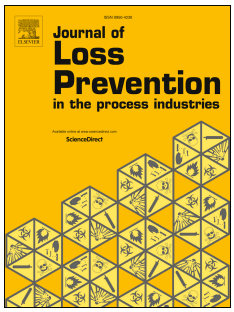

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Application of the graph theory and matrix calculus for optimal HAZOP nodes order determination

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ABSTRACT

This paper presents a method for determining the optimal order of HAZOP nodes, as well as the issues related with a description of streams flows of information among the elements of process systems. Determination of the optimal HAZOP nodes sequence (a sequence of nodes being sources of information streams are analysed before the nodes receiving the streams) allows avoiding the necessity of assuming and afterward verifying an existence of possible deviation and their transmission from the upstream nodes to the one being the subject of the analysis. This procedure constitutes a difficult task for process installations with a complicated structure. The optimal order of HAZOP nodes can be determined by using the graph theory and the matrix calculus. The described method has been implemented to carry out analyzes of complicated process systems. The main rules of the proposed method and results of application are HAZOP analyzes of steam boiler plant and one of the Underground Gas Storage Plant operated in Poland are presented in the paper.

1. Introduction

HAZOP analysis is similar to the sequential modular approach used in chemical and process engineering for mathematical modeling of process plants. In both methods, the system is divided into smaller nodes/modules, which are then analyzed according to the established order. The optimal sequence analysis of the nodes can have a significant impact on the effectiveness of the HAZOP studies, especially when the risk ranking is applied.
HAZOP (HAZard and OPerability Study) on the nodes, which are the subject of analysis, examines deviations from the established operational parameters, identifies their causes, effects and safeguards, and may determine the risk associated with a given scenario CCPS (1992); Markowski (2000); IEC 61882 (2001). The causes of the deviations need not be placed in the analyzed node, but also other nodes can be the source. Finding the causes of deviation in the node which is not a subject of the analysis is nothing else like stopping the analysis of the node and starting analysis of another one. This action can complicate and disrupt the workflow of the team and it can increase the probability of omitting the causes beyond the analyzed node. Of course, it is possible to assume a priori the transmission of the deviations from the adjacent nodes, however in order to avoid contradictions in the records, it requires a later return to the present scenarios