Monitoring report form
(Version 03.2)

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	04
Completion date of the monitoring report	15/07/2014
Registration date of the project activity	10/06/2011
Monitoring period number and duration of this monitoring period	Monitoring period number: 01 Duration of this monitoring period: 01/07/2011 – 31/03/2012 (the first and last days are included in this monitoring period)
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 Applied methodology: AM0064 (Version 02)
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	190 864 tCO_2e (prorated over the monitoring period length = 275 days)
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	36 010 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012 (if applicable)	36 010 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).	Not applicable.

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>The purpose of the project activity is to reduce greenhouse gas (GHG) emissions through the destruction and utilisation of methane at the Beatrix Gold Mine (referred to as Beatrix from this point on). Beatrix is a gold mining operation that is owned by GFI Mining South Africa (Pty) Ltd. The gold mine is located in the district of Theunissen in the Free State Province of South Africa.

The methane emitted at Beatrix can be classified into two categories:

1. Mine methane

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.

This project activity involves the destruction and utilisation of mine methane in the following manner:

The underground mine methane is piped approximately 3.5km from methane origination source (the geological faults) to the surface. At the surface, the methane is passed through a single enclosed flare to combust the gas. The flare is fitted with equipment necessary to measure the actual flare combustion efficiency. This equipment includes three different gas analysers which separately measure the methane concentration of the raw (inlet) gas, the methane concentration of the flue (exhaust) gas, and the oxygen concentration of the flue gas. The power consumption of the flare, the volumetric flow rate of gas, and the temperature of the exhaust gas are also measured (with a power meter, flow meter, and thermocouple respectively).

The flaring system was commissioned on 21/05/2011. Although no downtimes were experienced during this monitoring period, there were periods when the temperature of the exhaust gas of the flare was below 500ºC or when data was not recorded. No emission reductions for these periods have been claimed.

The flaring of mine methane is the first phase of this project activity. As a second phase of the project, internal combustion engines will be installed to generate electricity from the methane-rich gas. The flare will continue to operate when the engines are commissioned – either to flare excess gas that the engines cannot handle, or to flare all of the gas when the engines are offline for maintenance or unforeseen circumstances. These internal combustion engines were commissioned in April 2013.
Evidently, no emission reductions for the electricity generation portion of the project are claimed for this monitoring period.

2. Non-mine methane

Non-mine methane is emitted from boreholes that were drilled for exploration purposes at Beatrix. Since the start of the drilling program in the 1950s, a number of boreholes have intersected methane-carrying geological structures. 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 destruction of non-mine methane at these five boreholes. A single enclosed flare is installed at each of the boreholes to combust the non-mine methane. Each flare is equipped with solar panels to meet the entire energy requirement of the flaring activity.

The borehole flares are also fitted with the monitoring equipment required to claim the default flare efficiency. This monitoring equipment includes a flow meter to measure the flow rate of raw gas, a gas analyser to measure the methane concentration of raw gas, and a thermocouple to measure the temperature of the exhaust gas.

The commissioning dates for the borehole flares are provided in the table below. Also included in the table are the continued operational periods of the boreholes.

Flare	Commissioning date	Continued operational periods

DBE1	08/03/2011	Still operational at the time of writing MR.
2264	04/03/2011	Discontinued operation on 08/04/2011 due to low gas flow rates. This flare may become operation again if the gas flow increases.
1400	06/03/2011	Still operational at the time of writing MR.
EX1	23/03/2011	Still operational at the time of writing MR.
ST23	02/03/2011	Still operational at the time of writing MR.

The total emission reductions achieved during this monitoring period (01/07/2011 – 31/03/2012) are 36,010 tCO_2e.

A.2. Location of project activity

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Host Party:
Republic of South Africa

Region/State/Province:
Free State Province

City/Town/Community:
District of Theunissen

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. The GPS coordinates of the flares are provided in the table below.

Flare	GPS coordinates (degrees)	GPS coordinates (decimals)
Main flare	S 28° 15' 44" E 26º 47' 06"	-28.262 26.785
DBE1	S 28º 11' 066" E 26º 45' 488"	-28.184 26.764
EX1	S 28º 16' 334" E 26º 44' 612"	-28.272 26.744
ST23	S 28º 11' 995" E 26º 44' 312"	-28.200 26.139
1400	S 28º 13' 323" E 26º 44' 607"	-28.222 26.760
2264	S 28º 13' 908" E 26º 47' 078"	-28.232 26.785

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) Promethium Carbon (Pty) Ltd (Private Entity)	No
Switzerland	Mercuria Energy Trading SA (Private Entity)	No

A.4. Reference of applied methodology

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Applied methodology

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

Tools 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

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Type: Renewable
Start date: 01/07/2011
Length: Seven years

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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Description of the installed technology, technical processes and equipments

This project can be divided into two categories:

1. The destruction and utilisation of mine methane

On 21/05/2011, a single enclosed flare was commissioned to combust mine methane. This mine methane originates from underground geological faults which are intersected during mining activities at the Beatrix main shaft.

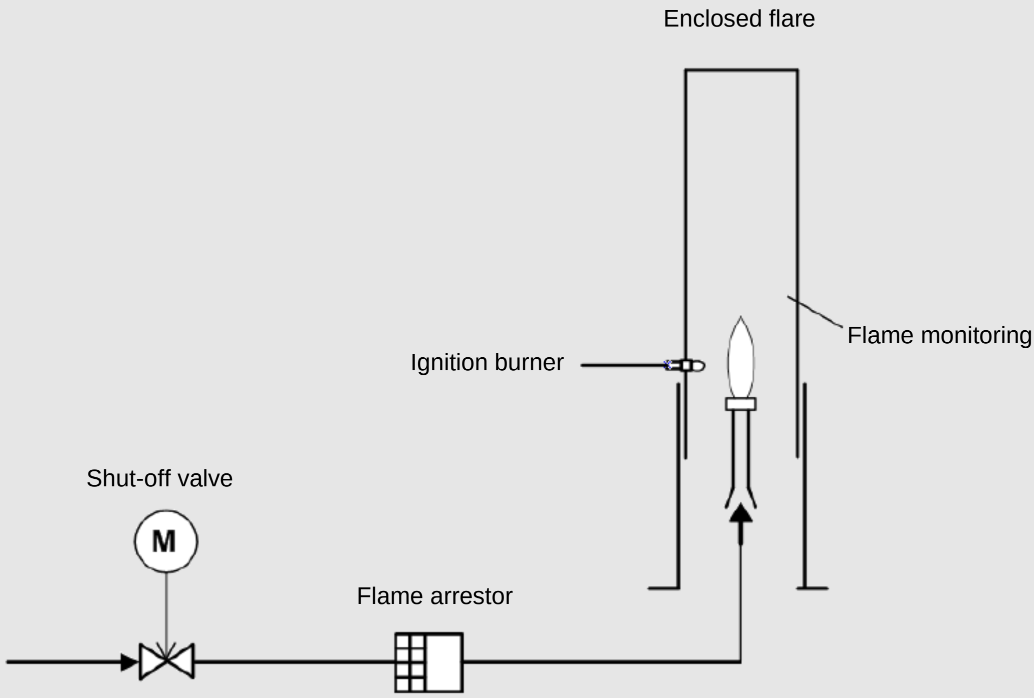
The flare installed at the main shaft is designed for a maximum gas flow rate of 400l/s and a minimum gas flow rate of 7 l/s. The average flow rate of gas sent to the flare during this monitoring period (01/07/2011 – 31/03/2012) was 74l/s, which is well within these limits.

The flare at the main shaft is fitted with equipment necessary to measure the actual flare combustion efficiency. This equipment includes:

Monitoring Instrument	Description
Methane gas analysers	Non-dispersive infrared-photometers (NDIP) which record the absorption of infrared rays caused by the raw and flue gas.
Oxygen gas analyser	The gas analyser uses a chemical sensor to measure the oxygen content in the flue gas.
Thermocouple	A type-N thermocouple (NiCrSi-NiSi) is used to measure the temperature of the exhaust gas of the flare.
Flow meter	A differential pressure flow meter with pitot tubes and a deltabar differential pressure transmitter is used to measure the flow rate of the gas.
Power meter	The quantity of electricity consumed by the flare is measured by an energy metering unit (EMU).

The single enclosed flare and associated monitoring equipment was built by Hofstetter, a Swiss company specialising in flaring technology and degassing systems.

A graphical representation of the flare is given below.



As a second phase of this project, internal combustion engines will be installed to produce electricity from the mine methane. This phase has not yet been implemented – for more information on this, please see section A.1.

2. The destruction of non-mine methane

The project activity also includes the destruction of non-mine methane emanating from five exploration boreholes. A single enclosed flare is installed at each of the boreholes to combust the non-mine methane. These flares employ the same technology as the main flare however; each flare is fitted with solar panel to meet the entire energy requirement of the flare.

The borehole flares are equipped with the monitoring equipment required to claim the default flare efficiency. This monitoring equipment includes a differential pressure flow meter to measure the flow rate of raw gas, an NIDP gas analyser to measure the methane concentration of raw gas, and a Type-N thermocouple to measure the temperature of the exhaust gas.

<u>Information on the implementation and actual operation of the project activity</u>

The commissioning dates for the flares are provided in the table below. Also included in the table are the continued operational periods of the flares.

Flare	Commissioning date	Continued operational periods
Main flare	21/05/2011	Still operational at the time of writing MR.
DBE1	08/03/2011	Still operational at the time of writing MR.
2264	04/03/2011	Discontinued operation on 08/04/2011 due to low gas flow rates. This flare may become operation again if the gas flow increases.
1400	06/03/2011	Still operational at the time of writing MR.
EX1	23/03/2011	Still operational at the time of writing MR.
ST23	02/03/2011	Still operational at the time of writing MR.

For this monitoring period, there were no downtimes of equipment or major overhauls. There were, however, times when the exhaust gas of the 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’). There were also certain days when data was not recorded. No Certified Emission Reductions (CERs) are claimed for these periods, as shown in the table below.

Flare	Number of days when no CERs can be claimed during monitoring period		
	Exhaust gas temperature below 500ºC	No data recorded	Total
Main Flare	88	6	94
DBE1	77	29	106
2264	275	0	275
1400	11	8	19
EX1	0	0	0
ST23	17	44	61

The registered PDD 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 but the tentative timeline to engine commissioning is provided in section A.1 of this report.

The registered PDD also makes a provision for the installation of additional monitoring equipment at the two biggest emitting boreholes – ST23 and EX1 – to measure both the inlet and outlet gas conditions in order to calculate the actual combustion efficiency. No plans have yet been made to install this equipment.

Descriptions or situations that occurred during the monitoring period that may impact the applicability of the applied methodology and how issues resulting from these events or situations have been addressed

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.

Submission of any requests for prior approval by the Board of changes to the registered CDM project activity

No requests for prior approval of changes to the registered PDD have been submitted to the Board.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

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Not applicable.

B.2.2. Corrections

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Not applicable.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

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Not applicable.

B.2.4. Changes to project design of registered project activity

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Not applicable.

B.2.5. Changes to start date of crediting period

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Not applicable.

B.2.6. Types of changes specific to afforestation or reforestation project activity

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Not applicable.

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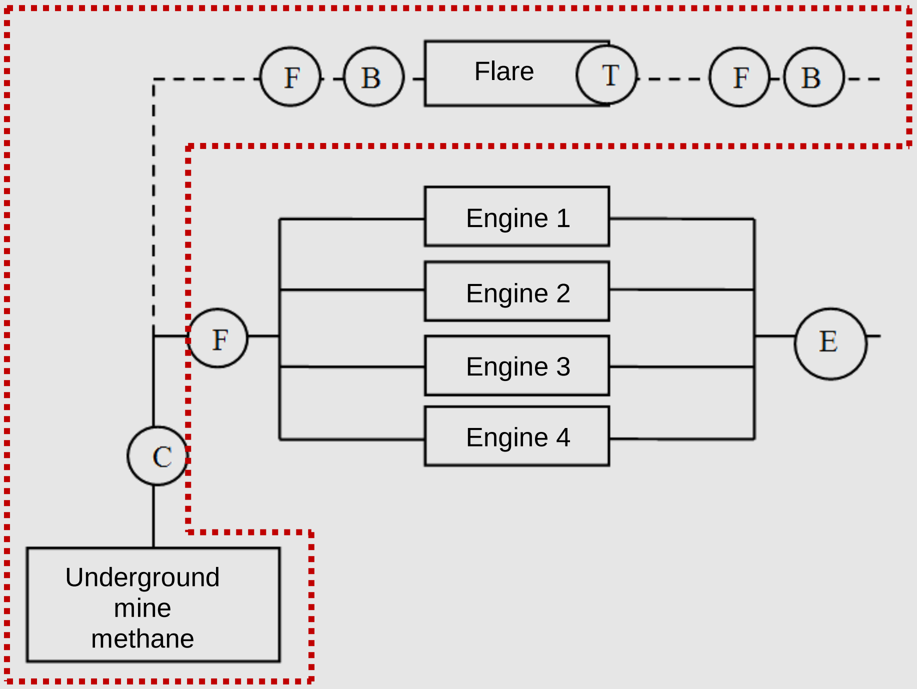
Beatrix's monitoring system ensures that the project activity's emission reductions are accurately monitored, recorded and reported.

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 Beatrix's main shaft. The monitoring equipment for this flare (and the placing of the equipment) is shown in the diagram below, extracted from the registered PDD. Since only Phase 1 of the project is relevant to this monitoring period i.e. the flaring of the mine methane, only the monitoring equipment outlined in red is relevant to this monitoring period.



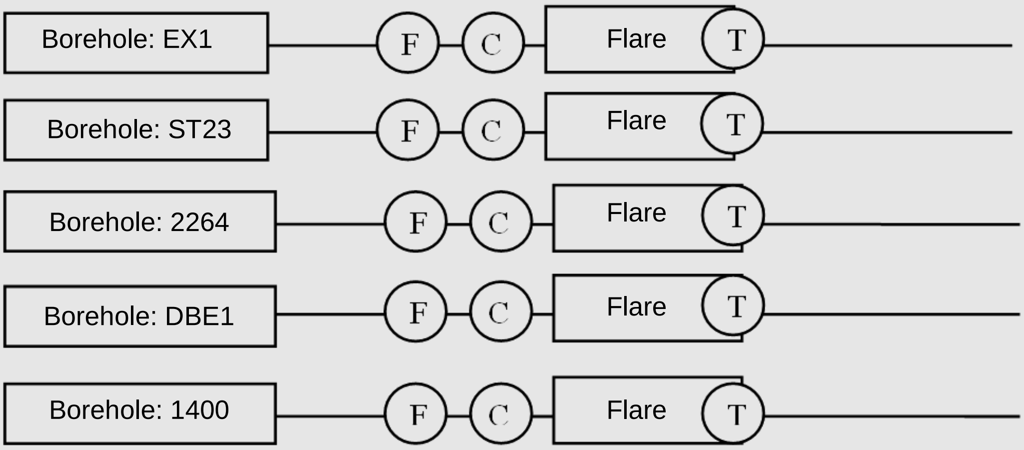
A description of the symbols is provided in the table below.

Symbol	Description	Function
B	Methane and Oxygen Concentration Meter	Measure CH_4 and O_2 concentration of gas.
F	Gas Flow Meter	Measure gas flow rate sent to generators and flares.
T	Thermocouple	Measures the temperature of the flare to ensure correct operation.
E	Electricity Meter	Measure electricity generated by the engines.
C	Gas composition	Measuring the composition of the gas (CH_4, NMHC). The gas will be sampled every 3 months and tested for the NMHC concentration.

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.

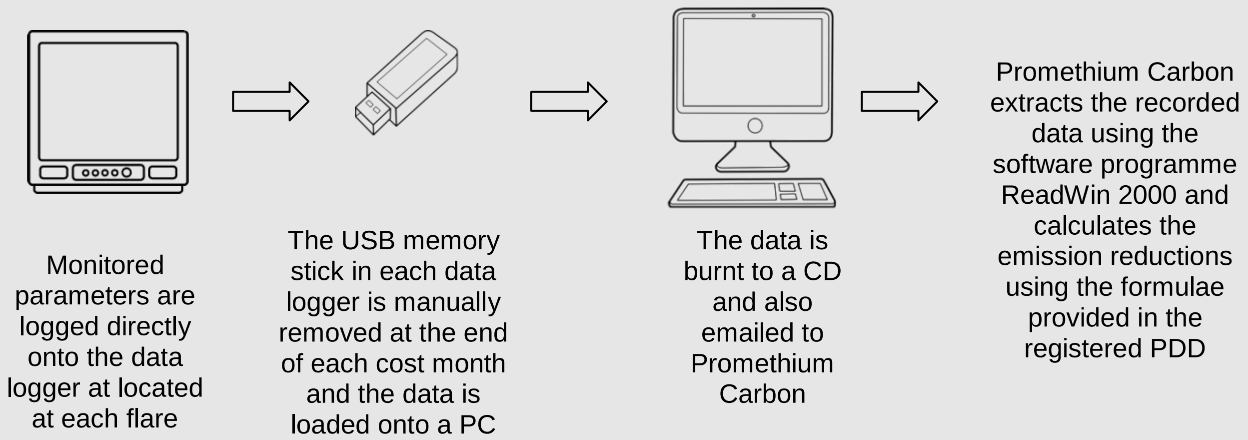
Symbol	Description	Function
F	Gas flow meter	Measures gas flow rate.
C	Concentration meter	Measures methane concentration of gas.
T	Thermocouple	Measures temperature of flare to ensure correct operation.

<u>Data collection procedures and information flow</u>

Each flare is fitted with a data logger where the monitored data (from the start of flare operation) is stored. A 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.

The information flow in the project activity is visually represented as follows:



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:	“Tool to determine project emissions from flaring gases containing methane” (Version 01)
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:	-

Data / Parameter:	s_{grid}
Unit:	percentage
Description:	Percentage of the electricity demand supplied by the grid imports for the 3 years preceding the implementation of the project.
Source of data:	Current and historical mining operations at Beatrix mine.
Value(s) applied:	100%
Purpose of data:	Baseline and project emission calculations.
Additional comment:	No captive electricity generation occurs in the baseline. Historically, all electricity is sourced from the national grid.

Data / Parameter:	$s_{captive}$
Unit:	percentage

Description:	Percentage of the electricity demand supplied by captive electricity generation for the 3 years preceding the implementation of the project.
Source of data:	Current and historical mining operations at Beatrix mine.
Value(s) applied:	0%
Purpose of data:	Baseline and project emission calculations.
Additional comment:	No captive electricity generation occurs in the baseline. Historically, all electricity is sourced from the national grid.

Data / Parameter:	Eff_{ELEC}
Unit:	percentage
Description:	Efficiency of methane destruction/oxidation in power plant
Source of data:	IPCC default value as stated in AM0064
Value(s) applied:	99.5%
Purpose of data:	Project emission calculations
Additional comment:	-

Data / Parameter:	TH_{BL}
Unit:	tCH4/year
Description:	Average annual thermal demand over the past 5 years.
Source of data:	Current and historical mining operations at Beatrix mine.
Value(s) applied:	0
Purpose of data:	Baseline emission calculations
Additional comment:	Historically the baseline scenario had no thermal demand.

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:	$MM_{PR,flare,y}$ or $MMES_{FL,y}$
Unit:	tCH_4/yr (or tCH_4/month)
Description:	Mine methane captured, sent to and destroyed by flare in the project activity in year *y*
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:	<table><tr><th>Period</th><th>tCH₄</th></tr><tr><td>Jul 2011</td><td>49.6</td></tr><tr><td>Aug 2011</td><td>58.4</td></tr><tr><td>Sep 2011</td><td>66.9</td></tr><tr><td>Oct 2011</td><td>34.6</td></tr><tr><td>Nov 2011</td><td>123.1</td></tr><tr><td>Dec 2011</td><td>121.2</td></tr><tr><td>Jan 2012</td><td>130.1</td></tr><tr><td>Feb 2012</td><td>137.0</td></tr><tr><td>Mar 2012</td><td>92.1</td></tr></table>
Monitoring equipment:	<u>Flow meter:</u> Type: PMD70-1BJ7B1DAAA manufactured by Endress+Hauser GmbH+Co. KG Accuracy class: +/- 1.2% measurement tolerance Serial number: DA00220109D Calibration frequency: Yearly Calibration dates relevant to this monitoring period: This meter was factory calibrated on 06/10/2010. However, since the main flare was only commissioned on 25/05/2011, this meter will remain in calibration until 24/05/2011 (which forms part of the next monitoring period). <u>Gas analyser:</u> Type: 4010.24-1, manufactured by NENNING UND KRUMM (NUK) GmbH Accuracy class: +/- 1% full scale measurement tolerance Serial number: A1543 Calibration frequency: Weekly Calibration dates relevant to this monitoring period: 24/06/2011; 15/07/2011; 22/07/2011; 29/07/2011; 12/08/2011; 19/08/2011; 26/08/2011; 02/09/2011; 09/09/2011; 23/09/2011; 07/10/2011; 28/10/2011; 01/11/2011; 04/11/2011; 11/11/2011: 18/11/2011; 30/11/2011; 02/12/2011; 09/12/2011; 20/01/2012; 06/02/2012; 13/02/2012; 20/02/2012; 02/03/2012; 09/03/2012; 19/03/2012; 30/03/2012. In the cases where the gas analyser calibration has been delayed for a period of more than 7 days, paragraph 238 of version 03 of the Validation and Verification Standard has been applied to conservatively calculate emission reductions.

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).
QA/QC procedures:	The flow meter and gas analyser are calibrated in accordance with manufacturer's specifications. The flow meter is calibrated using a multimeter. The equalising valve manifold is closed and different pressures are applied. A low range pressure is applied and the output of the transmitter is set to 4mA. A high range pressure is applied and the output of the transmitter is set to 20mA. The CH_4 gas analyser is calibrated using calibration gas (consisting of a mixture of 40 Vol% CH_4, 35 Vol% CO_2 and 25% N_2) in the following manner: For the sensitivity adjustment, the bottle with span gas is connected to the calibration gas. Using the measuring gas switch, the 'gas mixture' option is selected and the gas flow is adjusted to 50l/h. The analyser with the sensitivity switch is then set to the methane concentration from the span gas bottle. For the zero point adjustment, the bottle with air is connected to the calibration gas. Using the measuring gas switch, the 'air' option is selected and the gas flow is adjusted to 50l/h. The analyser with the zero point switch is then set to the zero point.
Purpose of data:	Baseline and project emission calculations.
Additional comment:	The data unit for this parameter is given as tCH_4/y in the registered PDD; however, since this is a nine month monitoring period, emission reductions have been calculated on a monthly basis, hence the unit tCH_4/month has been used.

Data / Parameter:	$EC_{PJ,y}$
Unit:	MWh/y (or MWh/month)
Description:	Quantity of electricity consumed by the project electricity consumption source in year *y*
Measured/ Calculated / Default:	Measured continuously and recorded in kWh/day. This data is then converted to MWh/month for the purposes of calculating monthly emission reductions.
Source of data:	Energy Measuring Unit (EMU)

Value(s) of monitored parameter:	<table><tr><td>Period</td><td>MWh</td></tr><tr><td>Jul 2011</td><td>1.58</td></tr><tr><td>Aug 2011</td><td>2.21</td></tr><tr><td>Sep 2011</td><td>2.51</td></tr><tr><td>Oct 2011</td><td>1.07</td></tr><tr><td>Nov 2011</td><td>3.65</td></tr><tr><td>Dec 2011</td><td>3.98</td></tr><tr><td>Jan 2012</td><td>5.42</td></tr><tr><td>Feb 2012</td><td>6.64</td></tr><tr><td>Mar 2012</td><td>3.43</td></tr></table>
Monitoring equipment:	Energy Measuring Unit (EMU) Type: EMU32x4, 5(g)A manufactured by EMU Elektronik AG Accuracy class: +/- 2% measurement tolerance Serial number: 106043 Calibration frequency: Biennial replace Date of last calibration: 2010/10/08 Validity: Two years
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:	The data unit for this parameter is given as MWh/y in the registered PDD; however, since this is a nine month monitoring period, emission reductions have been calculated on a monthly basis, hence the unit MWh/month has been used.

Data / Parameter:	PC_{NMHC}
Unit:	%
Description:	NMHC concentration (in mass) in extracted gas
Measured/ Calculated / Default:	Measured
Source of data:	NECSA test results
Value(s) of monitored parameter:	<table><tr><td>Aug 2011</td><td><1%</td></tr><tr><td>Nov 2011</td><td><1%</td></tr><tr><td>Feb 2012</td><td><1%</td></tr></table>
Monitoring equipment:	The gas is sampled and the samples are sent to a laboratory for testing.
Measuring/ Reading/ Recording frequency:	The gas is sampled every three months initially and tested for the NMHC concentration. (The frequency of sampling will be reduced to twice a year after the first year of operation of the plant.)
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Not applicable – tests are done by a third party.

Purpose of data:	To determine whether to include the emissions from the combustion of NMHC in the flare as project emissions.
Additional comment:	The emissions from the combustion of NMHC in the flare are included as project emissions if the NMHC accounts for more than 1% by volume of extracted mine methane.

Data / Parameter:	TDL_y
Unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to the project activity.
Measured/ Calculated / Default:	Default. According to page 75 of the registered PDD 'A default value of 3% was used because the scenario presented below was found to be applicable to the project: *(b) project and leakage electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies.*'
Source of data:	Page 12 of the 'Tool to calculate baseline, project and/or leakage emissions from electricity consumption' version 01, and page 75 of the registered PDD.
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:	-

Data / Parameter:	$FV_{RG,h}$
Unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis as normal conditions in the hour *h*.
Measured/ Calculated / Default:	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.
Source of data:	Flow meter

Value(s) of monitored parameter:	Period / m^3/hr: Jul 2011: 238; Aug 2011: 216; Sep 2011: 249; Oct 2011: 230; Nov 2011: 357; Dec 2011: 389; Jan 2012: 439; Feb 2012: 481; Mar 2012: 503
Monitoring equipment:	Flow meter: Type: PMD70-1BJ7B1DAAA manufactured by Endress+Hauser GmbH+Co. KG Accuracy class: +/- 1.2% measurement tolerance Serial number: DA00220109D Calibration frequency: Yearly Calibration dates relevant to this monitoring period: This meter was factory calibrated on 06/10/2010. However, since the main flare was only commissioned on 25/05/2011, this meter will remain in calibration until 24/05/2011 (which forms part of the next monitoring period).
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 using a multimeter. The equalising valve manifold is closed and different pressures are applied. A low range pressure is applied and the output of the transmitter is set to 4mA. A high range pressure is applied and the output of the transmitter is set to 20mA.
Purpose of data:	Project emission calculations.
Additional comment:	-

Period	m^3/hr
Jul 2011	238
Aug 2011	216
Sep 2011	249
Oct 2011	230
Nov 2011	357
Dec 2011	389
Jan 2012	439
Feb 2012	481
Mar 2012	503

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:	<table><tr><th>Period</th><th>Methane volumetric fraction</th><th>Nitrogen volumetric fraction</th></tr><tr><td>Jul 2011</td><td>0.0037</td><td>0.9963</td></tr><tr><td>Aug 2011</td><td>0.0044</td><td>0.9966</td></tr><tr><td>Sep 2011</td><td>0.0031</td><td>0.9969</td></tr><tr><td>Oct 2011</td><td>0.0026</td><td>0.9980</td></tr><tr><td>Nov 2011</td><td>0.0020</td><td>0.9980</td></tr><tr><td>Dec 2011</td><td>0.0040</td><td>0.9960</td></tr><tr><td>Jan 2012</td><td>0.0030</td><td>0.9970</td></tr><tr><td>Feb 2012</td><td>0.0030</td><td>0.9970</td></tr><tr><td>Mar 2012</td><td>0.0110</td><td>0.9890</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.
Monitoring equipment:	Gas analyser: Type: 4010.24-7, manufactured by NENNING UND KRUMM (NUK) GmbH Accuracy class: +/- 1% full scale measurement tolerance Serial number: A1568 Calibration frequency: Weekly Calibration dates relevant to this monitoring period: 24/06/2011; 15/07/2011; 22/07/2011; 29/07/2011; 12/08/2011; 19/08/2011; 26/08/2011; 02/09/2011; 09/09/2011; 23/09/2011; 07/10/2011; 28/10/2011; 01/11/2011; 04/11/2011; 11/11/2011: 18/11/2011; 30/11/2011; 02/12/2011; 09/12/2011; 20/01/2012; 06/02/2012; 13/02/2012; 20/02/2012; 02/03/2012; 09/03/2012; 19/03/2012; 30/03/2012. In the cases where the gas analyser calibration has been delayed for a period of more than 7 days, paragraph 238 of version 03 of the Validation and Verification Standard has been applied to conservatively calculate emission reductions.
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):	Not applicable. No calculation method is used.
QA/QC procedures:	The CH_4 gas analyser is calibrated using calibration gas (consisting of a mixture of 40 Vol% CH_4, 35 Vol% CO_2 and 25% N_2) in the following manner: For the sensitivity adjustment, the bottle with span gas is connected to the calibration gas. Using the measuring gas switch, the ‘gas mixture’ option is selected and the gas flow is adjusted to 50l/h. The analyser with the sensitivity switch is then set to the methane concentration from the span gas bottle. For the zero point adjustment, the bottle with air is connected to the calibration gas. Using the measuring gas switch, the ‘air’ option is selected and the gas flow is adjusted to 50l/h. The analyser with the zero point switch is then set to the zero point.
Purpose of data:	Project emission calculations.
Additional comment:	-

Data / Parameter:	$fv_{CH_4,FG,h}$
Unit:	mg/m^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:	Flow meter and gas analyser
Value(s) of monitored parameter:	(see table below)
Monitoring equipment:	<u>Flow meter:</u> Type: PMD70-1BJ7B1DAAA manufactured by Endress+Hauser GmbH+Co. KG Accuracy class: +/- 1.2% measurement tolerance Serial number: DA00220109D Calibration frequency: Yearly Calibration dates relevant to this monitoring period: This meter was factory calibrated on 06/10/2010. However, since the main flare was only commissioned on 25/05/2011, this meter will remain in calibration until 24/05/2011 (which forms part of the next monitoring period). <u>Gas analyser:</u> Type: 4010.24-7, manufactured by NENNING UND KRUMM (NUK) GmbH Accuracy class: +/- 1% full scale measurement tolerance Serial number: A1568 Calibration frequency: Weekly Calibration dates relevant to this monitoring period: 24/06/2011; 15/07/2011; 22/07/2011; 29/07/2011; 12/08/2011; 19/08/2011; 26/08/2011; 02/09/2011; 09/09/2011; 23/09/2011; 07/10/2011; 28/10/2011; 01/11/2011; 04/11/2011; 11/11/2011: 18/11/2011; 30/11/2011; 02/12/2011; 09/12/2011; 20/01/2012; 06/02/2012; 13/02/2012; 20/02/2012; 02/03/2012; 09/03/2012; 19/03/2012; 30/03/2012. In the cases where the gas analyser calibration has been delayed for a period of more than 7 days, paragraph 238 of version 03 of the Validation and Verification Standard has been applied to conservatively calculate emission reductions.
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.

Value(s) of monitored parameter:

Period	mg/Nm^3
Jul 2011	2944
Aug 2011	2864
Sep 2011	2343
Oct 2011	1611
Nov 2011	1322
Dec 2011	2831
Jan 2012	1920
Feb 2012	2148
Mar 2012	1623

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. The flow meter is calibrated using a multimeter. The equalising valve manifold is closed and different pressures are applied. A low range pressure is applied and the output of the transmitter is set to 4mA. A high range pressure is applied and the output of the transmitter is set to 20mA. The CH_4 gas analyser is calibrated using calibration gas (consisting of a mixture of 40 Vol% CH_4, 35 Vol% CO_2 and 25% N_2) in the following manner: For the sensitivity adjustment, the bottle with span gas is connected to the calibration gas. Using the measuring gas switch, the 'gas mixture' option is selected and the gas flow is adjusted to 50l/h. The analyser with the sensitivity switch is then set to the methane concentration from the span gas bottle. For the zero point adjustment, the bottle with air is connected to the calibration gas. Using the measuring gas switch, the 'air' option is selected and the gas flow is adjusted to 50l/h. The analyser with the zero point switch is then set to the zero point.
Purpose of data:	Project emission calculations.
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:	see table below

Period	Oxygen volumetric fraction
Jul 2011	0.17
Aug 2011	0.17
Sep 2011	0.16
Oct 2011	0.15
Nov 2011	0.13
Dec 2011	0.13
Jan 2012	0.15
Feb 2012	0.15
Mar 2012	0.14

Monitoring equipment:	Gas analyser: Type: 4010.24-7, manufactured by NENNING UND KRUMM (NUK) GmbH Accuracy class: +/- 1% full scale measurement tolerance Serial number: A1557 Calibration frequency: Weekly Calibration dates relevant to this monitoring period: 24/06/2011; 15/07/2011; 22/07/2011; 29/07/2011; 12/08/2011; 19/08/2011; 26/08/2011; 02/09/2011; 09/09/2011; 23/09/2011; 07/10/2011; 28/10/2011; 01/11/2011; 04/11/2011; 11/11/2011: 18/11/2011; 30/11/2011; 02/12/2011; 09/12/2011; 20/01/2012; 06/02/2012; 13/02/2012; 20/02/2012; 02/03/2012; 09/03/2012; 19/03/2012; 30/03/2012. In the cases where the gas analyser calibration has been delayed for a period of more than 7 days, paragraph 238 of version 03 of the Validation and Verification Standard has been applied to conservatively calculate emission reductions.
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 O_2 gas analyser is calibrated using calibration gas (consisting of a mixture of 40 Vol% CH_4, 35 Vol% CO_2 and 25% N_2) in the following manner: For the sensitivity adjustment, the bottle with span gas is connected to the calibration gas. The gas flow is adjusted to 50l/h and the analyser with the sensitivity switch is then set to 21 Vol% O_2. For the zero point adjustment, the bottle with air is connected to the calibration gas. The gas flow is adjusted to 50l/h, and the analyser with the zero point switch is then set to the zero point.
Purpose of data:	Project emission calculations.
Additional comment:	-

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:	see table below

Period	%
Jul 2011	0.30
Aug 2011	0.36
Sep 2011	0.26
Oct 2011	0.22
Nov 2011	0.17
Dec 2011	0.35
Jan 2012	0.26
Feb 2012	0.25
Mar 2012	0.93

Monitoring equipment:	Gas analyser: Type: 4010.24-7, manufactured by NENNING UND KRUMM (NUK) GmbH Accuracy class: +/- 1% full scale measurement tolerance Serial number: A1568 Calibration frequency: Weekly Calibration dates relevant to this monitoring period: 24/06/2011; 15/07/2011; 22/07/2011; 29/07/2011; 12/08/2011; 19/08/2011; 26/08/2011; 02/09/2011; 09/09/2011; 23/09/2011; 07/10/2011; 28/10/2011; 01/11/2011; 04/11/2011; 11/11/2011: 18/11/2011; 30/11/2011; 02/12/2011; 09/12/2011; 20/01/2012; 06/02/2012; 13/02/2012; 20/02/2012; 02/03/2012; 09/03/2012; 19/03/2012; 30/03/2012. In the cases where the gas analyser calibration has been delayed for a period of more than 7 days, paragraph 238 of version 03 of the Validation and Verification Standard has been applied to conservatively calculate emission reductions.
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 CH_4 gas analyser is calibrated using calibration gas (consisting of a mixture of 40 Vol% CH_4, 35 Vol% CO_2 and 25% N_2) in the following manner: For the sensitivity adjustment, the bottle with span gas is connected to the calibration gas. Using the measuring gas switch, the 'gas mixture' option is selected and the gas flow is adjusted to 50l/h. The analyser with the sensitivity switch is then set to the methane concentration from the span gas bottle. For the zero point adjustment, the bottle with air is connected to the calibration gas. Using the measuring gas switch, the 'air' option is selected and the gas flow is adjusted to 50l/h. The analyser with the zero point switch is then set to the zero point.
Purpose of data:	Project emission calculations.
Additional comment:	-

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:	Exceeding 500ºC for 187 days of the 275 day monitoring period.
Monitoring equipment:	Thermocouple: Type: 90.1102.4520 manufactured by JUMO Mess- und Regeltechnik AG Accuracy class: +/- 1.2% measurement tolerance Serial number: D9185B14180 Calibration frequency: Not applicable, the thermocouple is replaced yearly Calibration dates relevant to this monitoring period: Not applicable, the thermocouple is replaced yearly

Measuring/ Reading/ Recording frequency:	The temperature in the exhaust gas of the flare is measured every minute. These values are averaged daily.
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:	Emission reductions are only claimed on the days when the temperature in the exhaust gas of the flare exceeds 500ºC.

Non-mine methane capture and destruction

Data / Parameter:	$FV_{RG,h}$
Unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*.
Measured/ Calculated / Default:	Measured
Source of data:	Flow meter
Value(s) of monitored parameter:	(see table below)

Period	DBE1	2264	1400	EX1	ST23
Jul 2011	Flare temperature below 500ºC	Flare not operational during the monitoring period	35.2	121.7	255.7
Aug 2011			34.1	120.9	233.5
Sep 2011			37.7	124.4	232.9
Oct 2011	41.8		40.1	125.0	290.5
Nov 2011	38.6		39.2	125.5	231.6
Dec 2011	37.2		38.7	125.3	250.5
Jan 2012	36.3		37.4	125.4	235.0
Feb 2012	35.4		36.6	125.0	224.8
Mar 2012	34.7		36.1	124.6	214.9

Monitoring equipment:

<u>Flow meter:</u>

	DBE1	2264	1400	EX1	ST23
Type	PDM70-1BJ7B1DAAA manufactured by Endress+Hauser GmbH+Co. KG				
Accuracy class	+/- 1.2% measurement tolerance				
Serial number	D908720109D	D908730109D	D908740109D	D908750109D	D908760109D
Calibration frequency	Yearly				
Calibration dates relevant to this monitoring period	Factory calibration: 04/10/2010 (Since DBE1 was commissioned on 08/03/2011, the meter will remain in calibration until 07/03/2012.)	Factory calibration: 04/10/2010 (Since DBE1 was commissioned on 04/03/2011, the meter will remain in calibration until 03/03/2012.)	Factory calibration: 04/10/2010 (Since 1400 was commissioned on 06/03/2011, the meter will remain in calibration until 05/03/2012.)	Factory calibration: 04/10/2010 (Since EX1 was commissioned on 23/03/2011, the meter will remain in calibration until 22/03/2012.)	Factory calibration: 04/10/2010 (Since DBE1 was commissioned on 02/03/2011, the meter will remain in calibration until 01/03/2012.)

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 using a multimeter. The equalising valve manifold is closed and different pressures are applied. A low range pressure is applied and the output of the transmitter is set to 4mA. A high range pressure is applied and the output of the transmitter is set to 20mA.
Purpose of data:	Baseline and project emission calculations.
Additional comment:	-

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
Jul 2011	Flare temperature below 500ºC	Flare not operational during the monitoring period	0.99	0.76	0.03
Aug 2011			0.99	0.91	0.40
Sep 2011			0.97	1.00	0.93
Oct 2011	0.90		0.98	0.99	0.92
Nov 2011	0.88		1.00	1.00	0.96
Dec 2011	0.90		1.00	1.00	0.96
Jan 2012	0.95		1.00	1.00	0.96
Feb 2012	0.93		0.99	0.99	0.97
Mar 2012	0.93		0.98	0.99	0.97

Nitrogen volumetric fraction

Period	DBE1	2264	1400	EX1	ST23
Jul 2011	Flare temperature below 500ºC	Flare not operational during the monitoring period	0.01	0.24	0.97
Aug 2011			0.01	0.09	0.60
Sep 2011			0.03	0.00	0.07
Oct 2011	0.10		0.02	0.01	0.08
Nov 2011	0.12		0.00	0.00	0.04
Dec 2011	0.10		0.00	0.00	0.04
Jan 2012	0.05		0.00	0.00	0.04
Feb 2012	0.07		0.01	0.01	0.03
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.

Monitoring equipment:	<u>Gas analyser:</u>

	DBE1	2264	1400	EX1	ST23
Type	4010.24-7	4010.24-6	4010.21-3	4010.24-4	4010.24-2
	Manufactured by NENNING UND KRUMM (NUK) GmbH				
Accuracy class	+/- 1.2% measurement tolerance				
Serial number	A1545	A1547	A1546	A1533	A1544
Calibration frequency	Weekly				
Calibration dates relevant to this monitoring period	01/07/2011 08/07/2011 15/07/2011 22/07/2011 29/07/2011 05/08/2011 07/10/2011 14/10/2011 17/10/2011 31/10/2011 04/11/2011 11/11/2011 24/11/2011 09/12/2011 21/12/2011 06/01/2012 13/01/2012 20/01/2012 27/01/2012 06/02/2012 13/02/2012 20/02/2012 27/02/2012 02/03/2012 09/03/2012 19/03/2012 23/03/2012 30/03/2012	Not relevant as flare not operational during monitoring period	01/07/2011 08/07/2011 15/07/2011 22/07/2011 29/07/2011 05/08/2011 12/08/2011 19/08/2011 02/09/2011 09/09/2011 16/09/2011 23/09/2011 30/09/2011 14/10/2011 31/10/2011 04/11/2011 11/11/2011 24/11/2011 09/12/2011 21/12/2011 06/01/2012 13/01/2012 20/01/2012 27/01/2012 06/02/2012 13/02/2012 20/02/2012 27/02/2012 02/03/2012 09/03/2012 19/03/2012 23/03/2012 30/03/2012	01/07/2011 08/07/2011 15/07/2011 22/07/2011 29/07/2011 05/08/2011 12/08/2011 19/08/2011 26/08/2012 02/09/2011 09/09/2011 16/09/2011 23/09/2011 30/09/2011 07/10/2011 14/10/2011 31/10/2011 04/11/2011 11/11/2011 24/11/2011 09/12/2011 21/12/2011 06/01/2012 13/01/2012 20/01/2012 27/01/2012 06/02/2012 13/02/2012 20/02/2012 27/02/2012 02/03/2012 09/03/2012 19/03/2012 23/03/2012 30/03/2012	01/07/2011 08/07/2011 15/07/2011 22/07/2011 29/07/2011 05/08/2011 12/08/2011 19/08/2011 26/08/2012 02/09/2011 09/09/2011 16/09/2011 23/09/2011 30/09/2011 07/10/2011 14/10/2011 31/10/2011 04/11/2011 11/11/2011 24/11/2011 09/12/2011 21/12/2011 06/01/2012 20/01/2012 27/01/2012 06/02/2012 13/02/2012 20/02/2012 27/02/2012 02/03/2012 09/03/2012 19/03/2012 23/03/2012 30/03/2012

In the cases where the gas analyser calibrations have been delayed for a period of more than 7 days, paragraph 238 of version 03 of the Validation and Verification Standard has been applied to conservatively calculate emission reductions.

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):	Not applicable. No calculation method is used.

QA/QC procedures:	The CH_4 gas analyser is calibrated using calibration gas (consisting of a mixture of 40 Vol% CH_4, 35 Vol% CO_2 and 25% N_2) in the following manner: For the sensitivity adjustment, the bottle with span gas is connected to the calibration gas. Using the measuring gas switch, the ‘gas mixture’ option is selected and the gas flow is adjusted to 50l/h. The analyser with the sensitivity switch is then set to the methane concentration from the span gas bottle. For the zero point adjustment, the bottle with air is connected to the calibration gas. Using the measuring gas switch, the ‘air’ option is selected and the gas flow is adjusted to 50l/h. The analyser with the zero point switch is then set to the zero point.
Purpose of data:	Project emission calculations.
Additional comment:	-

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:	Each flare’s exhaust gas temperature exceeded 500ºC for the following amount of days of the 275 day monitoring period:

DBE1	2264	1400	EX1	ST23
198	0	264	275	258

Monitoring equipment:	Thermocouple:

	DBE1	2264	1400	EX1	ST23
Type	90.1102.4520 manufactured by JUMO Mess- und Regeltechnik AG				
Accuracy class	+/- 1% full scale measurement tolerance				
Serial number	D9144714 180	D9144614 180	D9144814 180	D9144914 180	D9144A14 180
Calibration frequency	Not applicable, the thermocouples are replaced yearly				
Calibration dates relevant to this monitoring period	Not applicable, the thermocouples are replaced yearly				

Measuring/ Reading/ Recording frequency:	The temperature in the exhaust gas of the flares is measured every minute. These values are averaged daily.
Calculation method (if applicable):	Not applicable. No calculation method is used.
QA/QC procedures:	The thermocouples are replaced yearly in accordance with manufacturer specifications.
Purpose of data:	Project emission calculations.
Additional comment:	Emission reductions are only claimed on the days when the temperature in the exhaust gas of the flare exceeds 500ºC.

D.3. Implementation of sampling plan

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A sampling plan does not form part of this project activity. This section is 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

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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 (BE_y) are calculated using equation 1 of the applied methodology.

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{USe,y}$$

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 baseline emissions from the venting of methane ($BE_{MR,y}$) are calculated using equation 6 of the applied methodology. Since no ventilation air methane was used in the baseline or in the project case, $VAM_{PR,i,y} = VAM_{BL,i,y} = 0$. Furthermore, since no mine methane as captured and used in the baseline, $MM_{BL,i,y} = 0$. Therefore, equation 6 of the applied methodology simplifies to:

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

Where,

GWP_{CH_4}	Global Warming Potential of methane (tCO_2e/tCH_4)
$MM_{PR,flare,y}$	Mine methane captured, sent to and destroyed by flare in the project activity in year *y* (tCH_4/yr)

The calculation of BE_y for mine methane in this monitoring is shown below.

A sample calculation of BE_y for mine methane for the month of July 2011 is shown below.

$$BE_y = 21\frac{tCO_2e}{tCH_4} \times 49.6\frac{tCH_4}{month} = 1\,041\frac{tCO_2e}{month}$$

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.

$$BE_y = \sum_{h=1}^{8760} TM_{RG,h} \times \frac{GWP_{CH_4}}{1000}$$

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 hour *h* (kg/h)
$1/1000$	Factor to convert kg/year to ton/year

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

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

Where,

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

A sample calculation of $TM_{RG,h}$ and BE_y for borehole flare DBE1 in October 2011 is shown below.

$$TM_{RG,h} = 41.8 \frac{m^3}{h} \times 0.90 \times 0.716 \ \frac{kg}{m^3} = 28.6 \ \frac{kg}{h}$$

$$BE_y = 28.6 \frac{kg}{h} \times 24 \frac{hours}{day} \times 26 \frac{days}{month} \times \frac{21}{1000} = 351 \ \frac{tCO_2e}{month}$$

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.

<u>Mine methane capture and destruction</u>

Project emissions from flaring ($PE_{flare,y}$)

According to AM0064 version 02, the project participant shall account for the emissions from the combustion of methane in a flare using version 01 of the 'Tool to determine project emissions from flaring gases containing methane'. The formulae used in the calculation of these emissions are provided below.

STEP 1: Determination of the mass flow rate of the residual gas that is flared

This step calculates the residual gas mass flow rate in each hour h, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h} \qquad \text{(Flaring Tool 1)}$$

Where:

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

A sample calculation of $FM_{RG,h}$ for mine methane for the month of October 2011 is shown below.

$$FM_{RG,h} = 0.86\,\frac{kg}{m^3} \times 230\,\frac{m^3}{h} = 198\,\frac{kg}{h}$$

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n} \qquad \text{(Flaring Tool 2)}$$

Where:

$\rho_{RG,n,h}$	Density of residual gas at normal conditions in hour *h*
P_n	Atmospheric pressure at normal conditions (101,325 Pa)
R_u	Universal ideal gas constant (8 314 Pa.m^3/kmol.K)
$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (kg/kmol)
T_n	Temperature at normal conditions (273.15K)

A sample calculation of $\rho_{RG,n,h}$ for mine methane for the month of October 2011 is shown below.

$$\rho_{RG,n,h} = \frac{101\ 325\ Pa}{\frac{8\ 314\,\frac{Pa.m^3}{kmol.K}}{19.3\,\frac{kg}{kmol}} \times 273.15\ K} = 0.86\,\frac{kg}{m^3}$$

$$MM_{RG,h} = MM_{CH4} \times fv_{CH4} + MM_{N2} \times fv_{n2} \qquad \text{(Flaring Tool 3)}$$

Where:

$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (kg/kmol)
$fv_{i,h}$	Volumetric fraction of component *i* in the residual gas in the hour *h*
MM_i	Molecular mass of residual gas component *i*
i	The components CH_4, CO, CO_2, O_2, H_2, N_2

A sample calculation of $MM_{RG,h}$ for mine methane for the month of October 2011 is shown below.

$$MM_{RG,h} = 19.3\,\frac{kg}{kmol} \times 0.73 + 28.02\,\frac{kg}{kmol} \times 0.27 = 19.3\,\frac{kg}{kmol}$$

STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

The mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, were calculated from the volumetric fraction of each component *i* in the residual gas, as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \times AM_j \times NA_{j,i}}{MM_{RG,h}} \qquad \text{(Flaring Tool 4)}$$

Where:

$fm_{i,h}$	Mass fraction of element *j* in the residual gas in hour *h*
$fv_{i,h}$	Volumetric fraction of component *i* in the residual gas in the hour *h*
AM_i	Atomic mass of element *j* (kg/kmol)
$NA_{j,i}$	Number of atoms of element *j* in the component *i*
$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (kg/kmol)
j	The elements carbon, hydrogen, oxygen and nitrogen

i The components CH_4, CO, CO_2, O_2, H_2, N_2

A sample calculation of $fm_{N,h}$ for mine methane for the month of October 2011 is shown below.

$$fm_{N,h} = \frac{fv_{N2,h} \times AM_N \times NA_{N,N2}}{MM_{RG,h}} = \frac{0.27 \times 14.01 \frac{kg}{kmol} \times 2}{19.3 \frac{kg}{kmol}} = 0.40$$

STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis

The average volumetric flow rate of the exhaust gas in each hour *h* is based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, and the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h}$$ (Flaring Tool 5)

Where:

$TV_{n,FG,h}$	Volumetric flow rate of the exhaust gas in basis at normal conditions in hour *h* (m^3/h)
$V_{n,FG,h}$	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in hour *h* (m^3/h residual gas)
$FM_{RG,h}$	Mass flow rate of the residual gas in hour *h* (kg residual gas/h)

A sample calculation of $TV_{n,FG,h}$ for mine methane for the month of October 2011 is shown below.

$$TV_{n,FG,h} = 28.2 \frac{m^3}{kg} \times 198 \frac{kg}{h} = 5\ 586 \frac{m^3}{h}$$

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h}$$ (Flaring Tool 6)

Where:

$V_{n,FG,h}$	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas)
$V_{n,CO2,h}$	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h (m^3/kg residual gas)
$V_{n,O2,h}$	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas)
$V_{n,N2,h}$	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas)

A sample calculation of $V_{n,FG,h}$ for mine methane for the month of October 2011 is shown below.

$$V_{n,FG,h} = 0.84 \frac{m^3}{kg} + 4.40 \frac{m^3}{kg} + 22.9 \frac{m^3}{kg} = 28.2 \frac{m^3}{kg}$$

$$V_{n,O2,h} = n_{O2,h} \times MV_n$$ (Flaring Tool 7)

Where:

$V_{n,O2,h}$	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas)
$n_{O2,h}$	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (kmol/kg residual gas)
MV_n	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)

A sample calculation of $V_{n,O2,h}$ for mine methane for the month of October 2011 is shown below.

$$V_{n,O2,h} = 0.20\frac{kmol}{kg} \times 22.4\frac{m^3}{kmol} = 4.40\frac{m^3}{kg}$$

$$V_{n,N2,h} = MV_n \times \left\{ \frac{fm_{N,h}}{200AM_n} + \left(\frac{1-MF_{O2}}{MF_{O2}} \right) \times \left[F_h + n_{O2,h} \right] \right\} \quad \text{(Flaring Tool 8)}$$

Where:

$V_{n,N2,h}$	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h (m^3/kg residual gas)
MV_n	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)
$fm_{N,h}$	Mass fraction of nitrogen in the residual gas in hour *h*
AM_n	Atomic mass of nitrogen (kg/kmol)
MF_{O2}	O_2 volumetric fraction of air
F_h	Stoichoimetric quantity of moles O2 required for complete oxidation of one kg residual gas in hour *h*
$n_{O2,h}$	Quantity of moles of O2 in the exhaust gas of the flare per kg residual gas flared in hour *h*

A sample calculation of $V_{n,O2,h}$ for mine methane for the month of October 2011 is shown below.

$$V_{n,O2,h} = 22.4\frac{m^3}{kg} \times \{\frac{0.40}{200 \times 14.01\frac{kg}{kmol}} + \left(\frac{1-0.21}{0.21}\right) \times \left[0.08\frac{kmol}{kg} + 0.20\frac{kmol}{kg}\right] = 22.9\frac{m^3}{kg}$$

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_c} \times MV_v \quad \text{(Flaring Tool 9)}$$

Where:

$V_{n,CO2,h}$	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas)
$fm_{C,h}$	Mass fraction of carbon in the residual gas in the hour *h*
AM_C	Atomic mass of carbon (kg/kmol)
MV_n	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)

A sample calculation of $V_{n,CO2,h}$ for mine methane for the month of October 2011 is shown below.

$$V_{n,CO2,h} = \frac{0.45}{12\frac{kg}{kmol}} \times 22.4\frac{m^3}{kmol} = 0.84\frac{m^3}{kg}$$

$$n_{O2,h} = \frac{t_{O2,h}}{\left(1 - \frac{t_{O2,h}}{MF_{O2}}\right)} \times \left[\frac{fm_{C,h}}{AM_c} + \frac{fm_{N,h}}{2AM_N} + \frac{1-MF_{O2}}{MF_{O2}} \times F_h \right] \quad \text{(Flaring Tool 10)}$$

Where:

$n_{O2,h}$	Quantity of moles O_2 in the exhaust gas of the flare per kg residual flared in hour *h* (kmol/kg residual gas)
$t_{O2,h}$	Volumetric fraction of O_2 in the exhaust gas in the hour *h*
MF_{O2}	Volumetric fraction of O_2 in the air (0.21)
$fm_{C,h}$	Mass fraction of C in the residual gas in hour *h*

$fm_{N,h}$	Mass fraction of N in the residual gas in hour *h*
F_h	Stociometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h* (kmol/kg residual gas)
AM_C	Atomic mass of C (kg/kmol)
AM_N	Atomic mass of N (kg/kmol)

A sample calculation of $n_{o2,h}$ for mine methane for the month of October 2011 is shown below.

$$n_{o2,h} = \frac{0.15}{1 - \frac{0.15}{0.21}} \times \left[\frac{0.45}{12\frac{kg}{kmol}} + \frac{0.40}{2 \times 14.04\frac{kg}{kmol}} + \frac{1 - 0.21}{0.21} \times 0.08\frac{kmol}{kg}\right] = 0.20\frac{kmol}{kg}$$

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{o,h}}{2AM_O}$$ (Flaring Tool 11)

Where:

F_h	Stociometric quantity of moles of O*2* required for a complete oxidation of one kg residual gas in hour *h* (kmol/kg residual gas)
$fm_{C,h}$	Mass fraction of C in the residual gas in hour *h*
$fm_{H,h}$	Mass fraction of H in the residual gas in hour *h*
$fm_{O,h}$	Mass fraction of O in the residual gas in hour *h*
AM_C	Atomic mass of C (kg/kmol)
AM_H	Atomic mass of H (kg/kmol)
AM_O	Atomic mass of O (kg/kmol)

A sample calculation of F_h for mine methane for the month of October 2011 is shown below.

$$F_h = \frac{0.45}{12\frac{kg}{kmol}} + \frac{0.15}{4 \times 1.01\frac{kg}{kmol}} - \frac{0}{2 \times 16\frac{kg}{kmol}} = 0.08\ \frac{kmol\ O_2}{kg}$$

STEP 4: Determination of methane mass flow rate in the exhaust gas on a dry basis

The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} \times fv_{CH4,FG,h}}{1{,}000{,}000}$$ (Flaring Tool 12)

Where:

$TM_{FG,h}$	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h* (kg/h)
$TV_{n,FG,h}$	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h* (m^3/h exhaust gas)
$fv_{CH4,FG,h}$	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h* (mg/m^3)

A sample calculation of $TM_{FG,h}$ for mine methane for the month of October 2011 is shown below.

$$TM_{FG,h} = \frac{5\ 586\frac{m^3}{h} \times 1\ 611\frac{mg}{m^3}}{1\ 000\ 000} = 9.00\ \frac{kg}{h}$$

STEP 5: Determination of methane mass flow rate in the residual gas on a dry basis

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

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

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$FV_{RG,h}$	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 (0.716 kg/m^3)

A sample calculation of $TM_{RG,h}$ for mine methane for the month of October 2011 is shown below.

$$TM_{RG,h} = 230\frac{m^3}{h} \times 0.73 \times 0.716\frac{kg}{m^3} = 120\frac{kg}{h}$$

STEP 6: Determination of the hourly flare efficiency

The tool states that the in case of enclosed flares and continuous monitoring of the flare efficiency, the flare efficiency in the hour h ($\eta_{flare,h}$) is:

- 0% if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour h.
- determined as follows in cases where the temperature of the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h :

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$$ (Flaring Tool 14)

Where:

$\eta_{flare,h}$	Flare efficiency in the hour *h*
$TM_{FG,h}$	Methane mass flow rate in the exhaust gas averaged in a period of time *t* (kg/h)
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)

A sample calculation of n_{flare} for mine methane for the month of October 2011 is shown below.

$$n_{flare} = 1 - \frac{9.00\frac{kg}{h}}{120\frac{kg}{h}} = 0.92$$

STEP 7: Calculation of annual project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions from each hour *h*, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1{,}000}$$ (Flaring Tool 15)

Where:

$PE_{flare,y}$	Project emissions from flaring the residual gas stream in year *y* (tCO_2e)

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$\eta_{flare,h}$	Flare efficiency in hour *h*
GWP_{CH4}	Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)

A sample calculation of $PE_{flare,y}$ for mine methane for the month of October 2011 is shown below.

$$PE_{flare,y} = 120\frac{kg}{h} \times 24\frac{h}{day} \times 12\frac{days}{month} \times (1-0.92) \times \frac{21\frac{kg}{kg}}{1000} = 54.4\frac{tCO_2e}{month}$$

Project emissions (PE_y)

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

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

Where,

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

A sample calculation of $PE_{flare,y}$ for mine methane for the month of October 2011 is shown below.

$$PE_{flare,y} = 1.11\frac{tCO_2e}{month} + 88\frac{tCO_2e}{month} + 54.4\frac{tCO_2e}{month} = 144\frac{tCO_2e}{month}$$

Project emissions from mine methane capture and destruction ($PE_{ME,y}$)

The project emissions for mine methane capture and destruction ($PE_{ME,y}$) are calculated using equation 14 of the applied methodology.

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

Where,

$\boldsymbol{PE_{ELEC,y}}$	Project emissions from the use of electricity for capture, transportation, compression and utilisation or destruction of MM/VAM in year y (tCO_2e/yr)
$\boldsymbol{PE_{FF,y}}$	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 $PE_{FF,y} = 0$.

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*

A sample calculation of $PE_{EC,y}$ for mine methane for the month of October 2011 is shown below.

$$PE_{EC,y} = 1.07\frac{MWh}{month} \times \frac{1.01tCO_2e}{MWh} \times (1 + 0.03) = 1.11\frac{tCO_2e}{month}$$

Project emissions from methane destroyed in the project activity ($PE_{MD,y}$)

The project emissions from methane destroyed in the project activity ($PE_{MD,y}$) 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:

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

A sample calculation of $PE_{MD,y}$ for mine methane for the month of October 2011 is shown below.

$$PE_{MD,y} = 32\frac{tCH_4}{month} \times 2.75\frac{tCO_2}{tCH_4} = 88\frac{tCO_2e}{month}$$

The amount of methane destroyed through flaring ($MD_{FL,y}$) 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

A sample calculation of $MD_{FL,y}$ for mine methane for the month of October 2011 is shown below.

$$MD_{FL,y} = 35\,\frac{tCH_4}{month} - \left(\frac{54.4\,\frac{tCO_2e}{month}}{21\,\frac{tCO_2}{tCH_4}}\right) = 32\,\frac{tCH_4}{month}$$

The project emissions of non-combusted CH$_4$ from the flaring of the residual gas stream ($PE_{UM,y}$)

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:

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

Therefore, $PE_{UM,y}$ in October 2011 is 54.4 tCO_2e/month.

Non-mine methane capture and destruction

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

$$PE_y = PE_{ME,y} + PE_{MD,y} + PE_{UM,y}$$

(AM0064 equation 24)

Where,

$\boldsymbol{PE_y}$	Project emissions in year y (tCO_2e/yr)
$\boldsymbol{PE_{ME,y}}$	Project emissions from energy use to capture and use methane in year y (tCO_2e/yr)
$\boldsymbol{PE_{MD,y}}$	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 are equipped with solar panels. There is no fossil fuel consumption for the operation of the non-mine methane facilities. Hence, $PE_{ME,y} = 0$.

A sample calculation of PE_y for borehole flare DBE1 in October 2011 is shown below.

$$PE_y = 0 + 41.4\,\frac{tCO_2e}{month} + 35.1\,\frac{tCO_2e}{month} = 76.5\,\frac{tCO_2e}{month}$$

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'.

A sample calculation of $PE_{MD,y}$ for borehole flare DBE1 in October 2011 is shown below.

$$PE_{MD,y} = 26.8\frac{kg}{h} \times 24\frac{h}{day} \times 26\frac{days}{month} \times 0.9 \times \frac{2.75\frac{tCO_2}{tCH_4}}{1000} = 41.4\frac{tCO_2e}{month}$$

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'.

A sample calculation of $PE_{UM,y}$ for borehole flare DBE1 in October 2011 is shown below.

$$PE_{UM,y} = 26.8\frac{kg}{h} \times 24\frac{h}{day} \times 26\frac{days}{month} \times (1 - 0.9) \times \frac{21\frac{tCO_2}{tCH_4}}{1000} = 35.1\frac{tCO_2e}{month}$$

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

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	46 032	10 021	0	36 010

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 (t CO_2e)	190 864 (prorated over the monitoring period length = 275 days[1])	36 010

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. There were also times when no data was recorded.

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

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	36 010	Not applicable

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[1] The registered PDD estimates the ex-ante emission reductions for the project to be 253,329 tCO_2e/ year. Over a period of 275 days this is equivalent to 253,329 x 275/365 = 190,864 tCO_2e.

Document information

Version	*Date*	*Description*
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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