Assessment and potential levels of technosphere industrial safety

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Abstract. The article discusses approaches to assessing cause-effect relationships determining the causes of emergencies at the enterprise, including the identification of direct and indirect factors, the direction and intensity of emergencies at the enterprise using the methods (risk sessions) of hazard research. The article poses the classical problem of hazard identification based on methods (risk sessions) in a matrix format with subsequent decision-making based on identification results. The authors of the article provide justifications, conclusions and recommendations regarding the development and launch of measures to improve the efficiency and reliability of industrial safety systems at a hazardous production facility. The principal distinguishing feature of the research results are: the variability of the managerial decision on the corresponding challenge of the industrial safety system of a particular facility and the security of the region in which the subject operates; “Ideal” solution to the potential problem of loss of efficiency and reliability of industrial safety systems at a hazardous production facility.

1. Introduction

Today, business is perceived by investors not only from the position of meeting the needs of society in certain products. But, to a greater extent, from the point of view of the investment object, the Top managers are tasked with enriching private capital without taking into account the territorial features of the location of the enterprise and possible technological risks associated with the production sphere. In current conditions, measures to reduce technological risks due to the drop in business and consumer activity of markets have lost particular relevance. Not only small and medium, but also large businesses faced with the loss of liquidity, contracts and orders. The problems are aggravated by the aging of production capacities in the conditions of limited available funds and the uncertainty of the economic situation not only in our country, but also in world practice. The investor will recover for a long time from the downtime caused by the pandemic. And as a result, a return to the previously achieved levels of business and investment activity of enterprises will not happen soon. To build up production, intellectual and innovative potentials, enterprises need social stability and a decent level of quality of life. From here we get a vicious circle, in order for the enterprise to reach the specified volumes of industrial production, it is necessary to improve the consumer market, which, in turn, needs stable sources of cash income, which the company does not have the ability to provide its employees. As a result, as the worst option for breaking the vicious circle is to reduce the cost of production. The easiest ways to reduce costs from the perspective of an investor should be recognized as the liberalization of the principles of environmental and technosphere safety of production processes. Consequently, Rostekhnadzor and Rospotrebnadzor, together with the population, will have
to strengthen the attention and control of domestic business in the coming years, especially those that are part of the group of technological risks with a high probability of accidents. In an unstable and rapidly changing environment, the ability of enterprise managers and executive authorities to correctly assess in real time the potential environmental situation in the region and make high-quality management decisions in order to minimize technological risks in the region, thereby ensuring comfortable and safe living conditions for the population, is of particular relevance.

2. Literature review

The use of a wide range of scientific approaches, methods and tools in identifying direct and indirect factors determining the direction and intensity of emergencies at the enterprise allows substantiating renovation programs in relation to strategic and investment plans for the development of domestic industry and Russian cities. Classical heuristic methods and statistical tools (observation, sampling, polling), which have earned the trust of line managers in monitoring production and technological presses, are described in the works of the following authors [1-7]. At the level of large companies, synergetic methods (the theory of joint actions) or nonlinear dynamics methods are used [8,9,10]. Yu.A. Izvekov, E.M. Gugina, V.V. Shemetova draws attention to the following features: "Nonlinear dynamics can be very useful for evaluation of the personnel opportunities range in the analysis and prevention of technogenic risks" [8]. The authors of the article propose to dwell on specific methods and approaches in relation to the features of the raised problems of this study. To date, the following modern methods (risk sessions) of hazard identification in the HSE have received the most appreciation. These reasons can be classified both technical and organizational, described in [11-15].

An analysis of industrial accidents shows that most of them are due to repeated errors. Moreover, numerous problems could be easily detected during a systematic risk assessment, which should cover the entire life cycle from concept development to dismantling.

To summarize the review of regulatory documents and scientific publications. The risk analysis process should go through the following stages: planning and organization of work, collection of information; hazard identification; assessment of the risk of accidents at the hazardous facilities and (or) its components; establishing the degree of danger of accidents at the hazardous facilities and (or) determining the most dangerous (taking into account the possibility of occurrence and severity of the consequences of accidents) of the components of hazardous facilities; development (adjustment) of measures to reduce the risk of accidents.

The set of features of the application and functional purpose of hazard identification methods is presented in the review [16-18].

HASID - research on hazard identification (Hazard Identification Studies) consists in conducting sessions on the principle of “brainstorming - the most effective method based on the established process or stage” by an interdisciplinary team of specialists aimed at identifying potential dangers associated with the implementation of a large project [16]. PHISER - a study in the field of labor protection, industrial safety and environmental protection, (Project HSE review) is a structured review of issues on the profile of industrial and environmental safety (IES), labor protection (LP), is the main risk management tool for each stage of the life cycle large object [18]. As part of the PHISER review, plans and activities related to a specific large project are checked, the result of PHISER allows you to decide on the transfer of the controlled object to the next stage.

HAZOP [9,11-13,18] - a systematic and comprehensive analysis of technological risks (HAZard ) and equipment functionality ( O Perability ), a world-recognized systematic approach to identifying failure sources (constructive and procedural). This session is characterized by the following : tied to the procedure capital project: using a skills multidisciplinary team working together on a well-defined methodology; assessment ivaeat enough s stipulated safeguards technological system; determined yaet workable s equipment in the data conditions.

The use of risk-session techniques allows you to verify design decisions in terms of possible dangers resulting from various deviations; identify the causes of hazards and evaluate their consequences; identify existing remedies and assess their adequacy; to develop recommendations for
reducing the consequences of the identified problems, which emphasizes the relevance of the problem raised by the authors of the choice of method and tools for diagnosing and preventing technological risks.

3. Results of approbation

The study, which served as the foundation of this publication, was carried out on the basis of the Messoyakhaneftegaz joint venture during operation in the Tyumen Region on the territory of the Yamalo-Nenetsky District in the Tazovsky District of the East Messoyakhskoye Field. Based on the results of the technical assignment issued by the industrial partner of the Tyumen Industrial University, the authors used a synthesis of statistical tools and modern methods (risk sessions) for identifying hazards at a hazardous customer site. The purpose of the risk-session identification of hazards: detection of hazardous factors during the operation of the facility; fixing of dangerous factors and their elimination, reduction or their indication; identify as many likely risks and scenarios as possible and further rank them by impact and likelihood for further analysis and mitigation; carrying out recommended improvement measures. Senior students during their summer internship were involved in the research work.

According to Rostekhnadzor, the cause of numerous accidents, namely 60% in the oil and gas industry in Russia, is the low level of organization of work. At the same time, the three most significant factors affecting the occurrence of accidents are the human factor, the technological factor, the lack of emergency protection systems, and the lack of attention of enterprise managers to industrial safety and labor protection issues.

A review in accordance with the terms of reference for the analysis of HAZOP risk sessions was carried out in relation to the following items: inspection of the territory and perimeter of the fence; arrangement of crossings through the lines of technological pipelines; lighting at night; fire warning systems; the state of evacuation routes and their marking; consideration of instructions for the safe operation of the facility; control of the backup power supply; checking the system of automatic switching of power supply from working input to standby; consideration of the scenario of a possible ignition of a diesel power plant when it is automatically turned on (during the next test of the power plant’s operability).

Verification results: inspection of technological linear pipelines for the collection of crude oil; reviewed the results of previous risk sessions; inspection of the backup power station; analyzed the risks associated with overloading the generator; considered a possible scenario for a fire of a diesel power station; planned an event to reduce the possibility of fire at the station (install a safety device that excludes automatic start-up of the power station until the short circuit of the electrical networks inside the production area is eliminated). The site of the fishing facility is located north of the Arctic Circle in the polar tundra zone. The main feature of the climate is sharply continental, which affects both the large differences between the temperatures of winter and summer, and between day and night temperatures. The deposit area is characterized by the permafrost distribution zone. The technological process of Messoyakhaneftegas JSC consists in the preparation and collection of oil at the East Messoyakhskoye field.

About Pasnie substance n When operating facilities in accordance with Annex 1 of the Federal Law of July 21, 1997 № 116-FL "On industrial safety of hazardous production facilities" are presented in Table 1.

The technological site and the tank site of the declared object were monitored. We list the list of the main factors contributing to the occurrence and development of accidents at the declared facility: handling in the process of significant quantities of hazardous substances that can form explosive mixtures with air; the content of a large number of hazardous substances in a single equipment. The authors believe that the main reasons contributing to the occurrence of accidents at Messoyakhaneftegas JSC are the poor-quality system for preventing emergencies, accidents and accidents and the technical condition of the main and auxiliary equipment, industrial buildings and structures. In the territory of the enterprise containing hazardous substances, accidents are possible,
accompanied by explosions, fires and pollution of the territory. Moreover, the largest negative impact, according to the studied documents for five years, is associated with oil pollution of the natural environment and fire during ignition of spilled oil. There is also a high level of equipment wear. There are facts of non-compliance with safety regulations by maintenance personnel. The quality of construction, installation and welding works, technology and the construction season is doubtful. The facts of equipment fire were recorded (violation of the tightness of pipelines, failures of fittings and detachable joints, depressurization of capacitive equipment).

Table 1. Data on hazardous substances at the declared facility.

| Component (section) of the declared object | Name of hazardous substance | Amount, t | in devices | in pipelines | in the largest piece of equipment |
|-------------------------------------------|-----------------------------|-----------|------------|--------------|----------------------------------|
| Technological site                         | Oil                         | 2052.01   | 1616.65    | 86.22        |
|                                           | Associated petroleum gas    | 25.73     | 0.82       | 1.23         |
|                                           | Diesel fuel                 | 35.22     | -          | 17.0         |
|                                           | Mineral oil                 | 0.28      | 0.17       | 0.14         |
|                                           | Inhibitors                  | 64.64     | 3.35       | 3.84         |
|                                           | Demulsifiers                | 29.79     | 2.01       | 31.825       |
| Reservoir area                            | Oil                         | 34488     | -          | 6897.6       |
| Total                                     | Oil                         | 38156.66  |            |              |
|                                           | Associated petroleum gas    | 26.55     |            |              |
|                                           | Diesel fuel                 | 35.22     |            |              |
|                                           | Mineral oil                 | 0.45      |            |              |
|                                           | Inhibitors                  | 67.99     |            |              |
|                                           | Demulsifiers                | 31.80     |            |              |

The main dangerous consequences of accidents possible at the declared facility are: the formation of a pollution zone during oil spills, a gas contamination zone during gas release; formation of a zone of fire and thermal damage in case of oil spill fires, gas flaring; formation of a zone of damage by high-temperature combustion products during the implementation of the “fire-flash”; the formation of an air shock wave during explosive transformations of clouds in an open area or in an enclosed space; the formation of a fragmentation field during the destruction of equipment, buildings and structures.

4. Conclusion
The monitoring and identification procedure of direct and indirect factors that determine the factor of emergencies at the enterprise using the methods (risk sessions) of hazard research allow us to formulate the primary measures to improve the efficiency and reliability of industrial safety systems at the hazardous production facility of Messoyakhaneftegaz JSC and adjacent to territory:
1. Application and timely renovation of production equipment that meets the requirements of regulatory documentation and is not a source of injuries and occupational diseases.
2. Rational placement of production equipment and organization of jobs.

The following activities should be attributed to trivial, but nevertheless extremely important, when carrying out work on localization and liquidation of the consequences of accidents in terms of protecting the health and life of people working or in the danger zone and technical support:
1. To revise the schedule of the current repair of machinery and equipment that had downtime and malfunctions in the course of fulfilling tasks to localize and eliminate the consequences of accidents.
2. Review the cost estimate for the maintenance of equipment in full.
3. To revise the standard of engineering support for work on localization and liquidation of the consequences of accidents in terms of the quality of preparation and rational distribution of engineering equipment involved to ensure work on localization and liquidation of the consequences of accidents.

Summing up the above, it can be noted that, on the one hand, the results of the risk session of hazard identification on the basis of a fishing facility in the Tyumen region made it possible to assess the possible consequences for the enterprise when avoiding preventive measures on a regular basis. On the other hand, any project, enterprise or industrial facility should have not only commercial effectiveness, but also environmental and social effectiveness. The latter directly depend on the level of technosphere security in the region chosen by the investor, often forgetting about social responsibility to society. The results of the study confirm the objectivity of the conclusions that the investor can and should control and manage the factors that trigger the accident. Particular attention should be paid to identifying potential dangers for maintaining the technosphere security of the region and creating a comfortable environment for society.

When solving the problem of increasing the efficiency of capacity utilization, top-managers in the field are faced with unresolved issues regarding the formation of the balance of the income-expense system and environmental and technosphere risks. The transfer of all responsibility from the investor and the top management of the enterprise to the field, as the domestic practice of developing the fuel and energy complex shows, does not allow achieving sustainable comfortable development of the northern territories of Russia for the population living in climate conditions that are not so favorable. Consequently, those conclusions and the implementation of these measures by the enterprise will minimize technological and technological risks, thereby ensuring technosphere security for the population in such a complex region. The described approach to monitoring and identifying risk factors should be of particular importance for Russian business at the present stage of formation of an active civil position of society.

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