IDENTIFICATION AND ASSESSMENT OF DOMINO SEQUENCES INITIATED BY LOSS OF CONTAINMENT

Nassim Alileche[a,b] ; Jean-Christophe Buvat[a] ; Lionel Estel[a] ; Damien Olivier[b]

[a] LSPC (EA 4704) INSA de Rouen, Avenue de l'Université, BP8, 76801 Saint-Étienne du Rouvray Cedex, France.

[b] LITIS (EA 4108) Université du Havre, 25 rue Ph. Lebon, BP540, 76058 Le Havre Cedex, France.

Abstract.
A Domino Effect (DE) can be initiated by several types of primary accidents, which are often caused by Loss of Containment (LOC). In this paper we clarify the concept of domino effect based on a solid literature research. To enable readers to understand it without having much prior knowledge. Then we explain our approach based on modelling of accident scenarios triggered by LOC, and aims at DE risk estimation for land use planning purpose. Finally the method is applied to a case study.

Key-words. loss of containment, accident, propagation, domino effect, risk analysis, land use planning.

THE DOMINO EFFECT

Definitions

Several definitions are available in the literature to describe the effect, in the context of the assessment of industrial risks, because of the different evaluations that researchers may have. None has been universally accepted by scientists to describe this phenomenon Abdolhamidzadeh et al., (2011)[1]. However, a definition proposed by Cozzani et al, (2006)[2], is widely used in quantitative risk analysis includes three aspects found in most definitions referring to the particularity of domino accidents; it characterizes the domino effect by the following sequences:

- A primary accidental scenario, which initiates the domino accidental sequence;
- The propagation of the primary event, due to an "escalation vector" generated by the physical effects of the primary scenario, that results in the damage of at least one secondary equipment item;
- One or more secondary events (i.e. fire, explosion and toxic dispersion), involving the damaged equipment items.

More recently Genserik Reniers and Valerio Cozzani (2013)[3] propose the following definition:
An accident in which a primary unwanted event propagates within an equipment ("temporally"), or/and to nearby equipment ("spatially"), sequentially or simultaneously, triggering one or more secondary unwanted events, in turn possibly triggering further (higher order) unwanted events, resulting in overall consequences more severe than those of the primary event.

Scientific approaches and existing methodologies

Two approaches are being followed by researchers in an attempt to solve problems arising from the study of this phenomenon. The first one is the analysis of past accidents, which is essential for the second: the development of analysis or prevention methods for domino effect risks.

PROPOSED METHODOLOGY

After designing a database that lists the required information for the development of the proposed method, which includes the equipment types considered by the model, the annual frequencies of losses of containment, a classification of hazardous materials stored or handled within the units. We started the modelling steps, where primary accident scenarios were modelling first and then their propagation to the nearby units and establishments.

The modelling of primary accident scenarios

As consequences from LOC(s), the possible scenarios are multiple and could vary according to several parameters (type of leakage, equipment characteristics, substances, weather conditions, etc.). To determine the final outcomes (primary accidents) of these accident scenarios and their likelihood of occurrence, on the equipment where the release occurred; we draw up event trees in which each branch represents an accident scenario.

The modelling of accidents propagation

For each LOC after allocation of an event tree, the next step is to model the propagation, to determine if the neighboring facilities of the installation source where the critical event occurred will be impacted due to these accidents.

References

[1]Abdolhamidzadeh, B., Abbasi, T., Rashtchian, D., Abbasi, S.A., 2011. Domino effect in process-industry accidents – An inventory of past events and identification of some patterns. J. Loss Prev. Process Ind. 24, 575–593.

[2]Cozzani, V., Antonioni, G., Spadoni, G., 2006. Quantitative assessment of domino scenarios by a GIS-based software tool. J. Loss Prev. Process Ind. 19, 463–477.

[3]Genserik Reniers, Valerio Cozzani: *Features of Escalation Scenarios*, Domino Effects in the Process Industries, 2013, Pages 30-42.