Draft revision to approved baseline methodology AM0009

"Recovery and utilization of gas from oil wells that would otherwise be flared"

Source

This methodology is based on the Rang Dong Oil Field Associated Gas Recovery and Utilization Project, Vietnam, whose baseline study, monitoring and verification plan and project design document belong to Japan Vietnam Petroleum Co. Ltd. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0026: "Rang Dong Oil Field Associated Gas Recovery and Utilization Project" on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"

Applicability

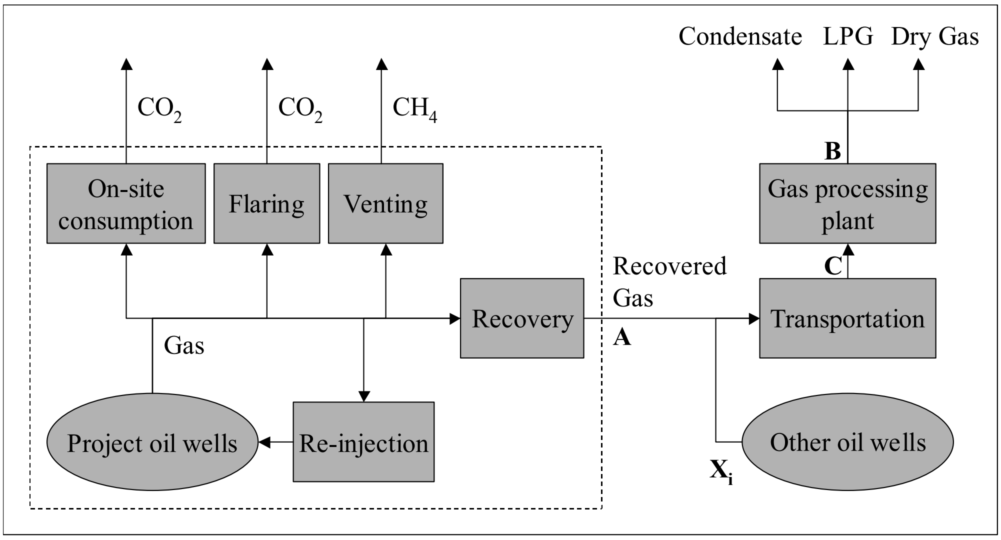
This methodology is applicable to projects recovering gas at oil wells under the following conditions:

- Gas at oil wells is recovered and transported in pipelines to a process plant where dry gas, LPG and condensate are produced;
- Energy required for transport and processing of the recovered gas is generated by using the recovered gas;
- The products (dry gas, LPG and condensate) are likely to substitute in the market only the same type of fuels or fuels with a higher carbon content per unit of energy;
- The substitution of fuels due to the project activity is unlikely to lead to an increase of fuel consumption in the respective market;
- In the absence of the project activity, the gas is mainly flared;
- Data (quantity and fraction of carbon) is accessible on the products of the gas processing plant and on the gas recovered from other oil exploration facilities in cases where these facilities supply recovered gas to the same gas processing plant.

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0009/version 2 ("Recovery and utilization of gas from oil wells that would otherwise be flared").

Project activity

Figure 1: Schematic illustration of the project activity



The project activity encompasses the recovery of gas at oil fields, the transportation of the recovered gas to a gas processing plant and the production of the products dry gas, LPG and condensate in a gas processing plant. These products are distributed to end-users, substituting fossil fuels at end-users and thereby reducing GHG emissions. The project activity is illustrated in Figure 1 above.

Project Area
The project area should be defined clearly by project participants. The project area may encompass several wells under a Production Sharing Contract (PSC) with a production target.

Projection and adjustment of project and baseline emissions
Project as well as baseline emissions depend on the quantity of gas recovered. The quantity of recovered gas is linked to the oil production. Oil production may be projected with the help of a reservoir simulator, reflecting the rock and fluid properties in the oil reservoir. As projections of the oil production, the methane content of the gas and other parameters involve a considerable degree of uncertainty, the quantity and composition of the recovered gas are monitored ex post and baseline and project emissions are adjusted respectively during monitoring.

Sources of project emissions
The following sources of project emissions are accounted in this methodology:

- CO_2 emissions due to fuel combustion for recovery, transport and processing of the gas;
- CO_2 emission due to consumption of other fuels in place of the recovered gas, and
- CH_4 and CO_2 emissions from leaks, venting and flaring during the recovery, transport and processing of recovered gas.

If these emission sources are under the control of the project participants, they should be included and considered as project emissions within the project boundary. This is for example the case, if the transportation system and the gas processing plant are operated by the project participants. If these emission sources are not under control of the project participants, they should be considered and calculated as leakage effects. This is the case if project participants do not operate the transportation system and/or the gas processing plant. However, in both cases the methodological approach described below can be followed to calculate emissions.

CO_2 emissions

CO_2 emissions from fuel combustion, leaks, flaring and venting[1] during transport and processing of recovered gas are not calculated from single emission sources, but a carbon mass balance is conducted between points A, B and X_i in Figure 1. In doing so, it is assumed that all carbon in the recovery gas released, flared, vented or combusted will be oxidized completely to CO_2. This approach is appropriate, as the methodology is only applicable to projects where the energy required to transport and process the recovered gas is generated with the gas and not with other fuel sources.

The quantity of CO_2 emissions corresponds to the difference of carbon in the products of the gas processing plant (point B) and the carbon supplied by the project activity (point A) and other oil wells (points X_i). CO_2 emissions are attributed to the project activity according to the relative share of gas recovery of the project activity:

$$PE_{CO2,gas,y} = \frac{m_{carbon,A,y}}{m_{carbon,A,y} + m_{carbon,X,y}} \cdot \left(m_{carbon,A,y} + m_{carbon,X,y} - m_{carbon,B,y}\right) \cdot \frac{44}{12} \cdot \frac{1}{1000} \quad (1)$$

with

$$m_{carbon,A,y} = V_{A,y} \cdot w_{Carbon,A,y} \quad (2)$$

$$m_{carbon,B,y} = V_{B,dry\ gas,y} \cdot w_{carbon,dry\ gas,B,y} + m_{LPG,B,y} \cdot w_{carbon,LPG,B,y} + m_{condensate,B,y} \cdot w_{carbon,condensate,B,y} \quad (3)$$

$$m_{carbon,X,y} = \sum_i V_{Xi,y} \cdot w_{Carbon,Xi,y} \quad (4)$$

where:

$PE_{CO2,gas,y}$	Are the CO_2 emissions from the project activity due to combustion, flaring or venting of recovered gas during the period y in tons of CO_2.
$m_{carbon,A,y}$	Is the quantity of carbon in the recovered gas from the project area at point A in Figure 1 during the period y in kg.
$m_{carbon,B,y}$	Is the quantity of carbon in the products (dry gas, LPG, condensate) leaving the gas processing plant at point B in Figure 1 during the period y in kg.
$m_{carbon,X,y}$	Is the quantity of carbon in recovered gas from other oil wells at all points X_i in Figure 1 during the period y in kg.
$V_{B,dry\ gas,y}$	Is the quantity of dry gas that is produced in the gas processing plant (point B Figure 1) during the period y in m^3.
$m_{LPG,B,y}$	Is the quantity of LPG that is produced in the gas processing plant (point B Figure 1) during the period y in kg.
$m_{condensate,B,y}$	Is the quantity of condensate that is produced in the gas processing plant (point B Figure 1) during the period y in kg.
$V_{A,y}$	Is the volume of gas recovered at point A in Figure 1 during the period y in m^3.
$V_{Xi,y}$	Is the volume of gas recovered from oil well i at point X in Figure 1 during the period y in m^3.
$w_{carbon,A,y}$	Is the average content of carbon in the gas recovered at point A in Figure 1 during the period y in kg-C/m^3.
$w_{carbon,dry\ gas,B,y}$	Is the average content of carbon in dry gas at point B in Figure 1 during the period y in kg-C/m^3.
$w_{carbon,LPG,B,y}$	Is the average content of carbon in LPG at point B in Figure 1 during the period y in

[1] Venting is associated with CO_2 emissions, as it is assumed that all hydrocarbons, including methane, oxidize to CO_2 in the atmosphere over time.

kg-C/kg.

$w_{carbon,condensate,B,y}$ Is the average content of carbon in condensate at point B in Figure 1 during the period y in kg-C/kg.

$w_{carbon,Xi,y}$ Is the average content of carbon in the gas recovered from oil well i at point X in Figure 1 during the period y in kg-C/m³.

The carbon content of the products ($w_{Carbon,dry\ gas,B,y}$, $w_{Carbon,LPG,B,y}$, $w_{Carbon,condensate,B,y}$) may be taken from project specifications, if products are homogeneous in their composition, or should be monitored if the carbon content of the products varies.

If other fossil fuels than the recovered gas are consumed at the oil well and if this consumption is a result of the project activity (e.g. substitution of gas for on-site generation or use in the compressor station), CO_2 emissions from combustion of these fuels should also be accounted:

$$PE_{CO2,other\ fuels,y} = \frac{1}{1000} \cdot \sum_{Fuels} m_{fuel,y} \cdot NCV_{fuel} \cdot EF_{CO2,fuel} \qquad (5)$$

where:

$PE_{CO2,other\ fuels,y}$ Are the CO_2 emissions due to consumption of other fuels than the recovered gas due to the project activity during the period y in tons of CO_2.

$m_{fuel,y}$ Is the quantity of a specific fuel type that is consumed due to the project activity during the period y in kg.

NCV_{fuel} Is the net calorific value of the respective fuel type in kJ/kg.

$EF_{CO2,fuel}$ Is the CO_2 emission factor of the respective fuel type in kg CO_2/kJ.

CH_4 emissions from recovery and processing the gas

Fugitive CH_4 emissions occurring during the recovery and processing of gas may in some projects be small, but should be estimated as a conservative approach. Emission factors may be taken from the IPCC Good Practice Guidance and/or from the 1995 Protocol for Equipment Leak Emission Estimates, published by EPA[2]. Emissions should be determined for all relevant activities and all equipment (such as valves, pump seals, connectors, flanges, open-ended lines, etc.).

Where the Average Emission Factor Approach by EPA is used to estimate emissions from the production of recovered gas and from the gas processing plant, emissions should be estimated separately for streams with different compositions. The following data needs to be obtained to follow this approach:

1. The number of each type of component in a unit (valve, connector, etc.).
2. The service each component is in (gas, light liquid or heavy liquid).
3. The total organic compound and methane concentration of the stream, and
4. The time period each component is in that service.

The EPA approach is based on average emission factors for total organic compounds (TOC) and has been revised to estimate CH_4 emissions. Methane emissions are calculated for each single equipment by multiplying the CH_4 concentration in the respective stream with the appropriate emission factor from Table 1.

$$PE_{CH4,plants,y} = GWP_{CH4} \cdot \frac{1}{1000} \cdot \sum_{equipment} w_{CH4,stream} \cdot EF_{equipment} \cdot T_{equipment} \qquad (6)$$

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

where:

$PE_{CH4,plants,y}$ Are the CH_4 emissions from the project activity at the gas recovery facility and the gas processing plant during the period y in tons of CO_2 equivalents.
GWP_{CH4} Is the approved Global Warming Potential for methane.
$T_{equipment}$ Is the operation time of the equipment in hours (in absence of further information, the monitoring period could be considered as a conservative approach).
$w_{CH4,A,y}$ Is the average methane weight fraction in the respective stream in kg-CH_4/kg.
$EF_{equipment}$ Is the appropriate emission factor from Table 1 in kg/hour/equipment.

For the purpose of this calculation it is recommended to group the equipment according to the different stream types.

Table 1: Oil and gas production operations average emission factors

Equipment Type	Service	Emission Factor (kg/hour/source) for TOC
Valves	Gas Heavy oil Light oil	4.5E-03 8.4E-06 2.5E-03
Pump seals	Gas Heavy oil Light oil	2.4E-03 NA 1.3E-02
Others[3]	Gas Heavy oil Light oil	8.8E-03 3.2E-05 7.5E-03
Connectors	Gas Heavy oil Light oil	2.0E-04 7.5E-06 2.1E-04
Flangs	Gas Heavy oil Light oil	3.9E-04 3.9E-07 1.1E-04
Open-ended lines	Gas Heavy oil Light oil	2.0E-03 1.4E-04 1.4E-03

Source: US EPA-453/R-95-017 Table 2.4, page 2-15

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

CH_4 emissions from transport of the gas in pipelines under the normal operation condition
Fugitive CH_4 emissions occurring during the transport of the gas in pipelines may, in some projects, be small, but should be estimated as the same approach as "CH4 emissions from recovery and processing the gas", explained above.

$$PE_{CH4,pipeline,y} = GWP_{CH4} \cdot \frac{1}{1000} \sum_{equipment} w_{CH4,pipeline} \cdot EF_{pipeline} \cdot T_{equipment} \quad (7)$$

where:

$PE_{CH4,pipeline,y}$ Are the CH_4 emissions from the project activity during the transport of the gas in

[3] "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.

	pipelines under the normal operation during the period y in tons of CO_2 equivalents.
GWP_{CH4}	Is the approved Global Warming Potential for methane.
$w_{CH4,pipeline}$	Is the average methane weight fraction in the pipeline in kg-CH4/kg.
$EF_{pipeline}$	Is the appropriate emission factor from Table 1 in kg/hour/pipeline
$T_{equipmen}$	Is the operation time of the equipment in hours (in absence of further information, the monitoring period could be considered as a conservative approach)

CH_4 emissions from transport of the gas in pipelines when accidental event occurred

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. In the interest of conservativeness, the volume set out above should be estimated as the gas leakage from a pipeline caused by an accident.

CH4 emissions from the transport of the gas in pipelines when accidental event occurred can be calculated as:

$$PE_{CH4,pipeline,accident} = GWP_{CH4} \cdot \frac{1}{1000}(V_{A,accident} + V_{remain,accident}) \cdot W_{CH4,pipeline,accident} \quad (8)$$

with:

$$V_{A,accident} = t_{accicdent} \cdot F = (t_2 - t_1) \cdot F \quad (9)$$

$$V_{remain,accident} = d^2 \cdot \pi \cdot L \cdot \frac{P_p}{P_s} \cdot \frac{T_s}{T_p} \cdot \frac{V_{A,d,accident}}{\sum_i V_{Xi,d,accident}} \quad (10)$$

where:

$PE_{CH4,\ pipeline,\ accident}$	Are the CH4 emissions from the project activity due to transport of the recovered gas in the pipeline when the accidental event happens in tons of CO2 equivalent.
GWP_{CH4} $VA,_{t,\ accident}$	Is the approved Global Warming Potential for methane. Is the volume of gas supplied from the oil well at point A in Figure 1 from the time the gas leakage started until the shutdown valves closed the pipeline in m^3.
$V_{remain,accident}$	Is the volume of gas remaining in the pipeline after the shutdown valves close the pipeline in m^3.
$W_{CH4,\ pipeline,\ accident}$	Is the average methane weight fraction in the gas recovered at point A in Figure 1 in kg-CH4/m^3
$t_{accident}$	Is the time difference between t1 and t2 determined as “retention time” in seconds.
t_1	Is the time the gas leakage caused by the accident occurred. “t1” is determined based on the continuous monitoring data such as pressure etc.
t_2	Is the time that the shutdown valves closed both the upstream and downstream pipeline. “t2” is determined based on the operation data.
F	Is the flow rate of gas supplied from the oil well at point A in Figure 1 in m^3/second.
d	Is the radius of the pipeline in meters. The data is derived from P & I (Piping and Instrument).
π	Is the ratio of the circumference of a circle to its diameter.
L	Is the length of the pipeline in meters. The data is derived from P & I (Piping

	and Instrument).
P_p	Is the pressure in the pipeline when the shutdown valves close both the upstream and downstream of the pipeline in atmospheres (atm).
P_s	Is the standard pressure in atm.
T_p	Is the temperature in the pipeline when the shutdown valves close both the upstream and downstream of the pipeline in degrees Centigrade.
T_s	Is the standard temperature in Centigrade.
$V_{A,\ d,\ accident}$	Is the volume of gas supplied to the pipeline from oil well at point A in Figure 1 before the accident occurs during the period day in m^3.
$V_{xi,\ d,\ accident}$	Is the volume of gas supplied to the pipeline from oil well i at point X in Figure 1 before the accident occurs during the period day in m^3.

In summary, CH4 emissions from pipeline caused by accidental events will be estimated based on the above formulae and data.

Baseline

In calculating baseline emissions, it is assumed that the recovered gas would mainly be flared in the absence of the project. A minor part may be combusted for on-site energy generation.[4] It is assumed that all carbon in the gas is completely oxidized to carbon dioxide.

In practice, flaring is often conducted under sub-optimal combustion conditions and part of the gas is not combusted, but released as methane and other volatile gases. However, measurement of the quantity of methane released from flaring is difficult. Hence, for the purpose of determining baseline emissions, it is assumed that all carbon in the gas is converted into carbon dioxide. This is a conservative assumptions, as accounting of methane emissions from flaring would increase baseline emissions.

Baseline emissions are calculated as follows:

$$BL_y = V_{A,y} \cdot W_{carbon,A,y} \cdot \frac{44}{12} \cdot \frac{1}{1000} \qquad (11)$$

where:

BL_y Are the baseline emissions during the period y in tons of CO_2 equivalents.
$V_{A,y}$ Is the volume of gas recovered from the oil field at point A in Figure 1 during the period y in m^3.
$w_{carbon,A,y}$ Is the average content of carbon in the gas recovered at point A in Figure 1 during the period y in kg-C/m^3.

The average methane content in the gas $w_{CH4,A,y}$ is determined from regular measurements of the composition of the gas, taking into account the molecular weight of all fractions of the gas.

Leakage

Leakage emissions comprise:

- CO_2 emissions due to fuel combustion for transport and processing of the gas, where the transport and processing of the gas is not under control of project participants;

[4] If the gas would be used for on-site energy generation in the absence of the project, other fossil fuels (e.g. diesel) may be used in place of the gas for on-site generation after implementation of the project activity. If this is the case, GHG emissions from combustion of such fuels are accounted as part of the project emissions in equation 5 above.

- CH_4 and CO_2 emissions from leaks, venting and flaring during transport and processing of recovered gas, where the transport and processing is not under control of project participants, and
- Changes in CO_2 emissions due to the substitution of fuels or additional fuel consumption at end-users, where these effects occur.

To determine CO_2 and CH_4 emissions during transport and processing of the gas the methodological approach described above under "Project Activity" can be followed.

Changes in CO_2 emissions due to the substitution of fuels at end-users
Project participants should assess

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

For this purpose the market of the products should be analyzed. If such leakage effects may result from the project activity, emission reductions should be adjusted for these leakage effects respectively in a conservative manner. Where the fuels of the project activity substitute fuels with a higher carbon intensity, emission reductions should as a conservative assumption not be adjusted.

Emission Reductions

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

$$EF_y = BL_y - PE_{CO2,\, other\ fuels,\, y} - PE_{CH4,\, plants,\, y} - PE_{CH4,\, pipeline,\, y} - PE_{CH4,\, pipeline,\, accident} - L_y \text{ ....(12)}$$

where:

EF_y	Are the emissions reductions of the project activity, adjusted for leakage, during the period y in tons of CO_2 equivalent.
BL_y	Are the baseline emissions during the period y in tons of CO_2 equivalent.
$PE_{CO2,gas,y}$	Are the CO_2 emissions from the project activity due to combustion, flaring or venting of recovered gas during the period y in tons of CO_2.
$PE_{CO2,other\ fuels,y}$	Are the CO_2 emissions due to consumption of other fuels than the recovered gas due to the project activity during the period y in tons of CO_2.
$PE_{CH4,plants,y}$	Are the CH_4 emissions from the project activity at the gas recovery facility and the gas processing plant during the period y in tons of CO_2 equivalent.
$PE_{CH4,pipeline,y}$	Are the CH_4 emissions from the project activity due to transport of the recoverd gas in the pipeline during the period y in tons of CO_2 equivalent.
$PE_{CH4,\ pipeline,\ accident}$	Are the CH4 emissions from the project activity due to transport of the recovered gas in the pipeline when the accidental event occurs in tons of CO2 equivalent.
L_y	Are any leakage emissions during the period y in tons of CO_2 equivalent.

Additionality

Additionality is addressed, by determining the most likely course of action, taking into account economic attractiveness and barriers. Gas at oil fields could be treated in the following ways:

Option 1: Release to the atmosphere at the oil production site (venting).
Option 2: Flaring at the oil production site.
Option 3: On-site consumption.
Option 4: Injection into the oil reservoir.
Option 5: Recovery, transportation, processing and distribution to end-users.

Project participants should assess and compare the economic attractiveness and legal aspects of these options.

Step 1: Evaluating legal aspects
In evaluating legal aspects, the following issues should be addressed:

- Are the options permitted by law or other (industrial) agreements and standards?
- Are there laws or other regulations (e.g. environmental regulations) which implicitly restrict certain options?

Step 2: Evaluating the economic attractiveness
The economic attractiveness is assessed for those options that are feasible in technical terms and that are identified as legally permitted by law or other (industrial) agreements and standards in Step 1. The economic attractiveness of these options is assessed by determining the expected Internal Rate of Return (IRR) of each option. The IRR should be determined using inter alia the following parameters:

- Overall projected gas production;
- The projected quantity of gas recovered, excluding gas flared, vented or consumed on-site (point A in Figure 1);
- The agreed price for the delivery of recovered gas (e.g. from a Production Sharing Contract);
- The net calorific value of the gas;
- Capital expenditure for gas recovery facilities, pipelines, etc. (CAPEX);
- Operational costs (OPEX);
- Any cost recovery or profit sharing agreements.

The option that is economically the most attractive course of action is considered as the baseline scenario. To apply the methodology project participants should demonstrate that flaring (Option 2) is the baseline scenario. The project activity can be considered additional, if the IRR of the project activity is lower than the hurdle rate of the project participants (typically about 10%). The DOE should verify what value for the IRR is typical for this type of investment in the respective country. The calculations should be described and documented transparently.

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- Gas at oil wells is recovered and transported in pipelines to a process plant where dry gas, LPG and condensate are produced;
- Energy required for transport and processing of the recovered gas is generated by using the recovered gas;
- The products (dry gas, LPG and condensate) are likely to substitute in the market only the same type of fuels or fuels with a higher carbon content per unit of energy;
- The substitution of fuels due to the project activity is unlikely to lead to an increase of fuel consumption in the respective market;
- In the absence of the project activity, the gas is mainly flared;
- Data (quantity and fraction of carbon) is accessible on the products of the gas processing plant and on the gas recovered from other oil exploration facilities in cases where these facilities supply recovered gas to the same gas processing plant.

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM0009/version 2 ("Recovery and utilization of gas from oil wells that would otherwise be flared").

Monitoring Methodology

The monitoring methodology involves monitoring of the following:
- The composition and quantity of recovered gas at point A and all points X_i as well as the composition and quantity of products (dry gas, LPG, condensate) from the gas processing plant at point B;
- The quantity of gas provided to the gas processing plant at point C;
- The quantity of any additional consumption of other fossil fuels than the recovered gas;
- If the EPA approach is used to estimate fugitive CH4 emissions in the gas recovery facility and the gas processing plant[5]: The approximate methane content of streams and the approximate operation

[5] If IPCC GPG 2000 default values are used, only the quantity of recovered gas has to be multiplied with the appropriate emission factors of Table 2.16.

time of equipment subject to leakage of CH_4 emissions in the gas recovery facility and the gas processing plant.

Parameters to be monitored

ID number	Data type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
1. $V_{A,y}$ F $V_{A.\,t.\,accident}$ $V_{A,\,d,\,accident}$	Volume	Quantity of recovered gas at point A in Figure 1	m³	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. orifice meters
2. $w_{Carbon,A,y}$ $w_{CH4,A,y}$ $W_{CH4,\,pipeline,\,y}$ $W_{CH4,\,pipeline,\,accident}$	Composition	Composition of recovered gas at point A in Figure 1	% and kg/m³	m	monthly	100%	electronic	Until two years after the end of the crediting period	Measurement with gas chromatography
3. $V_{xi,y3}$ $V_{xi,d,\,accident}$	Volume	Quantity of recovered gas at point Xi from all other oil wells i serving the gas processing plant (and serving the pipeline where accident occurred)	m³	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. orifice meters
4. $w_{Carbon,Xi,y}$	Composition	Composition of recovered gas at all points X_i in Figure 1	% and kg/m³	m	monthly	100%	electronic	Until two years after the end of the crediting period	Measurement with gas chromatography
5. $V_{B,dry\ gas,y}$	Volume	Volume of dry gas produced in the gas processing plant (point B in Figure 1)	m³	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. orifice meters

ID number	Data type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
6. $w_{carbon,dry\ gas,B,y}$	Composition	Composition of dry gas at point B in Figure 1	% and kg/m³	m	monthly	100%	electronic	Until two years after the end of the crediting period	Measurement with gas chromatography
7. $m_{LPG,B,y}$	Mass	Quantity of LPG produced in the gas processing plant (point B in Figure 1)	t	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. coriolis meters
8. $w_{carbon,LPG,B,y}$	Composition	Composition of LPG at point B in Figure 1	% (kg/kg)	m	monthly	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. gas chromatography
9. $m_{condensate,B,y}$	Mass	Quantity of Condensate produced in the gas processing plant (point B in Figure 1)	t	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. coriolis meters
10. $w_{carbon,condensate,B,y}$	Composition	Composition of Condensate at point B in Figure 1	% (kg/kg)	m	monthly	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. gas chromatography
11. $m_{fuel,y}$	Mass	Quantity of other fossil fuel(s) used due to the project activity	t	m or c	annually	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. coriolis meters
12. $w_{CH4,steam}$	Mass content	Methane content of streams in the gas recovery facility and the gas processing plant	Kg CH_4/ kg	m, c or e	annually	100%	electronic	Until two years after the end of the crediting period	Only required if EPA approach is used

ID number	Data type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
13. $T_{equipment}$	Time	Operation time of each equipment in the gas recovery facility and the gas processing plant	hours	m, c or e	annually	100%	electronic	Until two years after the end of the crediting period	Only required if EPA approach is used
14. $T_{equipment, pipeline}$	Time	Operation time of each equipment of the pipeline	hours	m, c or e	annually	100%	electronic	Until two years after the end of the crediting period	Only required if EPA approach is used

Parameters to be monitored specifically when accidental event occurred

ID number	Data type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
15. *t1, t2*	Time	Time the gas leakage caused by the accident occurred, Time that the shutdown valves closed both the upstream and downstream pipeline	Day/hour/minutes/second	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. operation controller
16. *Pp*	Pressure	Pressure in the pipeline	atm	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. pressure meters

ID number	Data type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
17. *Tp*	Temperature	Temperature in the pipeline	Centigrade	m	continuously	100%	electronic	Until two years after the end of the crediting period	Measurement with e.g. temperature meters

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

Data	Uncertainty Level of Data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation how QA/QC procedures are planned
1.	Low	Yes	Consistency checks of measurements with commercial data
2.	Medium	Yes	Cross-check with data from previous month and with measurements from other wells of the same oil field if possible
3.	Low	Yes	Consistency checks of measurements with commercial data
4.	Medium	Yes	Cross-check with data from previous month and with measurements from other wells of the same oil field if possible
5.	Low	Yes	Consistency checks of measurements with commercial data
6.	Medium	Yes	Consistency checks of measurements with commercial data
7.	Low	Yes	Consistency checks of measurements with commercial data
8.	Low	Yes	Consistency checks of measurements with commercial data
9.	Low	Yes	Consistency checks of measurements with commercial data
10.	Low	Yes	Consistency checks of measurements with commercial data
11.	Low	Yes	Consistency checks of measurements with commercial data
12.	Medium	Yes	Consistency is of overall calculations is checked by comparing overall results for methane leakage with IPCC GPG default values for gas production and gas processing
13.	Medium	Yes	Consistency of overall calculations is checked by comparing overall results for

Data	Uncertainty Level of Data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation how QA/QC procedures are planned
			methane leakage with IPCC GPG default values for gas production and gas processing
14.	Medium	Yes	Consistency of overall calculation is checked by comparing overall results for methane leakage with other international default values for pipeline e.g. IPCC GPG
15.	Low	Yes	Consistency checks of measurement with operation data
16.	Low	Yes	Consistency checks of measurement with operation data
17.	Low	Yes	Consistency checks of measurement with operation data