Draft revision to the approved baseline and monitoring methodology AM0037

"Flare reduction and gas utilization at oil and gas processing facilities"

I. SOURCE AND APPLICABILITY

Source

This methodology is based on the project activity "Reduction of Flaring and Use of Recovered Gas for Methanol Production", whose baseline and monitoring methodology and project design document were prepared by MDL Ambiente.

For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0145: "Flare reduction and gas utilization at oil and gas processing facilities" 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.[1]

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 that recover tail gas from oil and natural gas processing facilities that was previously flared and utilize this tail gas for productive uses (e.g., as a fuel or a feedstock).

The following conditions apply to the methodology:

- Tail gas from an oil or natural gas processing facility, used by the project activity, was flared (not vented for the last 3 years, prior to the start of the project, or as long as the processing facility has been in operation.
- Previously-flared tail gas from an oil or natural gas processing plant is used to produce useful energy or a useful product (e.g. methanol, ethylene, or ammonia). The surplus tail gas substitutes the same type of fuels/feedstock or fuel/feedstock with a higher CO_2 equivalent emissions impact.
- The facility producing the useful energy or a useful product has an operating history of at least three years and the implementation of the project activity will not result in increase in production at the facility.
- ~~If the tail gas is used as a feedstock in a new facility, the production of the useful products (e.g. methanol, ethylene, etc.) by the project activity does not lead to displacement of production in a new plant that would be built in the absence of the project activity in an Annex I country; and would emit more than 1% of the emissions due to flaring of the tail gas in the baseline situation. The project participants can use market studies of the useful product, interviews with appropriate~~

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

~~experts, analysis from research institutes with expertise the market for that useful product, etc. to demonstrate that such a displacement of production in Annex I country is highly unlikely to occur.~~

- The use of the tail gas by the project activity will not lead to an increase in fuel consumption outside of the project boundary.[2]
- Energy requirements for the project activity are primarily met using the previously-flared tail gas. If additional fossil fuel is required for the project activity, these emissions should be counted as project emissions.
- Accurate data on the quantity and carbon content on the tail gas are available.

II. BASELINE METHODOLOGY

Project boundary

The project boundary for this methodology includes:

- The pipeline from the processing facility to the:
  - The site of the original tail gas flaring site;
  - The pipeline connecting the processing facility to the facilities utilizing the tail gas; and
  - The facility(ies) using the tail gas in the project activity.

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	Flaring	CO_2	Yes	main source of emissions in the baseline.
		CH_4	No	It is assumed that flaring results in complete oxidation of carbon in tail gas, resulting in a more conservative baseline
		N_2O	No	Assumed negligible
	Fuel consumption for tail gas transport	CO_2	Yes	If fossil fuels (other than tail gas) or electricity are used (e.g., in pipeline compressors).
		CH_4	No	Assumed negligible
		N_2O	No	Assumed negligible
	Fugitives resulting from tail gas transport	CO_2	No	Assumed negligible
		CH_4	Yes	CH_4 emissions may occur if gas is transported to a flare in the baseline scenario.
		N_2O	No	Assumed negligible
Project Activity	Fuel consumption for tail gas transport	CO_2	Yes	If fossil fuels (other than previously flared tail gas) are used (e.g., in pipeline compressors).
		CH_4	No	Assumed negligible
		N_2O	No	Assumed negligible
	Fugitives resulting from tail gas transport	CO_2	No	Assumed negligible
		CH_4	Yes	Fugitive CH_4 emissions may occur if tail gas is transported to the end use facility in the project scenario.
		N_2O	No	Assumed negligible

	Fugitive emissions from accidents	CO_2	No	Assumed negligible
		CH_4	Yes	Fugitive CH_4 emissions may occur if there is an equipment failure in equipment transporting tail gas to the end use facility in the project scenario.
		N_2O	No	Assumed negligible
	Additional energy used by feedstock facility	CO_2	Yes	If project activity results in increased fossil fuels (other than previously flared tail gas) use in end use facility.
		CH_4	No	Assumed negligible
		N_2O	No	Assumed negligible

Procedure for the selection of the most plausible baseline scenario

- Step 1: Identify all realistic and credible alternative scenarios to the proposed project activity and eliminate alternative that do not comply with legal or regulatory requirements;
- Step 2: Assess the alternatives to the proposed project activity and eliminate alternatives that face prohibitive barriers; and
- Step 3: Determine the most likely alternative (baseline scenario).

Step 1: Identify all realistic and credible alternative scenarios to the proposed project activity and eliminate alternative that do not comply with legal or regulatory requirements. The plausible alternative baseline scenarios for use of tail gas could include, inter alia:

(a) Flaring at the oil or gas processing site;
(b) On-site consumption of tail gas for energy;
(c) Injection of tail gas into oil reservoir;
(d) Recovery, transportation, processing and distribution of tail gas to end-users.
(e) Tail gas is used as a fuel and/or feedstock at offsite facility; and
(f) Another source of feedstock, other than the tail gas, is used at the end use facility where the tail gas is used in the project activity. The list of feedstock for an existing end use facility should include the existing feedstock used. ~~In case of new end use facility, all possible feedstock should be evaluated.~~ .

All baseline alternatives shall be in compliance with all applicable legal and regulatory requirements, even if these laws have objectives other than GHG reductions.

If an alternative does not comply with all applicable legislation and regulations, eliminate such alternative unless it is demonstrated, based on an examination of current practice in the country or region in which the law or regulation applies, that applicable legal or regulatory requirements are systematically not enforced and that non-compliance is widespread.

Step 2: Assess the alternatives to the proposed project activity and eliminate alternatives that face prohibitive barriers.

Establish a complete list of barriers that would prevent alternative scenarios. Since the "proposed project activity not being registered as a CDM project activity" shall be one of the considered alternatives, any barrier that may prevent the project activity to occur shall be included in that list. Show which alternatives are prevented by at least one of the barriers previously identified and eliminate those alternatives from further consideration. All alternatives shall be evaluated for a common set of barriers.

If only one alternative remains, it shall be the baseline scenario.

Step 3: Determine the most likely alternative (baseline scenario)
Where more than one credible and plausible alternative remains after Steps 1 and 2, the alternative that results in the lowest baseline emissions shall be the baseline scenario.

The methodology is applicable if the baseline scenario is (a) flaring of the tail gas; and (b) ~~if a new facility is built for use of tail gas, the baseline is no facility would have been built in absence of the project activity, else, for an existing facility~~ the baseline feedstock is continuation of the present situation in absence of the project activity.

Additionality

The project will be demonstrated as additional using a version of the EB-approved "*Tool for the Demonstration and Assessment of Additionality.*" Specific guidance in using the Tool with this methodology is provided below. All the scenarios identified in step 1 of the baseline scenario selection procedures, described in previous section, shall be used for evaluating the additionality of the project activity. ~~The evaluation should specifically include the following alternative, if the end use facility is a new facility:~~

- ~~End use facility, where the tail gas is used in the project activity, is built that does not utilize feedstock other than the tail gas. The scenario should clearly list the possible feedstock and their source.~~

If Step 2 of the Tool (Investment Analysis) is used, then an IRR analysis of the entire project is required ~~(not limited to use of tail gas but including analysis of investment in any new tail gas end use facility).~~ IRR analysis of all the alternative scenarios shall be performed if Step 2 (Substep 2b – Option 2, Investment Comparison Analysis) is chosen.

Steps 4 and 5 of the Tool should be completed as specified in the latest version of the "*Tool for the Demonstration and Assessment of Additionality*".

Baseline emissions

In calculating baseline emissions, it is assumed that the recovered gas would be flared in the absence of the project. It is also assumed that all carbon in the tail gas (i.e. in methane and other gases including other hydrocarbons, CO, and CO_2) is completely oxidized to carbon dioxide. Baseline emissions are calculated as follows in Equation 1:

$$BE_y = \left(V_y \times w_{carbon,y} \times 44/12\right) + \left(FCT_{flare,x} \times V_y \times EFFCT_{flare,x}\right) + FE_x \quad (1)$$

Where:

BE_y	=	Baseline emissions during the year y (t CO_2-e/yr)
V_y	=	The volume of tail gas utilized in year y ~~at intake point to end use facility~~ (m^3)
$w_{carbon,y}$	=	The carbon content of tail gas flared in year y (t C/m^3)
$FCT_{flare,x}$	=	Energy or fuel consumed for transportation (e.g., for pipeline compressor) to flare per unit volume of tail gas in year x (e.g. m^3/m^3, liters/m^3, kJ/m^3, kWh/m^3)[3]
$EFFCT_{flare,x}$	=	Emissions factor for fuel or energy used for transportation of tail gas to flare in year x (e.g., t CO_2/m^3, t CO_2/liter, t CO_2/kJ, t CO_2/kWh)[4]
FE_x	=	Fugitive CH_4 emissions along the transportation path to the point of flaring (t CO_2-e/yr)
x	=	Baseline year (i.e., the year before the flare was stopped and the project activity was started)
y	=	Project year

Fugitive CH_4 emissions along the transportation path to the point of flaring

Fugitive CH_4 emissions occurring during the transport of tail gas may be small, but they should be estimated to be conservative. Emission factors may be taken from the IPCC Good Practice Guidance and/or from the 1995 Protocol for Equipment Leak Emission Estimates, published by U.S. EPA.[5] Emissions should be determined for all relevant activities and all equipment (such as valves, pump seals, connectors, flanges, open-ended lines, etc.).

The U.S. EPA approach is based on average emission factors for total organic compounds (TOC). In Equation 2, methane emissions are calculated by multiplying the methane concentration in the in the tail gas with the appropriate emission factor from Table 1 and then summing across all pieces of equipment.

$$FE_x = GWP_{CH4} \times 1/1000 \times \sum_{equipment}\left[w_{CH4,pipeline} \times EF_{pipeline} \times t_{equipment}\right] \quad (2)$$

Where:

GWP_{CH4}	=	The approved Global Warming Potential for methane
$w_{CH4,pipeline}$	=	The mass fraction of methane in the pipeline tail gas (kg CH_4/kg)
$EF_{pipeline}$	=	The appropriate emission factor from Table 2 or the IPCC Good Practice Guidance (kg CH_4/hour/equipment)
$t_{equipment}$	=	The operation time of the equipment in hours (in absence of further information, the

[3] Additional energy or fuel is not provided by tail gas.

[4] Where self-generation occurs emissions should be based on actual fuel consumption and carbon content data. Were grid electricity is used the project, the combined margin approach outlined in ACM0002 should be used to estimate a tonnes CO_2/kWh factor.

[5] Please refer to Document EPA-453/R-95-017 at <http://www.epa.gov/ttn/chief/efdocs/lks95_ch.pdf>

monitoring period could be considered as a conservative approach)

All data for gas volumes in all equations should be converted to common standard temperature and pressure values. The default density of methane at 0 degree Celsius and 1 atm is 0.0007168 t CH_4/m^3.

For the purpose of the calculation in Equation 2, it is recommended to group the equipment according to the different types listed in the Table 2.

Table 2: Oil and natural gas production average emission factors

Equipment Type	Service	Emission Factor (kg/hour/equipment item) for TOC
Valves	Gas	4.5E-03
Pump seals	Gas	2.4E-03
Others*	Gas	8.8E-03
Connectors	Gas	2.0E-04
Flanges	Gas	3.9E-04
Open-ended lines	Gas	2.0E-03

TOC: Total organic compounds
Source: US EPA-453/R-95-017 Table 2.4, page 2-15
*"Other" equipment type was derived from compressors, diaphragms, drains, dump arms, hatches, instruments, meters, pressure relief valves, polished rods, relief valves and vents. This "other" equipment type should be applied for any equipment type other than connectors, flanges, open-ended lines, pumps or valves.

Where the IPCC Good Practice Guidance (2000) is used to estimate fugitive CH_4 emissions, the appropriate refined Tier 1 emission factors in Table 2.16 of the IPCC Good Practice Guidance should be applied.

Project Emissions

Project emissions would occur if fossil fuel were consumed in the process of transporting the gas to its new end use and any resulting fugitive emissions[6] from its transport. Project emissions can be calculated as follows ~~in Equation 3~~:

$$PE_y = (FCT_y \times EFFCT_y x V_y) + (FE_y) + (EFA_y) + (FFU_y) \quad \textbf{(3)}$$

Where:

PE_y	=	Project emissions in year y
FCT_y	=	Energy or fuel consumed for transportation (e.g., for pipeline compressor) to end use facility per unit volume of tail gas in year y (e.g., m^3/m^3, liters/m^3, joules/m^3, kWh/m^3)
$EFFCT_y$	=	Emissions factor for fuel or energy used for transportation of tail gas to end use facility in year y (e.g., t CO_2/m^3, t CO_2/liter, t CO_2/kJ, t CO_2/kWh)[7]
V_y	=	The volume of tail gas utilized in year y at intake point to end use facility (m^3)
FE_y	=	Fugitive CH_4 emissions along the transportation path to the point of flaring (t CO_2-e/yr)

[6] Fugitive methane emissions may result from the transportation of gas to the end-user. For example, if gas is transported in a pipeline to the end-user site, that pipeline may leak.
[7] Where self-generation occurs emissions should be based on actual fuel consumption and carbon content data. Were grid electricity is used the project, the combined margin approach outlined in ACM0002 should be used to estimate a tonnes CO_2/kWh factor.

EFA_y = Fugitive emissions of CH_4 from accidents
FFU_y = Additional energy may be used by the end use facility that utilizes the tail gas (e.g., grid electricity or other fossil fuels besides tail gas) (t CO_2-e)[8]

Fugitive CH_4 emissions along transport pipeline (FE_y)

It may be unnecessary to calculate some project (as well as baseline) emissions in cases where the pipeline transporting tail gas to the end use facility is identical (in terms of length, design, and other characteristics likely to affect fugitive emissions and energy demands for compressors) to the pipeline used to transport tail gas to the flare in the baseline scenario. If transport of the tail gas to the end use facility only requires an extension of the pipeline to the flare in the baseline scenario, then baseline emissions along the pipeline[9] can be ignored and project emissions only need to be estimated for the pipeline extension.

The fugitive emissions will be estimated using the procedure defined in the baseline emissions section.

All data for gas volumes in all equations should be converted to common standard temperature and pressure values (e.g.,). The default density of methane at 0 degree Celsius and 1 atm is 0.0007168 t CH_4/m^3.

CH_4 emissions from transport of tail gas in pipelines when accidental event occurs (EFA_y)

When an accident causes gas leakage from the pipeline, the gas volume is calculated as the sum of (1) the total amount of gas flow from the time the accident occurred until gas flow was shut off, and (2) the total amount of gas remaining in the pipeline at time of shut off. Accidental release of methane from the pipeline should be calculated as:

$$EFA_y = GWP_{CH4} \times \frac{1}{1000}\left(V_{accident} + V_{remain,accident}\right) \times w_{CH4,pipeline,accident} \quad \textbf{(5)}$$

with:

$$V_{accident} = t_{accident} \times F = (t_2 - t_1) \times F \quad \textbf{(6)}$$

$$V_{remain,accident} = d^2 \times \pi \times L \times \frac{P_p}{P_s} \times \frac{T_s}{T_p} \times \frac{V_{d,accident}}{\sum_i V_{Xi,d,accident}} \quad \textbf{(7)}$$

Where:

EFA_y = Methane emissions from the transport pipeline due to an accidental event (t CO_2-e)
$V_{accident}$ = The volume of tail gas supplied to the pipeline from the oil and natural gas processing plant from the time the gas leakage started until the shutdown valves were closed (m^3)
$V_{remain,accident}$ = The volume of tail gas remaining in the pipeline after the shutdown valves have been closed (m^3)

[8] Additional energy or fuel is not provided by tail gas.
[9] In other words, emissions from $\left(FCT_{flare,x} \times V_y \times EFFCT_{flare,x}\right) + FE$

$W_{CH4,\ pipeline,\ accident}$	=	The fraction of methane in the tail gas on a mass basis (kg CH_4/m^3)
t_1	=	The time the gas leakage caused by the accident occurred (sec)
t_2	=	The time that the shutdown valves closed both the upstream and downstream pipeline (sec)
F	=	The flow rate of tail gas in the pipe supplying gas to end use facility ~~supplied~~ from the oil and natural gas processing plant (m^3/sec)
d	=	The radius of the pipeline (meters)
π	=	The ratio of the circumference of a circle to its diameter (unitless)
L	=	The length of the pipeline (meters)
P_p	=	The pressure in the pipeline when the shutdown valves close both the upstream and downstream of the pipeline (atm)
P_s	=	Standard pressure (atm)
T_p	=	The temperature in the pipeline when the shutdown valves close both the upstream and downstream of the pipeline (ºC)
T_s	=	Standard temperature (ºK)
$V_{d,accident}$	=	The volume of tail gas supplied to the pipeline from the oil and natural gas processing plant before the accident occurs during the period (m^3)
$V_{xi,d,accident}$	=	The volume of gas supplied to the pipeline from other sources if any before the accident occurs during the period (m^3)

Additional energy used by end-use facility(FFU_y)

$$FFU_y = QF_y * EF_{facility,y} \quad (4)$$

Where:

QF_y	=	Energy or fuel consumed by end use facility (e.g., for processing tail gas as a feedstock material)in year y (e.g., m^3, liters, kJ, kWh)[10]
$EF_{facility,y}$		Emissions factor for fuel or energy used by end use facility in year y (e.g., t CO_2/m^3, t CO_2/liter, t CO_2/kJ, t CO_2/kWh)[11]

Leakage

Leakage is expected to be negligible unless fugitive methane for tail gas transportation emissions is outside the control of the project participants. In this case, the calculation of leakage would be the same as in the corresponding project emissions section.

The project participants should also address:

- Whether the supply of additional fossil fuels by the project activity to the market will lead to additional fuel consumption, and
- Whether the fuels produced by the project activity will substitute fuels with a lower carbon intensity (e.g., if electricity generation with the recovered gas substitutes renewable electricity generation).

[10] Additional energy or fuel is not provided by tail gas.

[11] Where self-generation occurs emissions should be based on actual fuel consumption and carbon content data. Were grid electricity is used the project, the combined margin approach outlined in ACM0002 should be used to estimate a tonnes CO_2/kWh factor.

For this purpose the market of the products produced by the end use facility should be analyzed. If such leakage effects result from the project activity, emission reductions should be conservatively adjusted for.

Emission reductions

Emission reductions are calculated as the difference between baseline and project emissions, taking into account any adjustments for leakage:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(8)}$$

Where:

ER_y = Emission reductions during the year *y* (tCO_2/yr)
LE_y = Leakage emissions during the year *y* (tCO_2/yr)

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.

Data and parameters not monitored

Data / parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
Source of data:	IPCC
Measurement procedures (if any):	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	

III. MONITORING METHODOLOGY

Monitoring procedures

The monitoring methodology involves monitoring of the following:

- The composition and quantity of tail gas produced by oil and natural gas processing facility;
- The quantity and carbon intensity of any additional energy consumed for transportation purposes or for the processing of the tail gas as a feedstock material by the end use facility.
- Any fugitive emissions of methane along the tail gas transport pipeline (including from accident events).

Baseline emissions from flaring are calculated *ex post* using measured data on tail gas supplied to the end use facility (versus to flare). Baseline emissions from energy use and fugitive releases of methane are calculated using *ex ante* data on energy use for transport (e.g., for compressors) and fugitive methane emissions along the pipeline.

Project emissions are all calculated *ex post* based on actual energy use and fugitive emissions data.

Data and parameters monitored

Use the following table for each data/parameter

Data / parameter:	V_y
Data unit:	m^3
Description:	The volume of tail gas utilized in year y at intake point to end use facility
Source of data:	Flow meter totalizer data (can be obtained from oil or natural gas processing plant that supplies the tail gas)
Measurement procedures (if any):	Data should be measured using accurate and calibrated flow meters. Measurements should be taken at the point that tail gas enters the pipeline for transport to the flare (in the baseline scenario) or enters the pipeline for transport to the end use facility (in the case of the project scenario). Data can be collected in conjunction with *F*.
Monitoring frequency:	Continuous
QA/QC procedures:	Volume of gas should be completely metered with regular calibration of metering equipment, similar to what is called for in other approved methodologies.
Any comment:	Data must be archived for two years following the end of the crediting period.

Data / parameter:	$w_{carbon,y}$
Data unit:	t C/m^3
Description:	The carbon content of tail gas flared in year y
Source of data:	Chemical analysis (e.g., gas chromatography)
Measurement procedures (if any):	Analysis can be performed in conjunction with measurement of the methane content of the tail gas ($w_{CH4,pipeline}$)
Monitoring frequency:	Weekly (minimum)
QA/QC procedures:	Carbon content of gas should be crossed checked with previous months' data as well as with the owners of the oil and gas processing plant. Data will be archived for two years following the end of the crediting period.
Any comment:	None

Data / parameter:	$FCT_{flare,x}$
Data unit:	m^3/m^3, liters/m^3, kJ/m^3, kJ/kg, or kWh/m^3 depending on energy source
Description:	Energy or fuel consumed for transportation (e.g., for pipeline compressor) to flare per unit volume of tail gas in year x
Source of data:	Purchase or usage records for solid or liquid fuels, flow meter data for gaseous fuels, or electricity meter in combination with flow rate data for tail gas sent to flare.
Measurement procedures (if any):	Measurement requires collecting simultaneous data on energy/fuel use and tail gas flow rates to produce a fuel consumption rate per unit of tail gas flared.
Monitoring frequency:	Continuous
QA/QC procedures:	Meters must be properly calibrated and tested.
Any comment:	Measured in baseline year only, which is the year before the project begins. This energy or fuel is provided by sources other than the tail gas itself (i.e., it is not included in the data for V_y). Data will be archived for two years following the end of the crediting period.

Data / parameter:	$EFFCT_{flare,x}$
Data unit:	T CO_2/m^3, t CO_2/liter, t CO_2/kJ, t CO_2/kg, or t CO_2/kWh depending on energy source. The units should be in consonance with the units used for $FCT_{flare,x}$
Description:	Emissions factor for fuel or energy used for transportation of tail gas to flare in year x
Source of data:	IPCC default data or fuel analysis (i.e., carbon content of fossil fuel) ACM0002 for grid electricity
Measurement procedures (if any):	Where self-generation occurs emissions should be based on actual fuel consumption and carbon content data. Were grid electricity is used the project, the combined margin approach outlined in ACM0002 should be used to estimate a tonnes CO_2/kWh factor.
Monitoring frequency:	Annually
QA/QC procedures:	See ACM0002
Any comment:	Most recent and representative IPCC data should be used. Data will be archived for two years following the end of the crediting period.

Data / parameter:	$w_{CH4,pipeline}$
Data unit:	kg CH_4/kg
Description:	The mass fraction of methane in the pipeline tail gas
Source of data:	Chemical analysis (e.g., gas chromatography)
Measurement procedures (if any):	Analysis can be performed in conjunction with measurement of the carbon content of the tail gas ($w_{carbon,y}$)
Monitoring frequency:	Weekly (minimum)
QA/QC procedures:	Methane content of gas should be crossed checked with previous months' data as well as with the owners of the oil and gas processing plant. Data will be archived for two years following the end of the crediting period.
Any comment:	None

Data / parameter:	$t_{equipment}$
Data unit:	Time (hours of use)
Description:	The operation time of the equipment in hours (in absence of further information, the monitoring period could be considered as a conservative approach)
Source of data:	Plant records or time of use meters
Measurement procedures (if any):	None
Monitoring frequency:	Annually
QA/QC procedures:	Time of use meters will be calibrated as often as required by manufacturing recommendations.
Any comment:	The pipeline taking the tail gas to the flare will be measured for the hours of its operation providing the required data to estimate the fugitive emissions from the pipe over the course of the baseline year. Data will be archived for two years following the end of the crediting period.

Data / parameter:	Equipment (index)
Data unit:	Number of equipment items for each equipment type
Description:	Type and number of valves, pump seals, connectors flanges, open-ended lines, as defined in Table 2.
Source of data:	Pipeline schematics, or audit of pertinent sections of pipeline
Measurement procedures (if any):	None
Monitoring frequency:	Once
QA/QC procedures:	Requires a count of potential sources of leaks as identified by the U.S. EPA guideance.
Any comment:	Prior to project validation, the pertinent sections of pipelines will be examined for any of the likely locations of leaks as outlined by U.S. EPA and used for similar purposes in AM0009. Data will be archived for two years following the end of the crediting period. This data is used to assess the emission factor for fugitive emissions of methane during transportation.

Data / parameter:	FCT_y
Data unit:	m^3/m^3, liters/m^3, kJ/m^3, kJ/kg, or kWh/m^3 depending on energy source
Description:	Energy or fuel consumed for transportation (e.g., for pipeline compressor) to end use facility per unit volume of tail gas in year y
Source of data:	Purchase or usage records for solid or liquid fuels, flow meter data for gaseous fuels, or electricity meter in combination with flow rate data for tail gas sent to end use facility.
Measurement procedures (if any):	Measurement requires collecting simultaneous data on energy/fuel use and tail gas flow rates to produce a fuel consumption rate per unit of tail gas flared.
Monitoring frequency:	Continuous
QA/QC procedures:	Meters must be properly calibrated and tested.
Any comment:	This energy or fuel is provided by sources other than the tail gas itself (i.e., it is not included in the data for V_y). Data will be archived for two years following the end of the crediting period.

Data / parameter:	$EFFCT_y$
Data unit:	t CO_2/m^3, t CO_2/liter, t CO_2/kJ, t CO_2/kg, or t CO_2/kWh depending on energy source
Description:	Emissions factor for fuel or energy used for transportation of tail gas to end use facility in year y
Source of data:	IPCC default data or fuel analysis (i.e., carbon content of fossil fuel) ACM0002 for grid electricity
Measurement procedures (if any):	Where self-generation occurs emissions should be based on actual fuel consumption and carbon content data. Were grid electricity is used the project, the combined margin approach outlined in ACM0002 should be used to estimate a tonnes CO_2/kWh factor.
Monitoring frequency:	Annually
QA/QC procedures:	See ACM0002
Any comment:	Most recent and representative IPCC data should be used. Data will be archived for two years following the end of the crediting period.

Data / parameter:	QF_y
Data unit:	Energy or fuel consumed by end use facility (e.g., for processing tail gas as a feedstock material) in year y
Description:	m^3, liters, kg, kJ, kWh depending on energy source
Source of data:	Purchase or usage records for solid or liquid fuels, flow meter data for gaseous fuels, or electricity meter
Measurement procedures (if any):	Measurement requires collecting simultaneous data on energy/fuel use and tail gas flow rates to produce a fuel consumption rate per unit of tail gas sent to end use facility.
Monitoring frequency:	Continuous
QA/QC procedures:	Meters must be properly calibrated and tested.
Any comment:	This energy or fuel is provided by sources other than the tail gas itself (i.e., it is not included in the data for V_y). Data will be archived for two years following the end of the crediting period.

Data / parameter:	$EF_{facility,y}$
Data unit:	t CO_2/m^3, t CO_2/liter, t CO_2/kJ, t CO_2/kg, or t CO_2/kWh depending on energy source
Description:	Emissions factor for fuel or energy used by end use facility in year y
Source of data:	IPCC default data or fuel analysis (i.e., carbon content of fossil fuel) ACM0002 for grid electricity
Measurement procedures (if any):	Where self-generation occurs emissions should be based on actual fuel consumption and carbon content data. Were grid electricity is used the project, the combined margin approach outlined in ACM0002 should be used to estimate a tonnes CO_2/kWh factor.
Monitoring frequency:	Annually
QA/QC procedures:	See ACM0002
Any comment:	Most recent and representative IPCC data should be used. Data will be archived for two years following the end of the crediting period.

Data / parameter:	*WCH4, pipeline, accident*
Data unit:	kg CH_4/m^3
Description:	The fraction of methane in the tail gas on a mass basis
Source of data:	Chemical analysis (e.g., gas chromatography)
Measurement procedures (if any):	Analysis can be performed in conjunction with measurement of the methane content of the tail gas ($w_{CH4,pipeline}$)
Monitoring frequency:	Weekly (minimum)
QA/QC procedures:	Methane content of gas should be crossed checked with previous months' data as well as with the owners of the oil and gas processing plant. Data will be archived for two years following the end of the crediting period.
Any comment:	None

Data / parameter:	t_1 and t_2
Data unit:	sec
Description:	t_1: The time the gas leakage caused by the accident occurred. t_2:The time that the shutdown valves closed both the upstream and downstream pipeline.
Source of data:	Plant records
Measurement procedures (if any):	None
Monitoring frequency:	Once per event
QA/QC procedures:	None
Any comment:	None

Data / parameter:	*F*
Data unit:	m^3/sec
Description:	The flow rate of tail gas supplied from the oil and natural gas processing plant
Source of data:	Flow meter data (can be obtained from oil or natural gas processing plant that supplies the tail gas)
Measurement procedures (if any):	Data should be measured using accurate and calibrated flow meters. Measurements should be taken at the point that tail gas enters the pipeline for transport to the flare (in the baseline scenario) or enters the pipeline for transport to the end use facility (in the case of the project scenario). Data can be collected in conjunction with V_y.
Monitoring frequency:	Continuous
QA/QC procedures:	Volume of gas should be completely metered with regular calibration of metering equipment, similar to what is called for in other approved methodologies.
Any comment:	Data must be archived for two years following the end of the crediting period.

Data / parameter:	*d* and *L*
Data unit:	meters
Description:	d: The radius of the pipeline. L: The length of the pipeline.
Source of data:	Pipeline schematics, or audit of pertinent sections of pipeline
Measurement procedures (if any):	Can be measured in conjunction with equipment counts.
Monitoring frequency:	Once
QA/QC procedures:	None
Any comment:	None

Data / parameter:	T_p
Data unit:	ºC
Description:	The temperature in the pipeline when the shutdown valves close both the upstream and downstream of the pipeline
Source of data:	Temperature meter
Measurement procedures (if any):	Reading of meter by operational staff and recording into log and database
Monitoring frequency:	When an accident causes gas leakage from a pipeline, the gas leakage volume is less than the sum of (1) the total amount of gas that flowed during the time the accident occurred until the gas flow is shut and (2) the total amount of gas remaining in the pipeline. Therefore, the temperature of the gas in the pipeline needs to be measured only when the shutdown valves close.
QA/QC procedures:	Consistency checks of measurement with operation data – same as AM0009
Any comment:	

Data / parameter:	P_p
Data unit:	Atm
Description:	Pp is the pressure in the pipeline when the shutdown valves close both the upstream and downstream of the pipeline in atmospheres (atm).
Source of data:	Pressure meter
Measurement procedures (if any):	Reading of meter by operational staff and recording into log and database
Monitoring frequency:	Once when the shutdown valves close
QA/QC procedures:	Consistency checks of measurement with operation data – same as AM0009
Any comment:	

Data / parameter:	T_s
Data unit:	º Kelvin
Description:	Standard temperature 273 degree Kelvin
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

Data / parameter:	P_s
Data unit:	atm
Description:	Standard pressure, 1 atmosphere
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

Data / parameter:	$V_{d, accident}$
Data unit:	m^3
Description:	The volume of tail gas supplied to the pipeline from the oil and natural gas processing plant before the accident occurs during the period day
Source of data:	Orifice meter
Measurement procedures (if any):	Reading of meter by operational staff and recording into log and database
Monitoring frequency:	Continuously
QA/QC procedures:	Consistency checks of measurements with commercial data – same as AM0009
Any comment:	

Data / parameter:	$V_{xi,d\ accident}$
Data unit:	m^3
Description:	The volume of gas supplied to the pipeline from other sources if any before the accident occurs during the period day
Source of data:	Orifice meter
Measurement procedures (if any):	Reading of meter by operational staff and recording into log and database
Monitoring frequency:	Continuously
QA/QC procedures:	Consistency checks of measurements with commercial data – same as AM0009
Any comment:	