Monitoring report form for CDM project activity
(Version 06.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the project activity	The Capture and Utilisation of Methane at the Sibanye Gold Limited owned Beatrix Mine in South Africa	
UNFCCC reference number of the project activity	4728	
Version number of the PDD applicable to this monitoring report	30	
Version number of this monitoring report	02	
Completion date of this monitoring report	21/11/2017	
Monitoring period number	Monitoring period: 2 01/04/2012 – 30/04/2013	
Duration of this monitoring period	13 months	
Monitoring report number for this monitoring report	n/a	
Project participants	GFI Mining South Africa (Pty) Ltd Promethium Carbon (Pty) Ltd Mercuria Energy Trading SA	
Host Party	Republic of South Africa	
Sectoral scopes	Sectoral Scope 10: Fugitive emissions from fuels (solid, oil and gas).	
Applied methodologies and standardized baselines	Approved baseline and monitoring methodology AM0064: “Methodology for methane capture and utilization or destruction in underground, hard rock, precious and base metal mines” Version 02, EB 42	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	29,541	18,193
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	274,440	

SECTION A. Description of project activity

A.1. General description of project activity

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The Beatrix Methane Project was registered on 10 June 2011. The first monitoring period was from 10 June 2011 – 31 March 2012. This monitoring report covers the second monitoring period, from 1 April 2012 – 30 April 2013.

(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 owned by Sibanye Gold Limited. Beatrix is located in the Free State Province of South Africa. The project activity involves the destruction of methane at Beatrix. The project has 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 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 GHG 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 equipment

Six enclosed flares are included in the project activity:

1. One flare is located at the Beatrix Number 1 shaft (for the flaring of mine methane)

2. 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 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. During the monitoring period in question however (01/04/2012 – 30/04/2013), no electricity generation had been implemented.

(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 following table.

Table 1: Commissioning dates of the Beatrix flares

Flare		**Commissioning date**
Mine methane	Main (Number 1 Shaft)	21/05/2011
Non-mine methane	DBE1	08/03/2011
	1400	06/03/2011
	EX1	23/03/2011
	ST23	02/03/2011
	2264	04/03/2011

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

The total emission reductions achieved during this monitoring period (01/04/2012 – 30/04/2013) are 47,734 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 28°13'908" E 26°47'078"	-28.232 26.785

A.3. Parties and project participants

Parties involved	**Project participants**	**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)	No
Switzerland	Mercuria Energy Trading SA (Private Entity)	No

A.4. Reference to applied methodologies and standardized baselines

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Applied methodology

Approved baseline and monitoring methodology AM0064: "Methodology for methane capture and utilization or destruction in underground, hard rock, precious and base metal mines" Version 02, EB 42.

Tools to which the applied methodology refers

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" Version 01;
"Combined tool to identify the baseline scenario and demonstrate additionality" Version 02.2;
"Tool to determine project emissions from flaring gases containing methane" Annex 13, EB28; Version 1 (EB28, Annex 13);
"Tool to calculate the emission factor for an electricity system" Version 02.

Applied standardized baseline(s)

No standardized baselines are applicable to this project activity.

A.5. Crediting period type and duration

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Type: Renewable
Length: Seven years
Period: 01/07/2011 – 30/06/2018

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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a. Description of the installed technology, technical processes and equipment

This project comprises two categories: 1.) The destruction and utilisation of mine methane and 2.) The destruction of non-mine methane.

1. The destruction and utilisation of mine methane

A single enclosed flare was commissioned on 21/05/2011 to combust mine methane. This mine methane originates from underground geological faults which intersect 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 single enclosed flare and associated monitoring equipment were built by Hofstetter, a Swiss company that specialises in flaring technology and degassing systems.

The flare at the main shaft is fitted with the monitoring equipment required to claim the default flare efficiency. This monitoring equipment includes:

Table 2: Mine methane (main flare) monitoring equipment

Monitoring instrument	Description
Methane gas analyser	Non-dispersive infrared-photometers (NDIP) record the absorption of infrared rays caused by the raw gas.
Thermocouple	A type-N thermocouple measures 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.

The second phase of the Beatrix methane project entails electricity generation. In phase two, the mine methane is used to generate electricity. Any excess methane that the engines cannot handle is flared.

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 NDIP gas analyser to measure the methane concentration of raw gas, and a type-N thermocouple to measure the temperature of the exhaust gas.

b. Information on the implementation and actual operation of the project activity

The first phase of the project entails the commissioning of flares to destroy the mine and non-mine methane. The commissioning dates for the flares are provided in the following table. Also included in the table are the operational status of the boreholes during the second monitoring period.

Table 3: Commissioning date and operational status of flares

Flare	Commissioning date	Continued operational periods
Main flare	21/5/2011	Still operational at the time of writing the monitoring report.
DBE1	08/03/2011	Interrupted operations during the third quarter of 2012 due to multiple cases of vandalism and theft of equipment. Borehole DBE1 and flare were subsequently decommissioned (rehabilitated) on 31/05/2016.
1400	06/03/2011	Still operational at the time of writing monitoring report.
EX1	23/03/2011	Still operational at the time of writing monitoring report.
ST23	02/03/2011	Still operational at the time of writing monitoring report.
2264	04/03/2011	During the course of the project implementation, the gas levels emanating from borehole 2264 significantly reduced. As a result, borehole 2264 and related flare were decommissioned (rehabilitated) on 10/12/2015.

For this monitoring period, there were times when the temperature of the exhaust gas of the flares was below 500°C for 20 minutes or more during the hour. 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'). In addition, there were periods where no data sets were recorded. In these periods, no emission reductions will be claimed.

The following table represents where the following conditions occur:

- Where the temperature is below 500°C for more than 20 minutes in the hour; or

- There is no recorded gas flow; or
- There is no methane concentration measurement.

Table 4: Total hours where no data sets recorded or flare temperatures below 500°C

	Main flare	DBE1	1400	ST23
Apr-12	720	174	129	
May-12	744		100	
Jun-12	720	161	460	4
Jul-12	744	175	263	3
Aug-12	744	263	233	
Sep-12	310	283	213	9
Oct-12	284	288	201	
Nov-12	201	287	43	
Dec-12	230	288	282	249
Jan-13	180	288	181	85
Feb-13	199	288	10	
Mar-13	272	288		
Apr-13	602	288	47	
Total hours	**5 950**	**3 071**	**2 162**	**350**

The maximum number of hours in a year is 8 760 hours.

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.

The second phase of the project entails electricity generation by combusting the mine methane in internal combustion engines. The project design entails the installation of three Cummins engines with an installed capacity/electricity output of 1.12 MW each, with the possibility to install another fourth engine in case sufficient mine methane gas is extracted in the future. However phase 2, electricity generation, was not initiated during the monitoring period in question (1 April 2012 – 30 April 2013).

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 the applicability of the methodology. All conditions of AM0064 version 02 were met.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

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No changes in terms of standardized baseline or registered monitoring plan. A Standardized baseline is not used in this project.

B.2.2. Corrections

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Corrections that have been approved by the Board as applicable from the period prior to this monitoring period:

1. The title of the PDD has been changed from "The Capture and Utilisation of Methane at the GFI Mining South Africa owned Beatrix Mine in South Africa" to "The Capture and Utilisation of Methane at the Sibanye Gold Limited owned Beatrix Mine in South Africa".

2. A correction has been made to Equation 28 in section B.6.3. In the registered PDD, the value reflected was 0, which was a typographical error. In section B.6.1 of the registered PDD, the value for THk is clearly and consistently marked as '0', however in the table pertaining to equation 28 there are values under the THk column. In the calculation used for the registered PDD: '<' was replaced with an '='. The equation is indeed MEk – (MMESELEC,k + MMESHEAT,k) < THk. As a result, this typographical error has been revised in the latest PDD. Leakage therefore remains 0, as per the registered PDD.

Approval date: 01 October 2017
Reference number of PRC: PRC-4728-001

B.2.3. Changes to the start date of the crediting period

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Start date is still the same as in the PDD thus not applicable.

B.2.4. Inclusion of monitoring plan

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Not applicable.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

>>
Not applicable.

B.2.6. Changes to project design

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Corrections that have been approved by the Board as applicable from the period prior to this monitoring period:

1. The Jenbacher engines, which were specified for installation in the registered PDD, have been replaced with Cummins engines that are supplied on a power purchase agreement by Aggreko. Cummins engines were favoured by the project participant due to the low price of carbon at that point in time. Sibanye Gold could thus combust the methane to produce electricity through a power purchase agreement instead of investing capital in Jenbacher engines, which are much more costly.

Approval date: 01 October 2017
Reference number of PRC: PRC-4728-001

SECTION C. Description of monitoring system

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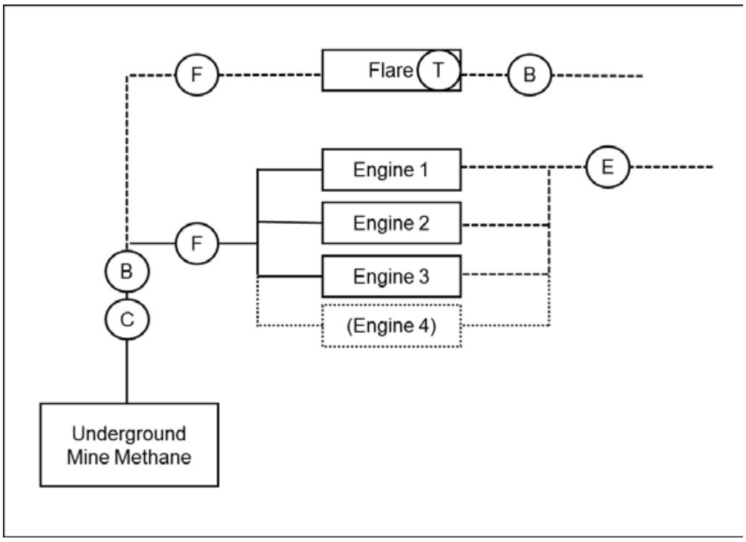
Beatrix's monitoring system ensures that the project activity's emission reductions are accurately monitored, recorded and reported.

<u>Line diagrams showing relevant monitoring points</u>

Enclosed flares are installed at the main shaft and the 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. This is in accordance with version 01 of the "Tool to determine project emissions from the flaring of gases containing methane" (EB28, Annex 13). To be conservative, the flare efficiency is considered 0% if the temperature falls below the 500 °C mark within the hour and emission reductions are discounted.

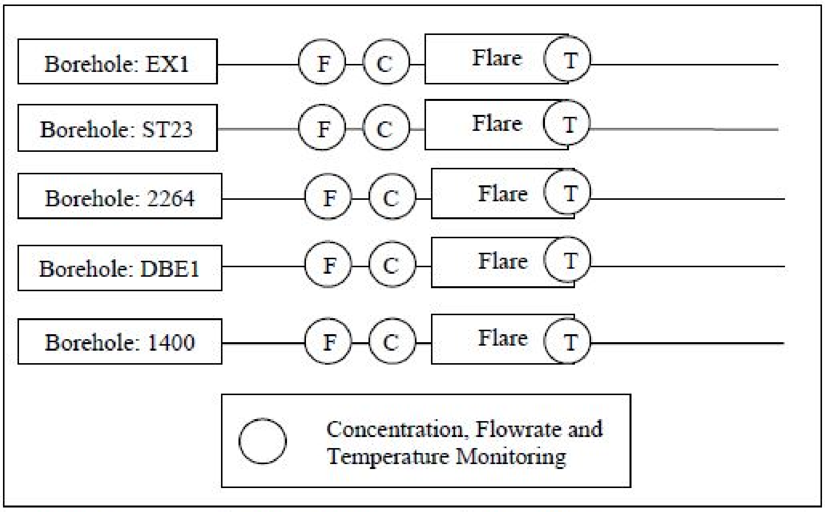
The placing of the monitoring equipment of the flare and the engines (which are not relevant for monitoring during the second monitoring period) at the main shaft is shown in the following diagram.



Monitoring Equipment Key		
Symbol	**Description**	**Function**
(B)	Methane and oxygen concentration meter	Measure CH4 and O2 concentration of gas
(F)	Gas flow meter	Measure gas flowrate
(E)	Electricity meter	Measure electricity generated by the engines
(T)	Thermocouple	Measure the temperature of the flare to ensure correct operation
(C)	Gas composition	Measuring the composition of the gas (CH4, NMHC)
———	Gas lines: Phase A	
·········	Gas lines: Phase B	
– – –	Electricity	

Figure 1: Mine methane monitoring system

The placement of the monitoring equipment of the flares at the boreholes is shown in the following diagram.



Symbol	Description	Function
C	Concentration Meter	Measure CH_4 concentration of the gas
F	Gas Flow Meter	Measure methane sent to flare
T	Thermocouple	Measures the temperature of the flare to ensure correct operation

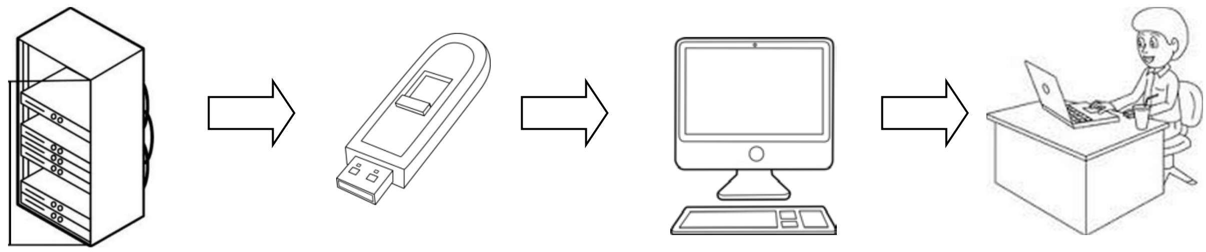
Figure 2: Non-mine methane monitoring system

Data collection procedures and information flow

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 sets are viewed in the software programme ‘ReadWin 2000’.

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

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



Monitored parameters are logged directly onto the data logger located at each flare	The USB memory stick in each data logger is manually removed at the end of each cost month and the data is loaded onto a PC	The data is copied to a CD and also emailed to Promethium Carbon	Promethium Carbon extracts the recorded data using the software programme ReadWin 2000 and calculates the emission reductions using the formulae provided in the PDD.

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 also extracts 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

Data/Parameter	MM_i
Unit	kg/kmol
Description	Mass of the molecule, where i refers to the respective molecule
Source of data	Periodic table
Value(s) applied	MM_{CH4} = 16.04 MM_{CO} = 28.01 MM_{CO2} = 44.01 MM_{O2} = 32 MM_{H2} = 2.02 MM_{N2} = 28.02
Choice of data or measurement methods and procedures	Not applicable.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	AM_i
Unit	kg/kmol

Description	Mass of an atom of a chemical element.
Source of data	Periodic table
Value(s) applied	AM_c = 12 AM_h = 1.01 AM_o = 16 AM_n = 14.01
Choice of data or measurement methods and procedures	Not applicable
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	Chemical constants
Unit	Atmospheric pressure at normal conditions (P_n) = Pa Universal ideal gas constant (R_u) = $Pa.m^3/kmol.K$ Temperature at normal conditions (T_n) = K O2 volumetric fraction of air (MF_{O2}) = - Global warming potential of methane (GWP_{CH4}) = t_{CO2}/t_{CH4} Volume of one mole of any ideal gas at normal conditions (MV_n) = $m^3/kmol$
Description	Constant of a chemical reaction is the value of the reaction quotient when the reaction has reached equilibrium.
Source of data	Chemical constants
Value(s) applied	P_n = 101325 R_u = 8314.472 T_n = 273.15 MF_{O2} = 0.21 GWP_{CH4} = 21 MV_n = 22.414
Choice of data or measurement methods and procedures	Not applicable.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

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
Choice of data or measurement methods and procedures	No captive electricity generation occurs in the baseline. Historically, all electricity is sourced from the national grid.
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**GWP_{CH4}**
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
Choice of data or measurement methods and procedures	Not applicable.
Purpose of data/parameter	Baseline and project emission calculations.
Additional comments	-

Data/parameter:	$\mathbf{EF_{grid}}$
Unit	tCO_2/MWh
Description	Emission factor of the grid.
Source of data	Eskom and NERSA data
Value(s) applied)	1.01
Choice of data or measurement methods and procedures	Calculated in accordance with version 02 of the 'Tool to calculate the emission factor for an electricity system', as per the registered PDD.
Purpose of data	Project emission calculations.
Additional comments	-

Data/parameter:	$\mathbf{S_{captive}}$
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
Choice of data or measurement methods and procedures	No captive electricity generation occurs in the baseline. Historically, all electricity is sourced from the national grid.
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	$\mathbf{CEF_{CH4}}$
Unit	tCO_{2e}/tCH_4
Description	Carbon emission factor for combusted methane
Source of data	As stated in AM0064
Value(s) applied)	2.75
Choice of data or measurement methods and procedures	Ex ante value stated in AM0064
Purpose of data	Calculation of project emissions
Additional comments	44/16 = 2.75 tCO_2e/tCH_4

Data/parameter:	$\mathbf{Eff_{ELEC}}$
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

Choice of data or measurement methods and procedures	Not applicable.
Purpose of data	Project emission calculations
Additional comments	-

Data/parameter:	**TH_{BL}**
Unit	tCH_4/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
Choice of data or measurement methods and procedures	Not applicable.
Purpose of data	Calculation of baseline emissions
Additional comments	-

D.2. Data and parameters monitored

Mine methane capture and utilization or destruction

Data/Parameter	$MM_{PR,engine,y}$ or $MMES_{ELEC,y}$
Unit	tCH_4/yr
Description	Mine methane captured, sent to and destroyed by internal combustion engines in the project activity in year y
Measured/calculated/ Default	Measured
Source of data	Engine specifications were used for the purpose of the ex-ante calculations. The flowrate will be measured in the project activity. The methane concentration of the gas will be metered at the flare.
Value(s) of monitored parameter	0
Monitoring equipment	-
Measuring/reading/recording frequency	The methane concentration will be measured continuously at the flare and consolidated to a monthly figure for the monitoring report.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The flowmeter and concentration meter will be calibrated according to manufacturer's specifications.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	The internal combustion engines were not fully commissioned in the monitoring period therefore the value for this parameter is 0.

Data/Parameter	$MM_{PR,flare,y}$ or $MMES_{FL,y}$
Unit	tCH_4/yr
Description	Mine methane captured, sent to and destroyed by flare in the project activity in year y
Measured/calculated/ Default	Measured
Source of data	A flow meter and concentration meter measure the flowrate of methane sent to the flare.

Value(s) of monitored parameter	Month / MMPR,flare,y: Apr-12: No data May-12: No data Jun-12: No data Jul-12: No data Aug-12: No data Sep-12: 137 Oct-12: 159 Nov-12: 197 Dec-12: 203 Jan-13: 195 Feb-13: 180 Mar-13: 151 Apr-13: 19
Monitoring equipment	Flow meter: Instrument code: FIR 71.51 Type: Endress and Hauser Accuracy class: +/- 1.2% measurement tolerance Serial number: DA00220109D Calibration frequency: Yearly Date of last calibration: 03/12/2013 Validity: until 03/12/2014 Gas analyser: Type: Endress and Hauser Accuracy class: +/- 1% full scale measurement tolerance Serial number: A211 Calibration frequency: Weekly Date of last calibration: 03/05/2013 Validity: valid until 10/05/2013
Measuring/reading/recording frequency	The methane concentration is measured continuously at the flare and consolidated to a monthly figure for the monitoring report.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The flowmeter and concentration meter are calibrated according to manufacturer's specifications.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	-

Data/Parameter	GEN_y
Unit	MWh
Description	Electricity generated by the project activity in year y
Measured/calculated/ default	Measured
Source of data	The electrical output will be measured by an electricity meter installed at the engines.
Value(s) of monitored parameter	0
Monitoring equipment	-
Measuring/reading/recording frequency	Monitoring will occur continuously, integrated hourly and logged electronically.
Calculation method (if applicable)	Not applicable.

QA/QC procedures	The meter will be calibrated according to manufacturer's specifications.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	The internal combustion engines were not commissioned in the monitoring period therefore the value for this parameter is 0.

Data/Parameter	PC_{CH4}
Unit	%
Description	Concentration (in mass) of methane in extracted gas (%), measured on wet basis
Measured/calculated/ default	Calculated
Source of data	The concentration of methane is monitored continuously at the underground monitoring stations. The methane concentration of the gas is then monitored again at the flare.
Value(s) of monitored parameter	<table><tr><th rowspan="2">Month</th><th>PC_{CH4}</th></tr><tr><th>%</th></tr><tr><td>Apr-12</td><td>No data</td></tr><tr><td>May-12</td><td>No data</td></tr><tr><td>Jun-12</td><td>No data</td></tr><tr><td>Jul-12</td><td>No data</td></tr><tr><td>Aug-12</td><td>No data</td></tr><tr><td>Sep-12</td><td>56</td></tr><tr><td>Oct-12</td><td>56</td></tr><tr><td>Nov-12</td><td>56</td></tr><tr><td>Dec-12</td><td>55</td></tr><tr><td>Jan-13</td><td>56</td></tr><tr><td>Feb-13</td><td>53</td></tr><tr><td>Mar-13</td><td>51</td></tr><tr><td>Apr-13</td><td>52</td></tr></table>
Monitoring equipment	Gas analyser: Type: Endress and Hauser Accuracy class: +/- 1% full scale measurement tolerance Serial number: A211 Calibration frequency: Weekly Date of last calibration: 03/05/2013 Validity: valid until 10/05/2013
Measuring/reading/recording frequency	Monitoring occurs continuously, integrated hourly and logged electronically.
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/m3) and dividing it by the density of the residual gas.
QA/QC procedures	Maintenance of concentration meters is done according to manufacturer's specification.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	-

Data/Parameter	$EC_{PJ,y}$
Unit	MWh/y
Description	Quantity of electricity consumed by the project electricity consumption source in year y

Measured/calculated/ default	Measured
Source of data	The electricity consumption of the electricity generating equipment and auxiliaries is measured using an Energy Measuring Unit (EMU)
Value(s) of monitored parameter	see table below
Monitoring equipment	Type: EMU32x4, 5(g)A manufactured by EMU Elektronik AG Accuracy class: +/- 2% measurement tolerance Serial number: 106043 Date of last calibration: calibration prior to installation Calibration frequency: every 10 years as per SANS 474:2009, Edition 1.1
Measuring/reading/recording frequency	The data is continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The data are continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Month	EC_{PJ} MWh
Apr-12	No data
May-12	No data
Jun-12	No data
Jul-12	No data
Aug-12	No data
Sep-12	6
Oct-12	8
Nov-12	11
Dec-12	11
Jan-13	9
Feb-13	10
Mar-13	8
Apr-13	3

Data/Parameter	TDLy
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to source in year y
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	3
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.
QA/QC procedures	Not applicable.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	-

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	Measurements are taken using a flow meter.
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: DA00220109D Calibration frequency: Yearly Date of last calibration: 03/12/2013 Validity: valid until 03/12/2014
Measuring/reading/recording frequency	The data are continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.
Calculation method (if applicable)	-
QA/QC procedures	Flow meters are periodically calibrated according to the manufacturer's recommendation
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	-

Value(s) of monitored parameter:

Month	$FV_{RG,h}$
	m^3/month
Apr-12	No data
May-12	No data
Jun-12	No data
Jul-12	No data
Aug-12	No data
Sep-12	587
Oct-12	575
Nov-12	690
Dec-12	685
Jan-13	627
Feb-13	669
Mar-13	625
Apr-13	397

Data/Parameter	$fv_{i,h}$
Unit	-
Description	Volumetric fraction of component i in the residual gas in the hour *h* Where i is CH_4, CO, CO_2, O_2, H_2, N_2
Measured/calculated/ default	Measured.
Source of data	Gas analyser.

Value(s) of monitored parameter	Month / $fv_{CH4,h}$ fraction / $fv_{N2,h}$ fraction: Apr-12: No data / No data May-12: No data / No data Jun-12: No data / No data Jul-12: No data / No data Aug-12: No data / No data Sep-12: 0.69 / 0.31 Oct-12: 0.69 / 0.31 Nov-12: 0.69 / 0.31 Dec-12: 0.68 / 0.32 Jan-13: 0.69 / 0.31 Feb-13: 0.66 / 0.34 Mar-13: 0.64 / 0.36 Apr-13: 0.65 / 0.35
Monitoring equipment	<u>Gas analyser:</u> Type: Endress and Hauser Accuracy class: +/- 1% full scale measurement tolerance Serial number: A211 Calibration frequency: Weekly Date of last calibration: 03/05/2013 Validity: valid until 10/05/2013
Measuring/reading/recording frequency	The data are continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The gas analyser is calibrated in accordance with manufacturer specifications.
Purpose of data/parameter	Calculation of project emissions
Additional comments	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 be nitrogen.

Month	$fv_{CH4,h}$	$fv_{N2,h}$
	fraction	fraction
Apr-12	No data	No data
May-12	No data	No data
Jun-12	No data	No data
Jul-12	No data	No data
Aug-12	No data	No data
Sep-12	0.69	0.31
Oct-12	0.69	0.31
Nov-12	0.69	0.31
Dec-12	0.68	0.32
Jan-13	0.69	0.31
Feb-13	0.66	0.34
Mar-13	0.64	0.36
Apr-13	0.65	0.35

Data/Parameter	$fv_{CH4,FG,h}$
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	Measured
Source of data	Gas analyser.

Value(s) of monitored parameter	<table><tr><td rowspan="2">Month</td><td>$fv_{CH4,FG,h}$</td></tr><tr><td>mg/m³</td></tr><tr><td>Apr-12</td><td>No data</td></tr><tr><td>May-12</td><td>No data</td></tr><tr><td>Jun-12</td><td>No data</td></tr><tr><td>Jul-12</td><td>No data</td></tr><tr><td>Aug-12</td><td>No data</td></tr><tr><td>Sep-12</td><td>0.72</td></tr><tr><td>Oct-12</td><td>0.72</td></tr><tr><td>Nov-12</td><td>0.46</td></tr><tr><td>Dec-12</td><td>0.32</td></tr><tr><td>Jan-13</td><td>0.48</td></tr><tr><td>Feb-13</td><td>0.59</td></tr><tr><td>Mar-13</td><td>0.65</td></tr><tr><td>Apr-13</td><td>0.91</td></tr></table>
Monitoring equipment	Flow meter: Instrument code: FIR 71.51 Type: Endress and Hauser Accuracy class: +/- 1.2% measurement tolerance Serial number: DA00220109D Calibration frequency: Yearly Date of last calibration: 03/12/2013 Validity: valid until 03/12/2014 Gas analyser: Type: Endress and Hauser Accuracy class: +/- 1% full scale measurement tolerance Serial number: A2120 Calibration frequency: weekly Date of last calibration: 03/05/2013 Validity: valid until 10/05/2013
Measuring/reading/recording frequency	The data are continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The instruments are calibrated in accordance with the manufacturer's specifications.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	-

Data/Parameter	$t_{O2,h}$
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	<table><tr><td>Month</td><td>$t_{O2,h}$</td></tr><tr><td></td><td>fraction</td></tr><tr><td>Apr-12</td><td>No data</td></tr><tr><td>May-12</td><td>No data</td></tr><tr><td>Jun-12</td><td>No data</td></tr><tr><td>Jul-12</td><td>No data</td></tr><tr><td>Aug-12</td><td>No data</td></tr><tr><td>Sep-12</td><td>0.0000</td></tr><tr><td>Oct-12</td><td>0.0000</td></tr><tr><td>Nov-12</td><td>0.0002</td></tr><tr><td>Dec-12</td><td>0.0003</td></tr><tr><td>Jan-13</td><td>0.0001</td></tr><tr><td>Feb-13</td><td>0.0001</td></tr><tr><td>Mar-13</td><td>0.0001</td></tr><tr><td>Apr-13</td><td>0.0002</td></tr></table>
Monitoring equipment	Gas analyser: Type: Endress and Hauser Accuracy class: +/- 1% full scale measurement tolerance Serial number: A2120 Calibration frequency: weekly Date of last calibration: 03/05/2013 Validity: valid until 10/05/2013
Measuring/reading/recording frequency	The data are continuously monitored and logged electronically, hourly. The values are consolidated and reported on a monthly basis.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The analyser is periodically calibrated according to the manufacturer's recommendation.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	-

Data/Parameter	T_{flare}
Unit	°C
Description	Temperature in the exhaust gas of the flare
Measured/calculated/ default	Measured
Source of data	Measurements by project participants

Value(s) of monitored parameter	<table><tr><td rowspan="2">Month</td><td>Tflare</td></tr><tr><td>°C</td></tr><tr><td>Apr-12</td><td>No data</td></tr><tr><td>May-12</td><td>No data</td></tr><tr><td>Jun-12</td><td>No data</td></tr><tr><td>Jul-12</td><td>No data</td></tr><tr><td>Aug-12</td><td>No data</td></tr><tr><td>Sep-12</td><td>822</td></tr><tr><td>Oct-12</td><td>785</td></tr><tr><td>Nov-12</td><td>837</td></tr><tr><td>Dec-12</td><td>851</td></tr><tr><td>Jan-13</td><td>850</td></tr><tr><td>Feb-13</td><td>833</td></tr><tr><td>Mar-13</td><td>657</td></tr><tr><td>Apr-13</td><td>276</td></tr></table>
Monitoring equipment	Thermocouple: Instrument code: TIR 71.53 Type: Endress and Hauser Type N Accuracy class: +/- 2.5°C Serial number: Not applicable Calibration frequency: Yearly replacement Date of last calibration: Not applicable Validity: Not applicable
Measuring/reading/recording frequency	The data are continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Thermocouples are replaced every year.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	To be conservative, the efficiency of the flare for each hour is taken to be 0% when the temperature of the flare is less than 500 °C for 20 minutes or more during the hour.

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	Measurements are taken using a flow meter at each borehole

<table>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><td></td><td colspan="5">FV_{RG} (Nm3/h)</td></tr>
<tr><td>Month</td><td>EX1</td><td>ST23</td><td>1400</td><td>DBE1</td><td>2246</td></tr>
<tr><td>Apr-12</td><td>102</td><td>95</td><td>100</td><td>88</td><td>-</td></tr>
<tr><td>May-12</td><td>44</td><td>94</td><td>99</td><td>39</td><td>-</td></tr>
<tr><td>Jun-12</td><td>89</td><td>45</td><td>88</td><td>30</td><td>-</td></tr>
<tr><td>Jul-12</td><td>99</td><td>38</td><td>83</td><td>34</td><td>-</td></tr>
<tr><td>Aug-12</td><td>95</td><td>62</td><td>75</td><td>50</td><td>-</td></tr>
<tr><td>Sep-12</td><td>99</td><td>53</td><td>92</td><td>17</td><td>-</td></tr>
<tr><td>Oct-12</td><td>97</td><td>89</td><td>97</td><td>80</td><td>-</td></tr>
<tr><td>Nov-12</td><td>99</td><td>93</td><td>98</td><td>90</td><td>-</td></tr>
<tr><td>Dec-12</td><td>98</td><td>93</td><td>98</td><td>89</td><td>-</td></tr>
<tr><td>Jan-13</td><td>98</td><td>94</td><td>98</td><td>89</td><td>-</td></tr>
<tr><td>Feb-13</td><td>98</td><td>94</td><td>98</td><td>87</td><td>-</td></tr>
<tr><td>Mar-13</td><td>98</td><td>96</td><td>98</td><td>89</td><td>-</td></tr>
<tr><td>Apr-13</td><td>98</td><td>96</td><td>97</td><td>88</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td></td><td>EX1</td><td>ST23</td><td>1400</td><td>DBE1</td><td>2264</td></tr>
<tr><td>Type</td><td colspan="5">Endress and Hauser</td></tr>
<tr><td>Accuracy class</td><td colspan="5">+/- 1.2% measurement tolerance</td></tr>
<tr><td>Serial number</td><td>D9002A0111B</td><td>D9007404267</td><td>D908740109D</td><td>D908750109D</td><td>D908720109D</td></tr>
<tr><td>Calibration frequency</td><td colspan="5">Yearly</td></tr>
<tr><td>Date of last calibration</td><td></td><td></td><td>02/12/2013</td><td>02/12/2013</td><td>02/12/2013</td></tr>
<tr><td>Validity</td><td></td><td></td><td>Valid until 02/12/2014</td><td>Valid until 02/12/2014</td><td>Valid until 02/12/2014</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>The data are continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable.</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meters are periodically calibrated according to manufacturer’s specifications.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project and baseline emissions</td></tr>
<tr><td>Additional comments</td><td>-</td></tr>
</table>

Data/Parameter	$fv_{i,h}$
Unit	-
Description	Volumetric fraction of component i in the residual gas in the hour *h* Where i is CH_4, CO, CO_2, O_2, H_2, N_2
Measured/calculated/ default	Gas analyser.
Source of data	The methane concentration of the residual gas is measured and the remainder is considered as N_2

Value(s) of monitored parameter

Month	$fv_{CH4,h}$ Fraction				
	EX1	**ST23**	**1400**	**DBE1**	**2264**
Apr-12	1.00	0.97	1.00	0.93	-
May-12	0.45	0.97	0.99	0.41	-
Jun-12	0.91	0.48	0.89	0.34	-
Jul-12	1.00	0.40	0.85	0.38	-
Aug-12	0.97	0.65	0.77	0.53	-
Sep-12	0.99	0.56	0.94	0.20	-
Oct-12	0.98	0.92	0.98	0.83	-
Nov-12	0.99	0.96	0.99	0.94	-
Dec-12	0.99	0.96	0.99	0.94	-
Jan-13	0.99	0.96	0.99	0.93	-
Feb-13	0.99	0.97	0.99	0.92	-
Mar-13	0.99	0.98	0.99	0.93	-
Apr-13	0.99	0.98	0.98	0.93	-

Month	$fv_{N2,h}$ Fraction				
	EX1	**ST23**	**1400**	**DBE1**	**2264**
Apr-12	0.00	0.03	0.00	0.07	-
May-12	0.55	0.03	0.01	0.59	-
Jun-12	0.09	0.52	0.11	0.66	-
Jul-12	0.00	0.60	0.15	0.62	-
Aug-12	0.03	0.35	0.23	0.47	-
Sep-12	0.01	0.44	0.06	0.80	-
Oct-12	0.02	0.08	0.02	0.17	-
Nov-12	0.01	0.04	0.01	0.06	-
Dec-12	0.01	0.04	0.01	0.06	-
Jan-13	0.01	0.04	0.01	0.07	-
Feb-13	0.01	0.03	0.01	0.08	-
Mar-13	0.01	0.02	0.01	0.07	-
Apr-13	0.01	0.02	0.02	0.07	-

Monitoring equipment	<table><tr><td></td><td>**EX1**</td><td>**ST23**</td><td>**1400**</td><td>**DBE1**</td><td>**2264**</td></tr><tr><td>Type</td><td colspan="5">Endress and Hauser</td></tr><tr><td>Accuracy class</td><td colspan="5">+/- 1.2% measurement tolerance</td></tr><tr><td>Serial number</td><td>A2030</td><td></td><td>A2001</td><td>A1540</td><td>A1541</td></tr><tr><td>Calibration frequency</td><td colspan="5">Weekly</td></tr><tr><td>Date of last calibration</td><td colspan="5">03/05/2013</td></tr><tr><td>Validity</td><td colspan="5">Valid until 10/05/2013</td></tr></table>
Measuring/reading/recording frequency	The data are continuously monitored, integrated hourly and logged electronically. The values are consolidated and reported on a monthly basis for the verification.
Calculation method (if applicable)	-
QA/QC procedures	The instrument measuring the concentration of methane is calibrated according to manufacturer's specifications.
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	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.

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	<table><tr><td rowspan="3">Month</td><td colspan="5">Tflare</td></tr><tr><td colspan="5">°C</td></tr><tr><td>**EX1**</td><td>**ST23**</td><td>**1400**</td><td>**DBE1**</td><td>**2264**</td></tr><tr><td>Apr-12</td><td>875</td><td>809</td><td>556</td><td>479</td><td>-</td></tr><tr><td>May-12</td><td>875</td><td>802</td><td>562</td><td>574</td><td>-</td></tr><tr><td>Jun-12</td><td>901</td><td>811</td><td>516</td><td>523</td><td>-</td></tr><tr><td>Jul-12</td><td>917</td><td>812</td><td>536</td><td>494</td><td>-</td></tr><tr><td>Aug-12</td><td>960</td><td>821</td><td>539</td><td>416</td><td>-</td></tr><tr><td>Sep-12</td><td>931</td><td>817</td><td>528</td><td>410</td><td>-</td></tr><tr><td>Oct-12</td><td>597</td><td>823</td><td>547</td><td>366</td><td>-</td></tr><tr><td>Nov-12</td><td>700</td><td>829</td><td>586</td><td>360</td><td>-</td></tr><tr><td>Dec-12</td><td>599</td><td>831</td><td>615</td><td>329</td><td>-</td></tr><tr><td>Jan-13</td><td>-36</td><td>817</td><td>627</td><td>348</td><td>-</td></tr><tr><td>Feb-13</td><td>116</td><td>815</td><td>608</td><td>294</td><td>-</td></tr><tr><td>Mar-13</td><td>506</td><td>807</td><td>596</td><td>243</td><td>-</td></tr><tr><td>Apr-13</td><td>489</td><td>811</td><td>579</td><td>221</td><td>-</td></tr></table>

<table>
<tr><td rowspan="7">Monitoring equipment</td><td>Flare</td><td>EX1</td><td>ST23</td><td>1400</td><td>DBE1</td><td>2264</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>Serial number</td><td colspan="5">Not applicable</td></tr>
<tr><td>Calibration frequency</td><td colspan="5">Yearly replacement</td></tr>
<tr><td>Date of last calibration</td><td colspan="5">Not applicable</td></tr>
<tr><td>Validity</td><td colspan="5">Not applicable</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td colspan="6">The data are continuously monitored and logged electronically. The values are consolidated and reported on a monthly basis for the verification.</td></tr>
<tr><td>Calculation method (if applicable)</td><td colspan="6">-</td></tr>
<tr><td>QA/QC procedures</td><td colspan="6">Thermocouples are replaced every year.</td></tr>
<tr><td>Purpose of data/parameter</td><td colspan="6">Calculation of project and baseline emissions</td></tr>
<tr><td>Additional comments</td><td colspan="6">To be conservative, the efficiency of the flare for each hour is taken to be 0% when the temperature of the flare is less than 500 °C for 20 minutes or more during the hour.</td></tr>
</table>

D.3. Implementation of sampling plan

>>

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

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

>>

This section provides the baseline emission calculations for mine and non-mine methane capture and destruction.

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

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

$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y}$ **(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, $BE_{MD,y} = 0$ as no methane was destructed in the baseline. Therefore equation 1 simplifies to:

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

Baseline emissions from the venting of methane ($BE_{MR,y}$ ***)***

The baseline emissions from the venting of methane ($BE_{MR,y}$) are calculated using equation 6 of the applied methodology.

$$BE_{MR,y} = GWP_{CH4} \times \sum_i \left[\left(MM_{PR,i,y} - MM_{BL,i,y} \right) + \left(VAM_{PR,i,y} - VAM_{BL,i,y} \right) \right]$$

(AM0064 equation 6)

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 was captured and used in the baseline, $MM_{BL,i,y} = 0$. Therefore, equation 6 of the applied methodology simplifies to:

$$BE_{MR,y} = GWP_{CH_4} \times (MM_{PR,engine,y} + MM_{PR,flare,y})$$ **(AM0064 equation 6.1)**

Where,

GWP_{CH4}	Global Warming Potential of methane
$MM_{PR,engine,y}$	Mine methane captured, sent to and destroyed by internal combustion engines in the project activity in year y (tCH_4/yr)
$MM_{PR,flare,y}$	Mine methane captured, sent to and destroyed by flare in the project activity in year y (tCO_2e/yr)

A sample calculation of $BE_{MR,y}$ for mine methane for the month of September 2012 is shown below.

$$BE_{MR,y} = 21 \frac{tCO_2e}{tCH_4} \times (0 \frac{tCH_4}{month} + 137 \frac{tCH_4}{month}) = 3{,}234 tCO_2e$$

Baseline emissions from the generation of electricity ($BE_{Use,y}$ ***)***

The baseline emissions from the generation of electricity are calculated using equation 7 of the applied methodology. Equation 7 has been simplified, as no heat or chilling are generated in the project activity.

$BE_{Use,y} = GEN_y \times EF_{ELEC,y}$

(AM0064 equation 7)

Where,

GEN_y	Electricity generated by the project activity in year y (MWh)
$EF_{ELEC,y}$	Emission factor for electricity generation (grid, captive or a combination) replaced by the project activity (tCO_2/MWh)

A sample calculation of $BE_{Use,y}$ for mine methane for the month of September 2012 is shown below.

$$BE_{Use,y} = 0 \frac{MWh}{month} \times 1.01 \frac{tCO_2e}{MWh} = 0 \frac{tCO_2e}{month}$$

<u>Non-mine methane capture and destruction</u>

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_{CH4}	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).

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$ **(Flaring Tool equation 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 (kg/m^3)

Sample calculations of $TM_{RG,h}$ and BE_y for borehole flare ST23 in April 2012 follow.

$$TM_{RG,h} = 192\frac{m^3}{h} \times 0.76 \times 0.716\ \frac{kg}{m^3} = 133\frac{kg}{h}$$

$$BE_y = \left(\sum_{d=1}^{31} 133\frac{kg}{h} \times \frac{1t}{1000kg}\right) \times 21\frac{tCO_2e}{tCH_4} = 2016\ \frac{tCO_2e}{month}$$

E.2. Calculation of project emissions or actual net removals

>>
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 are calculated in accordance with 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)

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.

$PE_{ME,y} = PE_{ELEC,y} + PE_{FF,y}$ **(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 $PE_{FF,y} = 0$.

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.

$$PE_{EC,y} = EC_{PJ,grid,y} \times EF_{EL,grid,y} \times \left(1 + TDL_{grid,y}\right)$$ **(Flaring 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 September 2012 is shown below.

$$PE_{EC,y} = 6\frac{MWh}{month} \times 1.01\frac{tCO_2e}{MWh} \times (1 + 0.03) = 7\frac{tCO_2e}{month}$$

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 $r = \frac{PC_{NMCH}}{PC_{CH_4}}$
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. Therefore, $MD_{OX,y} = MD_{GAS,y} = MD_{heat,y} = 0$.

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:

$$PE_{MD,y} = (MD_{FL,y} + MD_{Elec,y}) \times CEF_{CH_4}$$

A sample calculation of $PE_{MD,y}$ for mine methane for the month of September 2012 is shown below.

$$PE_{MD,y} = (137 \frac{tCH_4}{month} + 0 \frac{tCH_4}{month}) \times 2.75 \frac{tCO_2}{tCH_4} = 377 \frac{tCO_2e}{month}$$

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 September 2012 is shown below.

$$MD_{FL,y} = 154 \frac{tCH_4}{month} - \left(\frac{352 \frac{tCO_2e}{month}}{21 \frac{tCO_2}{tCH_4}} \right) = 137 \frac{tCH_4}{month}$$

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:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH4}}{1{,}000}$$ **(Flaring Tool equation 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 September 2012 is shown below.

$$PE_{flare,y} = 330\frac{kg}{h} \times 24\frac{h}{day} \times 30\frac{days}{month} \times (1-0.79) \times \frac{21\frac{kg}{kg}}{1000} = 352\frac{tCO_2e}{month}$$

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 equation 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 November 2012 is shown below.

$$TM_{RG,h} = 781\frac{m^3}{h} \times 0.69 \times 0.716\frac{kg}{m^3} = 383\frac{kg}{h}$$

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.

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

(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) for the month of September 2012 becomes:

$$PE_{UM,m} = \left[21\frac{tCO_2e}{tCH_4} \times \left(\sum_{d=1}^{31} 0\,tCH_4 \times (1-0.995)\right)\right] + 352\,tCO_2e = 352\,tCO_2e$$

Therefore, $PE_{UM,y}$ in the month of September 2012 is 352 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 (tCO2e/yr)
$\boldsymbol{PE_{ME,y}}$	Project emissions from energy use to capture and use methane in year y (tCO2e/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 is 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 ST23 in April 2012 is shown below.

$$PE_y = 0 + 238\frac{tCO_2e}{month} + 202\frac{tCO_2e}{month} = 439\frac{tCO_2e}{month}$$

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 ST23 in April 2012 is shown below.

$$PE_{MD,m} = \left(\sum_{d=1}^{31} 133\frac{kg}{h} \times \frac{1t}{1000kg}\right) \times (0.90) \times 2.75\frac{tCO_2e}{tCH_4} = 238\frac{tCO_2e}{month}$$

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 ST23 in April 2012 is shown below.

$$PE_{UM,m} = \left(\sum_{d=1}^{31} 133\frac{kg}{h} \times \frac{1t}{1000kg}\right) \times (1-0.90) \times 21\frac{tCO_2e}{tCH_4} = 202\frac{tCO_2e}{month}$$

E.3. Calculation of leakage emissions

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No leakage is considered, in accordance with AM0064 version 02.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	67,376	19,642	0	29,541	18,193	47,734

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
47,734	274,440

E.6. Remarks on increase in achieved emission reductions

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Emission reductions did not increase therefore not applicable.