KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

Legal and Methodological Basis of Gas Distribution Systems' Operating Reliability

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Date: 4-8 June 2012

Venue: Kuala Lumpur

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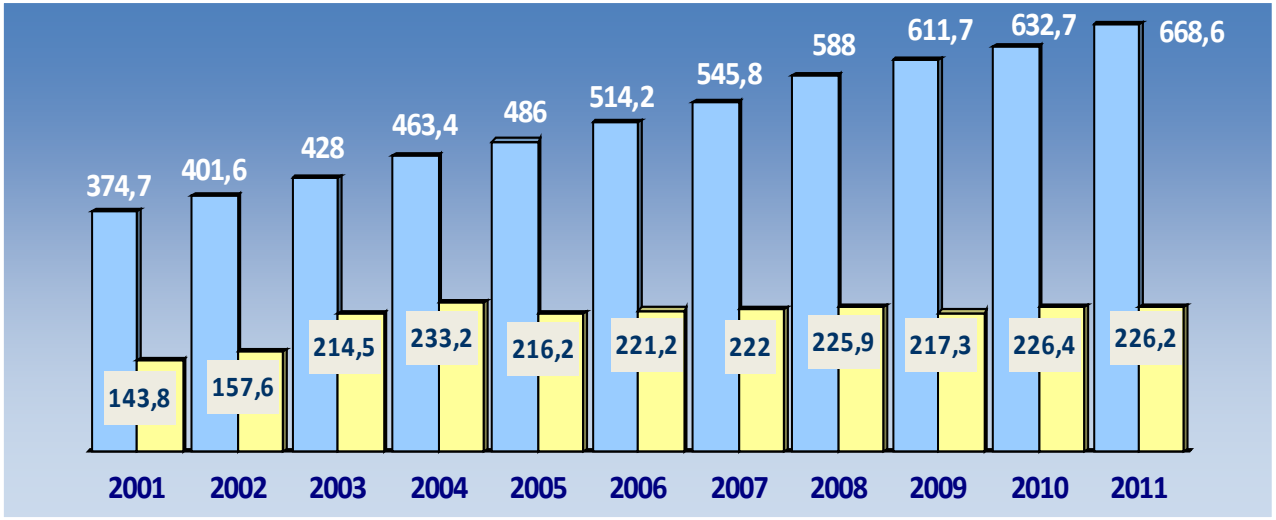
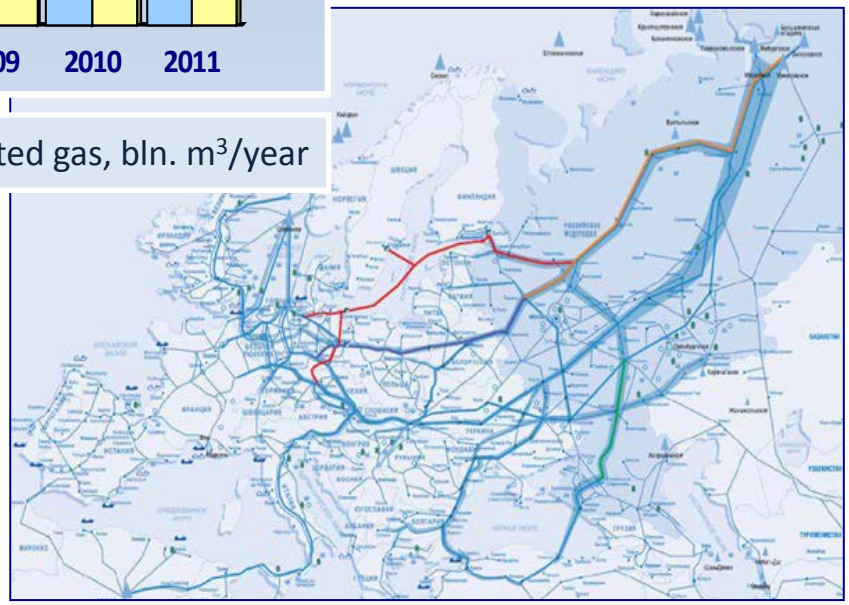
Position of Gazprom Group in gas distribution in Russia



Tasks of Gazprom JSC in gas distribution :

- ensuring reliable and safe functioning
- Increase of profitability and streamlining of business processes



Length of gas pipelines – **668, 6 thousand km.**
Volume of transported gas – **226,2 bln. m³/year**
Number of gasified:

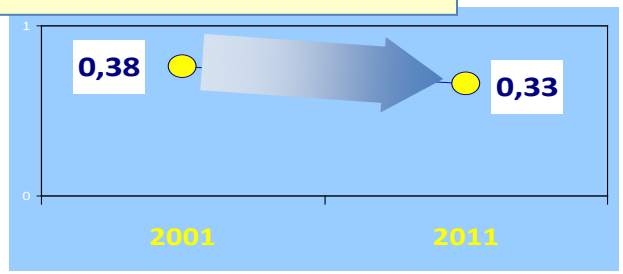
- inhabited localities – **76,4 thousand**
- Apartments – **25,6 млн.**
- Enterprises – **301 thousand**

Number of GDOs - **187**
Number of employees – **142 thousand**
Number of GRPs – **213,4 thousand**

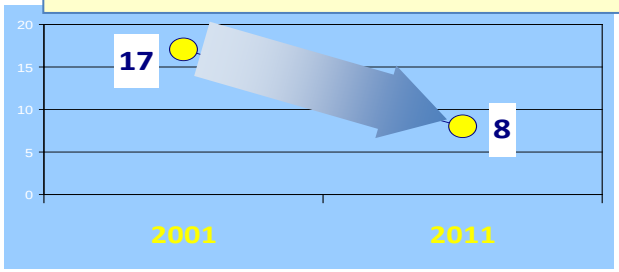
Special Features of Gas Distribution in Russia

- increase of length of gas distribution networks
- decrease of gas pipelines load level
- growing depreciation of networks, growing demand for diagnostics and reconstruction
- limitation of required operation expenses
- operating infrastructure falling behind the development of gas distribution
- excessive system of networks scheduled maintenance
- special features of technical regulation and standardization
- shortage of qualified staff, etc.

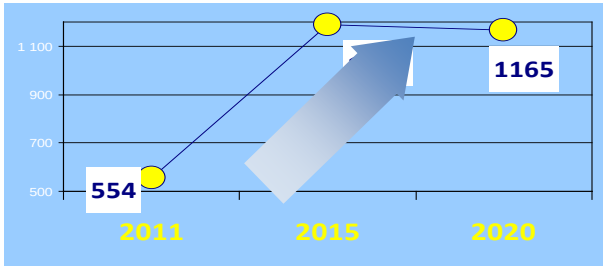
Gas pipelines load level, mln. m^3/km



Depreciation percentage, %



Demand for reconstruction, km



Special Features of Technical Regulation in Russia

Law «About technical regulation»

Law «About industrial safety»

Technical regulations:
«About safety of buildings and structures»,
«About safety of gas distribution networks and gas consumption networks»,
«About fire safety requirements»

Subordinate acts

Technical regulations

Subordinate acts

Federal norms and rules

Federal norms and rules in the field of industrial safety of gas distribution networks

Documents enforcing the requirements of regulations and rules (national standards, codes of rules)

Standards of organization (standards, recommendations, technical specifications)

Standardization system of Gazprom and Gazprom Gazoraspredeleniye **Products and processes. Devices**

Standardization system of Gazprom and Gazprom Gazoraspredeleniye **Industrial safety and fire safety, labor safety, environment protection**

Special Features of Technical Regulation in the Branch of Industry

The Concept
of Technical Regulation

2009

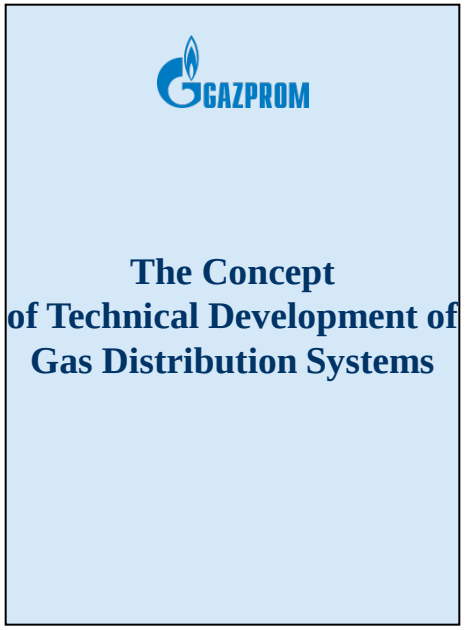
Perspective Plan
for development of documents
related to technical regulation at JSC "Gazprom"
during 2011 – 2015

The Concept
of JSC "Gazprom"participation in the gasification of regions of the Russian Federation

2009

National Standardization
Work Plan
ТК23 «Equipment and technologies for oil and gas extraction and processing»
(ПК4 «Gas distribution and gas consumption»)

Operation According to Technical Condition



Operation according to technical condition - the package of operations aimed at sustaining operability or working order of the facility, performed on the basis of evaluating the technical condition of the facility and considering / forecasting the risk of operation

It is necessary to be able: to evaluate the technical condition of the facility and to forecast the risk of its operation

For this purpose:

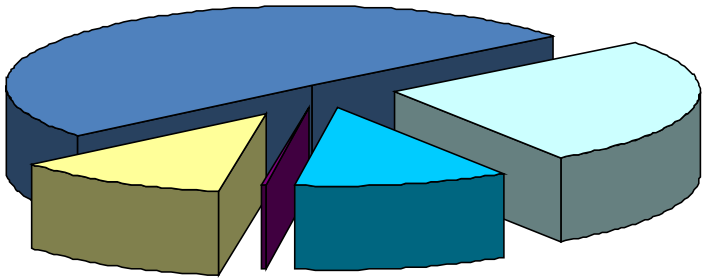
- to have the criteria of reliability
- to define the acceptable levels of the criteria of reliability
- to be able to make distinction between the acceptable levels of reliability and safety
- to be able to determine the risk of operation (calculation of the accident risk and extent of damages)

Criteria (Indices) of Reliability

	System	System elements
Failure-free operation indices		
▪ probability of failure-free operation	✓	✓
▪ mean time between failures		✓
▪ forecast value of the flow of failures parameter		
Maintainability indices		
▪ mean time to recover		✓
▪ probability of recovery		✓
▪ average labor content of recovery		✓
Integral indices of reliability		
▪ gas pipe line availability coefficient	✓	
▪ relative short-delivery of gas because of accident on the gas pipe line	✓	

Failure Prediction Model

Element failure causes (statistics)



Human impact	50,5%
Natural impact	26,4%
Corrosion	11,3%
Defects	0,5%
Other	11,3%

Probabilistic-statistical Model

Decomposition into elements

element failure flow rate parameter

ω (1/km year)

Summing up for the system

Statistical expectation of the number of system failures:

$$\left\langle N_{var.}^{GP} \right\rangle = \sum_i \left(\sum_j \omega_i^j \right) \times L_i$$

Probability of failure-free operation :

$$P_0^{GP} = \prod_i P_0^i = e^{-N_{var.}^{GP}}$$

Availability coefficient :

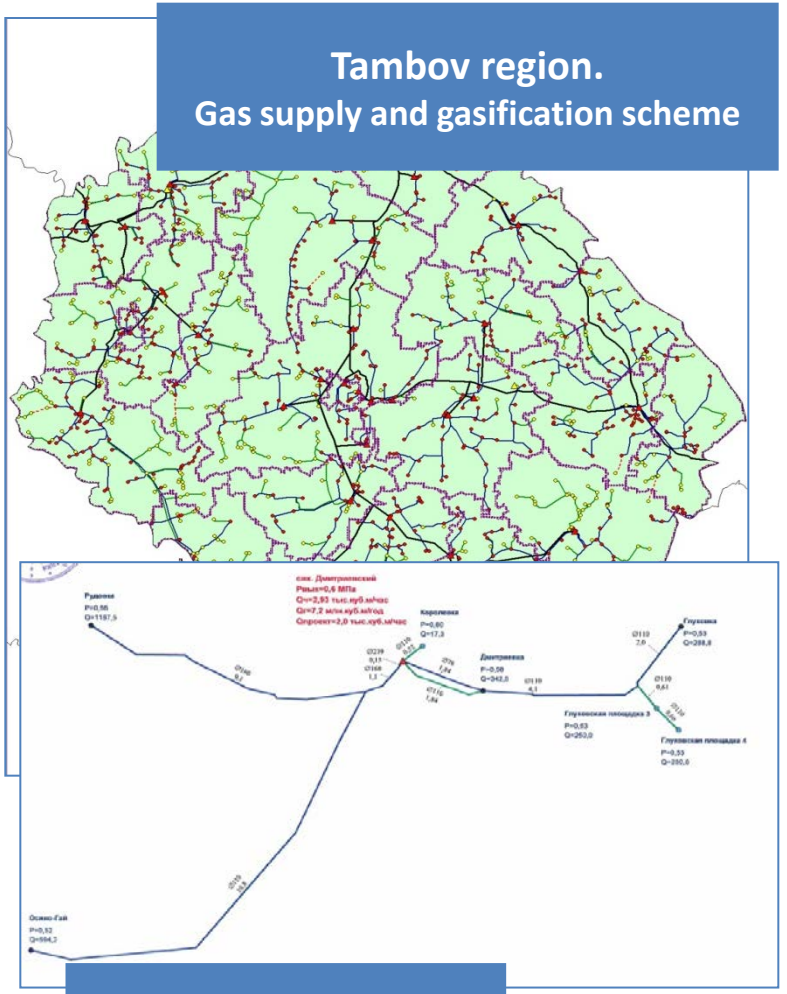
$$K_{prep.} = 1 - \frac{\sum_i \Delta T_{variation}^i}{8760 - \sum \Delta T_{shed.\ maint.}}$$

Reliability Calculation Example

Gas distribution system reliability indices calculation

Reliability index	UOM	Value	
		Gas pipe line	System
Probability of failure-free operation	-	0,9978	0,9945
Forecast value of the flow of failures parameter	1/(km year)	0,0011	
Mean time between failures	h	164801	16778
Availability coefficient	-	0,99994	0,948
Volume of short-delivery because of accident	m^3	913,7	

Tambov region.
Gas supply and gasification scheme



Distribution gas pipe line

Improving the methodology

- transition to prediction basing on failure **statistics**
- creation of **informational database** related to failures
- interfacing with methodologies of **evaluation of technical condition**
- **rating** of reliability indices
- usage of reliability indices as **efficiency estimation criteria**

1 Aggregated calculation method

- Purpose and laying method, operating life, material
- Failure causes

2 Enhanced calculation method

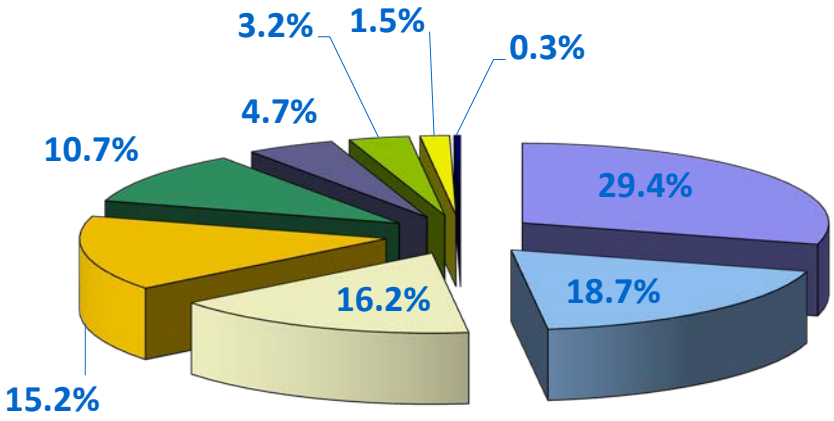
- Statistical models of failures
- Data about technical condition, instrumental examination
- Expert evaluations by specialists

3 Prediction of failure risk

- Determining remaining life expectancy
- Results of laboratory tests etc.

Reliability Data Base

Causes of accidents and incidents during years 2005 – 2009 (в %)



- Motor transport runover, 29,4%
- Mechanical damage during excavation work, 18,7%
- Corrosion damage, 16,2%
- Gas leakage, equipment failure, 15,2%
- Damage by fallen trees or by parts of structures, 10,7%
- Damage by fallen trees or by parts of structures, 4,7%
- Natural calamities, deflections of gas pipe line, damage of supports, 3,2%
- Explosion of gas-air mixture, fire, inflammation, 1,5%
- Break of welded joints, 0,3%

Motor transport runover	29,4%	HuHuman impact	52,8%
Mechanical damage during excavation work	18,7%		
Intervention of unauthorized persons	4,7%		
Corrosion damage	16,2%	Specifics of operation	32,9%
Gas leakage from fittings, equipment failure	15,2%		
Explosion of gas-air mixture, fire, inflammation	1,5%		
Damage by fallen trees or by parts of structures	10,7%	Natural impact	13,9%
Natural calamities, deflections of gas pipe line, damage of supports	3,2%		
Break of welded joints	0,3%	Quality of construction and assembly work	0,3%

Rating of Reliability

Target indices (set by the managing company)
Considering:

- actual reliability
- planned reliability
- programs of reconstruction and construction
- volume of investments

Indices:

Number of accidents and incidents, emergency repairs, disconnections of consumers

Rated indices
(set for subsidiary companies)
Considering :

- target indices
- structure of serviced networks
- actual reliability
- required volumes of reconstruction and repair

Indices :

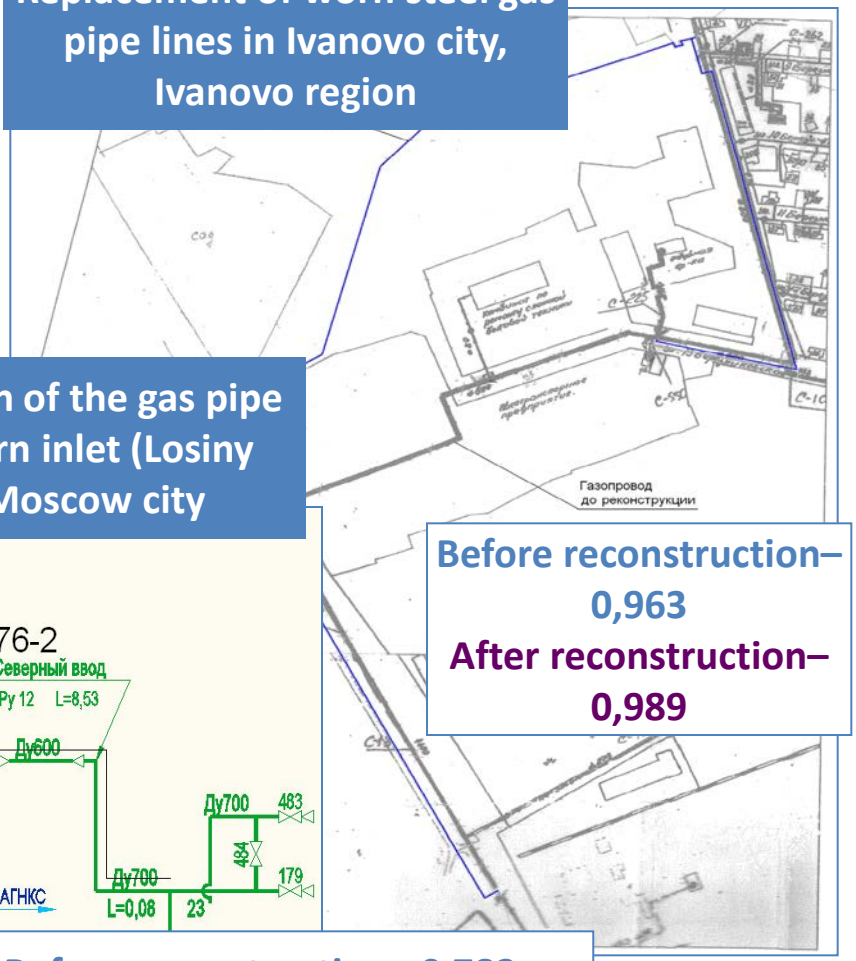
- coefficient of failure-free performance, number of accidents and incidents, emergency repairs, disconnections of consumers in the system per year
- failure flow rate parameter, duration and labor content of recovery, short-delivery of gas
- probability of failure-free performance, time between failures, failure flow rate parameter, availability coefficient
- categorizing of failures

Reliability Management

Change of reliability indices:

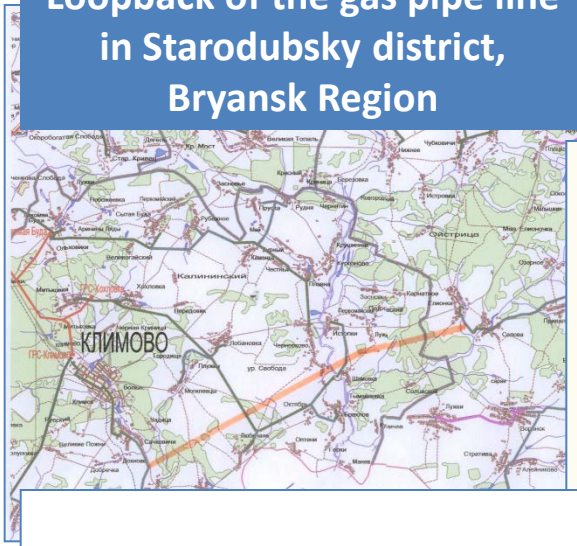
- during reconstruction and repair
- during technical upgrading
- With increase of level of technical equipment of the services
- during stock management, etc.

Replacement of worn steel gas pipe lines in Ivanovo city, Ivanovo region



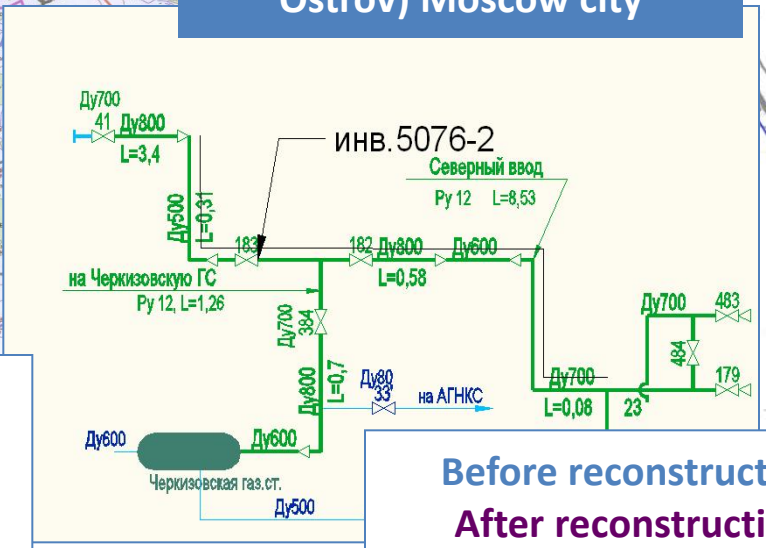
Before reconstruction– 0,963
After reconstruction– 0,989

Loopback of the gas pipe line in Starodubsky district, Bryansk Region



Before reconstruction– 0,959
After reconstruction– 0,9997

Rehabilitation of the gas pipe line Northern inlet (Losiny Ostrov) Moscow city



Before reconstruction– 0,782
After reconstruction– 0,966

Thank you for your attention