

Improvement of the Production Process Management System in Gas Distribution Organizations on the Basis of Modern GIS Technologies

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1. Introduction

With commencement of JSC «Gazprom» investments in establishing gas supply and distribution in the Russian Federation regions, the development rates of regional gas supply systems have considerably increased. The annual growth of distribution gas pipelines (including all sources) amounts to ca. 30,000 km, which greatly exceeds the volumes of gas pipeline construction and commissioning during the period of mass gasification.

In the 50s-60s of the last century, gas distribution organizations (GDO) – offices and groups for operation and repair of gas facilities – were established to operate gas facilities. Most GDOs in the Russian Federation have already celebrated their 50-year anniversaries while the equipment and management technologies almost have not changed.

The given statistics data evidence that the length of distribution gas pipelines in the RF and the gas transport volumes have grown 1.5 – 2-fold for the last 10 years

At the same time, the number of personnel in the gas sector companies has stayed at the same level. This could have been explained by modification of the maintenance and repair modes, implementation of automatic control systems, advanced technologies and methods in operation and repair of gas distribution systems. However, none of this has happened and only few GDOs show traces of improvement in production management systems.

The technical procurement has remained at the same level for the last 10 years as well, which is evidenced by low dynamics of the transport and machinery fleet development.

Technological backwardness and absence of technical strategy for the development of the GDOs do not enable to use the advanced modes of managing gas supplies, operation and industrial safety to the full extent. Low technological level of the GDOs does not enable to optimize operating costs, carry out activities on reduction of losses in the gas supply systems, gas consumption for auxiliary and technological needs, energy saving when using electrical energy for active corrosion protection of gas pipelines.

Weak technical procurement of the GDOs hinders implementation of efficient financial and economic policies. As a result, in the conditions of financial resources shortage, untimely upgrade of worn-out fixed production assets (FPA) occurs, level of wages remains low, social programmes are reduced, and the industry sector gradually becomes socially unattractive.

Quite high level of security and reliability of the gas supply systems laid down during the construction with a great margin of safety enables to ensure sustainable operation of gas supply facilities for the time being. However, as at 01.01.2011 generally in Russia, 38,751 km have been operated for more than 40 and more years already, 3,034 km require renovation, 7,826 km require diagnostics, total – 10,861 km). In addition to very low volumes of renovation of the gas distribution facilities, the estimated current repairs that are required though not made yet amount to 20 billion Roubles, and the annual need amounts to 5 billion Roubles.

In order to satisfy the interests of JSC Gazprom in the domestic market, ensure reliable and secure gas supply for all categories of consumers, pursue the uniform industry technical, financial, economic and corporate policies, JSC Gazpromregiongaz Management Company was established in 2005 (now - OJSC Gazprom Gazoraspredelenie). Today, the holding system includes 168 GDOs (according to the engineering certificate for

Gazpromregiongaz) that operate 633,000 kilometres of distribution gas pipelines, which is more than 80% of the total length thereof in Russia.

The presence of the efficient management company in the market enabled to define basic principles of technical, financial, economic, and corporate policies.

Financial, economic, technical and scientific potential of OJSC Gazprom Gazoraspredelenie enables to systematically develop and implement efficient management systems for the gas supply facilities of their branches and in the Moscow Region in the first place. Such opportunities are not available for most other GDOs.

The low technical procurement and weak financial capabilities of the GDOs, significantly worn-out fixed production assets, and intensive development of regional gas supply systems gave rise to the necessity of synchronization of development of the gas supply systems and GDOs for the benefit of JSC Gazprom and associate companies.

Development of the regional gas supply systems is a strategic task of JSC Gazprom; it is subject to regional policy based on mutually beneficial cooperation with the administrations of constituent entities of the Russian Federation in accordance with the social and economic development plans of the regions.

Alongside with the development of the gas supply systems, there is a need in renovation of the gas supply facilities that is determined by technological, economic and environmental factors and implemented to improve security and reliability of the gas supply systems.

The Concept of the JSC Gazprom's Participation in the Gasification of Regions of the Russian Federation provides for the implementation of new technical solutions, technologies and materials during construction of gasification projects. However, only polyethylene technologies were widely applied at the design stage. Most advanced technologies accepted by JSC Gazprom, such as:

- Technology of using check valves for direct underground installation;
- Use of unattended gas control equipment;
- Technology for compartmentation of underground steel pipelines for the purposes of efficient corrosion protection;
- Improvement of telemechanics systems and automated information systems (AIS)

have not been practically applied; this hinders their implementation and development of GDO management systems.

The following will be needed for the optimal development of the gas distribution complex: sectoral scientific and technical support, systematisation of achievements in the field of development and implementation of technical means and technologies, consolidation of financial and organisational capabilities of all participants of the gas distribution and utilization systems of the Gazprom Group.

2. Objectives

The main objective of the development under the theme of "Improvement of the Production Process Management System in Gas Distribution Organizations on the Basis of Modern GIS Technologies" is to define priority directions of development, strategic goals and plans, and mechanism for their phased implementation.

Development of GDO and gas supply systems shall be subject to the principle of mutual interdependence, whereas it is necessary to define the order of interaction when designing the investment programmes and projects of gasification, renovation and technical modernization of the gas supply facilities, and plans of production and economic activities of the GDOs with respect to development, acquisition and implementation of technologies and technical means for the improvement of operation and industrial safety management systems.

3. Methods

Geoinformation systems (GIS) built on the basis of electronic diagrams of gas



pipelines superposed over electronic base maps may serve the foundation for the operation and industrial safety management systems. The electronic diagrams of gas pipelines with the posted structures and facilities should be complemented with electronic datasheets containing characteristics of fixed production assets (gas pipeline segments, cabinet type gas reducing stations (CGRS), gas distribution plants (GDP), pipeline electrochemical protection plants (ECP), valving).

The mandatory precondition is to match the electronic diagram with the actual data received by the AIS monitoring the basic operation parameters at the reducing fittings of gas sources and users, such as:

- Inlet and outlet gas pressures;
- Gas throughput volumes;
- Degree of gas contamination of premises;
- Unauthorized access;
- Filter pressure differentials;
- Condition of protective devices and valving.
- Active safety current and voltage in the ECP plants.

The necessity of monitoring other parameters should be determined at the stage of the specification requirements development.

Results of development of the given theme and its stepwise implementation will enable simultaneous development of the gas supply systems and GDO with achievement of the targets formulated as follows:

- To include in the projects of gasification and renovation gas supply systems the advances technical solutions and necessary activities on technical development of basic operation facilities in coordination with development of the gas supply systems;
- To issue datasheets for fixed production assets (FPA);
- To create electronic gas supply diagrams;
- To create and develop telemechanics systems and AIS;
- To utilize the possibilities of hydraulic simulation for gas supply mode control;
- To efficiently manage operation and industrial safety using database and software when designing plans and schedules of repair and maintenance and production control; development, reconstruction and modernisation programmes;
- To analyze and assess the technical condition of the FPA;
- To perform the accident rate analysis and forecast the risks in operating hazardous industrial facilities.

The foregoing proposals may be discussed as a basis for the preparation of arguments to support investments in technical development of the GDOs.

Two options of implementation of the developed Recommendations will be possible.

a) Option 1

Based on the concept approved by JSC Gazprom, bundled software, systems, subsystems and technology for management of development of the gas supply systems and GDO is to be developed

Based on the examination and assessment of technical capability, 2 or 3 gas supply companies are to be selected; and stepwise implementation of the developed bundled software and technologies is to be performed.

Step 1:

- Installation of the bundled software in GDOs, training of personnel.
- Presentation in GDOs of typical telemechanics system designs and automated metering systems (AIS), development of new or adaptation of existing AISs to the implemented systems.

Step 2:

- Gas network breakdown into gas pipeline segments featuring similar parameters (commissioning year, diameter, pressure, pipe material, laying technique etc.), issue of electronic datasheets.
- Issue of electronic datasheets for GDP, CRP, ECP plants, valving.



- At the same time, the datasheets should include information on the time and results of comprehensive instrumental examination, technical diagnosis, preventive repair, bypass of gas pipeline routes and gas distribution plants, as well as on accidents and incidents.

Step 3:

- Superposing the electronic gas pipeline diagrams over the base maps with highlighted gas pipelines with respect to pressures, laying techniques, and pipe materials.

Step 4:

- Development of AIS for monitoring the basic process parameters of the gas supply system (pressures, gas consumption, gas contamination of premises, electric potentials of ECP plants).

Step 5:

Integration of electronic datasheets and AIS data into the gas pipeline electronic diagram to create a hydraulic model and create GIS

Step 6:

Pilot operation of GIS with the following functions implemented:

- Gas supply mode control, accident location and liquidation, development and renovation project design using the hydraulic gas supply model;
- Recording and analysis of accidents and incidents;
- Analysis and evaluation of the technical condition of FPA;
- Preparation of maintenance schedules and records of the results of maintenance, preventive repair, technical diagnosis;
- Designing programmes for gas supply systems development, renovation and refurbishment.

Step 7:

- Building a multi-level AIS consisting of the following levels: level one – inter-regional and municipal operators, level two – regional (covering a region, territory, republic) GDO; level three – JSC Gazprom, JSC Gazprom Mezhrefiongaz, OJSC Gazprom Gazoraspredeleenie.

Step 8

Industrial operation of the GIS with the software complex copied in all GDOs of the Gazprom Group and design supervision.

The overall implementation of the entire complex of activities will take from 8 to 10 years provided that the GDOs will be technically ready, including with regard to:

- Concept development - 1 year;
- Bundled software and systems development - 1 year;
- Steps 1-7 - 3 years;
- Step 8 - from 3 to 10 years depending on technical readiness of the GDOs.

b) Option 2

The difference between Option 2 and Option 1 is that the complex will be installed in all GDO concurrently. It will require a greater number of professionals at the time of implementation and will enable to reduce the implementation period by 5 years; however, it does not provide guaranteed elimination of probable risks that may occur due to probable development errors.

4. Results

The developments resulted in approval of the following documents by JSC Gazprom:

- The Concept of Improvement of Production Processes in GDO;
- R Gazprom “Gas Distribution Systems. Strategy for Creation of Uniform Process Production Management System for GDO”;
- R Gazprom “Gas Distribution Systems. Organisational and Technical Requirements for Creation of Uniform Process Production Management System for GDO. Basic Functions”;



- R Gazprom “Gas Distribution Systems. Typical Technical Requirements for Electronic Base Maps”;
- R Gazprom “Gas Distribution Systems. Typical Technical Solutions for Creation of Electronic Gas Supply Diagrams Based on the Electronic Base Maps”;
- R Gazprom “Gas Distribution Systems. Typical Technical Solutions for Creation of Computerized Process Control System (CPCS)»;
- R Gazprom “Gas Distribution Systems. Typical Technical Solutions for Integration of Electronic Datasheets of FPA and CPCS into Electronic Gas Supply Diagrams”;
- R Gazprom “Gas Distribution Systems. Typical Technical Solutions for Creation of Hydraulic Simulation for Gas Supply Mode Control”;
- R Gazprom «Gas Distribution Systems. Typical Technical Requirements for Organizational and Technical and Information Support of GDOs”;
- R Gazprom “Gas Distribution Systems. Multi-Level Information System for Information Transmission and Processing”.

5. Conclusions

Based on the provided material, a conclusion can be made that the processes of development and improvement of the gas distribution complex must be scientifically grounded, comprehensive and systemic and must have an efficient management system.

In the provided Proposals, the following issues have been left undiscussed that relate to the improvement of efficiency of other activities that are in the area of GDO’s responsibility and that require scientific and technological arguments for their improvement and development:

- Metrological provision;
- Ecology and energy saving;
- Corporate general liability insurance and insurance of assets;
- Management of property and land assets;
- Human resource management, talent pool creation, and personnel training etc.

The exclusive role of JSC Gazprom Promgas in the gas distribution and utilization market may consist in establishment of scientific framework for the issues of prospective strategic development of the gas distribution complex of JSC Gazprom, system forecast and risk assessment.

When solving local problems, which can be seen at present, the efficiency of financial investments is impaired, incompatibility of some systems occurs, and development dynamics slows down.

For the efficient management of the Project in JSC Gazprom Promgas the issues of development and renovation of the gas supply systems and technical development of the GDOs should be integrated into one complex.