ABSTRACT
In order to illustrate a comprehensive assessment procedure for flammable gas dispersion behavior to adjacent vessels from FPSO leakage accidents, the statistical method of LHS was employed to select the scenarios. The accident scenario simulations were performed using a CFD approach. Flammable gas dispersion and the corresponding impact on adjacent support platform were studied with selected scenarios, including wind speed, wind direction, leak rate and leak position and et al. The spatial range variation distribution of flammable gas cloud was predicted, and the dangerous area was assessed by using the FLACS software. A comprehensive simulation method was set up to evaluate the risk of flammable gas dispersion and explosion accidents. Finally, the flammable gas dispersion behavior to adjacent vessels was illustrated and the corresponding prevention and mitigation strategies were discussed.

KEY WORDS: gas dispersion behavior; adjacent vessels; spatial range variation distribution; FPSO leakage accident

INTRODUCTION
FPSO is the floating production storage and offloading unit which is typically based on a ship vessel with equipment built in modules positioned on deck, as shown in Fig. 1. The FPSO receives crude production from one or a number of undersea oil reservoirs via risers. The production is then separated at the topside (vessel deck) into oil, flammable gas, and water (Silva et al 2019).

Thus a FPSO may have various potential risks of chain accidents such as a fireball, flash fire, Vapour Cloud Explosion (VCE) and pool fire when the vapour is ignited (Baalisampang et al., 2019), especially catastrophic fire and explosion accident may be induced when gas disperses into the atmosphere (Wei et al., 2014). Accidental FPSO gas leakage or blowout in crude oil treatment system threatens the operation safety of adjacent surface vessels, integrity of assets and human life (Olsen and Skjetne, 2016). E.g., The Piper Alpha tragedy in 1988 caused 165 deaths due to an explosion after the release of flammable gas. In an accident, leakage of gas occurred, and the presence of an ignition source caused multiple events such as a fireball and jet fire, followed by VCEs. The sequence of events led to the total loss of the FPSO and adjacent surface vessels (Baalisampang, 2018). In 2010, the Macondo accident in the Gulf of Mexico occurred with a series of events such as blowout, dispersion of released hydrocarbons, explosion and fire (DHSG 2011). The flame propagating from the explosion reached the flammable vapour, dispersed over the adjacent surface vessels and led to the fire at the source of release at the FPSO. In comparison to onshore processing facilities, offshore facilities are deemed more vulnerable to transitional events due to limited topside space and harsh environmental conditions (Baalisampang et al., 2016).

Many domestic and foreign researchers have made important progress in the analysis of offshore platform disaster analysis technology and the consequences of cascading disasters. Most studies only analyse part of the oil and gas leakage and explosion, which reduces the accuracy of the safety assessment results to a certain extent. Several experimental analyses have been carried out and show that the distribution of the risk source area is an important factor affecting fire characteristics (Darbra et al. 2010). Zhou et al. (2015) used Fluent software to numerically simulate the leakage and diffusion of a dangerous and heavy combustible gas in a tank area in different situations. Shekhar et al. (2018) analysed the influencing factors of flame heat flux in detail through experiments. In the past decade, considerable efforts were made on the flammable gas plume from FPSO release, whereas the studies about the dispersion behavior of gas after leak out and spread to the adjacent vessels in the atmosphere can

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