Specifics of oil pipeline systems' risks management

Urpash Zhaniyzovna Shalbolova, Saule Meyrbekovna Yegemberdiyeva, Saken Seytkanovich Uderbayev, Madina Abzhalievna Elpanova, Liman Aydarbekovna Kazbekova

The Korkyt Ata Kyzylorda State University, Aiteke Bi str., 29-A, Kyzylorda, 120014, Kazakhsnan

Abstract. Some difficulties (risks) that occur in realization of oil pipeline projects may cause undesirable consequences and significantly affects the result. Possibilities of emergency conditions occurrences have been analyzed by authors. Ways, factors of risk situations occurrence in oil-trunk pipelines exploitation have been analyzed. Methods of quantitative risk evaluation have been proposed and methods of oil pipeline systems risks management. Analysis of danger and risk of possible breakdowns has been made and evaluation of breakdowns frequency on pipeline route has been provided. Measures to decrease risks have been proposed to provide reliability and safety of large objects.

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Introduction

The Republic of Kazakhstan is a state with carbohydrates national stockpile capable of affecting development of global energy resource market. Despite relatively high internal oil and gas potential geographical distance between production, processing and consumption sites may hamper achieving national power independence [1]. So pipeline transport development in the Republic of Kazakhstan should be focused on stability of domestic oil refineries supply by building of new pipelines and also provisioning of Kazakhstan oil delivery on foreign markets by internal means and by routes that are most satisfactory for consignors [2]. Capacity of existing pipelines systems does not allow provisioning in sufficient volume. Certain risks occur.

Operation of an enterprise engaged in oil pipeline systems exploitation are subjected to different types of risks that have negative impact on the economy of a subject and require management. To survive in the market it is necessary to make decisions of technological innovations deployment and to undertake bold non-trivial actions that increase risks. So enterprises should rather assess risks and manage them to reduce them than try to avoid risks [3].

Main body

Oil pipeline system projects realization that is oil transportation by oil-trunk pipelines is fraught with some uncertainties and difficulties. It is especially characteristic for international projects. International project with high capital costs affecting interests, strategic objectives and possibilities of different enterprises (companies) thus affects both political and economical relations of different countries. So there are some uncertainties and risks for realization of such project.

Diversification (distribution of enterprise's efforts for types of activity); risk spread over project members; acquiring of additional information to reduce the possibility of ineffective decision making; unforeseen costs coverage anticipation are the main ways of risk reduction [4]. Risk factors revealing related to estimation of project solutions efficiency for their further evaluation and measurement is made by expert evaluation of simulation, great number of various and complicated investment conditions control and continuous verification of uncertainty and risk [5].

Quantitative assessment of risk for analysis and choice of reliable basic variant of project with strict observance of best methods that allow increasing reliability of objects and equipment functioning, prevent failures, damages and breakdowns of systems may be made according the following function:

Quantitative assessment of risk = Frequency x Damage size (1)

General approach to risk analysis is based on classical principle of definition of relative events frequencies in long-term tests. Realization of oil projects is based on decision made and should follows preset schedule.

Anyway some difficulties may occur in project realization that may cause undesirable events and have significant effect on the result. Risk of these difficulties is defined as measure of uncertainty related to the possibility of undesirable events occurrence and consequences in projects realization [6]. It is especially characteristic for long-run pipelines projects realization that usually cross several natural and climate zones, countries with different level of economic development and different political systems.

The most significant environmental effect of oil-trunk pipelines is potential danger of great material and ecological losses due to oil pipelines breakdowns during startup and exploitation. Time required for breakdown elimination and relative oil loss grows with the growth of oil-trunk pipelines diameters and span. Loss in case of forced stopping may be dozen times higher.

So importance of reduction of existing risks both related to building and exploitation grows. The main focus of these efforts is development of reliable systems that are protected from emergency situations and destructions with product release and regular pipelines examination for technical state evaluation during exploitation.

Such analysis is basically qualitative. It allows evaluating the scope of loss in case of development of this or that situation. But emergency situation analysis is development of the most detailed scenario tree depending on events occurrence. It is applied together with one of the methods of quantitative assessment of risk.

Quantitative assessment of an environmental risk, i.e. pollution of the environment during oil-trunk pipelines exploitation is being calculated as follows:

Quantitative assessment of an environmental risk = Frequency of damages x the Volume of the poured oil x Coefficient of sensitivity of environment (2)

Methods of analysis of functioning in critical and emergency situations is related to study of analogous emergency situations in operation tests with results of different variants of emergency situations and not with causes these situations resulted from.

Risks management in design, realization and exploitation stages is logical and necessary continuation and development of project risks analysis [7, 8]. Oil pipeline systems' risks are managed in two ways. The first is risks reduction to the minimal and rationally acceptable level, the second is risk funding. The higher are costs on risk reduction the lower is risk level and higher safety level of oil pipelines systems relatively but the costs of risk reduction should be not lower that the minimal acceptable level and be in rationally optimal limits for each individual object. Cost as a function of r.isk may be formalized as exponent as follows:

$$R(S) = \exp(-\lambda S) \tag{3}$$

Where R is the probability of risk; S - costs, λ [lambda] - parameter that characterizes the intensity of costs.

To classify crisis situations and the results of dangerous events authors propose the project of virtual oil production station with pipeline communications. All project's components are viewed as risk factors including compressor plants, oil and new oil transportation pipelines, oil terminals. The list of events that may cause large scale breakdowns is made up for each component and then probabilities of dangerous events are determined by degrees of danger. Degrees of danger are listed in table 1.

Table 1. Dangerous events classification

Degree of danger	Dangerous events occurrence probability	Dangerous events occurrence frequency	Dangerous events occurrence probability per year, 1/year
4	Very frequent	Few times during object's life cycle	10^{-1}
3	Rare	Two times during object's life cycle	10^{-2}
2	Probably	Dangerous events occurrence probability is low but exists	10^{-3}
1	Very low probability	Not expected during object's life cycle, very low probability	10^{-4}

For large objects reliability and safety assurance the following requirements should be observed: project management that is considered adequate to observation of mandatory statutory provisions; accounting and reporting system application; revealing of all major dangers; evaluation of risk factors and development of measures of risk reduction to minimal accessible and effective level [9].

Risk matrix like the one shown in Fig. 1 is compiled of the results of classification of dangerous events and evaluation of consequences of these events. All risks types are summarized by the matrix and total project risk is calculated.

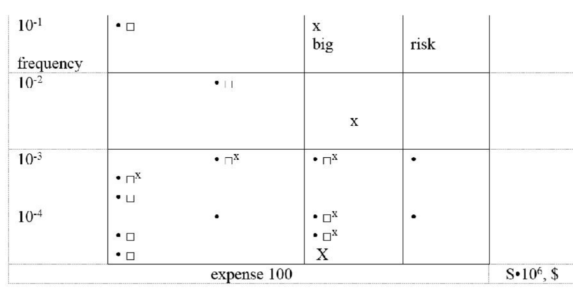

Figure 1. Risk matrix

Most technological objects of oil-trunk pipelines are classified as dangerous facilities. So assessment of danger and risk of possible breakdowns is one of the important problems of industrial safety provisioning. Assessment of breakdowns frequency along oil pipeline run is made on the base of identifications of danger and risk assessment for individual parts that are characterized by roughly similar distribution of specific risk indicators for all the length of a part (typical run of a part is 1-3 km). The value of numerical score of technical state of pipeline part is calculated for each n th pipeline run [10, 11, 12]:

$$F_n = \sum_{i=1}^{I} \sum_{j=i}^{J(i)} p_i \cdot q_{ij} \cdot B_{ij} \; ; \; B_{ij} = \frac{1}{N} \cdot \sum_{n=1}^{N} Fn \qquad (4)$$

Where B_{ij} is factor score F_{ij}; p_i is the share of i[th] group of factors; q_{ij} the share of j th factor in i th group of factors; F_n is numerical score of n th part; N – total number of parts along pipeline run.

The value of local frequency of breakdowns in part λ_n [lambda] (breakdowns/km/year) is defined according the formula:

$$\lambda_n = \overline{\lambda} \cdot \frac{F_n}{B_{ij}} \qquad (5)$$

Where $\overline{\lambda}$ [lambda] is average intensity (frequency) of breakdowns on a certain oil-trunk pipeline, (breakdowns/km/year).

The frequency of conducive to accident leakage from oil-trunk pipeline is calculated with account for impact factors defined by expert and empirical methods that may be arranged in the following groups: corrosion; quality of pipes production; external anthropogenic impact; quality of construction-assembly work; constructive and technological factors; environmental effect; defects of metal and welds; operating factors.

Major results of risk evaluation for analyzed projects of oil transportation allow making conclusion on higher safety level of oil pipeline system comparing average value of specific breakdowns intensity that equals 0.145 thousand kilometers a year and average mass of losses of oil in case of breakdown that is about 700 ton. This conclusion is proved also by comparing the above results with analogous calculations achieved by declaring of industrial safety of existing oil-trunk pipelines.

Table 2. Generalized indicators of breakdowns risks in linear part of oil-trunk pipeline

Risk indicator	Linera part of pipeline
Breakdowns intensity over the run, 1/year	0.145
Specific intensity of breakdowns, 1/year/1000 km	0.138
Average mass of oil leakage in case of breakdown, ton	700
Average mass of oil loss in case of breakdown, ton	200
Specific foreseen losses of oil in case of breakdown, ton/year/1000 km	41
Foreseen mass of oil loss in case of breakdown, ton/year	42
Average loss in case of breakdown including:	12500
- average fine for of environmental pollution in case of breakdown, thousand of tenge	8900
- average cost of loss of oil in case of breakdown, thousand of tenge	6600
Integral breakdown risk for all trunk run, thousand of tenge/year	3300
Specific breakdown risk, tenge/year/km	3250
Collective risk of lethal injury of people, people/year	$6.4 \cdot 10^{-4}$

Calculation of the main indicators allowed revealing integral breakdown risks and collective risk of lethal injury of people that in turn allowed planning measures on their reduction. High specific indicators of oil-trunk pipeline may be explained mainly by application and deployment of modern technical solutions and construction methods together with increased surveillance and control in all stages of design, building and deployment of dangerous industrial object.

Conclusions

So qualitative assessments and risk analysis of industrial breakdowns in enterprises of oil industry promote revealing of parts of oil-trunk pipelines with high risk of breakdown and the most important factors of danger that support making effective managerial decisions in industrial safety.

Corresponding Author:
Dr.Shalbolova Urpash Zhaniyzovna
The Korkyt Ata Kyzylorda State University
Aiteke Bi str., 29-A, Kyzylorda, 120014, Kazakhsnan

References

1. Yegemberdieva, S.M., 2009. Republic of Kazakhstan oil and gas complex potential. Gumilev ENU Gerald, 5: 233-237.
2. Shalbolova, U.Zh., 2003. Pipeline structure of oil and gas in Kazakhstan: state and perspectives. Moscow: Academy of national economy of the Government of the Republic of Kazakhstan, pp: 13-19.
3. Arrow, K.J., 1971. Essays in the Theory of Risk – Bearing, Markham Publishing Company. Chicago, pp: 145.
4. Smolyak, S.K. 2002. Assessment of investment projects in situation of risk and uncertainty. Moscow. Nauka, pp: 46-54.
5. Andreev, A.F., V.D. Zubarev and A.S. Sarkisov, 1996. Methodical aspects of investment projects in oil and gas industry. Moscow: Poligraf, pp: 190.
6. Andreev, A.F., V.F. Dunaev and V.D. Zubareva. 1997. Basics of project analysis in oil and gas industry. Moscow. pp: 60.
7. Shapiro A.C. 1990. Modern Corporate Finance, MacMillan Publishing Company. New York, 104.
8. Tarczynski W. and M, Zwolankowski. 1999. Inzynieria finansowa, Agencja Wyd. Placet. Warszawa. pp: 69.
9. Economist Intelligence Unit, Managing Business Risks, 10. (With analogous analysis in DeLoach, Enterprise-Wide Risk Management. pp: 15-16.
10. Nurpeisov, M.S., 2008. Risk management in oil production industry (on material of Kyzyl-Orda region), PhD thesis, Techcenter "Rakhat", Turkestan.
11. Antoshkina, A.V. and A.S. Smaskulov, 2001. Mehtodology of oil-trunk pipelines' risk assessment. Theory and practice of economy reformation in post-Soviet space, Almaty: Institution of Economic research.
12. Yerali A.K., A.V. Antoshkina and A.L. Yeralieva. 2002. Methodology of analysis and risk assessment in objects of oil-trunk pipelines. Business and education: the vector of development, Almaty: International Academy of Business.

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