Approved baseline methodology AM0023

"Leak reduction from natural gas pipeline compressor or gate stations"

Source

This baseline methodology is based on the proposals from the following proposed methodology:

- NM00091: "Leak reduction from natural gas pipeline compressor or gate stations", whose baseline study, monitoring and verification plan and project design document were prepared by QualityTonnes on behalf of MoldovaGas.

This methodology also refers to the latest approved versions of the following tool:

- "Tool for the demonstration and assessment of additionality".

For more information regarding the proposed new methodologies and the tools, as well as their consideration by the Executive Board, please refer to <http://cdm.unfccc.int/goto/MPappmeth.>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions".

Applicability

This methodology is applicable to project activities that reduce leaks in natural gas pipeline compressor stations and gate stations in natural gas long-distance transmission systems, as well as to other surface facilities in gas distribution systems including pressure regulation stations by establishing advanced leak detection and repair practices:

- Where natural gas pipeline operators have no current systems in place to systematically identify and repair leaks;
- Where leaks can be identified and accurately measured;
- Where a monitoring system can be put in place to ensure leaks repaired remain repaired.

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0023 ("Leak reduction from natural gas pipeline compressor or gate stations").

Additionality

The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board,[1] taking into account the added considerations noted below.

[1] Please refer to: <http://cdm.unfccc.int/goto/MPappmeth>.

Step 1

As part of the identification of candidate baseline scenarios, the project developer should determine if similar efforts have been made or are expected to be made to reduce methane leaks from key components such as unit valves, blow down valves, rod packings and pressure relief valves, using similarly capable leak detection and measurement technology as described in this methodology (below). This could be determined by interviewing compressor/gate station staff, as well as other appropriate officials in the gas company. If the answer is yes, and the leak detection and repair activities are expected to occur under business-as-usual conditions, the project would be considered the baseline scenario – and no emission reductions would be counted for CERs. Documented evidence should be provided to the DOE.

Step 2: Financial Incentive

In most cases, identifying methane leaks is cost-effective as long as the pipeline operator economically benefits from the gas savings. In some cases (not all), the pipeline operator is like a delivery service – it only brings the gas from Point A to Point B and does not get penalized for lost gas or rewarded if those losses are reduced. In this case, the pipeline operator has no incentive to reduce leaks because it does not reap any financial benefits from the saved gas. It can be reasonably assumed that the operator would only do the project, therefore, for the CDM credits. In this case, project participants must prove to the DOE that the operator of the compressor and gate stations has no economic incentive to reduce leaks. Evidence can be shown through delivery-service contracts (if publicly available) demonstrating that the operator does not get penalized or rewarded if the level of gas losses changes. Project participants must also show that even if the losses are reduced, moving the respectively increased quantity of gas through the pipeline will not change the level of fees paid to the pipeline operator. If the contract and other documentation are not publicly available, the project developer should obtain letters from the pipeline company stating the contractual situation, as well as allow the DOE to interview key staff from the pipeline company as related companies (e.g. the gas producing company). Project participants may also provide a letter from the gas producer and/or gas distribution company (the buyer of the piped gas) stating the general terms of the contract.

If there is no financial incentive to reduce gas losses, other than the CER revenues, then project participants can use the simple cost analysis (Option 1) to demonstrate that the project is not financially attractive. If this is the case, project participants can skip Step 3, and move on to Steps 4 and 5. If the financial incentive to reduce leaks does exist – if the reduced losses in gas can be sold by the operator or if the operator has other direct or indirect economic benefits from reduced gas losses – the "simple cost analysis (Option 1) fails to prove additionality.

Step 3: Barrier Analysis

The barrier analysis should include discussion of the following:

- Institutional barriers:

  Leak detection can be very labour-intensive, requiring the hiring of new staff, as well as training them in using advanced and sensitive measurement and repair practices. In addition to this training, the leaks have to be re-screened year after year. Undertaking such an intensive use of leak detection equipment would only happen as a result of the rigorous process of monitoring CH_4 reductions. Project participants must prove to the DOE that current staff are unable to conduct this project, either because they are not trained or because the existing staffing levels are too low to allow additional work functions – and that only with added support (such as that provided by the CDM) would the staff (a) receive the necessary training and (b) conduct annual re-screening of every leak (which would not be conducted under normal circumstances).

- Technical familiarity:

  The project activity involves the use of advanced leak detection and measurement practices (see description below). Such practices are relatively new and are rarely used for compressor and gate stations even in industrialized countries. Project participants should submit evidence that the staff of the gas company is not familiar with these practices. Evidence to support such a claim could come from the lack of use in the particular country (see common practice test). Additional evidence can be provided through interviews with company staff about their familiarity with advanced leak detection and measuring equipment. In many cases, operators of compressor and gate stations may perceive the risks associated with an unfamiliar technology as high and may indicate to DOE interviewers how the CDM– which may enable a third party to introduce leak detection and repair practices – could help overcome this barrier.

- Barriers to financing:

  The cost of the measurement equipment is fairly expensive, as well as the training required in how to use it. Project participants should show that funding is not available internally for such projects or that the investment priority for leak reduction in compressor/gate stations is very low (for example, the company could present a list of investment priorities and timelines). If the project is being financed by a third party investor and if that investment would occur as a result of the CDM (e.g. the third party investor gains CER revenues as the only source of its return), it can be assumed that the third party investor would not undertake the project in the absence of the CDM.

Any evidence presented using the barrier analysis should be transparent and well-documented, offering conservative interpretations as to how this evidence demonstrates the existence and significance of the identified barriers. Anecdotal evidence can be included, but alone is not a sufficient proof of a barrier. As indicated above, examples of documented evidence could include, but are not limited to the following:

- Interviews with gas pipeline staff on their familiarity with advanced leak measurement technologies before the project activity – interviews also to assess overall staffing levels and ability to undertake the rigors of a monitoring effort sufficiently effective in detecting leaks to an extent similar to the project activity;
- List of investment priorities of the company operating the compressor and gate stations and their relative timeline;
- Financial statements indicating the financial health of the company operating the compressor and gate station and its ability to finance investments;
- Statements and other documents from outside investors who expressed interest in financing the leak detection project if they would obtain a certain amount of the CERs or the revenues from CERs. Such a statement from an investor should explain why the investor would not invest in this activity without CDM revenue (e.g. the credit risk of the company is too high, inflation and currency risks are too high, IRR of the project without the CDM is at an unacceptably-low level, etc.).

If the identified barriers also affect other alternatives, the project developer should explain how they are affected less strongly than they affect the proposed CDM project activity. In other words, how are the identified barriers not preventing a wide spread implementation of at least one of the alternatives? Any alternative that would be prevented by the barriers identified in above is not a viable alternative, and should be eliminated from consideration.

Step 4: Common Practice Analysis

Project participants should also indicate if other companies operating compressor and gate stations are undertaking similar activities, using comparable leak detection and measuring equipment in compressor and gate stations. If the entire pipeline transmission system is owned by one national company, project participants should identify whether there are other sections within the company undertaking leak detection efforts in compressor and gate stations (if leak detection and repair is undertaken in pipelines, this would not be considered in this analysis).

Documented evidence could include notes from interviews with other pipeline operators and/or letters from other pipeline operators indicating that no such activities are being undertaken or planned. The DOE should confirm the validity of these statements during project validation. If no such activities are being undertaken, proceed to Step 5.

If other companies operating compressor and gate stations or other staff within a national pipeline company are undertaking similar leak measurement activities in compressor/gate stations – using comparable measuring equipment –project participants should state why those activities are unique and not able to be replicated more broadly. This could include the involvement of donors, government subsidies or other factors implying that this activity is under usual circumstances not happening – and therefore not likely to be replicated.

Step 5

As per the “Tool for the demonstration and assessment of additionality”.

Project boundary

The physical boundary will be the physical compressor, gate stations, and other surface facilities in gas distribution systems including pressure regulation stations. Only methane emissions from unintentional leaks of equipment (e.g. valves) in these facilities are included. Emissions from the regular operation of the engines or other equipment (e.g. combustion or flaring) are not included in the project boundary.

Baseline scenario

Project participants shall identify the most plausible baseline scenario among all realistic and credible alternatives(s). Steps 2 and/or 3 of the latest approved version of the “Tool for the demonstration and assessment of additionality” should be used to assess which of these alternatives should be excluded from further consideration (e.g. alternatives where barriers are prohibitive or which are clearly economically unattractive). Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario.

This methodology is applicable if and only if the most likely baseline scenario is the continuation of the current leak detection and repair practices.

Emission reductions

The level of emission reductions is determined *ex post* as part of the project implementation and monitoring. However, project participants shall provide an *ex ante* estimation of the level of emission reductions.

The level of emission reductions is determined in several steps:

(1) The current practice of leak detection and repair activities is assessed and described. Clear and transparent criteria are established to identify whether the detection and repair of a leak would also have occurred in the absence of the project activity;
(2) The time schedules for replacement of equipment in the absence of the project activity are determined;
(3) Data on leaks is collected during project implementation;
(4) The functioning of leak repair is checked during monitoring;
(5) Emission reductions are calculated *ex post* based on data collected in the previous steps.

Steps 1 and 2 should be undertaken as part of the preparation of the CDM-PDD. Steps 3, 4 and 5 are undertaken continuously during the crediting period. The data collected in these steps should be included in the monitoring reports. All data should be stored in a database. Each monitoring report should include the complete information from this database.

1. Assessment and description of the current leak detection and repair practices

As part of preparation of the CDM-PDD, project participants shall assess and describe the current leak detection and repair practices in the company operating the compressor and gate stations or on the distribution side, pressure-regulator stations and other surface facilities. The objective of this assessment is to clearly identify which types of leaks are detected and repaired under the current practices and which are not. Only those types of leaks that are not detected and repaired under current practices are considered in the calculation of emission reductions.

For this purpose, project participants should classify different types of leaks. The following criteria may, *inter alia*, be taken into account in the classification of leaks.

- **Safety aspects.** Some leaks need to be repaired for safety reasons. An assessment of the safety regulations and their implementation may help in identifying what types of leaks are detected and repaired under the current safety policy of the company and the country;
- **Accessibility.** Some companies may detect and repair leaks only in places which are regularly accessed by staff of the company. For example, some leaks may be detected by staff working on the ground, while leaks several meters above the ground may not be detected. Some companies may repair leaks only if the leak is reasonably accessible. For example, the repair of some leaks may require ladders with fall-protection or lifts;
- **Visibility, audibility and/or smell.** Some companies may detect and repair leaks only if they are visible, if the staff notices the smell of the gas or the noise of the leak;
- **Leak detection technologies.** Different technological means and measurement instruments can be used to detect leaks. Which types of leaks are identified, depends on these technological practices. The introduction of new advanced technologies as part of the project activity may help to identify leaks that would otherwise not be detected. It has to be defined which types of leaks are usually detected using the current technological means and measurement instruments.

In undertaking the assessment, project participants should use the following type of information:

- Written protocols and all leak repair records available from the previous years;
- Written internal procedures which instruct staff how to identify and repair leaks;
- Interviews with key staff of the company, in particular managers responsible for leak detection and repair, e.g. on “informal” practices;
- Documentation on the technologies and measurement instruments used to detect leaks.

Using this type of information, clear and transparent criteria should be established to identify whether the detection and repair of a leak during project implementation would also have occurred under current practices. These criteria should be documented in the CDM-PDD and be validated by the DOE.

2. Documentation of the replacement schedules for equipment

In calculating emission reductions, it is assumed that a leak, which has been detected and repaired due to the project activity, would have continued to emit methane until the equipment concerned would have been replaced. In some cases, the repair of a leak may include the replacement of that equipment. In this case, the equipment is replaced due to the project activity at an earlier point in time than in the absence of the project activity, and consequently, emission reductions from that leak should only be accounted until the equipment would have been replaced in the absence of the project activity.

Therefore, project participants shall identify the expected time schedules for replacement for equipment that may be subject to leaks. For this purpose, project participants should identify when single components or the overall compressor or gate stations will be subject to replacement during the crediting period.

In order to identify planned or proposed replacements, project participants should use written documentation by the company and interviews with managers on planned replacements. In addition, project participants should determine the typical average lifetime of all relevant equipment types that may be subject to leaks, based on relevant norms, industry standards or studies, and/or records of equipment replacements in the company. The planned or proposed replacements as well as the assumed average lifetime of equipment not subject to replacement plans should be documented in the CDM-PDD and be validated by the DOE.

3. Data collection during project implementation

The implementation of the project involves an initial survey and regular subsequent surveys of each compressor and gate station within the project boundary. Each major component in the stations will be surveyed, including:

- Unit valves on blown down compressors;
- Blow down valves on pressurized compressors;
- Rod packings on pressurized compressors;
- Pressure relief valves;
- Power gas vents for compressor unloaders;
- Engine crankcase vents.

For each leak that is detected and repaired as part of the project activity, project participants should

- Apply the established criteria in Step 1 in order to identify whether the leak would also have been detected and repaired in the absence of the project activity;
- Note the date of leak detection;
- Note the date of leak repair;
- Note the exact location of the leak;
- Measure the leak flow rate (volume per time), as described further below;
- Note the measurement method in order to determine the uncertainty range of the measurement;
- In cases where the repair involves a replacement of any equipment: note the date when the equipment would be replaced if the leak would not have been detected, using either the planned replacement schedule by the company or the difference between the average lifetime and the age of the equipment, whatever is earlier.

All data collected during project implementation should be entered into a database. The database should be continuously updated during the crediting period, including new leaks detected and repaired during the crediting period. The data in the database should also be included in each monitoring report.

Project participants may use the following advanced tools to detect, but not to quantify, the leaks in compressor and gate stations:

- **Electronic Screening** using small hand-held gas detectors or "sniffing" devices to detect accessible leaks. Electronic gas detectors are equipped with catalytic oxidation and thermal conductivity sensors designed to detect the presence of specific gases. Electronic gas detectors can be used on larger openings that cannot be screened by soaping;
- **Organic Vapor Analyzers (OVAs)** and **Toxic Vapor Analyzers (TVAs)** are portable hydrocarbon detectors that can also be used to identify leaks. An OVA is a flame ionization detector (FID), which measures the concentration of organic vapors over a range of 9 to 10,000 parts per million (ppm). TVAs and OVAs measure the concentration of methane in the area around a leak;
- **Acoustic Leak Detection** using portable acoustic screening devices designed to detect the acoustic signal that results when pressurized gas escapes through an orifice. As gas moves from a high-pressure to a low-pressure environment across a leak opening, the turbulent flow produces an acoustic signal, which is detected by a hand-held sensor or probe, and read as intensity increments on a meter. Although acoustic detectors do not measure leak rates, they provide a relative indication of leak size – a high intensity or "loud" signal corresponds to a greater leak rate.

One of the following technologies shall be used to measure leak flow rates:

- **Bagging techniques** are commonly used to measure flow rates from equipment leaks. The leaking component or leak opening is enclosed in a "bag" or tent. An inert carrier gas such as nitrogen is conveyed through the bag at a known flow rate. Once the carrier gas attains equilibrium, a gas sample is collected from the bag and the methane concentration of the sample is measured. The leak flow rate from the component is calculated from the purge flow rate through the enclosure and the concentration of methane in the outlet stream as follows:

  $$F_{CH4,i} = F_{purge,i} \, x \, w_{CH4,i} \qquad \textbf{(1)}$$

  Where:

$F_{CH4,i}$	=	The leak flow rate of methane for leak i from the leaking component (m^3/h)
$F_{purge,i}$	=	The purge flow rate of the clean air or nitrogen at leak *i* (m^3/h)
$w_{CH4,i}$	=	The measured concentration of methane in the exit flow (volume percent)

- **High volume or hi-flow samplers** capture all emissions from a leaking component to accurately quantify leak flow rates. Leak emissions, plus a large volume sample of the air around the leaking component, are pulled into the instrument through a vacuum sampling hose. High volume samplers are equipped with dual hydrocarbon detectors that measure the concentration of hydrocarbon gas in the captured sample, as well as the ambient hydrocarbon gas concentration. Sample measurements are corrected for the ambient hydrocarbon concentration, and the leak rate is calculated by multiplying the flow rate of the measured sample by the difference between the ambient gas concentration and the gas concentration in the measured sample. Methane emissions are obtained by calibrating the hydrocarbon detectors to a range of concentrations of methane-in-air. High volume samplers are equipped with special attachments designed to ensure complete emissions capture and to prevent interference from other nearby emissions sources.[2] The hydrocarbon sensors are used to measure the exit concentration in the air stream of the system. The sampler essentially makes rapid vacuum enclosure measurements. The leak flow rate of methane is calculated as follows:

$$F_{CH4,i} = F_{sampler,i} \times (C_{sample,i} - C_{back,i}) \quad \textbf{(2)}$$

Where:

$F_{CH4,i}$	=	The leak flow rate of methane for leak *i* from the leaking component (m³/h)
$F_{sampler,i}$	=	The sample flow rate of the sampler for leak *i* (m³/h)
$C_{sample,i}$	=	The concentration of methane in the sample flow from leak *i* (volume percent)
$C_{back,i}$	=	The concentration of methane in the background near the component (volume percent)

- **Rotameters** and other flow meters are used to measure extremely large leaks that would overwhelm other instruments. Flow meters typically channel gas flow from a leak source through a calibrated tube. The flow lifts a "float bob" within the tube, indicating the leak rate. Rotameters and other flow metering devices can supplement measurements made using bagging or high volume samplers. The leak flow rate of methane is calculated as follows:

$$F_{CH4,i} = 3600 \times w_{CH4,gas} \times k \times A \times \sqrt{g \times h} \quad \textbf{(3)}$$

Where:

$F_{CH4,i}$	=	The leak flow rate of methane for leak *i* from the leaking component (m³/h)
$w_{CH4,gas}$	=	The concentration of methane in the natural gas (volume percent)
k	=	A constant of the measurement equipment
A	=	The annular area between the float and the tube wall (m²)
g	=	The acceleration of gravity (9.81 m/s²)
h	=	The pressure drop across the float (as height in m)

- **Calibrated bag** measurements use anti-static bags of known volume (e.g. 0.085 m^3 or 0.227 m^3) with a neck shaped for easy sealing around the vent. Measurement is made by timing the bag expansion to full capacity while also employing a technique to completely capture the leak while the inflation is being timed. The measurement is repeated on the same leak source numerous times (at least 7, typically 7 to 10 times) in order to ensure a representative average for the fill times (outliers or problem times should be omitted and the tests rerun until a representative average rate is established). The temperature of the gas is measured to allow correction of volume to standard conditions. Additionally, gas composition is measured to verify the proportion of methane in the vented gas, since in some cases air may also be vented, resulting in a mixture of natural gas and air. Calibrated bags allow for reliable measurement of leak flow rates of more than 250 m^3/h. The leak flow rate of methane is calculated as follows:

$$F_{CH4,i} = V_{bag} \times w_{sampleCH4,i} \times 3600 / t_{aver,i} \quad \textbf{(4)}$$

[2] The background concentration must be subtracted from the main sample concentration because it may be elevated due to other leaks in the vicinity of the leak being measured. Variables such as wind speed and wind direction may cause the background concentration to fluctuate, so the background is measured simultaneously with the sample concentration.

Where:

$F_{CH4,i}$	=	The leak flow rate of methane for leak i from the leaking component (m^3/h)
V_{bag}	=	Volume of calibrated bag used for measurement (m^3)
$w_{sampleCH4,i}$	=	The concentration of methane in the sample flow from leak i (volume percent)
$t_{aver,i}$	=	Average bag fill time for leak i (seconds)

- **Ultrasonic flow meters** send ultrasonic signals across a pipe at an angle: one signal with the flow of gas, and one against the flow. The meter then measures the "transit time" of each signal. When the ultrasonic signal travels with the flow, it travels faster than when it travels against the flow. The difference between the two transit times is proportional to flowrate. Ultrasonic flow meters feature two main designs – wetted or clamp-on. The clamp-on meters, with transducers mounted outside of pipework, enable non-intrusive measurement of gas flows with no downtime or disruption of flow, which is particularly useful when measuring high-volume compressor unit valve leaks through open-ended lines. Ultrasonic flow meter can reliably measure leaks of more than 1,500 m^3/h. The leak flow rate of methane is calculated as follows:

$$F_{CH4,i} = F_{USM,i} \ x \ C_{sample,i} \quad (5)$$

Where:

$F_{CH4,i}$	=	The leak flow rate of methane for leak i from the leaking component (m^3/h)
$F_{USM,i}$	=	The sample flow rate as measured by the ultrasonic meter for leak i (m^3/h)
$C_{sample,i}$	=	The concentration of methane in the sample flow from leak i (volume percent)

4. Monitoring requirements

As part of monitoring, project participants should regularly monitor each leak included in the database. During these inspections, the same tools as described above should be used to detect any leaking from the repaired leaks. The following information should be collected:

- Date of monitoring;
- An assessment whether the relevant equipment has been replaced after the repair of the leak;
- The number of hours the relevant equipment was operating (not turned off) since the last monitoring inspection;[3]
- An assessment whether the repair of the leak functions appropriately.

If the repair of the leak does not function appropriately, i.e. a leak at the same location is detected, project participants should note the date of leak repair. All information should be added to the database and be included in monitoring reports.

5. Calculation of emission reductions

In calculating emission reductions, the basic underlying assumption is that a leak, which has been detected and repaired due to the project activity, would have continued to emit methane with the flow rate measured prior to repair, until the equipment concerned would have been replaced. In most cases it is conservative to assume that the leak flow rate prior to repair of the leak would have remained constant, since leaks may grow larger over time.

[3] Note that the hours of operation need to be monitored continuously.

The following assumptions should be made in the calculation of emission reductions:

- If a repair ceases to function, it is conservatively assumed that that the leak resumed at the same flow rate the day after the last inspection, or in case of the first inspection, the day after the repair has taken place. Thus, leaks where the repair failed are excluded from emission reductions from the day after the last inspection;
- Emission reductions from a specific leak i are included in the calculations until whichever of the following are earlier:

  (a) The equipment concerned is replaced for a non-leak related reason (i.e. it breaks down); or
  (b) Its date of predicted replacement as identified as part of data collection in the Step 2 above; or
  (c) The end of the crediting period of the overall project activity.

- The uncertainty of the measurement is taken into account conservatively by using the flow rate at the lower end of the uncertainty range of the measurement at a 95% confidence interval for avoided emissions from leaks. For example, if the measured flow rate is 1 m^3/h and the uncertainty range of a measurement is ±10%, emissions reductions will be calculated at an effective flow rate of 0.9 m^3/h (see equation 6 below).

Emission reductions are calculated as follows:

$$ER_y = ConvFactor \times \sum_i \left[F_{CH4,i} \times T_{i,y} \times (1 - UR_i)\right] \times GWP_{CH4} \qquad \textbf{(6)}$$

Where:

ER_y	=	The methane emission reductions of the project activity during the period y (tCO_2 equivalents). In the case, the component is replaced due to the project activity at an earlier point in time than in the absence of the project activity, emission reductions from that component should only be accounted until the equipment would have been replaced in the absence of the project activity
ConvFactor	=	The factor to convert m^3 CH_4 into t CH_4. At standard temperature and pressure (0 degree Celsius and 101.3 kPa ~~1,013 bar~~) this factor amounts to 0.0007168 t CH_4/m^3 CH_4
i~~*I*~~	=	All leaks eligible towards accounting of emissions reductions, taking into account the guidance described above
$F_{CH4,i}$	=	The leak flow rate of methane for leak i from the leaking component (m^3CH_4/h)
UR_i	=	The uncertainty range for the measurement method applied to leak i, determined, where possible, at a 95% confidence interval, consulting the guidance provided in chapter 6 of the 2000 IPCC Good Practice Guidance. If leak measurement equipment manufacturers report an uncertainty range without specifying a confidence interval, a confidence interval of 95% may be assumed
$T_{i,y}$	=	The time (in hours) the relevant component for leak i has been operating during the monitoring period y, taking into account the guidance described above (e.g. regarding deductions for broken leaks)
GWP_{CH4}	=	The global warming potential for methane (tCO_2eq/tCH_4)

Crediting period

The crediting period of the project activity should start at the latest with the first repair of a leak as part of the project activity. Note that leaks repaired during the crediting period are included in the calculations of emission reductions but that nevertheless a crediting period ends for all leaks 7 (or 10) years after the start of the crediting period.

Leakage

No significant leakage is expected to occur in these types of projects.

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Applicability

This methodology is applicable to project activities that reduce leaks in natural gas pipeline compressor stations and gate stations in natural gas long-distance transmission systems, as well as to other surface facilities in gas distribution systems including pressure regulation stations by establishing advanced leak detection and repair practices:

- Where natural gas pipeline operators have no current systems in place to systematically identify and repair leaks;
- Where leaks can be identified and accurately measured;
- Where a monitoring system can be put in place to ensure leaks repaired remain repaired.

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM0023 ("Leak reduction from natural gas pipeline compressor or gate stations").

Monitoring Methodology

Monitoring includes both the emissions from new leaks being detected and the monitoring of previously repaired leaks.

Specifically, a project developer will survey the components in the compressor and gate stations for leaks using a variety of high-tech methods including electronic 'gas sniffing' devices, organic vapor analyzers (OVA), toxic vapor analyzers (TVA), and sonic (acoustic) leak detectors.

Once identified, the leaks will be tagged and numbered. The flow rate for each leak will then be quantified using advanced measurement technologies including, bagging techniques, high volume samplers, ~~and~~ rotameters, calibrated bags or ultrasonic flow meters. The project developer will then repair the leak recording the date of repair. The repairs will be monitored – using the same leak detection technologies on each leak identified in the baseline – to ensure they are maintained. Where a leak repair fails, it is conservatively assumed that that the leak resumed the day after the last inspection, or in case of the first

inspection, the day after the repair has taken place. Emission reductions are counted from the date of subsequent repair of that same leak.
All relevant data for the calculation of emission reductions (as described in the procedures under the baseline methodology) should be stored in a database. Each monitoring report should include the complete information from this database.

Parameters to be monitored

Relevant data necessary for determining reductions of anthropogenic emissions by sources of greenhouse gases (GHG) within the project boundary and how such data will be collected and archived

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. i	Number	Number of Leak identified, repaired and then re-surveyed	Number	m~~M~~	Once	100%	Electronic	Each leak will be tagged with a number and monitored after repair for any additional leaks
2. T_i	Time	Hours of equipment operation for each leak	# of hours per reporting year	m~~M~~	Constant	100%	Electronic	Hours of operation will end when the equipment concerned is replaced for a non-leak related reason (i.e. it breaks down), or when the date of predicted replacement as identified in the PDD is reached (whatever is earlier)
3.	Date	Repair and monitoring log	Date of repair and monitoring	m~~M~~	Constant	100%	Electronic	Date of repair will be used along with hours of operation of equipment to determine total hours. In cases of re-emerging leaks, the re-emerging leak will be assumed to have occurred the day after the most recent check which showed no leak

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
4. GWP_{CH4}	Global warming potential	IPCC	Tonnes of CO_2 Equivalent	c~~C~~	Constant	100%	Electronic	Project developer will monitor any changes in the methane global warming potential number published by the IPCC and agreed upon by the COP
5. $F_{CH4,i}$	Ratio	Leak rate of CH_4 for each leak detected	m^3 CH_4/hr	m~~M~~	Annual	100%	Electronic	Recorded at the high end of the leak detection equipment's margin of error. (If equipment measure .070 m^3/hr and has a ± ten percent margin of error then the project developer would use .063 m^3/hr)
6.	Temperature and pressure	Temperature and pressure of gas	◦C and bar	m~~M~~	Constant / periodically	100%	Electronic	Measured to calculate the density of the CH_4. Note: Although these variables will be measured, it is not expected that there will be much variance because the pressure and temperature within stations are expected to be basically constant
7. UR_i	Uncertainty Factor for Leak Measurement Equipment	Manufacturer data and/or IPCC GPG	Fraction	m or e	Periodically	100%	Electronic	Estimated where possible, at a 95% confidence interval, consulting the guidance provided in chapter 6 of the 2000 IPCC Good Practice Guidance. If leak measurement equipment manufacturers report an uncertainty range without specifying a confidence interval, a confidence interval of 95% may be assumed

Quality Control (QC) and Quality Assurance (QA) Procedures

Data	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1.	Low	Each leak will be tagged with a number and monitored after repair for any additional leaks
2.	Low	Data loggers will be installed wherever possible for machines that turn off frequently to measure hourly usage
3.	Low	Work orders, receipts and other records will be kept in addition to repair logs
4.	Low	Project participants will keep track of any new GWPs adopted by the COP
5.	Low	Leak rates will be measured and double checked before repair-major discrepancies will warrant a third test. In other words, if a hi-flow sampler is used to measure the rate of a leak, if the results of two tests are far apart, the testing should continue until two measurements have results very close together (to reduce any inaccuracies in the testing process). Should the hi-flow sampler or other equipment need recalibration or adjustment to ensure their accuracy, the project participants will take the necessary action to do so
6.	Low	Data recording equipment will be calibrated and double checked on a regular basis
7.	Med/Low	The IPCC GPG will be consulted in compiling uncertainty estimates

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History of the document

Version	Date	Nature of revision(s)
03	EB 50, Annex 4 16 October 2009	The methodology was revised in response to AM_REV_0161, to expand scope of the applicable leak flow rate measurement techniques to include calibrated bags and ultrasonic meters.
02.1	EB 45, Annex 7 13 February 2009	Editorial revision to adjust the text in the Project Boundary section to be consistent with the Applicability Conditions section as modified from version 01 to version 02 of this methodology.
02	EB 31, Annex 10 4 May 2007	Revision to expand the applicability of the approved methodology to project activities that reduce leakage in distribution systems above ground.
01	EB 20, Annex 13 8 July 2005	Initial adoption.
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