Legal and Methodological Basis of Gas Distribution Systems' Operating Reliability

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Introduction

At present a reform of the technical regulation and standardization system is underway in Russia. The reform was initiated by the Russian Federation Federal Law "On Technical Regulation" of 27.12.2002, No.184-FZ. The Law changes cardinally the earlier system of setting and applying mandatory specifications to products, design, manufacture, construction, and operation of such products.

Only the technical regulations may contain the mandatory requirements to products or relevant processes; other requirements may be applied voluntarily.

Pursuant to Federal Law "On Technical Regulation", national standardization is implemented in accordance with the principle of voluntary application of standards.

The executive authorities' documents, national standards, codes containing mandatory requirements, which were developed and put in force before 2002, will be in force only until adoption of respective technical regulations and updated standards.

Upon completion of the reform, the technical regulation system will have a vertically integrated form to reflect different levels of setting the requirements and their methodology. In this system, the bottom level of the technical regulation – the organization standardization system – will acquire great significance.

The new technical regulation system confers largely the responsibility for ensuring reliability and safety of potentially hazardous facilities on the owners of such facilities, granting them a certain level of freedom in their choice of the means and methods of that assurance. A system of standardization of the operators of hazardous facilities serves the foundation of the reliability and safety assurance. The organization standardization system may include both the organization's in-house standards and other organizations' standards if they serve that organization's purposes.

Aims

In 2010, in view of the changes in the technical regulation legislation, JSC «Gazprom» adopted the Concept of Technological Development of Gas Distribution Systems (hereinafter – the Concept). The Concept defines the main objectives of JSC «Gazprom» and its companies to migrate to operation of gas distribution systems based on their actual technical condition. Operation on the basis of actual technical condition involves planning of maintenance and repairs according to the assessment of the physical and economically justified condition of the gas distribution systems' facilities with regard to the risk of causing damage to humans, property and environment during their operation. Creation of the conditions for migration to operation of gas distribution systems based on their technical condition includes, inter alia, development of respective gas distribution legal and methodological basis of JSC «Gazprom».

The Concept addresses the accumulated gas distribution problems related to the previous regulation system that is still effective.

The existent system of gas distribution system maintenance is based on the regulation by the national regulatory documents of the regularity and scope of preventive maintenance jobs. The regulated minimal interval between rounds ignores the factor of aging, dividing gas-lines into two groups only: those that have been operated for up to 40 years and those that have been operated for more than 40 years.

For instance, for steel gas-lines having been in service for up to 40 years, which are situated in the built-up community areas, the regularity of rounds is once a month and if they have been operated for more than 40 years then daily for the purposes of diagnosis and extension of their service life. The technical director of gas distributing organizations (hereinafter - GDO) is empowered to establish a different frequency of rounds of underground gas-line routes depending on their actual technical condition, availability and efficiency of electrical protection installations, equipment monitoring system, gas-line pressure category, operational and other factors, but not less frequently than specified in the state supervisory body' regulatory documents.

At present, there are no methods of establishing technologically and economically justified regularity of rounds and preventive maintenance depending on the above factors. Developing the maintenance and repair plan, the GDO director has to rely on his experience and observations over the current status of facilities. At the same time, the technical director's possibilities of increasing the scope of maintenance and repair jobs are limited by the GDO financial resources.

The income of gas distributing organizations in Russia is limited by the current system of regulation of the gas rates for consumers. Setting their rates for the next term, GDO substantiate their future expenses on maintenance and repairs by the effective regulations. Hence, the above-level gas-line maintenance jobs are not covered by tariffs resulting in extra costs and reduced income of GDO.

Growth of gas distribution systems' constructions happened in the seventies of the previous century, so at present the number of steel gas-lines that have been in operation for almost forty years is increasing, which is the time when it is necessary to establish their actual technical condition and decide whether to extend the gas-line service life or withdraw from service.

The recent high pace of construction of new gas-lines accepted by gas distributing organizations for servicing also demand additional material funds and resources from GDO to take care about their preventive and emergency maintenance, increase the manpower and expand the servicing infrastructure.

The current government rate regulation system aimed at keeping the prices on natural gas for consumers down results in emergency and maintenance services of GDOs having insufficient material and technical equipment, in noncompliance with maintenance and repair plans, lower quality and smaller scope of scheduled maintenance.

Under these circumstances, there are two possible options to resolve the problem of discrepancy between the costs required for good-quality servicing of gas distribution system and GDO income determined by the set rate. The first option is to change the rate regulation system; the second one is to change the gas distribution systems' servicing system.

The first option – revision of the rate regulation system – might increase the GDO income so that it would be sufficient to compensate the justified increase of GDO operating expenses. The actual reliability or the operation risk, the level of compliance of the reliability indices with regulatory figures might serve as the quantitative measure of reasonableness of GDO expenses in this instance. But increase of GDO expenses would inevitably entail growth of gas rates for consumer, which is inconsistent with the social and economic policy of the Russian Government and, hence, this method of resolving the problem is irrelevant in the current economic situation.

The second option – revision of the servicing system – will allow a more efficient allocation of limited GDO funds to operation. To this end, GDO should be more independent in their choice of means and methods of ensuring operational reliability and safety of gas distribution facilities, only the final result – the regulatory reliability and safety indices – being controlled; and gas distribution organizations should be equipped with a legal and methodological basis of determining the efficacy of these or other measures of ensuring reliability and safety of the facilities serviced. The ratio of the expenses on implementation of measures to increase of the operational safety index or risk level reduction may serve as the quantitative measure of efficiency of such measures.

It should be noted that both methods imply existence of the methodology of risk calculation and assessment of the efficiency of risk reduction measures as the legal and methodological basis; but the application of methodologies is different and the status of methodologies should be different.

When the methodology is used to substantiate the GDO expenses that are necessary to ensure the required operational reliability and risk level, the methodology should have the governmental status since it will be applied by the Federal Tariff Service (hereinafter – FTS). The methodology should provide a single-value result in the calculation of both the actual operational reliability and risk indices, and the planned (forecast) values, as well as the costs required to achieve them. This gives rise to the problem of determining and setting the regulatory operational reliability and risk values for GDO, which shall be the objective function in substantiation of the GDO costs. The methodology should pass extensive testing because the responsibility for the calculation results is very high. The requirements listed make the task of developing and approving such methodology extremely important and complex.

The methodology of calculating the operational reliability and risk indices, which is applied by the GDO technical director in the development of an optimal plan of gas distribution facilities' maintenance and repair, may have the status of an industrial standard and recommendations. The main purpose of the methodology is to render methodological assistance in the quantitative evaluation of the efficiency of planned works to maintain gas distribution system's operability and reduce the risk of its operation. In this instance, the requirements to the methodology are less stringent: the methodology should be clear to GDO specialists, should not contradict the existent operation experience, should provide GDO specialists with information on the efficiency of these or other measures taken, should help selecting the most efficient service plan at the specified limited resources. In this instance, the decision rests with the GDO technical director and the calculation results have an auxiliary importance.

The aim of the works currently carried out by JSC «Gazprom» and its companies is to demonstrate the new opportunities of gas distributing organizations servicing the gas distribution facilities resulting from the reform of the technical regulation and standardization system in Russia, to migrate to a more flexible servicing and planning system. In this instance, the obligatory scheduled maintenance will be provisionally reduced and the scope of preventive maintenance aimed at prevention of failures and safety assurance will be increased. Using this approach, GDO will be able to service the gas-lines and gas distribution system's facilities selectively, allocate their resources to top priority maintenance of critical and worn out sections, reasonably assign priorities as regards the regularity and emergency of scheduled maintenance jobs.

Since 2008 JSC «Gazprom promgaz», on the order of JSC «Gazprom», has been doing research aimed at development of the methods and methodologies of the calculation and quota setting of gas distribution operational reliability and technical risks. These efforts are aimed at creation of a legal and methodological basis and tools for introduction of new approaches to GDO asset management and production planning based on the regulatory operational reliability and industrial safety requirements.

Operational reliability of a gas distribution system is the reliability manifested during gas distribution system operation. The gas distribution system's operational reliability is ensured by routine repairs and strict observance by the operator of the maintenance jobs. Increased operational reliability is usually achieved by overhaul and reconstruction of unreliable and worn out elements.

Reliability Indices

Operational reliability is quantitatively characterized by reliability indices (hereinafter - RI). A distinction should be made between reliability indices of particular gas distribution system elements and reliability indices of the overall gas distribution system.

<u>The Notion of Failure in Gas Distribution Systems</u>

The question of what should be regarded as gas distribution system's failure is rather intricate and debating at present. Obviously, the cases of unscheduled cessation of gas transportation to consumers, including during emergency repairs, should be regarded as failures in the gas distribution system functioning. In view of the more stringent requirements to the industrial safety of gas distribution systems, violations of integrity of the gas-lines, connections and gas equipment accompanied by gas leakage, even if they have not resulted in cessation of gas supply to consumers, should be also regarded as failures.

The regulatory documents of JSC «Gazprom» give the list of events that should be regarded as gas distribution system failures:

- events classified as an gas distribution system accident or an incident according to the effective regulatory documents;
- violations of integrity of the gas-lines, connections and gas equipment accompanied by gas emission (leakage),
- detection of a gas distribution system damage or fault requiring emergency repair;
- clogging entailing limitation (cessation) of gas transportation to consumers;
- detection of faulty gas equipment of outside gas-lines and GDP requiring unscheduled repair;
- deviations of gas parameters at the GDP outlet beyond the permissible values, including shutdowns;
- other cases of unscheduled limitation (cessation) of gas transportation to consumers due to technical reasons in the gas distribution system.

However, at present there is no formal delimitation between the leakage posing a hazard and requiring immediate remedy and non-hazardous «working» leakages.

<u>Gas Distribution System's Reliability Indices</u>

The following indices are used as the overall gas distribution system's reliability indices: the expected number of gas distribution system's failures during a year; mean time to failure; availability factor; short-delivery of gas to consumers due to failures.

Depending on the failure consequences, the following indices are used:

– $N_{0,95}^{ав+инц}$ - the maximal number of failures classified as an accident or incident for a year;

– $N_{0,95}^{рем}$ - the maximal number of emergency repairs for a year (the total number of accidents, incidents, through corrosion damages and other failures repaired as emergency);

– $N_{0,95}^{откл}$ - the maximal number of failures resulting in consumers' disconnection for a year;

– $N_{0,95}^{катег}$ - the maximal number of failures resulting in disconnection of 'not to be disconnected' consumers or consumers having technological reserved gas consumption quota for a year;

– $N_{0,95}^{отопл}$ - the maximal number of failures resulting in interruption of heat supply to population during the autumn and winter heating period for more than 24hrs, for a year.

The mean time of gas supply resumption after failure characterizes the gas distribution system's maintainability. Depending on the failure consequences for consumers, the following indices are used:

– $t_{\text{ср откл}}^{ГС}$ - mean duration of consumers' disconnections during failures with cessation of gas supply to consumers, hr;

– $t_{\text{ср отказ}}^{ГС}$ - mean duration of consumers' disconnections during failures (including failures without cessation of gas supply to consumers), hr.

The availability factor $К_{\text{гот}}$ is applied as the reliability index of both the overall gas distribution system and particular gas distribution system facilities: gas distribution plants, gas equipment, particular gas-lines. The gas distribution system availability factor $K_{гот}^{ГС}$ is a stochastic observation calculated using a failure prediction model. The operational availability factor is determined based on the actual data about duration of gas distribution system's failures and characterizes the actual functioning and maintenance conditions.

The relative gas short-delivery $d\overline{Q}^{ГС}$ is determined as the ratio of gas volume not delivered to consumers due to failures to the planned delivery (transportation) volume for a year:

$$d\overline{Q}^{ГС} = \frac{\sum_i \Delta Q_i}{Q_{план}},$$

where $\sum_i \Delta Q_i$ is the total gas short-delivery due to failures for a year;

$Q_{план}$ is the planned volume of gas transportation via gas distribution systems for a year.

The suggested indices are both operational i.e. they can be determined based on GDO review data, and computational i.e. they can be forecasted using the developed methodology.

Reliability forecasting is a special case of facility reliability calculation on the basis of statistical models reflecting the trends in reliability variation of analogue facilities and/or expert analysis. The reliability forecasting methods allow tracing both the pipe ageing and equipment wearing out processes (overhaul, reconstruction, new construction) of the gas distribution system in terms of system reliability.

Specific reliability indices characterize reliability of gas supply to selected groups of consumers: population, heat suppliers, businesses having large consumption volume.

Reliability Indices of Gas Distribution System's Elements

The criterion of the technical condition of particular gas distribution system elements is the values of their operational reliability indices required for the analysis of the overall gas distribution system reliability and calculation of the probability and risk of failure.

As the reliability indices of structural gas distribution system elements – gas-line sections, stop and regulating valves, electrochemical protection installations, the traditional theoretical reliability indices are used: failure probability, remaining life expectancy, time between failures etc.

The methods of calculating the reliability indices of the main structural elements of the gas distribution system under development are based on the accumulated operational statistical data of failures of similar elements with regard to the specificity of gas distribution system operation in Russian regions, instrumental inspection and monitoring of the technical condition.

For instance, the probability of occurrence of a through damage in an underground steel gas-line is determined based on its operation time, the probability of «leakage to cock» - depending on the operation time of the non-gland cone cock widely used as a shutting-off device of gas supply to consumers. These dependencies were established as a result of statistical processing of data about failures during operation.

The task of converting the data of instrumental inspection of gas-lines and equipment into reliability indices implies an extensive scope of research including laboratory tests. For example, at present laboratory tests are carried out in order to build a model of check valves' contact surfaces wearing depending on the operation conditions. Experimental studies of the metal strain ageing in the heat affected zone near weld joints have been planned, which are necessary to determine the reliability indices and remaining life expectance of weld joints and the intervals of distribution gas-line diagnosis.

Information Basis

The essential condition of the integrity-based maintenance system and the allowed operation risk practical feasibility is the creation and populating of the information database. Apart from the failure reports, rated values of the units in operation, information on their actual technical condition, results on instrumental investigation, repairs done, service costs, etc.

The centralized acquisition of data on failure events and technical condition of the gas distribution network units will make it possible to perform a variety of actions aimed at the reliability analysis, evaluation of correspondence between the actual and standard reliability indices and to work out the measures to be taken by the specialists of the managing company aimed at increasing of efficiency.

In order to create such failure data base, JSC «Gazprom promgaz» has suggested and tested questionnaires to acquire data on gas distribution network failures: in the pipeline part of distribution gas-lines, gas distribution plants and gas equipment of outside gas-lines.

70 gas services have been questioned. The total number of failures during the period of 2008 - 2009 equaled to 8742 failures including: 4135 in the pipeline part, 3038 in gas distribution plants, 1569 in the check valves. The number of recorded accidents and incidents for the same period amounted to 4311.

The study of the information about gas-line failure consequences has shown that gas leakage occurred in 61.2% of cases. In the remaining cases, failures were characterized by cessation of gas supply to consumers due to al kind of clogging and damages of gas-lines without violation of their integrity. Among the leakage failures, the majority (98.5%) are leakages without inflammation. 2 indoor explosion cases resulted in human casualties.

According to the round and instrumental inspection data provide by GDO, only 10.4% and 4.4% of leakages in total were detected, respectively. The rest was detected through receipt of emergency requests. The uncertainty of classifying the leakages detected in the course of such types of maintenance as failures supports the requirement for a separate investigation to determine the efficacy of those types of maintenance for gas distribution systems' reliability assurance.

Based on the analysis of information provided by GDO concerning the failure reasons, seven main groups of failure reasons were singled out. Among them, the majority falls on human impact (50.5%), environmental impact (26.4%), and corrosion (11.3%). The number of failures and the percentage of the main reasons relative to the total number of failures are summarized in the table.

Table The number of gas-line failures in 2008-2009

Main Failure Reasons	Number of Failures (units)	Percentage (%)
6.1 Human impact	2090	50.54
6.2 Environmental impact	1091	26.38
6.3 Corrosion	469	11.34
6.4 Factory defects	21	0.51
6.5 CA quality	206	4.98
6.6 Design errors	7	0.17
6.7 Gas quality	93	2.25
6.8 Other	158	3.82
Total	4135	100

Methods

Probability-statistic model.

JSC «Gazprom promgaz» has developed a stochastic (large-sized) model of gas distribution system failure prediction, which enables calculating the reliability indices and failure risks depending on the technical characteristics, age and operation conditions of the pipeline section.

The suggested methodology allows establishing specific failure flow parameter (hereinafter – SFFP) inter-community gas-lines, intra-community distribution gas-lines, and input gas-lines, including their classification into categories based on their laying and material: above-surface, underground steel and polyethylene. Failure flow values are calculated depending on the failure reasons: human impact, environmental impact, corrosion, factory defects, the quality of construction and assembly operations, design errors, gas quality, and other.

The calculation starts with decomposition of the gas distribution system into separate functional elements (similar gas-line sections, gas reductions stations). Similar gas-line sections are characterized by constant parameters determining the section SFFP: gas-line designation, location relative to the surface, locality where the gas-line is laid, piping material, and service life. Each section is assigned with a constant SFFP according to its parameters.

Gas distribution plants are regarded in this mathematical model as separate structural units of the gas distribution system, which characterized by FFP depending on the type.

Check valves are not singled out as a separate structural unit of gas distribution systems due to excessively great number of check valves. At the present stage of the mathematical model development, distributed characteristics are used, namely, the number of check valves and the of check valves' failures is related to the length of outside gas distribution systems.

The overall gas distribution system reliability is calculated based on the assumption that possible failures in separate gas-line sections are statistically independent events.

The expected number of gas distribution system failures for a year $N_{отказ}^{ГС}$ is established by totaling over all gas distribution system elements identified during system decomposition. In general, the calculation is done according to formula:

$$N_{отказ}^{ГС} = \sum_{i} \left(\sum_{j} \omega_{i}^{j} \right) \cdot L_{i} + \sum_{k} l_{k} ,$$

where j is the totaling index by types of gas-line failures;

i is the totaling index by gas-line sections;

k is the totaling index by identified gas distribution system elements except for gas-line sections;

L_i is the length of gas distribution system's gas-line sections, km,

ω_i^j is the SFFP of gas-line sections, (km ·year)$^{-1}$;

l_k is the FFP of the k-th of identified gas distribution system elements, (year)$^{-1}$.

For each identified element, based on its parameters, the failure flow value is determined; and based on reliability indices of particular elements the reliability indices of the overall gas distribution system are calculated.

On the basis of experience of the large-sized prediction model and data about 9 thousand of failures in Gazprom Group GDO for the period of 2008 - 2009 (pipes, check valves and gas distribution plants), the directions of improving the gas distribution system failure prediction model through identification of separate structural elements of the gas distribution system, clarification and more extensive differentiation of the elements' failure flow values depending on their technical characteristics, clarification of failure criteria have been worded.

Failure Prediction Model Improvement

The developers' efforts are mostly aimed now at developing the methods of reliability indices calculation for the main functional elements of the gas distribution system (failure risk prediction) based on the analysis of all available information: data about facility's technical characteristics and operation conditions; data about facility technical condition obtained during rounds and visual inspections; data about earlier repairs of the facility; data about the facility technical condition obtained during instrumental inspections; data about performance of facilities equipped with remote monitoring systems; operators' expert reviews.

The most objective information on the technical condition can be obtained from instrumental inspection, during which the integrity, insulation material deterioration and pipeline body degradation are measured. Actual parameters of the insulation material and the material of the pipeline body change through time, thus making up the residual life of the pipeline and the possibility of outrage on the pipeline.

The creation of the reliability index calculation method based on the results of instrumental inspection will make possible the movement from the large-sized failure prediction model towards a more accurate second generation model.

The further development of the failure prediction model (third generation model) is connected with the development and application of the residual life of the pipelines' equipment (check valves, gas distribution plants) and pipe body. The residual life of the pipe body is estimated based on the metal properties in the most critical parts: in the heat affected zone near the welded joints and in the zones on existing corrosion damage. Results of laboratory tests, aimed at finding out wear regularities, will be used to define the residual life of the check valves, depending on the operating conditions.

Failure prediction model also considers the opinion of the GDO specialists on the technical condition of the network in service. Subjective evaluation score index should be considered alongside with the objective evaluation indexes of integrity, when the failure prediction model is being created.

Results

Reliability Quota Setting

The development of the reliability estimation and failure prediction methods is accompanied with the development of approaches to operational reliability quota setting and reliability management methods.

Reliability quota setting can become one of the most effective tools of assets management in gas distribution. In general, reliability quota setting for the gas facilities of Gazprom Group is being done through the setting of target reliability indices. Target reliability indices characterize the managing company's commission to achievement of the desirable reliability of the whole gas supply service in general. The target reliability indices are set for a certain period (planning period) and are the quantitative measure of the estimated reliability level within the whole of Gazprom Group.

The reliability quota setting procedure for the subsidiary and affiliated companies is performed by the managing company. The standard reliability indices for the gas distribution networks, operated by the gas distribution organizations of the Gazprom Group are calculated on the basis of the set target reliability indices. The operating conditions and the structure of the gas network are taken into consideration when standard reliability indices are being calculated for each GDO. The observation of the standard reliability indices by each GDO makes it possible for the whole of gas service of Gazprom Group to observe the set RI requirements.

The target reliability index of the overall gas distribution system (industrial indices) is 95%-fractal of the number of failures in the gas service for a year of the following types:

- accidents and incidents;
- emergency repairs (the total number of accidents, incidents and through corrosion holes);
- failures resulting in interruption in gas supply to consumers;
- failures resulting in interruption of heat supply to population during the autumn and winter heating season for more than 24 hrs;
- failures resulting in disconnection of consumers.

Reliability quota setting makes it possible to set the quantity requirements to the reliability level, analyze the compliance of actual reliability level with the standard level and justify the measures aimed at meeting the standard reliability level.

Reliability Management

Reliability management is the totality of coordinated actions carried out to meet the operational reliability requirements. One can say that all of the GDO efforts are aimed at ensuring operability (reliability) of the system in service, but it won't be quite correct to equate such efforts to «reliability management».

Reliability management implies safety requirements' formulating awareness (standard RI values), existence of benchmarking and quantitative evaluation feasibility.

As a result of gas distribution facilities maintenance service execution, minor and overhaul repair, modernization, re-equipment, growth of material assets and equipment capability a range of methods for the dynamic analysis of RI has been developed by now. The comparison of the growth of reliability and the costs of this growth makes it possible to compile long-term plans (a program) of managerial and engineering actions aimed at the achievement of the required reliability level of gas distribution networks with the reduction of overall costs.

This approach is also applicable in short-term planning of GDO's gas network servicing activities, planning of investment into the modernization and GDO's material management.

The aim of scope of network maintenance work planning is the optimal distribution of the available material and technical resources of the GDO, in order to ensure operational capability and maximally increase the efficiency of gas distribution networks.

The base version of the plan is the result of linear programming used for the solution of an algorithmic optimization problem. The target function is the RI of the serviced gas distribution system; the limits are the material and technical resources available; and the scope of compulsory scheduled maintenance. The solution of the problem is to choose from the list of possible actions (maintenance operations, current repair and preventive maintenance) the ones which give the maximum increase in the reliability of the system, with the overall costs being limited to by a set value.

During the period of the required investment planning and justification, the aim is to achieve standard reliability with minimum amount of investment possible.

The problem of maximal reliability improvement at limited reconstruction investment is formalized by equations:

$$\Delta P = \sum_{j=1}^{N} \left(\Delta p_j \cdot x_j \right),$$

$$\sum_{j=1}^{N} \left(\Delta z_j \cdot x_j \right) \le Z,$$

where ΔP - the target function – is the total incremental OR of the gas distribution system resulted from reconstruction;

N is the number of potential facilities to be reconstructed;

Z – limitation – is the investment allocated to the reconstruction (overhaul);

Δp_j is the incremental OR resulted from reconstruction of the j-th facility;

Δz_j is the cost of j-th facility reconstruction;

x_j is the variable equal to 1 when the facility is assigned for reconstruction, and otherwise - to 0.

If the task is to bring the gas distribution networks' reliability to the standard, then the facilities to be reconstructed are selected based on the minimal investment requirement solution. The problem of minimizing the cost of reliability improvement to the required level is formalized by equations:

$$Z = \sum_{j=1}^{N} \left(\Delta z_j \cdot x_j \right),$$

$$\Delta P \le \sum_{j=1}^{N} \left(\Delta p_j \cdot x_j \right),$$

where N is the number of potential facilities to be reconstructed;

Z – the target function – is the investment on the reconstruction (overhaul) providing improvement of the gas distribution system reliability to the standard;

ΔP – the limitation – is the required incremental gas distribution system OR resulted from the reconstruction;

x_j - is the variable equal to 1 when the facility is assigned for reconstruction, and otherwise - to 0.

The effectiveness of the methods developed has been demonstrated by the calculations made for the Nizhny Novgorod Region and Nizhny Novgorod city facilities. Application of the optimization procedure resulted in selection of 7 facilities out of 10 possible facilities. The criterion used was the gas distribution system's availability factor.

Thanks to the optimization solution, the facilities were chosen, which reconstruction has most improved the system's reliability within the funds allocated to the reconstruction. For the initial reconstruction project of ten facilities to the total cost of 81.5 million rubles, the reduction of the gas distribution system outage period due to reconstruction amounted to 873hrs during a year. Thanks to the optimization solution with limitation of the reconstruction cost to 50 million rubles, 7 facilities were chosen to the total cost of 48.1 million rubles. In this instance, the reduction of the gas distribution system outage period due to reconstruction amounted to 863hrs during a year.

Conclusion

The standard requirements to servicing of gas distribution systems as complex objects, which are used and under development in the developed industrial countries, are, first of all, aimed at continuous monitoring of the technical condition of such systems and predicted estimation of the damage resulting from an event (accident or incident). The necessity of harmonizing the Russian legal basis with the international standards calls for gradual streamlining the existent legal and methodological documents with the provisions fixed in the European and worldwide standardizing and regulatory legal acts.

After adoption of respective laws and legislative acts, a number of documents have been worked out and prepared, which specify the requirements to gas distribution facilities and their maintenance and regulate their material support.

Over the recent period JSC «Gazprom» and JSC «Gazprom promgaz» have developed a package of documents on assignment and estimation of reliability indices of gas distribution system and assurance of their standard level.

The suggested legal and methodological basis of gas distribution systems' operational reliability assurance lays the foundation for application of quantitative reliability indices in practical GDO resources and cost planning and maintenance, establishes benchmarking of the managerial and engineering actions aimed at the achievement of the required gas supply reliability and safety level based on the cost efficiency criterion.

Further efforts of JSC «Gazprom promgaz» aimed at improvement and testing of the standards and methods require a considerable scope of theoretic, practical and laboratory studies, up-to-date information analytical monitoring.