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Management of Technological Risk Factors in the Oil Industry

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Abstract

Risk analysis is an important component of the strategic management of any organization. Ensuring consistent use of best practices for controlling the major risks caused by industrial operations is an objective of companies in the oil industry. The discovery of the sources of danger and of the causes, their evaluation and the establishment of the necessary measures to avoid accidents are done through systematic analyzes of hazard identification. The analytical tools used introduce in addition to the safety element, the environmental element regarding the control and prevention of major technical risks. The paper presents aspects related to the analysis of technological risks and how PETROTEL-LUKOIL manages risks based on the international ISO 31000 standards.

Keywords: *Risk management; technological risks; oil industry.*

JEL Classification: *G32; L71; M11.*

Introduction

One of the main objectives of the oil industry is to reduce the risks and improve the safety and reliability of the installations involved in the technological process.

Technological risk can be generated by the use of new, advanced technologies. Because achieving the goals for which the new technologies were designed can be affected by uncertainty, the use of new technologies can be risk-generating. Also, the technological risk may also manifest as a result of technical faults.Risk analysis is an important component of the strategic management of the organization and involves identifying the risk, analyzing and evaluating the risk, determining the priority interventions for risk limitation and risk treatment (Vintilă, Armeanu, Filipescu, Moscalu, Lazăr, 2011).

Technological risk can be defined qualitatively and quantitatively. From the qualitative point of view, the significance of the technological risk is that of the possibility of producing a major damage during the exploitation of the technological system. From a quantitative point of view, the technological risk represents the probability of a major damage during the exploitation of the technological system.

In technical accidents, major failures that fall into the area of unacceptable risk should be given special attention.

The considerations presented so far outline the problem of risk analysis. The first stage is the identification of the malfunctions of the investigated technological system; this involves identifying all the risk factors (sources) involved in the system's implementation. Knowing the risk factors and the corresponding dysfunctions, one can proceed to identify the possible scenarios of production of the technical accidents (respectively those sequences of events that lead to the production of the technical accidents).

The risk assessment process comprises two broad categories of analysis:

- Qualitative risk analysis;
- Quantitative risk analysis.

The results of the qualitative risk analysis are less accurate, they are more indicative than precise. If these results are not satisfactory, the risk management also provides the quantitative analysis that presents results in numerical form as a result of the calculations made (Popa, 2014).

Risk analysis means analyzing the efficiency and profitability of the projects in conditions of uncertainty and risk, conditions in which the variation of the influence factors (parameters) is manifested with a certain probability.

Risk Identification and Analysis in the Oil Industry

PETROTEL-LUKOIL enterprise-level risk management system (EWRM) complies with International Risk Management Standard ISO 31000. Accidental risk analysis involves identifying major accident hazards and then assessing the risk they present, by examining the probabilities and consequences (severity) of the damages that may arise from these hazards.

The priority objective of the PETROTEL-LUKOIL management is to organize the activities on the industrial platform of the company in such a way that they can be carried out in complete safety conditions, at minimum risk conditions and at the most demanding safety standards.

The management of the company assumes responsibility for the allocation of the human and financial resources necessary to achieve this objective.

Accidental risk analysis involves identifying major accident hazards and then assessing the risk they present, by examining the probabilities and consequences (severity) of the damages that may arise from these hazards.

The oil industry, through the diversity of technologies and their high degree of complexity, is a potential source of chemical contamination of the environment, contamination that can become dangerous for the human factor and environmental factors.

The risk factor activities require that, in addition to the measures currently being taken, for safe operation, there is a permanent control and a continuous assessment of the risk and possible consequences.

The current imperatives of environmental issues are:

- quality assurance;
- prevention, combating environmental pollution;
- Reducing risks by increasing safety.

The risk management system is part of the general management system of an organization, designed to achieve the safety objectives, as set out in the company's risk policy.

The integration of risk management is based on an understanding of the organizational structure and context. The structure differs depending on the purpose, objectives and complexity of the organization. The risk is managed in each part of the organization structure. Everyone in the organization has the responsibility to manage the risks. Integrating risk management into an organization is a dynamic and iterative process and should be tailored to the needs and culture of the organization. Risk management should be part of the organisation's purpose, form of leadership, leadership and commitment, strategy, goals and operations (Roncea, 2018).

Designed as a component part of the integrated management system (SIM), starting in 2012 a security and risk management system was implemented and a person in charge of security and risk management was appointed.

Also at the organization level, the Emergency Management System has:

- Technical Commission for Emergency Situations;
- Emergency cell;
- Technical Secretariat

All these entities ensure a positive synergy and complement the integrated management system implemented in PETROTEL-LUKOIL as follows:

- The ISO 9001 quality management system certified in 2007, the date of the last certification 2017 - will be recertified in 2020;
- The ISO 14001 environmental management system certified in 2008, the date of the last certification 2017 - will be recertified in 2020;
- Occupational health and safety management system OHASAS 18001 certified in 2008, the date of the last certification 2017 - will be recertified in 2020;
- ISO 31000 risk management - implemented since 2012, certification is not currently achieved.

Within the integrated management system is established the procedure "Risk management". Based on this procedure, a "Risk analysis on potential conflicts of interest and risks on impartiality" takes place at least annually. Following this, "Measures are established to control / minimize / eliminate threats". The risk analysis is the object of the analysis carried out by the management within the quality management system, part of the integrated management system.

Methodology for Systematic Risk Analysis

The discovery of the sources of danger and of the causes, their evaluation and the establishment of the necessary measures to avoid accidents are done through systematic analyzes of hazard identification.

Hazard analysis must be performed with an appropriate method. The methods that can be applied are (Albu, 2018):

- Checklist;
- PAAG / HAZOP;
- Analysis of the sequence of events;
- Defect tree analysis;
- Analysis of the effects of the failure;
- Dow-Index method;
- Zürich Hazard analysis.

In the analysis of the risks involving hazardous substances and mixtures used on the site of the company PETROTEL-LUKOIL S.A., the HAZOP methodology was used.

The HAZOP / PAAG process - the most known and recognized systematic method in the whole world.

The way you work is brainstorming in the team and completing the results in a table. The method is inductive / deterministic.

The stages of work were the following:

- Establishing the nominal function of the machine;
- Identifying the parameters that can lead to accidents;
- Applying decisive words;
- Identifying the causes;
- Estimation of effects;
- Establishing actions.

The realization of the technical / technological systems requires the assurance - during all the characteristic phases (conception, realization and operation) - of high levels of reliability and of technical security.

An essential component of any risk analysis is the identification of all the risk factors involved in the implementation of the technical / technological systems. They are mainly identified with the factors that caused the accidents that cause technical accidents and are shown in the figure 1.

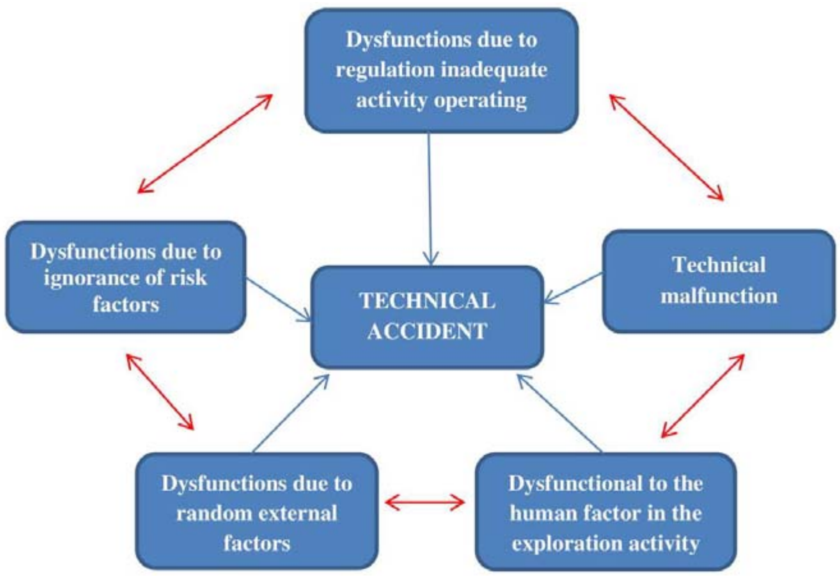

Fig. 1. Dysfunctions that generate technical accidents and the associated factors

Source: PETROTEL-LUKOIL Risk Management System Documentation

Taking into account the phases and stages of the implementation of a technical / technological system, the identification and systematization of the risk factors implies their grouping into the following three categories:

1. *The intrinsic factors*, characteristics of the technical / technological system considered; not only material in nature, they are associated with the design and implementation phases of the system and express, in essence, the defects with which they come into operation to the beneficiary;

2. *The factors associated with the conditions of exploitation and territorial location*; these factors - also of a not only material nature - are associated with all destructive actions exercised on the technical / technological system, during their exploitation;

3. *The human factor* involved in the exploitation phase; it groups all the human errors that are manifested in the maintenance and technological exploitation activities, throughout the service life regarding the technical / technological system

Intrinsic technological risk factors

The intrinsic technological risk factors, not only of material nature, are identified with the possible causes of the production of major failures, associated with the technical / technological systems themselves.

The intrinsic factors usually manifest themselves in the exploitation phase, concurrently with and in correlation with the human factor, as well as with the factors associated with the conditions of exploitation and territorial location. The flow chart of the main intrinsic technical risk factors is given in figure 2.

Each of the nominated intrinsic risk factors can manifest - respectively, it can become, from the hypothetical risk factor, potential risk factor - only in the context of favorable circumstances, that is, only together with the human factor and / or the corresponding associated risk factors.

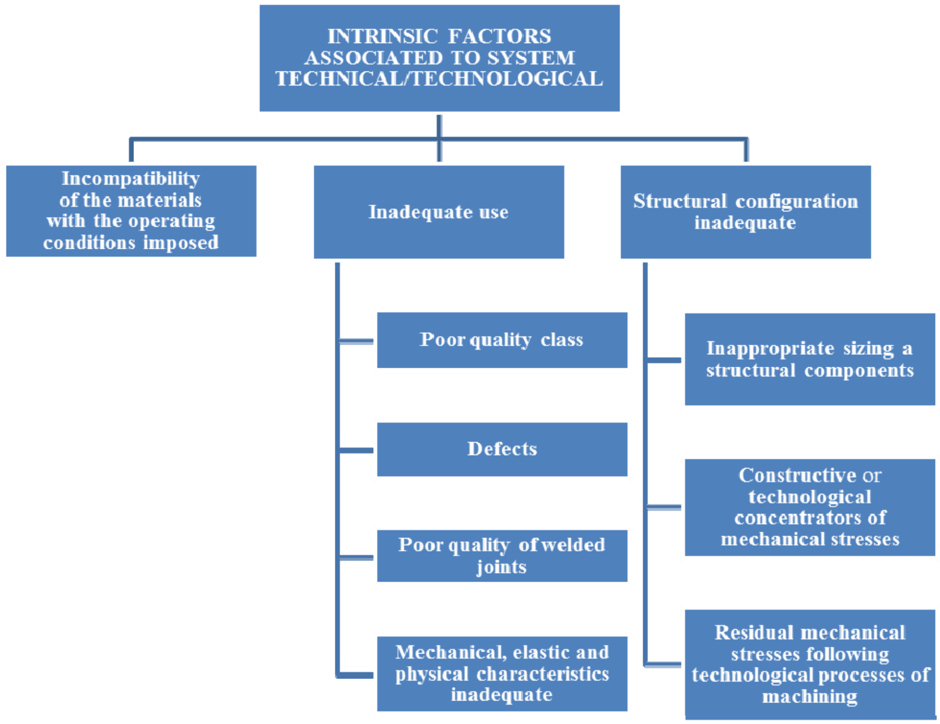

Fig. 2. Organization chart of the main intrinsic technical risk factors

Source: PETROTEL-LUKOIL Risk Management System Documentation

Technological risk factors associated

The technical risk factors associated with the conditions of exploitation and territorial location, not only of material nature, are identified with the possible causes of major damage, corresponding to all destructive actions exercised on the technical / technological system, during its exploitation.

The associated technical risk factors manifest only in conjunction with the intrinsic factors and / or the human factor (Maria, 2007).

Pressure action:

It may consist of the internal pressure or the external vacuum pressure.

The internal pressure can have the following effects:

- the technical flow of the material that constitutes within a limit of request, prior to the initiation of the material rupture;
- bursting / breaking of the wall of the structural component, with particularly serious implications for compressible, hot, flammable, explosive working environments;
- loss of leakage of the technological enclosure, with negative impact in the situation of flammable or explosive fluids;
- mechanical fatigue of the basic material that can initiate either the rupture or the cracking and subsequently the fatigue fracture of the material;
- detaching / removing the components of the technological equipment;
- the barrel shocks which, together with the existence of intrinsically unfavorable factors can initiate the cracking and fracturing of the material in the work

The action of temperature:

High temperatures can cause the following effects:

- expansion of the material;
- mechanical creep or relaxation;
- thermal or thermomechanical fatigue, which can initiate either the rupture or the cracking and, subsequently, the fatigue fracture of the material;
- hot brittle;
- thermal shocks;
- Physical and chemical transformations at the level of the material in the work, with direct effects on the mechanical resistance, toughness, ductility and corrosion resistance, in the sense of improving them.

Low temperatures can cause susceptibility to cold brittle, cracking and subsequently fracture of the base material.

The technological working environment can initiate different processes of corrosion, destructive chemical-mechanical-technological actions, cracking corrosion under load / tension, erosion of the basic material or the phenomenon of cavitation.

Continuous and continuous operation under load:

It can cause the following effects:

- creep or mechanical relaxation;
- fatigue - mechanical, thermal or thermomechanical;
- cracking of the material in the work, under the conditions of low demand temperatures and / or the destructive action of the working environment;
- Aging and / or wear of the basic material.

The climatic and tectonic factors can intensify the mechanical and / or thermal demands applied to the structural components (wind, snow, frost and earthquakes), initiate different destructive actions on the material in the work or change the levels of the mechanical characteristics of the basic material.

The human factor

Depending on their level of manifestation, human errors in operation can be:

- errors made in the conditions of the activity (wrong maneuvers, erroneous interpretation of information, faulty communication, etc.);
- errors made in the maintenance activity - non-observance of the procedures and / or procedures of technical supervision, monitoring, control, maintenance etc.,
- use of incomplete or outdated procedures for supervision, control, maintenance or intervention, repair or reconditioning or rehabilitation, omitting certain operations from

preventive or corrective maintenance activities, which potentiate certain intrinsic risk factors or associated with the operating conditions.
- errors in the transport of hazardous materials on site

Most of the technological installations in PETROTEL-LUKOIL can represent objectives with a more or less high degree of risk, which can lead to the production of accidents (breakdowns) that affect the actual objective, or affect the safe operation of other installations.

Possible places of damage can be considered:

- technological installations and sections;
- deposits (reservoir parks) of raw and auxiliary materials, finished petroleum products and liquefied gas (LPG);
- loading ramps for petroleum products, CF Auto;
- Mechanical and physical-chemical treatment and biological treatment of waste water.

Possible causes of damage can be:

- process disturbances (lack of utilities);
- human exploitation error;
- mechanical incidents;
- earthquake or other types of natural disasters that can lead to accidents and breakdowns at technological installations, machinery, pipelines, reservoir parks;
- the attack from the air;
- terrorist attack;
- diversion - sabotage.

The typology of the technological failures is diversified according to the manufacturing process (temperatures, pressures, machines, etc.), the raw materials and finished products, the use of open fire in some machines.

In this sense, they may appear:

- mechanical damage (cracks or breakage of vessels, pipes, leaks in the product pipes, condensers, heat exchangers, pipe or machinery breakages, pipe breakage inside the furnaces, breakage of gaskets, flanges, cable glands, pipe-related valves, cracking or breakage tanks);
- Malfunctions of dynamic machines in operation (pumps, compressors, fans, reducers, rotary ovens, etc.);
- Faults of the electrical nature in the deep and power supply stations that can lead to the shutdown of the installations or to a larger area.

Following the damage can be:

- Exhausts of toxic products outside;
- beginning of fire;
- fires;
- explosions;
- And for the fuel park areas, they can generate mass fires, when they are out of control.

The probability of producing a possible theoretical accident is in order:

- fires;
- Explosions;
- releases of toxic substances;
- failure;
- Chemical accidents.

Analysis of the frequency of occurrence of event types reveals:

- the installations where the most serious events can occur are:
- Atmospheric and vacuum distillation installations - DAV3;
- Cocsare - Cx installation;
- Catalytic Reformation facilities – RC
- Catalytic cracking complex - CC.
- the most common types of events are:
- fire (has the highest frequency in pump type equipment);
- mechanical accident;
- technical accident;
- explosion (the typical equipment is the oven).

In this context, specific technological measures must be taken to avoid the occurrence of such emergencies, to limit the effects generated by the probable production of such an accident.

Case Study - Concrete Example of the Opportunity of Implementing The Risk Management System

At the refinery level PETROTEL-LUKOIL S.A. In Ploieşti, a series of accidents can occur, as a result of the existence of significant quantities of crude oil, petroleum products (as intermediates and finished products), by-products, additives.

Substances present on site, present dangers from the point of view of physico-chemical properties, associated with high flammability and the property of forming explosive mixtures with air, acute toxicity and environmental pollution.

For the occurrence of a major accident it is necessary that, besides the existence of significant quantities of dangerous substances, an initiating event must also take place.

A major accident could occur on the PETROTEL-LUKOIL site due to one or more causes, as follows:

- Operational causes are those specific causes of installations, equipment and storage capacities existing on site.
- External causes are the causes of initiation of a major accident of external origin to the installation / site.
- Natural causes, respectively earthquakes, extreme weather phenomena (floods, landslides, violent storms).

Of the causes mentioned above, it is noted that the highest proportion in the production of accidents is due to human errors and technical faults.

For the classification of major accident hazards, both the probability of an accident occurring and its effects must be considered.

Based on the security reports periodically produced at the PETROTEL-LUKOIL level, an example of potential risk is identified at the level of the Atmospheric and Vacuum Distillation facility - DAV3.

Ruptures of tracks and machinery can occur, which can result in accidents with fires and explosions.

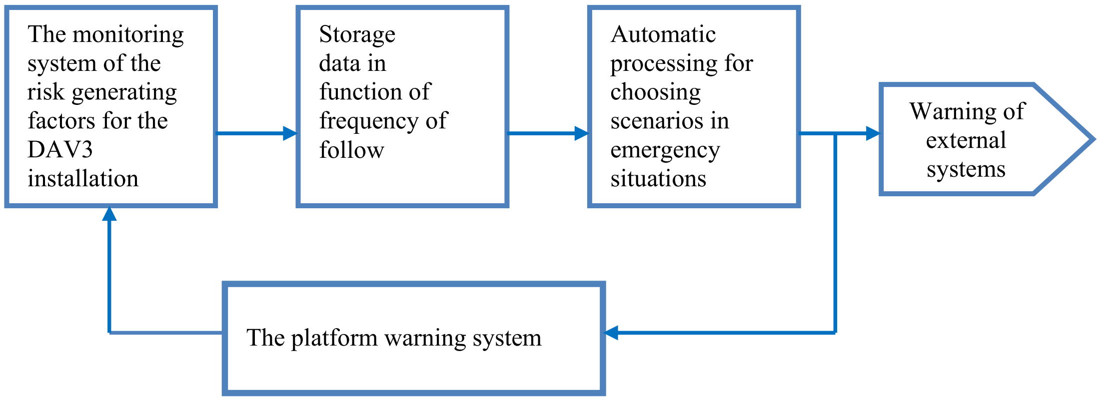

Fig. 3. Diagram of the informational flow of the activity of "Response in emergencies" for the Atmospheric and vacuum distillation installation - DAV3

In the structure of the information system, the following criteria were considered:

- emergency response within the factor protection platform human and environmental factors;
- Response in emergencies outside the platform for the protection of the human factor and environmental factors.

The advantage of implementing the risk management at the company level is the integration of the information system of the response activities in case of emergency in the managerial program for risk prevention.

Conclusions

The conclusions and recommendations resulting from an analysis of the technological risk factors reveal the opportunity to carry out audits for each installation. Internal audits are planned, objective and impartial and ensure prevention and the correction of the non-conformities associated with the risk management system, in order to minimize their consequences. These are carried out according to the provisions of the system procedure PS 05 “Internal Audit” and should cover the following:

- Description of the technological process;
- Presentation of the dangerous substances used;
- Major accident risk factors. Security measures. Conditions that can lead to accidents;
- Shutdown of the installation in accidental situations;
- Risk analysis;
- Equipment facilities for the prevention of major accidents;
- Equipment and measures for accident intervention;
- Measures to prevent and ensure the safety and security of the installation.

The assessment of the technological risk level on the objectives within the PETROTEL-LUKOIL platform reveals different degrees of risk associated with the main installations. The management of technological risk factors involves the evaluation of:

- the technological process carried out;
- possible sources of risk;
- the consequences / effects generated by the events carried out;
- facilities of the installation for the prevention of major accidents;
- The equipment and measures of intervention in case of accident.

Compared to those presented, it is considered necessary to maintain the control of the technological risk factors the development and implementation of the following aspects:

- continuous adaptation of the organizational structures for risk situations in relation to the activity carried out;
- continuous improvement of the risk management system by continually adapting the working procedures and instructions to the changes involved in the activity;
- Implementation of the program of measures established at company level regarding the assurance of the organizational framework and of the necessary equipments for carrying out the activity in safe conditions in order to reach the objectives regarding the policy for the prevention of major risks.

By identifying the specific activities and starting from the flow diagram of the DAV3 installation, presented in the case study, the author concluded that conducting early risk analyzes, modeling pollutant leaks in the environment - including fluid dynamics, dispersion of toxic, flammable pollutants and / or explosives, accuracy and speed of data transmission and expert system development, will provide a quick response to these events.

As a result of the present study and of the research conducted so far, it can be stated that the implementation of risk management as well as the technological risk management at the level of organizations raises and difficulties mainly generated by the lack of training in the field. Therefore, the main recommendation is to carry out regular training actions. Once this stage is over, all the personnel involved in the management activities of the technological risk factors can be considered prepared to correctly implement, in accordance with the provisions of ISO 31000 standard, the measures of identification, analysis, estimation and treatment of the risks.

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