MONITORING REPORT FORM (CDM-MR) *
Version 01

CONTENTS

MONITORING REPORT
Version 1.1 – 09th February 2012
Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor in Malaysia
Project 2467
Monitoring period and dates (01/07/2011 to 31/12/2011)

SECTION A. General description of the project activity

A.1. Brief description of the project activity

The Bukit Tagar Sanitary Landfill (BTSL) is operated by KUB-Berjaya Enviro Sdn. Bhd. (KBE) and located in Hulu Selangor, Malaysia. The landfill receives municipal solid waste (MSW) from the country's capital Kuala Lumpur and Selayang district in Selangor State.

The main objective for the Clean Development Mechanism (CDM) project is to avoid direct emissions of greenhouse gases (GHGs) from the landfill into the atmosphere through active extraction. The gas collected is destructed by high temperature enclosed flares as well as for power generation using gas engine with high efficiency.

Carbon emissions are reduced through two major activities:

Emission Reduction Aspects	How will emissions be reduced?
Landfill gas (LFG) Extraction and Destruction (CH_4 avoidance)	Instead of releasing LFG (consisting CH_4) to the atmosphere, the gas will be collected and destroyed in enclosed flares and gas engines
Power Generation (Fuel replacement)	Less CO_2 will be emitted by replacing electricity generated by grid power with electricity from LFG (considered as renewable)

The LFG extraction from the Advance Cell and Phase 1 Cell continued to operate during this monitoring period.

Two high temperature enclosed flares continued to be in operation while partial of gas captured was sent to one unit of gas engine to generate electricity. The electricity produced by the gas engine was exported to the grid during this monitoring period.

The fourth monitoring period is from 1st July 2011 to 31st December 2011 (inclusive of both days). The total emission reductions achieved during this monitoring period is **104,816 tCO_2e.**

A.2. Project Participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)
Malaysia (Host)	KUB-Berjaya Enviro Sdn. Bhd. (KBE) (Private)
Japan	Japan Carbon Finance, Ltd. (JCF) (Private)

A.3. Location of the project activity

The project location is situated approximately 5km to the west of the Bukit Tagar Interchange along the North-South Expressway and 40km from central Kuala Lumpur. The landfill is easily accessible via expressway and a dedicated Bukit Tagar Interchange has been developed for the access from the North-South Expressway. The landfill is situated in a leased agricultural land, surrounded by hectares of oil palm plantations and rubber trees.

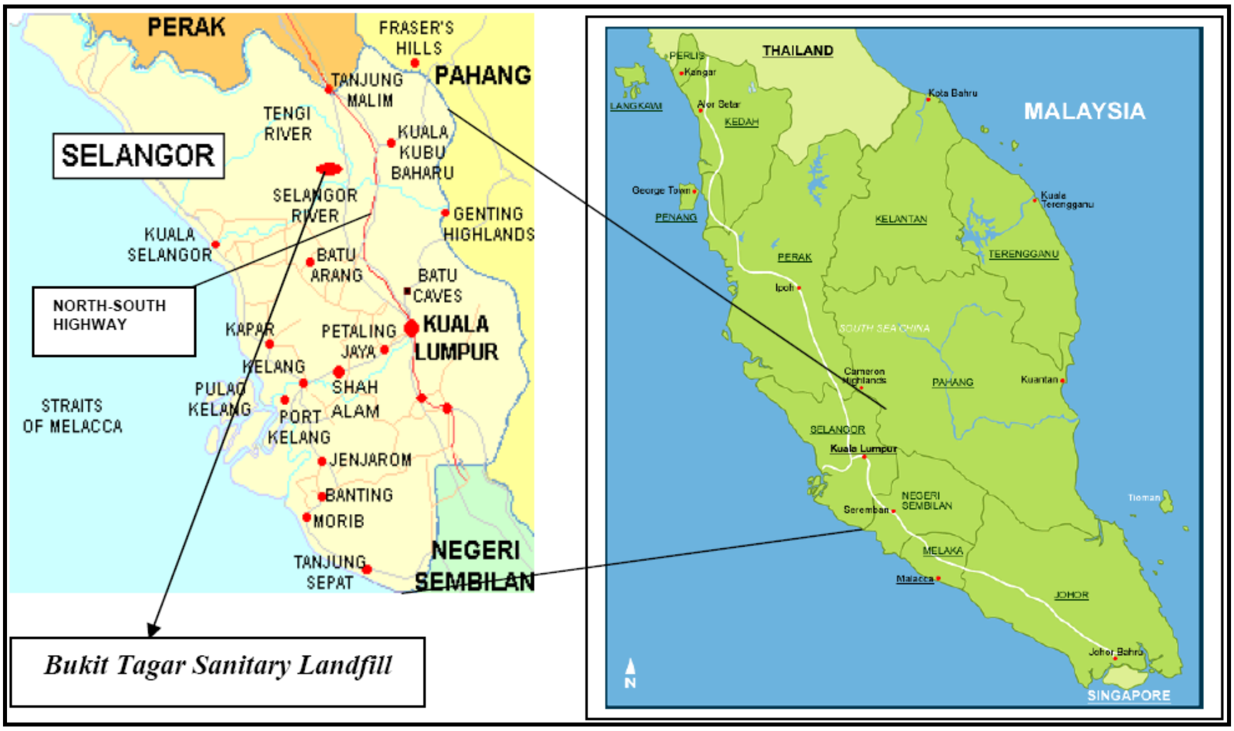


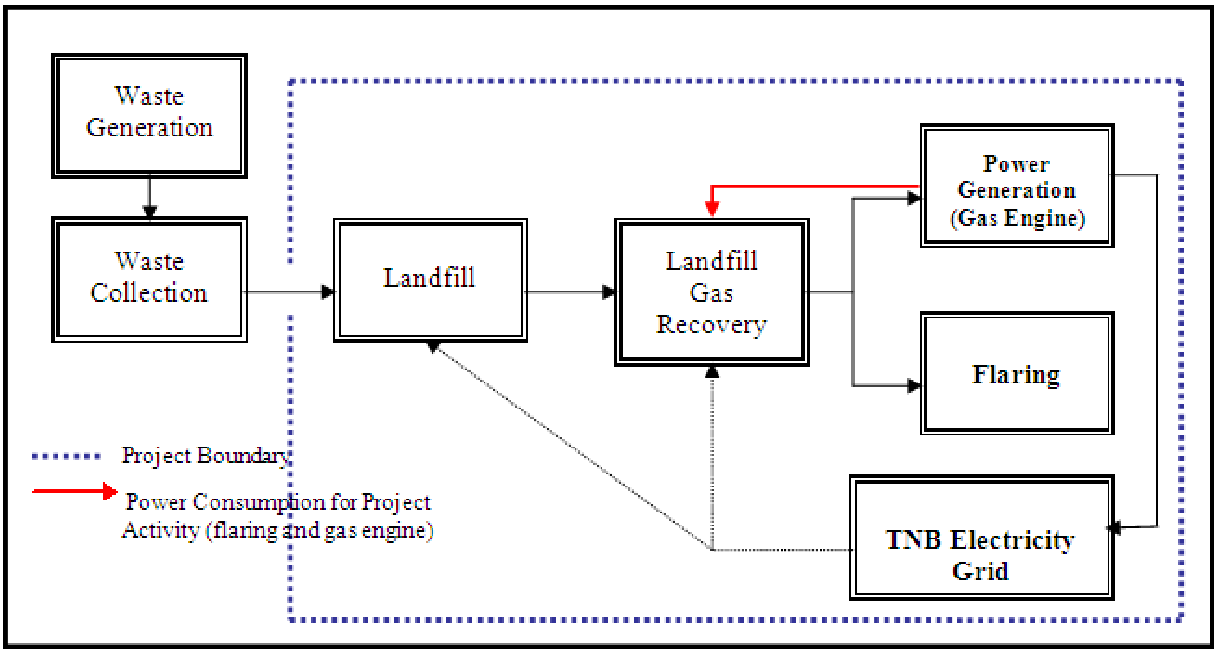
Figure 1: Location of Selangor State and BTSL

The specific geographical coordinates of the landfill are:

Latitude	Longitude	Description
3^0 30' 168''	101^0 28' 428''	North
3^0 29' 07''	101^0 28' 452''	South
3^0 29' 46''	101^0 28' 20''	West
3^0 29' 69''	101^0 29' 268''	East

A.4. Technical description of the project

The landfill gas recovery, flaring and power generation system can be illustrated below:



Note:

1. *With reference to paragraph 3, Section A.2, CDM PDD version 5.3, the landfill is being developed in phases. Currently, landfill gas extraction has been implemented on 2 closed cells in the landfill, i.e. Advance Cell and Phase 1. Both of these phases are included in this project, as well as any future phases to be developed in accordance to the PDD.*
2. *Notification of change was submitted earlier to remove the on-site power consumption for landfill operation.*

Figure 2: Overall LFG Recovery, Flaring and Power Generation Design

The technology applied and transferred into this project has been implemented and proven in Europe (Denmark and Germany) as well as China (extraction and flaring system).

Detail technical description is further described below:

<u>Gas Extraction System in Advance Cell</u>

Q2 Engineering Sdn. Bhd., a subsidiary of Q2 A/S of Denmark, was appointed as the turnkey contractor to construct the gas extraction and flaring system for Advance Cell. 42 vertical gas extraction pipes were installed in the landfill to extract the LFG. These wells were connected to 8 units of main gas collection pipes that led to the LFG flaring system.

Figure 3: An Example of Vertical Well Installed in Advance Cell

These vertical wells can be individually regulated and controlled.

First High-Temperature Enclosed Flaring System (Flare No.1)

One unit of high-temperature enclosed flaring system had been installed to flare off the LFG extracted. The flare system included a containerised blower and flaring system with a maximum capacity to flare off 2,500Nm^3/hr LFG.

Figure 4: Enclosed Flare Installed at Advanced Cell (Flare No.1)

The details of the flare specifications are listed below:

Specifications	Details
Manufacturer	Fairyland Environmental Technology, China
Gas flow	Maximum – 2,500Nm^3/hr
Retention time	>0.3 seconds at 800-1,000^{o}C
Gas blower	Twin-lobe roots blower
Gas analysers	Gas analysers for CH_4 and O_2

Gas Analyser and Data Logging

Monitoring of the correct functioning of the flare system was provided by a continuous-logging system which examines the operational parameters of the flare. The gas analyzing system is a multi-functional environmental monitoring equipment that can monitor up to 14 different measurements and data logging channels. Data from the logging system was presented on a local screen (on-line data) and stored in a local personal computer (PC) unit with external communication via Global System for Mobile Communications (GSM).

Data were downloaded directly from the built-in data logger to a PC and were also transmitted to external server and PC as back-up.

Gas Extraction System in Phase 1 Cell

Stage 1 of Phase 1 Cell was completed in August 2010. The cell is still an operational cell which will be filled according to the proposed plan of the landfill sequence at a later stage. The design of the gas extraction wells is based on a series of horizontal gas extraction wells constructed over the entire Phase 1 Cell.

Figure 5: Horizontal Gas Extraction Wells in Phase 1 Cell

Second High-Temperature Enclosed Flaring System (Flare No.2)

The second unit of high-temperature enclosed flaring system was installed to cater for the extra LFG extracted from Phase 1 Cell. The flare system included a containerised blower and flaring system with a maximum capacity to flare off 2,500Nm^3/hr LFG.

Figure 6: High-Temperature Enclosed Flares

The flare was supplied by the same manufacturer for Flare No.1. Details of the flare specifications are listed below:

Specifications	Details
Manufacturer	Fairyland Environmental Technology, China
Gas flow	Maximum – 2,500Nm^3/hr
Retention time	>0.3 seconds at 800-1,000^oC
Gas blower	Twin-lobe roots blower
Gas analysers	Gas analysers for CH_4 and O_2

The analyser and data logging system is similar to Flare No.1 (as described above).

<u>Gas Engine Energy Power Plants</u>

A high-efficiency (electrical efficiency > 42%) gas engine (net dispatch of 1MW) was chosen for the generation of electricity from LFG.

Figure 7: High-Efficiency Landfill Gas Engine Used in BTSL

The details of the gas engine specifications are listed below:

Specifications	Details
Manufacturer (Origin)	MWM (Germany)
Model	TCG 2020V12
Electric power output (net to grid)	1MW (total max. gross output 1.2 MW)
Voltage	11kV
Frequency	50Hz
Minimum heating value (LHV)	5.9kWh/m^3

To ensure that good quality LFG arrives at the gas engine, a LFG pre-treatment system comprising of a chiller (made in Germany) and activated carbon filter was also set up to remove moisture and impurities such as H_2S and siloxanes before the gas engine.

A landfill gas blower was installed to ensure that the required gas pressure for gas engine is maintained.

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

The project has applied the following approved methodology and tools:

Approved Methodology:

ACM0001 – *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8)

Methodological Tools referred to include:

- *Tool for the demonstration and assessment of additionality* (Version 5.2, EB 39, Annex 10);
- *Tool to determine project emissions from flaring gases containing methane* (Version 1, EB 28, Annex 13);
- *Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site* (Version 5, EB 55, Annex 18);
- *Tool to calculate the emission factor for an electricity system* (Version 2, EB 50, Annex 14); and
- *Tool to calculate baseline, project and/or leakage emissions from electricity consumption* (Version 1, EB 39, Annex 7).

A.6. Registration date of the project activity:

The registration date of Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor, Malaysia is 28thAugust 2009.

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

Crediting period of 7 years (renewable) was selected. The start date of the first crediting period is 28th August 2009 and the last date of the 7 years will be 27th August 2016.

A.8. Name of responsible person(s)/entity(ies):

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SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

For the reporting period of 1st July 2011 to 31st December 2011, the key CDM activities implemented are described below:

Gas Extraction System in Advance Cell and Flare No.1

The actual implementation of the flaring system was initiated in August 2009 and has continued through this monitoring period.

The table below shows the details on the downtime of the system (over the monitoring period covered by this report) due to maintenance, equipment breakdown, calibration of equipment, set point limit exceeded and other issues pertaining to the flare system.

Date	Flaring stopped		Reason
	From	To	
July 26, 2011	10:14	15:10	Maintenance – checked purge fan and serviced blower 1, 2 and filter element for moisture separator
July 29, 2011	9:00	11:20	Maintenance – serviced condensate tank, level sensor and purge fan 1
August 5, 2011	11:20	16:00	Maintenance – serviced internal part of blower 1 and 2
August 13, 2011	9:10	10:42	Maintenance – re-installed purge fan motor 1
August 17, 2011	21:56		Fault in blower 1
August 18, 2011		14:10	
August 23, 2011	4:12	4:26	Power surge in isolating transformers, instrument's power supply and power cabinet lighting
September 2, 2011	19:54	20:50	Equipment Breakdown – problem with chiller system
September 6, 2011	3:34	4:02	Isolating transformers tripped
September 8, 2011	11:44	12:58	Maintenance and Others - PT2 calibration

Date	Flaring stopped		Reason
	From	To	
September 11, 2011	19:22	19:46	Isolating transformers tripped
September 22, 2011	9:06	9:14	Exceed Set Point Limit and Others – MCB isolating transformers tripped
October 17, 2011	17:22	17:30	Equipment Breakdown – MCB isolating transformer for instrument tripped
November 14, 2011	13:54	18:12	Maintenance – serviced blower 1 and repaired motor 1 – bearing
November 16, 2011	12:30	13:14	Others – checked (Supervisory Control and Data Acquisition-Programmable Logic Controllers) SCADA-PLC connection for centralised control system
November 18, 2011	16:06	17:22	Maintenance and Others – changed belt for motor and blower 2
November 19, 2011	12:36	12:40	Maintenance – re-connected blower 2 after installation
November 23, 2011	14:32	14:38	PT2 above danger set point
November 30, 2011	14:34	16:26	Maintenance – major service of blower 2 and its motor
December 2, 2011	12:16	14:12	Fairyland checked the flare system to upgrade the blower
December 7, 2011	10:22	12:40	Re-installed motor and blower 2 after major service and changed motor bearing for motor 2
December 13, 2011	10:24	11:02	Maintenance and Others – checked PLC programme
December 15, 2011	12:24	12:30	Others – checked centralized SCADA programme and PLC programme
	13:08	13:14	Others – checked centralized SCADA programme and PLC programme
	15:32	15:54	Others – checked centralized SCADA programme and PLC programme

The total running time for Flare No.1 was 98% during this monitoring period.

Gas Extraction System in Phase 1 Cell and Flare No.2

The flaring system in Phase 1 was completed during the 2nd monitoring period and started its operation on 7th August 2010. Flare No.2 was located next to Flare No.1 where most of the LFG extracted from Phase 1 Cell is transferred via a transfer pipe and fed to Flare No.2.

The table below shows the details on the downtime of the system (over the monitoring period covered by this report) due to maintenance, equipment breakdown, scheduled blower service, set point limit exceeded and other issues pertaining to the flare system.

Date	Flaring stopped		Reason
	From	To	
July 6, 2011	11:03	13:11	Others – made some changes to SCADA system (upgrade) to accommodate for FT3 accuracy
	18:37	18:47	Maintenance and Others – checked new updated SCADA system
July 12, 2011	16:11	17:17	Others – checked new updated SCADA system
August 17, 2011	18:29	19:05	Equipment Breakdown – error in blower 2
August 28, 2011	10:22	12:28	Exceed Set Point Limit – CH_4 exceeded set point limit. Changed CH_4 analyser & restarted the system
September 9, 2011	10:58	14:49	Equipment Breakdown and Others – MCB for instrument (QF8) tripped
	17:12	18:25	Equipment Breakdown – MCB for instrument inside control room tripped
September 17, 2011	17:34		Power Failure –Tenaga Nasional Berhad (TNB) total power failure. Unable to restart after TNB power restored due to Flare 2 computer problem
September 22, 2011		17:02	
October 11, 2011	9:04	17:35	Flare stack roof repaired
December 1, 2011	16:20	18:45	Others – checked on the overall flare system - PLC, SCADA sensor and burner controller. Fairyland changed the main flame sensor and flame controller for main flame
December 5, 2011	17:08	17:58	Maintenance – checked blower setting, PLC programme & SCADA programme
December 13, 2011	10:50	12:57	Maintenance and Others – checked PLC programme at site
December 15, 2011	9:30	13:07	Maintenance – scheduled blower service
December 19, 2011	11:44	16:34	Others – check for SCADA and PLC programme and weekly mdb auto data lodging

During this monitoring period, a flame detection sensor problem has caused the frequent intermittent flare system shutdown over a short period. The details are presented in **Appendix 1**.

The total running time for Flare No.2 was 90% during this monitoring period.

Power Generation

During this monitoring period, power generated from gas engine No. 1 continued to be uploaded to the grid.

The table below shows the details on the downtime of the gas engine due to testing and commissioning, problem with flare, power failure and other issues pertaining to the gas engine.

Date	Gas Engine Stopped		Description Of Event
	From	To	
July 1, 2011	11:40	11:50	Reverse VAR - TNB change PF GE settings
July 2, 2011	11:01	17:36	Contractor works
July 6, 2011	10:40	15:45	VFD auto settings
July 7, 2011	10:20	13:27	TNB power failure
July 9, 2011	11:24	23:59	Isolation Transformer - High Temperature
July 10, 2011	0:00	23:59	
July 11, 2011	0:00	15:54	
July 12, 2011	12:15	18:10	Touch up paint, install DC converter
July 18, 2011	15:29	18:13	GDU trip / high temperature
July 19, 2011	16:14	18:05	T147 - High Temperature
July 20, 2011	15:33	16:20	T147 - High Temperature
July 21, 2011	13:33	19:29	Top-up lub oil, replace valve
July 22, 2011	10:06	10:15	GDU malfunction - No Fault
July 22, 2011	19:34	21:59	GE trip - Fault Reverse VAR
July 25, 2011	5:00	7:51	Combustion Chamber T476 & 463
July 26, 2011	7:58	9:07	GE trip - Fault Reverse VAR
July 29, 2011	19:39	20:59	GE trip - Fault Reverse VAR
August 2, 2011	13:36	14:55	T147 - High Temperature
August 2, 2011	19:02	23:59	Power Deviation Control
August 3, 2011	0:00	9:14	
August 7, 2011	18:26	21:25	Gov. Reg. Fail
August 8, 2011	8:42	8:58	Combustion Chamber
August 8, 2011	14:06	16:46	Fault - P145 Crankcase
August 9, 2011	0:27	7:55	Gov. Reg. Fail
August 9, 2011	9:08	10:06	Combustion Chamber A1
August 11, 2011	16:12	16:26	Combustion Chamber A1
August 11, 2011	20:17	21:42	Combustion Chamber A5
August 13, 2011	22:33	23:59	Combustion Chamber A6
August 14, 2011	0:00	23:59	
August 15, 2011	0:00	23:59	
August 16, 2011	0:00	23:59	
August 17, 2011	0:00	23:59	
August 18, 2011	0:00	23:59	
August 19, 2011	0:00	23:59	
August 20, 2011	0:00	23:59	

Date	Gas Engine Stopped		Description Of Event
	From	To	
August 21, 2011	0:00	16:39	
August 22, 2011	14:52	15:02	Combustion Chamber B6
August 23, 2011	4:11	8:19	Combustion Chamber B1
August 24, 2011	12:14	19:24	Outstanding works
August 26, 2011	0:00	8:24	Combustion Chamber A1
August 26, 2011	11:26	15:57	SPE-VFD setting (blower)
August 28, 2011	10:22	13:00	Combustion Chamber B6 & A6
August 28, 2011	22:29	23:59	P145 crankcase
August 29, 2011	0:00	10:44	
September 6, 2011	3:34	9:12	Power Deviation Control & Combustion Chamber A1
September 6, 2011	12:30	23:03	Outstanding works: check air filter
September 7, 2011	14:29	18:53	Check crankcase breather
September 9, 2011	10:58	18:50	Check lub oil leakage
September 11, 2011	19:22	23:59	Reverse VAR & MCB trips
September 12, 2011	0:00	17:27	Reverse VAR & MCB trips
September 12, 2011	23:03	23:59	Engine Safety Chain
September 13, 2011	0:00	8:39	Engine Safety Chain
September 13, 2011	16:25	16:29	GE GDU trip
September 13, 2011	21:23	22:30	Reverse Power
September 17, 2011	17:34	23:59	Flare 2 Shut Down
September 18, 2011	0:00	23:59	Flare 2 Shut Down
September 19, 2011	0:00	23:59	Flare 2 Shut Down
September 20, 2011	0:00	23:59	Flare 2 Shut Down
September 21, 2011	0:00	23:59	Flare 2 Shut Down
September 22, 2011	0:00	16:10	Flare 2 Shut Down
October 2, 2011	10:32	10:44	Power Deviation - Throttle Valve
October 7, 2011	8:10	9:32	T206 - Jacket Water Outlet / Inlet (T207) T462 Combustion Chamber A2
October 11, 2011	9:02	22:06	Service turbo charger - gas engine
October 12, 2011	9:10	23:59	Reverse VAR
October 13, 2011	0:00	23:59	Gas Engine Major Fault - unable to restart
October 14, 2011	0:00	23:59	- Ignition Box / Ignition Problem
October 15, 2011	0:00	23:59	- Combustion Chamber A&B
October 16, 2011	0:00	23:59	
October 17, 2011	0:00	23:59	
October 18, 2011	0:00	17:03	
October 19, 2011	15:57	16:07	Combustion Chamber A3, B6
October 19, 2011	22:59	23:42	Flare 2 Shut Down
October 20, 2011	3:52	4:15	Flare 2 Shut Down
October 22, 2011	23:12	23:20	Reverse VAR

Date	Gas Engine Stopped		Description Of Event
	From	To	
October 23, 2011	8:51	9:18	T473 Combustion Chamber B3
October 24, 2011	23:10	23:59	TNB Power Failure - Total site power shut down
October 25, 2011	0:00	2:13	Combustion Chamber A6
October 25, 2011	17:56	18:51	Combustion Chamber B2
November 24, 2011	16:59	17:24	Reverse VAR
November 25, 2011	10:48	10:53	Reverse VAR
November 25, 2011	14:38	14:57	Reverse VAR
November 25, 2011	22:40	22:53	Reverse VAR
November 27, 2011	14:19	15:16	T46 X 7 Combustion Chamber Average (B)
November 30, 2011	23:38	23:59	TNB Power Failure
December 1, 2011	0:00	2:44	
December 5, 2011	16:57	18:06	Flare 2 to check for PLC Programme
December 7, 2011	17:01	17:04	Reverse VAR
December 8, 2011	13:42	13:52	Power Surge - Combustion Chamber
December 9, 2011	21:29	21:43	Combustion Chamber A2 T462
December 13, 2011	10:42	13:58	Centralization SCADA
December 15, 2011	9:28	14:16	Flare 2 - Blower Service
December 19, 2011	11:40	11:48	Flare 2 - Checking for SCADA
December 20, 2011	8:26	8:33	Combustion Chamber B - Below average reading
December 22, 2011	8:39	8:46	Combustion Chamber A

Currently, the data recording for the amount of gas channelled to gas engine is linked with the Flare No. 2 SCADA system. Hence, the shutdown of Flare No. 2 also indicated the shutdown of gas engine No. 1. The details of the shutdown of gas engine No. 1 due to the flame detection sensor problem are presented in **Appendix 2**.

B.2. Revision of the monitoring plan

The revision of monitoring plan was submitted to UNFCCC on 14th October 2011 for approval.

B.3. Request for deviation applied to this monitoring period

No deviation during this monitoring period.

B.4. Notification or request of approval of changes

The notification request was submitted to UNFCCC on 14th October 2011 for approval.

SECTION C. Description of the monitoring system

Monitoring Methodology

The basis of the MP was formulated based on the approved methodology ACM0001 – *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8).

Operation and Management Structure for Monitoring

The organization structure for the Bukit Tagar CDM monitoring team is shown below:

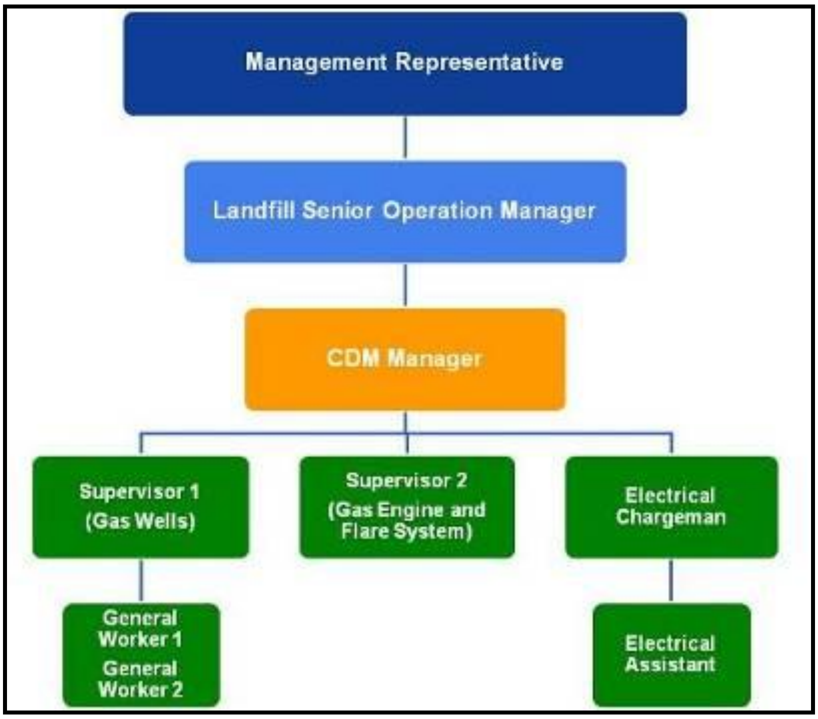


Figure 8: Organisational Structure for CDM Monitoring for BTSL LFG Recovery and Utilisation Project

The roles and responsibilities of the monitoring team in carrying out the monitoring plan are detailed as follow:

Table 1: Responsibilities of the CDM Monitoring Team

Role	Responsibility in CDM monitoring
Management Representative	• Reports to and obtain decisions from management on CDM-related matters • Chairs internal meetings on CDM matters • Signs off official correspondence for external parties
Senior Landfill Operation Manager	• Reports to the management representative • Oversees entire operation of landfills (including LFG management system)

Role	Responsibility in CDM monitoring
	• Covers responsibility of CDM Manager when he is not available
CDM Manager	• Reports to the Senior Landfill Operation Manager • Oversees and coordinates the entire CDM monitoring plan • Verifies and signs off all relevant monitoring records • Ensures Quality Control / Quality Assurance (QC/QA) is carried out • Ensures all data are recorded and necessary documentations are prepared according to the requirements of CDM monitoring • Responsible in optimising the LFG extraction and utilisation system
CDM Consultant	• Provides advice on all CDM-related matters • Prepares monitoring reports for verifications • Liaises with the verifier on verification process • Conducts regular audits on CDM monitoring
Supervisors	• Report to the CDM Manager on CDM monitoring issues • Check and ensure that the flaring system is functional • Ensure all data recording devices are functioning and calibrated as planned (including performing QA/QC) • Check and sign the daily monitoring log sheets for CDM monitoring • Supervise general workers in maintenance work and record monitored parameters for CDM monitoring • Identify maintenance requirement and contact the supplier if maintenance and support are needed • Optimise the flare operation together with the CDM Manager • Responsible with the security of locked PLC control room. The supervisor will hold the door key for the PLC control room
Electrical Chargeman	• Conducts regular checks on the electrical components of the flaring system • Ensures continuous power supply to flaring system • Identifies and fixes all electrical and electronic faults detected • Ensures all electrical meters are functioning and calibrated as per the supplier requirement / industrial standards • Records the electricity consumption for the flare system in the daily monitoring log sheets
General Workers	• Perform regular operational and maintenance tasks • Record necessary readings in daily monitoring log sheets and request verification from the supervisors on the log sheets • Report any fault to supervisor-in-charge or the electrical chargeman

The team is overall headed by the management representative (MR) who oversees the entire CDM monitoring implementation. The MR receives direct updates and support from the site staff headed by the Senior Landfill Operation Manager. The Senior Landfill Operation Manager is supported by the CDM Manager who is the key coordinator to all CDM monitoring matters on site. The CDM Manager is assisted by a group of technicians and workers who will perform the daily recording and checking tasks.

The CDM Consultant (Eco-Ideal Consulting Sdn. Bhd.) was appointed to assist KBE in ensuring that the monitoring plan and requirements were done according to the MP. The consultant played the role of a trainer and conducted independent audits as part of the Quality Assurance / Quality Control (QA/QC) procedures set up for this project.

During this monitoring period, a CDM Management Meeting was held on 16th August 2011.

Relevant Monitoring Points

The parameters monitored during the monitoring period are illustrated in the following figure:

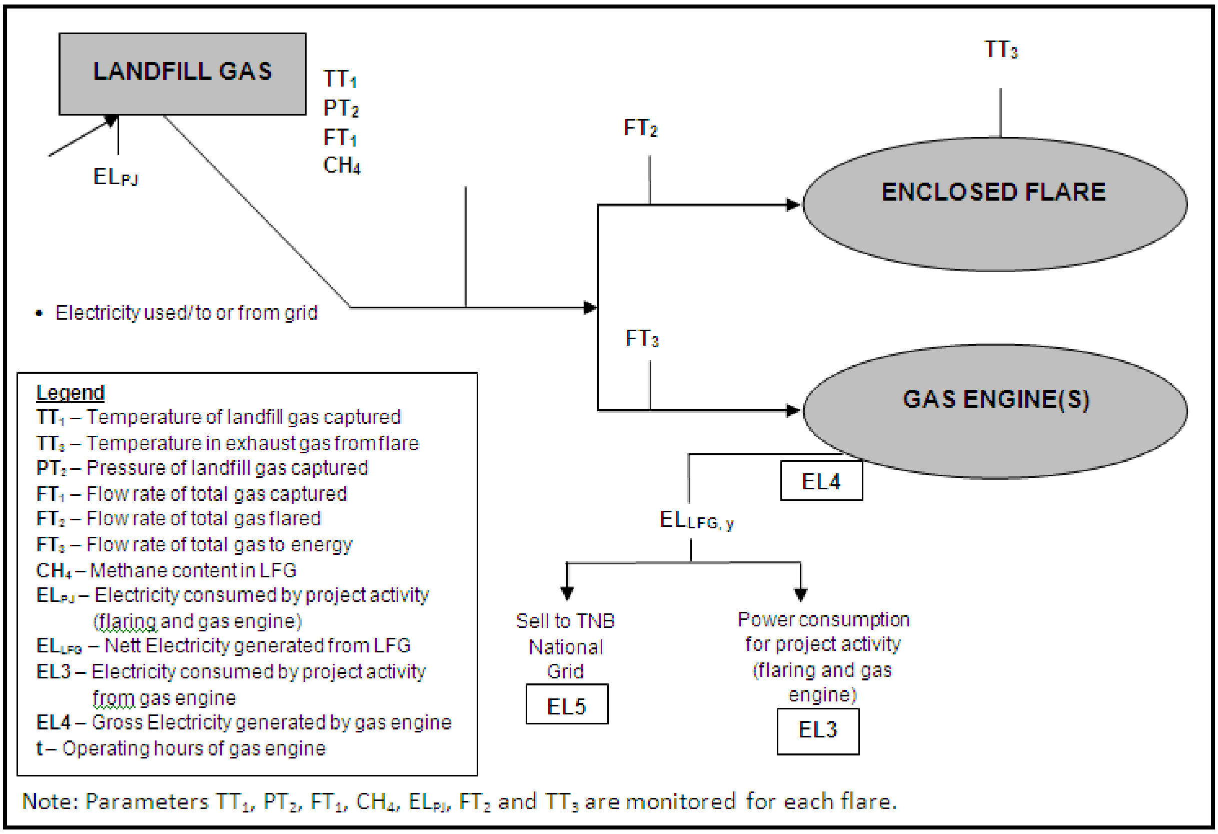


Figure 9: Key Parameters Monitored under the CDM Monitoring Plan

A physical connection has been installed to allow the transfer of gas from Phase 1 to Flare 1. When Flare 2 is unable to operate, the gas from Phase 1 will be channelled to Flare 1 to be flared. A part of the gas will also be transferred to the gen-set for electricity production if required. Necessary monitoring is carried out to ensure compliance with the monitoring plan.

<u>Data Recording and Documentation</u>

All relevant data/measurements of the parameters taken were recorded and kept in an appropriate format and archived after the crediting period to ensure that the data are accessible especially during the monitoring and verification process of the project.

Data was recorded in the following way:

Continuous Monitoring – Data in Softcopy:

Data logger (automatic recording in computer)

Manual Recording – Data in Hardcopy:

Daily monitoring log sheets and record books (manual recording)

Based on the MP, key parameters (temperature, pressure, flow of gas, CH_4 concentration in biogas) were continuously monitored and recorded via the data logger at the control room.

As a back-up data recording system, the on-site workers were required to manually record certain monitored parameters in daily monitoring log sheets. These records were filed and kept in the office which can be accessible by the CDM Manager and technicians whenever necessary. These log sheets (in hard copies) were scanned for electronic filing on a monthly basis.

A summary of the data directly monitored is tabulated below:

Table 2: CDM Monitoring Parameters, Frequency and Archiving

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
Temperature	$T_{TT1,F1}$ $T_{TT1,F2}$	$TT_{1,Flare No.1/ Flare No.2}$	Thermocouple	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into pdf format for archiving
Flare Temperature	$T_{Flare,F1}$ $T_{Flare,F2}$	$TT_{3,Flare No.1/ Flare No.2}$	Thermocouple	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into pdf format for archiving
Pressure	$P_{PT2,F1}$ $P_{PT2,F2}$	$PT_{2,Flare No.1/ Flare No.2}$	Pressure Gauge	Every 1 min (auto) Daily (manual) –	Softcopy Hardcopy	(.MDB MS Access database) Daily log

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
				as back-up		sheet will be scanned into pdf format for archiving
Flowrate	$LFG_{total,\ Flare\ No.1/\ Flare\ No.2,y}$ $LFG_{flare,\ Flare\ No.1/\ Flare\ No.2,y}$ $LFG_{electricity,\ Flare\ No.2,y}$	$FT_{1,Flare\ No.1/\ Flare\ No.2}$ $FT_{2\ ,Flare\ No.1/\ Flare\ No.2}$ $FT_{3,Flare\ No.2}$	V-Cone Differential Pressure Flowmeter	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into pdf format for archiving
Methane Fraction	$W_{CH4,\ Flare\ No.1/\ Flare\ No.2,y}$	$CH_{4,Flare\ No.1/\ Flare\ No.2}$	Continuous Infrared Gas Analyser	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into pdf format for archiving
Electricity consumed by the project	$EL_{PJ,\ y}$ $EL_{PJ,GE,\ Flare\ No.\ 1\ \&\ 2,y}$ $EL_{PJ,GE,\ auxiliary\ \&\ flare,\ y}$ $EL_{PJ,\ grid\ +\ GE,\ Flare\ No.1/\ Flare\ No.2,y}$	EL_{PJ} (EL1) $EL_{PJ,GE,\ Flare\ No.\ 1\ \&\ 2}$ (EL2) $EL_{PJ,GE,\ auxiliary\ \&\ flare}$ (EL3) $EL_{PJ,\ grid\ +\ GE,\ Flare\ No.1/\ Flare\ No.2}$	kWh meter	Daily (manual)	Softcopy (scanned copy) Hardcopy	Data recorded will be compiled into MS Excel and aggregated for monthly amount Daily log sheet will be scanned for archiving

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
Electricity generated by LFG	$EL_{LFG, GE, total, y}$	$EL_{LFG,GE, total}$ (EL4)	kWh meter	Daily (manual)	Softcopy (scanned copy) Hardcopy	Data recorded will be compiled into MS Excel and aggregated for monthly amount Daily log sheet will be scanned for archiving
	$EL_{LFG,y}$	EL_{LFG} (bEL5, TNB meter)	kWh meter	Daily (manual)	Softcopy (scanned copy) Hardcopy	TNB joint meter reading certificate will be scanned for archiving

NOTE:
Data recorded by the flow meter were normalised to Nm^3 with the temperature and pressure monitored automatically via the software. Thus, there was no need to normalise the recorded flow further.

Monitoring Equipment and Equipment Calibration

The list of CDM monitoring equipments used is shown in Table 3 & Table 4 below:

Table 3: List of CDM Monitoring Equipments and Calibration for Flare No.1

No	Item	Parameters	Equipment ID	CDM Monitoring ID	Unit	Manufacturer	Model No.	Serial No.	Accuracy	Range	Last Calibration Date & Cert No.	Recommended Next Calibration Date	Recommended Frequency of Calibration
Flare System													
1	Temperature Transmitter	Temperature (T)	$TT_{1,Flare\ No.1}$	$T_{TT1,F1}$	°C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B224836437	±0.5%	0-100°C	28/04/11 & SB 110587 (1 July 11 - 31 Dec 11)	27/04/12	Annually
2	Temperature Transmitter	Flare Temperature ($T_{flare,y}$)	$TT_{3,Flare\ No.1}$	$T_{Flare,F1}$	°C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B123070037	±0.5%	0-1200°C	03/03/11 & SB 110454 (1 July 11 - 31 Dec 11)	02/03/12	Annually
3	Pressure Sensor	Pressure Transmitter (P)	$PT_{2,Flare\ No.1}$	$P_{PT2,F1}$	kPa	Rosemount	3051TG1A2B21AB4 E5M5Q4	02255815	±0.25%	0-2 to 0-207 kPa	24/06/10 & 80415781 (1 July 11 - 7 September 11)	23/06/11	Annually
											08/09/11 & SB 110807 (8 September 11 - 31 Dec 11)	07/09/12	
4	Flow Meter	Total Biogas Flow Rate ($LFG_{total,y}$)	$FT_{1,Flare\ No.1}$	$LFG_{total,Flare\ No.1,y}$	NM^3/hr	Kingsway Vcone Flow transmitter	3051 / KVS10IIKC23FSN	4972946 / FT119 (8102101)	±1%	3-5000Nm^3/h	28/04/11 & SB 110591 (1 July 11 - 31 Dec 11)	27/04/13	24 months
5	Flow Meter	Flaring Biogas Flow Rate ($LFG_{flare,y}$)	$FT_{2,Flare\ No.1}$	$LFG_{flare,Flare\ No.1,y}$	NM^3/hr	Kingsway Vcone Flow transmitter	3051 / KVS10IIKC23FSN	4972945 / FT120 (8102102)	±1%	3-5000Nm^3/h	28/04/11 & SB 110592 (1 July 11 - 31 Dec 11)	27/04/13	24 months
Gas Analysers													
6	CH_4 Meter	Methane fraction of LFG	$CH_{4,Flare\ No.1}$	$W_{CH4,Flare\ No.1,y}$	%	Guardian Plus	97460	28931	±2%	0-100%	28/04/11 & SB 110593 (1 July 11 - 31 Dec 11)	27/04/12	Annually
Power Generation and Electricity Consumption													
7	Power meter	Power consumed	$EL_{PJ,grid+GE,Flare\ No.1}$	$EL_{PJ,grid+GE,Flare\ No.1,y}$	kWh	Krizik Slovakia	ET 421 HF612132C	8383258	Class 2 (±2%)	0-999,999kWh	06/05/11 & SP/RA/2011/172/001-001 (1 July 11 - 31 Dec 11)	05/05/12	Annually

** The maximum permissible error of ±0.25% was applied for PT2 from 1st July 2011 – 7th September 2011 as a conservative approach. The impact of applying these errors to the flow normalisation is negligible.*

Span Gas			
No	**Parameters**	**Analysis date**	**Best if used by**
1	N_2, CH_4	18/02/09	18/02/14
		01/08/11	01/08/21
2	N_2, CO_2	03/02/09	03/02/14
3	N_2, O_2	26/10/09	26/10/19
		09/01/12	09/01/22

Table 4: List of CDM Monitoring Equipments and Calibration for Flare No.2

No	Item	Parameters	Equipment ID	CDM Monitoring ID	Unit	Manufacturer	Model No.	Serial No.	Accuracy	Range	Last Calibration Date & Cert No.	Recommended Next Calibration Date	Recommended Frequency of Calibration
Flare System													
1	Temperature Transmitter	Temperature (T)	$TT_{1,Flare\ No.2}$	$T_{TT1,F2}$	^{0}C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B839917437	±0.5% of span	0-100°C	29/04/11 & SB 110595 (1 July 11 - 31 Dec 11)	28/04/12	Annually
2	Temperature Transmitter	Flare Temperature	$TT_{3,Flare\ No.2}$	$T_{Flare,F2}$	^{0}C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B838901937	±0.5% of span	0-1200°C	29/04/11 & SB 110597 (1 July 11 - 31 Dec 11)	28/04/12	Annually
3	Pressure Sensor	Pressure Transmitter (P)	$PT_{2,Flare\ No.2}$	$P_{PT2,F2}$	kPa	Rosemount	3051TG1A2B21AB4E 5Q4	5584784	±0.25%	0-2 to 0-207 kPa	29/04/11 & SB 110598 (1 July 11 - 31 Dec 11)	28/04/12	Annually
4	Flow Meter	Total Biogas Flow Rate	$FT_{1,Flare\ No.2}$	$LFG_{total,Flare\ No.2,y}$	NM^3/hr	Kingsway Flow transmitter	3051CD1A22A1AM5K 5Q4 /	5476626 / FT141 (10031702)	±0.5%	$3\text{-}5000Nm^3/h$	29/04/11 & SB 110601 (1 July 11 - 31 Dec 11)	28/04/13	24 months
5	Flow Meter	Flaring Biogas Flow Rate	$FT_{2,Flare\ No.2}$	$LFG_{flare,Flare\ No.2,y}$	NM^3/hr	Kingsway Flow transmitter	3051CD1A22A1AM5K 5Q4 /	5476627 / FT140 (10031701)	±0.5%	$3\text{-}5000Nm^3/h$	29/04/11 & SB 110600 (1 July 11 - 31 Dec 11)	28/04/13	24 months
6	Flow Meter	Flow Rate of Total Gas to Energy ($LFG_{electricity,y}$)	$FT_{3,Flare\ No.2}$	$LFG_{electricity,Flare\ No.2,y}$	NM^3/hr	Kingways Control Flow transmitter (Rosemount)	3051CD1A22A1AM5K 5Q4 / KVS08IIKC23FSN	5490821 / FT161 (11011001)	±0.5%	$200\text{-}2000Nm^3/h$	20/01/11 & D11-046-JG (1 July 11 - 31 Dec 11)	19/01/13	24 months
Gas Analysers													
7	CH_4 Meter	Methane fraction of LFG	$CH_{4,Flare\ No.2}$	$W_{CH4,Flare\ No.2,y}$	%	Guardian Plus	97460	32560	±2%	0-100%	05/05/11 & E-0508/0511 (1 July 11 - 27 Aug 11)	04/05/12	Annually
								30548	±2%	0-100%	21/06/11 & E-0644/0611 (28 Aug 11 - 31 Dec 11)	20/06/12	Annually
Power Generation and Electricity Consumption													
8	Power meter	Energy consumed	$EL_{PJ,grid+GE,Flare\ No.2}$	$EL_{PJ,grid+GE,Flare\ No.2,y}$	kWh	Contrel Elettronica S.R.L.	EMM-R4h	4309	±1%	0/999999999k Wh / kVArh	15/10/09 & TR012CIU (1 July 11 - 31 Dec 11)	14/10/12	36 months
9	Power meter	Energy consumed	EL_{PJ} (EL1)	$EL_{PJ,y}$	kWh	IME	NEMO 96HD+ (MF96021)	2167 8900 35	Class 0.5S (±0.5%)	0-400/5A	10/05/11 & 2167 8900 35 (1 July 11 - 31 Dec 11)	09/05/14	36 months
10	Power meter	Energy consumed	$EL_{PJ,GE,Flare\ No.1\ \&\ 2}$ (EL2)	$EL_{PJ,GE,Flare\ No.1\ \&\ 2,y}$	kWh	IME	NEMO 96HD+ (MF96021)	2135 3800 22	Class 0.5S (±0.5%)	0-250/5A	10/05/11 & 2135 3800 22 (1 July 11 - 31 Dec 11)	09/05/14	36 months
11	Power meter	Energy consumed	$EL_{PJ,GE,auxiliary\ \&\ flare}$ (EL3)	$EL_{PJ,GE,auxiliary\ \&\ flare,y}$	kWh	IME	NEMO 96HD+ (MF96021)	2153 4300 16	Class 0.5S (±0.5%)	0-500/5A	10/05/11 & 2153 4300 16 (1 July 11 - 31 Dec 11)	09/05/14	36 months
12	Power meter	Energy generation (MWh)	$EL_{LFG,GE,total}$ (EL4)	$EL_{LFG,GE,total,y}$	kWh (to be converted to MWh)	EDMI Limited	Mk6E	210225256	Class 0.5S	99999999.99k Wh	15/07/10 & 210225256-1918937 (1 July 11 - 31 Dec 11)	14/07/12	24 months
13	Power meter	Energy generation (MWh)	EL_{LFG} (EL5)	$EL_{LFG,y}$	kWh	Itron	SL761A071	53099690	Class 0.20	999999999kW h	01/04/11 & TNBM-QR-064 (1 July 11 - 31 Dec 11)	31/03/16	5 years

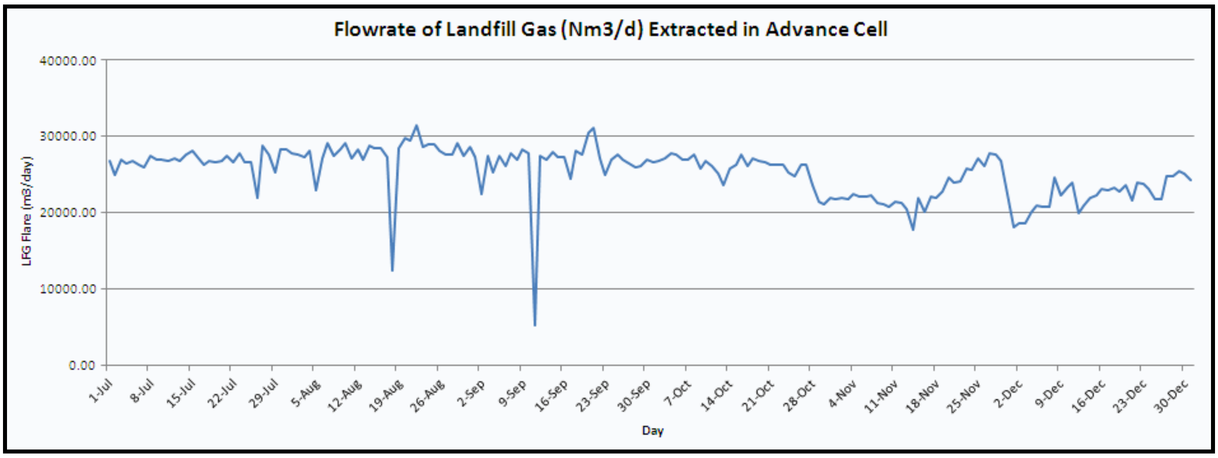
Span Gas			
No	Parameters	Analysis date	Best if used by
1	N_2, CH_4	04/10/10	04/10/20
2	N_2, CO_2	04/10/10	04/10/20
3	N_2, O_2	04/10/10	04/10/20

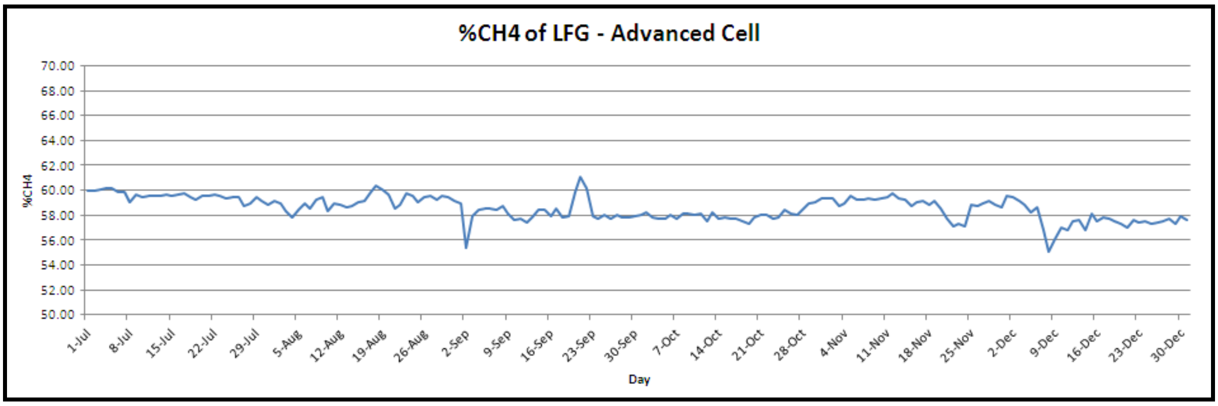
Data Collection (for the whole monitoring period)

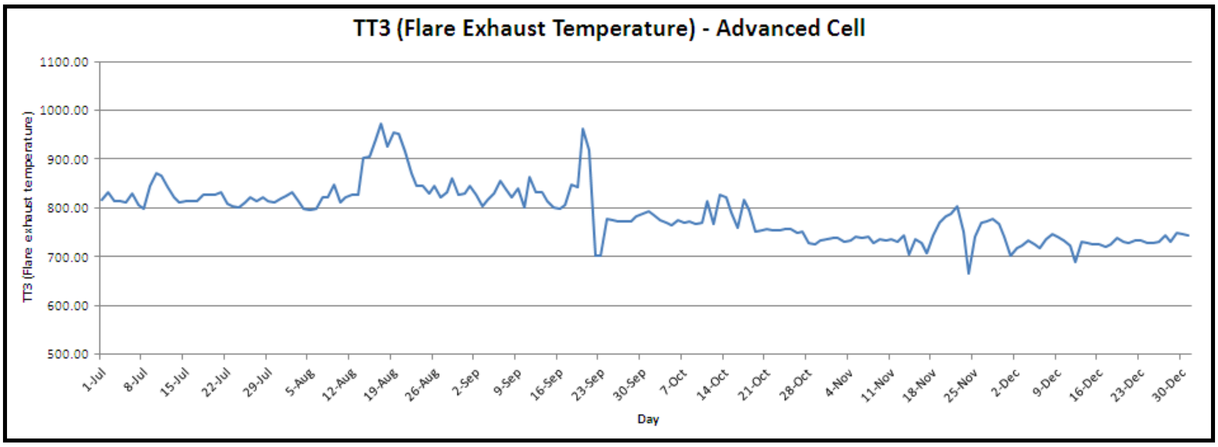
Based on the monitoring plan, key flaring parameters (temperature, pressure, flow of gas, CH_4 concentration in LFG) were continuously monitored and recorded via the data logger at the flare system control room. Continuous flaring data were logged and archived in every 1 minute in the database file. These raw data were compiled and analysed for the calculation of Certified Emission Reductions (CERs).

Data recorded for key parameters are compiled and presented below:

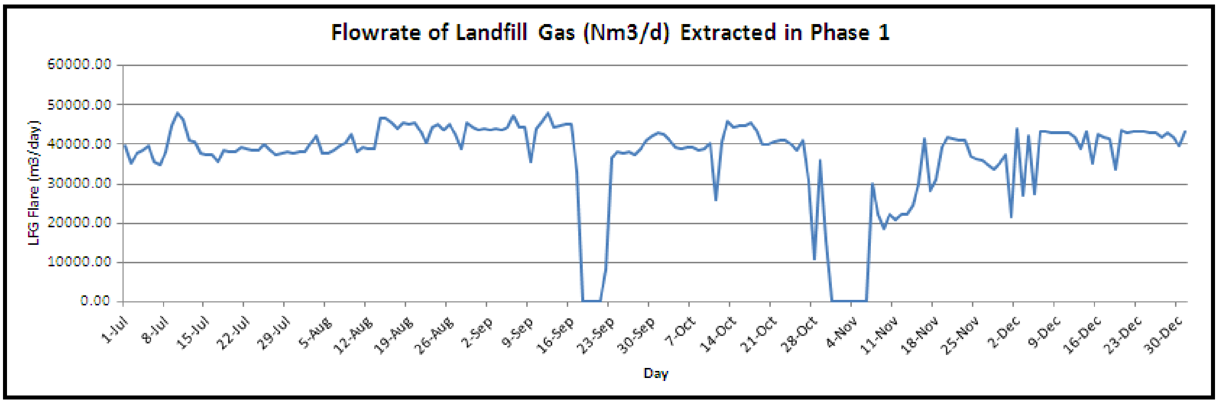
Flare No.1

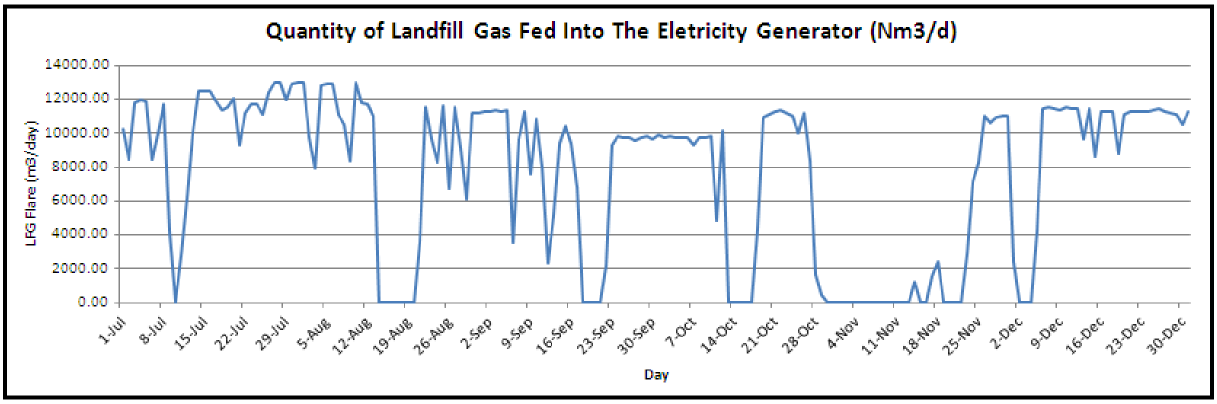


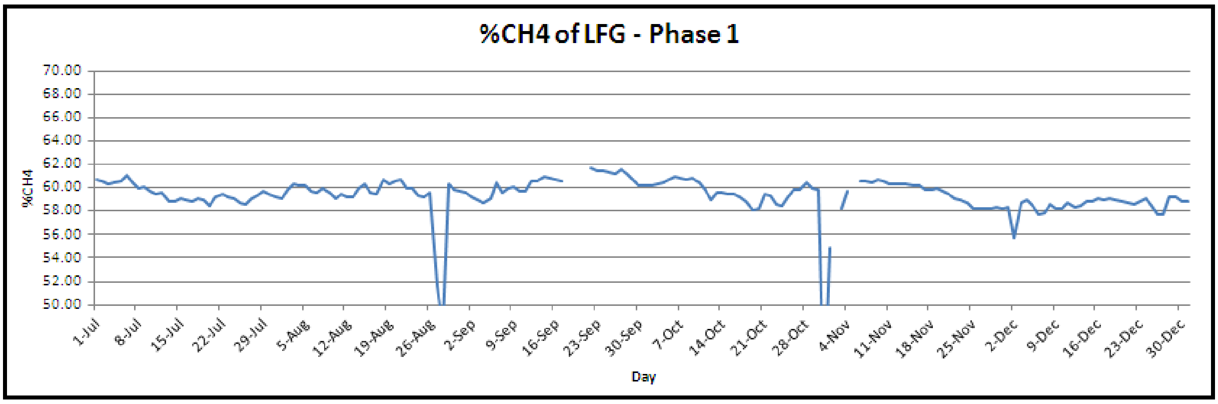


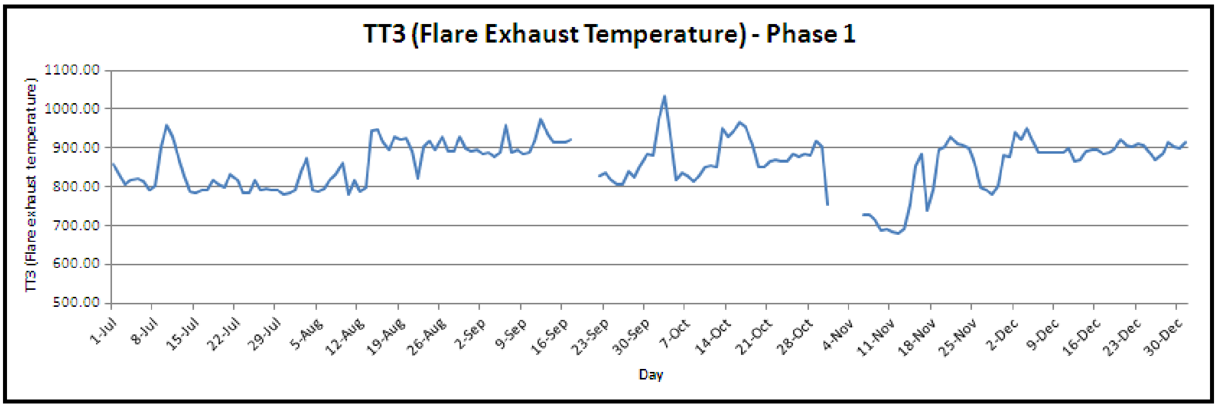


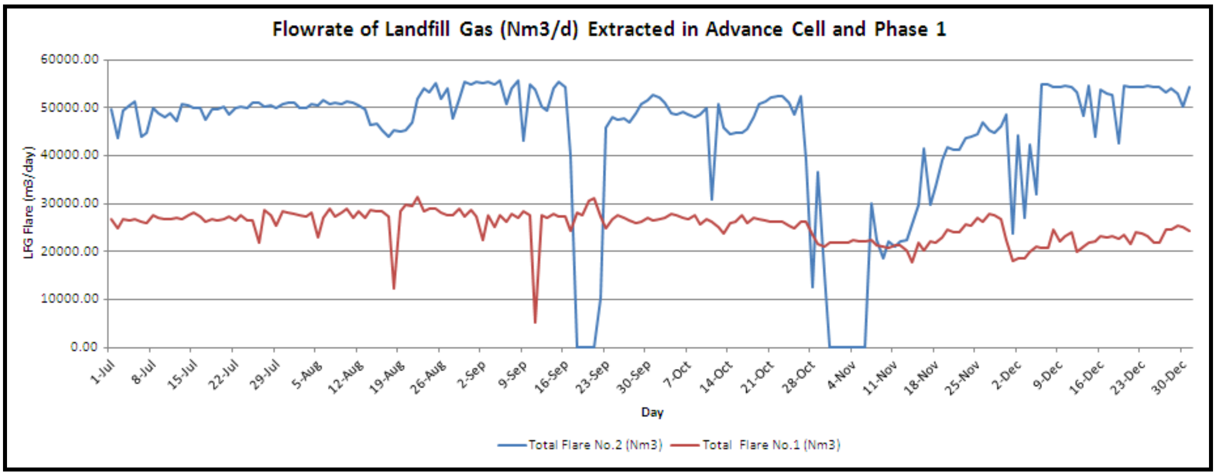
Flare No.2


Flowrate of Landfill Gas (Nm3/d) Extracted in Phase 1
LFG Flare (m3/day)
60000.00
50000.00
40000.00
30000.00
20000.00
10000.00
0.00
1-Jul 8-Jul 15-Jul 22-Jul 29-Jul 5-Aug 12-Aug 19-Aug 26-Aug 2-Sep 9-Sep 16-Sep 23-Sep 30-Sep 7-Oct 14-Oct 21-Oct 28-Oct 4-Nov 11-Nov 18-Nov 25-Nov 2-Dec 9-Dec 16-Dec 23-Dec 30-Dec
Day


Quantity of Landfill Gas Fed Into The Eletricity Generator (Nm3/d)
LFG Flare (m3/day)
14000.00
12000.00
10000.00
8000.00
6000.00
4000.00
2000.00
0.00
1-Jul 8-Jul 15-Jul 22-Jul 29-Jul 5-Aug 12-Aug 19-Aug 26-Aug 2-Sep 9-Sep 16-Sep 23-Sep 30-Sep 7-Oct 14-Oct 21-Oct 28-Oct 4-Nov 11-Nov 18-Nov 25-Nov 2-Dec 9-Dec 16-Dec 23-Dec 30-Dec
Day


%CH4 of LFG - Phase 1
%CH4
70.00
68.00
66.00
64.00
62.00
60.00
58.00
56.00
54.00
52.00
50.00
1-Jul 8-Jul 15-Jul 22-Jul 29-Jul 5-Aug 12-Aug 19-Aug 26-Aug 2-Sep 9-Sep 16-Sep 23-Sep 30-Sep 7-Oct 14-Oct 21-Oct 28-Oct 4-Nov 11-Nov 18-Nov 25-Nov 2-Dec 9-Dec 16-Dec 23-Dec 30-Dec
Day


TT3 (Flare Exhaust Temperature) - Phase 1
TT3 (Flare exhaust temperature)
1100.00
1000.00
900.00
800.00
700.00
600.00
500.00
1-Jul 8-Jul 15-Jul 22-Jul 29-Jul 5-Aug 12-Aug 19-Aug 26-Aug 2-Sep 9-Sep 16-Sep 23-Sep 30-Sep 7-Oct 14-Oct 21-Oct 28-Oct 4-Nov 11-Nov 18-Nov 25-Nov 2-Dec 9-Dec 16-Dec 23-Dec 30-Dec
Day



As a back-up data recording system, the on-site workers have manually recorded certain monitored parameters in the daily monitoring log sheets. These records were scanned into soft copies for electronic filing on a monthly basis.

Data recorded manually (not recorded in the data logger system), i.e. electricity consumed as well as electricity generated were recorded in daily monitoring log sheets on a daily basis and compiled in Microsoft (MS) Excel format weekly.

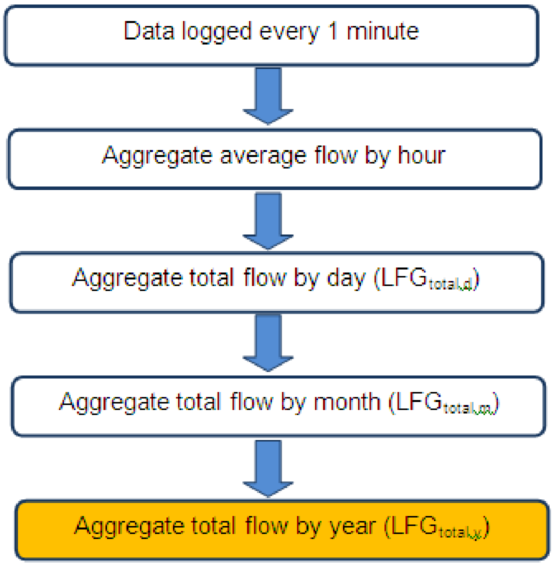
Data Processing

The data logged were archived in .db file format and compiled.

Data recorded were further processed to yield the results required. A specific computation programme (in MS Access) was developed by the CDM Consultant to process continuously-monitored data to the required format and summary.

An example of data aggregation on-site for flow rate of LFG at the main pipe is shown as follows:

Parameter: FT_1 (Flow rate of LFG at main pipe)



Hour	LFG-Total LFG Flow (m^3)
00:00-01:00	780
01:01-02:00	880
02:01-03:00	950
.....	
Total (day)	22,000

Figure 10: Example of Data Aggregation for Continuous Monitoring

Raw data logged at one (1) minute's interval were used to compute the hourly average. Subsequently, daily readings were computed, followed by aggregation into monthly and finally, yearly summaries.

Similar average values were computed for parameters such as the temperature, pressure and % CH_4.

In accordance to the "Tool to determine project emissions from flaring gases containing methane" (EB 28, Annex 13), 3 conditional default values for flare efficiency can be used for the calculation of CERs. The main criteria or condition for choosing the right default values for each hour is to assess the exhaust gas temperature from the flare stack ($T_{flare,h}$). On the other hand, all the operational parameters (temperature, pressure, etc.) related to CDM monitoring will also have to be taken into account as these parameters can affect $T_{flare,h}$. Therefore, the data of these parameters were recorded continuously through the PLC system.

Quality Assurance and Quality Control (QA & QC)

Documented Procedures and QA/QC Measures

QA/QC was applied throughout the monitoring period:

- Daily inspection of LFG extraction, flaring and monitoring systems;
- Checking and counter-signing of data forms by the CDM Manager;
- Data security (restricted access, password control) was applied to ensure the integrity of data;
- Inspection, observations, incidents and follow-up actions were documented;
- Independent audits were carried out by external consultants; and
- Data was analysed on a weekly basis to determine any irregularities.

Data Management and Storage

A proper data back-up system has been set up to ensure that the data will not be compromised in case of any unforeseen incidents at site resulting in total loss of data.

Continuous Monitoring (data logging system)

The data from continuous monitoring (data logger) was primarily stored in the hard disk located in the flare control room. To ensure that all data recorded are safe and properly archived, the following back-up system was applied for this project:

Types of back-up	Frequency	Back-up location
Manual back-up using a portable hard disk (HD) (weekly)	Monthly	At the flare
Automatic back-up to the CDM Manager's PC located at the site office, BTSL	Weekly	On-site (site office)

Types of back-up	Frequency	Back-up location
Data server in the CDM Consultant's office (Eco-Ideal Consulting Sdn. Bhd., C-7-2, Wisma Goshen, Plaza Pantai, Kuala Lumpur, Malaysia)	Weekly	Off-site (consultant's office)

The data stored in the data server located at the CDM Consultant's office will be used as the primary back-up data in case of any emergency situation resulting in the loss of data from the flare data recording system.

The automatic data back-up system based on internet data transmission can be illustrated as follows:

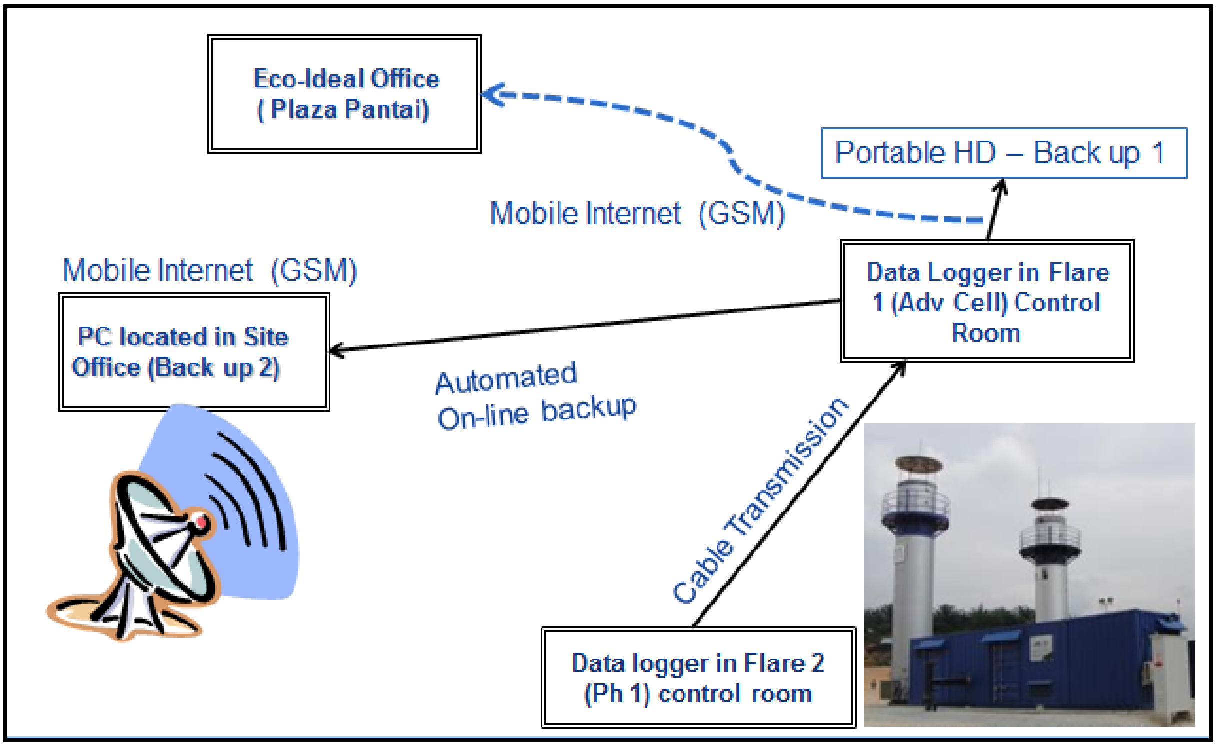


Figure 11: Automatic Data Back-Up for Flaring System at BTSL

Manual Recording

Daily operational data (consisting of CDM parameters monitored) recorded manually was backed-up by scanning all the daily monitoring log sheets on a weekly basis. These data were primarily stored in the computer at the cabin office next to the flare cabin. A copy of these scanned log sheets were handed to the CDM Consultant on a monthly basis for secondary back-up.

Independent Audits and Control Measures

All procedures for audit and QC measures were detailed in the CDM Audit Plan and Procedures (November 2009). An independent audit relevant to the 4th monitoring period was conducted by the consultant (Eco-Ideal Consulting Sdn. Bhd.):

- Audit No. 7 – 17th January 2012

The independent audit served as an important QC measure to ensure that all the monitoring required are done in accordance to the plan. Through the audit, the project can pre-empt any potential problems, issues as well as identify improvement measures during the monitoring period.

Training

Training is important to ensure that all the involved staff is provided with the needed knowledge and skills to undertake their roles effectively according to the CDM MP.

During this monitoring period, the staff has attended several technical/operational trainings as listed below:

No	Description	Date	No. of participants
1	Gas engine SCADA system	18th August 2011	5
2	Gas engine – operation	21st September 2011	9
3	Flare system – refresher training	23rd November 2011	5

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	**Regulatory requirement relating to landfill gas projects**
Data unit:	-
Description:	Regulatory requirement relating to landfill gas projects
Source of data used:	There is no regulatory requirement to recover and utilize landfill gas in Malaysia. Confirmation from the Department of National Solid Waste Management of the Ministry of Housing and Local Government regarding regulation aspects of landfill gas has already been obtained at the beginning of the earliest crediting period, i.e. during the 1st Monitoring Period (28th August 2009 – 28th February 2010).
Value (s):	NA
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	NA

Data / Parameter:	$\mathbf{GWP_{CH4}}$
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential (GWP) for CH_4
Source of data used:	Intergovernmental Panel on Climate Change (IPCC), Technical Summary, Working Group 1, pg. 33 The default value given by IPCC 2006 guideline for GWP of CH_4
Value (s):	21
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	NA

Data / Parameter:	$\mathbf{D_{CH4}}$
Data unit:	t_{CH4}/m^3_{CH4}
Description:	CH_4 density at standard temperature and pressure
Source of data used:	ACM0001 – “Consolidated baseline and monitoring methodology for landfill gas project activities” (Version 8)
Value (s):	0.0007168

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculation
Additional Comment:	-

Data / Parameter:	**Φ**
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of data used:	This uncertainty factor was adopted and the value is 0.9 based on recommendations in the "Tool to determine methane emissions avoided from dumping waste at solid waste disposal site".
Value (s):	0.9
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	-

Data / Parameter:	**f**
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data used:	There are no methane flaring, combustion or other usage of the methane in the baseline scenario.
Value (s):	0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	-

Data / Parameter:	**OX**
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used:	Site-visit reveals that this landfill is well managed and soil cover is applied on a daily basis. Therefore, the value 0.1 was applied as recommended by the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".
Value (s):	0.1
Indicate what the data are used for (Baseline/ Project/ Leakage emission	Baseline emission calculation

calculations)	
Additional Comment:	-

Data / Parameter:	F
Data unit:	%
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	This value was applied based on the recommendation of the IPCC in the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".
Value (s):	0.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	-

Data / Parameter:	DOC_f
Data unit:	%
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	This value was applied based on IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value (s):	0.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	-

Data / Parameter:	MCF
Data unit:	-
Description:	Methane Correction Factor
Source of data used:	This value was applied based on the recommendation of the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. The Bukit Tagar Sanitary Landfill site is a fully anaerobic managed solid waste disposal site. The waste received at the landfill was deposited at a specific tipping phase and there was no scavenging of waste in the landfill. Wastes were covered daily with compacted soil and compaction as well as levelling were practiced based on international landfill operational practices.
Value (s):	1.0

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	-

Data / Parameter:	**DOC_j**
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data used:	The above values were adopted from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 2.4)
Value (s):	The following values for the different waste fraction (types) were applied: (see table below)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	-

DOC_j		
Waste type j	**DOC_j (% wet basis)**	**DOC_j (% dry basis)**
Wood and wood products	**43**	50
Pulp, paper and cardboard (other than sludge)	**40**	44
Food, food waste, beverages and tobacco (other than sludge)	**15**	38
Textiles	**24**	30
Garden, yard and park waste	**20**	49
Glass, plastic, metal, other inert waste	**0**	0
Nappies	**24**	60

Data / Parameter:	**kj**
Data unit:	-
Description:	Decay rate for the waste type *j*
Source of data used:	The above values were adopted from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)

Value (s):	The following values for the different waste fraction (types) were applied:

Waste type j		Boreal and Temperature (MAT<20^{o}C)		Tropical (MAT>20^{o}C)	
		Dry (MAP/PET<1)	Wet (MAP/PET>1)	Dry (MAP<1000mm)	Wet (MAP>1000mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0/06	0.045	**0.07**
Slowly degrading	Wood, wood products and straw	0.02	0.03	0.025	**0.035**
Moderately degrading	Other (non-food) organic putrescrible garden and park waste	0.05	0.1	0.065	**0.17**
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	**0.4**

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional Comment:	The project site is located in the State of Selangor, Malaysia. The climate is tropical with an annual mean 24-hr temperature of approximately 27°C and annual mean precipitation of around 2,700mm. These values were long-term averages documented in the EIA report prepared for the landfill in 2005. Thus, the K-values for tropical temperature and wet climate were used.

Data / Parameter:	**TDL_y**
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to the grid in year y
Source of data used:	Default values from TNB Report, 2007
Value applied:	0.1
Indicate what the data	Project emission calculation

are used for (Baseline/ Project/ Leakage emission reduction calculations)	
Additional comment:	TDL_y should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to.

D.2.	**Data and parameters monitored**

Data / Parameter:	**$LFG_{total,y}$**
Data unit:	m^3
Description:	Total amount of LFG captured during the project at normal temperature and pressure
Measured/ Calculated/ Default:	Measured
Source of data:	Continuous measurement by flow meter during operation of project activity. This parameter was measured continuously and separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period. During temporary malfunctioning of flow meter or data logging system resulting in unrepresentative data, the value of LFG_{total} for the affected period will be taken as the sum of LFG_{flare} and $LFG_{eletricity.}$

<table>
<tr><td>Value (s) of monitored parameter:</td><td>As a conservative approach, the value presented from July – December 2011 for Flare No.2 is the total of the values of FT2 and FT3 which have been re-calculated by taking into consideration the lower value between the measured FT1 and FT2 + FT3.

<table><tr><th>Months</th><th>Flare No. 1 Value (Nm³)</th><th>Flare No. 2 Value (Nm³)</th></tr><tr><td>July 11</td><td>831,404</td><td>1,528,996</td></tr><tr><td>August 11</td><td>857,008</td><td>1,555,589</td></tr><tr><td>September 11</td><td>790,912</td><td>1,290,546</td></tr><tr><td>October 11</td><td>801,382</td><td>1,368,222</td></tr><tr><td>November 11</td><td>690,053</td><td>847,338</td></tr><tr><td>December 11</td><td>694,092</td><td>1,545,314</td></tr><tr><td>Total</td><td>4,664,850</td><td>8,136,004</td></tr></table></td></tr>
<tr><td>Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Baseline and Project emission calculation</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td><table><tr><th rowspan="2">Item</th><th>Flare No. 1 Description Kingsway V-cone Flow Transmitter (Rosemount)</th><th>Flare No. 2 Description Kingsway V-cone Flow Transmitter (Rosemount)</th></tr><tr><th>1 July – 31 Dec 11</th><th>1 July – 31 Dec 11</th></tr><tr><td>Type</td><td>Differential Pressure Transmitter</td><td>Differential Pressure Transmitter</td></tr><tr><td>Accuracy class</td><td>± 1%</td><td>± 0.5%</td></tr><tr><td>Serial No.</td><td>4972946 (Rosemount) / FT1 – FT119 (8102101)</td><td>5476626 (Rosemount) / FT1 – FT141 (10031702)</td></tr><tr><td>Calibration frequency</td><td>2 years</td><td>2 years</td></tr><tr><td>Date of last calibration</td><td>28/04/11</td><td>29/04/11</td></tr><tr><td>Validity</td><td>2 years</td><td>2 years</td></tr></table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measured continuously with a flow meter. Data was aggregated on both monthly and yearly basis.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
</table>

QA/QC procedures to be applied:	Flow meters were tested, calibrated and maintained regularly.

Data / Parameter:	**$LFG_{flare,y}$**
Data unit:	m^3
Description:	Total amount of LFG sent to flare at normal temperature and pressure
Measured/ Calculated/ Default:	Measured
Source of data:	Continuous measurement by flow meter during operation of project activity. This parameter was measured separately for both of the flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period. During temporary malfunctioning of flow meter or data logging system resulting in unrepresentative data, the value of LFG_{flare} for the affected period will be derived by subtracting $LFG_{electricity}$ from $LFG_{total.}$
Value (s) of monitored parameter:	(see table below)
Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculation

Months	Flare No. 1 Value (Nm^3)	Flare No. 2 Value (Nm^3)
July 11	831,404	1,205,519
August 11	857,008	1,308,044
September 11	790,912	1,060,315
October 11	801,382	1,153,345
November 11	690,053	769,348
December 11	694,092	1,251,909
Total	**4,664,850**	**6,748,479**

<table>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th rowspan="2">Item</th><th>Flare No. 1 Description Kingsway V-cone Flow Transmitter (Rosemount)</th><th>Flare No. 2 Description Kingsway V-cone Flow Transmitter (Rosemount)</th></tr>
<tr><th>1 July – 31 Dec 11</th><th>1 July – 31 Dec 11</th></tr>
<tr><td>Type</td><td>Differential Pressure Transmitter</td><td>Differential Pressure Transmitter</td></tr>
<tr><td>Accuracy class</td><td>± 1%</td><td>± 0.5%</td></tr>
<tr><td>Serial No.</td><td>4972945 (Rosemount) / FT2 – FT120 (8102102)</td><td>5476627 (Rosemount) / FT2 – FT140 (10031701)</td></tr>
<tr><td>Calibration frequency</td><td>2 years</td><td>2 years</td></tr>
<tr><td>Date of last calibration</td><td>28/04/11</td><td>29/04/11</td></tr>
<tr><td>Validity</td><td>2 years</td><td>2 years</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measured continuously with flow meter. Data was aggregated on both monthly and yearly basis.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Raw data logged at 1 minute's interval were used to compute the hourly average. Subsequently, daily readings were computed, followed by aggregation into monthly and finally, yearly records.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>Flow meters were tested, calibrated and maintained regularly.</td></tr>
</table>

Data / Parameter:	**$LFG_{electricity,y}$**
Data unit:	m^3
Description:	Amount of landfill gas combusted in power plant (gas engines) at normal temperature and pressure
Measured/ Calculated/ Default:	Measured
Source of data:	Continuous measurement by flow meter during operation of project activity. During temporary malfunctioning of flow meter or data logging system resulting in unrepresentative data, the value of $LFG_{electricity}$ for the affected period will be derived by subtracting LFG_{flare} from $LFG_{total.}$

Value (s) of monitored parameter:	(see table below)

Months	Flare No. 2 Value (Nm^3)
July 11	323,477
August 11	247,544
September 11	230,230
October 11	214,876
November 11	77,990
December 11	293,405
Total	**1,387,526**

Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(see table below)

Item	Flare No. 2 Description Kingsway V-cone Flow Transmitter (Rosemount)
	1 July – 31 Dec 11
Type	Differential Pressure Transmitter
Accuracy class	± 0.5%
Serial No.	5490821 (Rosemount) / FT3 – FT161 (11011001)
Calibration frequency	2 years
Date of last calibration	20/01/11
Validity	2 years

Measuring/ Reading/ Recording frequency:	Measured with flow meter. Data will be aggregated both monthly and yearly.
Calculation method (if applicable)	Raw data logged at 1 minute's interval were used to compute the hourly average. Subsequently, daily readings were computed, followed by aggregation into monthly and finally, yearly records.
QA/QC procedures to be applied:	Flow meters were tested, calibrated and maintained regularly.

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year *y*
Measured/ Calculated/ Default:	Calculated
Source of data:	Calculated as per the "Tool to determine project emissions from flaring gases containing methane" (EB 28, Annex 13, pg. 10)

<table>
<tr><td></td><td>This parameter was measured separately for both of the flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.</td></tr>
<tr><td>Value (s) of monitored parameter:</td><td>

Months	Flare No. 1 Value (tCO_2e)	Flare No. 2 Value (tCO_2e)
July 11	757.41	1,124.25
August 11	799.01	1,176.25
September 11	705.20	1,002.95
October 11	709.69	1,086.03
November 11	649.66	828.40
December 11	646.82	1,195.00
Total	**4,267.79**	**6,412.88**

</td></tr>
<tr><td>Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculation</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>Refer to $\mathbf{T_{flare}}$ below.</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>As per the “Tool to determine project emissions from flaring gases containing methane” (EB 28, Annex 13, pg. 10)

As the project has installed an enclosed flaring system, the default value of 0.90 for enclosed flare efficiency for flare temperatures above 500^0C for more than 40 minutes in an hour was applied and monitored during the monitoring period. This is conservative as the enclosed flare was typically designed to operate at a much higher temperature (>900^0C).</td></tr>
<tr><td>Calculation method (if applicable)</td><td>As per the “Tool to determine project emissions from flaring gases containing methane” (EB 28, Annex 13, pg. 10)</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>As per the “Tool to determine project emissions from flaring gases containing methane” (EB 28, Annex 13, pg. 10)</td></tr>
</table>

Data / Parameter:	$\mathbf{w_{CH4}}$
Data unit:	m^3 CH4 / m^3 LFG
Description:	Fraction of CH_4 in LFG
Measured/ Calculated/ Default:	Measured
Source of data:	Continuous measurement by using certified equipment.

<table>
<tr><td></td><td>
This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.
In case of temporary situation such as the installed CH_4 gas analyser malfunctioned or gave unrepresentative results due to data logging problem, the w_{CH4} shall be measured manually with a portable gas analyser according to ACM0001 Version 8. At least 8 hourly samples shall be taken per operating day. For any affected day, the calculation of the values measured using the portable analyser will be based on the Guidelines to calculate the fraction of methane in the landfill gas from periodical measurements (Version 1). As a conservative approach, the lower bound of the 95% Confidence Interval will be applied as per the guideline.
</td></tr>
<tr><td>Value (s) of monitored parameter:</td><td>
<table>
<tr><th>Months</th><th>Flare No. 1 Value (% wet basis)</th><th>Flare No. 2 Value (% wet basis)</th></tr>
<tr><td>July 11</td><td>59.55%</td><td>59.52%</td></tr>
<tr><td>August 11</td><td>59.12%</td><td>59.17%</td></tr>
<tr><td>September 11</td><td>58.24%</td><td>60.37%</td></tr>
<tr><td>October 11</td><td>58.03%</td><td>59.12%</td></tr>
<tr><td>November 11</td><td>58.87%</td><td>59.37%</td></tr>
<tr><td>December 11</td><td>57.62%</td><td>58.52%</td></tr>
<tr><td>Average</td><td>58.57%</td><td>59.35%</td></tr>
</table>
</td></tr>
<tr><td>Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Baseline and Project emission calculation</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th rowspan="2">Item</th><th>Flare No. 1 Description</th><th colspan="2">Flare No. 2 Description</th></tr>
<tr><th>1 July – 31 Dec 11</th><th>1 July – 27 Aug 11</th><th>28 Aug – 31 Dec 11</th></tr>
<tr><td>Type</td><td>Infra-Red Gas Monitor</td><td>Infra-Red Gas Monitor</td><td>Infra-Red Gas Monitor</td></tr>
<tr><td>Accuracy class</td><td>± 2%</td><td>± 2%</td><td>± 2%</td></tr>
<tr><td>Serial No.</td><td>28931</td><td>32560</td><td>30548</td></tr>
<tr><td>Calibration frequency</td><td>Annually</td><td>Annually</td><td>Annually</td></tr>
<tr><td>Date of last calibration</td><td>28/04/11</td><td>05/05/11</td><td>21/06/11</td></tr>
<tr><td>Validity</td><td>1 year</td><td>1 year</td><td>1 year</td></tr>
</table>
</td></tr>
</table>

Measuring/ Reading/ Recording frequency:	The CH_4 fraction were measured continuously with a certified equipment or measured manually with a portable gas analyser during emergency cases.
Calculation method (if applicable)	Raw data logged at 1 minute's interval was used to compute the daily average readings.
QA/QC procedures to be applied:	The CH_4 gas analyser was checked and calibrated regularly according to the manual given by the manufacturer.

Data / Parameter:	**T ($T_{TT1,F1}$ and $T_{TT1,F2}$)**
Data unit:	°C
Description:	Temperature of the LFG
Measured/ Calculated/ Default:	Measured
Source of data:	Continuous measurement by temperature meter. This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.
Value (s) of monitored parameter:	(see table below)
Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculation

Months	Flare No. 1 Value (°C)	Flare No. 2 Value (°C)
July 11	54.07	45.47
August 11	57.82	46.34
September 11	56.72	47.34
October 11	57.39	44.68
November 11	54.76	39.20
December 11	53.19	46.02
Average	**55.66**	**44.84**

<table>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th rowspan="2">Item</th><th>Flare No. 1 Description</th><th>Flare No. 2 Description</th></tr>
<tr><th>1 July – 31 Dec 11</th><th>1 July – 31 Dec 11</th></tr>
<tr><td>Type</td><td>Temperature Transmitter</td><td>Temperature Transmitter</td></tr>
<tr><td>Accuracy class</td><td>± 0.5%</td><td>± 0.5% of span</td></tr>
<tr><td>Serial No.</td><td>B224836437</td><td>B839917437</td></tr>
<tr><td>Calibration frequency</td><td>Annually</td><td>Annually</td></tr>
<tr><td>Date of last calibration</td><td>28/04/11</td><td>29/04/11</td></tr>
<tr><td>Validity</td><td>1 year</td><td>1 year</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measured continuously by temperature meter.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Raw data logged at 1 minute’s interval was used to compute the daily average readings.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>The temperature transmitter was calibrated regularly according to the manual given by the manufacturer.</td></tr>
</table>

Data / Parameter:	**P ($P_{PT2,F1}$ and $P_{PT2,F2}$)**
Data unit:	Pa
Description:	Pressure of the LFG
Measured/ Calculated/ Default:	Measured
Source of data:	Continuous measurement by pressure transmitter. This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.

Value (s) of monitored parameter:	see tables below

Gauge pressure (Months)	Flare No. 1 Value (kPa)	Flare No. 2 Value (kPa)
July 11	15.23	9.65
August 11	18.79	10.81
September 11	18.23	11.26
October 11	20.38	10.08
November 11	19.49	6.46
December 11	15.52	11.46
Average	**17.94**	**9.95**

Absolute pressure (Months)	Flare No. 1 Value (kPa)	Flare No. 2 Value (kPa)
July 11	116.555	110.975
August 11	120.115	112.135
September 11	119.555	112.585
October 11	121.705	111.405
November 11	120.815	107.785
December 11	116.845	112.785
Average	**119.27**	**111.28**

The value of atmospheric pressure used is 101,325Pa.

Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	see table below

Item	Flare No. 1 Description		Flare No. 2 Description
	1 July – 7 Sept 11	8 Sept – 31 Dec 11	1 July – 31 Dec 11
Type	Pressure Transmitter	Pressure Transmitter	Pressure Transmitter
Accuracy class	± 0.25%	± 0.25%	± 0.25%
Serial No.	02255815	02255815	5584784
Calibration frequency	Annually	Annually	Annually
Date of last calibration	24/06/10	08/09/11	29/04/11
Validity	1 year	1 year	1 year

- *The maximum permissible error of ± 0.25% was applied to Flare No.1 PT2 from 1st July 2011 – 7th September 2011 as a conservative approach. The impact of applying these errors to*

	the flow normalisation is negligible.
Measuring/ Reading/ Recording frequency:	Measured continuously by a pressure transmitter.
Calculation method (if applicable)	Raw data logged at 1 minute's interval was used to compute the daily average readings.
QA/QC procedures to be applied:	The meter was checked and calibrated regularly according to the manual given by the manufacturer.

Data / Parameter:	**EL_{LFG}**
Data unit:	MWh
Description:	Net amount of electricity generated using landfill gas
Measured/ Calculated/ Default:	Measured
Source of data:	Data as measured by electricity meter
Value (s) of monitored parameter:	(see table below)
Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(see table below)
Measuring/ Reading/ Recording frequency:	Measured continuously with electricity meter installed.

Value (s) of monitored parameter:

Months	Flare No. 2 Value (MWh)
July 11	609.66
August 11	460.02
September 11	424.98
October 11	420.96
November 11	160.54
December 11	563.74
Total	**2,639.90**

Monitoring equipment:

Item	Flare No. 2 Description (EL4)	Flare No. 2 Description (EL5)
	From 1 July – 31 Dec 11	From 1 July – 31 Dec 11
Type	Power Meter	Power Meter
Accuracy class	Class 0.5S	Class 0.20
Serial No.	210225256	53099690
Calibration frequency	24 months	5 years
Date of last calibration	15/07/10	01/04/11
Validity	2 years	5 years (according to the Malaysian Grid Code, version 1/2010)

	The net amount of electricity generated shall be derived by deducting the amount consumed by the project activity (EL3) from the gross generated amount recorded by installed electricity meter (EL4).
Calculation method (if applicable)	NA
QA/QC procedures to be applied:	As a quality control procedure, the amount of electricity actually uploaded to grid will be measured by another electricity meter (EL5) and compared with the net amount derived from above. Lower value of the amount will be taken as the net amount for emission reduction calculations. Electricity meters (except the meter owned by the grid operator i.e. EL5) will be checked and calibrated regularly according to manufacturer's recommendations. The meter EL5 is owned by the grid operator and thus, it is not within the control of the project. The calibration of this meter will be based on the grid operator's requirement and standard practice.

Data / Parameter:	**$CEF_{elec,PR,y}$**
Data unit:	tCO_2/MWh
Description:	Carbon emission factor of electricity
Measured/ Calculated/ Default:	Calculated
Source of data:	Grid connected baseline for Peninsular Malaysia for 2009 by Malaysian Energy Centre.
Value (s) of monitored parameter:	**0.683** based on the latest released grid connected baseline emission factor for Peninsular Malaysia for 2009
Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	NA
Measuring/ Reading/ Recording frequency:	To be re-calculated with the latest release of grid connected baseline emission factor. The emission factor for year 2009 was applied for this monitoring period as this was the latest publicly released data for the grid

	emission factor for Malaysia during this monitoring period. Referring to page 6 of the "Tool to calculate the emission factor for an electricity system" *Version 2, EB 50*, if the data is usually only available 18 months after the end of year *y*, the emission factor of the year proceeding the previous year *y-2* may be used. In other words, for year 2011, the data for 2009 (*y-2*) can be used for our case.
Calculation method (if applicable)	The $\mathbf{CEF_{elec,PR,y}}$ was calculated based on the "Tool to calculate the emission factor for an electricity system" (Version 2, EB 50)
QA/QC procedures to be applied:	NA

Data / Parameter:	**Operation of the energy plant (t)**
Data unit:	Hours
Description:	Operation of the energy plant
Measured/ Calculated/ Default:	Measured
Source of data:	Based on actual documented operating hours
Value (s) of monitored parameter:	(see table below)
Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	NA
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Gas Engine TEM Evo System
Measuring/ Reading/ Recording frequency:	This is monitored annually using a run time meter to ensure methane destruction is claimed for methane used in the electricity plant when it is operational.
Calculation method (if applicable)	NA
QA/QC procedures to be applied:	The run time meter was checked and calibrated regularly according to the manual given by the manufacturer.

Months	Operating time (hr)
July 11	631
August 11	470
September 11	544
October 11	504
November 11	181
December 11	614
Total	**2,944**

Data / Parameter:	$\mathbf{EL_{PJ,y}}$

<table>
<tr><td>Data unit:</td><td>MWh</td></tr>
<tr><td>Description:</td><td>Quantity of electricity consumed by project activity</td></tr>
<tr><td>Measured/
Calculated/ Default:</td><td>Measured</td></tr>
<tr><td>Source of data:</td><td>Based on continuous measurement by sealed electricity meter installed.

This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.</td></tr>
<tr><td>Value (s) of
monitored parameter:</td><td><table>
<tr><th>Months</th><th>Flare No. 1 & Flare No. 2 Value (MWh)</th></tr>
<tr><td>July 11</td><td>28.32</td></tr>
<tr><td>August 11</td><td>20.97</td></tr>
<tr><td>September 11</td><td>12.04</td></tr>
<tr><td>October 11</td><td>22.24</td></tr>
<tr><td>November 11</td><td>28.55</td></tr>
<tr><td>December 11</td><td>10.20</td></tr>
<tr><td>Total</td><td>122.32</td></tr>
</table></td></tr>
<tr><td>Indicate what the
date are used for
(Baseline/ Project/
Leakage emission
calculations)</td><td>Project emission calculation</td></tr>
</table>

<table>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th rowspan="2">Item</th><th>Flare No. 1 Description</th><th>Flare No. 2 Description</th></tr>
<tr><th>1 July – 31 Dec 11</th><th>1 July – 31 Dec 11</th></tr>
<tr><td>Type</td><td>Analog kWh Meter</td><td>Digital Energy Multimeters</td></tr>
<tr><td>Accuracy class</td><td>Class 2 (± 2%)</td><td>± 1%</td></tr>
<tr><td>Serial No.</td><td>8383258</td><td>4309</td></tr>
<tr><td>Calibration frequency</td><td>Annually</td><td>36 months</td></tr>
<tr><td>Date of last calibration</td><td>06/05/11</td><td>15/10/09</td></tr>
<tr><td>Validity</td><td>1 year</td><td>3 years</td></tr>
</table>
<table>
<tr><th rowspan="2">Item</th><th>Project Activity (EL1)</th><th>Flare No. 1 & 2 from GE (EL2)</th><th>Flare No. 2 Description (EL3)</th></tr>
<tr><th>1 July – 31 Dec 11</th><th>1 July – 31 Dec 11</th><th>1 July – 31 Dec 11</th></tr>
<tr><td>Type</td><td>Power Meter</td><td>Power Meter</td><td>Power Meter</td></tr>
<tr><td>Accuracy class</td><td>Class 0.5S (± 0.5%)</td><td>Class 0.5S (± 0.5%)</td><td>Class 0.5S (± 0.5%)</td></tr>
<tr><td>Serial No.</td><td>2167 8900 35</td><td>2135 3800 22</td><td>2153 4300 16</td></tr>
<tr><td>Calibration frequency</td><td>36 months</td><td>36 months</td><td>36 months</td></tr>
<tr><td>Date of last calibration</td><td>10/05/11</td><td>10/05/11</td><td>10/05/11</td></tr>
<tr><td>Validity</td><td>3 years</td><td>3 years</td><td>3 years</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Continuous measurement</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>The electricity meter was tested and calibrated as per the specifications prescribed by the manufacturer.</td></tr>
</table>

Data / Parameter:	$\mathbf{T_{flare,y}}$
Data unit:	°C
Description:	Temperature in exhaust gas of the enclosed flare
Measured/ Calculated/ Default:	Measured
Source of data:	Continuous measurement by temperature meter. This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used

<table>
<tr><td></td><td>for the monitoring period.</td></tr>
<tr><td>Value (s) of monitored parameter:</td><td>
<table>
<tr><th>Months</th><th>Flare No. 1 Value (°C)</th><th>Flare No. 2 Value (°C)</th></tr>
<tr><td>July 11</td><td>821.49</td><td>819.35</td></tr>
<tr><td>August 11</td><td>855.76</td><td>868.88</td></tr>
<tr><td>September 11</td><td>815.08</td><td>882.41</td></tr>
<tr><td>October 11</td><td>769.10</td><td>885.44</td></tr>
<tr><td>November 11</td><td>744.22</td><td>799.11</td></tr>
<tr><td>December 11</td><td>729.69</td><td>898.60</td></tr>
<tr><td>Average</td><td>789.22</td><td>858.97</td></tr>
</table>
</td></tr>
<tr><td>Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculation</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th rowspan="2">Item</th><th>Flare No.1 Description</th><th>Flare No.2 Description</th></tr>
<tr><th>1 July – 31 Dec 11</th><th>1 July – 31 Dec 11</th></tr>
<tr><td>Type</td><td>Temperature Transmitter</td><td>Temperature Transmitter</td></tr>
<tr><td>Accuracy class</td><td>± 0.5%</td><td>± 0.5% of span</td></tr>
<tr><td>Serial No.</td><td>B123070037</td><td>B838901937</td></tr>
<tr><td>Calibration frequency</td><td>Annually</td><td>Annually</td></tr>
<tr><td>Date of last calibration</td><td>03/03/11</td><td>29/04/11</td></tr>
<tr><td>Validity</td><td>1 year</td><td>1 year</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>The enclosed flare is monitored continuously by a temperature meter.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Data logged at 1 minute’s interval was used to determine the default flaring efficiency for each hour in accordance to the “Tool to determine project emissions from flaring gases containing methane” (EB 28, Annex 13)</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>The temperature meter was tested and calibrated as per the specifications prescribed by the manufacturer.</td></tr>
</table>

Data / Parameter:	**Relevant policies and circumstances at the beginning of each crediting period**

Data unit:	NA
Description:	
Measured/ Calculated/ Default:	NA
Source of data:	Monitoring of change of policies and circumstances was done by consultation with relevant governmental authorities (Department of Environment and Department of National Solid Waste Management, Malaysia)
Value (s) of monitored parameter:	Not applicable during this monitoring period as it is not at the beginning of a crediting period.
Indicate what the date are used for (Baseline/ Project/ Leakage emission calculations)	NA
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	NA
Measuring/ Reading/ Recording frequency:	To be checked at the beginning of a crediting period.
Calculation method (if applicable)	NA
QA/QC procedures to be applied:	NA

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

The total baseline emissions according to ACM0001 (Version 8) were calculated according to the equations below:

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

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

Determination of $MD_{project,y}$ for Flare No.1

	$MD_{flared,y} = \{LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4})$								$MD_{project,y}$
Month	Quantity of Flare No.1 Flare No. 1,y (Nm3)	Methane average fraction Flare No.1 WCH4 (% wet basis)	Density of Methane Flare No.1 DCH4 (t/Nm3)	Total methane Flare No.1 (tCH4)	Global Warming Potential Flare No.1 GWP (tCO2/tCH4)	Emissions from methane Flare No.1 (tCO2e)	PE Flare No.1 (tCO2e)	Quantity of Methane destroyed by flaring MD flared,y (tCH4)	Quantity of methane that would have been destroyed MD project,y (tCH4)
Jul-11	831,404	59.55%	0.0007168	354.90	21	7452.9	757.41	318.83	318.83
Aug-11	857,008	59.12%	0.0007168	363.18	21	7626.7	799.01	325.13	325.13
Sep-11	790,912	58.24%	0.0007168	330.17	21	6933.6	705.20	296.59	296.59
Oct-11	801,382	58.03%	0.0007168	333.36	21	7000.6	709.69	299.57	299.57
Nov-11	690,053	58.87%	0.0007168	291.19	21	6115.0	649.66	260.25	260.25
Dec-11	694,092	57.62%	0.0007168	286.68	21	6020.3	646.82	255.88	255.88

Determination of $MD_{project,y}$ for Flare No.2

	$MD_{flared,y} = \{LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4})$								$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4}$			$MD_{project,y}$
Month	Quantity of to Flare No.2 Flare No.2,y (Nm3)	Methane average fraction Flare No.2 WCH4 (% wet basis)	Density of Methane Flare No.2 DCH4 (t/Nm3)	Total methane Flare No.2 (tCH4)	Global Warming Potential Flare No.2 GWP (tCO2/tCH4)	Emissions from methane Flare No.2 (tCO2e)	PE Flare No.2 (tCO2e)	Quantity of Methane destroyed by flaring MD flared,y (tCH4)	Quantity of Landfill Gas Fed into the Electricity Generator No. 1 LFG electricity,y (m^3 LFG)	Average methane fraction of the landfill gas as measured WCH4 (% wet basis)	Quantity of methane destroyed by generation of electricity MD electricity,y (tCH4)	Quantity of methane that would have been destroyed MD project,y (tCH4)
Jul-11	1,205,519	59.52%	0.0007168	514.30	21	10800.2	1124.25	460.76	323477.18	0.60	138.00	598.76
Aug-11	1,308,044	59.17%	0.0007168	554.78	21	11650.5	1176.25	498.77	247544.76	0.59	104.99	603.76
Sep-11	1,060,315	60.37%	0.0007168	458.85	21	9635.9	1002.95	411.09	230230.98	0.60	99.63	510.72
Oct-11	1,153,345	59.12%	0.0007168	488.77	21	10264.2	1086.03	437.06	214876.95	0.59	91.06	528.12
Nov-11	769,348	59.37%	0.0007168	327.41	21	6875.7	828.40	287.97	77990.51	0.59	33.19	321.16
Dec-11	1,251,909	58.52%	0.0007168	525.15	21	11028.1	1195.00	468.24	293405.72	0.59	123.08	591.32

Determination of BE_y

	Flare 1	Flare 2				
	$(MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$	$(MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$	$EL_{LFG,y} \cdot CEF_{elec,BL,y}$			
Month	Emissions from Flare No.1 (tCO2e)	Emissions from Flare No.2 (tCO2e)	Total electricity generated EL,LFG,y (MWh)	CoEF for electricity Flare No.2 CEF electricity,y	Baseline Emission from electricity generation Flare No.2 (tCO2e)	Total BEy
Jul-11	6695.47	12573.97	609.66	0.683	416.40	19,685
Aug-11	6827.69	12679.05	460.02	0.683	314.20	19,820
Sep-11	6228.42	10725.20	424.98	0.683	290.26	17,243
Oct-11	6290.87	11090.49	420.96	0.683	287.51	17,668
Nov-11	5465.34	6744.27	160.54	0.683	109.65	12,319
Dec-11	5373.53	12417.69	563.74	0.683	385.04	18,176

For this project, the following applies:

1. $MD_{thermal,\ y}$ and $MD_{PL,\ y}$ are not applicable (=0 to this project since there are no heat generation and feeding to the natural gas pipeline.
2. For this project, $MD_{BL,\ y}$ is zero since there are no destroy or combustion of CH_4 today due to the regulatory and contractual requirements.
3. $ET_{LFG,\ y}$ and $CEF_{ther,\ BL,\ y}$ are not applicable (=0) to this project since there are no thermal energy production.
4. Density of CH_4 for LFG is obtained from ACM0001, Version 8, pg. 14.
5. The emission factor of 2009 was applied as this was the latest released data.

E.2. Project emissions calculation

The total project emissions according to ACM0001 (Version 8) were estimated according to the equations below:

$$PE_y = PE_{EC,y} + PE_{FC,j,y}$$

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \cdot (1+TDL_y)$$

Month	Electricity consumed by project activity ELPJ,y (MWh)	Coefficient for grid electricity EF grid,y	Transmission and Distribution Losses TDL,y	Total Project Emission from project activity (tCO2e)
Jul-11	28.32	0.683	0.1	21.28
Aug-11	20.97	0.683	0.1	15.76
Sep-11	12.04	0.683	0.1	9.04
Oct-11	22.24	0.683	0.1	16.71
Nov-11	28.55	0.683	0.1	21.45
Dec-11	10.20	0.683	0.1	7.66

For this project, the following applies:

1. $PE_{FC,\ y}$ is zero as no heat of fossil fuel is used to generate electricity for this project.
2. The grid connected baseline for Peninsular Malaysia for 2009 was applied to this project and the $EF_{BL,\ EL,\ y}$ calculated was 0.683tCO_2/MWh.
3. TDL = 10% was adopted as stated in the PDD, page 35 (TNB Annual Report 2007). http://announcements.bursamalaysia.com/EDMS%5Csubweb.nsf/LsvAllByID/8B0DC73587EFBC114825750B0033ED71?OpenDocument)

E.3. Leakage calculation

No leakage is applicable to this project.

E.4. Emission reductions calculation / table

The total emission reduction was calculated as follows:

$$ER_y = BE_y - PE_Y$$

Month	Total BEy	Total PEy	Total ER = BEy - PEy
Jul-11	19,685	22	19,663
Aug-11	19,820	16	19,804
Sep-11	17,243	10	17,233
Oct-11	17,668	17	17,651
Nov-11	12,319	22	12,297
Dec-11	18,176	8	18,168
Total	**104,911**	**95**	**104,816**

Note:

1. *$MD_{thermal}$ and $MD_{PL,\ y}$ is not relevant for this project because the LFG is not used for heat generation or natural gas distribution.*
2. *PE_y is equivalent to $PE_{EC,\ y}$ only because no fossil fuel or heat is consumed at site. The baseline emission figure has been rounded down while the project emission has been rounded up for conservativeness.*

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reduction (tCO_2e)	97,634*	104,816

** proportioned for 6 months (July – December 2011) – 195,268 x (6/12)*

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

The total emission reduction claimed was about 7% higher as compared to the value in the ex-ante calculation. This is mainly due to the higher methane collection rate achieved as well as the high operating rate of flaring system.

Appendix 1: Records of Intermittent Shut Down due to Flame Detection Sensor Problem (Main Flame Not Detected) for Flare No.2

Date	Flaring stopped	
	From	To
October 11, 2011	18:43	18:55
October 19, 2011	22:58	23:14
October 20, 2011	3:52	4:06
October 28, 2011	15:30	16:01
	16:36	16:43
	19:05	19:13
	19:43	19:53
October 29, 2011	0:00	0:22
	6:49	9:18
	11:34	11:46
	15:56	16:07
	18:26	18:35
October 30, 2011	1:20	1:26
	8:52	
October 31, 2011		13:46
	16:26	
November 3, 2011		12:17
	14:29	14:46
	21:04	21:13
November 4, 2011	13:40	14:02
	14:25	14:32
	14:44	16:47
	21:08	21:17
November 6, 2011	1:38	1:45
	2:04	2:20
	3:48	4:03
	5:11	5:15
	18:58	19:02
	19:14	19:16
	23:14	23:21
November 8, 2011	1:51	2:03
	6:08	6:27
	6:30	6:32
	10:09	10:17
	10:25	10:30
	10:53	12:05
	12:15	12:19
	13:46	13:55
	15:01	15:43
	20:30	20:37
	20:51	20:55

Date	Flaring stopped	
	From	To
	23:12	23:19
	23:27	23:32
November 9, 2011	0:01	0:05
	5:53	6:04
	8:00	8:05
	9:09	9:14
	9:21	9:25
	9:36	12:10
	14:14	14:20
	15:04	15:21
	16:52	16:58
	17:22	17:26
	22:29	23:17
November 10, 2011	1:01	1:17
	1:35	1:38
	1:42	1:44
	2:38	2:40
	10:38	10:46
	17:01	17:05
	21:39	21:48
November 11, 2011	5:39	5:57
	6:43	6:46
	7:00	7:03
	7:19	7:22
	7:27	7:34
	9:12	9:18
	9:45	10:20
	11:28	11:34
	11:58	12:09
	23:28	23:40
November 12, 2011	0:15	0:18
	3:37	3:41
November 13, 2011	8:02	8:09
	11:27	11:33
	11:45	11:48
	13:33	13:45
	22:30	22:34
November 14, 2011	11:05	11:08
	11:22	11:24
	13:52	16:39
	17:20	17:31
	17:35	17:39
	20:51	20:55

Date	Flaring stopped	
	From	To
	21:02	21:05
	21:26	22:02
	22:48	22:56
November 15, 2011	0:47	0:54
	5:17	5:24
	5:51	5:58
	8:28	8:59
November 16, 2011	2:01	2:17
	3:19	3:24
	3:29	3:31
	14:19	14:23
	22:53	23:07
November 18, 2011	10:38	10:43
	22:05	22:14
	22:19	22:24
	22:50	22:56
	23:10	23:16
	23:18	
November 19, 2011		0:34
	2:50	2:56
	3:16	3:28
	5:46	5:49
	6:07	6:12
	6:30	6:43
	10:32	10:39
	11:58	12:04
	12:39	12:46
	16:07	16:11
	16:54	16:58
	23:32	23:42
	23:48	23:56
November 20, 2011	3:11	3:15
	3:46	3:54
	7:33	7:43
	11:48	11:55
	12:08	12:23
November 21, 2011	9:11	9:15
	11:02	11:11
	11:25	11:38
	12:29	12:39
	13:08	13:10
	15:38	15:42
	18:27	18:29

Date	Flaring stopped	
	From	To
	22:36	22:41
	23:17	23:27
	23:32	23:34
November 22, 2011	1:49	1:52
	2:14	2:19
	4:32	4:37
	5:08	5:14
	5:55	5:58
	6:37	6:41
	7:08	7:14
	7:21	7:27
	17:39	17:43
	19:07	19:11
December 1, 2011	9:33	9:32
	11:13	11:23
December 2, 2011	15:13	15:32
December 3, 2011	2:28	2:32
	2:43	2:45

Appendix 2: Records of Intermittent Break Down of Gas Engine due to Flame Detection Sensor Problem (Main Flame Not Detected) for Flare No.2

Date	Gas Engine Stopped		Description Of Event
	From	To	
October 28, 2011	15:31	22:23	Flare 2 Shut Down - Main flame not detected
October 29, 2011	0:00	14:53	Flare 2 Shut Down - Main flame not detected
October 29, 2011	15:56	23:59	Flare 2 Problem - Main flame not detected
October 30, 2011	0:00	23:59	
October 31, 2011	0:00	23:59	
November 1, 2011	0:00	23:59	
November 2, 2011	0:00	23:59	
November 3, 2011	0:00	23:59	
November 4, 2011	0:00	12:12	
November 4, 2011	13:41	23:59	Flare 2 Problem - Main flame not detected
November 5, 2011	0:00	23:59	
November 6, 2011	0:00	23:59	
November 7, 2011	0:00	23:59	
November 8, 2011	0:00	23:59	
November 9, 2011	0:00	23:59	
November 10, 2011	0:00	23:59	
November 11, 2011	0:00	23:59	
November 12, 2011	0:00	23:59	
November 13, 2011	0:00	23:59	
November 14, 2011	0:00	23:59	
November 15, 2011	0:00	23:59	
November 16, 2011	0:00	23:59	
November 17, 2011	0:00	23:59	
November 18, 2011	0:00	23:59	
November 19, 2011	0:00	23:59	
November 20, 2011	0:00	23:59	
November 21, 2011	0:00	23:59	
November 22, 2011	0:00	23:59	
December 1, 2011	9:22	9:38	Flare 2 - Main Flame not detected
December 1, 2011	11:13	11:37	Flare 2 - Main Flame not detected
December 1, 2011	15:03	23:59	Flare 2 -Check Flare 2 SCADA & PLC for error - Main Flare Not Detected
December 2, 2011	0:00	23:59	
December 3, 2011	0:00	23:59	
December 4, 2011	0:00	23:59	
December 5, 2011	0:00	14:48	Gas Engine - restart after full system checking - Main flame not detected

Currently the amount of gas channelled to gas engine is interlinked with Flare 2 SCADA system, therefore the shutdown of Flare No.2 also indicated the shutdown of gas engine No. 1.