



JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 – in effect as of: June 15, 2006

CONTENTS

- A. General description of the project
- B. Baseline
- C. Duration of the project / Crediting period
- D. Monitoring plan
- E. Estimation of greenhouse gas emission reductions
- F. Environmental impacts
- G. Stakeholders' comments

Annexes

- Annex 1: Contact information on project participants
- Annex 2: Baseline Information
- Annex 3: Monitoring plan



LIST OF ABBREVIATIONS USED IN PROJECT DESIGN DOCUMENTATION

OJSC – Open Joint Stock Company
JIM – Joint Implementation Mechanism
CDM – Clean Development Mechanism
UGSSR – Ukrainian Gas Supply System Safety Rules
PDD – Project Design Documentation
JI – Joint Implementation
PETM – Purposeful Examination and Technical Maintenance

**SECTION A. General description of the project****A.1. Title of the project:**

Reduction of methane leakage at flange, threaded joints and shut-down devices of the equipment of OJSC "Kyivgas"

Area 10. Volatile emissions from fuels (solid, liquid fuels and gases).

Version of Project Design Documentation: 03.

Date: July 07, 2010.

A.2. Description of the project:

The purpose of the project is reduction of natural gas leakage at gas transport and gas distribution infrastructure of OJSC "Kyivgas". The main sources of leakage are switch mechanisms (bolts, cocks, valves), flange and threaded joints of gas pipelines of OJSC "Kyivgas" in the amount of 60 613 pieces. The main reason for natural gas leakage is quick failure of sealant elements. Methane, the main component of natural gas (92-95 vol.%) is a greenhouse gas. Elimination of methane leakage will result in reduction of greenhouse gas emission. Hereinafter an expression "methane leaks" is used to determine natural gas leakage, as instrumental measurements concerning methane in particular.

The situation before the start of the project

OJSC "Kyivgas" is the company providing natural gas transportation and supply to industrial and domestic consumers as well as to the population in the city of Kyiv.

The structure of current gas transport rates regulated by the government does not include depreciation and investment needs of gas distribution enterprises. Such fact results in deficit of the funds for performance of necessary repair works and modernization of gas networks, purchase of appropriate engineering equipment and components, and also promotes increase of natural gas leakage at the objects of OJSC "Kyivgas".

Application of JI project mechanisms provided for by Kyoto Protocol was planned before the beginning of implementation of this project. For this purpose the preliminary investment Contract as to JI project was signed in July 2005 by VEMA S.A. (Switzerland) and OJSC "Kyivgas".

Baseline scenario

Before the start of the project (2005) OJSC "Kyivgas" only detected leakages with the help of detectors according to the Ukrainian Gas Supply System Safety Rules¹ in order to avoid emergency and explosive situations. Measurement of the leakage volume, its registration and accounting were not performed, and appropriate measuring devices were missing. Theoretical calculations of the leak volumes on the ground of performed measurements of natural gas leakage in the result of faulty sealing of switch mechanisms (bolts, cocks, valves), flange and threaded joints of distribution gas pipelines of OJSC "Kyivgas" can make 80 million m³ per year. Absence of financing sources does not allow elimination of these leaks.

Decree of the State Labor Protection Control Committee of Ukraine as of від 01.10.1997 No. 254, Registered in the Ministry of Justice of Ukraine on May 15, 1998 under the No. 318/2758

Project scenario.



Project activities include reduction of methane leakage which is the result of faulty sealing of ground and underground fittings implemented at the switch mechanisms (bolts, cocks, valves), flange and threaded joints of gas pipelines of OJSC “Kyivgas” in the amount of 60 613 pieces.

Types and quantity of fittings are given in the Table 1:

No.	Type of devices (type of joint)	Quantity of devices, pcs.
1.	Shut-down devices in gas wells– block valves (flanged joint)	6447
2.	Ground shut-down devices – block valves (flanged joint)	10451
3.	Electrical insulating flanges (flanged joint)	22120
4.	Underground shut-down devices of well-less plant - block valves (flanged joint)	3739
5.	Ground shut-down devices - cocks (threaded joint)	17856
Всього		60613

Table 1. Quantity of fittings by type involved in the Project

Within the scope of the project for repair of equipment, for the purpose of methane leakage elimination, modern compacting materials will be used, replacing service and repair practice based on rubberized asbestos fabric and rubber gaskets, and compacting padding made of cotton fibre with fat soakage and asbestos graphite filler. This practice does not give long-term effect, which leads to additional methane leakage. In addition to reduction of methane leakage, the project activity will lead to reduction of technical leaks of natural gas (and thus, to reduction of financial costs), and will contribute to improvement of environmental situation, to reduction of the risk of accidents, especially for in-house gas pressure regulators and overland gas pipelines.

The project activity includes:

- Implementation of purposeful examination and technical maintenance (PETM) of all switch mechanisms (bolts, cocks, valves), flange and threaded joints – modern and the most economically effective practice, which allows not only detection of leaking areas, but also determination of leakage volume (i.e., potential volume of gas leakage reduction). This key information is required for substantiation of efficiency of repair works and priority choice of its objects, which is important under short financing for elimination of all leakages. This activity will include purchase and calibration of modern measuring equipment, appropriate training of employees, development of monitoring map for each switch mechanism, flange and threaded joint of gas distribution network, with the list of all equipment components to be regularly examined, creation of leakage data collection and storage system, and implementation of internal audit and quality system for elimination and accounting of methane leakage.
- Detection and measurement of leakage: Monitoring system of leaks at all switch mechanisms (bolts, cocks, valves), flange and threaded joints, including eliminated leaks (repaired components of equipment). Monitoring will be done on a regular basis (once in four days or once per week – depending on the type of equipment) by specially trained staff. Each component will be checked according to the monitoring map, and detected leakage will be duly marked with individual number; gas leakage volumes will be measured and registered in the database.
- Elimination of all detected leakages: repairs of leaking equipment under this project will vary from replacement of gaskets and wedge valves, use of new compactors or sealing materials, to capital repairs and replacement of equipment. Repaired equipment components will be regularly checked as a part of a standard monitoring program (see above) to make sure they have not become the source of leakage again.

The project was initiated in June, 2005:



In July 2005 the examination of shut-down devices (bolts, cocks, valves), flanged and threaded joints of gas-distribution networks of OJSC “Kyivgas” was conducted and the initial measurement of leakage was executed, results of which became the basis for project baseline formation.

On July 29, 2005 the preliminary investment contract as to JI project was signed between VEMA S.A. (Switzerland) and OJSC “Kyivgas”. The contract also provided for that Company VEMA S.A. shall elaborate the emission monitoring program and PDD of JI project.

July 29, 2005 – the Work team was organized, which main task was ensuring of the project implementation.

July 30, 2005 the project participants agreed PDD of the project (version 01), which included the emission monitoring program.

August 2005 – commencement of monitoring and repair of shut-down devices (bolts, cocks, valves), flanged and threaded joints of OJSC “Kyivgas” equipment.

Duration of the project is not limited, as PETM, monitoring and leakage elimination programs are aimed to become a part of work of OJSC “Kyivgas”. Reduction of emissions CO₂-equiv. is stated for the period of 13 years according to modality and Joint Implementation Procedures.

A.3. Project participants:

Invited Party	Business Name of Project participant	Please state whether Invited Party is willing to be considered <u>Project Participant</u> (YES/NO)
Ukraine (HOST PARTY)	OJSC “Kyivgas”	NO
SWITZERLAND	Vema S.A.	NO

A.4. Technical description of the project:**A.4.1. Location of the project:**

The project is located in the city of Kyiv-capital of Ukraine (**Picture 1**).



Pic. 1. Map of Ukraine with regions, neighbouring countries and indication of location of Kyiv-capital of Ukraine.

A.4.1.1. Host Party(-ies)

The project is located on the territory of Ukraine.

Ukraine is a country in the East Europe, which has ratified Kyoto Protocol to UN Framework Convention as of February 04, 2004, enters the list of countries given in the Annex 1, and meets the requirements for participation in Joint Implementation projects.

A.4.1.2. Region/State/Province etc.:

The project is located in the city of Kyiv.

A.4.1.3. City/Town/Community etc.:

City of Kyiv.

Register of shut-down devices, flanged and threaded joints of distribution gas pipelines of OJSC "Kyivgas" is given in the accompanying document 1¹.

¹ Register of shut-down devices, flanged and threaded joints of distribution gas pipelines of JSC Kyivgas is made in the electronic format and is submitted to the National Agency for Environmental Investments of Ukraine and to the project verifier of Bureau Veritas Certification Holding SAS.

A.4.1.4. Detail of physical location, including information allowing the unique identification of the project (maximum one page):

Kyiv is the capital and the largest city of Ukraine. Kyiv is located in the North of the central part of Ukraine and on the Dnieper riverside. Kyiv is separate political subdivision of Ukraine, moreover it is the administrative centre of Kyiv region. The city is the cultural and governmental centre of Ukraine. Population is about 2,7 mln. inhabitants. Territorially Kyiv is divided into 10 administrative districts.



Pic. 2. Administrative districts of Kyiv city where the project will be implemented

List and addresses of the objects included into the Project are given in the register of shut-down devices, flanged and threaded joints of distribution gas pipelines of OJSC “Kyivgas”; see accompanying document 1¹.

A.4.2. Technology(-ies) to be employed, or measures, operations or actions to be implemented by the project:

1. Development and implementation of natural gas leakage measurement method

To measure leakage volume of natural gas it was decided to use the method based on the Calibrated Bag Technology described in the approved baseline strategy AM0023 “Reduction of natural gas leakage at compressor and gas distribution stations of main gas lines”. One of the problems incurred by using this method is difficult accounting of the volume of the valves measurements are done on, and of the initial air volume upon determination of gas volume received in the bag.

A special plant was made to solve these problems. It is made on the basis of a plastic capacity of a certain volume (0,87 m³), package, plastic hose and pressure gauge (see Annex 3, Picture 3). All junctions are sealed



Pic. 3. Photo of a plant for quantitative measurement of methane leakage

Gas analyzer EX-TEC® SR5. To determine methane concentration in the sample a high-precision gas analyzer EX-TEC® SR5 is used.



Pic. 4. Photo of gas analyzer EX-TEC® SR5.

Gas analyzer has the following characteristics:

- explosion insulation (CENELEC),
- methane detection upon control of pipeline networks (ppm range),
- gas detection at the internal installations (ppm range);
- alarm upon approaching the lower level of explosion (% UEG or Vol. %-range),
- Measurement of concentration upon gas contamination and purging of lines (Vol. % range),
- measurement of concentration in probe aperture (Vol. %-range).

Relative error makes 10%, which meets the standard EN 50054/57²

After detection and measurement of leakage respective repair works will be done on the leaking joints of the elements, shut-down devices (bolts, cocks, valves), flanged and threaded joints of gas pipelines of OJSC “Kyivgas”, which will include use of modern sealing materials according to GOST 7338-90³, GOST 5152-84⁴ or GOST 10330-76⁵.

Detailed information on the measuring methods used in leakage monitoring is given in the Annex 3.

2. Implementation of modern sealants for leakage elimination.

Sealants (GOST 7338-90) made of oil and petrol resistant rubber are provided for production of mechanical rubber goods used for sealing of immovable joints, prevention of friction between metal surfaces, for perception of single shock loads, and as gaskets, floors and other sealing items.

Packing (GOST 5152-84). Asbestos braided packings are used for sealing packing chambers of the fittings, eccentric and piston pumps, and different plants at the working temperatures from -70 to +300°C.

Lubrication of shut-down devices and sealing of threaded joints by flax fiber GOST 10330-76 and oil Plitol-M (TU U 25404313.004-2201)

Braided packings are the most popular sealing material used for filling packing chambers of the fittings, eccentric and piston pumps and different plants. Over 80% of fittings are completed with this sealant. They differ in material they are made of and in the production method (structure). Both factors considerably effect operating characteristics of packings. Different types of soakage and fillers are an important component of packings which give them the necessary characteristic.

²³Electrical apparatus for the detection and measurement of combustible gases. General requirements and test methods.

⁴«Rubber and rubber-fabric plates»

⁴⁵«Stuffing boxes»

⁶«Scutched flax. Technical specifications»



3. Replacement of shut-off and regulating valves.

Shut-off and regulating valves. The scope of the project also implies replacement of technically and morally obsolete shut-off and regulating fittings produced in the USSR, with the valves produced by the European manufacturers.

4. Installation of centralized natural gas leakage accounting system.

During implementation of the project manufacturers of equipment used in detection and elimination of leaks can be replaced depending on the appearance of modern and better technologies and equipment.

Selection of devices and materials will depend on the size, source of leak and operating mode of system component where this leak has been detected using modern PETM system of gas-distribution networks, including:

- Investigation of basic conditions – upon using measuring devices described above.
- Registration of results and determination of priority in elimination of leaks, which ensures the highest efficiency of this work upon scarcity of repair means.
- Data analysis and evaluation of reduction of natural gas leaks and volumes of emission reduction.
- Development of the plan of future examinations and further monitoring of joints of shut-down devices (bolts, cocks, valves), flanged and threaded joints of gas pipelines of OJSC “Kyivgas” inclined to leakage, and monitoring of already eliminated leaks

Implementation Schedule.

1. Execution of the Register of equipment. Examination of the equipment of gas networks and initial monitoring measurements. Signing of the preliminary investment contract as to JI project. Organization of Working Team. Development of Monitoring Plan and Program, PDD of the project and financing plan. (June – July 2005)
2. Sealing (reconstruction) of 32398 objects of equipment (August – October 2005)
3. Sealing (reconstruction) of 27880 objects of equipment (May – July 2006)
4. Sealing (reconstruction) of 281 objects of equipment (July 2007.)
5. Sealing (reconstruction) of 47 objects of equipment (May 2008)
6. Sealing (reconstruction) of 7 objects of equipment (May – July 2009)



A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or field policies and circumstances:

The project activity includes: sealing of shut-down devices (bolts, cocks, valves), flanged and threaded joints of gas pipelines of OJSC “Kyivgas” using modern sealing materials; leakage monitoring aimed to detect natural gas leaks through leakage points; following restoration of tightness of shut-down devices, flanged and threaded joints. Reduction of natural gas leaks will result in reduction of CH₄ emissions.

Subject to the absence of the proposed project all equipment, including old equipment with less leak proofness than that of proposed equipment, but yet operable one, will be operated for a long time in the usual mode, and reduction of emissions will not take place.

**A.4.3.1. Estimated amount of emission reductions over the crediting period:**

During implementation of the project the following emission reductions will be reached at each of project stages:

Length of crediting period	Years
2005-2007	3
Years	Estimate of annual emission reductions in tons of CO ₂ equivalent
2005	155 779
2006	905 524
2007	1 126 093
Total estimated emission reductions over the crediting period 2005 - 2007	2 187 397
Annual average of estimated emission reductions over the crediting period (in tons of CO ₂ equivalent)	729 132

Length of the crediting period	Years
2008-2012	5
Years	Expected annual emission reductions in tons of CO ₂ equivalent
2008	1 126 893
2009	1 126 979
2010	1 126 987
2011	1 126 987
2012	1 126 987
Total estimated emission reductions over the crediting period 2008 - 2012	5 634 832
Annual average of estimated emission reductions over the crediting period (in tons of CO ₂ equivalent)	1 126 966

Length of the crediting period under post-Kyoto Mechanism	Years
2013-2017	5
Years	Expected annual emission reductions in tons of CO ₂ equivalent
2013	1 126 987
2014	1 126 987
2015	1 126 987
2016	1 126 987
2017	1 126 987
Total estimated emission reductions over the crediting period 2013 - 2017 in total	5 634 935
Annual average of estimated emission reductions over the crediting period (in tons CO ₂ equivalent)	1 126 987



Table 3. Estimated amount of CO₂ emission reduction

Description of formula used for calculation of emission reduction is given in the paragraph D.1.4.

Operation of the system of leakage detection and elimination, and further maintenance of tightness of equipment created under the Project does not have any time limitation. Therefore, the Project will give reduction of methane emission after expiration of the crediting period as well.

A.5. Project approval by the Parties involved:

The project has been already supported by the Government of Ukraine, namely by the National Environmental Investment Agency of Ukraine, which has issued a Letter of Endorsement for the JI Project (No. 419/23/7 as of 23.04.2010). Therefore organizational risks for the project has been minimized.

After receiving Determination Report from the Certified Independent Body the project documentation will be submitted to the National Environmental Investment Agency of Ukraine for receiving a Letter of Endorsement. Another Letter of Endorsement will be received from the other party of the project participant.

**SECTION B. Baseline****B.1. Description and justification of the baseline chosen:****1. Baseline determination approach.**

Baseline determination (measurement and calculation of natural gas leaks) has been done using the approved guidelines of Clean Development Mechanism AM0023 version 03 «Reduction of natural gas leaks at compressor or gas distribution stations of main gas lines»³ with the modification concerning application of more accurate methane leakage measurement method.

Method AM0023 Revision 03 states that it can be applied for the projects for natural gas leak reduction at compressor, gas-distribution stations in the system of main gas lines, as well as for equipment of gas-distribution systems, including gas-pressure adjusting stations.

Lawfulness of using this methodology in this project arises from the following analysis.

According to Method AM0023/Revision 03 the following three conditions shall be fulfilled:

1. Companies – operators of gas-distribution networks do not use the system allowing systematic detection and elimination of methane leaks by the moment of project implementation;
2. Natural gas leaks can be detected and measured precisely;
3. Monitoring system can be implemented to make sure eliminated methane leaks will not occur again.

The Project fully complies with the second and the third conditions, and with the first condition subject to some notes given below.

Under the *first condition*, before the beginning of the project OJSC “Kyivgas” only detects leakages with the help of detectors according to the Ukrainian Gas Supply System Safety Rules in order to avoid emergency and explosive situations. Measurement of the leakage volume, its registration and accounting are not performed, and appropriate measuring devices are missing. Theoretical calculation of leak volumes on the ground of performed measurements make 80 million m³ per annum.

But the above-specified measures do not give an idea about real volumes of leaks mainly through using of old compacting materials. The project does not provide for more frequent checkups, but provides for using up-to-date compacting material.

By the results of international experience and data from the regions where this material has been already used, up-to-date compacting materials shall significantly reduce leak volumes at shutters with stuffing-box seals.

Moreover, through the lack of modern equipment for detection and measurement of leak volumes it is expected that effective program for detection and elimination of leaks could not be applied without project activities. The Companies which were mainly motivated by the safety condition could only detect the fact of leak, but could not measure its volume.

³ Leak reduction from natural gas pipeline compressor or gate stations
(<http://cdm.unfccc.int/UserManagement/FileStorage/JY2L0XEKMB3HD18T7RPO6ZSFCQINGA>)



In other words, we want to emphasize that the practice existed at OJSC “Kyivgas” before this project realization was not able to eliminate leaks included to this Project.

Under the *second condition*, purchase of up-to-date equipment for detection and measurement of leak volume and actual measurement of leak volume at the shutters have shown that leaks can be detected and measured precisely subject to application of modern practices and equipment.

Under the *third condition*, implementation of stepped procedures, creation of comprehensive database and use of additional equipment will enable reliable monitoring of repaired shutters and detection of newly appeared leaks (See Annex 3 to Monitoring Plan). On-site training of personnel and quality control at all stages will allow accurate realization of Monitoring Plan.

2. Application of selected approach in baseline determination.

Initial conditions

Only two variants of initial conditions can be considered as possible and valid alternatives for the Project:

1. keeping the current system for detection and elimination of leaks;
2. implementation of this Project not as JI project.

The facts submitted in this PDD (see section B.2.) prove that maintenance of the existing leakage detection and elimination system is the most probable development scenario subject to the absence of the Project.

Thus, this scenario can be accepted as Initial Conditions

Emission Reduction

The method for detection of leakage volumes according to the Method AM0023/Revision 03 lies in the preliminary evaluation of emissions with further determination of actual volume.

According to the Method AM0023/Revision 03, the level of emission reduction is determined in the following order:

1. Current practice of natural gas leakage detection and elimination is evaluated and described. Clear and transparent criteria for determination of whether methane emission detection and elimination are done under the absence of this actual Project are established.
2. The terms for equipment replacement under the absence of this Project are determined.
3. Leakage data are collected in the course of Project fulfilment.
4. Repair efficiency is checked during the monitoring.
5. Actual volume of methane emission reduction is calculated on the basis of the data collected at the previous steps.

Application of these steps for this Project is described below.

Step 1. Evaluation and description of current practice of emission detection and elimination.

The Method AM0023/Revision 03 stipulates that “the calculation of emission reduction volumes shall take into account only those types of emissions which are not detected and not eliminated according to the current practice”. As mentioned before, this project method does not fully comply with the original version of the Method AM0023, but it has been developed on the basis of the Method AM0023. The



difference of suggested methodology from original methodology AM0023 lies in the methodology of methane leakage volumes. The method for measurement of methane leakage volume used in this Project is described in the Step 3 below and in Annex 3 of this PDD.

Due to the accepted method all flanged and threaded joints and shut-down devices were included to the project, i.e. were examined and repaired, despite of the fact that they were regularly examined and repaired under the existing maintenance system. From the other side, according to the project all flanged and threaded joints and shut-down devices will be repaired using modern sealing materials, not taking into account whether the leak has been detected or not, in order to prevent leaks in future. At the moment traditional material used for the equipment of OJSC “Kyivgas” presented in this project in performance of repair works ensures only temporary elimination of natural gas leaks, while the approach stipulated by the Project ensures safe elimination of natural gas leaks for a long period of time.

Detailed explanations are given in the section 2.4 and in Annex 2 of this project documentation.

Step 2. Term of equipment replacement

Starting from 2005 upon detection of natural gas (methane) leakage repair of flanged and threaded joints and shut-down devices is done according to the activities stipulated in this project. Inclusion of any similar cases of potential replacement of components into calculations of emission reduction is not reasonable as they will not produce any considerable effect on the Project result, i.e. on the level of methane emission reduction. It should be also mentioned that under this Project the sealing material will be replaced at all flanged and threaded joints and shut-down devices, even if leaks are detected only on some of them.

Step 3. Data collection during the project realization.

Collection of data on methane emissions arranged together with repair works on all shut-down devices (bolts, cocks, valves) and flanged and threaded joints of gas pipelines covered by this Project. Detection of natural gas leakage was done with the help of detectors acting on the basis of catalytic oxidation/heat conduction. Repair works on the shut-down devices and flanged and threaded joints were done after measurement of methane leakage volumes. Leakage volume of methane (in the natural gas) was measured using the method developed by VEMA S.A. in 2005. The method is based on using a device as a part of insulated vessel of a certain volume, and a gas analyzer EX-TEC® SR5 (see Annex 3).

By its principle this method is the closest to the method of Calibrated Bag used in revision 03 of the method AM0023. After issuance of the method AM0023 revision 03 it was decided to keep to the previously used method for the following reasons:

- The procedure described in the Method AM0023 does not take into account the volume of equipment, which is the object of measurement;
- Use of insulated bag does not allow making precise measurement because of very difficult determination of initial volume of the let-out bag;
- Use of the bag in the manner described in the Method AM0023 does not allow permanent control of methane concentration in it, which can result in creation of combustible mix of methane and air, working with which is hazardous even when using antistatic bag.

After performance of repair works new measurement is done to make sure methane leakage has been eliminated.

The data collected will be included to the reports on monitoring plan fulfilment. All the data are kept in the database. Each report on monitoring plan fulfilment will include complete information from such database (Annex 3 of this project documentation).

Step 4. Requirements to monitoring procedures.

Step 4 of the Project includes monitoring of the objects of the Project for checking for repeated methane leakages. Monitoring plan for this Project covers all repaired bolts, cocks, valves, flange and threaded joints of gas pipelines. Frequency of emission detection and measurement in the places where the emissions have been eliminated is indicated in the Monitoring Plan. Methane emissions from the components on which repeatedly detected leakage doesn't exceed leakage volumes measured after repair, will be taken equal to leakage volumes measured after the repair for the whole period after the last check-up/monitoring. Methane emission volume for the components where repeated methane emission is detected shall be measured using the measuring instruments with the accuracy equal to the accuracy corresponding to (or being not worse than) the accuracy of the instruments used in the primary inspection. It will be considered that such emission volume remained on the same level, starting from the day after the last repair of bolts, cocks, valves, flange or threaded joints done according to the Project, or from the last check-up of eliminated emissions, depending on which event occurred later, which corresponds to the requirements established in the Method AM0023/Revision 03. Such methane emissions will be eliminated repeatedly, after which new measurement of methane emissions will be done.

The data collected will be included to the regular reports on monitoring plan fulfilment. All the data are kept in the database. Each report on monitoring plan fulfilment will include complete information from such database (Annex 3 of this project documentation).

Step 5. Calculation of methane emission reduction.

Methane emission reduction reached in the result of the Project is determined as the difference between emissions measured before the repair (Step 3) and after repair (Step 4). In (hypothetic) case if the emissions after repair are more than those measured before the repair, negative methane emission reduction will be marked for respective component. In other words, the Method used provides for the case in which methane emissions in the course of the Project exceed the emissions determined in the initial conditions.

Description of Baseline and substantiation of its choice are given in the item B.2. below

Key information for determination of baseline is given in the tables below.

Data/Parameter	i
Measurement unit	Non-dimensional
Description	Serial number of bolt, cock, valve, flanged or threaded joint where gas leakage was detected
Periodicity of measurement/monitoring	Once, in the beginning of the project
The source of data applied/to be applied	Leakage measurement activity
Data values (for ex-ante calculations/measurements)	-
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>The staff will have appropriate qualification for results fixation</i>
Comments	List of shut-down devices (bolts, cocks, valves), flanged and threaded joints is given in the accompanying document 1 ⁴

⁴ Register of shut-down devices, flanged and threaded joints of distribution gas pipelines of OJSC Kyivgas.



Data/Parameter	T_i
Measurement unit	hour
Description	Number of running hours of the equipment at which leakage was detected during the year
Periodicity of measurement/monitoring	Permanent
The source of data applied/to be applied	Records of check-up results
Data values (for ex-ante calculations/measurements)	-
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>The staff will have appropriate qualification for results fixation</i>
Comments	Number of running hours of the equipment during the year after its repair (replacement)

Data/Parameter	GWP_{CH_4}
Measurement unit	Tons of CO ₂ equivalent
Description	Global warming potential
Periodicity of measurement/monitoring	Permanent
The source of data applied/to be applied	IPCC
Data values (for ex-ante calculations/measurements)	21
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	-
Measurement quality management/quality assurance procedures applied/to be applied	<i>The person responsible for monitoring verifies the data on an annual basis</i>
Comments	Project designer will perform monitoring of any changes in the global warming potential for methane, published by IPCC and approved by COP

Data/Parameter	$F_{CH_4,i}$
Measurement unit	m ³ CH ₄ /hr
Description	Methane leakage speed for each detected leakage
Periodicity of measurement/monitoring	On an annual basis
The source of data applied/to be applied	Calculation
Data values (for ex-ante calculations/measurements)	-



Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Calculation according to the Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>Equipment has been calibrated and verified according to the quality management procedures. Regular maintenance is done according to the technical specifications.</i>
Comments	-

Data/Parameter	t_i
Measurement unit	$^{\circ}\text{C}$
Description	Gas temperature
Periodicity of measurement/monitoring	Permanent / Periodical
The source of data applied/to be applied	Mercury glass thermometer TL-4, according to GOST 8.279 ⁵
Data values (for ex-ante calculations/measurements)	-
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>Equipment has been calibrated and verified according to the quality management procedures. Regular maintenance is done according to the technical specifications.</i>
Comments	Measured for determination of CH ₄ density. Note: Notwithstanding measurements, many variants are not expected as temperature at different stations is taken constant.

Data/Parameter	P_i
Measurement unit	kPa
Description	Gas pressure
Periodicity of measurement/monitoring	Permanent / Periodical
The source of data applied/to be applied	Pressure gauge «D-59N-100-1.0 6 kPa» according to the requirements of GOST 12997 ⁶
Data values (for ex-ante calculations/measurements)	-
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>Equipment has been calibrated and verified according to the quality management procedures. Regular maintenance is done according to the technical specifications.</i>

⁵ “Working liquid-in-glass thermometers. Calibration methods”.

⁶ “SSI products. General specifications”.



Comments	Measured for determination of CH ₄ density. Note: Notwithstanding measurements, many variants are not expected as pressure at different stations is taken constant.
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Data/Parameter	V_{bag}
Measurement unit	m ³
Description	Reservoir capacity
Periodicity of measurement/monitoring	Once, in the beginning of the project
The source of data applied/to be applied	Flow meter
Data values (for ex-ante calculations/measurements)	0.87 m ³
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>Equipment has been calibrated and verified according to the quality management procedures. Regular maintenance is done according to the technical specifications.</i>
Comments	Reservoir is filled in with water. Amount of water measured by flow meter will be reservoir capacity Measurement showed that reservoir capacity is 0.87 m ³ .

Data/Parameter	$W_{sampleCH_4,i}$
Measurement unit	%
Description	Methane concentration in sample
Periodicity of measurement/monitoring	Periodical
The source of data applied/to be applied	Gas analyzer EX-TEC® SR5.
Data values (for ex-ante calculations/measurements)	-
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>Equipment has been calibrated and verified according to the quality management procedures. Regular maintenance is done according to the technical specifications.</i>
Comments	Methane concentration in the reservoir of leak i is the difference between methane concentration in the reservoir in the beginning and in the end of measurement Concentration is measured with gas analyzer EX-TEC® SR5.

Data/Parameter	τ_i
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Measurement unit	second
Description	The time during which methane concentration reaches certain level
Periodicity of measurement/monitoring	Periodical
The source of data applied/to be applied	Stopwatch «SOS pr-2b-2», according to GOST 5072-72 ⁷
Data values (for ex-ante calculations/measurements)	-
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>Equipment has been calibrated and verified according to the quality management procedures. Regular maintenance is done according to the technical specifications.</i>
Comments	-

Data/Parameter	URi
Measurement unit	%
Description	Uncertainty factor of the equipment where leakage is measured
Periodicity of measurement/monitoring	On an annual basis
The source of data applied/to be applied	IPCC
Data values (for ex-ante calculations/measurements)	95
Confirmation of data selection, or description of the measurement method and procedures applied/to be applied	Method AM0023
Measurement quality management/quality assurance procedures applied/to be applied	<i>The person responsible for monitoring verifies the data on an annual basis</i>
Comments	Where possible, 95% confidence interval is evaluated; advice of Good Practice Guide given in section 6 2000 IPCC of GPG. If manufacturer of equipment where leaks are measured specifies uncertainty range without specification of confidence interval, it can be taken 95%

B.2. Description of how anthropogenic emissions of greenhouse gases from the sources will reduce to the level of those emissions which would exist in case of the JI project absence:

1. Approach to demonstration of the fact that the project generates reduction of emissions from the sources being additional to those which would exist in case of its absence

⁷ “Mechanical stopwatch”



The Methodology AM0023 Revision 03, and the last revision of “Methodological way of demonstration and evaluation of additionality” Revision 05.2, approved by the Executive Committee of Clean Development Mechanism, have been used for substantiation of the project additionality.

This approach can be used for this project of methane emission reduction because it has been developed particularly for the projects of this type. Taking into account local conditions and laws will allow impartial evaluation of its additionality.

2. Application of selected approach. Proofs of the project additionality.

Step 1 – Detection of alternatives of Project realization, which comply with the effective Ukrainian laws and regulations.

Step 1a – Determination of alternatives of Project realization.

Only two variants of initial conditions can be considered as acceptable for the Project:

Variant 1: Retention of current situation;

Variant 2: The activities provided for by the Project will be performed without using the mechanism established by article 6 of Kyoto Protocol of UN Framework Convention On Climate Change.

Variant 1: Retention of the current practice of detection and elimination of natural gas leaks, and therefore – methane leaks, is the most real and valid alternative of the Project realization, as this variant implies minimal expenses for OJSC Kyivgas.

OJSC Kyivgas does not receive any financial profit from methane emission reduction. The existing Ukrainian system of rates formation for natural gas provides for reduction of rates for natural gas upon reduction of leakage. The current fee for methane emission within the established limits is hard or impossible to be charged because of the absence of the measurement procedure and because of big amount of small emissions spread over the large area.

Variant 2: According to the Method AM0023/Revision 03, to determine the probably variant of initial conditions it is necessary to determine “whether such activities for reduction of methane emissions from such important components as bolt units, blowdown valves, sealing of rods and pressure release valves, using the technologies for detection and measurement of methane emissions similar to those described in this Method”. Until recently OJSC Kyivgas did not perform the activities for direct inspection and technical maintenance which would exceed the safety requirements established by the regulations. Types and volumes of engineering leaks in the Ukrainian gas distribution networks were generally unknown until the first direct inspections and preventive examinations have been done for evaluation of possibilities of projects realization under the mechanisms established by article 6 of Kyoto Protocol to UN Framework Convention On Climate Change. Evaluations of net volume of gas consumption and leakage were approximate because most end users do not have gas meters, and invoicing is done on the basis of standard norms.

In addition, OJSC Kyivgas has neither incentives nor means for realization of the activities provided for by the Project in the absence of its support by the mechanisms established by article 6 of Kyoto Protocol to UN Framework Convention On Climate Change (step 1.2, step 2 and step 3 further on). The Project provides for additional expenses on measuring instruments, modern compacting materials and staff training. In order to cover such expenses on realization of this Project or similar activities represented in this project OJSC Kyivgas does not financial incentives, except for possible receipts received under the mechanism established by article 6 of Kyoto Protocol to UN Framework Convention On Climate Change.



Evaluation: OJSC Kyivgas will not agree to the expenses upon implementation of Variant 2. Therefore, the most real and valid variant of the Project realization is Variant 1.

Step 1b – Conformance to the effective Ukrainian laws and norms.

Variant 1: Current practice of detection and elimination of natural gas leaks and therefore, methane emissions, conforms to all effective laws and norms of Ukraine. The law allows natural gas leaks, and therefore, methane leaks during natural gas transportation. The norms only determine the periodicity of inspection of equipment to be done by gas distribution organization for detection of natural gas leaks. The practice of natural gas leakage detection by OJSC Kyivgas conforms to the specified norms. Control of conformance to the norms is done by means of annual revisions performed by the authorized bodies.

The project also conforms to the existing legislative requirements in Ukraine concerning detection of natural gas leakage and methane emission at gas distribution objects, and to any other currently applicable legislative norms.

The program of OJSC Kyivgas for regular detection of natural gas leakage will be realized parallel to application of more up-to-date methods of detection and measurement of natural gas leakage, and therefore, methane emissions, and the activities for long-term elimination of natural gas leakage, and therefore, methane emissions, provided for by this Project.

Conclusion: selected realistic conservative variant deserving trust (variant 1) fully conforms to compulsory requirements and norms of the Ukrainian laws.

Step 2 – Investment Analysis

Step 2a – Determination of applicable analysis method.

As realization of the Project does not bring any other financial or economic advantage except for the profit from realization of the Project, which can be received under the mechanism established by article 6 of Kyoto Protocol to UN Framework Convention On Climate Change, a simple cost analysis is used according to the additionality tools in case of the absence of such profit to determine that the suggested realization of the Project is less reasonable from the economic point of view.

Currently available Procedure for Rates Formation approved by the National Commission For Energy Market Adjustment does not allow receiving benefits in case of reduction of natural gas leaks..

The following steps have been done according to the additionality tools of the CDM Executive Committee “Methodological way of demonstration and evaluation of additionality” (revision 05.2).

Step 2b – Variant 1. Use of simple cost analysis.

Realization of the Project will require the costs in addition to the existing expenses, for performance of the activities for detection and elimination of natural gas leakage, and therefore – methane emissions. Additional expenses on realization of the Project will include the costs of: purchase of modern equipment for detection and measurement of methane emissions, sealing materials, replacement of obsolete shut-off and regulating valves, staff training, preventive check-ups, systematic data collection etc.



Materials used in this Project are the best ones from the point of view of leak tightness, performance quality and used technical solutions, out of all materials represented at the Ukrainian market. Important characteristics considered in choice of equipment were availability of spare parts in Ukraine.

Up-to-date sealing material will be used in the course of project realization. According to the previous monitoring results sealing material according to GOST 7338-90, GOST 10330-76 and GOST 5152-84 is much more effective, but also more expensive than the sealing materials used in the current practice. In the result of real practice all natural gas leaks are imposed on the end consumers, and OJSC Kyivgas has no reasons to purchase and to use the foregoing sealing material.

By the moment of project beginning obsolete shut-off and regulating valves produced in the USSR are used in the gas distribution units of OJSC Kyivgas, which have worse insulation characteristics than new samples produced by the European manufactures, but which are much cheaper. Therefore installation of new equipment produced by European manufacturers could not be of mass character because of the lack of funds.

Application of Kyoto mechanisms to this project makes these activities economically efficient and is the only way to their implementation.

Conclusion: It goes from the everything stated above that this project is economically unattractive without registration of the project as JIP, which will indicate additionality of this project.

Step 3 – Barrier analysis.

The Project is the first project of this type, and therefore there are some types of barriers. OJSC Kyivgas faces serious financial barriers, and lack of potential and experience in using new approaches and measuring tools for detection and elimination of gas leaks at its objects, including:

- Organizational barrier.

Lack of labour and technical resources at OJSC Kyivgas for implementation and performance of purposeful examination, technical maintenance and reconstruction of all switch mechanisms (bolts, cocks, valves), and flange and threaded joints of gas pipelines. It is connected with the absence of qualified staff: during the last years the company faced considerable outflow of qualified workers, and newly employed workers do not have enough experience and knowledge yet.

- Absence of special technical knowledge.

By the moment of project beginning available qualified staff did not have experience in using the tools and methods for measurement of gas leakage volume: tool (gas analyzer) used by OJSC Kyivgas only ensures detection of leaks, but does not measure and register volume of leaks. Therefore, project implementation requires time to gain practical experience in measurement of natural gas leakage volumes.

- ***Financial barrier.***

Additional expenses on the project realization include the costs of:

- Purchase and use of modern equipment for detection and measurement of methane emissions (gas analyzer EX-TEC® SR5);
- Purchase and application of sealing materials of different type and diameter;

- Replacement of obsolete shut-off and regulating valves with new valves of European manufacturers;
- Staff training for performance of actual preventive examination and technical maintenance, and for using and maintenance of sealing materials, shut-off and regulating valves produced by European manufacturers;
- Systematic data collection and management;
- Systematic and long-term control of efficiency of elimination of detected natural gas leakage

Financial barriers are connected with the structure of existing tariffs for gas transport and distribution, which are regulated by the government and do not take into account depreciation and investments needs of gas distribution enterprises. Such state of business result in permanent lack of funds and impossibility of timely performance of capital repair, assurance of equipment operation, investment into modernization and development of gas distribution infrastructure.

OJSC Kyivgas will not receive any direct economic advantage from reduction of methane emission, which is reached by the Project realization, not taking into account receipts from sale of reduction units, as under the existing tariff system all network leaks are carried onto the end consumers of natural gas.

It should be also taken into account that in Ukraine methane is not included to the list of ecologically harmful gases and is not punished by environmental fines. Therefore, OJSC Kyivgas does not face any financial difficulties in connection with payments for environmental pollution, and therefore will not receive any financial advantage from reduction of emission volume from the point of view of reduction of payments for pollution.

As emission reduction does not bring any economic advantage to OJSC Kyivgas, and realization of this project does not bring any economic advantage to the other project participants, including the project applicant, except for the advantage to be formed under JP Project, we can make a conclusion that realization of the Project without receiving profits under JIP will produce barriers for investments.

Step 4 – Analysis of generally used practice.

Step 4a – Analysis of other activity similar to that suggested in the Project

Absence of financial incentives described for Step 2 and barriers described in Step 3 is typical not only for OJSC Kyivgas, but also for other companies operating low-pressure gas distribution networks in Ukraine. Therefore the existing practice of detection and elimination of methane leakage described in the variant of initial conditions selected for real Project is common for Ukraine in general.

In general, the whole Ukraine uses the same devices for detection of natural gas leakage as those used in Odessa region. Sealing materials used for leakage reduction also differ a little by regions. Gas companies of Ukraine do not have the equipment for measurement of natural gas leakage volumes. The programs for detection and elimination of natural gas leakage used in Ukraine are focused at fulfilment of safety requirements and at prevention of accidents.

Step 4b – Discussion of similar approved decisions

Beside this Project and other projects realized under the mechanism established by article 6 of Kyoto Protocol to UN Framework Convention on Climate Change, Ukraine does not realize the other programs for actual detection and elimination of natural gas leakage from gas distribution networks. The Project provides for use of modern technologies and equipment for detection and measurement of natural gas leakage. Such equipment and its application are rather new.



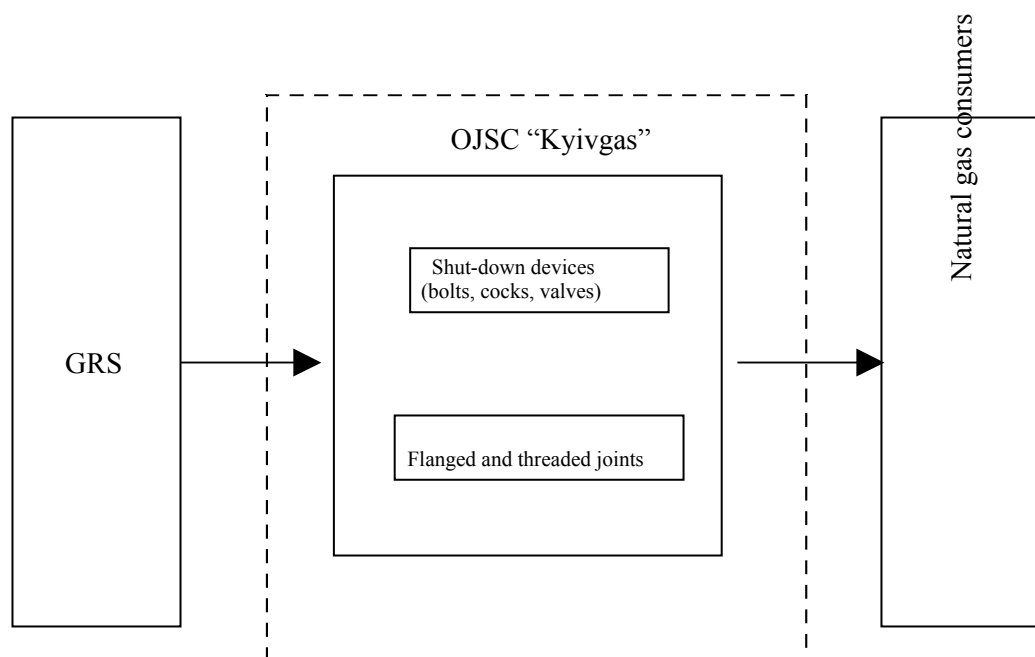
Perspectives for Project financing under the mechanism established by article 6 of Kyoto Protocol to UN Framework Convention on Climate Change allowed its developer to prepare this Project. Thus, we can believe that any actions, similar to those provided for by the present Project, are developed and realized in Ukraine in expectation of profit according to the mechanisms established by article 6 of Kyoto Protocol to UN Framework Convention on Climate Change.

Conclusion: The activities similar to those provided for by this Project can be done at the present time only subject to receipt of expected profit from realization of the mechanism established by article 6 of Kyoto Protocol to UN Framework Convention on Climate Change. Thus, the real Project is considered to be the project which satisfies the additionality criterion.

B.3. Description of how the definition of the project boundary is applied to the project:

Sources of greenhouse gases and project boundary:

Project boundary for a basic scenario are marked with dashed line at the scheme (Pic. 5)



Pic. 5 Project boundary scheme.

The project covers only methane leakage through leakage in shut-down devices (bolts, cocks, valves) and flanged and threaded joints of the equipment of OJSC "Kyivgas", located on the territory of Kyiv city.

B.4. Further information about baseline, including the date of baseline determination and the name(s) of the person(s)/company(-ies) determining the baseline:

Baseline formation date: 30/07/2005

Baseline has been determined by VEMA S.A..

VEMA S.A. is the participant of the project

VEMA S.A.

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**SECTION C. Duration of the project / Crediting period****C.1. Starting date of the project:**

The project activity begins on 29/07/2005 - date of signing of the preliminary investment contract as to JI project between VEMA S.A. (Switzerland) and OJSC "Kyivgas".

C.2. Expected operational lifetime of the project:

Operation of the system of leakage detection and elimination, and further maintenance of tightness of equipment created under the Project does not have any time limitation, as periodical replacement of sealing materials on gas valves will be carried out on a permanent basis. Following the principle of conservatism, we will take the life cycle and respective crediting period for further calculations equal to 13 years/156 months (2005-2017).

C.3. Length of the crediting period:

The JI project relates to the first period of obligations and makes 5 years/60 months (January 01, 2008 – December 31, 2012).

Starting date of the crediting period was the date of the first actions on project implementation, - July 29, 2005. The end date of the crediting period is December 31, 2012. Therefore, length of the crediting period will make 8 years/96 months.

If after the first period of obligations under Kyoto Protocol its validity is not prolonged, crediting period under the project can be shortened to December 31, 2017. Taking into account the period preceding the crediting period, the crediting period and the period after its expiration, the total crediting period will make 13 years/156 months.

**SECTION D. Monitoring plan****D.1. Description of monitoring plan chosen:**

For the purpose of quantitative evaluation and preparation of reports on emission reduction on the ground of baseline and project activity, the Method AM0023 “Reduction of natural gas leakage at compressor and gas distribution stations of main lines” will be used with modification concerning improvement of accuracy of measurement of leakage volume as per section B.1. above will be applied.

After detection and measurement of leakage a detailed monitoring program will be developed for each switch mechanism, flange and threaded joint. Realization of such program will become a part of the JI project activity. Monitoring will cover leakage from the sources of leakages which are repeatedly detected, and control of already repaired equipment where gas leaks have been detected before.

Under the JI project Working Team of OJSC Kiyvgas executed a Register of shut-down devices, flanged and threaded joints of distribution gas pipelines of OJSC Kiyvgas (see Accompanying document 1), which includes full information about all shut-down devices, flanged and threaded joints of the Project, and which is regularly updated during the reconstruction.

All relevant data connected with calculation of emission reduction will be saved in the electronic database. Each monitoring report will contain full information from this database.

Data and the documents on the project in the electronic and hard form according to the Order as of 29.07.2005 issued by the management of OJSC Kiyvgas will be saved till 31/12/2019.

D.1.1. Subsection 1 – Emission monitoring in project option, and basic option:

By the moment of project beginning there was no uniform method for methane leakage measurement and monitoring in Ukraine. Therefore, OJSC Kiyvgas entered into preliminary investment contract as to JI project as of 29.07.2005 with VEMA S.A., according to which VEMA S.A. undertook to elaborate Methane leakage monitoring plan and program.

Monitoring plan was developed on the basis of monitoring plan given in the Methodology AM0023 “**Reduction of natural gas leakage at compressor and gas distribution stations of main gas lines**” (Revision 03) with some assumptions concerning measurement method of methane leakage volume described in the item B.1. above; detailed description of monitoring method is given in Annex 3.



D.1.1.1 Data to be collected for monitoring of emissions from the project, the manner these data will be received:								
Identification Number <i>(please use numbers to facilitate cross reference to D.2.)</i>	Variable Data	Data Sources	Data measurement unit	Measured (m), calculated (c) or evaluated (e)	Record frequency	Data frequency for monitoring	The form of data delivery (electronic/paper)	Comments
1. i	Serial number of bolt, cock, valve, flange or threaded joint where gas leakage was detected, eliminated and then checked Number	Leakage measurement activity	Non-dimensional	m	Once	100%	Electronic	The leakage detected at the device is given a serial number. List of shut-down devices (bolts, cocks, valves), flanged and threaded joints is given in the accompanying document 1. Inspection is done after repair.
2. T _i	Time	Records of check-up results	Number of running hours of the equipment at which leakage was detected during the year	m	Permanent	100%	Electronic	Number of running hours of the equipment during the year after its replacement (repair)
3.	Date	Repair (reconstruction) and	Date of repair (reconstruction) and	m	Permanent	100%	Electronic	Date of reconstruction, used together with



		monitoring data (register)	monitoring					the number of running hours of equipment for determination of the total number of running hours In case of repeated leaks it is taken the same as the date of the last inspection which showed the absence of leakage.
4. GWP_{CH_4}	Global warming potential	IPCC	Tons of CO_2 equivalent	c	Permanent	100%	Electronic	Project designer will perform monitoring of any changes in the global warming potential for methane, published by IPCC and approved by COP
5. $F_{CH_4,i}$	Leakage speed for each detected leakage	Leakage measurement activity	$m^3 CH_4/hour$	c	On an annual basis	100%	Electronic	Calculated using the biggest deviation of device error (for gas analyzer – 10%)
6. t, P	Gas temperature and pressure	Measurement data from mercury-in-	$^{\circ}C$ and kPa	m	Permanent / Periodical	100%	Electronic	Measured for determination of CH_4 density.



		glass thermometer TL-4ta and from pressure gauge D-59N-100-1.0 6 kPa						Note: Notwithstanding measurements, many variants are not expected as pressure and temperature at different stations are taken constant
7. URi	Uncertainty factor of the equipment where leakage is measured	Information manufacturer and/or IPCC GPG	%	m or e	On an annual basis	100%	Electronic	Where possible, 95% confidence interval is evaluated; advice of Good Practice Guide given in section 6 2000 IPCC of GPG If manufacturer of equipment where leaks are measured specifies uncertainty range without specification of confidence interval, it can be taken 95%
8. Vbag	Reservoir capacity	Flow meter measurement data	m ³	m	Once	100%	Electronic and paper	Reservoir is filled in with water. Amount of water measured by flow meter will be reservoir capacity



								Measurement showed that reservoir capacity is 0.87 m ³ .
9. $W_{sampleCH_4,i}$	Methane concentration in sample	Measurement data from gas analyzer EX-TEC® SR5.	%	m	Every time during the measurement	100%	Electronic	Methane concentration in sample (in reservoir) of leak i is the difference between methane concentration in the beginning and in the end of measurement Concentration is measured with gas analyzer EX-TEC® SR5.
10. τ_i	The time during which methane concentration reaches certain level	Measurement data from stopwatch SOS pr-2b-2	seconds	m	Every time during the measurement	100%	Electronic	Time during which methane concentration in reservoir reaches certain level is determined with stop-watch. Measurement starts from the moment the tap is opened on the tank cap and ends when methane concentration inside the



								reservoir reaches certain level.
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According to the effective laws, all metering devices in Ukraine shall satisfy the established norms and standards and shall pass regular inspections (once per year).

D.1.1.2 Description of the formula used for evaluation of project emissions (for each gas, source, CO₂ emission units):

Using the method of measuring leak volumes with the help of hermetic capacity, volume of methane leaks from one equipment can be calculated by the formula:

$$F_{CH_4,P} = V_{bag} * w_{sampleCH_4,i} * 3600 / \tau_i \quad (1)$$

Where:

$F_{CH_4,P}$ = Methane leakage through leaking element of the device i after reconstruction (m³/hour);

V_{bag} = Capacity of sealed tank for measurement (m³);

$w_{sampleCH_4,i}$ = Methane concentration in a sample of leak i , which is a difference of concentrations in the beginning and in the end of measurement (%);

τ_i = Average duration of tank filling for leak i after reconstruction (seconds)

Annual methane leaks are calculated by the formula:

$$Q_{y,P} = ConvFactor * \sum [F_{CH_4,P} * T_{i,y} * UR_i] * GWP_{CH_4} * 0.9 \quad (2)$$

Where:

$Q_{y,P}$ = Methane emissions for the period y for reconstructed equipment (tCO₂eq).

$ConvFactor$ = Conversion factor miCH₄ into tCH₄, at standard temperature and pressure (0 degree Celsius and 101.3 kPa) it makes 0.0007168 tCH₄/miCH₄

UR_i = Factor taking into account uncertainty of measurement method

$T_{i,y}$ = Time (in hours) for i -equipment functioning during the period under consideration (monitoring period) y .

GWP_{CH_4} = Potential of Global Warming for methane (21 tCO₂eq/tCH₄)

0.9 = Factor taking into account equipment error

Reduction of methane volumes to standard conditions:

Methane leakage volumes received in the result of measurements are reduced to standard conditions ($R_n = 0,1013$ MPa, $T_n = 273$ K) by the formula:



$$F_{CH_4} = \frac{F \cdot 273 \cdot P}{0,1013 \cdot (273 + t)} \quad (3)$$

where F_{CH_4} – methane leakage volume reduced to standard conditions m³/hour;
 P – gas pressure in the tank, MPa;
 t – gas temperature in the tank, °C.

D.1.1.3. The data required for determination of baseline of anthropogenic emissions of greenhouse gases by the sources under the project, and the manner these data will be collected and delivered:

Identification Number <i>(please use numbers to facilitate cross reference to D.2.)</i>	Variable Data	Data Sources	Data measurement unit	Measured (m), calculated (c) or evaluated (e)	Record frequency	Data frequency for monitoring	The form of data delivery (electronic/paper)	Comments
1. i	Serial number of bolt, cock, valve, flange or threaded joint where gas leakage was detected, eliminated and then checked Number	Leakage measurement activity	Non-dimensional	m	Once	100%	Electronic	The leakage detected at the device is given a serial number. List of switch mechanisms (bolts, cocks, valves), flange and threaded joints is given in the accompanying document 1. Inspection is done after repair.
2. T _i	Time	Records of check-up	Number of running hours	m	Permanent	100%	Electronic	Number of running hours of



		results	of the equipment at which leakage was detected during the year					the equipment during the year after its replacement (repair)
3.	Date	Repair (reconstruction) and monitoring data (register)	Date of repair (reconstruction) and monitoring	m	Permanent	100%	Electronic	Date of reconstruction, used together with the number of running hours of equipment for determination of the total number of running hours In case of repeated leaks it is taken the same as the date of the last inspection which showed the absence of leakage.
4. GWP _{CH4}	Global warming potential	IPCC	Tons of CO ₂ equivalent	c	Permanent	100%	Electronic	Project designer will perform monitoring of any changes in the global warming potential for methane, published by IPCC and approved by COP



5. $F_{CH_4,i}$	Leakage speed for each detected leakage	Leakage measurement activity	$m^3 CH_4/hour$	c	On an annual basis	100%	Electronic	Calculated using the biggest deviation of device error (for gas analyzer – 10%)
6. t, P	Gas temperature and pressure	Measurement data from mercury-in-glass thermometer TL-4ta and from pressure gauge D-59N-100-1.0 6 kPa	$^{\circ}C$ and kPa	m	Permanent / Periodical	100%	Electronic	Measured for determination of CH_4 density. Note: Notwithstanding measurements, many variants are not expected as pressure and temperature at different stations are taken constant
7. UR_i	Uncertainty factor of the equipment where leakage is measured	Information manufacturer and/or IPCC GPG	%	m or e	On an annual basis	100%	Electronic	Where possible, 95% confidence interval is evaluated; advice of Good Practice Guide given in section 6 2000 IPCC of GPG If manufacturer of equipment where leaks are measured specifies uncertainty range without specification of



								confidence internal, it can be taken 95%
8. V_{bag}	Reservoir capacity	Flow meter measurement data	m^3	m	Once	100%	Electronic and paper	Reservoir is filled in with water. Amount of water measured by flow meter will be reservoir capacity Measurement showed that reservoir capacity is $0.87 m^3$.
9. $w_{sampleCH_4,i}$	Methane concentration in sample	Measurement data from gas analyzer EX-TEC® SR5.	%	m	Every time during the measurement	100%	Electronic	Methane concentration in sample (in reservoir) of leak i is the difference between methane concentration in the beginning and in the end of measurement Concentration is measured with gas analyzer EX-TEC® SR5.
10. τ_i	The time during which methane concentration reaches	Measurement data from stopwatch SOS pr-2b-2	seconds	m	Every time during the measurement	100%	Electronic	Time during which methane concentration in reservoir reaches certain level is determined with



	certain level							stop-watch. Measurement starts from the moment the tap is opened on the tank cap and ends when methane concentration inside the reservoir reaches certain level.
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**D.1.1.4. Description of the formula used for evaluation of basic emissions (for each gas, source, CO₂eq emission units):**

Using the method of measuring leak volumes with the help of hermetic capacity, volume of methane leaks from one equipment can be calculated by the formula:

$$F_{CH_4,B} = V_{bag} * w_{sampleCH_4,i} * 3600 / \tau_i \quad (4)$$

Where:

$F_{CH_4,B}$ = Methane leakage through leaking element of the device i before reconstruction (m³/hour);

V_{bag} = Capacity of sealed tank for measurement (m³);

$w_{sampleCH_4,i}$ = Methane concentration in a sample of leak i , which is a difference of concentrations in the beginning and in the end of measurement (%);

τ_i = Average duration of tank filling for leak i before reconstruction (seconds)

Annual methane leaks are calculated by the formula:

$$Q_{yB} = ConvFactor * \sum [F_{CH_4,y} * T_{i,y} * UR_i] * GWP_{CH_4} * 0.9 \quad (5)$$

Where:

Q_{yB} = Methane emissions for the period y for equipment before reconstruction (tCO₂equivalents).

ConvFactor = Conversion factor m³CH₄ into tCH₄, at standard temperature and pressure (0 degree Celsius and 101.3 kPa) it makes 0.0007168 tCH₄/m³CH₄

UR_i = Factor taking into account uncertainty of measurement method

$T_{i,y}$ = Hour (in hours) for respective component and during which it used to operate during the period under consideration (monitoring period) y , taking into account the methodology given above (for example, for calculation of incoming leaks)

GWP_{CH_4} = Potential of Methane Global Warming (21 tCO₂eq/tCH₄)

0.9 = Factor taking into account equipment error

Reduction of methane volumes to standard conditions is done by the formula (3).

D.1.2. Subsection 2 – Direct monitoring of emission reduction from the project (quantities shall match the data in section E):



D.1.2.1 The data collected to perform monitoring of emission reduction from the project, and the sources of these data:								
Identification Number <i>(please use numbers to facilitate cross reference to D.2.)</i>	Variable Data	Data Sources	Data measurement unit	Measured (m), calculated (c) or evaluated (e)	Record frequency	Data frequency for monitoring	The form of data delivery (electronic/paper)	Comments

Direct monitoring of emission reduction is not used.

D.1.2.2 Description of the formula used for calculation of emission reduction from the project (for each gas, source etc., CO₂eq emission units):

Direct monitoring of emission reduction is not used.



D.1.3. . Determination of leakage in the monitoring plan:

D.1.3.1. If possible, please describe the data and the information to be collected for the purpose of monitoring of project leakage impact:

Identification Number <i>(please use numbers to facilitate cross reference to D.2.)</i>	Variable Data	Data Sources	Data measurement unit	Measured (m), calculated (c) or evaluated (e)	Record frequency	Data frequency for monitoring	The form of data delivery (electronic/paper)	Comments

No leakage found.

D.1.3.2. Description of the formula used for evaluation of leakage (for each gas, source, formula/algorithm, CO₂ emission units):

No leakage found.

D.1.4. Description of the formula used for evaluation of emission reduction for the project (for each gas, source, CO₂ emission units):

Number of Emission Reduction Units (ERU), t CO₂e:

$$ERU = \sum [Q_{yB} - Q_{yP}] \tag{6}$$

ERU – emission reduction units, t CO₂;

Q_{yP} – project emissions, t CO₂;

Q_{yB} – basic emissions, t CO₂.



D.1.5. Relevant information required by the Party on the territory of which the project is implemented concerning collection and access to the information about the environmental impact of the project:

Implementation of this Project does not provide for any negative environmental impact (See section F below). Therefore data collection on environmental impacts of the Project is not required. There are no laws or regulations in Ukraine requiring collection of such information.

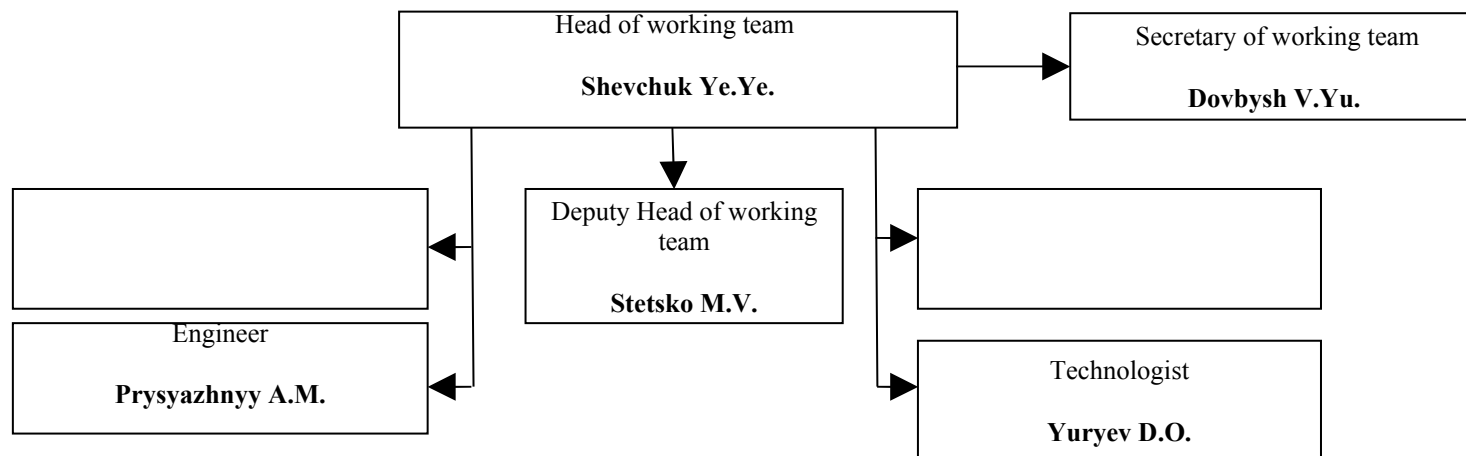
D.2. Quality Management (QM) and Quality Assurance (QA) procedures applied for data monitoring:		
Data <i>(Indicate the table and identification number)</i>	Data uncertainty level (High/Middle/Low)	Please explain whether any QM/QA procedures have been scheduled for these data, or why there is no need to perform such procedure
1.	Low	Each leakage shall be marked by a certain No., and monitoring shall be done after repair for the purpose of detection of additional leakage
2.	Low	Logbook shall be placed where it is possible for frequently switched-off equipment for the purpose of running hours counting.
3.	Low	Working orders, receipts and other records shall be kept in the additional repair logbook.
4.	Low	Project participants shall keep the records of any new greenhouse gases accepted by COP.
5.	Low	The leakage level will be measured and twice checked before the repair – the main discrepancies will be prevented by the third test. In other words, if gas analyzer is used for measurement of leakage level, and if the results of both tests significantly differ from each other, check-up shall continue until the results of two measurements are close to each other (to reduce any discrepancies in the process of testing). If gas analyzer or any other equipment requires recalibration to confirm its accuracy, project participants shall take necessary measures for that.
6.	Low	Records of data about calibrated and verified equipment, to be made on a regular basis
7.	Middle/Low	IPCC GPG will be consulted on the expected discrepancies.
8.	Low	The volume of insulated reservoir does not change with time, that is why permanent verification of its capacity is not obligatory.
9.	Low	Gas analyzer EX-TEC® SR5 meets the requirements of the European Standard EN50054/57, and goes through annual calibration/verification.



10.	Low	Stopwatch is a simple device, and is not included to the list of devices subject to annual verification. Stopwatch «SOS pr-2b-2» will be used, according to GOST 5072-72 ⁸
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D.3. Please describe the structure of administration and management for the project operator to implement monitoring plan

Coordination of activities of all departments and services of OJSC Kyivgas concerning the project implementation is done by the Working Team created pursuant to the Order of the management board of OJSC Kyivgas as of 29/07/2005. The structure of the Working Team is shown on the Picture 6.



Pic. 6 Structure of Working Team.

Yuryev D.O. are responsible for collection of all information provided for by monitoring plan, and for making all necessary settlements. Archiving of all received information in the result of measurements and settlements is done under guidance of Dovbysh V.Yu.. The head of working team Shevchuk Ye.Ye. on the basis of received information determines plan of measures under the Project and scope of resources required. Technical maintenance of the Project is carried out by Prysyazhnyy A.M.

⁸ “Mechanical stopwatch”



D.4. Name of the person(s) / enterprise(s) determining the monitoring plan:

VEMA S.A.
Route de Thonon 45
Geneva
Postal code: Case postale 170 CH-1222 Vésenaz
Switzerland
Telephone: +41 (22) 855 09 69
Fax: +41 (22) 855 09 79
E-mail: vema@bluewin.ch

**SECTION E. Estimation of greenhouse gas emission reductions****E.1. Evaluated project emissions:**

Evaluation of project emissions was done on the basis of the data received by the monitoring plan given in item D.1.1.2 and in Annex 3. The results of measurements and calculations done by the VEMA S.A. (see Annex B) according to the determined emission monitoring plan are given in the Table 4.

Year	Estimated project emissions (tons CO₂ equivalent)
2005	1 042 309
2006	292 564
2007	71 996
2005 - 2007 in total	1 406 868
2008	71 195
2009	71 110
2010	71 101
2011	71 101
2012	71 101
2008 - 2012 in total	355 609
2013	71 101
2014	71 101
2015	71 101
2016	71 101
2017	71 101
2013 - 2017 in total	355 507
Total (tons CO₂ equivalent)	2 117 984

Table 4. Estimated Project Emissions

E.2. Estimated leakage:

No leakage found.

E.3. The sum of E.1. and E.2.:

As there is no leakage, the sum of E.1. and E.2. will be equal to E.1. (see Table 4).

E.4. Estimated basic emissions:

Basic emissions given in the Table 5 were evaluated similar to the project emissions, using the formulas given in item D.1.1.4



Year	Estimated basic emissions (tons CO ₂ equivalent)
2005	1 198 088
2006	1 198 088
2007	1 198 088
2005 - 2007 in total	3 594 265
2008	1 198 088
2009	1 198 088
2010	1 198 088
2011	1 198 088
2012	1 198 088
2008 - 2012 in total	5 990 442
2013	1 198 088
2014	1 198 088
2015	1 198 088
2016	1 198 088
2017	1 198 088
2013 - 2017 in total	5 990 442
Total (tons CO₂ equivalent)	15 575 149

E.5. The difference between E.4. and E.3., which shows reduction of emissions in the project:

Estimated annual reduction of greenhouse gas emissions in the project is calculated by the formula:

$$\text{Estimated reduction of emissions in the project} = \text{Estimated basic emissions} - (\text{Estimated project emissions} + \text{Estimated leakage}) \quad (7)$$

All results of evaluation of emission reduction in the project are given in the Table 6 below.

E.6. The table explaining the quantities received by the formula given above:

Year	Estimated <u>baseline</u> emissions (tons CO ₂ equivalent)	Estimated <u>leakage</u> (tons CO ₂ equivalent)	Estimated <u>project</u> emissions (tons CO ₂ equivalent)	Estimated <u>emission</u> reductions (tons CO ₂ equivalent)
2005	1 198 088	0	1 042 309	155 779
2006	1 198 088	0	292 564	905 524
2007	1 198 088	0	71 996	1 126 093
Total 2005 – 2007 (tonnes of CO ₂ equivalent)	3 594 265	0	1 406 868	2 187 397



2008	1 198 088	0	71 195	1 126 893
2009	1 198 088	0	71 110	1 126 979
2010	1 198 088	0	71 101	1 126 987
2011	1 198 088	0	71 101	1 126 987
2012	1 198 088	0	71 101	1 126 987
Total 2008 - 2012 (tonnes of CO2 equivalent)	5 990 442	0	355 609	5 634 833
2013	1 198 088	0	71 101	1 126 987
2014	1 198 088	0	71 101	1 126 987
2015	1 198 088	0	71 101	1 126 987
2016	1 198 088	0	71 101	1 126 987
2017	1 198 088	0	71 101	1 126 987
Total 2013 – 2017 (tonnes of CO2 equivalent)	5 990 442	0	355 507	5 634 935
Total (tonnes of CO2 equivalent)	15 575 149	0	2 117 984	13 457 165

Table 6. Expected emissions CO₂.

**SECTION F. Environmental impacts**

F.1. The documents on analysis of evaluation of environmental impact of the project, including transboundary impact, according to the procedures determined by the Party on the territory of which the project is to be implemented.

According to ecologic norms of Ukraine natural gas emissions into the air are not considered polluting. Therefore no ecologic permits are required. The only environmental impact is reduction of natural gas emissions into the air.

Implementation of this project will allow increasing safe operation of gas equipment, which in its turn will reduce probability of explosions or fires.

Transboundary effects from project activity according to their definition in the text of the Convention on Transboundary Pollution at Big Distances ratified by Ukraine will not take place.

The project implementation does not provide for any harmful environmental impacts.

F.2. If the environmental impact is considered to be big by the project participants or by the Party on the territory of which the project is implemented, please give the conclusions and all references for support of the documents on evaluation of environmental impact done in accordance with the procedure to be done as required by the Party:

The project implementation does not provide for any harmful environmental impacts.



SECTION G. Stakeholders' comments

G.1. Information about Stakeholders' comments:

Consulting was done with the specialists of the Institute for Market Problems and Economic and Environmental Surveys of the NAS of Ukraine. No Stakeholders' comments were received. The project activity does not imply any negative environmental impact and negative social effect



Annex 1

Contact information on project participants

Supplier:

Company:	OJSC «Kyivgas»
Street, p.o. box	Kikvidze
Building:	4-B
City:	Kyiv
State/region	Kyiv
Zip-code	01103
Country	Ukraine
Telephone	+(044) 284-72-14
Fax	
Website	www.kyivgaz.com.ua
Represented by	
Position	Acting as Chairman of the Board
Reference	
Last Name	Gladkyy
Patronymic	Mykhaylovych
First Name	Oleksandr
Department:	
Direct fax	
Direct telephone	
Cellphone	
Personal e-mail	press@kyivgaz.com

**Partner - Buyer**

Company:	VEMA S.A. (Registered in Switzerland, 26 th of September 1994)
Street, p.o. box	Route de Thonon
Building:	45
City:	Geneva
State/region	
Zip-code	Case postale 170 CH-1222 Vérenaz
Country	Switzerland
Telephone	+41 (22) 855 09 69
Fax	+41 (22) 855 09 79
E-mail	vema@bluewin.ch
Website	
Represented by	
Position	DIRECTOR
Reference	MR.
Last Name	KNODEL
Patronymic	
First Name	FABIAN
Department:	
Direct fax	
Direct telephone	+41 (22) 855 09 79
Cellphone	+41 (22) 855 09 69
Personal e-mail	VEMA@BLUEWIN.CH

**Annex 2****Baseline Information**

The following parameters are used for baseline determination:

No.	Parameter symbol	Name of the parameter	Unit of data measurement
1.	i	Serial number of bolt, cock, valve, flanged or threaded joint where gas leakage was detected	Non-dimensional
2.	T_i	Number of running hours of the equipment at which leakage was detected during the year	hour
3.		Time of repair (rehabilitation)	Month and year
4.	GWP_{CH_4}	Global warming potential	Tons of CO ₂ equivalent
5.	$F_{CH_4,i}$	Methane leakage speed for each detected leakage	m ³ CH ₄ /hr
6.	t, P	Gas temperature and pressure	°C and kPa
7.	UR_i	Uncertainty factor of the equipment where leakage is measured	%
8.	V_{bag}	Reservoir capacity	m ³
9.	$w_{sampleCH_4,i}$	Methane concentration in sample	%
10.	τ_i	The time during which methane concentration reaches certain level	Second

Detailed description of the parameters for baseline determination is given in tables of Section B.1.

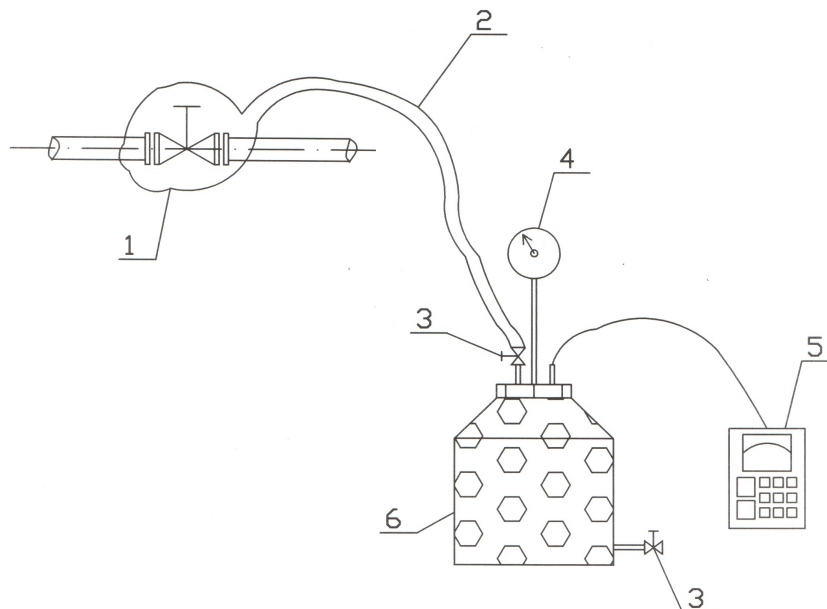
Calculation of baseline is conducted under the formulas (4) and (5) (section D.1.1.4).

Annex 3

Monitoring plan

Because of the absence of method and equipment for determination of methane leaks through the leakage in the equipment in Ukraine at the moment of project beginning, VEMA S.A. developed a plant on the basis of an insulated tank and gas analyzer EX-TEC® SR5.

The diagram of a plant is shown on the Picture 7.



Pic. 7 Diagram of Methane Leakage Measurement Plant.

References:

1. Insulated bag
2. Hose
3. Cock
4. Pressure gauge
5. Gas analyzer EX-TEC® SR5.
6. Insulated reservoir.

Methane leakage measurement procedure.

The team:

Master of the maintenance service of street gas pipelines and house inlets (MSSG and HI);
Locksmith for operation and repair of gas equipment at GDU – 1 person;



MSSG and HI locksmith – 1 person.

Required materials and equipment:

- 1) Wrenches, tools;
- 2) High-sensitive gas analyzer EX-TEC® SR5 – 1 piece;
- 3) Insulated tank, insulated bag, hose, sealant, adhesive tape (Scotch tape);
- 4) Pressure gauge
- 5) Thermometer
- 6) Stopwatch
- 7) Fire extinguisher

Procedure for natural gas leakage measurement at the equipment of gas regulating unit (GRU):

1. To mount the tank (6). To put plastic bag (1) on the measured element (bolt, filter, pressure controller etc.)
2. To connect the bag and the tank with hose (2). To seal joints with adhesive tape for tightness. To measure methane concentration in the tank.
3. To open cock (3).
4. To determine the time of tank filling with methane using the stopwatch.
5. Measurement should be stopped when concentration in the tank reaches 1% of CH₄. In case of small leaks in order to save time measurements are stopped after certain time from the beginning (at least in 2 min), and fixation of methane concentration by the end of measurement is done.
6. Gas concentration in the tank is determined using high-sensitive gas analyzer EX-TEC SR-5 (2).
7. Gas pressure is controlled by means of pressure gauge D-59N-100-1.0 6 kPa.
8. After measurement the cock (3) should be shut down. To disconnect the tank from the hose. To open cocks (3) and (7) for ventilation. To repeat measurement for at least three times.
9. After completion of measurements, to eliminate detected gas leaks and to repeat measurement.



PROGRAM

of initial monitoring measurement for switch mechanisms (cocks, valves, bolts), flange and threaded joints of gas distribution networks of OJSC Kyivgas

Content:

The purpose of initial measurement is:

1. Obtainment of more reliable evaluation of methane leakage volume from the system (EXCEPT FOR leakage connected with operation, technical maintenance or accidents), and in the result of that – determination of potential profit from the JI Project, and the volume of repair works/replacement of equipment which can be required subject to advantageous payback term of investments made to the project.
2. determination of priorities for works to be done at the objects, and for their distribution among these objects;
3. Piling up of some initial experience in using measurement equipment, determination of issues to be solved or improved (such as additional measurement equipment, accuracy level, necessary training of responsible workers) before the beginning of the project to ensure its proper operation.

JIP depends on the determination, measurement, elimination and monitoring of leakage. In case when measurements are required, the most important question at the initial stage is receipt of demonstrative example of leaks at shut-off station and gas distribution networks. If full examination of all elements at each station is unreasonable, it is necessary to select the most demonstrative and typical elements. For example, station workers shall have a grounded opinion as to the equipment being the best solution for particular objects and under which conditions, - these two questions are subject to verification. Some questions shall be systematically determined during the initial measurements:

- Where are leaks, their size (instructions for specialized use of metering devices shall be attached in the maximal possible amount);
- in which places the leakage is not big;
- Where the possibilities for repair and/or replacement (of such equipment as gaskets and flanges) require insufficient costs;
- Where are the biggest leaks elimination of which will not require big costs.

Qualitative information (e.g., difficulties in taking measurements at particular valves because of limited access to them) shall be also recorded where possible in order to facilitate project planning and fulfilment. Flow meters shall provide a possibility of data saving and loading; if there is such an option, it shall be used in addition to manual registration of meter readings. Nomination/numeration system shall be agreed BEFORE THE BEGINNING of measurements.

The tables given below shall be of explanatory and actual character, and not of ordering and regulatory character.

Measurement devices the leaks have been measured by:

1. Calibrated insulated bag of known capacity: bag capacity ____ m³ at the pressure of ____ kPa.
2. Gas analyzer EX-TEC® SR5.
3. Pressure gauge
4. Thermometer
5. Stopwatch



Monitoring Group:

1. _____
2. _____
3. _____
4. _____

Management Board _____

Table 1 Information about the object _____

A logbook of technical check-up of equipment (logbook for maintenance done by the trackmen) is maintained - once in four days, by the appropriate responsible worker. Leaks are indicated in the logbook of reports. Gas contamination is determined by using gas detector for the purpose of conformance to the requirements of UGSSR for prevention of accidents.

Regular repair is done once per year, technical maintenance – once per six months.

Object (object code according to the register)	Gas pressure at the inlet/outlet (MPa)	Gas temperature at the inlet/outlet, °C	% CH ₄ (methane) in gas

Table 2 Report on leaks at _____

Serial No.	Position	Measurement of air flow sample		Time of calibrated bag filling, sec	Methane leaks per hour, m ³ /h	Annual, tCO ₂ /hour
		Initial concentration, %	Sample concentration, %			
1	2	3	4	5	6	7

Explanations to Table 2

- (1) Serial number of equipment according to the register
- (2) Address of equipment



- (3) Initial concentration – methane concentration in the insulated reservoir before the beginning of measurement (vol. %)
- (4) Sample concentration – methane concentration in the insulated reservoir after the completion of measurement (vol. %)
- (5) Time of filling (seconds)
- (6) Methane leaks are calculated by the formula (1)
- (7) Annual methane leaks are calculated by the formula (2).

Reduction of methane volumes to standard conditions

Methane leakage volumes received in the result of measurements are reduced to standard conditions ($R_u = 0,1013$ MPa, $T_u = 273$ K) by the formula:

$$F_{CH_4} = \frac{F \cdot 273 \cdot P}{0,1013 \cdot (273 + t)}$$

where F – methane leakage volume, m³/hour;

P – gas pressure in the tank, MPa;

t – gas temperature in the tank, °C..