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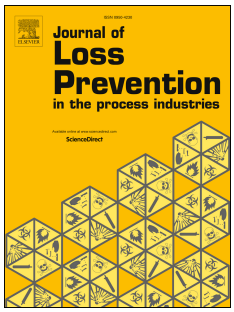

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Analysis of emergency response actions for preventing fire-induced domino effects based on an approach of reversed fuzzy Petri-net

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Abstract: In the chemical process industry, large quantities of different flammable substances are stored in tank farms. Due to potential mutual impacts among the tanks, severe domino accidents may occur after a tank catches fire. The emergency response to a tank fire may influence the development of the accident and impact the occurring of escalating events or so-called domino effects. In this paper, a fuzzy Petri-net (FPN) based reversed reasoning approach is proposed to analyze emergency response actions impacting domino effects. FPN is utilized to deduce the consequence-antecedent relationship between an accident and the emergency response actions. To analyze and compare the impacts of the actions on a domino effect, the backward reasoning is of special interest and often preferable when the occurrence probability of domino effects is known. As a tank fire accident in an oil depot usually lasts for a certain period of time, and as it may be greatly influenced by emergency response actions, it is taken as an example to illustrate the proposed approach.

Keywords：Chemical process industry; Emergency response; Domino effect; Fuzzy Petri-net; Backward reasoning

1. Introduction

In the chemical and process industries, various hazardous chemicals which have flammable, explosive, toxic or/and corrosive characteristics are handled and/or stored. Once an accident happens where such chemicals are involved, it may have a great impact and lead to huge losses. Such an accident may result in the failure of other equipment around, and become the cause of other accidents. The phenomenon where a primary accident develops into some secondary accidents is usually called the “domino effect”. A domino effect contains the following characteristics (Reniers & Cozzani, 2013):

(i) An initial accident triggering the domino effect;

(ii) Escalation effect under the actions of the propagation factors;

(iii) One or more secondary accidents.

A true domino effect always causes more significant damage than the initial accident. After an accident occurs, we should thus endeavor to prevent the accident from escalating. Safety management therefore requires risk assessment of domino effects. In Europe, the Seveso-III Directive requires the European member states to assess risks of domino effects in hazardous installations (Directive2012/18/EU).

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