MONITORING REPORT FORM (F-CDM-MR)
Version 02.0

MONITORING REPORT

Title of the project activity	The Capture and Utilisation of Methane at the GFI Mining South Africa owned Beatrix Mine in South Africa
Reference number of the project activity	4728
Version number of the monitoring report	01
Completion date of the monitoring report	25/05/2012
Registration date of the project activity	10/06/2011
Monitoring period number and duration of this monitoring period	Monitoring period: 1 01/07/2011 – 31/03/2012
Project participant(s)	GFI Mining South Africa (Pty) Ltd Promethium Carbon (Pty) Ltd Mercuria Energy Trading SA
Host Party(ies)	Republic of South Africa
Sectoral scope(s) and applied methodology(ies)	Sectoral Scope:10 ACM0064 / Version 02
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	189,997 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	41,305 tCO_2e

SECTION A. Description of project activity
A.1. Purpose and general description of project activity
>>
(a) Purpose of the project activity and the measures taken to reduce greenhouse gas emissions

The purpose of the project is to reduce greenhouse gas (GHG) emissions through the capture and destruction of methane.

The Beatrix Mine (referred to as Beatrix from here on) is a gold mine that is owned by GFI Mining South Africa; of which Gold Fields is the holding company. Beatrix is located in the Free State Province of South Africa.

The project activity involves the destruction of methane at Beatrix. The project can be divided into two distinct activities:

<u>The capture and destruction of mine methane</u>
Mine methane originates in the main Beatrix mine from intersecting geological faults during mining. The mining activity releases underground methane which is highly explosive and a safety hazard. The origin of this methane is unknown. Prior to the implementation of the project activity, the underground mine methane was diluted with ventilation air to below its explosion limits and released into the atmosphere through ventilation shafts. The project activity involves the flaring of the mine methane to reduce the amount of GHGs emitted to the atmosphere.

<u>The capture and destruction of non-mine methane</u>
Non-mine methane is emitted from boreholes drilled for exploration purposes by the Beatrix mine. Methane is released from numerous exploration boreholes. Since the start of the drilling program in the 1950s, a number of boreholes have intersected methane-carrying geological structures. During the development of this project, 488 holes were identified in the GFI Mining South Africa mining area. However, only five of these boreholes, geographically far apart from each other, are venting methane at rates that justified the implementation of a greenhouse gas reduction project. The project activity involves the flaring of the non-mine methane at these five boreholes to reduce the amount of GHGs emitted to the atmosphere.

(b) Brief description of the installed technology and equipments

Six enclosed flares are installed in the project activity:
- One flare is located at the Beatrix Number 1 shaft (for the flaring of mine methane)
- Five flares are located at the following boreholes (for the flaring of non-mine methane): DBE1; 2264; 1400; EX1; and ST23.

The mine methane flare is fitted with equipment necessary to measure the actual flare combustion efficiency, whilst the boreholes flares have the appropriate monitoring equipment required in order to claim the default flare efficiency of 90% (in accordance with version 01 of the ‘Tool to determine project emissions from flaring gases containing methane’).

The registered PDD provides for the installation of internal combustion engines for the generation of power from the mine methane. This, however, has not been implemented yet.

(c) Relevant dates for the project activity (e.g. construction, commissioning, continued operation periods, etc.)

The start of operation of the flares is shown in the table below.

Flare		Start of operation
Mine methane	Number 1 Shaft	21/05/2011
Non-mine methane	DBE1	08/03/2011
	2264	04/03/2011
	1400	06/03/2011
	EX1	23/03/2011
	ST23	02/03/2011

(d) Total emission reductions achieved in this monitoring period.

The total emission reductions achieved during this monitoring period (01/07/2011 – 31/03/2012) are 41,305 tCO_2e.

A.2. Location of project activity
>>
(a) Host Party

Republic of South Africa

(b) Region/ State/ Province

Free State Province

(c) City/ Town/ Community

District of Theunissen

(d) Physical/ Geographical Location

The project activity is located on Leeuwbult 52, which is a farm in the district of Theunissen near Virginia. Virginia is in the Free State Province of South Africa.

Mine methane:
The plant that destroys the underground mine methane is located at the Beatrix mine close to the Number 1 shaft. The GPS coordinates are: S 28° 15' 44" E 26° 47' 06"

Non-mine methane:
The project flares non-mine methane from five boreholes. The boreholes are located at the following GPS coordinates:

DBE1	S 28º 11' 066" E 26º 45' 488"
EX1	S 28º 16' 334" E 26º 44' 612"
ST23	S 28º 11' 995" E 26º 44' 312"
1400	S 28º 13' 323" E 26º 44' 607"
2264	S 28º 13' 908" E 26º 47' 078"

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of South Africa (host)	GFI Mining South Africa (Pty) Ltd (Private Entity)	No
	Promethium Carbon (Pty) Ltd (Private Entity)	
Switzerland	Mercuria Energy Trading SA (Private Entity)	No

A.4. Reference of applied methodology
>>
(a) The applied methodology

AM0064 "Methodology for methane capture and utilization or destruction in underground, hard rock, precious and base metal mines" (Version 02)

(b) Any tools and other methodologies to which the applied methodology refers

"Tool to determine project emissions from flaring gases containing methane" (Version 01)
"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01)

A.5. Crediting period of project activity
>>
Renewable crediting period
Seven years
01/07/2011 – 30/06/2018

SECTION B. Implementation of project activity
B.1. Description of implemented registered project activity
>>
The start of operation of the flares, together with the start of monitoring CDM parameters, is shown in the table below.

Flare		Start of operation
Mine methane	Number 1 Shaft	21/05/2011
Non-mine methane	DBE1	08/03/2011
	2264	04/03/2011
	1400	06/03/2011
	EX1	23/03/2011
	ST23	02/03/2011

The registered PDD also provides for the installation of internal combustion engines for the generation of power from the mine methane. This is Phase 2 of the project (Phase 1 being the installation of the flares). Phase 2, however, has not been implemented yet.

For this monitoring period, there were no downtimes of equipment or major overhauls. There were, however, times when the combustion temperatures of the borehole flares were below 500°C. During these times, the flare efficiency was assumed to be 0% (as per version 01 of the ‘Tool to determine project emissions from the flaring of gases containing methane’). Furthermore, not all of the flares monitoring systems were fully operational at the start of the monitoring period. No Certified Emission Reductions (CERs) are claimed for these periods, as shown in the table below.

Borehole flare	Period when no CERs were generated
Main Flare	6 days (data not recorded).
DBE1	121 (combustion temperature below 500°C).
2264	275 days (combustion temperature below 500°C).
1400	19 days (combustion temperature below 500°C).
EX1	0 days. The combustion temperature remained above 500°C for more than 40 minutes in every hour during the monitoring period.
ST23	60 days (data not recorded).

No events or situations occurred during this monitoring period that would impact on the applicability of the methodology. All conditions of AM0064 version 02 were met.

B.2. Post registration changes
B.2.1. Temporary deviations from registered monitoring plan or applied methodology
>>
Not applicable.

B.2.2. Corrections
>>
Not applicable.

B.2.3. Permanent changes from registered monitoring plan or applied methodology
>>
Not applicable.

B.2.4. Changes to project design of registered project activity
>>
Not applicable.

B.2.5. Changes to start date of crediting period
>>
Not applicable.

B.2.6. Types of changes specific to afforestation or reforestation project activity
>>
Not applicable.

SECTION C. Description of monitoring system

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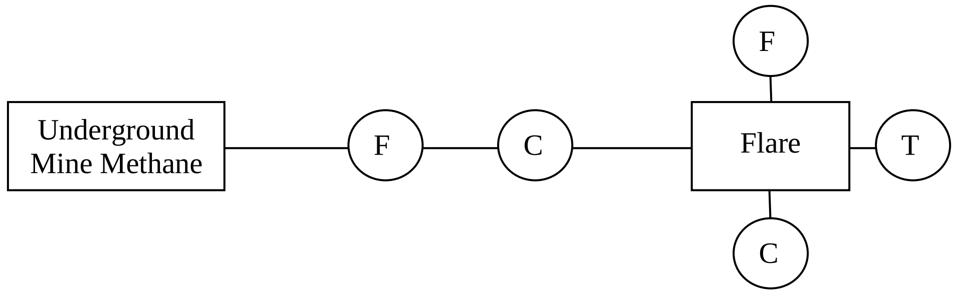
Beatrix's monitoring system ensures that the project activity's emission reductions are accurately monitored, recorded and reported.

1. Line diagrams showing relevant monitoring points

The monitoring system is divided into two sections – mine methane and non-min methane monitoring.

Mine methane monitoring

An enclosed flare is installed at the Beatrix Number 1 shaft. The mine methane monitoring equipment of this flare (and the placing of the equipment) is shown in the diagram below.



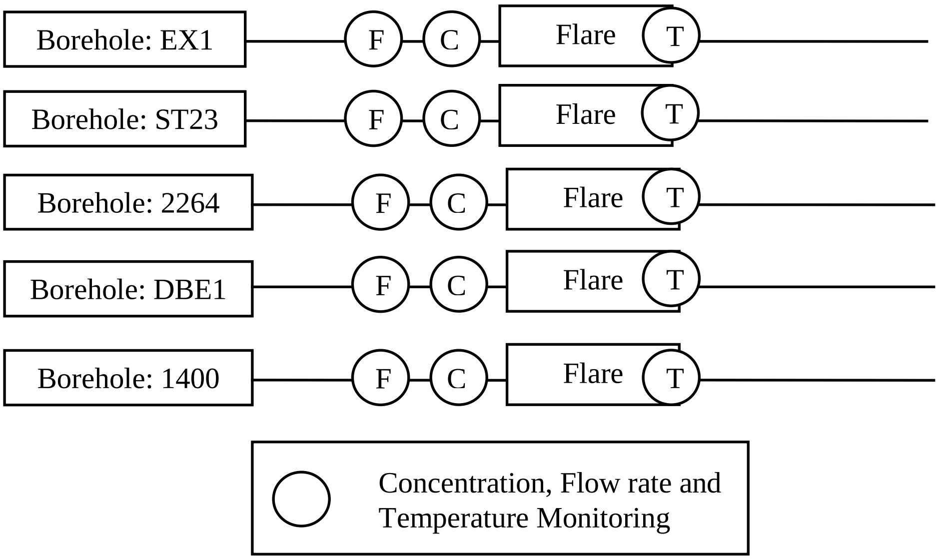
A description of the symbols is provided in the table below.

Symbol	Description	Instrument Code	Function
F	Gas flow meter	FIR 71.51	Measures gas flow rate
C	Concentration meter	CIR 71.52	Measures methane and oxygen concentration of gas
T	Thermocouple	TIR 71.53	Measures temperature of flare to ensure correct operation

Non-mine methane monitoring

Enclosed flares are installed at five boreholes. These flares are fitted with thermocouples to monitor the combustion temperature. A default flare efficiency of 90% is used when the flares are operating at temperatures above 500°C for more than 40 minutes in every hour. This is in accordance with version 01 of the 'Tool to determine project emissions from the flaring of gases containing methane'.

The non-mine methane monitoring equipment of the borehole flares (and the placing of the equipment) is shown in the diagram below.



A description of the symbols is provided in the table below.

Symbol	Description	Function
F	Gas flow meter	Measures gas flow rate
C	Concentration meter	Measures methane concentration of gas
T	Thermocouple	Measures temperature of flare to ensure correct operation

2. Data collection procedure

Each flare is fitted with a data logger where the monitored data (from the start of flare operation) is stored. A 4MB USB stick is installed in the data logger. This USB stick can be inserted into a computer when the monitored data needs to be extracted. The data is viewed in the software programme 'ReadWin 2000'.

The monitored data from each flare is extracted at the end of each cost month, and burnt to a disk which is stored at the Beatrix mine offices. This data is also sent to the CDM consultant (Promethium Carbon (Pty) Ltd) who is responsible for calculating the emission reductions and writing the monitoring report.

3. Roles and responsibilities of personnel

The Beatrix operations manager is responsible for ensuring that the data is monitored and recorded and that all of the instruments are in working order. The operations manager will also extract the monitored data from the data logger at each flare at the end of each cost month.

Promethium Carbon (Pty) Ltd is responsible for calculating the emission reductions and writing the monitoring report.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/Parameter	GWP_{CH_4}
Unit	tCO_2e/tCH_4
Description	Global warming potential for methane.
Source of data	AM0064 Version 02.
Value(s) applied	21
Purpose of data	Baseline and project emission calculations.
Additional comment	-

Data/Parameter	$EF_{EL,grid}$
Unit	tCO_2/MWh
Description	Emission factor of the grid.
Source of data	Eskom and NERSA data.
Value(s) applied	1.01
Purpose of data	Project emission calculations.
Additional comment	-

Data/Parameter	CEF_{CH_4}
Unit	tCO_2e/tCH_4
Description	Carbon emission factor for combusted methane.
Source of data	AM0064 Version 02.
Value(s) applied	2.75
Purpose of data	Project emission calculations.
Additional comment	-

The following values were also used in the flaring tool to calculate project emissions:

Parameter	SI Unit	Description	Value
MM_{CH4}	kg/kmol	Molecular mass of methane	16.04
MM_{CO}	kg/kmol	Molecular mass of carbon monoxide	28.01
MM_{CO2}	kg/kmol	Molecular mass of carbon dioxide	44.01
MM_{O2}	kg/kmol	Molecular mass of oxygen	32
MM_{H2}	kg/kmol	Molecular mass of hydrogen	2.02
MM_{N2}	kg/kmol	Molecular mass of nitrogen	28.02
AM_c	kg/kmol (g/mol)	Atomic mass of carbon	12
AM_h	kg/kmol (g/mol)	Atomic mass of hydrogen	1.01
AM_o	kg/kmol (g/mol)	Atomic mass of oxygen	16
AM_n	kg/kmol (g/mol)	Atomic mass of nitrogen	14.01
P_n	Pa	Atmospheric pressure at normal conditions	101 325
R_u	$Pa.m^3/kmol.K$	Universal ideal gas constant	8,314.472
T_n	K	Temperature at normal conditions	273.15

MF_{O2}	Dimensionless	O_2 volumetric fraction of air	0.21
GWP_{CH4}	t_{CO2}/t_{CH4}	Global warming potential of methane	21
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal conditions	22.414

D.2. Data and parameters monitored

Mine methane capture and destruction

Data/Parameter	$MMES_{PR,flare,y}$
Unit	tCH_4/month
Description	Mine methane captured, sent to and destroyed by flare in the project activity.
Measured/Calculated /Default	Calculated by multiplying the measured raw gas flow rate by the measured methane composition of the raw gas, and converting to mass by multiplying by the density of methane.
Source of data	A flow meter is used to measure the flow rate of the raw gas sent to the flare and a gas analyser is used to measure the methane concentration of the raw gas sent to the flare.
Value(s) of monitored parameter	(see table below)
Monitoring equipment	Flow meter: *Instrument code:* FIR 71.51 *Type:* Endress and Hauser *Accuracy class:* +/- 1.2% measurement tolerance *Serial number:* D9007A04267 *Calibration frequency:* Yearly Gas analyser: *Instrument code:* *Type:* Endress and Hauser *Accuracy class:* +/- 1% full scale measurement tolerance *Calibration frequency:* Weekly
Measuring/Reading/ Recording frequency	The methane concentration and the flow rate of the raw gas are measured every minute. The values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.
Calculation method (if applicable)	The measured pressure and temperature corrected raw gas flow rate (in Nm^3) is multiplied by the measured raw gas methane concentration (volume %), which is then multiplied by the density of methane (0.716 kg/m^3 – as specified by the applied methodology).

Period	$MMES_{PR,flare,y}$ (tCH_4)
01 – 31 Jul 2011	66
01 – 31 Aug 2011	67
01 – 30 Sep 2011	76
01 – 31 Oct 2011	41
01 – 30 Nov 2011	128
01 – 31 Dec 2011	125
01 – 31 Jan 2012	151
01 – 29 Feb 2012	153
01 – 31 Mar 2012	108

QA/QC procedures	The flow meter and gas analyser are calibrated in accordance with manufacturer's specifications.
Purpose of data	Baseline and project emission calculations.
Additional comment	-

Data/Parameter	$EC_{pj,y}$
Unit	MWh/month
Description	The quantity of electricity consumed by the project activity.
Measured/Calculated /Default	Measured in kWh/day and converted to MWh/month.
Source of data	Power meter.
Value(s) of monitored parameter	(see table below)
Monitoring equipment	<u>Power meter:</u> *Type:* Endress and Hauser *Accuracy class:* +/- 2% measurement tolerance *Calibration frequency:* Biennial replace
Measuring/Reading/ Recording frequency	The electricity consumption of the project activity is logged electronically and averaged daily. These values are aggregated monthly for the purposes of calculating the emission reductions.
Calculation method (if applicable)	Not applicable. No calculation method is used.
QA/QC procedures	The power meter is biennialy replaced.
Purpose of data	Project emission calculations.
Additional comment	-

Value(s) of monitored parameter:

Period	Measured power consumption (MWh)
01 – 31 Jul 2011	2.31
01 – 31 Aug 2011	2.52
01 – 30 Sep 2011	2.95
01 – 31 Oct 2011	1.53
01 – 30 Nov 2011	3.85
01 – 31 Dec 2011	4.24
01 – 31 Jan 2012	6.40
01 – 29 Feb 2012	7.60
01 – 31 Mar 2012	4.32

Data/Parameter	TDL_y
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to the project activity.
Measured/Calculated /Default	Default.
Source of data	‘Tool to calculate baseline, project and/or leakage emissions from electricity consumption’ version 01
Value(s) of monitored parameter	0.03
Monitoring equipment	Not applicable. The default value is sourced from the applied tool.
Measuring/Reading/ Recording frequency	Not applicable. The default value is sourced from the applied tool.
Calculation method (if applicable)	Not applicable. The default value is sourced from the applied tool.
QA/QC procedures	Not applicable.
Purpose of data	Project emission calculations.
Additional comment	-

<table>
<tr><td>Data/Parameter</td><td>$FV_{RH,h}$</td></tr>
<tr><td>Unit</td><td>Nm^3/hour</td></tr>
<tr><td>Description</td><td>Volumetric flow rate of the residual gas in dry basis as normal conditions in hour h.</td></tr>
<tr><td>Measured/Calculated /Default</td><td>The volumetric flow rate is measured on a dry basis to ensure that all of the moisture is removed prior to the analysis. The flow rate is measured after the dewatering unit and after the pressure increase of the blower (here there is a significant gas temperature increase). At this time, there is no condensate and the relative humidity is approximately 20-30%. Hence, the gas is dry.</td></tr>
<tr><td>Source of data</td><td>Flow meter.</td></tr>
<tr><td>Value(s) of monitored parameter</td><td><table>
<tr><th>Period</th><th>Volumetric flow rate (Nm^3/hr)
(Instrument number: FIR 71.51)</th></tr>
<tr><td>01 – 31 Jul 2011</td><td>188</td></tr>
<tr><td>01 – 31 Aug 2011</td><td>179</td></tr>
<tr><td>01 – 30 Sep 2011</td><td>208</td></tr>
<tr><td>01 – 31 Oct 2011</td><td>108</td></tr>
<tr><td>01 – 30 Nov 2011</td><td>324</td></tr>
<tr><td>01 – 31 Dec 2011</td><td>289</td></tr>
<tr><td>01 – 31 Jan 2012</td><td>364</td></tr>
<tr><td>01 – 29 Feb 2012</td><td>413</td></tr>
<tr><td>01 – 31 Mar 2012</td><td>363</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment</td><td><u>Flow meter:</u>
Instrument code: FIR 71.51
Type: Endress and Hauser
Accuracy class: +/- 1.2% measurement tolerance
Serial number: D9007A04267
Calibration frequency: Yearly</td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>The flow rate of the residual gas is measured every minute. The values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable. No calculation method is used.</td></tr>
<tr><td>QA/QC procedures</td><td>The flow meter is calibrated in accordance with manufacturer specifications.</td></tr>
<tr><td>Purpose of data</td><td>Project emission calculations.</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$fv_{i,h}$</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Volumetric fraction of methane and nitrogen in the residual gas in the hour h.</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured.</td></tr>
<tr><td>Source of data</td><td>Gas analyser.</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Period</th><th>Methane volumetric fraction</th><th>Nitrogen volumetric fraction</th></tr>
<tr><td>01 – 31 Jul 2011</td><td>0.64</td><td>0.64</td></tr>
<tr><td>01 – 31 Aug 2011</td><td>0.67</td><td>0.67</td></tr>
<tr><td>01 – 30 Sep 2011</td><td>0.70</td><td>0.70</td></tr>
<tr><td>01 – 31 Oct 2011</td><td>0.60</td><td>0.60</td></tr>
<tr><td>01 – 30 Nov 2011</td><td>0.74</td><td>0.74</td></tr>
<tr><td>01 – 31 Dec 2011</td><td>0.72</td><td>0.72</td></tr>
<tr><td>01 – 31 Jan 2012</td><td>0.72</td><td>0.72</td></tr>
<tr><td>01 – 29 Feb 2012</td><td>0.72</td><td>0.72</td></tr>
<tr><td>01 – 31 Mar 2012</td><td>0.68</td><td>0.68</td></tr>
</table>
As per the ‘Tool to determine project emissions from flaring gases containing methane’ (version 01), a simplified approach can be taken where project participants only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen.</td></tr>
<tr><td>Monitoring equipment</td><td><u>Gas analyser:</u>
Type: Endress and Hauser
Accuracy class: +/- 1% full scale measurement tolerance
Calibration frequency: Weekly</td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>The methane concentration of the residual gas is measured every minute. These values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable. No calculation method is used.</td></tr>
<tr><td>QA/QC procedures</td><td>The gas analyser is calibrated in accordance with manufacturer specifications.</td></tr>
<tr><td>Purpose of data</td><td>Project emission calculations.</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data/Parameter	$fv_{CH_4,FG,h}$
Unit	mg/Nm^3
Description	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*.
Measured/Calculated /Default	A flow meter is used to measure the flow rate of the raw gas sent to the flare and a gas analyser is used to measure the volumetric methane concentration in the exhaust gas of the flare. The methane concentration is measured on a dry basis by ensuring that all of the moisture is removed prior to the analysis.
Source of data	Gas analyser.
Value(s) of monitored parameter	see table below
Monitoring equipment	<u>Flow meter:</u> *Instrument code:* FIR 71.51 *Type:* Endress and Hauser *Accuracy class:* +/- 1.2% measurement tolerance *Serial number:* D9007A04267 *Calibration frequency:* Yearly <u>Gas analyser:</u> *Type:* Endress and Hauser *Accuracy class:* +/- 1% full scale measurement tolerance *Calibration frequency:* Weekly
Measuring/Reading/ Recording frequency	The flow rate of the residual gas and the methane concentration of the exhaust gas are measured every minute. These values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.
Calculation method (if applicable)	The concentration of methane in the exhaust gas is calculated by dividing the mass of methane in the exhaust gas (mg) by the volume of exhaust gas (Nm^3). The mass of methane in the exhaust gas is obtained by multiplying the volumetric flow by the methane volumetric fraction in the exhaust gas, and then multiplying by the density of methane.
QA/QC procedures	The flow meter and gas analyser are calibrated in accordance with manufacturer's specifications.
Purpose of data	Project emission calculations.

Value(s) of monitored parameter:

Period	$fv_{CH_4,FG,h}$ (mg/Nm^3)
01 – 31 Jul 2011	266
01 – 31 Aug 2011	303
01 – 30 Sep 2011	222
01 – 31 Oct 2011	143
01 – 30 Nov 2011	126
01 – 31 Dec 2011	284
01 – 31 Jan 2012	203
01 – 29 Feb 2012	205
01 – 31 Mar 2012	805

Additional comment	-

Data/Parameter	$t_{O_2,h}$
Unit	-
Description	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*.
Measured/Calculated /Default	Measured.
Source of data	Gas analyser.
Value(s) of monitored parameter	Period / $t_{O_2,h}$: 01 – 31 Jul 2011: 0.18; 01 – 31 Aug 2011: 0.18; 01 – 30 Sep 2011: 0.17; 01 – 31 Oct 2011: 0.18; 01 – 30 Nov 2011: 0.13; 01 – 31 Dec 2011: 0.15; 01 – 31 Jan 2012: 0.16; 01 – 29 Feb 2012: 0.16; 01 – 31 Mar 2012: 0.16
Monitoring equipment	Gas analyser: *Type:* Endress and Hauser *Accuracy class:* +/- 1% full scale measurement tolerance *Calibration frequency:* Weekly
Measuring/Reading/ Recording frequency	The volumetric fraction of the oxygen in the exhaust gas is measured every minute. These values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.
Calculation method (if applicable)	Not applicable. No calculation method is used.
QA/QC procedures	The gas analyser is calibrated in accordance with manufacturer specifications.
Purpose of data	Project emission calculations.
Additional comment	-

Values of monitored parameter:

Period	$t_{O_2,h}$
01 – 31 Jul 2011	0.18
01 – 31 Aug 2011	0.18
01 – 30 Sep 2011	0.17
01 – 31 Oct 2011	0.18
01 – 30 Nov 2011	0.13
01 – 31 Dec 2011	0.15
01 – 31 Jan 2012	0.16
01 – 29 Feb 2012	0.16
01 – 31 Mar 2012	0.16

Data/Parameter	PC_{CH_4}
Unit	%
Description	Concentration (in mass) of methane in extracted gas (%), measured on wet basis
Measured/Calculated /Default	Calculated.
Source of data	Gas analyser.
Value(s) of monitored parameter	Period: PC_{CH_4} 01 – 31 Jul 2011: 0.37 01 – 31 Aug 2011: 0.44 01 – 30 Sep 2011: 0.31 01 – 31 Oct 2011: 0.26 01 – 30 Nov 2011: 0.20 01 – 31 Dec 2011: 0.40 01 – 31 Jan 2012: 0.30 01 – 29 Feb 2012: 0.30 01 – 31 Mar 2012: 1.10
Monitoring equipment	Gas analyser: *Type:* Endress and Hauser *Accuracy class:* +/- 1% full scale measurement tolerance *Calibration frequency:* Weekly
Measuring/Reading/ Recording frequency	The methane concentration of the residual gas is measured every minute. These values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.
Calculation method (if applicable)	A gas analyser is used to measure the volumetric fraction of methane. This value is converted to a mass fraction by multiplying it by the density of methane at normal conditions (0.716 kg/m^3) and dividing it by the density of the residual gas.
QA/QC procedures	The gas analyser is calibrated in accordance with manufacturer specifications.
Purpose of data	Project emission calculations.
Additional comment	-

Period	PC_{CH_4}
01 – 31 Jul 2011	0.37
01 – 31 Aug 2011	0.44
01 – 30 Sep 2011	0.31
01 – 31 Oct 2011	0.26
01 – 30 Nov 2011	0.20
01 – 31 Dec 2011	0.40
01 – 31 Jan 2012	0.30
01 – 29 Feb 2012	0.30
01 – 31 Mar 2012	1.10

Data/Parameter	T_{flare}
Unit	°C
Description	Temperature in the exhaust gas of the flare.
Measured/Calculated /Default	Measured.
Source of data	Thermocouple
Value(s) of monitored parameter	>500
Monitoring equipment	Thermocouple: *Instrument code:* TIR 71.53 *Type:* Endress and Hauser Type N *Accuracy class:* +/- 2.5°C *Calibration frequency:* Yearly replace *Date of last calibration:* Not applicable *Validity:* Not applicable
Measuring/Reading/ Recording frequency	The temperature in the exhaust gas of the flare is measured every minute. These values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.
Calculation method (if applicable)	Not applicable. No calculation method is used.
QA/QC procedures	Thermocouple is replaced yearly.
Purpose of data	Project emission calculations.
Additional comment	-

Non-mine methane capture and destruction

Data/Parameter	$FV_{RH,h}$
Unit	Nm^3/hour
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h*.
Measured/Calculated /Default	Measured.
Source of data	Flow meter.
Value(s) of monitored parameter	See table below
Monitoring equipment	Flow meter: see table below
Measuring/Reading/ Recording frequency	The flow rate of the residual gas is measured every minute. The values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.
Calculation method (if applicable)	Not applicable. No calculation method is used.
QA/QC procedures	The flow meter is calibrated in accordance with manufacturer specifications.
Purpose of data	Baseline and project emission calculations.
Additional comment	-

Value(s) of monitored parameter:

Period	DBE1	2264	1400	EX1	ST23
01 – 31 Jul 2011	-	-	35.2	122	256
01 – 31 Aug 2011	-	-	34.1	121	234
01 – 30 Sep 2011	-	-	37.7	124	233
01 – 31 Oct 2011	41.8	-	40.1	125	291
01 – 30 Nov 2011	38.6	-	39.2	126	232
01 – 31 Dec 2011	37.2	-	38.7	125	251
01 – 31 Jan 2012	36.3	-	37.4	125	235
01 – 29 Feb 2012	35.4	-	36.6	125	225
01 – 31 Mar 2012	34.7	-	36.1	125	215

Monitoring equipment – Flow meter:

	DBE1	2264	1400	EX1	ST23
Type	Endress and Hauser				
Accuracy class	+/- 1.2% measurement tolerance				
Calibration frequency	Yearly				

Data/Parameter	$fv_{i,h}$
Unit	-
Description	Volumetric fraction of methane and nitrogen in the residual gas in the hour h.
Measured/Calculated /Default	Measured.
Source of data	Gas analyser.
Value(s) of monitored parameter	See tables below.

Methane volumetric fraction					
Period	DBE1	2264	1400	EX1	ST23
01 – 31 Jul 2011	-	-	0.99	0.76	0.03
01 – 31 Aug 2011	-	-	0.99	0.91	0.40
01 – 30 Sep 2011	-	-	0.97	1.00	0.93
01 – 31 Oct 2011	0.90	-	0.98	0.99	0.92
01 – 30 Nov 2011	0.88	-	1.00	1.00	0.96
01 – 31 Dec 2011	0.90	-	1.00	1.00	0.96
01 – 31 Jan 2012	0.95	-	1.00	1.00	0.96
01 – 29 Feb 2012	0.93	-	0.99	0.99	0.97
01 – 31 Mar 2012	0.93	-	0.98	0.99	0.97

Nitrogen volumetric fraction					
Period	DBE1	2264	1400	EX1	ST23
01 – 31 Jul 2011	-	-	0.01	0.24	0.97
01 – 31 Aug 2011	-	-	0.01	0.09	0.60
01 – 30 Sep 2011	-	-	0.03	0.00	0.07
01 – 31 Oct 2011	0.10	-	0.02	0.01	0.08
01 – 30 Nov 2011	0.12	-	0.00	0.00	0.04
01 – 31 Dec 2011	0.10	-	0.00	0.00	0.04
01 – 31 Jan 2012	0.05	-	0.00	0.00	0.04
01 – 29 Feb 2012	0.07	-	0.01	0.01	0.03
01 – 31 Mar 2012	0.07	-	0.02	0.01	0.03

As per the ‘Tool to determine project emissions from flaring gases containing methane’ (version 01), a simplified approach can be taken where project participants only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen.

<table>
<tr><td>Monitoring equipment</td><td><u>Gas analyser:</u>
<table><tr><td></td><td>DBE1</td><td>2264</td><td>1400</td><td>EX1</td><td>ST23</td></tr><tr><td>Type</td><td colspan="5">Endress and Hauser</td></tr><tr><td>Accuracy class</td><td colspan="5">+/- 1% full scale measurement tolerance</td></tr><tr><td>Calibration frequency</td><td colspan="5">Weekly</td></tr></table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>The methane concentration of the residual gas is measured every minute. These values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable. No calculation method is used.</td></tr>
<tr><td>QA/QC procedures</td><td>The gas analyser is calibrated in accordance with manufacturer specifications.</td></tr>
<tr><td>Purpose of data</td><td>Project emission calculations.</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>T_{flare}</td></tr>
<tr><td>Unit</td><td>°C</td></tr>
<tr><td>Description</td><td>Temperature in the exhaust gas of the flare.</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured.</td></tr>
<tr><td>Source of data</td><td>Thermocouple</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>>500 for more than 40 minutes in every hour that CERs are claimed.</td></tr>
<tr><td>Monitoring equipment</td><td><u>Thermocouple:</u>
<table><tr><td></td><td>DBE1</td><td>2264</td><td>1400</td><td>EX1</td><td>ST23</td></tr><tr><td>Type</td><td colspan="5">Endress and Hauser</td></tr><tr><td>Accuracy class</td><td colspan="5">+/- 2.5°C</td></tr><tr><td>Calibration frequency</td><td colspan="5">Yearly replace</td></tr><tr><td>Date of last calibration</td><td colspan="5">Not applicable</td></tr></table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>The temperature in the exhaust gas of the flares is measured every minute. These values are averaged daily, and then aggregated monthly for the purposes of calculating the emission reductions.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable. No calculation method is used.</td></tr>
<tr><td>QA/QC procedures</td><td>The thermocouples are replaced yearly in accordance with manufacturer specifications.</td></tr>
<tr><td>Purpose of data</td><td>Project emission calculations.</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

D.3. Implementation of sampling plan
>>
Not applicable.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks
>>
This section provides the baseline emission calculations for mine and non-mine methane capture and destruction.

Mine methane capture and destruction

The baseline emissions for mine methane capture and destruction are calculated using equation 1 of the applied methodology.

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{USe,y}$$ (AM0064 equation 1)

Where,

BE_y	Baseline emissions in year *y* (tCO_2e/yr)
$BE_{MD,y}$	Baseline emissions from the destruction of methane in the baseline scenario in year *y* (tCO_2e/yr)
$BE_{MR,y}$	Baseline emissions from the release of methane into the atmosphere in year *y* that is avoided by the project activity (tCO_2e/yr)
$BE_{Use,y}$	Baseline emissions from the production of power and/or heat displaced by the project activity in year *y* (tCO_2e/yr)

But, $BE_{MD,y} = BE_{Use,y} = 0$ as no electricity is generated in the project activity (gas engines have not yet been installed) and no methane was destructed in the baseline. Therefore equation 1 simplifies to:

$$BE_y = BE_{MR,y}$$

The table below shows the monthly values used in the calculation of BE_y.

Month	BE_y	$BE_{MR,y}$
	tCO_2e	tCO_2e
Jul-11	1 376	1 376
Aug-11	1 400	1 400
Sep-11	1 587	1 587
Oct-11	857	857
Nov-11	2 684	2 684
Dec-11	2 633	2 633
Jan-12	3 163	3 163
Feb-12	3 206	3 206
Mar-12	2 264	2 264

The baseline emissions from the venting of methane are calculated using equation 6 of the applied methodology.

$$BE_{MR,y} = GWP_{CH_4} \times \sum_i \left[\left(MM_{PR,i,y} - MM_{BL,i,y} \right) + \left(VAM_{PR,i,y} - VAM_{BL,i,y} \right) \right]$$

(AM0064 equation 6)

Where,

$BE_{MR,y}$ Baseline emissions from the release of methane into the atmosphere in year y that is avoided by the project activity (tCO_2e/yr)

GWP_{CH_4} Global Warming Potential of methane

$MM_{PR,i,y}$ Mine methane captured, sent to and destroyed by use *i* in the project activity in year *y* (tCH_4/yr)

$MM_{BL,i,y}$ Mine methane that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year *y* (tCH_4/yr)

$VAM_{PR,i,y}$ VAM captured, sent to and destroyed by use *i* in the project activity in year *y* (tCH_4)

$VAM_{BL,i,y}$ VAM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year *y* (tCH_4)

No ventilation air methane (VAM) is used in the baseline (BL) or in the project case (PR). The result is that $VAM_{PR,i,y} = VAM_{BL,i,y} = 0$. Furthermore, no mine methane (MM) is captured and used in the baseline (BL). The result is that $MM_{BL,i,y} = 0$.

The flaring of excess methane will take place in the project case (PR). Therefore, equation 6 simplifies to:

$$BE_{MR,y} = GWP_{CH_4} \times MM_{PR,flare,y}$$

Where:

$MM_{PR,flare,y}$ Mine methane captured, sent to and destroyed by flare in the project activity in year *y* (tCO_2e/yr)

The table below shows the monthly values used in the calculation of $BE_{MR,y}$.

Month	$BE_{MR,y}$	GWP_{CH4}	$MM_{PR,flare,y}$
	tCO_2e	tCO_2e/tCH_4	tCH_4
Jul-11	1 376	21	66
Aug-11	1 400	21	67
Sep-11	1 587	21	76
Oct-11	857	21	41
Nov-11	2 684	21	128
Dec-11	2 633	21	125
Jan-12	3 163	21	151
Feb-12	3 206	21	153
Mar-12	2 264	21	108

Non-mine methane capture and destruction

The baseline emissions for non-mine methane capture and destruction are calculated using equation 12 of the applied methodology.

$$BE_y = \sum_{h=1}^{8760} TM_{RG,h} \times \frac{GWP_{CH_4}}{1000}$$ (AM0064 equation 12)

Where,

BE_y Baseline emissions in year y (tCO_2e)

GWP_{CH_4} Global warming potential for methane (value of 21)

$TM_{RG,h}$ Mass flow rate of methane in the residual gas (in the “Tool to determine project emissions from flaring gases containing methane” it is defined as the gas stream flowing to the flare) in the hour *h* (kg/h)

$1/1000$ Factor to convert kg/year to ton/year

Borehole flare DBE1

The table below shows the monthly values used in the calculation of BE_y in borehole flare DBE1.

Month	BE_y	$TM_{RG,h}$	GWP_{CH4}
	tCO_2e	kg/h	tCO_2e/tCH_4
Jul-11	-	-	-
Aug-11	-	-	-
Sep-11	-	-	-
Oct-11	351	26.8	21
Nov-11	367	24.3	21
Dec-11	374	24.0	21
Jan-12	384	24.6	21
Feb-12	345	23.6	21
Mar-12	81	23.1	21

Borehole flare 2264

The table below shows the monthly values used in the calculation of BE_y in borehole flare 2264.

Month	BE_y	$TM_{RG,h}$	GWP_{CH4}
	tCO_2e	kg/h	tCO_2e/tCH_4
Jul-11	-	-	-
Aug-11	-	-	-
Sep-11	-	-	-
Oct-11	-	-	-
Nov-11	-	-	-
Dec-11	-	-	-
Jan-12	-	-	-
Feb-12	-	-	-
Mar-12	-	-	-

Borehole flare 1400

The table below shows the monthly values used in the calculation of BE_y in borehole flare 1400.

Month	BE_y	$TM_{RG,h}$	GWP_{CH4}
	tCO_2e	kg/h	tCO_2e/tCH_4
Jul-11	215	25.1	21.0
Aug-11	342	24.3	21.0
Sep-11	397	26.2	21.0
Oct-11	438	28.0	21.0
Nov-11	423	28.0	21.0
Dec-11	433	27.7	21.0
Jan-12	418	26.8	21.0
Feb-12	380	26.0	21.0
Mar-12	371	25.4	21.0

Borehole flare EX1

The table below shows the monthly values used in the calculation of BE_y in borehole flare EX1.

Month	BE_y	$TM_{RG,h}$	GWP_{CH4}
	tCO_2e	kg/h	tCO_2e/tCH_4
Jul-11	1 038	66.4	21
Aug-11	1 235	79.0	21
Sep-11	1 343	88.9	21
Oct-11	1 383	88.5	21
Nov-11	1 358	89.8	21
Dec-11	1 401	89.7	21
Jan-12	1 399	89.5	21
Feb-12	1 300	88.9	21
Mar-12	1 381	88.4	21

Borehole flare ST23

The table below shows the monthly values used in the calculation of BE_y in borehole flare ST23.

Month	BE_y	$TM_{RG,h}$	GWP_{CH4}
	tCO_2e	kg/h	tCO_2e/tCH_4
Jul-11	55	6	21
Aug-11	1 037	66	21
Sep-11	935	155	21
Oct-11	1 742	192	21
Nov-11	1 124	159	21
Dec-11	2 701	173	21
Jan-12	2 513	161	21
Feb-12	2 290	157	21
Mar-12	2 324	149	21

E.2. Calculation of project emissions or actual net GHG removals by sinks
>>
This section provides the project emission calculations for mine and non-mine methane capture and destruction.

Mine methane capture and destruction

The project emissions for mine methane capture and destruction are calculated using equation 13 of the applied methodology.

$$PE_y = PE_{ME,y} + PE_{MD,y} + PE_{UM,y}$$ (AM0064 equation 13)

Where,
PE_y Project emissions in year y (tCO_2e/yr)
$PE_{ME,y}$ Project emissions from energy use to capture and use methane in year y (tCO_2e/yr)
$PE_{MD,y}$ Project emissions from methane destroyed in year y (tCO_2e/yr)
$PE_{UM,y}$ Project emissions from un-combusted methane in year *y* (tCO_2e/yr)

The table below shows the monthly values used in the calculation of PE_y.

Month	PE_y	$PE_{ME,y}$	$PE_{MD,y}$	$PE_{UM,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Jul-11	209	2.40	176	30.9
Aug-11	214	2.62	179	32.1
Sep-11	230	3.07	205	21.6
Oct-11	122	1.59	111	9.8
Nov-11	365	4.00	350	11.0
Dec-11	374	4.41	341	29.0
Jan-12	448	6.65	410	31.5
Feb-12	455	7.90	416	31.1
Mar-12	382	4.49	284	93.6

The project emissions for mine methane capture and destruction are calculated using equation 14 of the applied methodology.

$$PE_{ME,y} = PE_{ELEC,y} + PE_{FF,y}$$ (AM0064 equation 14)

Where,
$PE_{ELEC,y}$ Project emissions from the use of electricity for capture, transportation, compression and utilisation or destruction of MM/VAM in year y (tCO_2e/yr)
$PE_{FF,y}$ Project emissions from the combustion of fossil fuels for capture, transportation, compression, and utilisation or destruction of MM/VAM in year y (tCO_2e/yr)

No fossil fuel will be used for the capture, transportation, compression, utilisation or destruction of MM/VAM in the project activity so $PE_{FF,y} = 0$.

The table below shows the monthly values used in the calculation of $PE_{ME,y}$.

Month	$PE_{ME,y}$	$PE_{ELEC,y}$	$PE_{FF,y}$
	tCO_2e	tCO_2e	tCO_2e
Jul-11	2.40	2.40	0
Aug-11	2.62	2.62	0
Sep-11	3.07	3.07	0
Oct-11	1.59	1.59	0
Nov-11	4.00	4.00	0
Dec-11	4.41	4.41	0
Jan-12	6.65	6.65	0
Feb-12	7.90	7.90	0
Mar-12	4.49	4.49	0

According to AM0064 Version 02, $PE_{ELEC,y}$ is calculated using the 'Tool to calculate baseline, project and/or leakage emissions from electricity consumption' (Version 01). The project emissions from the consumption of electricity in the project activity are calculated using equation 1 of the applied tool.

$$PE_{EC,y} = EC_{PJ,grid,y} \times EF_{EL,grid,y} \times \left(1 + TDL_{grid,y}\right) \qquad \text{(Tool equation 1)}$$

Where,

$PE_{EC,y}$	Project emissions from electricity consumption in year *y* (tCO_2/year)
$EC_{PJ,grid,y}$	Quantity of electricity consumed by the project from the grid in year *y* (MWh/yr)
$EF_{EL,grid,y}$	Emission factor of the grid (tCO_2/MWh)
$TDL_{grid,y}$	Average technical transmission and distribution losses for providing electricity in year *y*

The table below shows the monthly values used in the calculation of $PE_{EC,y}$.

Month	$PE_{EC,y}$	$EC_{PJ,j,y}$	$EF_{EL,j,y}$	$TDL_{j,y}$
	tCO_2e	MWh	tCO_2e/MWh	-
Jul-11	2.40	2.31	1.01	0.03
Aug-11	2.62	2.52	1.01	0.03
Sep-11	3.07	2.95	1.01	0.03
Oct-11	1.59	1.53	1.01	0.03
Nov-11	4.00	3.85	1.01	0.03
Dec-11	4.41	4.24	1.01	0.03
Jan-12	6.65	6.40	1.01	0.03
Feb-12	7.90	7.60	1.01	0.03
Mar-12	4.49	4.32	1.01	0.03

The project emissions from methane destroyed in the project activity are calculated using equation 15 of the applied methodology.

$$PE_{MD,y} = \left(MD_{FL,y} + MD_{OX,y} + MD_{ELEC,y} + MD_{heat,y} + MD_{GAS,y}\right) \times \left(CEF_{CH_4} + r \times CEF_{NMHC}\right)$$

(AM0064 equation 15)

Where,

$PE_{MD,y}$	Project emissions from MM/VAM destroyed in year *y* (tCO_2e/yr)
$MD_{FL,y}$	Amount of methane destroyed through flaring in year *y* (tCH_4/yr)
$MD_{OX,y}$	Amount of methane destroyed through catalytic oxidation in year *y* (tCH_4/yr)
$MD_{ELEC,y}$	Amount of methane destroyed through power generation in year *y* (tCO_2e/yr)
$MD_{heat,y}$	Amount of methane destroyed through heat generation in year *y* (tCO_2e/yr)
$MD_{GAS,y}$	Amount of methane destroyed after being supplied to gas grid or for vehicle use in year *y* (tCH_4)
CEF_{CH_4}	Carbon emission factor for combusted methane (2.75 tCO_2/ tCH_4)
CEF_{NMHC}	Carbon emission factor for combusted non methane hydrocarbons (the concentration varies and, therefore, to be obtained through periodical analysis of captured methane) ($tCO_2/tNMHC$)
r	Relative proportion of NMHC compared to methane $r = \frac{PC_{NMCH}}{PC_{CH4}}$
PC_{CH4}	Concentration (in mass) of methane in extracted gas (%), measured on wet basis
PC_{NMHC}	NMHC concentration (in mass) in extracted gas (%)

However, no mine methane will be destroyed through catalytic oxidation, supplied to a gas grid or used as vehicle fuel, or destroyed through heat generation. In addition, no electricity is generated in the project activity. Therefore, $MD_{OX,y} = MD_{ELEC,y} = MD_{GAS,y} = MD_{heat,y} = 0$.

Furthermore, gas analysis indicated that non-methane hydrocarbons (NMHCs) accounts for less than 1% of the residual gas composition, and are therefore not included in the emission reduction calculations (NMHCs can be assumed to negligible). Therefore, equation 15 simplifies to:

$$PE_{MD,y} = MD_{FL,y} \times CEF_{CH_4}$$

The table below shows the monthly values used in the calculation of $PE_{MD,y}$.

Month	$PE_{MD,y}$	$MD_{FL,y}$	CEF_{CH4}
	tCO_2e	tCH_4	tCO_2e/tCH_4
Jul-11	176	64	2.75
Aug-11	179	65	2.75
Sep-11	205	75	2.75
Oct-11	111	40	2.75
Nov-11	350	127	2.75
Dec-11	341	124	2.75
Jan-12	410	149	2.75
Feb-12	416	151	2.75
Mar-12	284	103	2.75

The amount of methane destroyed through flaring is calculated using equation (16) of the applied methodology.

$$MD_{FL,y} = MMES_{FL,y} - \left(PE_{flare,y}/GWP_{CH_4}\right)$$ (AM0064 equation 16)

Where,

$MMES_{FL,y}$ Amount of methane measured sent to flare in year *y* (tCH_4)

$PE_{flare,y}$ Project emissions of non-combusted CH_4, expressed in terms of tCO_2e, from flaring of the residual gas stream in year *y* (tCO_2e)

GWP_{CH_4} Global warming potential of methane

The table below shows the monthly values used in the calculation of $MD_{FL,y}$.

Month	$MD_{FL,y}$	$MMES_{FL,y}$	$PE_{flare,y}$	GWP_{CH4}
	tCH_4	tCH_4	tCO_2e	tCO_2e/tCH_4
Jul-11	13	14	3.8	21
Aug-11	65	65	14.7	21
Sep-11	64	66	30.9	21
Oct-11	65	67	32.1	21
Nov-11	75	76	21.6	21
Dec-11	40	41	9.8	21
Jan-12	127	128	11.0	21
Feb-12	124	125	29.0	21
Mar-12	149	151	31.5	21

The project emissions of non-combusted CH_4 (expressed in terms of CO_2e) from the flaring of the residual gas stream ($PE_{flare,y}$) were calculated following the procedures described in version 01 of the 'Tool to determine project emissions from flaring gases containing methane'. The calculations of the project emissions of non-combusted CH_4 can be found in the attached spreadsheet.

The project emissions from un-combusted methane are calculated using equation (23) of the applied methodology.

$$PE_{UM,y} = \left[GWP_{CH_4} \times \sum_i MMES_{i,j} \times (1 - Eff_i)\right] + PE_{flare,y} + PE_{OX,y} + GWP_{CH_4}$$
(AM0064 equation 23)

Where,

$PE_{UM,y}$ Project emissions from un-combusted methane in year *y* (tCO_2e)

GWP_{CH_4} Global warming potential of methane

$MMES_{i,j}$ Methane measured sent to use *i* in year *y* (tCH_4)

Eff_i Efficiency of methane destruction in use *i* (%)

$PE_{flare,y}$ Project emissions of non-combusted CH_4, expressed in terms of tCO_2e, from the residual gas stream (tCO_2e)

$PE_{OX,y}$ Project emissions of non oxidized CH_4 from catalytic oxidation of the VAM stream in year *y* (tCH_4)

As applied to this project, equation (23) becomes:

$$PE_{UM,y} = PE_{flare,y}$$

The table below shows the monthly values used in the calculation of $PE_{UM,y}$.

Month	$PE_{UM,y}$	$PE_{flare,y}$
	tCO_2e	tCO_2e
Jul-11	31	30.9
Aug-11	32	32.1
Sep-11	22	21.6
Oct-11	10	9.8
Nov-11	11	11.0
Dec-11	29	29.0
Jan-12	31	31.5
Feb-12	31	31.1
Mar-12	94	93.6

As mentioned above, the project emissions of non-combusted CH_4 (expressed in terms of CO_2e) from the flaring of the residual gas stream ($PE_{flare,y}$) were calculated following the procedures described in version 01 of the 'Tool to determine project emissions from flaring gases containing methane'. The calculations of the project emissions of non-combusted CH_4 can be found in the attached spreadsheet.

Non-mine methane capture and destruction

The project emissions for mine methane capture and destruction were calculated using equation (24) of the applied methodology.

$$PE_y = PE_{ME,y} + PE_{MD,y} + PE_{UM,y} \quad \text{(AM0064 equation 24)}$$

Where,

PE_y Project emissions in year y (tCO_2e/yr)

$PE_{ME,y}$ Project emissions from energy use to capture and use methane in year y (tCO_2e/yr)

$PE_{MD,y}$ Project emissions from methane destroyed in year y (tCO_2e/yr)

$PE_{UM,y}$ Project emissions from un-combusted methane in year y (tCO_2e/yr)

There is no electricity used for the operation of the borehole flares and instrumentation. Each of the flares is equipped with a solar panel. There is no fossil fuel consumption for the operation of the non-mine methane facilities. Hence, $PE_{ME,y} = 0$.

Borehole flare DBE1

The table below shows the monthly values used in the calculation of PE_y in borehole flare DBE1.

Month	PE_y	$PE_{ME,y}$	$PE_{MD,y}$	$PE_{UM,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	76.5	-	41.4	35.1
Nov-11	79.9	-	43.2	36.7
Dec-11	81.5	-	44.1	37.4
Jan-12	83.7	-	45.3	38.4
Feb-12	75.2	-	40.7	34.5
Mar-12	17.7	-	9.6	8.1

Borehole flare 2264

The table below shows the monthly values used in the calculation of PE_y in borehole flare 2264.

Month	PE_y	$PE_{ME,y}$	$PE_{MD,y}$	$PE_{UM,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	-	-	-	-
Nov-11	-	-	-	-
Dec-11	-	-	-	-
Jan-12	-	-	-	-
Feb-12	-	-	-	-
Mar-12	-	-	-	-

Borehole flare 1400

The table below shows the monthly values used in the calculation of PE_y in borehole flare 1400.

Month	PE_y	$PE_{ME,y}$	$PE_{MD,y}$	$PE_{UM,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Jul-11	46.8	-	25.3	21.5
Aug-11	74.6	-	40.4	34.2
Sep-11	86.4	-	46.7	39.7
Oct-11	95.4	-	51.6	43.8
Nov-11	92.2	-	49.9	42.3
Dec-11	94.3	-	51.0	43.3
Jan-12	91.1	-	49.3	41.8
Feb-12	82.8	-	44.8	38.0
Mar-12	80.8	-	43.7	37.1

Borehole flare EX1

The table below shows the monthly values used in the calculation of PE_y in borehole flare EX1.

Month	PE_y	$PE_{ME,y}$	$PE_{MD,y}$	$PE_{UM,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Jul-11	226	-	122	104
Aug-11	269	-	146	123
Sep-11	293	-	158	134
Oct-11	301	-	163	138
Nov-11	296	-	160	136
Dec-11	305	-	165	140
Jan-12	305	-	165	140
Feb-12	283	-	153	130

Borehole flare ST23

The table below shows the monthly values used in the calculation of PE_y in borehole flare ST23.

Month	PE_y	$PE_{ME,y}$	$PE_{MD,y}$	$PE_{UM,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Jul-11	12	-	6	5
Aug-11	226	-	122	104
Sep-11	204	-	110	94
Oct-11	380	-	205	174
Nov-11	245	-	132	112
Dec-11	588	-	318	270
Jan-12	547	-	296	251
Feb-12	499	-	270	229
Mar-12	506	-	274	232

The project emissions from methane destroyed (combusted methane) in year *y* were calculated using equation (26) of the applied methodology.

$$PE_{MD,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \eta_{flare,h} \times \frac{CEF_{CH4}}{1000}$$ (AM0064 equation 26)

Where,

$TM_{RG,h}$ Mass flow rate of methane in the residual gas (in the Tool it is defined as the gas stream flowing to the flare) in the hour h (kg/h)

$\eta_{flare,h}$ Flare efficiency in hour *h*, according to the 'Tool to determine project emissions from flaring gases containing methane'

CEF_{CH4} Carbon emission factor for combusted methane (tCO_2/tCH_4)

A default flare efficiency of 90% was used for all borehole flares (provided that the temperature in the exhaust gas of the flare was above 500°C for more than 40 minutes during the hour *h*), in accordance with version 01 of the 'Tool to determine project emissions from flaring gases containing methane'.

Borehole flare DBE1

The table below shows the monthly values used in the calculation of $PE_{MD,y}$ in borehole flare DBE1.

Month	$PE_{MD,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	CEF_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	41.4	26.8	0.9	2.75
Nov-11	43.2	24.3	0.9	2.75
Dec-11	44.1	24.0	0.9	2.75
Jan-12	45.3	24.6	0.9	2.75
Feb-12	40.7	23.6	0.9	2.75
Mar-12	9.6	23.1	0.9	2.75

Borehole flare 2264

The table below shows the monthly values used in the calculation of $PE_{MD,y}$ in borehole flare 2264.

Month	$PE_{MD,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	CEF_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	-	-	-	-
Nov-11	-	-	-	-
Dec-11	-	-	-	-
Jan-12	-	-	-	-
Feb-12	-	-	-	-
Mar-12	-	-	-	-

Borehole flare 1400

The table below shows the monthly values used in the calculation of $PE_{MD,y}$ in borehole flare 1400.

Month	$PE_{MD,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	CEF_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	25.3	25.1	0.9	2.75
Aug-11	40.4	24.3	0.9	2.75
Sep-11	46.7	26.2	0.9	2.75
Oct-11	51.6	28.0	0.9	2.75
Nov-11	49.9	28.0	0.9	2.75
Dec-11	51.0	27.7	0.9	2.75
Jan-12	49.3	26.8	0.9	2.75
Feb-12	44.8	26.0	0.9	2.75
Mar-12	43.7	25.4	0.9	2.75

Borehole flare EX1

The table below shows the monthly values used in the calculation of $PE_{MD,y}$ in borehole flare EX1.

Month	$PE_{MD,y\ y}$	$TM_{RG,h}$	$\eta_{flare,h}$	CEF_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	122	66.4	0.9	2.75
Aug-11	146	79.0	0.9	2.75
Sep-11	158	88.9	0.9	2.75
Oct-11	163	88.5	0.9	2.75
Nov-11	160	89.8	0.9	2.75
Dec-11	165	89.7	0.9	2.75
Jan-12	165	89.5	0.9	2.75
Feb-12	153	88.9	0.9	2.75
Mar-12	163	88.4	0.9	2.75

Borehole flare ST23

The table below shows the monthly values used in the calculation of $PE_{MD,y}$ in borehole flare ST23.

Month	$PE_{MD,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	CEF_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	176	124	0.9	2.75
Aug-11	6	6	0.9	2.75
Sep-11	122	66	0.9	2.75
Oct-11	110	155	0.9	2.75
Nov-11	205	192	0.9	2.75
Dec-11	132	159	0.9	2.75
Jan-12	318	173	0.9	2.75
Feb-12	296	161	0.9	2.75
Mar-12	270	157	0.9	2.75

The project emissions from un-combusted methane in year *y* were calculated using equation (27) of the applied methodology.

$$PE_{UM,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH_4}}{1000}$$ (AM0064 equation 27)

Where,

$TM_{RG,h}$ Mass flow rate of methane in the residual gas in the hour *h* (kg/h)

$\eta_{flare,h}$ Flare efficiency in hour *h*

GWP_{CH_4} Global warming potential of methane (tCO_2e/tCH_4)

$\frac{1}{1000}$ Factor to convert kg/y to tonne/y

A default flare efficiency of 90% was used for all borehole flares (provided that the temperature in the exhaust gas of the flare was above 500°C for more than 40 minutes during the hour *h*), in accordance with version 01 of the ‘Tool to determine project emissions from flaring gases containing methane’.

Borehole flare DBE1

The table below shows the monthly values used in the calculation of $PE_{UM,y}$ in borehole flare DBE1.

Month	$PE_{UM,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	GWP_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	35.1	26.8	0.9	21
Nov-11	36.7	24.3	0.9	21
Dec-11	37.4	24.0	0.9	21
Jan-12	38.4	24.6	0.9	21
Feb-12	34.5	23.6	0.9	21
Mar-12	8.1	23.1	0.9	21

Borehole flare 2264

The table below shows the monthly values used in the calculation of $PE_{UM,y}$ in borehole flare 2264.

Month	$PE_{UM,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	GWP_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	-	-	-	-
Nov-11	-	-	-	-
Dec-11	-	-	-	-
Jan-12	-	-	-	-
Feb-12	-	-	-	-
Mar-12	-	-	-	-

Borehole flare 1400

The table below shows the monthly values used in the calculation of $PE_{UM,y}$ in borehole flare 1400.

Month	$PE_{UM,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	GWP_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	21.5	25.1	0.9	21
Aug-11	34.2	24.3	0.9	21
Sep-11	39.7	26.2	0.9	21
Oct-11	43.8	28.0	0.9	21
Nov-11	42.3	28.0	0.9	21
Dec-11	43.3	27.7	0.9	21
Jan-12	41.8	26.8	0.9	21
Feb-12	38.0	26.0	0.9	21
Mar-12	37.1	25.4	0.9	21

Borehole flare EX1

The table below shows the monthly values used in the calculation of $PE_{UM,y}$ in borehole flare EX1.

Month	$PE_{UM,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	GWP_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	104	66.4	0.9	21
Aug-11	123	79.0	0.9	21
Sep-11	134	88.9	0.9	21
Oct-11	138	88.5	0.9	21
Nov-11	136	89.8	0.9	21
Dec-11	140	89.7	0.9	21
Jan-12	140	89.5	0.9	21
Feb-12	130	88.9	0.9	21
Mar-12	138	88.4	0.9	21

Borehole flare ST23

The table below shows the monthly values used in the calculation of $PE_{UM,y}$ in borehole flare ST23.

Month	$PE_{UM,y}$	$TM_{RG,h}$	$\eta_{flare,h}$	GWP_{CH4}
	tCO_2e	kg/h	-	tCO_2e/tCH_4
Jul-11	5	6	0.9	21
Aug-11	104	66	0.9	21
Sep-11	94	155	0.9	21
Oct-11	174	192	0.9	21
Nov-11	112	159	0.9	21
Dec-11	270	173	0.9	21
Jan-12	251	161	0.9	21
Feb-12	229	157	0.9	21
Mar-12	232	149	0.9	21

The mass flow rate in the residual gas on a dry basis ($TM_{RG,h}$) was calculated using equation (13) of the 'Tool to determine project emissions from the flaring of gases containing methane' Version 01.

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$ (Tool equation 13)

Where,
$FV_{RG,h}$ Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (m^3/h)
$fv_{CH4,RG,h}$ Volumetric fraction of methane in the residual gas on dry basis in hour *h*
$\rho_{CH4,n}$ Density of methane at normal conditions (kg/m^3)

Borehole flare DBE1

The table below shows the monthly values used in the calculation of $TM_{RG,h}$ in borehole flare DBE1.

Month	$TM_{RG,h}$	$FV_{RG,h}$	$fv_{CH4,RG,h}$	$\rho_{CH4,n}$
	kg/h	m^3/h	-	kg/m^3
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	26.8	41.8	0.90	0.716
Nov-11	24.3	38.6	0.88	0.716
Dec-11	24.0	37.2	0.90	0.716
Jan-12	24.6	36.3	0.95	0.716
Feb-12	23.6	35.4	0.93	0.716
Mar-12	23.1	34.7	0.93	0.716

Borehole flare 2264

The table below shows the monthly values used in the calculation of $TM_{RG,h}$ in borehole flare 2264.

Month	$TM_{RG,h}$	$FV_{RG,h}$	$fv_{CH4,RG,h}$	$\rho_{CH4,n}$
	kg/h	m^3/h	-	kg/m^3
Jul-11	-	-	-	-
Aug-11	-	-	-	-
Sep-11	-	-	-	-
Oct-11	-	-	-	-
Nov-11	-	-	-	-
Dec-11	-	-	-	-
Jan-12	-	-	-	-
Feb-12	-	-	-	-
Mar-12	-	-	-	-

Borehole flare 1400

The table below shows the monthly values used in the calculation of $TM_{RG,h}$ in borehole flare 1400.

Month	$TM_{RG,h}$	$FV_{RG,h}$	$fv_{CH4,RG,h}$	$\rho_{CH4,n}$
	kg/h	m^3/h	-	kg/m^3
Jul-11	25.1	35.2	0.99	0.716
Aug-11	24.3	34.1	0.99	0.716
Sep-11	26.2	37.7	0.97	0.716
Oct-11	28.0	40.1	0.98	0.716
Nov-11	28.0	39.2	1.00	0.716
Dec-11	27.7	38.7	1.00	0.716
Jan-12	26.8	37.4	1.00	0.716
Feb-12	26.0	36.6	0.99	0.716
Mar-12	25.4	36.1	0.98	0.716

Borehole flare EX1

The table below shows the monthly values used in the calculation of $TM_{RG,h}$ in borehole flare EX1.

Month	$TM_{RG,h}$	$FV_{RG,h}$	$fv_{CH4,RG,h}$	$\rho_{CH4,n}$
	kg/h	m^3/h	-	kg/m^3
Jul-11	66.4	122	0.76	0.716
Aug-11	79.0	121	0.91	0.716
Sep-11	88.9	124	1.00	0.716
Oct-11	88.5	125	0.99	0.716
Nov-11	89.8	126	1.00	0.716
Dec-11	89.7	125	1.00	0.716
Jan-12	89.5	125	1.00	0.716
Feb-12	88.9	125	0.99	0.716
Mar-12	88.4	125	0.99	0.716

Borehole flare ST23

The table below shows the monthly values used in the calculation of $TM_{RG,h}$ in borehole flare ST23.

Month	$TM_{RG,h}$	$FV_{RG,h}$	$fv_{CH4,RG,h}$	$\rho_{CH4,n}$
	kg/h	m^3/h	-	kg/m^3
Jul-11	6	256	0.03	0.716
Aug-11	66	234	0.40	0.716
Sep-11	155	233	0.93	0.716
Oct-11	192	291	0.92	0.716
Nov-11	159	232	0.96	0.716
Dec-11	173	251	0.96	0.716
Jan-12	161	235	0.96	0.716
Feb-12	157	225	0.97	0.716
Mar-12	149	215	0.97	0.716

E.3. Calculation of leakage
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No leakage is considered, in accordance with AM0064 version 02.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	**Baseline emissions or baseline net GHG removals by sinks (tCO_2e)**	**Project emissions or actual net GHG removals by sinks (tCO_{2e})**	**Leakage (tCO_2e)**	**Emission reductions or net anthropogenic GHG removals by sinks (tCO_2e)**
Total	51,050	9,735	0	41,305

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (tCO_2e)	189,997	41,305

E.6. Remarks on difference from estimated value in registered PDD

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The actual emission reductions are smaller than the values applied in the ex-ante calculation in the registered PDD. This is due to three reasons:

1. Lesser than expected flow rates of gas from the boreholes.

2. There were times during the monitoring period when the combustion temperatures of the borehole flares were below 500°C (this eventuality was not taken into account in the ex-ante emission calculations in the registered PDD). During these times, the flare efficiency was assumed to be 0% (as per version 01 of the 'Tool to determine project emissions from the flaring of gases containing methane'). No CERs have been claimed for these periods, as shown in section B.1 of this document.

3. No electricity was generated by internal combustions engines during this monitoring period.

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History of the document

Version	Date	Nature of revision
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Form **Business Function**: Issuance		