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Geo-Ecological Risks and Implementation of Master Scheme for Gas Industry Development

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Abstract: The aim of the given paper is to consider the possibilities of geo-ecological risks in the areas of gas production and to show the implementation of Master Scheme for Gas Industry Development. Methodological approaches to management of the risks in Master Plan as well risk assessment in gas industry development scenarios are validated.

Keywords: Geoecological risks, Master Scheme, scenarios for gas industry, sustainable development.

INTRODUCTION

Risk assessment consists of two stages, risk analysis and risk management. Risk analysis involves qualitative and quantitative determination of frequency and size of losses from a particular hazard and relies on scientific knowledge (Samsonov *et al.* 2009; Samsonov *et al.* 2010). The obtained results may serve as the baseline data in risk management. The latter is currently referred to as a decision-making process in regard to the risks associated with human economic activity and subsequent implementation of the decisions taken.

One notion to be considered in the course of risk analysis and assessment is that of 'an acceptable risk level' which is defined in contemporary literature as the level of potential loss that results from one or several hazards but does not lead to irreversible change or damage. Speaking about gas industry sustainable development as the most complicated multi-faceted economic, natural and social system it is worthy to identify the causes of 'integrated risk' which involve potential losses caused by multiple factors (environmental, geopolitical, industrial, economic, social, etc.) and sustained by a particular facility within a certain period of time. In monetary terms we could speak of the concept of 'economic risk' (Samsonov *et al.* 2007).

Gas industry sustainable development today should have a minimum acceptable impact on the environment. Geo-ecological risks are among those requiring complex procedures to determine their quantitative parameters and estimate potential damage to the environment and the population caused by the man-made and/or natural hazards at the current or future stages of industry development. The geo-ecological risks generally occur in the areas where gas facilities affect various ecosystems and their biotic and abiotic components, together with the population of those areas acting as recipients of the environmental risk (Bashkin 2007; Kazak & Bashkin 2007).

Analysis of sustainability and efficiency of gas industry development identifies potential risks to be associated with multi-variant development of the industry and its subsystems especially at the stage of new gas fields' exploration. General or specific risk assessment requires risk management efforts encompassing a set of legal-regulatory, organizational, administrative, economic, engineering and other activities aimed at mitigation or prevention of the potential or real economic losses or environmental damage in the areas of gas industry development.

Risk assessment and management are carried out with application of deterministic and probabilistic methodological approaches. Depending on the set goal and methods available it is possible to use qualitative (expert) or quantitative (modeling) techniques of risk assessment and management in order to shape the master scheme of gas industry and new gas fields development (Kazak & Samsonov 2007). To attain this, the following steps should be undertaken:

1) identification of critical sectors and facilities of the information infrastructure *via* risk analysis and assessment of gas facilities;

2) management of risks associated with the information security in large computer-aided organizational systems;

3) working out the requirements for information security in critical segments and facilities of the gas industry;

4) monitoring the condition of critical segments and facilities of the gas industry.

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METHODOLOGICAL APPROACHES TO MANAGEMENT OF THE RISKS IN MASTER PLAN

This section of paper presents methodological approaches to management of the risks associated with exploration of new gas-bearing fields as part of the master scheme for the gas industry development.

Effective risk management tends to be really significant due to the complicated natural and climatic conditions in the potential gas-producing provinces. Thus, studies of geo-ecological risks should be conducted at various gas facilities. Geo-ecological risks are defined by the following factors:

- joint impact of natural and man-induced factors on the environment and human health in the areas of gas facilities operation;
- impact of natural factors onto the gas industry development.

Diverse natural conditions coupled with gas industry multi-faceted structure account for the need to create a 'versatile tool' for geo-ecological risks assessment. This can be done by modeling the impact of gas facilities on the environment and human health in different situations and the effect of geo-ecological factors on various gas industry subsystems in the potential gas-bearing areas.

The need for risk assessment and management is triggered by complexity of the current gas industry system involving production, demand, transmission, processing and underground storage, and by the space and time uncertainty of many input parameters defining the status of this system.

METHODOLOGY FOR MULTIPLE SCENARIOS OF GAS INDUSTRY DEVELOPMENT AND EXPLORATION OF NEW GAS-BEARING PROVINCES

The master scheme of the gas industry development in different countries and the corresponding scenarios of new fields' exploration are based on long-term assessment of the status of the mineral resource base together with potential gas production, including reserves forecasting in new territories and water courses. The development outlook for particular gas-producing provinces should account for the increasing complexity of the geo-environmental, climatic and geographic conditions, which is accompanied not only by increase in risk size but often by uncertainty of input parameters required for gas production assessment and forecast.

The following macroeconomic parameters of the country's long-term development serve as the criteria for domestic gas demand forecasts as one of the basic components of the fuel-energy balance output capacity:

- rate of GDP change and its energy intensity;
- evolution of the living standards of the population, their impact on the scope and structure of power consumption;
- price ratio for different types of fuel.

Developing scenarios for domestic gas demand require optimization of the country's fuel and energy balance and gas share in the overall power consumption balance.

To forecast gas volumes supplied to the local and global markets within the timeframe of defining the master scheme for gas industry development (which normally takes 25-30 years) emphasis should be laid on the specific features of each particular importing country. Among them are natural climatic conditions, proximity to exporting countries, availability or lack of the domestic gas pipeline network, economic and industrial development trends, potential production and consumption facilities for gas and other resources, etc. At the same time, it is required that the market share of gas should be taken into account for a specific country. To this end, potential markets are located for natural gas export expansion (including liquefied gas) particularly in the Asia-Pacific Region.

In order to ensure gas demand and market risks mitigation various scenarios are developed that outline various timeframes of field development and potential amounts of gas production and import levels for the period under review. The period of field development is determined by the status of the mineral resource base and its enhancement potential, resources cost estimates, fields' categorization in line with their cost-effectiveness and gas transmission systems development.

Formulation of the master scheme for gas industry development involves identification of alternative options for the development of gas production capacities and pipeline transmission systems. Options should provide for completion of the current construction projects and implementation of potential projects to ensure synchronous increase in gas production and transmission capacities. In this regard, not only the absolute parity of capacities is considered but also the existing imbalance between gas consumption and resource supply to the country's provinces.

All the scenarios differ in terms of commissioning period for the developed gas fields. Each scenario should determine production, economic and environmental risks which may arise in case of their implementation and consider management decisions of risk mitigation.

RISK ASSESSMENT IN GAS INDUSTRY DEVELOPMENT SCENARIOS

Scenarios designated to optimize gas industry development at the stage of new fields' exploration should account for major risks (including process, financial, management, commercial, human resource, geo-ecological risks) and consider management decisions on risk mitigation.

Risks may be divided into several sub-groups. Process risks cover geological risks as well as availability and adaptation of technologies and equipment, etc., financial risks are interconnected with investment scope and efficiency, organizational risks depend on availability of material and technical resources and infrastructure, staff qualifications, safety risks are related to industrial and environmental safety.

To select the optimum scenario for gas industry development, it is practical to consider two key risk groups: production risks and economic risks. The abovementioned of risks sub-types may refer to each of the groups.

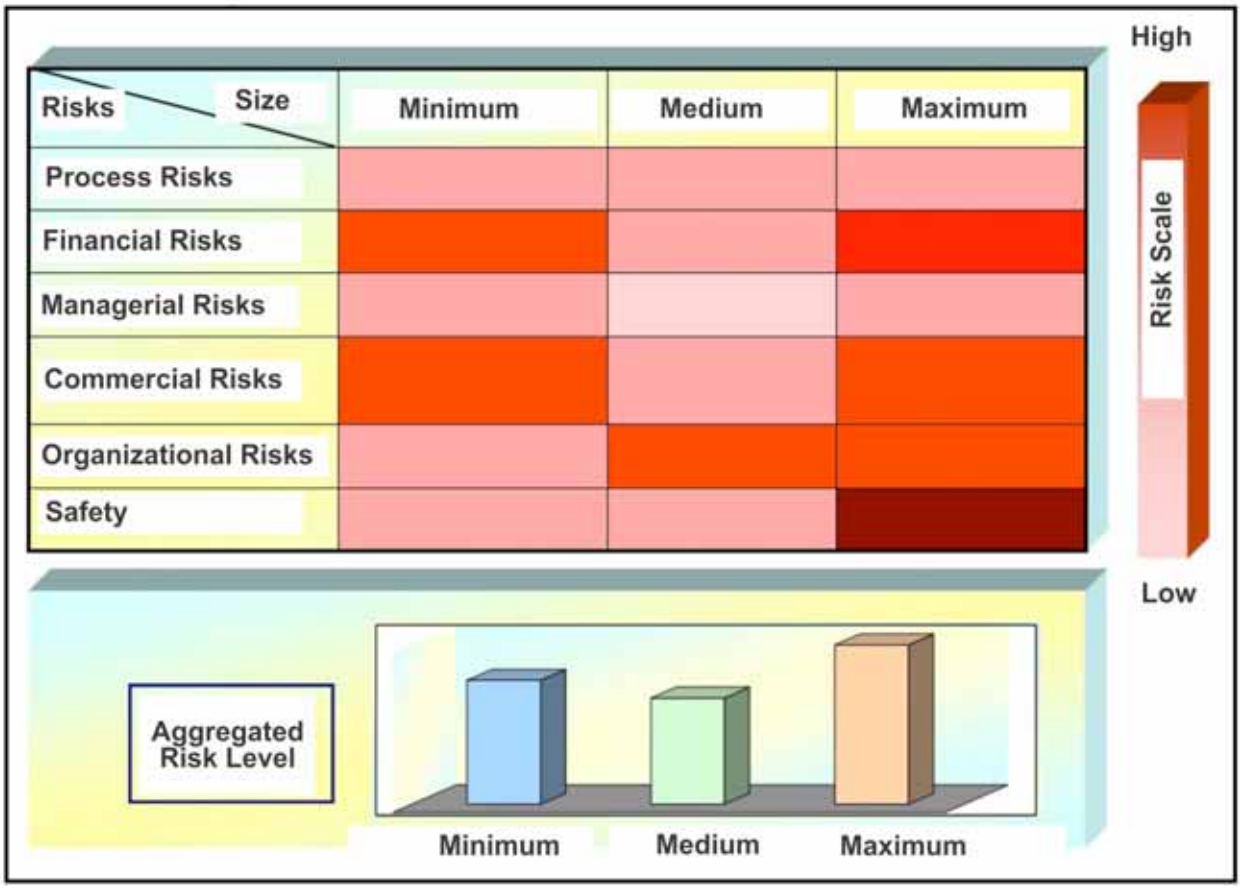

Fig. (1). Risk scale diagram for different scenarios.

Production risks may occur if gas demand significantly exceeds the ability to satisfy it. The following list of production risk factors may help analyze sustainability of the scenarios:

1) discrepancy between the pre-planned gas production and actual demand;

2) inflexible gas flow management;

3) lack of new technologies for the development of new fields in the areas with severe climatic conditions;

4) lack of technologies for the development of offshore and deep-water fields;

5) reduced volume of expected imports from other countries.

Economic risks may occur in the vaguely foreseeable future due to an unpredictable drop in gas demand and gas prices in different markets. Drop in demand compared to the expected level leads to under-use of capacities and a lower return on equity. Prices decline entail lower revenues from gas sales.

In scenarios with high capital investments (typical of new fields' development) a decrease in demand and prices may lead to a higher financial risk and credit default situation. If there is a sizeable deterioration of economic indicators, chances are high that repeated borrowing will be required to pay interest and pay off the current loan.

A reduction in demand compared to the forecast values is more likely to take place in scenarios involving entry into new markets. Prices in new markets may be much lower than the estimated prices. Accuracy of gas price forecasts in new markets is low due to the absence of existing contractual relationships and statistical data. Price-related risks are now especially high in the countries with either fast growing economy or competitive markets. In the latter case, risks can normally come from potential gas supplies to such markets from other exporting countries.

Scenarios based on the maximum demand in export markets suggest implementation of capital-intensive projects intended for construction of new gas transmission systems that require substantial borrowings and a high return on investments. Even a minor drop of demand may lead to a lower rate of return on investment of large-scale projects aimed at development of new gas transmission systems.

Fig. (**1**) is a diagram of the potential impact of each type of risk in the hypothetical scenarios. It demonstrates that the highest risks are observed in scenarios with a larger import share and those that involve implementation of projects on gas supply to fast-growing or competitive markets. Each scenario should specify timeframe for management decision-making with respect to commencement of field development and gas production in new gas-bearing provinces. This would ensure management of different types of risks regardless of hypothetical scenarios type.

CONCLUSION

The analysis of development sustainability contemplates working out of medium- and long-term forecast together with multifaceted assessments of different risks, and management of such risks. At the same time, any risk "assessments" is perceived as an integrated, theoretically substantiated methodology of probability forecasting of economic operations and their implications in highly uncertain environment, especially in the long term. The proper notion of risk includes the probabilistic measures of a hazard or a combination of hazards identified for a relevant object in the form of possible losses during certain pre-assigned period of time.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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