**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** | Mare Chicose Landfill Gas Project | |
| **UNFCCC reference number of the project activity** | 4359 | |
| **Version number of the PDD applicable to this monitoring report** | Version 7.1 dated 02/10/2012 | |
| **Version number of this monitoring report** | 1.0 | |
| **Completion date of this monitoring report** | 29/10/2018 | |
| **Monitoring period number** | Sixth Monitoring Period | |
| **Duration of this monitoring period** | 01/01/2017 to 31/12/2017, both days inclusive | |
| **Monitoring report number for this monitoring period** | 1 | |
| **Project participants** | Sotravic Limited (Republic of Mauritius)<br>Rhizome Limited (Republic of Mauritius) | |
| **Host Party** | Republic of Mauritius | |
| **Sectoral scopes** | Sectoral Scope 13: Waste Handling and Disposal | |
| **Applied methodologies and standardized baselines** | Approved Methodology:<br>ACM0001, version 11, "Consolidated baseline and monitoring methodology for landfill gas project activities"<br><br>Standardized Baseline: N/A | |
| **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 |
| | 0 | 52,614 $tCO_2e$ |
| **Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD** | 37,207 $tCO_2e$ | |

## SECTION A. Description of project activity

### A.1. General description of project activity

>>

**(a) Purpose of the project activity and the measures taken for GHG emission reductions or net anthropogenic GHG removals by sinks;**

The purpose of the proposed project is to utilize landfill gas to generate electricity, while excess landfill gas is flared. The Project generates certified emission reductions (CERs) by displacing electricity generation from grid connected fossil fuel-fired power plants that would otherwise be generating equivalent electricity and; destroying methane within the landfill gas that would otherwise have been vented directly into the atmosphere.

The project activity reduces Greenhouse Gas (GHG) emissions by setting up a more efficient gas collection system and destruction system (e.g. construction of additional wells, piping and installation of intermediary gas collection stations) than that required by the contractual obligations under landfill management agreement. A higher efficiency gas collection system enables emission reduction by combustion of higher volume of gas through flaring / generating electricity and displacement of equivalent fossil fuel-based electricity from the Mauritius grid.

The Mare Chicose landfill is a fully managed landfill site in Mauritius with leachate collection system and a leachate basin. The Mare Chicose landfill was operational as an active landfill since 1997.

In the baseline scenario, the landfill gas would have been collected and flared using the basic gas collection systems. The basic system would have been set up to flare the minimum amount of landfill gas as stated by Ministry of Local Government (MoLG) in its tender document, and no electricity would be generated.

**(b) Brief description of the installed technology and equipment;**

The project activity involves the installation of state-of-the-art Landfill Gas (LFG) collection technology:

- The project uses vertical wells drilled into the waste to extract the LFG. Horizontal wells have also been drilled to extract the maximum amount of gas from open cells.
- End-of-line collection system with pipes that connect groups of gas wells to manifolds. The manifolds are connected to a main pipe and then into the main header pipe which delivers the gas to the extraction plant and the flare. They allow the optimization of the extraction of gas from each well.
- The project activity involves two stationary enclosed gas flares provided by Hofstetter, consisting of pipe work, valves, blower, stack with burners, instrumentation and control panel. The combined maximum designed capacity for the flares is 3000 $Nm^3/h$ (1500$Nm^3/h$ X 2). The combustion temperature in the flare stack is specified to be between 1000° – 1200° C. Besides, the installed capacity of LFG engine generator set is 3 X 1.1 MW which uses captured LFG to generate electricity.

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

- The first flare was commissioned on 28 May 2008
- The second flare was commissioned on 18 September 2009.
- Commissioning of electricity generation system (2 X 1.1 MW) was on 31 October 2011
- Commissioning of the electricity generation system (1 X 1.1 MW) was on 22 January 2013

The systems have been under continued operation since their commissioning. In the current monitoring period, flare 2 has not been used as the gas available was sufficient to be consumed in the electricity generation system and flare 1 combined.

**(d) Total GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period.**

Total GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period: 52,614 $tCO_2e$.

### A.2. Location of project activity

>>

Cluny Road, Mare Chicose, Grand Port District, South Eastern Region of Mauritius, Republic of Mauritius (the "Host Country").

The geographic coordinates of the site are: $57^0$ 37' 54.2" E and $20^0$ 23' 11.8" S

### 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 Mauritius (host) | Sotravic Limited | No |
| Republic of Mauritius (host) | Rhizome Limited | No |

### A.4. Reference to applied methodologies and standardized baselines

>>

ACM0001, version 11, "Consolidated baseline and monitoring methodology for landfill gas project activities"

The following tools have been used as required by ACM0001, version 11:

"Tool to determine project emission from flaring gases containing methane", version 01 adopted at EB28;

"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", version 05, adopted at EB 55;

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption", version 01, adopted at EB 39; and

"Tool to calculate the emission factor for an electricity system", version 02, adopted at EB 50

All version numbers stated in this paragraph apply for the whole document. The above referred documents are available at http://cdm.unfccc.int/methodologies/PAmethodologies/approved

### A.5. Crediting period type and duration

>>

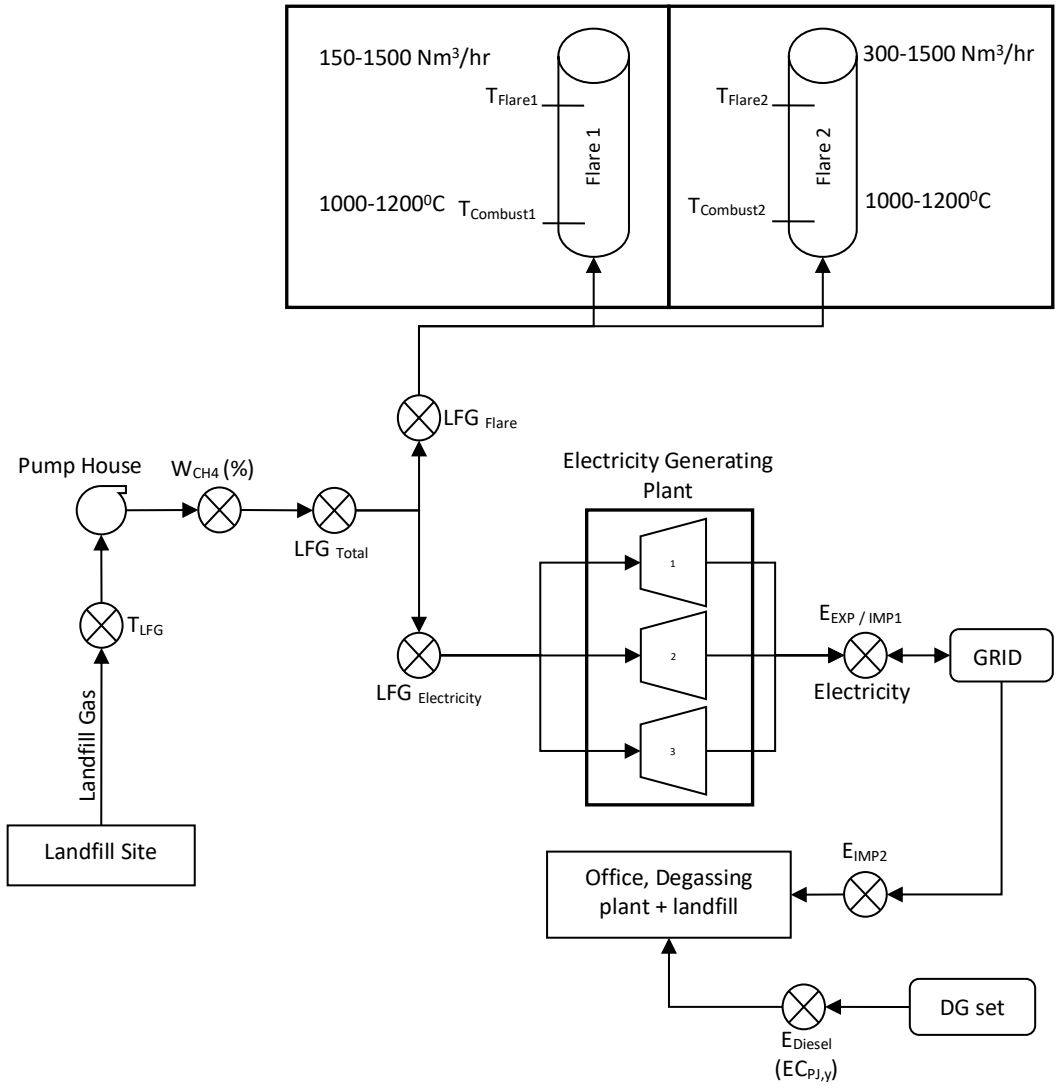
Renewable, duration: 01/04/2012 to 31/03/2019.

## SECTION B. Implementation of project activity

### B.1. Description of implemented project activity

>>

The project activity is demonstrated in the line diagram below:




**Landfill Gas Collection System**

The project activity involves the installation of LFG collection technology. This includes:

• Gas Collection Wells used to extract gas;

• Blowers to draw the LFG into the flare and/or the energy generator;

• Landfill capped by soil to provide cover for the site;

**Flare technology:**

The project activity involves the installation of two stationary enclosed gas flares consisting of pipe work, valves, blower, stack with burners, instrumentation and control panel. The details of the installed flares are as follows:

| Description | Make | Flow capacity range ($Nm^3/h$) | Combustion temperature range ($^0C$) | Commissioning date |
|---|---|---|---|---|
| **Flare 1** | Hofstetter LPM | 150 – 1500 | 1000 - 1200 | 28 May 2008 |
| **Flare 2** | Hofstetter LPM | 300 – 1500 | 1000 - 1200 | 18 September 2009 |

**Energy generation technology:**

The project has an installed electricity generation capacity of 3.3 MW using captured landfill gas as follows:

| Description | Make | Gas Engine capacity (kW) | Generator capacity (kW) | Commissioning date |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Generator 1** | Caterpillar G3516 | 1136 | 1100 | 31 October 2011 |
| **Generator 2** | Caterpillar G3516 | 1136 | 1100 | 31 October 2011 |
| **Generator 3** | Caterpillar G3516 | 1136 | 1100 | 22 January 2013 |

Besides, the project also has a backup diesel generator to meet the auxiliary electricity demand during power outage / shutdown as detailed below:

| Description | Make | Capacity (kW) | Generator capacity (kW) |
|---|---|---|---|
| **DG** | Scomat 3306 | 221 | 180 |

### B.2. Post-registration changes

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

>>

No temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline has been applied.

#### B.2.2. Corrections

>>

No corrections from the approved post registration changes revised registered PDD version 7.1, 02/10/2012 available at: https://cdm.unfccc.int/PRCContainer/DB/prcp399589485/view

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

>>

Not applicable

#### B.2.4. Inclusion of monitoring plan

>>

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

>>

No permanent changes from the approved post registration changes revised registered PDD version 7.1, 02/10/2012 available at: https://cdm.unfccc.int/PRCContainer/DB/prcp399589485/view

#### B.2.6. Changes to project design

>>

No project design changes from the approved post registration changes revised registered PDD version 7.1, 02/10/2012 available at: https://cdm.unfccc.int/PRCContainer/DB/prcp399589485/view

## SECTION C. Description of monitoring system

>>

**Data generation:** Total LFG captured and LFG sent to generators and/or the flares are continuously measured by the flow meters as mentioned in section D.2. Methane fraction in LFG is measured by a continuous gas analyzer and electricity exported and imported are measured continuously by electricity meter(s) (please see section D.2 for details).

**Data recording:** Measurements of the quantity total LFG captured, and LFG sent to generators and/or the flares are recorded electronically on a continuous basis at every 10 minutes. Methane fraction readings are recorded continuously every 10-minute interval. Electricity meter readings are recorded manually every month. All manual recordings are subsequently entered in an excel sheet.

**Data aggregation:** The monitored landfill gas data and electricity supplied to the grid are respectively summed over the monitoring period.

**Calculation:** see section D.2 and section E.

**Reporting:** The calculated values are included in an Excel sheet and reported in the CDM-MR.

Clear roles and responsibilities have been assigned to all staff involved in the CDM project, as described in the monitoring manual.

All staff involved in the collection of data and records are coordinated by the designated 'CDM Monitoring Manager. The CDM monitoring manager sends the data to Climate-Secure Services periodically for checking. Climate-Secure Services checks the data and calculates the achieved emission reductions. At the end of each monitoring period, Climate-Secure Services prepares the monitoring report.

## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante

*(Copy this table for each data or parameter.)*

| **Data/Parameter** | **$MD_{BL}$** |
|---|---|
| Unit | $tCH_4/yr$ |
| Description | Regulatory requirements relating to landfill gas projects |
| Source of data | Regulatory requirements as specified in the Tender document and follow-up documents, |
| Value(s) applied | 1709 |
| Choice of data or measurement methods and procedures | As mentioned in registered PDD, Table 6 (2009-2030) |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | - |

| **Data/Parameter** | **$GWP_{CH4}$** |
|---|---|
| Unit | $tCO_2e/tCH_4$ |
| Description | Global Warming Potential of methane ($CH_4$) |
| Source of data | IPCC |
| Value(s) applied | 25 |
| Choice of data or measurement methods and procedures | "Standard for Application of the Global Warming Potentials to Clean Development Mechanism Project Activities and Programmes of Activities for the Second Commitment Period of the Kyoto Protocol" released in EB69, Annex 3. http://cdm.unfccc.int/faq/Reference/Standards/meth/reg_stan02.pdf. The adoption of GWP of CH4 as 25 (100 year) is in line with the requirements specified by paragraphs 2,3 and 4 of the aforesaid standard and Fourth Assessment Report of IPCC, page 212 as available below: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | As applicable for the second commitment period |

| **Data/Parameter** | **$D_{CH4}$** |
|---|---|
| Unit | $tCH_4/m^3CH_4$ |
| Description | Methane Density |
| Source of data | Chemical constant |
| Value(s) applied | 0.0007168 |

| | |
|---|---|
| Choice of data or measurement methods and procedures | At standard temperature and pressure (0° C and 1,013 bar) the density of methane is 0.0007168 $tCH_4/m^3CH_4$. |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | - |

| **Data/Parameter** | **$CEF_{elec,BL,y}$** |
|---|---|
| Unit | $tCO_2/MWh$ |
| Description | Emission factor for the grid in year y |
| Source of data | Calculated in the PDD as per the "Tool to calculate the emission factor of an electricity system" |
| Value(s) applied | 0.967 |
| Choice of data or measurement methods and procedures | As mentioned in registered PDD |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | - |

| **Data/Parameter** | **$PP_{CP,Gen}$** |
|---|---|
| Unit | MW |
| Description | Rated capacity of the captive power plant that provides the project consumption sources with electricity |
| Source of data | Diesel Generator nameplate |
| Value(s) applied | 180kW |
| Choice of data or measurement methods and procedures | Not applicable |
| Purpose of data/parameter | Project emission calculation |
| Additional comments | - |

| **Data/Parameter** | **$EF_{EL,j,y}$** |
|---|---|
| Unit | $tCO_2/MWh$ |
| Description | Emission factor for electricity consumed |
| Source of data | "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" |
| Value(s) applied | 1.3 |
| Choice of data or measurement methods and procedures | Default value as per the tool |
| Purpose of data/parameter | Project emission calculation |
| Additional comments | - |

## D.2. Data and parameters monitored

| **Data/Parameter** | **$LFG_{total,y}$** |
|---|---|
| Unit | $Nm^3$ |
| Description | Total amount of landfill gas captured at Normal Temperature and Pressure |
| Measured/calculated/ default | Measured using normalised flow meter. |
| Source of data | On-site records |
| Value(s) of monitored parameter | 9,844,343 (for 10 minutes interval values refer the ER Calculation spreadsheet) |

<table>
<tr><td>Monitoring equipment</td><td>Normalised Gas Flow meter<br><br><table>
<tr><td>Period</td><td>01 Jan – 17 July 17</td><td>18 July – 31 Dec 17</td></tr>
<tr><td>Type</td><td colspan="2">Emerson Rosemount Mass Probar</td></tr>
<tr><td>Serial Number</td><td>8669401 02/09</td><td>8669403 02/09</td></tr>
<tr><td>Previous Calibration date</td><td>19 July 2016</td><td>29 June 2017</td></tr>
<tr><td>Calibration Frequency</td><td>Annual</td><td>Annual</td></tr>
<tr><td>Calibration status</td><td>Ok</td><td>ok</td></tr>
<tr><td>Accuracy</td><td>1% of flow rate</td><td>1% of flow rate</td></tr>
<tr><td>Permissible Error</td><td>±1%</td><td>±1%</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Flow rate measured continuously, recorded electronically at 10 minutes' interval. Aggregated monthly.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>The measured flow rate at every 10-minute interval, is time aggregated to give $LFG_{total}$</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meter is subject to a regular maintenance regime to ensure accuracy.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Baseline emission calculation</td></tr>
<tr><td>Additional comments</td><td></td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$LFG_{flare,y}$</td></tr>
<tr><td>Unit</td><td>$Nm^3$</td></tr>
<tr><td>Description</td><td>Amount of LFG flared at Normal Temperature and Pressure</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured using normalised flow meter</td></tr>
<tr><td>Source of data</td><td>On-site records</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>75,912<br>(for 10 minutes interval values refer the ER Calculation spreadsheet)</td></tr>
<tr><td>Monitoring equipment</td><td>Normalised Gas Flow meter<br><br><table>
<tr><td>Period</td><td>01 Jan – 26 April 17</td><td>27 April – 05 Oct 17</td><td>06 Oct-26 Oct 17</td><td>27 Oct – 31 Dec 27</td></tr>
<tr><td>Type</td><td colspan="4">Emerson Rosemount Mass Probar</td></tr>
<tr><td>Serial Number</td><td>8669403 02/09</td><td>8669402 02/09</td><td>8669404 02/09</td><td>8669402 02/09</td></tr>
<tr><td>Previous Calibration date</td><td>27 April 2016</td><td>23 March 2017</td><td>05 Oct 2016</td><td>23 March 2017</td></tr>
<tr><td>Calibration Frequency</td><td>Annual</td><td>Annual</td><td>Annual</td><td>Annual</td></tr>
<tr><td>Calibration status</td><td>Ok</td><td>Ok</td><td>Ok*</td><td>Ok</td></tr>
<tr><td>Accuracy</td><td>1% of flow rate</td><td>1% of flow rate</td><td>1% of flow rate</td><td>1% of flow rate</td></tr>
<tr><td>Permissible Error</td><td>±1%</td><td>±1%</td><td>±1%</td><td>±1%</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Flow rate measured continuously, recorded electronically at 10 minutes' interval. Aggregated monthly.</td></tr>
</table>

| | |
|---|---|
| Calculation method (if applicable) | The measured flow rate at every 10-minute interval, is time aggregated to give $LFG_{flared}$ |
| QA/QC procedures | Flow meter is subject to a regular maintenance regime to ensure accuracy. |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | * The flowmeter 8669404 02/09 was calibrated on 05 Oct 2016 and was put to first use, post calibration, on 04 November 2016 for measuring $LFG_{electricity,y}$. Thus, the validity of calibration for this meter is deemed till 03 November 2017. |

| **Data/Parameter** | **$LFG_{electricity,y}$** |
|---|---|
| Unit | $Nm^3$ |
| Description | Amount of LFG combusted in power plant at Normal Temperature and Pressure |
| Measured/calculated/ default | Measured using normalised flow meter |
| Source of data | On-site records |
| Value(s) of monitored parameter | 9,652,159<br>(for 10 minutes interval values refer the ER Calculation spreadsheet) |
| Monitoring equipment | Normalised Gas Flow meter |
| Measuring/reading/recording frequency | Flow rate measured continuously, recorded electronically at 10 minutes' interval. Aggregated monthly. |
| Calculation method (if applicable) | The measured flow rate at every 10-minute interval, is time aggregated to give $LFG_{electricity}$ |
| QA/QC procedures | Flow meter is subject to a regular maintenance regime to ensure accuracy |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | * The flowmeter 8669404 02/09 was calibrated on 05 Oct 2016 and was put to first use, post calibration, on 04 November 2016 for measuring $LFG_{electricity,y}$. Thus, the validity of calibration for this meter is deemed till 03 November 2017. |

| Period | 01 Jan – 05 Oct 17 | 06 Oct – 26 Oct 17 | 27 Oct- 31 Dec 17 |
|---|---|---|---|
| Type | Emerson Rosemount Mass Probar | | |
| Serial Number | 8669404 02/09 | 8669402 02/09 | 8669401 02/09 |
| Previous Calibration date | 05 Oct 2016 | 23 March 2017 | 27 Sep 2017 |
| Calibration Frequency | Annual | Annual | Annual |
| Calibration status | Ok* | Ok | Ok |
| Accuracy | 1% of flow rate | 1% of flow rate | 1% of flow rate |
| Permissible Error | ±1% | ±1% | ±1% |

| **Data/Parameter** | **$PE_{flare,y}$** |
|---|---|
| Unit | $tCO_2e$ |
| Description | Project emissions from flaring of the residual gas stream in year y |
| Measured/calculated/ default | Calculated |
| Source of data | On-site records |
| Value(s) of monitored parameter | 401<br>(for 10 minutes interval values refer the ER Calculation spreadsheet) |

| | |
|---|---|
| Monitoring equipment | NA. Calculated value. |
| Measuring/reading/recording frequency | Calculated for every 10-minute interval. Aggregated monthly. |
| Calculation method (if applicable) | Calculated as per the "Tool to determine project emissions from flaring gases containing Methane". |
| QA/QC procedures | All equipment are subject to a regular maintenance regime to ensure accuracy. |
| Purpose of data/parameter | Project emission calculations |
| Additional comments | - |

| **Data/Parameter** | **$w_{CH4}$** |
|---|---|
| Unit | $Nm_3CH_4$ / $Nm^3$ LFG |
| Description | Methane fraction in the landfill gas |
| Measured/calculated/ default | Measured using continuous methane gas analyser. |
| Source of data | On-site records. |
| Value(s) of monitored parameter | 49.58<br>(average over the monitoring period, for 10-minute interval values refer the ER Calculation spreadsheet) |
| Monitoring equipment | Online continuous methane fraction analyser |

| Period | 01 Jan – 02 July 17 | 03 July – 31 Dec 17 |
|---|---|---|
| Type | NUK | |
| Serial Number | A1702 | A1257 |
| Previous Calibration date | 04 July 2016 | 30 May 2017 |
| Calibration Frequency | Annual | Annual |
| Calibration Status | ok | ok |
| Accuracy | 2% | 2% |
| Permissible Error | ±2% | ±2% |

| | |
|---|---|
| Measuring/reading/recording frequency | Measured and recorded electronically at 10-minute interval. Aggregated monthly. |
| Calculation method (if applicable) | The measured methane fraction at every 10-minute interval is averaged to give $w_{CH4}$ |
| QA/QC procedures | The gas analyser is subject to a regular maintenance regime to ensure accuracy according to manufacturer's recommendation. |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | - |

| **Data/Parameter** | **$EL_{LFG}$** |
|---|---|
| Unit | MWh |
| Description | Net amount of electricity generated using LFG. |
| Measured/calculated/ default | Measured |
| Source of data | On-site records |
| Value(s) of monitored parameter | 15,750<br>for monthly values refer Annex I below |

| | |
|---|---|
| Monitoring equipment | Energy meters |

| Description | CEB Main meter (Bidirectional) | Import Meter 2 |
|---|---|---|
| Period | 01 Jan – 31 Dec 2016 | 01 Jan – 31 Dec 2016 |
| Type | Elster A1500 | EDMI MK10E |
| CEB Serial number | 10529112 | 14550052 |
| Previous Calibration date | 17 Aug 2016 | 17 Aug 2016 |
| Subsequent Calibration | 16 Aug 2017 | 16 Aug 2017 |
| Calibration Frequency | Annual | Annual |
| Calibration status | ok | ok |
| Accuracy | 0.2S | 0.5% |
| Permissible Error | +/- 0.2 % | +/- 0.5 % |

| | |
|---|---|
| Measuring/reading/recording frequency | Measured continuously using energy meters. Recorded monthly. |
| Calculation method (if applicable) | Electricity export – Electricity import |
| QA/QC procedures | The electricity meter is subject to regular maintenance in accordance with stipulation of the meter supplier to ensure accuracy. |
| Purpose of data/parameter | Baseline emission calculations |
| Additional comments | |

| **Data/Parameter** | **Operation of the energy plant** |
|---|---|
| Unit | Hours |
| Description | Operation of the energy plant in a year y |
| Measured/calculated/ default | Measured |
| Source of data | On-site records |
| Value(s) of monitored parameter | 8706.3 hrs |
| Monitoring equipment | Scada time meter |
| Measuring/reading/recording frequency | Monitored Continuously. |
| Calculation method (if applicable) | NA |
| QA/QC procedures | |
| Purpose of data/parameter | Data is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational |
| Additional comments | - |

| **Data/Parameter** | **$PE_{EC,y}$** |
|---|---|
| Unit | $tCO_2$ |
| Description | Project emissions from electricity consumption by the project activity during the year y |
| Measured/calculated/ default | Calculated |
| Source of data | On-site records |

| | |
|---|---|
| Value(s) of monitored parameter | 1<br>for monthly values refer Annex I below |
| Monitoring equipment | NA |
| Measuring/reading/recording frequency | Calculated monthly |
| Calculation method (if applicable) | Tool to calculate baseline, project and/or leakage emissions from electricity consumption" |
| QA/QC procedures | All related equipment are maintained in accordance with stipulation of the supplier to ensure accuracy. |
| Purpose of data/parameter | Project emissions calculation |
| Additional comments | The electricity consumption from grid has already been accounted under $EL_{LFG}$. This parameter provides project emissions from the standby diesel generator at the project site. |

| **Data/Parameter** | **$EC_{PJ,y}$** |
|---|---|
| Unit | MWh |
| Description | Onsite consumption of electricity provided by the grid and/or the captive power plant, attributable to the project activity during the year y |
| Measured/calculated/ default | Calculated |
| Source of data | On-site records |
| Value(s) of monitored parameter | 0.0<br>for monthly values refer Annex I below |
| Monitoring equipment | Calculated and recorded monthly |
| Measuring/reading/recording frequency | Metered electricity consumption from the diesel genset |

| Description | Diesel Genset Meter |
|---|---|
| Type | Elster A1350 |
| Manufacturer Serial Number | 01306516 |
| CEB Serial Number | 09519555 |
| Previous Calibration date | 17 Aug 2016 |
| Subsequent Calibration | 16 Aug 2017 |
| Calibration Frequency | Annual |
| Calibration Status | Ok |
| Accuracy | 1% |
| Permissible Error | +/- 1% |

| | |
|---|---|
| Calculation method (if applicable) | The meter(s) are maintained in accordance with stipulation of the supplier to ensure accuracy. |
| QA/QC procedures | Project emission calculation |
| Purpose of data/parameter | The project emissions from electricity imported from Grid are already account in the calculation of $EL_{LFG}$ (as net of export and import from grid) |
| Additional comments | |

| **Data/Parameter** | **$TDL_y$** |
|---|---|
| Unit | % |
| Description | Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site. |
| Measured/calculated/ default | Default |
| Source of data | Mauritius Central Electricity Board, annual report 2014 |
| Value(s) of monitored parameter | 6.59 |

| | |
|---|---|
| Monitoring equipment | NA |
| Measuring/reading/recording frequency | NA |
| Calculation method (if applicable) | NA |
| QA/QC procedures | NA |
| Purpose of data/parameter | Project emissions |
| Additional comments | - |

| **Data/Parameter** | **$T_{flare}$** |
|---|---|
| Unit | ˚C |
| Description | Temperature in the exhaust gas of the flare[1] |
| Measured/calculated/ default | Measured |
| Source of data | On-site records |
| Value(s) of monitored parameter | Refer "$T_{flare}$" in the ER Calculation spreadsheet |
| Monitoring equipment | **Description of thermocouple used for measuring $T_{Flare1}$** |

| Period | 01 Jan – 03 Oct 2017 | 04 Oct – 31 Dec 2017 |
|---|---|---|
| Type | JUMO type S | |
| Installation date | 04 Oct 2016 | 04 Oct 2017 |
| Replacement due date (annual replacement) | 03 Oct 2017 | 03 Oct 2018 |
| Replaced on | 04 Oct 2017 | -- |
| Calibration status | OK | OK |
| Accuracy | $\pm 1.0^0$C | $\pm 1.0^0$C |
| Correction factor to be applied | Not applicable | Not applicable |

| | |
|---|---|
| Measuring/reading/recording frequency | Measured and recorded electronically every 10 minutes. |
| Calculation method (if applicable) | NA |
| QA/QC procedures | The thermocouple is replaced every year. |
| Purpose of data/parameter | Project and Baseline emission calculation |
| Additional comments | New thermocouple unit (for measuring $T_{flare}$) was installed on 04 October 2016 during last monitoring period. This thermocouple cannot not be re-calibrated and hence was due for replacement on 03 October 2017 to be in compliance with the annual calibration frequency and hence was replaced on 04 October 2017. |

| **Data/Parameter** | **Other flare[2] operation parameters** |
|---|---|
| Unit | Various |

[1] Flare 2 has not operated during the entire monitoring period hence the conditions for flare 2 have not been mentioned for simplification.

[2] Flare 2 has not operated during the entire monitoring period hence the conditions for flare 2 have not been mentioned for simplification.

<table>
<tr><td>Description</td><td>Operational parameters for optimal operation of flare:<br>a) Minimum flare 1 flow ($Nm^3/h$) - 150 $Nm^3/h$<br>b) Maximum flare 1 flow ($Nm^3/h$) - 1500 $Nm^3/h$<br>c) Minimum $CH_4$ concentration to flare (%) – 30%<br>d) Minimum Temperature of Combustion (ºC) – $1000^0C$<br>e) Maximum Temperature of Combustion (ºC) – $1200^0C$<br>f) Minimum Temperature of Flare (ºC) (Tool condition) – $500^0C$</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>On-site records</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>a) Minimum flare 1 flow ($Nm^3/h$) – refer “$\mathbf{LFG_{flare,y}}$” above and in ER Calculation spreadsheet.<br>b) Maximum flare 1 flow ($Nm^3/h$) – refer “$\mathbf{LFG_{flare,y}}$” above and in ER Calculation spreadsheet.<br>c) Minimum $CH_4$ concentration to flare 1 (%) – refer $\mathbf{w}_{CH4}$ above and in ER Calculation spreadsheet.<br>d) Minimum Temperature of Combustion (ºC) – refer $T_{combust1}$ in ER Calculation spreadsheet.<br>e) Maximum Temperature of Combustion (ºC) - refer $T_{combust1}$ in ER Calculation spreadsheet.<br>f) Minimum Temperature of Flare (ºC) (Tool condition) – refer $T_{flare1}$ in the ER Calculation spreadsheet.</td></tr>
<tr><td>Monitoring equipment</td><td>a) Minimum flare 1 flow ($Nm^3/h$) – See parameter “$\mathbf{LFG_{flare,y}}$”<br>b) Maximum flare 1 flow ($Nm^3/h$) – See parameter “$\mathbf{LFG_{flare,y}}$”<br>c) Minimum $CH_4$ concentration to flare (%) – See parameter $\mathbf{w}_{CH4}$<br>d) Minimum Temperature of Flare (ºC) (Tool condition) – refer $T_{flare1}$<br>e) Minimum / Maximum Temperature of Combustion (ºC) - $T_{combust1}$
<table>
<tr><td>Period</td><td>01 Jan – 03 Oct 2017</td><td>04 Oct – 31 Dec 2017</td></tr>
<tr><td>Type</td><td colspan="2">JUMO Type S</td></tr>
<tr><td>Installation date</td><td>04 Oct 2016</td><td>04 Oct 2017</td></tr>
<tr><td>Replacement due date (annual replacement)</td><td>03 Oct 2017</td><td>03 Oct 2017</td></tr>
<tr><td>Replaced on</td><td>04 Oct 2017</td><td>--</td></tr>
<tr><td>Calibration Status</td><td>OK</td><td>OK</td></tr>
<tr><td>Accuracy</td><td>$\pm 1.0^0C$</td><td>$\pm 1.0^0C$</td></tr>
<tr><td>Correction factor to be applied</td><td>Not applicable</td><td>Not applicable</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Recorded at 10 minutes interval</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>All relevant equipment is maintained in accordance with stipulation of the supplier to ensure accuracy.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Project and Baseline emission calculation</td></tr>
<tr><td>Additional comments</td><td>New thermocouple unit (for measuring $T_{combust}$) was installed on 04 October 2016 during last monitoring period. This thermocouple cannot not be re-calibrated and hence was due for replacement on 03 October 2017 to be in compliance with the annual calibration frequency and hence was replaced on 04 October 2017.</td></tr>
</table>

| **Data/Parameter** | $\eta_{flare,h}$ |
|---|---|
| Unit | % |
| Description | Flare efficiency in hour h |
| Measured/calculated/ default | Default value as per the monitored flare parameters |

| | |
|---|---|
| Source of data | "Tool to determine project emissions from flaring gases containing methane" |
| Value(s) of monitored parameter | Refer ER Calculation spreadsheet for calculation of flare efficiency at 10-minute intervals |
| Monitoring equipment | NA |
| Measuring/reading/recording frequency | Recorded at 10-minute interval |
| Calculation method (if applicable) | NA |
| QA/QC procedures | All related equipment are maintained in accordance with stipulation of the supplier to ensure accuracy. |
| Purpose of data/parameter | Baseline emission calculation |
| Additional comments | - |

### D.3. Implementation of sampling plan

>>

Not applicable

## SECTION E. Calculation of emission reductions or net anthropogenic removals

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

>>

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + (EL_{LFG,,y} * CEF_{elec,BL,y})$$

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y}$$

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4})$$

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4}$$

$$PE_{flare,y} = \Sigma\ TM_{RG,h} * (1-\eta_{flare,h}) * GWP_{CH4} / 1000$$

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

Where:

| | |
|---|---|
| $BE_y$ | Baseline emissions in year *y* [$tCO_2e$]; |
| $MD_{project,y}$ | Methane destroyed/combusted by the project activity during a year *y* [$tCH_4$]; |
| $MD_{BL,y}$ | The amount of methane that would have been destroyed/combusted the year in the absence of the project due to regulatory and/or contractual requirement [$tCH_4$]; |
| $GWP_{CH4}$ | Global Warming Potential value for methane [$tCO_2e/tCH_4$][3]; |
| $EL_{LFG,y}$ | Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an onsite/off-site fossil fuel based captive power generation, during year *y* [MWh]; |
| $CEF_{elecy,BL,y}$ | $CO_2$ emissions intensity of the baseline source of electricity displaced [$tCO_2e$/MWh]. |
| $MD_{flared,y}$ | Quantity of methane destroyed by flaring during year *y* [$tCH_4$]; |
| $LFG_{flare,y}$ | Quantity of landfill gas fed to the flare(s) during the year *y* [$Nm^3LFG$]; |
| $w_{CH4,y}$ | Average methane fraction of the landfill gas as measured [4] during a year *y* [$Nm^3CH_4/Nm^3LFG$]; |
| $D_{CH4}$ | Methane density [$tCH_4/Nm^3CH_4$][5]; |
| $PE_{flare,y}$ | Project emissions from flaring of the residual gas stream in year *y* determined following the procedure described in the *"Tool to determine project emissions from flaring gases containing methane"* [$tCO_2e$]; |
| $MD_{electricity,y}$ | Quantity of methane destroyed by generation of electricity during year *y* [$tCH_4$]; |
| $LFG_{electricity,y}$ | Quantity of landfill gas fed into the electricity generator during year *y* [$Nm^3LFG$]; |
| $TM_{RG,h}$ | Mass flow rate of methane in the residual gas in the hour *h* [kg/h |

[3] This is 25 for the second commitment period.

[4] Methane fraction of the landfill gas to be measured on wet basis.

[5] At standard temperature and pressure (0° C and 1,013 bar) the density of methane is 0.0007168 $tCH_4$ / $m^3CH_4$.

| | |
|---|---|
| $\eta_{flare,\ h}$ | Flare efficiency in hour *h;*<br>• 0% if the temperature in the exhaust gas of the flare ($T_{flare}$) is below 500° C for more than 20 minutes during the hour *h*.<br>• 50%, if the temperature in the exhaust gas of the flare ($T_{flare}$) is above 500° C for more than 40 minutes during the hour *h,* but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*.<br>• 90%, if the temperature in the exhaust gas of the flare ($T_{flare}$) is above 500° C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*. |
| $TM_{RG,h}$ | 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* [$Nm^3/h$] |
| $fv_{CH4,RG,h}$ | Volumetric fraction of methane in the residual gas on dry basis in hour *h* |
| $\rho_{CH4,n}$ | Density of methane at normal conditions (0.7168 $kg/Nm^3$) |

For monthly values refer Annex 1. For detailed calculations refer "ER calculator"

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

>>

$PE_y = PE_{EC,y}$

$PE_{EC,y} = \sum EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y})$

Where:

| | |
|---|---|
| $PE_{EC,y}$ | Project emissions from electricity consumption by the project activity during the year *y* [$tCO_2/yr$]; |
| $EC_{PJ,y}$ | Quantity of electricity consumed by the project electricity consumption source *j* in year *y* [MWh/yr]; |
| $EF_{EL,j,y}$ | Emission factor for electricity generation for source j in year *y* [$tCO_2/MWh$]; |
| $TDL_{j,y}$ | Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site; |
| *J* | Sources of electricity consumption in project |

For monthly values refer Annex 1. For detailed calculations refer "ER calculator"

## E.3. Calculation of leakage emissions

>>

$LE_y = 0$

## 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** | 52,615 | 1 | 0 | 0 | 52,614 | 52,614 |

## 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 $CO_2e$) |
|---|---|
| 52,614 | 37,207 |

## E.6. Remarks on increase in achieved emission reductions

>>

The ex-post monitored emission reductions are higher than the ex-ante estimate because of the following:

1. Use of updated GWP of methane as 25 instead of 21. At a GWP of 21 the ex-post ERs would be 46,631 which is 25.33% higher than the PDD ex-ante estimate. For detailed calculations refer "ER calculator"
2. The reason for actual ERs higher than the ex-ante estimate in the PDD is because of practical variations between theoretical IPCC Tier II based calculation values in the PDD Vs. actual ex-post monitored values. A comparison of various parameters is illustrated below.

| Parameter | Value in PDD | Value in MR | Comment |
|---|---|---|---|
| $LFG_{total,y}$ | 9,038,489 | 9,844,343 | LFG generated by the landfill site is higher than that estimated in the registered PDD and is based on actual measurement records. |
| $LFG_{flare,y}$ | 0 | 75,912 | Actual LFG sent to flares during the monitoring period is non-zero considering the scenario when electricity generators were not available, and gas had to be flared. The PDD assumed no flaring as ideal scenario. |
| $LFG_{electricity,y}$ | 9,038,489 | 9,652,159 | LFG sent to gas engines is higher than that in the registered PDD due to relatively more landfill gas available from landfill as compared to that envisaged ex-ante in the PDD. |
| $w_{CH4}$ | 50 | 49.58 | Methane fraction is similar to that in the registered PDD. It is based on the actual measurement records. |
| $EL_{LFG}$ | 6,570 | 15,750 | Actual electricity generation is higher than that in the registered PDD due to the need for combusting relatively a higher volume of landfill gas available and reduced downtime of the energy plant. The PDD for additionality demonstration considers the net electricity generated by the project as 21,681 MWh which is higher than that $EL_{LFG}$ achieved during the monitoring period. |
| Operation of plant energy | 6570 | 8706.3 | Based on actual operation log. This is higher due to the need for combusting relatively a higher volume of landfill gas available and reduced downtime of the energy plant. |
| $EC_{PJ,y}$ | 900 | 0 | Electricity consumption based on actual values. This parameter only includes electricity imported from the diesel generator set. Electricity consumption from the grid is already accounted in the parameter $EL_{LFG,y}$. |
| $TDL_y$ | 9.70 | 6.59 | Transmission loss value sourced from the latest Annual Report (2015) published by Mauritius Central Electricity Board[6] |

The variation in the ERs is because following three reasons:

| Sl. No. | Description | Value in PDD | Value in current monitoring period at GWP of 25 | Value in MR at GWP of 21 | Increase in ER | Comment |
|---|---|---|---|---|---|---|

[6] http://ceb.intnet.mu/

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | Change in Baseline emissions due to methane destroyed by the project activity ($BE_{CH4,y}$) | 32,138 (page 69) | 37,391 | 31,408 | =-730 (i.e. 32,138-31,408) | There is a decrease in $BE_{CH4,y}$ is primarily on account of Project emissions from flaring, which has been considered 0 in the PDD. This variation is not under the control of the PP and is not because of any change in project design. Also, this does not impact the project scale or meth applicability. This change does not impact the additionality as the IRR from project activity is independent of the amount of methane destroyed by the project activity. |
| 2. | Change in Baseline emissions due to electricity generation ($BE_{elec,y}$) | 6,353 (page 69) | 15,224 | 15,224 | = 8,871 (i.e. 15,224 – 6,353) | The increase in $BE_{elec,y}$ is due to increased electricity generation by the project (15,224 MWh) vs. that specified in the PDD (6,353 MWh). This is because of relatively more quantity of gas available (as compared to PDD) resulting in relatively increased output from the gas engines. Also, an increased utilization of the electricity plant (8706.3 hours) due to less outage of the power plant units, compared to that in the PDD (6570 hours) as well as reduced TDL % have further contributed to an increase.<br>This variation is not attributable to change in project design, meth applicability or project scale.<br>This increase in electricity generation does not adversely impacts project additionality as the cash-flow in PDD already assumes a conservative figure of electricity generation at 100% load (i.e. 21,681 MWh) which is higher than the electricity generated by the project activity in the monitoring period |
| 3. | Change in project emissions due to use of back up diesel generator ($PE_{EC,y}$) | 1,283 (page 69) | 1 | 1 | = 1,282 (i.e. – (1 – 1,283)) | This is due to limited use of backup DG in the monitoring period due to lesser outage of the project power plant and lesser outage of the grid supply when project power plant is not operating. |
| Total Increase from PDD | | | | | = ~ 9,424 | 37,207 (ex-ante PDD value) + 9,424 = 46,631 which is the ER achieved during the current monitoring period (@ GWP =21) |

Moreover, the following comparison also illustrates that over a long term, the emission reductions achieved by the project activity are not exceeding the PDD estimates. A long-term comparison is deemed more suitable in case of landfill gas to energy projects, because of dynamic nature of the project performance (variable landfill gas quantity and quality utilized) compared to the theoretically modelled values in the PDD.

| Sl. No. | MP# | PDD value (at GWP of 21) | PDD value (at GWP of 25) | Monitored ERs |
|---|---|---|---|---|
| 1. | MP # 1 | 87,223 (apportioned to length of MP#1) | 87,223[7] | 30,054 |
| 2. | MP # 2 | 105,164 | 121,447 | 77,143 |
| 3. | MP # 3 | 84,045 | 96,810 | 86,228 |
| 4. | MP # 4 | 66,454 | 76,420 | 83,352 |
| 5. | MP # 5 | 52,754 | 60,553 | 62,961 |
| 6. | MP # 6 | 37,207 | 43,329 | 52,614 |
| **Total** | | **432,847** | **485,782** | **392,352** |
| **Average ERs** | | **72,141** | **80,964** | **65,392** |

[7] MP#1 was in 2012 for which GWP of 25 is not applicable

# Appendix 1: Person/entity responsible for completing the CDM-MR-FORM (additional)

| | |
|---|---|
| **Organization name** | Climate-Secure Services |
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## Document information

| *Version* | *Date* | *Description* |
|---|---|---|
| 06.0 | 7 June 2017 | Revision to:<br>• Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN);<br>• Make editorial improvements. |
| 05.1 | 4 May 2015 | Editorial revision to correct version numbering. |
| 05.0 | 1 April 2015 | Revisions to:<br>• Include provisions related to delayed submission of a monitoring plan;<br>• Provisions related to the Host Party;<br>• Remove reference to programme of activities;<br>• Overall editorial improvement. |
| 04.0 | 25 June 2014 | Revisions to:<br>• Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0));<br>• Include provisions related to standardized baselines;<br>• Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1;<br>• Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*;<br>• Editorial improvement. |
| 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 GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, 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). |

| *Version* | *Date* | *Description* |
|---|---|---|
| 01.0 | 28 May 2010 | EB 54, Annex 34. Initial adoption. |

Decision Class: Regulatory
Document Type: Form
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Keywords: monitoring report