CHAPTER

7

CONSEQUENCE ANALYSIS OF LNG DISPERSION FROM STORAGE TANK AND PIPELINE IN PT PERTA ARUN GAS FACILITY

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7.1 INTRODUCTION

Liquefied natural gas (LNG) is a colourless, clear, and nontoxic substance made up mostly of methane and ethane. It is created when natural gas is cooled to -162 °C (-260 °F). This cooling process is carried out to make shipping and storage to consumers easier and cheaper. It is because LNG is 600 times smaller than natural gas. However, LNG is usually delivered by pipeline to homes, factories and enterprises. Natural gas is commonly used in residential settings, especially for cooking, home heating, and power generation, as well as in industrial settings as a raw material for a variety of chemical items such as plastics, fertilisers, dyes, drugs, and also as a vehicle fuel (Ding et al., 2021; Solomon et al., 2021).

Moreover, the LNG market's demand continues to rise. Based on the results from Shell's annual global LNG trade report, demand is expected to rise to 360 million metric tons (MMT) in 2020, up from 358 MMT in 2019 (Davis, 2021). According to the projections, global LNG demand will reach 700 MMT by 2040, owing to a 75% increase in Asian growth as stated in the report done by Davis (2021). Therefore, it will increase the construction for natural gas processing and transportation such as storage tanks and pipelines. The escalating interest in liquefied natural gas (LNG) and the urgent need for new LNG terminals situated in close proximity to densely populated regions have given rise to numerous safety concerns in the realms of LNG transportation and regasification. Given the combustible nature of the vapour cloud, in-depth investigation of its dispersion profiling mechanism and the time-evolving behaviour of plume flow gave significant importance for the assessment and risk management in LNG applications. The layouts of most LNG processing facilities tend to be intricate and congested, worst the vicinity is very closed to residential and commercial infrastructure. Most of the research work emphasised that even a minor leakage of LNG at a small scale could result in catastrophic outcomes, underscoring the essential role of dispersion modelling (Baalisampang et al., 2019a). The potential for a large-scale LNG leak culminating in an explosion is profoundly perilous, and the impact is enormous to human and properties as well environment. In scenarios where the cloud encounters a partially confined space, disregarding the possibility of a deflagration to detonation transition (DDT) would be inappropriate. Thus, careful consideration of this aspect is imperative to avert the emergence of hazardous situations.

The dispersion of liquefied natural gas (LNG), the characteristics of its cloud, and its location are predominantly influenced by the conditions under which the leak occurs and the subsequent turbulent diffusion. The spread of the vapour cloud is impacted by factors including the rate and type of leak, the surrounding terrain and obstacles, the direction of discharge, weather stability, and turbulence conditions (Mishra & Mishra, 2021).

Upon ignition, the explosion of the vapour cloud depends on various elements such as the flammability limits, the source of ignition, and the speed at which combustion spreads. Subsequent to ignition, the released LNG presents the potential for several consequences, including pool fires, jet fires, fireballs, and vapour cloud explosions in both offshore and onshore facilities. Numerous studies have proposed different strategies to mitigate the risks and outcomes associated with accidental releases of flammable gases. These measures encompass actions like fireproofing gas pipelines and incorporating firewalls into facilities to diminish heat radiation (Rajendram et al., 2015). Moreover, the explosion's overpressure and resultant fragments could trigger a complex chain reaction, amplifying the accident and the associated risks within the processing plant (Ding et al., 2021; Mukhim et al., 2017; Zhou & Reniers, 2018).

For this work, areal locations of hazardous atmospheres (ALOHA) model has been chosen to simulate the scales of impact (threat zones) in the event of LNG release under realistic conditions (obstacles, terrain and wind), assuming an accidental leak in a PT Perta Arun Gas facility. This facility is a receiving and regasification terminal. A potential spill scenario for a storage tank and pipeline will be considered and simulations of LNG vapour dispersion at the different simulated boundary layers (unstable, neutral and stable) were performed in this work.

7.2 ALOHA-BASED DISPERSION ASSESSMENT FOR LIQUEFIED NATURAL GAS

This analysis uses ALOHA software to model and evaluate the dispersion of liquefied natural gas (LNG) in different release scenarios. It examines how LNG disperses under varying conditions such as wind and atmospheric stability, assesses potential impacts, and identifies safety zones and health risks. The findings support regulatory compliance and help in developing effective safety and emergency response plans.

7.2.1 ALOHA Model of Dispersion

The model of dispersion chosen for this research is ALOHA model, which the model is based on the Gaussian dispersion model of continuous, buoyant air pollution flumes (Zhou & Reniers, 2018). The latest version of ALOHA model available is version 5.4.1 (published in February 2007). The model was developed with other government