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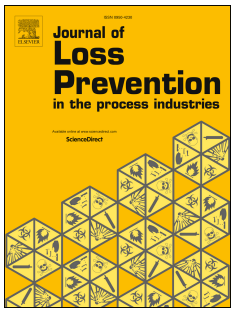

Quantitative risk assessment of direct lightning strike on external floating roof tank

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Quantitative risk assessment of direct lightning strike on external floating roof tank

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Abstract: Lightning-related fires and explosions may trigger escalated severe accidents for external floating roof tank (EFRT) farms. Quantitative risk assessment of lightning risk for EFRTs is an effective approach to reduce casualties and property damage. In this research, a quantitative methodology for the risk assessment of direct lightning strike on EFRTs is proposed, in which the risk-attenuating factors are considered by three special sub-models. The first sub-model allows the calculations of the frequencies of major accident scenarios with a small amount of inputs. The second sub-model allows the analysis of the influence of uncertainties on the physical effect due to full surface fire. By the third sub-model, the contribution of automatic firefighting systems and evacuation behavior to the decrease of the damage or death probability can be quantified. The three coherent sub-models constitute the main framework of the methodology in this research, and they are also applicable for other quantitative risk analysis. To demonstrate the applicability of this methodology and the flexibility of the sub-models, a case study is investigated and the contributions of risk-attenuating factors are further discussed. Finally, suggestions are proposed to optimize the lightning risk assessment for EFRTs.

Keywords: Direct lightning strike; External floating roof tank; Quantitative risk assessment; Risk-attenuating factor; Full surface fire

1 Introduction

External floating roof tanks (EFRTs) are widely used in refineries and storage terminals. While great emphases have been placed on the safety issues of EFRTs, there are still fire and explosion accidents, resulting in loss of life and property (Chang et al, 2006). A survey by Lastfire© Project indicated that 32.5% of all recorded EFRT fires were triggered by lightning (Lastfire© Project, 2005). A research program in China investigated 102 tank fires, and concluded that 61% of the EFRT fires were caused by direct lightning strikes (Liu et al, 2012). The issues on the EFRT's vulnerability to direct lightning have been attracting extensive attention from both academia and industries (Crippa et al, 2009; Renni et al, 2009; Renni et al, 2010).

Recent studies mainly focus on the damage mode of process and storage equipment following lightning impact. It is found that the perforation of metallic shell and the electric arcs at discontinuous parts are the two dominant causes of damage to metal vessels (Necci et al, 2013; Argyropoulos et al, 2012). Specifically, if the point at which the lightning flash connects with the structure (named "attachment point") is on the tank shell, it is highly possible that the shell melts through due to the lightning plasma arc, and that the minute pieces of incandescent metal may