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Systematic risk assessment methodology for critical infrastructure elements - Oil and Gas subsectors

Poster number **XY269**

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A. Introduction

The concern for the protection of critical infrastructure has been rapidly growing in the last few years in Europe. The level of knowledge and preparedness in this field is beginning to develop in a lawfully organized manner, for the identification and designation of critical infrastructure elements of national and European interest.

Oil and gas production, refining, treatment, storage and transmission by pipelines facilities, are considered European critical infrastructure sectors, as per Annex I of the Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. Besides identifying European and national critical infrastructure elements, member states also need to perform a risk analysis for these infrastructure items, as stated in Annex II of the above mentioned Directive.

B. Motivation

In the field of risk assessment there are a series of acknowledged and successfully used methods in the world, but not all hazard identification and assessment methods and techniques are suitable for a given site, situation, or type of hazard.

Some techniques can be used in more stages, others have been especially designed only for a certain stage and their use would be unsuitable in other stages. Despite the wealth of knowledge already created, there is a need for simple, feasible, and standardized criticality analyses (Theoharidou, M. et al.) [1]. As such, the development of a methodology which allows a systematic analysis of hazards and risks, with the possibility of identifying the suitable methods and techniques for a site, in this case sites pertaining to the oil and gas subsector of the critical infrastructure, is a needed initiative.

C. Objective

The objective of the study is to elaborate a *methodology which comprises in a systematic manner the current methods and techniques used in risk assessment*, so that it can be applied to the oil and gas sectors of critical infrastructure.

The methodology is followed step by step through all three levels of analysis: ***preliminary analysis***, ***criterial analysis*** and ***detailed analysis***. Following the thorough identification and assessment of risks, relevant conclusions regarding risks can be drawn on an informed basis.

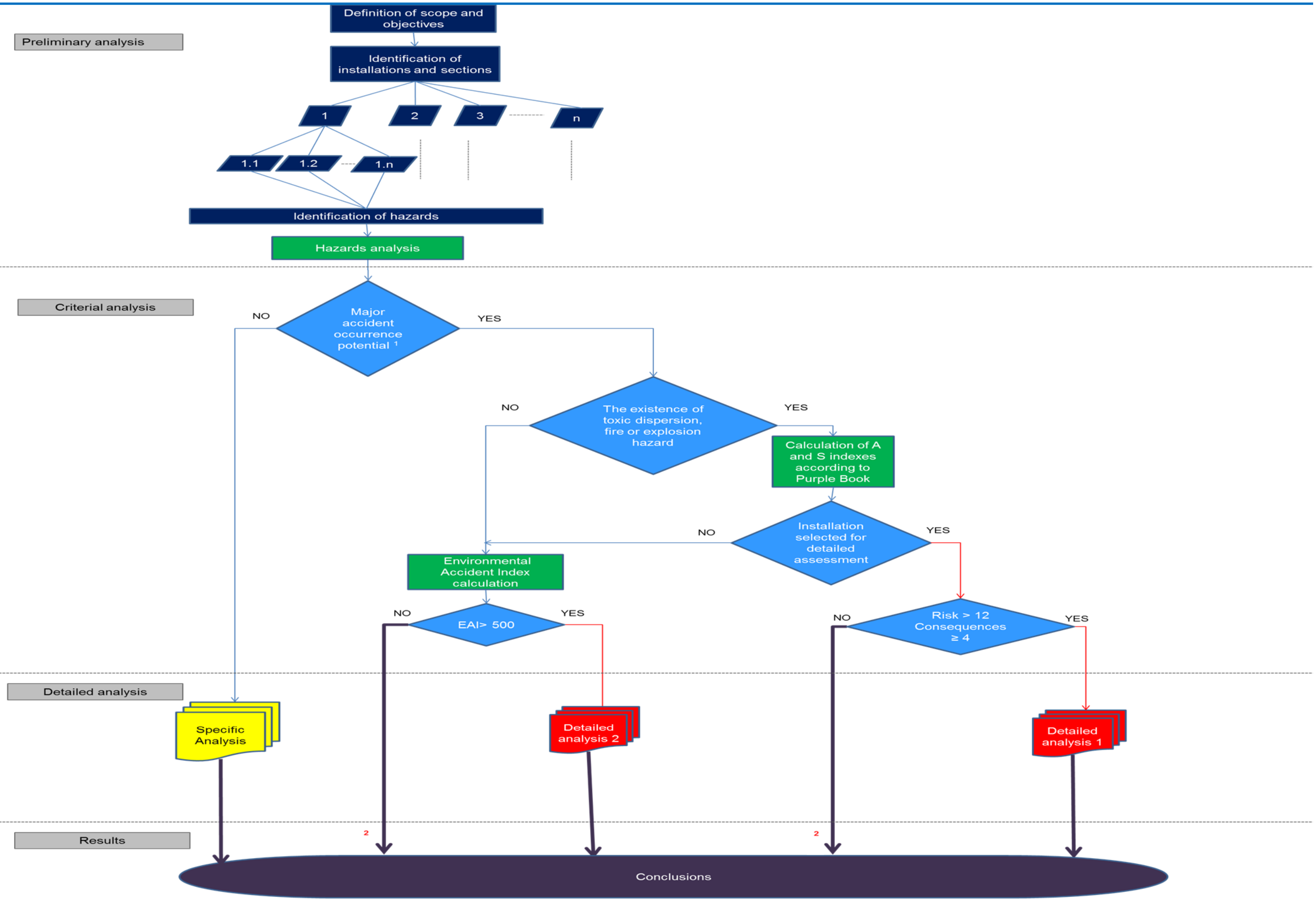
The elaborated methodology can also be applied to other industrial facilities, in order to assess the overall risk of a site through a systematic and cost effective process, which takes into consideration the sections and installations which contribute significantly to the overall risk on a site.

D. Methodology

Through a systematic approach we have in view the identification and evaluation of hazards and risks for all installations (sub-systems), sections and equipment on a certain site, as well as operations performed in each installation and section, main equipment involved in operations and the existing substances.

The general stages of the systematic risk assessment are the following:

- Preliminary analysis
- Criterial analysis
- Detailed analysis
- Results and conclusions



[1] Defined according to Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances, amended by Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003

[2] The conclusions reflect the results of the hazards analysis in the "Preliminary analysis" stage

D. Methodology - Systematic risk assessment methodology diagram for critical infrastructure elements - oil and gas subsectors [2]

D1. Preliminary analysis

a) Definition of scope and objectives of the preliminary analysis

b) Identification of installations and sections undergoing the assessment

c) Description of each section

d) Identification of hazards for each section

- hazards due to the nature of the installation and manipulated substances
- natural hazards susceptible to occur in the area
- possible Natech hazards (ranging from 2 to 5% of reported accidents [3]), , etc.

e) Hazards analysis => risk matrix

D2. Criterial analysis

a). Major accident occurrence potential

- For each section are identified the hazards which have the potential to generate a major accident according to Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances [4]

b). The existence of toxic dispersion, fire or explosion hazard

- substances which are toxic, flammable or explosive according to Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labeling of dangerous substances [5]

D2. Criterial analysis

c). <u>Risk and consequence criterion</u>

- hazards which present a risk level, estimated in the preliminary assessment stage, higher than 12 (high or extreme risk) or a consequence level of 4 (major) or 5 (catastrophic) are selected for the detailed risk assessment[6].

d). <u>Calculation of the Environmental Accident Index</u>

- EAI [7] is based on a series of chemical variables and a few site specific variables: acute toxicity for aquatic organisms, amount of substance stored or transported, consistency or viscosity/physical state of the chemical substance, solubility of the chemical substance in water, potential of the substance to penetrate the soil depending on the depth and mobility of groundwater.

$$EAI = Tox * Am * (Con + Sol + Sur)$$

D3. Detailed analysis

a). <u>Detailed analysis 1</u>

- *"Consequence based" methods*: the evaluation of consequences of possible accidents without quantifying explicitly the occurrence probability of these accidents. *Principle*: "if sufficient protection measures for the population exist in case of the most serious accident, sufficient protection will exist in the case of a less serious accident"[8].

- *"Risk based" methods:* also known as the probabilistic approach. The purpose is the assessment of the severity of potential accidents and the estimation of their occurrence probability.
  Generally, the risk based approach defines risk as a combination of consequences produced by more possible accidents and their probability of occurrence [8].

D3. Detailed analysis

b). Detailed analysis 2: Hazardous substances spills in the environment

- modeling and simulations of pollutants dispersion in the underground environment and surface waters.

Example of modeling systems: GMS (Groundwater Modeling System); the MODFLOW model; MT3D (Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion and Chemical Reactions of Contaminants in Groundwater Systems); SMS (Surface Water Modeling System)

c). Specific analysis

- geotechnical or geomorphologic analysis, hydro-climate risk analyses, etc.

D4. Results and conclusion

- evaluation of results of analyses performed in the first three steps of the methodology
- elaboration of conclusions related to hazards that pose unacceptable risks
- recommendations for risk reduction or elimination of the specific hazard and also regarding the monitoring of hazards.

E. Conclusion

The three-step approach proposed by this paper enables the evaluators to come to pertinent conclusions regarding the overall risk of a site, through selecting and analyzing the installations and sections that contribute most to this overall risk. Through eliminating from the detailed assessment stage those installations which are pertinently considered not to contribute significantly to the overall risk of the site, time and expenditures can be saved, without compromising the relevancy and adequateness of the conclusions of the risk assessment.

F. References

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Thank you for your attention!

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