Gas Consumption Networks Development Problems

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Abstract. One of the urgent problems of housing construction modern development is the use of gas-powered equipment on natural gas for heating, hot water supply and food preparation. To solve this problem, Government Decree No. 1314 of December 30, 2013 is in effect in the territory of the Russian Federation. The article sets out two options for the contractual obligations execution between the gas distribution organization and the applicant to connect to the gas distribution network of the capital construction object. As a result of the study, it was shown that the proposed measures, which allow to analyze the perspective connection to the gas distribution network and are aimed at reducing additional construction and installation works in the future, will help to increase the gas consumption networks development and reduce their connection times.

Introduction
The gas infrastructure development is a priority for the country’s energy complex, aimed at ensuring the natural gas availability and improving the environmental situation [1,2,3,4,5,6].

After the Government Decree No. 1314 of December 30, 2013 (hereinafter GD) entry into force the new rules for connecting capital construction facilities to the gas distribution network [7, 8] were applied in the Russian Federation. Prior to the entry into force of the GD, the applicants at their own expense carried out the measures to create a gas distribution network, which included design and survey, construction and installation works with the road surface restoration. In this regard, the gas distribution networks and gas consumption development was chaotic due to the lack of a uniform methodology and funds allocated from the budget. After the GD entry, the applicant is obliged to perform only measures for the gas consumption network creation, including the execution of design and construction and installation work inside its site and capital construction object. In this case, the gas distribution network is considered to be an external gas pipeline, laid from the point of connection to the existing gas pipeline to the border of the applicant’s land plot. And the gas consumption network is the external gas pipeline, which is laid from the connection point on the border of the land plot before entering the capital construction object, the internal gas pipeline and gas-using equipment.

Materials and methods
Currently, three categories of contractual obligations, the gradation of which occurs according to gas consumption, remoteness of the land plot boundary to the gas connection pipeline point and pressure are defined [9,10]. Let us consider the contractual obligations performance order between the gas distribution organization (hereinafter GDO) and the applicant, a specific GD for the first category. At the first stage, the applicant submits an application for connection to the gas distribution network of...
his capital construction facility. After a certain period of time, depending on the need to create a gas distribution network to the border of the applicant's land, the GDO offers the applicant to enter into an agreement to connect to the gas distribution network with a deadline of 12 months. Then the GDO will need to create a gas distribution network with a gas pressure not exceeding an average length of 200 meters along the shortest path from the connection point to the land plot border. Measures to create a gas distribution network include design, construction, installation and survey works, the optimal time for which can be 9 months. During this period, the applicant takes measures for the gas consumption network construction, including the project documentation development, construction and installation work with the contracting organization involvement and the capital construction object construction readiness reduction to gas start-up.

It should also be noted that the GD is primarily aimed at the gas distribution networks development in those areas where it is technically possible to connect the new applicants with gas consumption up to 5 m³/h and a distance of not more than 200 m from the existing gas distribution network. This is due to the fact that under such conditions, the contractual obligations conclusion between the GRO and the applicant will be carried out under the so-called “preferential” 1st category connection agreement, the cost of which will be 47,309 rubles in urban areas and 33,197 rubles in the countryside. The contractual obligations fulfillment term in the 1st category is from 10 working days to 12 months. If the connection is made to a gas pipeline laid inside the applicant’s section, then the connection time is from 10 working days to 3 months depending on the pressure in the gas pipeline. When building a gas distribution network in rural areas or the absence of the need for lengthy approvals, the connection period should not exceed 9 months. A connection period of no more than 12 months is provided for the gas distribution networks construction within the city limits with the city district operating organizations and the administration approval.

Results
To clarify the problems arising during the gas consumption networks development and affecting the development on the region's gasification level [11,12,13,14,15], it is proposed to consider two scenarios for the fulfillment of contractual obligations between the GPO and the applicant, concluded according to the most common 1st category contract in detail.

In the first variant, the GPO constructs the gas distribution network on the basis of the design documentation completed and approved in the established manner, for example, 200 meters long [7]. In the hydraulic calculation, the GPO does not take into account the prospect of connecting further applicants, thereby limiting the gas consumption networks development in the area. Let us suppose that during the design and construction works a low-pressure gas pipeline with a diameter of 63 mm is laid (Fig. 1). Due to hydraulic losses above the permissible value of 1200 Pa [16], this gas distribution network cannot ensure the gas consumption networks further development (Table 1). This will lead to the fact that only the applicant’s neighbors can connect to this gas distribution network or it will be possible to extend the gas distribution network by the last stage for a certain distance depending on the hydraulic calculation. In this case, the GPO fully fulfills its contractual obligations to the applicant, which consists in creating a gas distribution network that satisfies the need for 5 m³/h. It will also be possible to connect the additional consumers with a total gas flow rate of up to 35 m³/h to this gas distribution network, that is, to conclude 7 more contracts for connection to this low-pressure gas pipeline. As a result, the installed gas distribution network will provide a maximum of 8 gas consumption networks with a total consumption of 40 m³/h and the gas distribution network development in the area will be suspended.

Subsequent applicants will be asked to conclude an agreement on the 2nd or 3rd category when applying to the GPO, since the connection point will be a gas pipeline at a distance of more than 200 meters or it will be necessary to reconstruct the existing gas distribution network to increase capacity. It should be noted that the cost of the contract in the 1st category can be at least 10 times lower than the cost of the contract in the 2nd or 3rd category.
Figure 1. The first option of performance of obligations on construction of network of gas distribution

Thus, the result of the 1st version of the contractual obligations between the GRO and the applicant execution for 2 years will be the gas distribution network, which will not allow connecting additional gas consumption networks on preferential terms to conclude the agreement. In addition, all those who might further wish to connect to the gas distribution network will be offered contracts that will cast doubt on the gas-using equipment use as the sole source of heat. Subsequent applicants will be forced to look for alternative heat supply options for their capital construction projects if there is a gas distribution network in their area.

Table 1. Results of the first option hydraulic calculation.

| site No. | Expense, [m³/h] | Length, m | Inside diameter, [mm] | Initial pressure, [Pa] | Final pressure, [Pa] | Losses |
|----------|-----------------|-----------|-----------------------|------------------------|----------------------|--------|
| 1        | 2               | 5         | 200                   | 50                     | 3000.0               | 2963.9 | 36.1   |
In the 2nd option, the contractual obligations implementation between the GRO and the applicant at the design stage provides the connection prospect in the area. For example, potential applicants can be identified on the data basis from a public cadastral map, where the future applicants’ number will be equal to the number of plots within the given region gas distribution point action radius (Fig. 2). Let us assume that, based on the hydraulic calculation, the GPO provides about 100 additional potential applicants in the area and the network will be developed in the same way as in the first variant, in two stages with construction not more than 200 m away from the connection point. The area will already be limited to the range of hydraulic fracturing and the allowable value of losses in external gas networks (Table 2) [16]. It will be possible to connect about 100 new gas consumption networks with a maximum hourly flow rate of 5 m$^3$/h each over 2 stages of gas distribution network construction in future.

Figure 2. The obligations performance second version for the gas distribution networks construction
It is recommended that the gas distribution network be laid across the public territory on the existing construction rules basis by the underground method, therefore, the GDO may provide the gas outlets from the ground at the adjacent sections common border. Such a design will protect the future gas distribution companies from additional construction and installation work and speed up the connection of newly announced subscribers, since the connection times will already be no more than 10 working days from the moment of signing the act on the gas consumption network readiness.

Table 2. The 2nd option hydraulic calculation results

| site No. | Expense, [m³/h] | Length, [m] | Inside diameter, [mm] | Initial pressure, [Pa] | Final pressure, [Pa] | Losses |
|----------|----------------|------------|-----------------------|------------------------|----------------------|--------|
| 1        | 2              | 500        | 200                   | 184                    | 3000.0               | 2765.8 | 234.2 |
| 2        | 3              | 400        | 50                    | 130.8                  | 2765.8               | 2565.4 | 200.4 |
| 3        | 4              | 300        | 50                    | 130.8                  | 2565.4               | 2444.3 | 121.1 |
| 4        | 5              | 200        | 50                    | 90                     | 2444.3               | 2092.5 | 351.8 |
| 5        | 6              | 100        | 50                    | 90                     | 2092.5               | 1987.9 | 104.6 |
| 6        | 7              | 50         | 20                    | 90                     | 1987.9               | 1975.5 | 12.4  |
| 7        | 8              | 40         | 20                    | 90                     | 1975.5               | 1967.1 | 8.4   |
| 8        | 9              | 20         | 40                    | 50                     | 1967.1               | 1885.4 | 81.6  |

Thus, the contractual obligations execution 2nd option, which provides the prospect of connecting gas consumption networks, will provide an increase in the number of gas consumption networks by 12.5 times and eliminate the need to perform an excessive amount of construction and installation work when connecting applicants along the designed route. The difference in the cost of building the gas distribution network in the first and second options will pay off with a large number of contracts for connection and an increase in natural gas consumption in the area.

Discussion

The Government Decree has been in effect on the territory of the Russian Federation for 6 years already and during this time a lot of work has been done on the external gas distribution networks construction and connecting new subscribers. It should be noted that the Ministry of Energy has not yet developed guidelines and recommendations for the GD implementation, aimed at increasing the gas consumption networks number within the current legislation framework. At the same time, the GPO may fulfill the GD requirements in various ways, which will have a very significant effect on the growth dynamics in the number of gas consumers and, accordingly, gas consumption networks.

Summary

Based on the above-mentioned, it can be concluded that when implementing connection measures according to the GD, it is necessary to take into account the prospect of connecting new gas consumption networks and take measures to reduce construction and installation work when new applicants are connected in future. When implementing the above-given recommendations, the terms of contractual obligations fulfillment will be reduced and the gas-using equipment on natural gas will be the main source of heat for heating, hot water supply and food preparation of the housing stock.

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