Technical Assistance for the supply and use of Gas pressure Regulators [AHEF 100.UZ]

DRAFT FINAL REPORT

INOGATE Technical Secretariat (ITS) and Integrated Programme in support of the Baku Initiative and the Eastern Partnership energy objectives

Contract No 2011/278827

A project within the INOGATE Programme

Implemented by:
Ramboll Denmark A/S (lead partner)
EIR Development Partners Ltd.
The British Standards Institution
LDK Consultants S.A.
MVV decon GmbH
ICF International
Statistics Denmark
Energy Institute Hrvoje Požar
### Document title

Technical Assistance for the supply and use of Gas pressure Regulators (AHEF 100.UZ)

### Document status

Final

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### Acronyms

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<th>Acronym</th>
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<tr>
<td>atm</td>
<td>Atmosphere – obsolete measure of pressure</td>
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<tr>
<td>Bar</td>
<td>Measure of pressure – SI unit</td>
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<td>EC</td>
<td>European commission</td>
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<td>EU</td>
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<td>IGEM</td>
<td>Institution of Gas Engineers and Managers - UK</td>
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<tr>
<td>Mbar</td>
<td>One thousandth division of 1 Bar</td>
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<td>Ofgem</td>
<td>Office of Gas and Electricity Markets</td>
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<td>MOP</td>
<td>Maximum operating pressure</td>
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<td>NRV</td>
<td>Non Return Valve</td>
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<td>RIIO</td>
<td>UK Energy Regulator (Ofgem) price control model Revenue=Incentives+ Innovation + Outputs</td>
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<td>PRMS</td>
<td>Pressure reduction and metering station</td>
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<td>PCV</td>
<td>Pressure Control Valve</td>
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<td>PRV</td>
<td>Pressure Relief Valve</td>
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<tr>
<td>SDR</td>
<td>Standard diameter ratio – used for PE pipe</td>
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1 Executive Summary

For the “INOATEG Technical Secretariat & Integrated Programme in support of the Baku Initiative and the Eastern Partnership energy objectives” and within the AHEF (Ad Hoc Expert Facility) “Technical Assistance for the supply and use of Gas Pressure Regulators (AHEF. 100-UZ)” this report has been prepared for the purpose of specifying functionally appropriate pressure regulators and systems to be purchased by Uzbekneftegaz/Uztransgas to provide accurate metering when installed with the new gas meters that they have already purchased (32,200) or installed (2000). The solution will achieve accurate gas measurement to consumers and reduce the non-technical gas losses associated with unmetered gas usage. Additionally the report recommends internationally referenced bench marked systems for the safe and secure supply of natural gas and the reduction of technical losses.

Following the preparation, issue and return of a questionnaire to Uztransgas two study visits were made to Tashkent, Uzbekistan. The purpose of the visits was to clarify the characteristics of the gas transmission and distribution network and understand the pressure regulating issues.

From information obtained at meetings with Uzbekneftegaz/Uztransgas and the site visits the Experts have drawn the following conclusions:

- Gas pressure regulation and metering systems do not meet the latest international standards embodied in the design codes ASME 31.8 and IGE/TD/13. These international standards recommend process safety design to maintain continuity of gas supply and provide over pressure protection in the event of equipment malfunction so as to mitigate the risks to people and property located near to gas transmission/distribution infrastructure. The safety recommendations have been developed in response to serious incidents previously encountered on gas networks.
- The existing gas distribution pressure control modules are of obsolete design and will deliver an unstable pressure as they will not compensation for fluctuation in gas supply pressure. This will result in inaccurate metering and resultant non-technical losses.
- Meter governors are not installed which are required to ensure that gas appliance safe operating pressure limits are not exceeded and to provide a stable pressure for accurate metering.
- The Uztransgas distribution network suffers from significant seasonal pressure fluctuations. Uztransgas are therefore considering combining Tier 3 and 4 pressure tiers to stabilise operating pressures by increasing overall network pressure. This stabilisation of pressures will provide more accurate metering and reduction of non-technical losses. The Experts support this approach subject to the recommendations below.
At the time of the SIMISE report 2011 Uztransgas supplied gas to 4,452,940 consumers through a gas transmission/distribution network of approximately 138,000 km. Uztransgas reported that they have a population of approximately 98,000 pressure control installations. Upgrading all pressure reduction installations to meet current safety standards and rationalising the entire distribution network as proposed in item 4 above would therefore require a substantial infrastructure investment.

The report provides a detailed response to the issues identified in the study. The recommendations for Uzbekneftegaz/ Uztransgas are summarised as follows:

- A programme should be put in place to replace or upgrade obsolete transmission and distribution network pressure reduction equipment at all pressure Tier levels to meet internationally recognised process safety standards embedded in ASME 31.8 and IGE/TD/13. This is a key safety recommendation of the report. Modern pressure regulators will also provide more effective pressure control leading to accurate metering and reduction in non-technical losses. New distribution pressure reduction modules should be located away from buildings and in their own enclosure comprising filtering, pressure control and over pressure/supply interruption protection. They can be either twin or single stream depending on the number of customers connected downstream of the regulator and the quantity of gas being supplied.

- Meter regulators should be installed as standard so as to ensure downstream gas appliances are not pressurised beyond their design limit and a constant pressure is provided at the metering point. Meter pressure regulators cost no more than €20 each.

- A 4bar standard is recommended for the Tier 3 and Tier 4 pressure rationalisation being considered by Uztransgas. This rationalisation and uprating of the network should not take place until gas mains have been replaced with new Polyethylene pipe specified to the standard recommended in the report however it is recognised that moving to a modern polyethylene system will require a significant departure from the current Uztransgas practice of laying steel pipe above ground.

- The current safety standard in UK and Europe for gas pressures entering buildings limits the gas pressure to less than 75 mbar. The current Uztransgas practice of supplying gas at a pressure in excess of 75 mbar up to a meter located within an open space within a building will need to be reviewed when implementing the proposed pressure reduction proposals.
The Uztransgas standard of distributing gas at pressures of less than 30 mbar downstream of the meter complies with UK and European standards

- System improvements should only take place following preparation of a design bases for the gas network to ensure consistent application of standards and policies. The replacement of pressure regulators should not take place in isolation from an overall review of infrastructure design

- A pilot project is being considered by Uztransgas and a route map for undertaking the study is provided in the report. It has been calculated that if the pilot project comprised the 29,200 meters purchased by Uztransgas, but not yet installed, the cost of the project would be approximately €136 million. This assumes that gas pressure reduction equipment is upgraded and gas mains are replaced as recommended in the report. A more limited pilot project could be implemented with costs pro rata to the number of consumers comprising the pilot study

- Risk mitigation will be enhanced by the introduction of a maintenance regime as recommended in the report

The international market for gas pressure regulator modules is well developed and compliant gas pressure reduction modules at competitive prices can be sourced from a number of suppliers by issuing a simple functional specification recommended in the report.

*We strongly recommend that a design basis is written for the system before modifications are implemented. A design basis has not been provided in this AHEF as it is outside of the terms of the reference for this project.*

Following the issue of a draft report to the Beneficiary for comment, a workshop was held on the 6th and 7th October 2014 at which operational engineers from Uztransgas attended. A further site visit was carried out on the 8th October to assist in clarification of matters presented in the report and workshop discussions.
2 Introduction

2.1 INOGATE programme

The INOGATE Programme is an international energy co-operation programme between the European Union and the Partner Countries (PC) of Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine and Uzbekistan. The Partner Countries agreed to work together towards achieving the following major objectives:

1. Converging energy markets on the basis of the principles of the EU internal energy market, taking into account particularities of the involved countries;
2. Enhancing energy security by addressing the issues of energy exports/imports, supply diversification, energy transit, and energy demand;
3. Supporting sustainable energy development such as the development of energy efficiency, renewable energy, and demand side management; and
4. Attracting investment towards energy projects of common and regional interest.

Under the framework of the INOGATE programme the European Commission (EC) has launched a new project entitled “INOGATE Technical Secretariat & Integrated Programme in support of the Baku Initiative and the Eastern Partnership energy objectives”. Activities commenced on 1st February 2012 and are being carried out over a 3-year period.

Under the Component B4: Sustainable and efficient energy transit infrastructures, the new project includes sub-components to deal with the:

- Transfer of EU best practice on technologies and methodologies of gas losses detection & reduction;
- Transfer of surveillance techniques, feasibility of pipeline safety, and security system;
- Introduction to pipeline management infrastructure and training on software solutions; and
- Improvement of metering and billing.

2.2 Reduction in natural gas losses

The UNFCCC’s Clean Development Mechanism (CDM) has offered some PC gas operators the incentive and opportunity to assess and reduce gas losses in their natural gas networks. While numerous CDM projects have been registered in Eastern Europe/Caucasus and Central Asia to address distribution system losses, only one has been undertaken in the transmission sector (Public Company Uztransgas in Uzbekistan).

Based on the study Uztransgas proceeded to purchase and install smart meters in households where meters are not installed or gradually replace existing obsolete and inaccurate meters. Following the commencement of the meter installation programme problems were encountered with pressure
regulators that supplied gas to the meters. The pressure regulating equipment was found to be based on old technology which is now obsolete inhibiting the equipment from supplying gas at a reasonably constant pressure to facilitate accurate metering.

This present initiative is focusing on specifying functionally appropriate pressure regulators to be purchased by the beneficiary for them to install with new the gas meters they have already purchased or installed. The solution will achieve accurate gas measurement to consumers and reduce drastically the non-technical gas losses associated with unmetered gas usage.

New pressure regulator modules of modern configuration will also improve safety and facilitate more efficient network design therefore reducing associated investment costs in gas mains extensions or replacement.

2.3 Study objectives

The objectives of this assignment are specified as follows:

- Assessment of existing gas distribution network and existing pressure regulators
- Determine current local practices regarding design, construction, maintenance and operation of pressure control and metering systems
- Determine quantities of pressure control and metering systems
- Provide fit for purpose minimum functional specifications for compliant pressure control and metering systems to:
  - Interface with existing local infrastructure
  - Meet European and International standards
  - Address key risks associated with over pressure and loss of supply
- Technical Evaluation of the international market for pressure regulators (to be acquired by Uztransgas) on adaptability with the recently purchased advanced gas meters
- Identify sources and key vendors for resourcing of compliant pressure control modules
- Specify optimum maintenance and risk management strategies
- Provide headline costs for gas pressure reduction population replacement

2.4 Study scope

The scope of works as expressed in the project Terms of Reference (TOR) is specified as follows:

- Prepare questionnaire to identify design, components and O&M strategy for local operator
- Carry out local discussions, interviews and site visits to facilitate detailed understanding of local contextual issues and current equipment population
Present a summary report meeting the requirements of the objectives of the study including a description of the existing system of pressure regulating and metering, the specification of pressure regulators adopting to the purchased gas meters and the evaluation of the various types

Present and discuss the report and the findings with the Uztransgas managers and engineers in a one day workshop

2.5 Measures of success

The success of the project will result in measurable improvements in the conveyance of natural gas in Uztransgas. The measures should be taken over a specific time period of 1 year following the completion of the project. Specific improvement measures are listed as follows:-

- Reduction of technical and non-technical gas losses in the distribution network in Uztransgas expressed in volume per connected customer and volume per km of pipeline network
- Improve the operation, maintenance and emergency management of the network measured in operating costs per connected customer and km of pipeline network
- Number of new regulators installed as a percentage of total population for each pressure Tier
- Percentage of unmetered consumers in a period of one year after the purchase of the new pressure regulators (according to SEMISE study in 2010 was 27%)\(^1\)
- The difference (as percentage) of technical gas losses when the new regulators and meters are in operation compared with the existing percentage of 2.4% (see SEMISE study)

\(^1\) SEMISE Ad Hoc Facility "Reduction of Non-technical Natural Gas Losses in Transmission Gas Pipelines System and Gas Distribution Network, 29th July, 2011
3 Background

3.1 Uzbekneftegas/Uztransgas

The Public Company "Uztransgas" was established in the form of the open joint stock company by a Decree of the President of the Republic of Uzbekistan № UP-2154 dated December 11, 1998, the Resolution of the Cabinet of Ministers №523 dated December 15, 1998, the Order of the State Property Committee №04-k-PO dated January 6, 1999, and registered by the Khokimiyat of the Yakkasaraysky District of Tashkent on May 5, 1999 under the №11-011919.

In order to develop a common policy in the sphere of development and operation of gas distribution networks, to create an effective management system for the transportation and sale of natural gas to the domestic consumers, and to allow the efficient use of natural gas and to strengthen the gas payment discipline, the Resolution of the President of the Republic of Uzbekistan № PP-438 dated August 8, 2006 "On measures aimed at streamlining the organisation of work of the public company "Uztransgas" was adopted. In line with the mentioned Resolution, the Public Company “Uztransgas” has been reorganised by removing regional gas distribution companies from the Uzbek Agency "Uzkomunikhzimat" and passing them to the Public Company "Uztransgas" of the NHC "Uzbekneftegaz"; also six inter-regional enterprises in the form of unitary enterprises of the Public Company “Uztransgas” were formed on the basis of territorial gas supply companies to supply gas to all categories of consumers.

The beneficiary of this project is Uzbekneftegaz however Uztransgas provided all the technical information requested and will implement the project on the approval of the holding company Uzbekneftegaz.

3.2 The study visits

Following the preparation, issue and return of a questionnaire to Uztransgas two study visits were made to Tashkent, Uzbekistan. The first visit was conducted by Achilleas Gekas between the dates 9th and 11th of April 2014 and the second visit by Phil Winnard between the dates 29th April and the 3rd May 2014. The purpose of the visits was to clarify the characteristics of the gas transmission and distribution network and understand the pressure regulating issues. Discussions were held with senior management and engineers of Uzbekneftegaz and Uztransgas to obtain the required information for the study. In addition site visits to key installations and local gas supply connections were conducted on the 10th April and 1st May 2014.

The findings of the study visits are summarised as follows:-

3.3 Uztransgas gas supply network

Gas received from the gas producing company is supplied to the gas transportation system of the PC “Uztransgas” for its onward transportation and to the gas distribution stations of the distribution networks.

The gas supply network comprises the following elements:-
• Tier 1 - Transportation of gas at a pressure within the range 35 - 75 atm. Delivery and acceptance takes place at the boundary limit between the gas production company and gas transmittal pipelines administration (directly subordinated enterprises) of the PC “Uztransgas”

• Tier 2 - Transportation / distribution of gas at a pressure within the range of 6 - 20 atm. These include connections to the large industrial consumers from the Level 2 pipelines. There are pressure reduction and metering installations (Gas Distribution Stations – GDS) for these large industrial consumers positioned between the PC "Uztransgas" and the gas consumer. The GDS’s are owned by PC "Uztransgas" but in some cases these GDS’s are located on the consumer property.

• Tier 3 - Distribution of gas at a pressure within the range from 3 to 6 atm. Some consumers are connected directly to the Level 3 pipelines, others are connected downstream after additional pressure reduction installations. Unitary enterprises operate gas distribution networks and sell the natural gas

• Tier 4 – Much of the distribution pipework is located above ground on the outside of buildings. The operating pressure of the pipework seen on the visit was between 0.15 and 0.80 atm

Uztransgas is considering rationalising Tier 3 and Tier 4 to achieve consistent extremity pressures at times of high gas demand. A diagram illustrating the present gas supply arrangements is provided in Appendix 4.

3.4 Gas transportation station visit

GDS “BEKTEMIR” of the Tashkent Gas Transmission Pipelines Administration of the Public Company “Uztransgas” supplies gas to the consumers of the city of Tashkent and "ASAKA INVESTMENT" (glass factory).

3.4.1 Site description

The Gas Transportation installation was constructed in 2005 and has a capacity as follows:-

• 6 million cubic metres per day (MMCMD) to gas distribution and

• 15 thousand cubic metres per day (MCMD) to Asaka Investment

The gas distribution supply installation comprises the following:-

• Inlet to station pressure circa 20 atmospheres
Outlet to distribution circa 6 atmospheres

Inlet scrubber filtration – single unit

Single Pressure Control Valve (PCV) pressure reduction streams - 4 in number – each stream of a different size to regulate volumes – no preheating to mitigate Joules Thompson effect temperature loss

3 metering streams

Odorant injection

One Pressure Relief Valve (PRV) of partial capacity

The Asaka investment supply installation comprises the following:

Inlet to station pressure circa 20 atmospheres

Outlet to Asaka Investments circa 3 atmospheres

Inlet scrubber filtration – common to both the distribution supply and the Asaka Investments

Twin stream moisture knock out pots – not used as the gas dew point is now below 0 deg C

Twin stream filters

Water bath heater – not been used for some time as the weather has been warm

Single PCV pressure reduction streams - Twin stream

2 metering streams

One PRV of partial capacity

The installations are shown diagrammatically as follows:
Figure 1: General arrangement

Asaka Investments
PRMS
District Distribution
supply
6 ATM
3 ATM
20 ATM

Figure 2: Gas network pressure control and metering

Customer meter
Pressure Control Valve (PCV)
Pressure Relief Valve (PRV)

DISTRICT DISTRIBUTION SUPPLY - SIMPLIFIED
3.4.2 Compliance comments

Following an examination of the equipment configurations and checking against applicable UK, European and US standards listed in Section 4.1 below comments are as follows:

- Filtration should be achieved to 50 microns with twin stream filtration units
- Regulator streams should be at least twin stream with 100% redundancy – consequence supply failure on regulator breakdown
- Each stream should comprise a slam shut device and an active monitor configured regulator system – Consequence over pressurization of the downstream system – at least two levels of failure redundancy is required – If the active regulator fails the monitor will take over (normally open). If both regulators fail to control the stream will slam off with gas supply being provided through the standby stream
- Stream selection – The equipment should include downstream Non Return Valves NRV’s in each stream to prevent over pressure slamming off the standby stream
- Orifice plate metering should be replace with ultrasonic metering for improved accuracy

Figure 3: Factory supply pressure control and metering
• Removal of relief valve and replacement with a creep relief valve only. The high flow relief valve is both a safety and environmental hazard – Hazardous area compliance is also required

3.5 Gas distribution station Bectemir

“Gas distribution point (medium pressure) of the Bектemirsky branch of Tashkent Shakhar Gas that supplies gas to the academic lyceum”

3.5.1 Primary distribution regulator installation

Photographs showing the installation are as follows:

Figure 4: Bectemir primary pressure reduction station photographs

3.5.1.1 Site description

The Installation capacity is not known and a basic description of installation is as follows:

• Inlet to station pressure circa 4 atm
• Outlet to school 0.8 atm
• Inlet filter
• Safety shut off device – purpose not confirmed
• Single PCV – make and specification not known
• Regulator and installation manual bypass – not allowed under current safety regulations
The installation is shown diagrammatically as follows:

![Diagram of the installation](image)

- Manually operated bypass
- PCV Filter
- Safety device
- Unknown specification
- Circa 4 Atm
- Circa 0.8 Atm
- To buildings

**Figure 5: Bectemir primary pressure reduction station schematic**

### 3.5.1.2 Compliance comments

Following an examination of the equipment configurations and checking against applicable UK, European and US standards listed in Section 4.1 below comments are as follows:

- The unit should be twin stream with no manual bypass
- Fluctuating pressure likely to be due to regulator obsolescence – outlet pressure following inlet pressure – Large seasonal and diurnal pressure fluctuations due to demand cycle
- Filtration should be achieved to 200 microns with twin stream filtration units
- Regulator streams should be at least twin stream with 100% redundancy – consequence supply failure if one regulator breaks down
- Each stream should comprise a slam shut device and an active monitor configured regulator system – Consequence over pressurization of the downstream system – at least two levels of failure redundancy is required – If the active regulator fails the monitor will take over (normally open). If both regulators fail to control the stream will slam off with gas then being supplied through the standby stream
- Stream selection – downstream NRV’s to prevent downstream over pressure slamming off the standby stream
- Removal of relief valve and replacement with a creep relief valve only. The high flow relief valve is both a safety and environmental hazard – Hazardous area compliance is also required

3.5.2 Secondary distribution regulator installation

Photographs showing the installation are as follows:

![Figure 6: Bectemir secondary pressure reduction station photographs](image)

3.5.2.1 Site description

The Installation capacity is not known and a basic description of installation is as follows:

- Meter installed before the secondary regulator module – normally downstream so metering on a stable pressure
- Inlet to station pressure circa 0.8 atm
- Outlet to school boiler installation circa 0.3 atm
- Inlet filter
- Safety shut off device – It is not confirmed if this activates on low inlet pressure or otherwise
- Single PCV – make and specification is not known
- Regulator and installation with manual bypass – not compliant

The installation is shown diagrammatically as follows:
3.5.2.2 Compliance comments

Following an examination of the equipment configurations and checking against applicable UK, European and US standards listed in Section 4.1 below comments are as follows:

- The unit should not incorporate a manual bypass
- Filtration should be achieved to 200 microns with twin stream filtration units
- Regulator streams can be single stream as only on small commercial building is supplied
- The regulator stream should comprise a slam shut device and an active regulator – Consequence over pressurization of the downstream system – at least one level of failure redundancy is required – Process is if active regulator fails to control the stream will slam off
- Meter to be installed downstream of pressure control to achieve a stable pressure for metering accuracy

0.3 atm downstream pressure is higher than allowed – should be no more than 0.075 atm entering a building – some tolerance is allowed due to separate building for the boiler installation.

3.6 Gas distribution station – Makhali Mirishkor of the Bektemirsky region”

3.6.1 Secondary distribution regulator installation

Photographs showing the installation are as follows:
Figure 8: Mirishkor neighbourhood secondary pressure reduction station photographs
3.6.1.1 Site description

The module supplies a multi-level building with the regulator fastened to the outside of the building. Installation pipework is fastened to the outside of the building with pipe entering the building to each meter point.

Additional gas supply pipes tracked across the road at high level to commercial properties and were connected to the inlet supply of the regulator module. All pipes are welded steel.

The installation comprises the following:

- Installation capacity is not known
- Inlet to station pressure circa 0.8 atm
- Outlet to school 0.15 atm
- Inlet filter
- Safety shut off device – not confirmed if this activates on low inlet pressure or high outlet pressure
- Single PCV – make and specification not known
- Regulator manual bypass – not allowed in current regulations

The installation is shown diagrammatically as follows: -
3.6.1.2 Compliance comments

Following an examination of the equipment configurations and checking against applicable UK, European and US standards listed in Section 4.1 below comments are as follows:

- The unit should not incorporate a manual bypass
- Filtration should be achieved to 200 microns with twin stream filtration units
- Regulator streams should be at least twin stream with 100% redundancy due to it supplying a multi occupancy building – consequence supply failure on regulator breakdown
- Each stream should comprise a slam shut device and an active regulator system – Consequence over pressurization of the downstream system – at least one level of failure redundancy is required – Process is if active regulator fails to control the stream will slam off with gas being supplied through the standby stream
- Stream selection – downstream NRV’s to prevent over pressure slamming off the standby stream
- 0.15 atm downstream pressure is higher than normally allowed – should be no more than 0.075 atm entering a building

3.7 Smart meter installation

YAQQASARAI DISTRICT – ITRON SMART METER INSTALLATION

Photographs showing the installation are as follows:
3.7.1 Site description

The installation comprised:

- Itron meter installed in series to existing meter
- Badged at 150mbar MOP
- Meter – ItronGalvus SV GG4
- Remote monitoring and shut down
- Most pipework outside the building
- No meter governor is installed so the appliance will be supplied with full upstream pressure

3.7.2 Compliance comments

Following an examination of the equipment configurations and checking against applicable UK, European and US standards listed in Section 4.1 below comments are as follows:

- Convert installations to less than MOP of 75 mbar
- Consider risk review of operating pressure of installation pipework taking into account welded steel construction

3.8 Summary of findings

A summary of the findings of the study visit are as follows:
- Gas pressure regulation and metering streams should be updated to the latest international standards embodied in the design codes ASME 31.8 and IGE/TD/13. Such installations comprise process safety design to maintain continuity of gas supply and over pressure protection in the event of equipment mall function. The policy of installing full bore relief valves should be discontinued for safety, unaccounted for gas and environmental reasons.

- The gas distribution control modules are of obsolete design and will deliver an unstable pressure as they will not compensation for fluctuation in gas inlet pressure. This will result in inaccurate metering and resultant non-technical losses.

- Uztransgas are considering combining Tier 3 and 4 pressure tiers to stabilise operating pressures and provide more accurate metering and reduction of non-technical losses. The experts support this approach however uprating gas pressures should only be carried out following the replacement of steel system with polyethylene. This is recommended for safety engineering reasons (see later in the report).

### 3.9 Recommendations

Following the findings of the site visits the recommendations of the experts are summarised as follows:-

- System improvements should only take place following preparation of a design bases for the gas network to ensure consistent application of standards and policies.

- A pilot installation is being considered and a route map for undertaking the study is provided later in the report. The replacement of pressure regulators should not take place in isolation from an overall review of infrastructure design.

- Pressure reduction equipment at all pressure Tier levels should be replaced or upgraded to meet internationally recognised process safety standards embedded in ASME 31.8 and IGE/TD/13.

- Obsolete distribution pressure reduction equipment should be replaced so as to provide more effective pressure control leading to accurate metering and the reduction non-technical losses.

- Meter regulators should be installed so as to ensure downstream gas appliances are not pressurised beyond their design limit.

- A 4bar standard should be adopted for Tier 3 and 4 pipework as discussed later in the report.
4 Design proposals

A basis of design for pressure regulating installations and associated systems is provided in the following sections.

4.1 Applicable standards

International applicable standards for the design and operation of gas transmission and distribution infrastructure are listed as follows:

Pressure regulators

- IGE/TD/13 – Pressure Regulating Installations for Transmission and Distribution Systems
- ASME 31.8 – Gas Transmission and Distribution Piping Systems

Hazardous zones

- EN 94/9 CE

Meters

- EN 1359 – Standard for diaphragm gas meters
- EN 12480 – Standard for rotary displacement gas meters
- EN12261 – Standard for turbine gas meters

Pipework

- ASME 31.8 – Gas transmission and distribution piping systems
- IGE/TD/3 – Steel and PE pipelines for gas distribution
- IGE/TD/1 – Steel pipelines for high pressure gas transmission
PED 97/23 Pipework and vessels with CE marking where applicable

4.2 Gas distribution network overview

There are many combinations of network pressures and pipework configuration comprising distribution networks throughout Europe. The number of pressure tiers and the chosen system material is influence by:

- Design code requirements
- Existing gas distribution mains materials and jointing. Where mains pipework is aging and of unknown quality lower pressures are specified to mitigate the safety risks associated with gas losses especially from leaking joints
- Building development plan. Where gas mains need to be laid in close proximity to buildings due to confined spaces then higher specification materials are specified for improved safety. Mains laid in close proximity to multi-occupancy buildings should also be constructed from a higher specification material to reduce the risk of multiple injuries or fatalities caused by material or component failure

4.2.1 Uztransgas current network design basis

Uztransgas networks are based on 4 pressure tiers and they have stated their intention, if possible, to standardise on a 3 pressure tier network.

The Uztransgas 4 pressure tier current network configuration is shown diagrammatically as follows:-
Figure 11: Uztransgas network – current

By reference to the above diagram it can be seen that gas installation pipework (red lines) supplying buildings is operated at between 150 and 300 mbar. Pipework is of welded steel and is secured to the outside of buildings in many instances. The installation pipework enters a building to supply gas meters before onward supply to appliances. So far as could be seen there is no additional pressure reduction at the inlet to the gas meter which means that the supply pressure of 150 mbar may be supplied to within a building complex. Pressure control at the appliance or meter may not be suitably rated for the upstream pressure.

It is good safety practice for the gas pressure inside a building to be as low as possible. Whilst the Uztransgas standard for gas supply pressures within a building is less than 30 mbar and complies with UK and European standards it was found that gas pressures up to a meter located within an open area within a building complex can be in excess of the UK and European standards of 75 mbar. Furthermore a single meter regulator with no safety shut off device operating at these higher inlet pressures does not comply with UK and European standards.

It should be ensured that gas meters and appliances are always suitably rated for the gas installation pressure.
4.2.2 Uztransgas proposed network design basis

In general the Experts support the proposal to simplify the Uztransgas network to 3 pressure tiers so as to stabilise pressures at network extremities during times of high gas demand therefore improving metering accuracy and the reduction of non-technical loses. However we recommend that this should only be carried out after the pipework which is to be uprated in pressure has been replaced using modern polyethylene materials and constructed using automatic fusion jointing techniques.

The Experts recommend that a 4 bar (upstream) to 75 mbar (maximum downstream) regulator module is installed at the curtilage of each property. The downstream installation pipework should be of welded steel construction rated to PN16.

An additional pressure regulator should be installed upstream of each meter to ensure the gas installation pressure does not exceed the maximum pressure rating of connected appliances. These meter regulators are simple devices costing less than 20 Euro each.

An appliance survey should be carried out to ensure appliances are suitably rated for the gas installation pressure controlled by the gas meter regulator.

There is no specific recommendation in international standards for gas distribution pressures other than pressures limited by material specification and building proximity.

A 4 bar distribution standard has become popular for new gas networks for reasons explained later in this report. A proposed network arrangement for Uztransgas is shown in the following diagram.
Figure 12: Uztransgas network – proposed design basis

Note:- All recommended design pressures will be stipulated in the SI Units replacing the convention currently used in Uztransgas.

At each customer premises a gas pressure reduction installation will be installed on the boundary and separated from each building. The pipework that then conveys gas into the buildings will be operated at as low a pressure as practicable but should not exceed 75 mbar. The gas meter pressure regulator will further reduce the gas pressure for onward conveyance to appliances. A typical gas meter pressure regulator is shown in Appendix 1

4.3 Pressure control design

This section describes the design considerations when specifying modular pressure regulator configurations which would be installed at the boundary of customer premises when operating a 4 bar gas network. The section includes:-

1. An approach to risk mitigation
2. Recommended regulator module configurations for each type of gas consumer
3. The market for pressure regulator modules
4. Recommended maintenance philosophy

4.3.1 Risk Mitigation

Pressure reduction and metering modules should be designed to mitigate the following risks:-

1. Fluctuation in downstream pressure potentially leading to metering measurement errors
2. Over pressure of the downstream pipework potentially leading to pipe failure, leakage, fire and/or explosion endangering life and/or property
3. Interruption in gas supply potentially leading to unignited gas entering a building and when supplies are reinstated potentially leading to fire and/or explosion endangering life and/or property. This situation will arise if connected appliances do not incorporate flame failure devices. Appliances seen during the study visits were of obsolete design and did not incorporate safety flame failure devices.

Maintenance strategies for maintaining the level of risk are discussed in Section 4.3.4

The UK Institution of Gas Engineers and Managers standard IGE/TD 13 recommends the following safety devices for risk mitigation:-

1. For upstream pressures less than 100 mbar no protection device is necessary.
2. For upstream pressures greater than 100 mbar but less than 2 Bar then one safety device is recommended
3. For upstream pressures greater than 2 Bar then 2 safety devices are recommended unless a risk assessment determines that one device is acceptable

This generally reflects the advice given in the equivalent European and American standards listed above.

Where one level of safety is incorporated pressure is controlled by a pressure control valve (active) and the addition of one safety device which can be either an additional regulator in series (monitor) or a slam shut valve.

For two levels of safety the installation will incorporate a monitor regulator and a slam shut valve in addition to the active pressure control valve.

It is advised that the slam shut valve should incorporate a facility for activation on both high downstream pressure and low upstream pressure. This is so that if the upstream pressure were to fall below a safe minimum the slam shut would activate requiring a manual reset following turning off of customer supplies.
4.3.2 Regulator module configurations

The recommended configurations for modular pressure control installations are specified as follows:

4.3.2.1 Single occupancy residential and small commercial buildings

For single occupancy residential and small commercial properties a module incorporating an active regulator and slam shut is recommended.

For residential installations where metering is provided within a building, possibly multi occupancy buildings, the meter shown in this example could be dispensed with.

---

**Figure 13: Residential and small commercial pressure control and metering arrangement**

The control arrangements for single occupancy residential and small commercial customers will incorporate the following:

- A single pressure regulator
- Single stream configuration
- Upstream filtering to protect the control devices
- A pressure sensing slam shut device which will interrupt the gas steam should:
  - Over pressure be sensed downstream of the pressure control regulator
There is an interruption in gas supply upstream of the regulator on the gas distribution network.

- A slam shut device incorporating a manual reset

### 4.3.2.2 Multi occupancy residential, commercial and industrial

For multi occupancy residential, large commercial and industrial properties a module incorporating an active regulator, monitor regulator and slam shut is recommended.

For residential installations, where metering is provided within the buildings, then the meter shown in this example can be dispensed with.

---

**Figure 14: Large commercial and industrial pressure control and metering arrangement**

The control arrangements for large commercial and industrial customers will incorporate the following:

- Duplicate streams to provide more secure supply in-case of failure of one stream
- Wafer check non return valve in each stream
- Additional pressure control regulator in each stream to provide additional redundancy in case one pressure regulator fails
- Pressure regulators will be fail open devices and will act in active monitor configuration
- A locked meter bypass can be provided or a duplicate meter in parallel
- The gas flow through the meter will be corrected for pressure and temperature and will have a remote monitoring capability

A typical functional specification is tabulated as follows:

4.3.3 Technical evaluation of the international market for pressure regulators

The international market for gas pressure regulators is well established with many suppliers fully established in the UK, Europe and United States. Pressure regulators and associated safety devices are not normally purchased as individual components except for meter regulators. The established practice is to purchase pressure control equipment assembled in modular construction. The pressure control modules will incorporate equipment including filters, regulators, over pressure devices, creep relief valves and instruments.

Pressure control modules can be sourced by issuing a minimum functional specification to potential suppliers as detailed in Table 1 below. Pressure control modules can then be competitively sourced ensuring equipment meets the standard established in IGE/TD/13 - Pressure Regulating Installations for Transmission and Distribution Systems. IGE/TD/13 incorporates the requirements of EN 12186:2000 ‘Gas Supply Systems – Gas Pressure Regulating Stations for Transmission and Distribution – Functional Requirements’ and EN 12279:2000 ‘Gas Supply Systems – Gas Pressure Regulating Installations on Service Lines – Functional Requirements.'
### Table 1: Regulator module minimum functional specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification/cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Design flow</td>
<td>Xx m³/hour</td>
</tr>
<tr>
<td>2 Supply inlet pressure</td>
<td>4 Bar</td>
</tr>
<tr>
<td>3 Delivery outlet pressure</td>
<td>50 mbar</td>
</tr>
<tr>
<td>4 Module configuration</td>
<td>Active slam/twin stream</td>
</tr>
<tr>
<td>5 Design standard inlet pressure</td>
<td>PN 16</td>
</tr>
<tr>
<td>6 Design standard outlet pressure</td>
<td>PN 16</td>
</tr>
<tr>
<td>7 Housing - 2 sets of double doors</td>
<td>Required</td>
</tr>
<tr>
<td>8 Designed and constructed in accordance with IGE/ TD / 13</td>
<td>Required</td>
</tr>
<tr>
<td>9 All manuals and maintenance requirements</td>
<td>Required</td>
</tr>
<tr>
<td>10 Commissioning, 12 months 24/7 fault and repair cover</td>
<td>Required</td>
</tr>
<tr>
<td>11 Delivery</td>
<td>21st January 2015</td>
</tr>
</tbody>
</table>

Source: Expert advice

A list of suppliers is tabulated in Appendix 3. The list is not exhaustive and no supplier preference has been made or implied. The choice of supplier will be influenced by the availability of a local contact and post installation support for responding to faults and provision of spare parts.

Typical examples of gas pressure regulator module configurations from Forentini and Francel can be seen in Appendix 2 of this document.

#### 4.3.4 Typical maintenance and inspection regime for pressure regulators
Maintenance and inspection tasks based on the UK standard IGE/TD/13 and UK network codes of practice will incorporate:

1. Routine inspections
2. Functional checks
3. Major overhauls

The inspections will be incorporated the tasks detailed as follows:

4.3.4.1 Routine inspection
Routine inspection will typically comprise the following tasks:

- Check security of the site and note any abnormalities. Ensure that site labels, where used, are correctly displayed
- Note any defects in the structure of the housing and record on appropriate document(s)
- Check atmosphere around the installation for the presence of gas and report any leakage found
- Check installation for water ingress and pipework/regulator for corrosion. Report any significant deterioration
- Check that the relief vents are correctly positioned and free from any visible obstructions
- Connect a pressure gauge to the test nipple on the outlet of the regulator/meter and record the outlet pressure. Report any deviation from set point
- Report any nearby works or buildings extensions which may have a detrimental effect on the operation of the installation, e.g. additional flues or electrical work.
- Lubricate locks and hinges where appropriate
- Check if the fire valve cover/box is still accessible and report as appropriate

4.3.4.2 Functional check
A functional check will typically comprise the following tasks:

- All those items for Routine Inspection
- If a bypass facility exists, connect a correctly sized regulator to maintain supply to the consumers
- If not, the supply to the consumer must be interrupted.
- Where it is necessary to interrupt customers’ supplies, the consumer installation should be tested before bringing back into service
- Check the lock-up of the regulator
- Isolate stream and check for leakage through isolation valve
- On stand-alone filter, check condition of element and clean/change as necessary
- Check the set point of the relief valve by gradually applying a controlled pressure to the outlet connection of the regulator. Note - If the slam shut trips before the relief valve lifts, record the trip pressure
- Check the slam-shut valve trip pressure (minimum of 3 trips) by applying a controlled pressure to the impulse line or to the outlet connection of the regulator. Monitor the downstream pipework for let-by after the first trip. Care must be taken to ensure that the applied pressure is not allowed to dissipate through the relief valve vent or spring adjuster cap, giving rise to a false test pressure. Note - It is possible that the trip pressure will rise above the desired setting due to the effects of stiction. Such a rise in trip pressure is permitted although the trip pressure must not exceed the set point +30%.
- If any faults are found during testing they must be reported through a Fault Data Collection Scheme
- Before leaving site check all connections for leakage
- Ensure that the site is tidy and secure on leaving site

4.3.4.3 Major overhaul
Refer to manufacturers recommendations.

4.3.4.4 Frequency of inspection
The frequencies of inspections are typically as specified in the following table:-
4.4 Gas distribution network design

The Uztransgas existing gas distribution network comprises mainly above ground steel pipe with welded joints. The pipe and welded joints are of unknown specification and quality and it is therefore considered in-prudent to elevate the pressure in these pipes. The failure of a pipe could lead to fire or explosion with consequences for life and buildings located adjacent to the pipe.

The proposed rationalisation of Tier 3 and 4 gas distribution networks at a maximum operating pressure of 4 Bar is recommended for the following reasons:

- Bench mark system network pressure for new gas distribution networks
- Utilisation of SDR 17.6 PE 100 distribution pipe which is more flexible than SDR 11 pipe needed for higher pressures. If 4 bar network pressures cannot be guaranteed by upgrading pressure control equipment as recommended in the report then SDR 11 pipe should be utilised to increase the pipe safety factor
- Lesser building proximity distances compared with PE pipework operating at higher pressures
- Smaller diameter pipes than for pipes operating at a lower pressure to deliver same capacity – less cost to install
- Only pneumatic pressure testing required in preference to hydrostatic testing – no water to remove after testing

A proposed Tier 3 and 4 uprating scheme is described as follows:

<table>
<thead>
<tr>
<th>PRMS Type</th>
<th>Routine inspection frequency</th>
<th>Functional check frequency</th>
<th>Major overhaul frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network, large commercial and industrial installations and residential installations supplying more than 10 premises</td>
<td>As determined by local risk assessment</td>
<td>No less frequent than every 12 months</td>
<td>Determined by manufacturers recommendations but no less frequent than every 6 years</td>
</tr>
<tr>
<td>Small commercial and residential installations supplying less than 10 premises</td>
<td>As determined by local risk assessment but no less frequent than every 5 years</td>
<td>For installations inside an enclosure no less frequent than every 10 years and for all other installations no less frequent than every 6 years</td>
<td>Determined by manufacturers recommendations</td>
</tr>
</tbody>
</table>

Source: IGE/TD/13 and UK network codes of practice

Table 2: Inspection frequencies
1. Construct a 4 bar PE 100 gas distribution system. The following constraints will apply:-
   a. PE pipe shall be laid no closer to buildings in accordance with the following recommendations made IGE/TD/3:-
      i. Up to 315mm Diameter – 5 metres
      ii. Between 315mm diameter and 400mm diameter - 8 metres
      iii. Greater than 400mm diameter – 13 metres
2. Pipework in closer proximity to buildings must be constructed in welded steel pipe designed for PN 16 pressure rating and protected from corrosion with a cathodic protection systems
3. Install upstream pressure regulation in accordance with internationally recognised standards to protect against overpressure and maintain continuity of supply. These shall comprise the following:-
   a. Twin stream pressure control regulator to provide 100% redundancy in case one stream fails
   b. Pressure regulators will be fail open devices and will act in active monitor configuration
   c. Upstream slam shut device
   d. Compliant filtering and metering
It is recognised that moving to a modern polyethylene system will require a significant departure from the current Uztransgas practice of laying steel pipe above ground.
5  Pilot project

The Experts propose that a pilot project is implemented to develop a basis of design for future modifications to the gas network and to trial the proposed new gas pressure control arrangements. The outputs of the pilot study will provide both a technical and financial evaluation of the proposed solutions. Scoping of the pilot project is beyond the scope of this AHEF however the following route map for a pilot project is provided to assist the Beneficiaries understanding of its requirements.

1. Carry out customer survey to list all appliances installed in each building included in the pilot study together with their estimated gas demand. This is so that all upstream equipment can be designed to accommodate the maximum peak instantaneous gas consumption. Meter data should not be used. The appliance badged rating value should be used

2. Specify the gas installation pressure to be supplied into each building and up to the meter regulator. This should be less than 75 mbar and preferably less than 30 mbar in accordance with the Uztransgas standard

3. Assess the condition of the installation pipework and replace as necessary to PN16 standard

4. Carry out hydraulic modelling of the gas installation pipework to calculate is it of adequate diameter – replace as necessary to PN16 standard

5. Carry out hydraulic modelling for the new 4 bar gas distribution system to select pipe diameters based on the gas loads listed during the site survey

6. Select regulator modules and suppliers in accordance with the recommended design and capacity requirements derived from the customer survey

7. Select PE 100 suppliers for the pipe sizes calculated in the hydraulic modelling – specify material specification SDR 17.6 or SDR 11

8. Select pipe routes using the building proximity distances specified in the design. All pipe must be laid underground to an agreed standard of depth, location and protection

9. Select a location for the 4 bar to 30-75 mbar regulator modules. In own building and separate from any other building. Also not to be near any source of ignition as stipulated in a hazardous area survey

10. Check and replace appliance regulators as required – It may be necessary to replace appliances which are obsolete and unsafe

11. Replace gas meters with the type specified in the current pilot study including the installation of a meter regulator
12. Prepare a scheme for the pilot study installation and construction including design drawings, specifications all submitted and approved by competent person

13. Appoint a competent gas network and gas installation contractor with industry standard experience and qualifications – Proof of competence must be supplied for both the person and the organisation carrying out the work

14. Procure materials and implement the pilot scheme

15. Monitor, inspect and supervise the works so as to meet the standards of design, construction and testing

16. Compile construction records and handover package for commissioning in accordance with the prepared standard

The proposed route map is illustrated as follows:-
1. Carry out customer survey to list all appliances installed in each building.
2. Specify the gas installation pressure to be supplied into each building.
3. Select a location for the 4 bar to 30-75mbar regulator installation.
4. Assess the condition of the installation pipework.
5. Carry out hydraulic modelling of the gas installation pipework.
6. Replace the installation pipework as necessary either due to condition or sizing.
7. Carry out hydraulic modelling for the new 4 bar gas distribution system.
8. Select regulator modules and suppliers – issue mfs.
9. Select PE 100 suppliers for the pipe sizes calculated in the hydraulic modelling.
10. Select pipe routes.
11. Select a location for the 4 bar to 30-75 mbar regulator module.
12. Check and replace appliance regulators as required.
13. Replace gas meters with the type specified in the current pilot study including meter regulators.
14. Prepare a scheme for the pilot study installation and construction.
15. Appoint a competent gas network and gas installation contractor.
16. Procure and implement the pilot scheme.
17. Monitor, inspect and supervise the works.
18. Compile construction records and handover package for commissioning.

| Table 3: Pilot study route map |

### 5.1 Pilot study support

It is recommended that Uztransgas receives additional support during the pilot project implementation. This is to ensure the development and implementation of internationally recognised standards for the safe conveyance of natural gas and delivering of environmental targets.
This support will include:-

1. Development and instruction on available standards of the design, construction and operation of gas distribution systems

2. Preparation of internationally complaint design basis to be applied to all future network projects

3. Selection and training of competent contractors

4. Implementation of an appropriate system for monitoring and supervising the construction contract

5. Development and implementation of an appropriate records system

5.2 Measures of success

Appropriate bench marks for measuring the success of the pilot project will be:-

1. Zero harm to consumers and members of society during construction and future operation of the gas network

2. Reduction of technical and non-technical losses to an internationally bench mark standard

3. Achieve Construction costs in accordance with international bench marks
6 Costs and benefits

6.1 Populations

The Uztransgaz (UTG) operates approximately 14,000 km of transmission pipelines and approximately 124,000 km of gas distribution networks. These cover all regions of Uzbekistan and have interconnections to gas transportation system of neighbouring countries, i.e. Turkmenistan, Kazakhstan, Kyrgyzstan and Tajikistan.

6.1.1 Gas consumer population

The customer populations supplied by the gas distribution network in Uzbekistan is listed in the following table:-

<table>
<thead>
<tr>
<th>Consumer Categories</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Residential Consumers</td>
<td>4,369,187</td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
</tr>
<tr>
<td>Apartments</td>
<td>1,029,680</td>
</tr>
<tr>
<td>Houses</td>
<td>3,339,507</td>
</tr>
<tr>
<td>Wholesale consumers (industrial, social, business, CNG stns)</td>
<td>83,646</td>
</tr>
<tr>
<td>Direct consumers connected to main gas lines</td>
<td>107</td>
</tr>
<tr>
<td>Total Number of Consumers</td>
<td>4,452,940</td>
</tr>
</tbody>
</table>

Source:- SEMISE Reduction of Non-technical Natural Gas Losses in Transmission Gas Pipelines System and Gas Distribution Networks report 2011

Table 4: Gas consumer population

6.1.2 Pressure reduction equipment population

Information received from Uztransgas during the study has indicated that within the gas distribution network of Uzbekistan there are approximately:-

- 8,000 installations which reduce the pressure from Tier 2 (circa 20 atm) to Tier 3 (circa 6 atm) and
• 90,000 installations which reduce the pressure from Tier 3 (circa 6 atm) to Tier 4 (circa 0.3 atm)

Using a very broad based assessment the ratio of gas consumers to pressure reduction installations is approximately 45 consumers per installation and the ratio of distribution mains per consumer is 30 metres per consumer. These ratios will be used in calculating the project costs associated with delivering a pilot study as described in Section 5

6.2 Pressure reduction module costs

Enquiries have been made of pressure reduction module manufacturers and the following table shows the estimated purchase and installation costs for the pressure control module designs recommended in the study:

<table>
<thead>
<tr>
<th>Regulator module type</th>
<th>Module</th>
<th>Enclosure</th>
<th>Installation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small residential supplying up to 4 consumers</td>
<td>€830</td>
<td>€250</td>
<td>€1000</td>
<td>€2080</td>
</tr>
<tr>
<td>- 4 bar to 75 mbar (Circa 20scmh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single commercial/residential greater than 4 and</td>
<td>€2550</td>
<td>€415</td>
<td>€2000</td>
<td>€4965</td>
</tr>
<tr>
<td>up to 30 customers - 4 bar to 75 mbar (Circa 150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>scmh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large commercial/industrial - 4 bar to 75 mbar</td>
<td>€14400</td>
<td>€4800</td>
<td>€8000</td>
<td>€27200</td>
</tr>
<tr>
<td>(Circa 500 scmh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large multi-network installation 20 bar to 4 bar</td>
<td>€480,000</td>
<td>N/a</td>
<td>€380,000</td>
<td>€860,000</td>
</tr>
<tr>
<td>(Replacement existing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Survey of pressure regulator suppliers and UK contract costs

Table 5: Regulator module costs

6.3 Benchmark mains replacement costs

To facilitate a revised network design basis it is anticipated that a proportion of the existing gas network will need to be upgraded to 4 bar requiring existing pipework to be replaced in High Density Polyethylene pipe (PE100). Unit costs of replacement are normally expressed in costs per metre of pipe abandoned (cut off and replaced with new pipe).
With reference to UK Ofgem UK gas network RIIO determination the average benchmark costs per metre of main abandoned is 220 Euro a metre. This unit cost will be used in calculating the out-turn cost of a pilot project.

6.4 Estimated costs of a pilot project

Uztransgas have stated that they have purchased 31,200 new gas meters of which 2,000 have been installed. If we assume that the 29,200 meters purchased would comprise the pilot project then the estimated costs of the pilot project are as follows:-

<table>
<thead>
<tr>
<th>Cost elements</th>
<th>Calculation</th>
<th>Estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of gas regulator modules</td>
<td>(29200 consumers) @ (30 customers per regulator installation) @ (€4965 per regulator installation)</td>
<td>€4.8 million</td>
</tr>
<tr>
<td>Cost of pipe upgrading assuming approximately 60% of pilot network would need to be upgraded</td>
<td>(29200 customers) @ (30 metres per customer) @ (€220 per metre) @ (60% replacement rate)</td>
<td>€115.6 million</td>
</tr>
<tr>
<td>Design and project services</td>
<td>13% of (€4.8 million + €115.6 million)</td>
<td>€15.7 million</td>
</tr>
<tr>
<td>TOTAL OF COSTS OF PILOT PROJECT</td>
<td></td>
<td>€136.1 million</td>
</tr>
</tbody>
</table>

Table 6: Pilot project costs

6.5 Gas losses

The technical gas losses for 2010 as reported in the SEMISE Report 2011 were 2.4%. At the time of writing the SEMISE report no information was available on the quantity of non-technical losses.

The report highlighted the issue of un-metered supplies which was particularly acute in Uzbekistan where 1.8 million customers out of a total of 4.5 million were unmetered i.e. 27% of the total.

Following the report Uztransgas purchased 31200 gas meters of which only 2000 have been installed. Unstable pressure control on the gas system was identified as the cause preventing the new meters providing accurate recording of customer gas consumption. The purchase of pressure control equipment, to be installed with the new meters, and implementation of a new operating basis for the gas network will substantially eliminate non-technical losses associated with unmetered gas. Whilst 31200 out of a total population of 1.8 million meters is only a small proportion the pilot
project the policy will eventually lead to substantial reductions in un-metered gas supplies and therefore non-technical losses.

So far as the impact of the pressure controls equipment on technical losses (2.4% for 2011) is concerned. The optimisation of network pressures and the upgrading of gas mains systems have been identified in Europe as key components for reducing gas leakage and therefore technical losses. Gas mains leakage contributes 97% of the total leakage element. In its submission to the UK Office of Gas and Electricity Markets (Ofgem) National Grid asserted that gas mains leakage is 0.5% of total annual gas throughput and that by implementing an effective mains upgrade and pressure management policy mains leakage could be reduced by approximately 10% during the next regulatory period.

For Uztransgas adoption of an effective pressure management and mains upgrade policy as proposed in this report could reduce technical losses from 2.4% to 2.35%.

The SEMISE report estimates that total gas losses, included technical and non-technical, were valued at US$ 850 million per annum. Whilst the report does not quantify the allocation of cost between technical and non-technical losses a reduction of 0.05% in technical loses would have a significant impact on the value of lost gas.

\(^2\) National Grid submission to Ofgem – December 2012
7 Conclusions and recommendations

Following the preparation, issue and return of a questionnaire to Uztransgas two study visits were made to Tashkent, Uzbekistan. The purpose of the visits was to clarify the characteristics of the gas transmission and distribution network and understand the pressure regulating issues.

From information obtained at meetings with Uzbekneftegaz/Uztransgas and the site visits the Experts have drawn the following conclusions:-

- Gas pressure regulation and metering systems do not meet the latest international standards embodied in the design codes ASME 31.8 and IGE/TD/13. These standards recommend process safety design to maintain continuity of gas supply and provide over pressure protection in the event of equipment malfunction so as to mitigate the risks to people and property located near to gas transmission/distribution infrastructure. The safety recommendations have been developed in response to serious incidents previously encountered on gas networks

- The existing gas distribution pressure control modules are of obsolete design and will deliver an unstable pressure as they will not compensate for fluctuation in gas supply pressure. This will result in inaccurate metering and resultant non-technical losses

- Meter governors are not installed which are required to ensure gas appliance safe operating pressure limits are not exceeded and to provide a stable pressure for accurate metering

- The Uztransgas distribution network suffers from significant seasonal pressure fluctuations. Uztransgas are therefore considering combining Tier 3 and 4 pressure tiers to stabilise operating pressures by increasing overall network pressure. This stabilisation of pressures will provide more accurate metering and reduction of non-technical losses. The Experts support this approach subject to the recommendations below

- At the time of the SIMISE report 2011 Uztransgas supplied gas to 4,452,940 consumers through a gas transmission/distribution network of approximately 138,000 km. Uztransgas reported that they have a population of approximately 98,000 pressure control installations. Upgrading all pressure reduction installations to meet current safety standards and rationalising the entire distribution network as proposed in item 4 above would therefore require a substantial infrastructure investment
The report provides a detailed response to the issues identified in the study. The recommendations for Uzbekneftegaz/ Uztransgas are summarised as follows:

- A programme should be put in place to replace or upgrade obsolete transmission and distribution network pressure reduction equipment at all pressure Tier levels to meet internationally recognised process safety standards embedded in ASME 31.8 and IGE/TD/13. This is a key safety recommendation of the report. Modern pressure regulators will also provide more effective pressure control leading to accurate metering and reduction in non-technical losses. New distribution pressure reduction modules should be located away from buildings and in their own enclosure comprising filtering, pressure control and over pressure/supply interruption protection. They can be either twin or single stream depending on the number of customers connected downstream of the regulator and the quantity of gas being supplied.

- Meter regulators should be installed as standard so as to ensure downstream gas appliances are not pressurised beyond their design limit and a constant pressure is provided at the metering point. Meter pressure regulators cost no more than €20 each.

- A 4bar standard is recommended for the Tier 3 and Tier 4 pressure rationalisation being considered by Uztransgas. This rationalisation and uprating of the network should not take place until gas mains have been replaced with new Polyethylene pipe specified to the standard recommended in the report however it is recognised that moving to a modern polyethylene system will require a significant departure from the current Uztransgas practice of laying steel pipe above ground.

- The current safety standard in UK and Europe for gas pressures entering buildings limits the gas pressure to less than 75 mbar. The current Uztransgas practice of supplying gas at a pressure in excess of 75 mbar up to a meter located within an open space within a building will need to be reviewed when implementing the proposed pressure reduction proposals. The Uztransgas standard of distributing gas at pressures of less than 30 mbar downstream of the meter complies with UK and European standards System improvements should only take place following preparation of a design bases for the gas network to ensure consistent application of standards and policies. The replacement of pressure regulators should not take place in isolation from an overall review of infrastructure design.

- A pilot project is being considered by Uztransgas and a route map for undertaking the study is provided in the report. It has been calculated that if the pilot project comprised the 29,200
meters purchased by Uztransgas, but not yet installed, the cost of the project would be approximately €136 million. This assumes that gas pressure reduction equipment is upgraded and gas mains are replaced as recommended in the report. A more limited pilot project could be implemented with costs pro rata to the number of consumers comprising the pilot study.

- Risk mitigation will be enhanced by the introduction of a maintenance regime as recommended in the report.

- The international market for gas pressure regulator modules is well developed and compliant gas pressure reduction modules at competitive prices can be sourced from a number of suppliers by issuing a simple functional specification recommended in the report.
Appendix 1: Gas meter regulator

Figure 15: Typical Jeavons gas meter regulator
Appendix 2 Regulator module information

Figure 16: Typical Fiorentini regulator module
Figure 17: Typical Fiorentini regulator module – P&ID – IGE/TD/13 compliant
Figure 18: Typical Francel pressure regulator module – 160 SCMH – Residential or small commercial
Figure 19: Typical Francel pressure regulator module – 1000 SCMH – Multi Residential or Commercial
Appendix 3: Regulator module suppliers

<table>
<thead>
<tr>
<th>REGULTOR MODULE SUPPLIER</th>
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<tbody>
<tr>
<td><strong>1</strong></td>
</tr>
<tr>
<td>Fiorentini</td>
</tr>
<tr>
<td>Brooke House</td>
</tr>
<tr>
<td>Spartan Close</td>
</tr>
<tr>
<td>Warwick</td>
</tr>
<tr>
<td>Warwickshire</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>CV34 6RR (map)</td>
</tr>
<tr>
<td>Tel: 01926 336745</td>
</tr>
<tr>
<td>Fax: 01926 336647</td>
</tr>
<tr>
<td>Website: <a href="http://www.fiorentiniuk.com">www.fiorentiniuk.com</a></td>
</tr>
</tbody>
</table>

| **2**                  |
| Tartarini or Francel Regulator Modules |
| Emerson                   |
| Mavllyanova street, 48   |
| Tashkent 700084           |
| tel +998 71 235-18-91     |
| +998 71 235-17-30         |
| tel/fax +998 71 234-13-06 |
| emersonuz@inbox.uz        |
| [www.emersonprocess.ru](http://www.emersonprocess.ru) |

| **3**                  |
| AFC                     |
| Active Flow Controls    |
| Brackenwood House       |
| Kimbell Road            |
| Basingstoke             |
| Hampshire               |
| United Kingdom          |
| RG22 4AT                |
| Tel + 44 1256364590     |

| **4**                  |
| BRYAN DONKIN           |
| 210 Century Drive      |
| Bristol, CT 06010      |
| United Kingdom         |
| Toll Free: 866-4 MY REGS |
| 866-469 – 7347         |
Table 7: List of pressure reduction module suppliers

| 5 | ElsterMesstechnik GmbH  
    | Otto-Hahn-Ring 2-4  
    | 64653 Lorsch  
    | Tel: +49 6251-59301-0  
    | Fax: +49 6251-59301-80  
    | E-Mail: messtechnik@elster.com  
    | www.elstermesstechnik.com |
Appendix 4: Uztransgas network schematic representation

Figure 20: Uztransgas network schematic diagram