main causes of these failures are mechanical failures (typically due to a combination of overload) and inadequate design and corrosion. It should be noted that external aggression and human error are also possible causes of these failures.

According to the analysis carried out by the event tree, the hazardous phenomena are an Unconfined Vapour Cloud Explosion (UVCE)/flash fire, pool fire, jet fire and dispersion of the toxic cloud to the atmosphere/pollution. The scenario of dispersion of the toxic cloud to the atmosphere was not the subject of our study. As a result of this application and for small leaks, the phenomenon of Pool fire, UVCE / Flash fire and Jet fire are considered Tolerable due to their low frequency of occurrence despite having high frequencies of occurrences > Ft = E -5/ year (ALARP principle). The phenomenon of vaporization of the butane pool can also be tolerated in the case of a medium or large leak due to their weak effects, on the other hand this phenomenon is considered unacceptable in the event of slick ignition. In the case of medium and large leaks, UVCE / Flash fire and Jet fire phenomena are considered unacceptable due to their height consequences (effects), despite their low frequency of occurrence (1.28 E-5 and 3.2 E -5 / year respectively for medium leaks and 1.092 E-5 and 1.82 E -5/year respectively for large leaks). The results of the identified high-risk scenarios were modelled using the ALOHA simulator, and subsequently, we identified the areas exposed to different accidental effects such as: thermal, toxic and overpressure effects… This modelling was also used to develop or update the response structure and emergency plans.

Keywords: Risk analysis, LPG leakage, Major accidents, event tree and consequences modeling.

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