Approved baseline and monitoring methodology AM0043

"Leak reduction from a natural gas distribution grid by replacing old cast iron pipes with polyethylene pipes"

I. SOURCE AND APPLICABILITY

Source

This methodology is based on the project activity "CEG Gas Distribution Pipeline Replacement Project in Rio de Janeiro", whose baseline and monitoring methodology and project design document were prepared by EcoSecurities (Den Haag, The Netherlands).

For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0151: "CEG Gas Distribution Pipeline Replacement Project in Rio de Janeiro" on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

This methodology also refers to the latest version of the "Tool for the demonstration and assessment of additionality".

Selected approach from paragraph 48 of the CDM modalities and procedures

"Actual or historical emissions, as applicable"

Applicability

The methodology is applicable to project activities where:

- cast iron pipes of the natural gas distribution grid are replaced with polyethylene pipes; and
- the replacement of pipes is additional to normal repair and maintenance and planned pipeline replacement.

The following conditions apply to the methodology:

- The grid covered by the project activity is a natural gas distribution system that
    a. operates at low pressure (up to 50 mbar), and
    b. does not include gas transmission pipeline or gas storage facilities, and
    c. is not undergoing or has not recently undergone (within the most recent 3 years) a switch from servicing other gases (e.g. town gas) such that pressures or other operational requirements might change as a consequence;
- The project activity involves the accelerated replacement of cast iron pipeline, which has been in use for at least 30 years, with polyethylene pipeline.
- There are at least 2.0 leaks per kilometer in the cast iron pipelines included in the project boundary or if it can be demonstrated that the leakage in the replaced section of the pipeline is at least 0.5% of the total volume of gas flowing through replaced section.[1]

[1] This requirement is to ensure consistency with the cast iron pipe leakage rate used in this methodology.

- There are no supply interruptions or gas shortages in the gas distribution system related to the physical gas leakages covered under the project activity; and
- The total gas supply capacity and pattern of the gas distribution system is not altered by the project activity.

II. BASELINE METHODOLOGY

Project boundary

The project boundary is defined as the *operational* gas distribution grid pipeline sections expected to be replaced by the project activity. Operational is defined as pipes being under normal operation pressure and supplying natural gas to customers. This grid must be clearly established and mapped in the draft CDM-PDD and no additions to this area can be made during the lifetime of this project activity (this would be considered as new project activity and submitted as a separate PDD).

The project boundary includes both main and service lines (since service lines must be monitored as well). However, for the purpose of estimating emission reductions only distribution mains will be counted in terms of the equations below. All pipeline sections that become non-operational during the project lifetime must be removed from the project boundary. The project boundary also should exclude all parts of the gas distribution network where there are legal/regulatory requirements to replace the cast iron grid, e.g., for reasons of safety or smell.

The only gas included in the project boundary is methane (from pipeline leakage).

Table 1: Summary of gases and sources included in the project boundary, and justification / explanation where gases and sources are not included.

Source		Gas	Included?	Justification / Explanation
Baseline	Leakage of natural gas from pipelines	CO_2	No	CO_2 content in natural gas is small
		CH_4	Yes	More than 90% of natural gas is methane.
		N_2O	No	N_2O content in natural gas is negligible
Project Activity	Leakage of natural gas from pipelines	CO_2	No	CO_2 content in natural gas is small
		CH_4	Yes	More than 90% of natural gas is methane.
		N_2O	No	N_2O content in natural gas is negligible

Procedure for identification of the most plausible baseline scenario

The baseline scenario corresponds to the most reasonable, conservative replacement rate for the cast iron pipelines, taking into account both planned pipeline replacement (NPB_k_A, to be determined *ex ante* and included in the draft CDM-PDD) and business-as-usual replacement activities that may be undertaken for safety or operational reasons (NPB_k_B, to be determined through *ex post* monitoring on an annual basis). The additional length of new pipeline in the baseline scenario in the given year of emission reduction calculation (NPB_k) is therefore determined annually as the greater of the *ex ante* and *ex post* pipeline replacement analyses for year k as follows:

$$NPB_k = MAX(NPB_k\_A, NPB_k\_B) \quad \textbf{(1)}$$

Where:

NPB_k	=	Additional length of the new pipeline in the Baseline laid in year k (m)
NPB_k_A	=	Analysis A: *Ex Ante* Baseline Pipeline Replacement in year k (m)
NPB_k_B	=	Analysis B: *Ex Post* Baseline Pipeline Replacement in year k (m)
k	=	Year of emission reduction calculation

The determination of the ***Ex Post* Baseline Pipeline Replacement** (NPB_k_B) is explained by Equations 6-8 under the section on baseline emissions.

The values for the planned, ***Ex Ante* Baseline Pipeline Replacement** (NPB_k_A) for each year k are determined prior to the start of the crediting period and are to be specified in the draft CDM-PDD. The *Ex Ante* Baseline Pipeline Replacement (i.e., the additional length of new pipeline planned to be laid in the Baseline) is the most rapid (conservative) replacement option among:

- Historical: The average annual length of historical pipeline replacement during the three years prior to the start of the project activity (NPB_k_Ah);
- Planned: The length of pipeline replacement planned in year k, if documentation of existing replacement plans is available (NPB_k_Ap);
- Estimated: The length of estimated pipeline replacement in year k, assuming linear replacement of all pipes over their full remaining lifetime (NPB_k_Ae)

and is determined according to the following equation:

$$NPB_k\_A = MAX\left(\left(\left(\sum_{k=0}^{-2} NPB_k\_Ah\right) \div 3\right), NPB_k\_Ap, NPB_k\_Ae\right) \quad \textbf{(2)}$$

Where:

NPB_k_A	=	Additional length of new pipeline planned to be laid in Baseline in year k (m), referred to as the *Ex Ante* Baseline Pipeline Replacement
NPB_k_Ah	=	Length of historical pipeline replacement during each of the three years prior to the start of the project (m)
NPB_k_Ap	=	Length of pipeline replacement planned for year k, if available (m)
NPB_k_Ae	=	Length of estimated pipeline replacement in year k (m)

$$NPB_k\_Ae = \sum_j \frac{OP_j}{RLT_j} \quad \textbf{(3)}$$

Where:

OP_j	=	Length of operational cast iron distribution main pipe section j expected to be replaced (m)
RLT_j	=	Estimated remaining lifetime of pipe section j in year 0 (years)

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, available at the UNFCCC CDM web site[2].

Instructions are provided below for some of the steps in the Tool that are more specific to this type of project activity. These instructions should be considered as an addition to the instructions in the Tool itself.

- **Step 1.**

  Sub-step 1a.

  The baseline scenario must be defined in accordance with the procedure outlined in the previous section. The alternatives to be included in the analysis are then:
  - the proposed project activity, i.e. the accelerated replacement of the cast iron pipes as planned under the project activity
  - the continuation of the current situation, which is defined as the replacement of the cast iron pipes as established in the previous section.

  Sub-step 1b.

  The analysis of legal and regulatory requirements should at least include all regulations that set a maximum gas losses limit from gas distribution pipes, and those relating to the safety of the distribution system. The analysis shall take into account all the E+/E- category policies and regulations (i.e., sectoral mandatory regulations adopted by a local or national public authority motivated by the reduction of negative local environmental externalities) in place at the time the decision to implement the proposed CDM project activity was taken. The decision to implement the proposed CDM project activity shall be validated by DOE based on documented evidence provided in the draft CDM-PDD submitted for registration.

  The project activity is considered additional if and only if the project activity replacement rate is more than what would have been required by legal or regulatory requirements, such as any:
  - general legal requirements, or any requirements set at the company level (e.g. concession or permit), that limit the total amount of admissible leakage (e.g., maximum annual gas loss permissible as per concession agreement).
  - legal requirement at the specific locations where the project is implemented (e.g. a grid in a certain town, neighbourhood) to improve the existing grid by replacing the cast iron grid for reasons of e.g. safety or smell.

- **Step 2.**

  The project developer shall use Step 2 of the Tool and perform an investment analysis to assess whether the project activity is additional. Step 3, barrier analysis, may only be used to provide supporting evidence to establish additionality.

  The financial analysis shall be based on all costs and revenues that are relevant to implementation of the project activity. For simplicity, revenues from gas sale and costs not directly related to keeping the

[2] Please refer to: < http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

grid operational may be excluded, as these would remain unchanged after implementing the project activity (gas sales would depend on consumer demand). This financial analysis shall be based on the calculations related to lengths of pipeline replaced and gas leakage volumes.

The key factors in the analysis are the:

- Investment cost of replacing the pipelines. The analysis should calculate these costs for the baseline replacement rate of cast iron pipes as identified by Step 1 of "Procedure for identification of most plausible baseline scenario".
- Savings from reduction in natural gas losses. The expected value of the gas lost due to the physical leakages over the remaining life time of replaced cast iron pipes shall be calculated using the price that the distribution company expects to pay for the gas. Sensitivity analysis should vary the projected cost of gas to the distribution company to assess robustness of the results.
- Savings in repair cost (i.e. the difference in maintenance cost of cast iron pipes and polyethylene pipes).

Baseline emissions

Step 0: Estimate *Ex Ante* Baseline Pipeline Replacement
Refer to Equations 1, 2 and 3 under the section on baseline scenario identification above.

Step 1: Determine Methane Emission Factors
Emission factors for old cast iron pipe and new polyethylene pipe are needed to estimate baseline and project emissions.

For baseline emissions of cast iron mains, the following emission factor applies, if all service lines in the project boundary (i.e. connected to the main pipelines) are also replaced with new polyethylene pipe[3]:

$$EF_{OP} = 0.00357 * F_{CH4} \quad \textbf{(4a)}$$

Otherwise the following emission factor for cast iron mains is used[4]:

$$EF_{OP} = 0.00299 * F_{CH4} \quad \textbf{(4b)}$$

[3] The baseline emissions factor for leaks of natural gas in a low pressure distribution network (less than 50 mbar) with cast iron pipes mains and services (EF_{OP}) is calculated in this methodology as 0.00357 * F_{CH4}. A project specific value for the percentage of methane in the gas is applied as this percentage would vary in different distribution grids. The factor 0.00357 is calculated from a factor of 5 m3/m pipeline/year (at normal conditions) by multiplying with a density factor of 0.000714. The factor of 5 Nm3/m pipeline/year is the former official factor for cast iron at low pressure developed and utilized until 2005 by Gas Natural SDG to estimate the annual leakage of natural gas from their distribution network in Spain (PGM-087-E Rev. 2. Gas Natural SDG). This factor was defined using the PGM-087-E procedure, which was developed quite some years ago by experts at Gas Natural and was used to report to the Spanish government on the emissions from the grid. Gas Natural began to use a higher factor as of 2005 to establish its emissions for Spain. To update the emission factors used in Spain, Gas Natural contracted the Centro Politécnico Superior of the University of Zaragoza, Spain. Based on a study of emissions factors from various sources, they developed a factor of 7.8 Nm3/m pipeline/year for cast iron pipes at low pressure (Barroso et al. 2005b). To be conservative, it was decided to use the lower old Gas Natural emission factor instead of the new emission factor as established by the University of Zaragoza.

[4] The emissions factor used is from EPA/GRI. 1996. Methane Emissions from the Natural Gas Industry, Volume 1: Executive Summary. Prepared by Harrison, M., T. Shires, J. Wessels, and R. Cowgill, eds., Radian International LLC for National Risk Management Research Laboratory, Air Pollution Prevention and Control Division, Research Triangle Park, NC, EPA- 600/R-96-080a. Alternative emissions factors can be used provided the information can be verified by a third party. This shall be checked by the DOE at the validation.

The emission factor for new polyethylene main pipeline is as follows[5]:

$$EF_{NP} = 0.00021 * F_{CH4} \quad \textbf{(5)}$$

Where:

EF_{OP}	=	Methane emission factor of the old pipeline (t CH_4/m*year)
EF_{NP}	=	Methane emission factor of the new pipeline (t CH_4/m*year)
F_{CH4}	=	Mass fraction of methane in natural gas (to be monitored)

Step 2. Determine Baseline Pipeline Replacement

The project developer must establish in each year of the project activity which part of the actual pipeline replacement is due to business-as-usual (BAU) replacement activities. To do so, the company must show all the internal safety and operational procedures that relate to pipeline replacement, and the BAU scenario under Analysis B will be based on these procedures. Normally, in the BAU scenario, the gas distribution company would survey a proportion of the total grid in each year to ensure integrity of the grid and safe operating conditions. From this survey, the gas distribution company would replace the pipes that do not meet their safety and operational requirements. It is important to note that the length of pipeline replaced would be reduced in each subsequent year because the total length of the original cast iron pipeline is reduced over time. Normally, this length of pipeline that is considered ‘unsafe’ would roughly be a constant proportion of the total remaining length of cast iron grid. However, due to ageing of the cast iron grid the proportion of ‘unsafe’ pipeline over the total cast iron grid could increase. In order to compensate for ageing of pipelines, in a conservative manner, this proportion is yearly adjusted.

The complexity in this *ex post* analysis is due to the fact that in the project situation the total length of the cast iron grid will be reduced more quickly than in the baseline scenario. Specifically, if the total length of the cast iron grid is different over time between the project and baseline scenario, then the amount of pipeline that would be replaced each year in the baseline cannot be directly monitored.

Through the use of Equations 6, 7 and 8 below, the project developer must calculate the amount of pipeline that would have been replaced in the baseline scenario (NPB_{k}_B), based on an analysis of the pipeline actually replaced in the project activity (NPP_k). Through this analysis the project developer must monitor which part of the replacement is due to procedural replacement based on existing procedures (NPP_{Mk}), see Equation 7.

Based on monitoring of the project activity, a proportion (RP_{Mk}) must be derived by dividing the length of the new pipeline in the project activity in year *k* due to procedural replacement (NPP_{Mk}) by the total remaining length of cast iron grid. In addition, the project developer must monitor the remainder of the cast iron grid (as represented as the divisor in Equation 7). It is important to note that the remaining length of cast iron grid would have been different in the baseline scenario. In order to compensate for this difference in size, the second part of Equation 6 calculates what would be the remainder under the baseline scenario.

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[5] The emissions factor for leaks of natural gas in a low pressure distribution network (less than 50 mbar) with new polyethylene pipes (EF_{NP}) is calculated in this methodology as $0.00021 * F_{CH4}$. As for the cast iron pipes, a project specific value for the percentage of methane in the gas is applied as this percentage would vary in different distribution grids. The factor 0.00021 is calculated from a factor of 0.3 m^3/m pipeline/year (at normal conditions) by multiplying with a density factor of 0.000714. The emission factor of 0.3 Nm^3/m pipeline/year was defined in 2005 by the Centro Politécnico Superior of the University of Zaragoza, Spain (Barroso et al. 2005a). The EF is based on the results of field tests in Spain that measured the volume of gas lost to fugitive emissions in the existing polyethylene distribution network using the Pressure Variation Method.

This proportion must be calculated during the first three years of the project activity, and used to calculate NPB_k_B. After the initial three years, the remaining length of the cast iron pipeline may be too short, therefore, the project developer must take the highest value of RP_{Mk} from these three years for the remainder of the crediting period. After the first four years, the proportion of 'unsafe' pipeline over the total cast iron grid is yearly adjusted by including an ageing coefficient for the calculations of RP_{Mk} (see Equation 8).

The proportion (RP_{Mk}), together with the adjusted remainder of the cast iron grid in the baseline scenario, enables the project developer to calculate the amount of pipeline that would have been replaced in the baseline scenario (NPB_k_B), according to Analysis B.

for

k = 1,

$$NPB_1\_B = NPP_{M1} * \left(\frac{OP - NPB_1\_A}{OP - NPP_{M1}}\right) \qquad \textbf{(6)}$$

Where:

NPP_{M1}	=	Length of the new pipeline in the Project in year *1*due to procedural replacement (m) (to be monitored)
NPB_1_B	=	Analysis B: *Ex Post* Baseline Pipeline Replacement in year *1* (m)
OP	=	Length of operational cast iron pipe to be replaced (m)
NPB_1_A	=	Additional length of new pipeline planned to be laid in Baseline in year *1* (m), referred to as the *Ex Ante* Baseline Pipeline Replacement
NPP_1		Length of the new pipeline in the Project in year *1* (m) (to be monitored)

for

k ≥ 2,

$$NPB_k\_B = RP_{Mk} \times \left(OP - \sum_{i=1}^{k-1} NPB_i\_B\right)$$

Where:

NPB_k_B	=	Analysis B: *Ex Post* Baseline Pipeline Replacement in year *k* (m)
RP_{Mk}	=	Proportion of the pipeline replaced in the Project due to procedural replacement from the original pipeline (%)
OP	=	Length of operational cast iron pipe to be replaced (m)
k	=	Year of emission reduction calculation
i	=	Index for of past years since start of the Project activity

The proportion (RP_{Mk}) is calculated during the first three years as follows:

$$RP_{Mk} = \frac{NPP_{Mk}}{OP - \sum_{i=1}^{k-1} NPP_i} \qquad (k = 1,2,3) \qquad \textbf{(7)}$$

Where:

NPP_{Mk} = Length of the new pipeline in the Project in year *i* due to procedural replacement (m) (to be monitored)
OP = Length of operational cast iron pipe to be replaced (m)
NPP_k = Length of the new pipeline in the Project in year *k* (m) (to be monitored)
k = Year of emission reduction calculation
i = Index for of past years since start of the Project activity

After the first three years the highest value of the proportion (RP_{Mk}) obtained from the three previous years is used to calculate the new value of RP_{Mk} in each year, based on an ageing coefficient of two percent:

$$RP_{Mk} = MAX(RP_{M,1}\ ,\ RP_{M,2}\ ,\ RP_{M,3}) \times 1.02^{k-4} \qquad (k > 3) \qquad \textbf{(8)}$$

Step 3: Calculate Baseline Emissions

The total baseline emissions are then calculated via Equations 9 – 11, where Equation 9 provides the general calculation of total baseline emissions:

$$BE_y = CH_4 BE_y \cdot GWP_{CH4} \qquad \textbf{(9)}$$

Where:

BE_y = Baseline Emission in year *y* (tCO_2e /year)
CH_4BE_y = Baseline Methane Emission in year *y* (t CH_4/year)
GWP_{CH4} = Global Warming Potential of CH_4 (tCO_2/tCH_4)
i = Year of emission reduction calculation

Based on the renewed length of pipeline in the Baseline summed over each year of the crediting period (up to and including year *i*), the methane emissions for each year *i* are calculated as follows:

$$CH_4 BE_y = CH_4 BE_0 - (\sum_{k=1}^{y} NPB_k - NOP_y) \times \left(EF_{OP} - EF_{NP}\right) \qquad \textbf{(10)}$$

Where:

CH_4BE_y = Baseline Methane Emission in year *y* (t CH_4/year)
CH_4BE_0 = Baseline Methane Emission in year 0 (t CH_4/year)
NPB_k = Additional length of the new distribution main pipeline in the Baseline laid in year *k* (m)
NOP_y = Length of distribution main pipeline replaced since start of crediting period that is non-operational in year *y* (m)
EF_{OP} = Methane emission factor of the old pipeline (t CH_4/m*year)
EF_{NP} = Methane emission factor of the new pipeline (t CH_4/m*year)
y = Year of emission reduction calculation
k = Years since start of crediting period, up to and including year *y*

Baseline emissions for year 0 (beginning of crediting period) are calculated by taking the total length of cast iron pipes (the project boundary) and using the emission factor for cast iron, as follows:

$$CH_4BE_0 = OP \cdot EF_{OP} \quad \textbf{(11)}$$

Where:

CH_4BE_0	=	Baseline Methane Emission in year 0 (t CH_4/year)
OP	=	Length of operational cast iron main pipe to be replaced (m)
EF_{OP}	=	Methane emission factor of the old pipeline (t CH_4/m*year)

Project Emissions

As explained above, project activity emissions are calculated using the same set of equations listed for baseline emissions. The same values established for EF_{OP} and EF_{NP} must be applied here.

$$PE_y = CH_4PE_y \cdot GWP_{CH4} \quad \textbf{(12)}$$

Where:

PE_y	=	Project Emission in year y (tCO_2e /year)
CH_4PE_y	=	Project Methane Emission in year y (t CH_4/year)
GWP_{CH4}	=	Global Warming Potential of CH_4 (tCO_2/tCH_4)
y	=	Year of emission reduction calculation

Based on the renewed length of pipeline in the Project activity over the past n years (including year i), the methane emissions for each year i are calculated as follows:

$$CH_4PE_i = CH_4BE_0 - (\sum_{k=1}^{y} NPP_k - NOP_y) \cdot \left(EF_{OP} - EF_{NP}\right) \quad \textbf{(13)}$$

Where:

CH_4PE_y	=	Project emission Methane Emission in year y (t CH_4/year)
CH_4BE_0	=	Baseline Methane Emission in year 0 (t CH_4/year)
NPP_k	=	Length of the new pipeline in the Project in year k (m)
NOP_y	=	Length of distribution main pipeline replaced since start of crediting period that is non-operational in year y(m)
EF_{OP}	=	Methane emission factor of the old pipeline (t CH_4/m*year)
EF_{NP}	=	Methane emission factor of the new pipeline (t CH_4/m*year)
y	=	Year of emission reduction calculation
k	=	Year, and if applicable, previous years of emission reduction calculation

The baseline methane emission in year 0 (CH_4BE_0) is calculated according to Equation 11.

The total length of pipeline replaced in the Project is the sum of pipelines replaced due to project activity and procedural replacement:

$$NPP_k = NPP_{Pk} + NPP_{Mk} \quad \textbf{(14)}$$

Where:

NPP_k = Length of the new pipeline in the Project in year k (m)

NPP_{Pk} = Length of the new pipeline in the Project in year k due to the project activity (m) (to be monitored)

NPP_{Mk} = Length of the new pipeline in the Project in year k due to procedural replacement (m) (to be monitored)

Leakage

No significant leakage is expected for this type of project activity under the applicability conditions stated, thus leakage can be ignored.

Emission reductions

Emission reductions for each year are calculated as follows:

$$ER_y = BE_y - PE_y \qquad \textbf{(15)}$$

Where:

ER_y = Emission reductions during the year y (tCO_2e /year)

BE_y = Baseline emissions during the year y (tCO_2e /year)

PE_y = Project emissions during the year y (tCO_2e /year)

Changes required for methodology implementation in 2nd and 3rd crediting periods

Consistent with guidance by the Executive Board, project participants shall assess the continued validity of the baseline and update the baseline. In order to assess the continued validity of the baseline, project participants should apply the procedure to determine the most plausible baseline scenario, as outlined in the baseline scenario of the most recent version of this methodology available at the renewal of the crediting period. If international literature would show that the emission factor for cast iron pipes has changed, the emission factor used in this methodology should be updated.

Data and parameters not monitored

Data / parameter:	*RLT*
Data unit:	years
Description:	Estimated remaining lifetime of original pipe in year 0
Source of data:	Technical specifications from the pipe manufacturer and/or an external expert opinion
Measurement procedures (if any):	Must be determined at the beginning of the crediting period.
Any comment:	

Data / parameter:	OP_j
Data unit:	m
Description:	Length of operational cast iron distribution main pipe section j expected to be replaced.
Source of data:	Planning documents and maps provided by the project developer.
Measurement procedures (if any):	Must be determined at the beginning of the crediting period. The records provided will need to show the lengths of pipeline as well as the pipeline grade and pipeline material. The project developer needs to keep records showing that the pipes are indeed cast iron. This evidence needs to be verifiable. Information provided by the project developer could additionally be checked with permits/concession letter from the municipality or relevant authorities.
Any comment:	QA/QC procedure: Project developer data shall be double-checked with third party information (e.g. from municipality) to ensure accuracy and consistency.

Data / parameter:	NPB_k_Ah
Data unit:	m
Description:	Length of historical pipeline replacement during each of the three years prior to the start of the project.
Source of data:	Planning documents and maps provided by the project developer.
Measurement procedures (if any):	Must be determined at the beginning of the crediting period. The records provided will need to show the lengths of pipeline as well as the pipeline grade and pipeline material. The project developer needs to keep records showing that the pipes are indeed cast iron. This evidence needs to be verifiable. Information provided by the project developer could additionally be checked with permits/concession letter from the municipality or relevant authorities.
Any comment:	QA/QC procedure: Project developer data shall be double-checked with third party information (e.g. from municipality) to ensure accuracy and consistency.

Data / parameter:	NPB_k_Ap
Data unit:	m
Description:	Length of pipeline replacement planned for year k, if available.
Source of data:	Planning documents and maps provided by the project developer.
Measurement procedures (if any):	Must be determined at the beginning of the crediting period. The records provided will need to show the lengths of pipeline as well as the pipeline grade and pipeline material. The project developer needs to keep records showing that the pipes are indeed cast iron. This evidence needs to be verifiable. Information provided by the project developer could additionally be checked with permits/concession letter from the municipality or relevant authorities.
Any comment:	

Data / parameter:	*GWP_{CH4}*
Data unit:	tCO_2/tCH_4
Description:	Global Warming Potential of CH_4
Source of data:	Default value 21 for the first commitment period
Measurement procedures (if any):	-
Any comment:	-

Data / parameter:	*Not applicable*
Data unit:	years
Description:	Age of pipeline
Source of data:	Project developer
Measurement procedures (if any):	
Any comment:	Used to determine applicability of methodology to CDM project activity. Age of pipeline must be at least 30 years, and the remaining lifetime of the pipelines must be sufficient to outlast the crediting period.

Data / parameter:	*Not applicable*
Data unit:	leaks/km
Description:	Average number of leaks per km
Source of data:	Project developer
Measurement procedures (if any):	To establish the number of leaks per km for the cast iron grid that is included in the project boundary, this data must be either established *ex-ante* at the beginning of the crediting period, based on historic data (1), or regular monitoring needs to take place of the cast iron parts with methane detectors (2). The procedure used must be in compliance with a referenced national and/or internationally recognized publication or standard.
Any comment:	Used to determine applicability of methodology to CDM project activity. Must be at least 2.0 leaks per km to ensure the conservativeness of the emission factor.

III. MONITORING METHODOLOGY

Monitoring procedures

This methodology monitors the variables needed to establish emissions in the project and the baseline. The total length of pipeline in the project boundary needs to be established. The length of pipeline that is replaced in the project scenario due to project-specific activities (NPP_{Pk}) as well as due to normal maintenance procedures (NPP_{Mk}) needs to be measured. Moreover, the fraction of methane in the gas as well as the pressure in the pipes is monitored. The monitoring plan provides for periodic measurements of the pipeline replaced and continuous measurement of the fraction of methane.

The main variables that need to be monitored are thus:

- The overall length of the operational cast iron pipeline to be replaced, *OP*, is to be established once at the beginning of the project on the basis of documentation provided by the project developer.

- The fraction of methane in the natural gas, F_{CH4}, needs to be monitored regularly to calculate the emission factors (EF_{OP} and EF_{NP}). It should be measured with a continuous analyser.
- The length of new pipeline in the project due to the project activity in year k, NPP_{Pk}, as well as the length of the new pipeline in the project due to procedural replacements, NPP_{Mk} are monitored regularly on the basis of data available from the project developer in order to determine project emissions. Moreover, NPP_{Mk} is also needed to determine baseline emissions *ex post*.

Although not used to establish emissions through the equations provided (and therefore not included in the data tables below), the following items also must be tracked as part of this methodology:

- Grid operation: To ensure that the grid is still operational within all parts of the project boundary, operational protocols and maps provided by the project developer need to be checked monthly. Information provided shall be cross-checked with bills from local households.
- Service line replacement: For each section of the main pipeline, all service lines must also be replaced. If this is not the case, a lower emission factor should be used. Project developer will need to implement a comprehensive log system, which may be cross-checked with third party information (e.g., from municipality) to ensure accuracy and consistency.

Data and parameters monitored

Data / parameter:	*OP*
Data unit:	m
Description:	Length of operational cast iron pipe to be replaced
Source of data:	Planning documents and maps provided by the project developer
Measurement procedures (if any):	Must be determined at the beginning of the crediting period. The records provided will need to show the lengths of pipeline as well as the pipeline grade and pipeline material. The project developer needs to keep records showing that the pipes are indeed cast iron. This evidence needs to be verifiable. Information provided by the project developer could additionally be checked with permits/concession letter from the municipality or relevant authorities.
Any comment:	QA/QC procedure: Project developer data shall be double-checked with third party information (e.g. from municipality) to ensure accuracy and consistency.

Data / parameter:	F_{CH4}
Data unit:	%
Description:	Fraction of methane in the natural gas
Source of data:	Project developer
Measurement procedures (if any):	Must be measured with a continuous analyzer periodically calibrated for zero and span check against standard gases.
Monitoring frequency:	Continuously
QA/QC procedures:	Monitored data shall be archived for two years following the end of the crediting period. The gas analyzer should be subject to regular calibration and general maintenance to ensure accuracy.
Any comment:	Used to calculate the average fraction of methane in a given year $F_{CH4,i}$

Data / parameter:	NPP_{Pk}
Data unit:	m
Description:	Length of the new pipeline in the Project in year *k* due to the project activity
Source of data:	Log system and maps provided by the project developer
Measurement procedures (if any):	The records provided will need to show the lengths of pipeline as well as the pipeline grade and pipeline material. The project developer has to demonstrate that the replacement with the new pipeline is undertaken to high quality standards by carrying out a 24-hour pressure test. In such a test, all valves are closed and air is pumped into the system after which the pressure is monitored for 24 hours, whereby no drop in pressure may occur.
Monitoring frequency:	Monthly
QA/QC procedures:	Monitored data shall be archived for two years following the end of the crediting period. Determination according to applicable national or international standards. Information provided could additionally be checked with permits/concession letter from the municipality or relevant authorities as well as bills for the purchase of new pipes.
Any comment:	

Data / parameter:	NPP_{Mk}
Data unit:	m
Description:	Length of the new pipeline in the Project in year k due to procedural replacement
Source of data:	Log system and maps provided by the project developer
Measurement procedures (if any):	The records provided will need to show the lengths of pipeline as well as the pipeline grade and pipeline material. The project developer has to demonstrate that the replacement with the new pipeline is undertaken to high quality standards by carrying out a 24-hour pressure test. In such a test, all valves are closed and air is pumped into the system after which the pressure is monitored for 24 hours, whereby no drop in pressure may occur.
Monitoring frequency:	Monthly
QA/QC procedures:	Monitored data shall be archived for two years following the end of the crediting period. Determination according to applicable national or international standards. Information provided could additionally be checked with pipeline integrity assessment data and/or other secondary information requiring a change of pipeline.
Any comment:	

Data / parameter:	NOP_i
Data unit:	m
Description:	Length of distribution main pipeline replaced since start of crediting period that is non-operational in year *i*
Source of data:	Project developer
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Monitored data shall be archived for two years following the end of the crediting period.
Any comment:	

Data / parameter:	*Pipeline Pressure*
Data unit:	mbar
Description:	Pressure of the natural gas in the pipeline system must be monitored to ensure pressures remain below 50mbar.
Source of data:	Project developer
Measurement procedures (if any):	Pressure transducer with electronic output connected to a data acquisition unit generating an electronic spreadsheet or chart including pressure as a function of time..
Monitoring frequency:	Continuous monitoring
QA/QC procedures:	Monitored data shall be archived for two years following the end of the crediting period. Weekly calibration for zero and span to be conducted according to international Standards.
Any comment:	CERs may not be issued for the period in which pressure exceeds 50mbar.