BIOMASS
Scientific Engineering Centre "Biomass"

JOINT IMPLEMENTATION MONITORING REPORT

Version 03

"Landfill methane capture and utilization at Mariupol landfills, Ukraine"

Track 1

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Registration number: UA1000286

Monitoring period: 15.02.2010 – 30.06.2011

August 25, 2011

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Annexes

SECTION A. General Project activity information

A.1. Title of the project activity:

“Landfill methane capture and utilization at Mariupol landfills, Ukraine”

A.2. Approval and registration:

Letters of approvals: National Environmental Investment Agency of Ukraine, №1219/23/7 from 18.08.2010; Ministry of Economy, Trade and Industry of Japan, №1 from 08.08.2011.
Registration number: UA1000286

A.3. Description of the project activity:

The Project activity consists of developing a Landfill Gas (“LFG”) collection and flaring system with an opportunity of its further energy utilization in order to avoid emissions of methane being released into the atmosphere. LFG production results from waste decay in the anaerobic conditions created in the landfill body. LFG contains approximately 50% methane (“CH_4”), which is a powerful greenhouse gas (“GhG”) contributing to global warming. By capturing the LFG, GhG emissions are reduced. In case of LFG energy utilization in a combined heat and power (“CHP”) plant additional emission reduction will be obtained by replacement of part of electrical and thermal energy from fossil fuels with the electricity and heat produced from CO_2 neutral fuel – Landfill Gas.

The Project is located in the Donetsk Region of Ukraine at two Municipal Solid Waste (MSW) Landfills in city of Mariupol (“Prymorsky” and “Ordzhonikidzevsky” Landfills). Mariupol is one of the most developed industrial cities of Eastern Region of Ukraine with population about 500 thousand inhabitants. The landfills are owned by municipality and are operated by municipal company “Poligon TPV”. The owner of the project – “TIS Eco” company has concluded contracts with Mariupol city council on the right of JI LFG collection project realization in 2009.

Prymorsky landfill is located within the city boundary, 3 km from Azov sea and has a total area of 14.3 ha and the active area of 12.43 ha. The operation of the landfill was started in 1967. It is situated in the previous opencast mine of brick factory with the depth of about 10 meters. Currently the landfill represents a dump with a height of 7 to 23 meters. From the middle of 2008 the landfill doesn’t receive waste except inert waste for surface covering.

According to operator’s data annual amount of MSW disposed at the landfill during last years was about 250-300 thousand m^3/year (60-70 thousand tons/year), waste was registered by trucks number and volume. Total amount of waste accumulated at the landfill is estimated by landfill volume to be about 2.56 million tons (end of 2008).

Ordzhonikidzevsky landfill is situated between two residential districts of the city – Illichivskyi and Ordzhonikidzensky, 100 meters from Kalmius river. The landfill was put into operation in 1976. According to the landfill passport the total area of waste disposal is about 17,6 ha, an active area is 12,2 ha. The closure of the landfill is expected soon.

According to operator’s data annual amount of MWS disposed at the landfill during last years was about 350-400 thousand m^3/year (90-100 thousand tons/year). Total amount of waste accumulated at the landfill to the end of 2008 is estimated to be about 2.54 million tons.

The proposed Project includes implementation of LFG collection system and LFG combusting in the flare and/or later CHP installation for combined electricity and heat production. The estimated electrical capacity of LFG power CHP engines which can be commissioned is 0.3 MW for the Primorsky landfill and 0.6 MW for the Ordzhonikidze landfill. The CHP would provide electricity for the Ukrainian power grid and heat for the local district heating network. The decision to implement CHP and choice of the actual capacity will be made after flaring trial period.

The flaring testing, trials and start of operation in Prymorsky landfill under registered PDD was scheduled in January 2010. After a testing and trial period of LFG capture system operation and a feasibility analysis, the installation and start-up of CHP in Prymorsky landfill under registered PDD was scheduled in September 2010.

The formal emission reductions started in February 2010. Now the Project formally is in the Flaring testing and trials period until September 2011. Anticipate that CHP will be installed in the September-October 2011. The calculated emission reduction from Flaring is **13,617 $tCO_{2\text{-}eq}$ for the period from February 15, 2010 to June 30, 2011**. A detailed ERU calculation results are presented in two Excel files named “ERU_Calculations_PL_15.02-31.12.10” and “ERU_Calculations_PL_01.01-30.06.11”. The brief results of ERU calculations are presented in Annex 1 and 2 of this report.

It should be noted that the reported emission reduction from flaring in Monitoring report is lower than emission reduction provided in PDD. This difference could be explained by two reasons. First, LFG-to-energy option is not realized yet. Second, not all extraction wells of collection system show the performance according design parameters. It is probable that the biodegradable waste in the area of influence of these extraction wells is oxidized due to imperfect landfill operation, landfill fires, etc. Unfortunately it was impossible to consider all impacts during PDD development. For this reason, two options of the project development were provided in PDD: LFG Flaring option and LFG-to-energy option. The decision to make final choice between two options is based on the actual quantity of landfill gas.

A.4. Monitoring period:

Monitoring period starting date: 15.02.10 at 12:00:00.
Monitoring period closing date: 30.06.11 at 23:59:59.

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A.5. Methodology applied to the project activity:

A.5.1 Baseline methodology:

The approved consolidated methodology ACM0001, version 11, May 2009, *“Consolidated baseline and monitoring methodology for landfill gas project activities”*[1] has been used to identify the baseline scenario of this project. This methodology also refers to the latest version of the following tools[2]:

- *“Tool for the demonstration and assessment of additionality”* *(Version 05.2, August 2008)*;

[1] Reference on methodology: http://cdm.unfccc.int/goto/MPappmeth

[2] Reference on tool: http://cdm.unfccc.int/goto/MPappmeth

- *"Tool to determine project emissions from flaring gases containing methane" (Version 01, August 2008);*
- *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01, August 2008)*;
- *"Combined tool to identify the baseline scenario and to demonstrate additionality"(Version 02.2, August 2008)*;
- *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (Version 04, August 2008)*;

A.5.2 Monitoring methodology:

The approved consolidated methodology ACM0001, version 11, May 2009, *"Consolidated baseline and monitoring methodology for landfill gas project activities"* has been used to identify the monitoring plan of this project.

A.6. Status of implementation including time table for major project parts:

The Project implementation schedule is divided into the following parts:

- **Prymorsky landfill**. Installation of gas extraction system, pipelines, flare and CHP unit in Prymorsky landfill from September 2009 to September 2011;
- **Ordzhonikidze landfill**. Installation of gas extraction system, pipelines, flare and CHP unit in Ordzhonikidze landfill in 2012.

Table 1. *Status of implementation*

Activity	Date of start-up according to the PDD	Date of start-up actual
Prymorsky landfill		
Extraction wells installation	December 2009	December 2009
Pipelines installation	December 2009	January 2010
Flare installation and start-up	January 2010	February 2010
CHP engine installation and start-up	September 2010	2011
Ordzhonikidze landfill		
Extraction wells installation	December 2010	2012
Pipelines installation	December 2010	2012
Flare installation and start-up	January 2011	2012

A.7. Intended deviations or revisions to the registered PDD:

There are no deviations or revisions to the registered PDD.

A.8. Intended deviations or revisions to the registered monitoring plan:

There are no deviations or revisions to the registered monitoring plan.

A.9. Changes since last verification:

Not applicable

A.10. Person(s) responsible for the preparation and submission of the monitoring report:

TIS Eco Ltd.
Tatyana Klimenko, Director
Nikolay Maiboroda, Chief Engineer

SEC Biomass Ltd.
Yuri Matveev, Deputy General Director
Denis Kutsyi, Monitoring Manager

SECTION B. Key monitoring activities according to the monitoring plan for the monitoring period stated in A.4.

Key monitoring activities for project could be described as follows:

Prymorsky landfill. The continuous measurement of both quantity and quality of LFG collected and fed to the combustion equipment (Flare) using a flow meter and on-line LFG analyzer are provided. LFG temperature and pressure are measured by corresponding sensors and used for calculation of standard and normal condition. The calculation of standard and normal condition is automatically realized by internal software of the flow meter and Memograph RSG40. The conversion ratio from standard conditions (T_S=293.15 K, P_S=0.101325 MPa) to normal conditions (T_N=273.15 K, P_N=0.101325 MPa) is set 0.93178.

During the testing and trials period (***Flaring option***, according PDD) enclosed Flare is used for the LFG combustion and its efficiency is determined according to the Option 1 “*Tool to determine project emissions from flaring gases containing methane*” (Version 01, August 2008). Therefore, 90%, 50%, 0% default value is used provided that compliance with manufacturer’s specification of Flare proven through continuous monitoring of the specifications (combustion and exhaust gas temperature). The combustion and exhaust gas temperature are continuously measured by thermocouples.

Electricity for operation of the methane collection and utilization system is imported from the grid. Continuous metering of the consumed electricity quantity is provided by individual electricity meter.

Information from flow meter, pressure and temperature sensors are transmitted to the BVR.M control and storage system and in parallel are transferred to the Memograph RSG40. The LFG analyzer parameters (CH_4, O_2 content), combustion and exhaust gas temperature are recorded electronically by Memograph RSG40. The quantities of electricity consumed are recorded by electricity meters and in parallel are also transferred to the Memograph RSG40.

All monitoring parameters are measured and saved continuously with the frequencies not less then hour. The archiving period for the log files is one year. Additionally all monitoring parameters has been recorded on CDs. These CDs will be stored till the end of the crediting period plus two years.

The monitoring system generally can be divided into a LFG part, a Flare efficiency part, an electrical part.

LFG measurements
For the purpose of monitoring of emission reductions the following parameters are continuously measured:

- Total amount of LFG captured;
- Total LFG captured pressure and temperature;
- Amount of LFG flared;
- LFG flared pressure and temperature;
- Methane concentration.

Flare efficiency measurements

For the purpose of Flare efficiency calculation the following parameters are continuously measured:

- Combustion temperature;
- Exhaust gas temperature;

Electrical measurements
For the purpose of monitoring of emission reductions the following parameters are continuously measured:

- Electricity consumed by the collection and utilization system.

B.1. Monitoring equipment types:

1. LFG flow meter DRG.M as a part of BVR.M -1 metering system (PC IPF «Sibnefteavtomatika»);
2. LFG pressure sensor MIDA-DI-13P-09-01Ex as a part of BVR.M -1 metering system («MIDAUS»);
3. LFG temperature sensor PVU-0197 as a part of BVR.M -1 metering system (NVP «Grempis»);
4. Gas analyzer NGA5-CH_4-O_2 («NUK»);
5. Termocoupls Type-S («JUMO»);
6. Electricity meter Alfa A1800 («Elster-Metronika»);
7. Recorder and data logger Memograph M RSG40 («Endress + Hauser Wetzer»).

B.1.2. Table providing information on the equipment used (incl. manufacturer, type, serial number, date of installation, date of last calibration, information to specific uncertainty, need for changes and replacements):

The monitoring system generally can be divided into a LFG part, a Flare efficiency part, an electrical part.

LFG measurements
According to the monitoring plan the following variable are continuously calculated (see equation 4 and 5 below):

- $MD_{flared,p}$ – the quantity of methane destroyed by flaring during the monitoring period p (tCH_4).

To calculate the quantity of methane destroyed by flaring during the monitoring period p ($MD_{flared,p}$) the following variables are continuously measured:

- $LFG_{flare,h}$ – amount of LFG flared in the hour h, in normal conditions (Nm^3/h);
- $W_{CH4,h}$ – methane fraction in LFG in the hour h (m^3 CH_4 /m^3 LFG);
- $T_{flare,h}$ – temperature of LFG flared in the hour h (^0C);
- $P_{flare,h}$ – pressure of LFG flared in the hour h (MPa).

In the scheme below the equipment for LFG parameters measurement are indicated that are installed at the Prymorsky landfill during the testing and trials period.

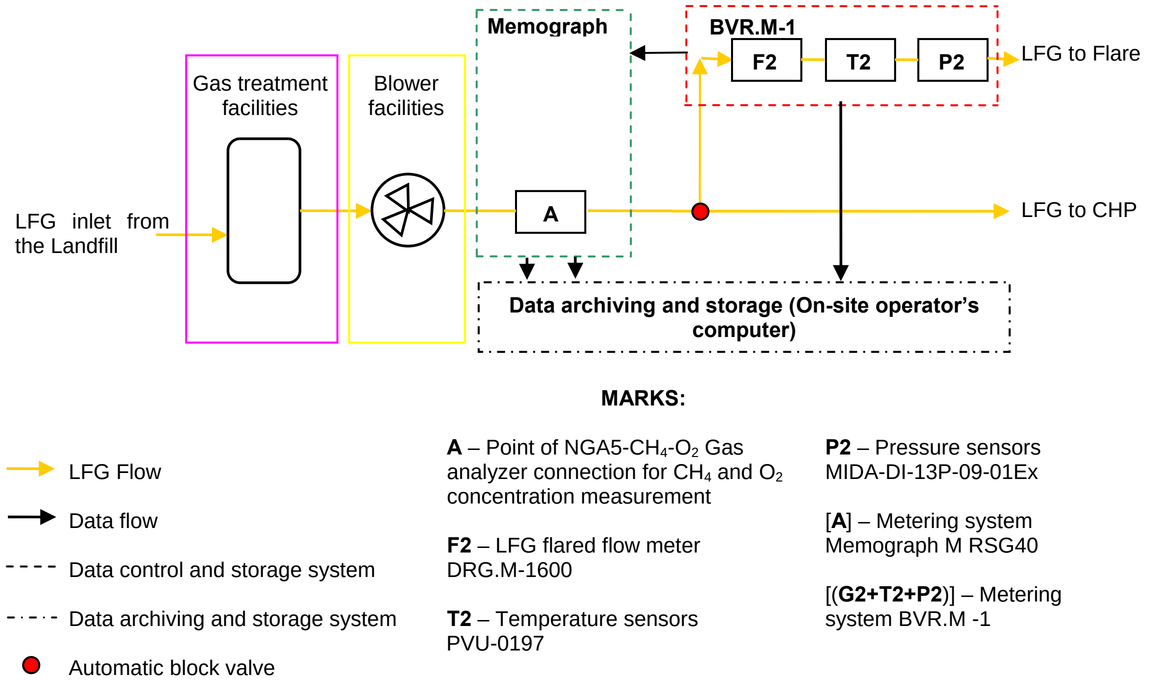

Figure 1. *Scheme of location of flow meters and sensors on Prymorsky landfill*

The general description of scheme

LFG flows from the wells through the lateral and sub-header piping to the header piping and delivered to the gas treatment facilities. At the treatment facilities LFG is dried and cleaned. Pure LFG transported to the blower as the blower created suction vacuum through piping to the wells. After the blower LFG sent thought header pipeline into the gas concentration measurement equipment. The concentration of LFG (including methane fraction, $W_{CH4,h}$) is measured by gas analyzer NGA5-CH_4-O_2 in A point. The concentration of LFG is measured for the sample from which moisture is previously removed due to individual gas cooler (dry basis). These data are electronically recorded by Memograph M RSG40.

The LFG is then routed to an automatic block valve which directs LFG to the Flare. Currently, the total LFG stream is go to the Flare, therefore the total amount of LFG captured ($LFG_{total,h}$) is equal to the amount of LFG flared ($LFG_{flare,h}$). In this scheme, the only one flow meter, type DRG.M-1600, temperature sensor PVU-0197 and pressure sensor MIDA-DI-13P-09-01Ex are mounted on the Flare pipeline. This is a temporary option and a separate LFG total amount ($LFG_{total,h}$) flow meter will be installed in conjunction with the CHP individual flow meter.

The flared flow rate is measured by DRG.M-1600 flow meter in F2 point. The temperature and pressure are measured by correspond sensors in T2 and P2 points. The data from flow meter and sensors are transmitted to the BVR.M-1 control system. The flow data is automatically corrected to dry basis due to temperature and pressure data. Additionally at the BVR.M-1 control system the flow data is automatically recalculated to standard conditions. Then the recalculated data in dry basis at standard conditions is transferred to the Memograph M RSG40. At the Memograph M RSG40 is a mathematical channel and flow data at standard conditions is automatically recalculates to the flow data at normal conditions.

The flared methane amount calculation is performed on the base of data received from BVR.M - 1 control system and concentration of methane received from gas analyzer NGA5-CH_4-O_2 due to Memograph M RSG40.

The gas analyzer NGA5-CH_4-O_2 is the subject of regular calibration in order to avoid substantial deviation of the measuring values. The calibration is performing with the frequency not less then one month. For this procedure the on-site operator uses two bottles with standard gases (Methane – 48%, Air-21%). The results of calibration and deviations are recorded and achieved into on-site Calibration Workbook.

The description of meters and sensors of LFG metering system are presented in the Tables below.

Table 4. *List of gas analyzers on Prymorsky landfill*

Item №	Metering parameter	Work parameter	Manufacturer	Type	Serial number	Accuracy level	Date of installation	Date of calibration	Date of next calibration	Comment
C1	Concentration of LFG	%	«NUK» Germany	NGA 5-CH_4-O_2	N4008.72	CH_4 - ±2.0% O_2 - ±1.0%	January 2010	25.10.2010	25.10.2011	Connection A

Table 5. *List of LFG control systems on Prymorsky landfill*

Item №	Metering parameter	Work parameter	Manufacturer	Type	Serial number	Accuracy level	Date of installation	Date of calibration	Date of next calibration	Comment
G2	Amount of flared LFG	m^3	«Sibnefteavtomatika» Russia	BVR.M -1	N08196	Pressure channels ±0.3% Temperature cannels ±0.5^{0}C Flow channels ±0.1% Running time measuring ±0.1%	January 2010	03.12.2009	03.12.2011	Flow control and metering system
M1	Concentration of LFG Combustion temperature Exhaust gas temperature Amount of flared LFG Electricity consumed	% ^{0}C ^{0}C m^3 MWh	«Endress + Hauser Wetzer» Germany	Memograph M RSG40	C 9009804267	±0.2%	January 2010	30.09.2009	30.09.2012	Monitoring data control and record system

Table 6. *List of meters and sensors of flow control and metering systems BWR.M-1 on Prymorsky landfill*

Item №	Metering parameter	Work parameter	Manufacturer	Type	Serial number	Accuracy level	Date of installation	Date of calibration	Date of next calibration	Comment
F2	Flow of Flared LFG	m^3	«Sibnefteavtomatika» Russia	DRG.M-1600	04632	±1.0%	January 2010	08.09.2009	08.09.2012	Connection G2
T2	Temperature of LFG flared	^0C	NVP «Grempis» Russia	PVU-0197	0912064	±0.25%	January 2010	09.12.2009 09.09.2010	08.09.2011	Connection T2
P2	Pressure of LFG flared	MPa	«MIDAUS» Russia	MIDA-DI-13P-09-01EX	08319027	±0.25%	January 2010	07.09.2010	08.09.2011	Connection P2

Flare efficiency measurements
According to the monitoring plan the following variable are continuously measured or calculated:

$PE_{flare,p}$ – emissions from flaring of the residual gas stream during monitoring period p (tCO_{2e}).

The emissions from flaring ($PE_{flare,p}$) is determined following the procedure described in the *"Tool to determine project emissions from flaring gases containing methane*" (Version 01, August 2008). According to this Tool the Option 1 is applied during monitoring period. Therefore the emissions from flaring ($PE_{flare,p}$, see equation 5 below) are calculated based on the default values for the flare efficiency in hour h ($\eta_{flare,h}$). In turn the flare efficiency in hour h is calculated as follows:

- 0% if the temperature in the exhaust gas of the flare is below 500 ^{0}C for more than 20 minutes during the hour h*;*
- 50%, if the temperature in the exhaust gas of the flare is above 500 ^{0}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;
- 90%, if the temperature in the exhaust gas of the flare is above 500 ^{0}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.

In accordance with manufacturer's specification, the flare efficiency is above 99% when the combustion temperature of the flare (T_{Flare}) is from 1000 to 1200 ^{0}C. To confirm manufacturer's specification the field testing of the flare had been done in March 2010. The obtained efficiency of the flare was higher than 99.8% (see Annex 3). Therefore following directly to the manufacturer's specification the conservative flare efficiency (99,0%) was used instead of efficiency (90,0%) from the Tool.

Consequently the following parameters according manufacturer's specification are continuously measured:

- $T_{Flue\ gas}$ – temperature of exhaust gases from flare (^{0}C);
- T_{Flare} – combustion temperature of the flare (^{0}C).

The two thermocouples, type S are mounted on the Flare envelope. The one thermocouple is continuously measured LFG combustion temperature and the other is continuously measured the exhaust gas temperature. These data are recorded by Memograph M RSG40 every minute. In accordance with this data the flare efficiency in hour h is calculated.

In the table below the description of thermocouples for temperature measurements are presented.

Table 8. *List of thermocouples for temperature measurements on Prymorsky landfill*

Item №	Metering parameter	Work parameter	Manufacturer	Type	Serial number	Accuracy level	Date of installation	Date of calibration	Date of next calibration	Comment
T_C1	Combustion temperature	^{0}C	«JUMO» Germany	S	№1	±1.0^{0}C	January 2010	09.09.2010	08.09.2011	Installed on the Flare
T_F1	Exhaust gas temperature	^{0}C	«JUMO» Germany	S	№2	±1.0^{0}C	January 2010	09.09.2010	08.09.2011	Installed on the Flare

Electrical measurements
According to the monitoring plan the following variables are continuously measured:

- $EC_{PJ,h}$ – quantity of electricity consumed by the collection and utilization system in hour h (MWh).

Electricity that is consumed by collection and utilization system is measured by one meter E1 (EC_{PJ}=E1). The commercial electricity meter is installed after the Transformer.

Information from the meter is collected in the meter memory and in parallel is transferred to the Memograph M RSG40. The archiving period of the log files into meter memory is thirty years. On daily base the log files from the electricity meters and Memograph M RSG40 are stored on the project on-site operator computer.

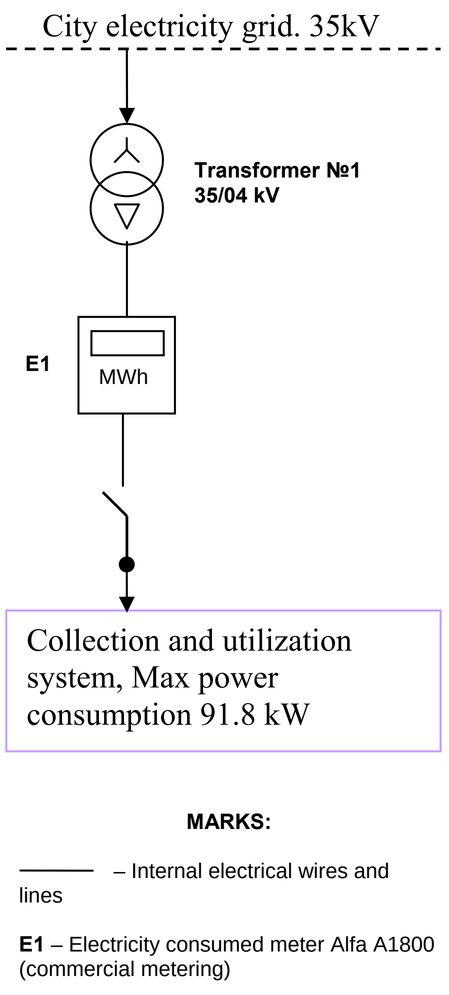

Figure 2. *Electricity metering scheme for Prymorsky landfill*

The description of electricity meters is provided in Table below.

Table 9. *List of electricity meters*

Item №	Metering parameter	Work parameter	Manufacturer	Type	Serial number	Accuracy level	Date of installation	Date of calibration	Date of next calibration	Comment
E1	Quantity of electricity imported for system operation	MWh	«Elster-Metronika» Russia	Alfa A1800	01191033	0.2S	January 2010	12.11.2008	12.11.2020	Connection after Transformator №1

B.1.3. Calibration procedures:

For gas analyzer

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of gas analyzer NGA 5-CH_4-O_2 is 1 year[3]	Donetsk Centre for Standardization, Metrology and Certification

For control systems

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of BVR.M metering system is 2 years	Donetsk Centre for Standardization, Metrology and Certification
Calibration interval of Memograph M RSG40 is 3 years	Donetsk Centre for Standardization, Metrology and Certification

For flow meters

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of DRG.M flow meters is 3 years	Donetsk Centre for Standardization, Metrology and Certification

[3] As there is no Ukrainian certificate for such kind of equipment there was a decision of Donetsk Centre for Standardization and Metrology for one year calibration period

For temperature sensors

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such sensors is 1 year	Donetsk Centre for Standardization, Metrology and Certification

For pressure sensors

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such sensors is 1 year	Donetsk Centre for Standardization, Metrology and Certification

For thermocouples

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of thermocouples is 1 year[4]	Donetsk Centre for Standardization, Metrology and Certification

For electricity meters

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such meters is 12 year	Donetsk Centre for Standardization, Metrology and Certification

B.1.4. Involved of Third Parties:

Donetsk Centre for Standardization, Metrology and Certification

[4] As there is no Ukrainian certificate for such kind of equipment there was a decision of Donetsk Centre for Standardization, Metrology and Certification for one year calibration period

B.2. Data collection (accumulated data for the whole monitoring period):

All continuously measured parameters (LFG concentrations, pressure and temperature, Flare temperature and electricity), are recorded electronically by Memograph M RSG40 and stored into on-site project operator computer. The data also can be downloaded on the both computers at SEC Biomass headquarter controlled by Monitoring Manager and TIS Eco headquarter. This is made due to internet connection and/or e-mail. The data files at both SEC Biomass and TIS Eco computers are entered into database and achieved there for whole monitoring period. The Figure below shows the scheme of data flow and operational structure of the project.

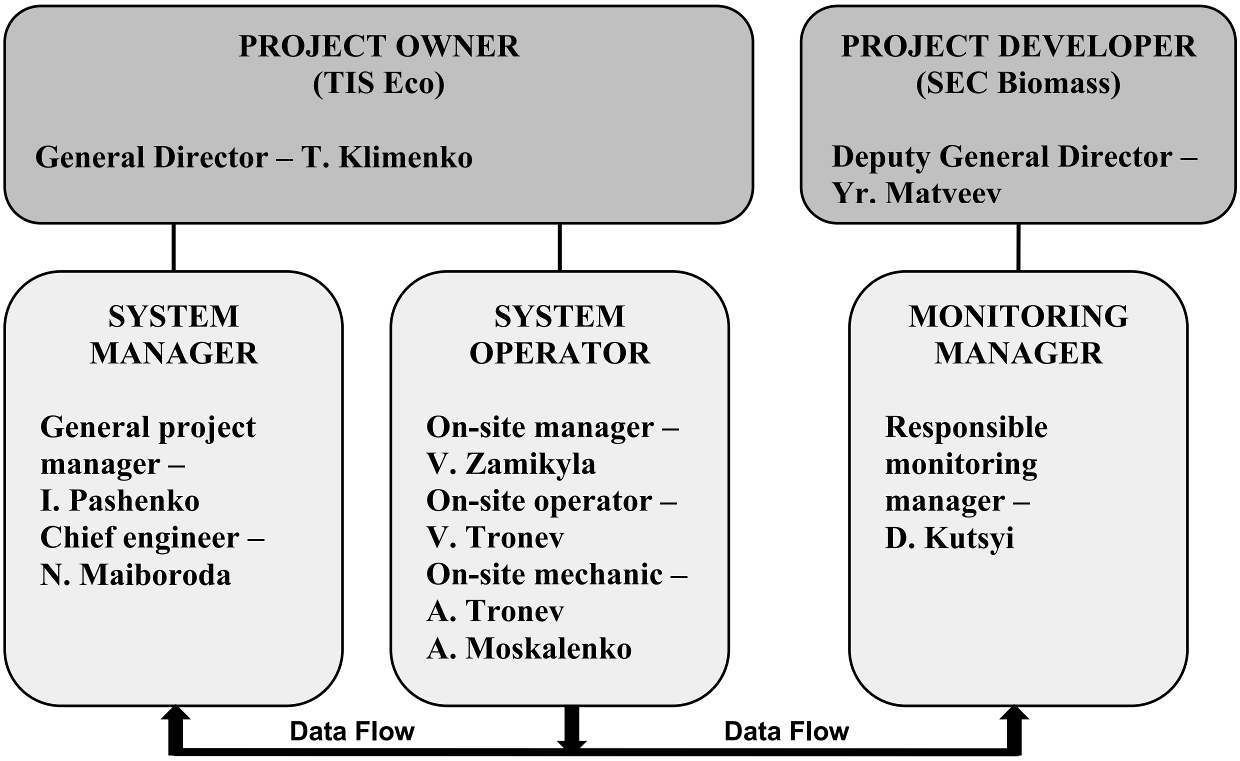

Figure 3. *Operational structure of the project and data flow*

B.2.1. List of fixed default values:

Table 10. *Project fixed default values*

Data variable	Source of data	Data unit	Comment
EF_{EL} Emissions factor for electricity consumption	Baseline study "Standardized emission factors for the Ukrainian electricity grid" (Version 5.02 February 2007) Global Carbon B.	tCO_{2e}/MWh	Equal to 0.896

Table 11. *Baseline fixed default values*

Data variable	Source of data	Data unit	Comment
GWP_{CH4} Global Warming Potential of Methane	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Vol. 2: Energy	tCO_{2e}/tCH_4	Equal to 21

B.2.2. List of variables:

Project emissions variables to be measured or calculated:

$MD_{flared,p}$ – the quantity of methane destroyed by flaring during the monitoring period p (tCH_4).
$PE_{flare,p}$ – emissions from flaring of the residual gas stream during monitoring period p (tCO_{2e}).

Baseline emissions variables to be measured or calculated:

$EC_{PJ,h}$ – quantity of electricity consumed by the collection and utilization system in hour h (MWh).

B.2.3. Data concerning GHG emissions by sources of the project activity:

Table 12. *Data to be collected in the project scenario*

Period	Variable	Description	Unit	Value
15.02.2010-30.06.2011	$MD_{flared,p}$	The quantity of methane destroyed by flaring	tCH_4	**650**
15.02.2010-30.06.2011	$PE_{flare,p}$	Project emissions from flaring of the residual gas stream	tCO_{2e}	**858**

B.2.4. Data concerning GHG emissions by sources of the baseline:

Table 13. *Data to be collected in the baseline scenario*

Period	Variable	Description	Unit	Value
15.02.2010-30.06.2011	$EC_{PJ,p}$	Quantity of electricity consumed by the collection and utilization system	MWh	**43**

B.2.5. Data concerning leakage:

No leakage effects have to be accounted for under the PDD.

B.2.6. Data concerning environmental impacts:

Environmental impact of the project activity is assessing by Mariupol Sanitary and Epidemiological Centre. The representatives of Mariupol Sanitary and Epidemiological Centre once at half a year attend the project and measure the quality of exhaust gases from Flare. Measured data concerning environmental impacts can be available by request.

B.3. Data processing and archiving (incl. software used):

All information from monitoring measurement equipment has electronically transmitted to the control operator’s computer and saved continuously into the database. In parallel all information transmitted to the both project owner and monitoring manager computers on a daily base and saved there.

The archiving period for the log files is not less than one year. Additionally all monitoring parameters has been recorded on CDs. These CDs will be stored till the end of the crediting period plus two years.

B.4. Special event log:

Prymorsky landfill. During the testing and trials period when enclosed Flare is used the temperature sensor of the flow control and metering system BVR.M -1 is wedging due to voltage jump. Therefore the LFG collection and utilization system was stopped from 03.09.2010 12:05:00 to 12.09.2010 15:35:00 for equipment calibration (temperature and pressure sensors). The data from the removed flow control and metering system BVR.M -1 before and after calibration are presented in the table below. The calibration protocols can be available by request of the on-site manager.

Prymorsky landfill. During the testing and trial period when enclosed Flare is used an electric input board of the flow control and metering system BVR.M -1 is failed due to another voltage jump. Therefore the LFG collection and utilization system was stopped from 09.06.2011 17:54:00 to 22.06.2011 12:00:00 for BVR.M -1 maintenance. The BVR.M -1 was displaced and repaired by the staff of Donetsk Centre for Standardization, Metrology and Certification. The corresponding displaces and maintenance protocols were written. It can be available by request of the on-site manager. The data from the removed flow control and metering system BVR.M -1 before and after maintenance are presented in the table below.

Table 14. *Data from the flow control and metering system BVR.M -1*

Item №	Measuring instrument	Work parameter	Type	Serial number	Data before replacing	Data after replacing	Differen ce
G2	Flow control and metering system	m^3	BVR.M -1	N08196	1,356,029	1,370,660	14631
G2	Flow control and metering system	m^3	BVR.M -1	N08196	2,874,316	2,834,316	0

SECTION C. Quality assurance and quality control measures

C.1. Documented procedures and management plan:

C.1.1. Roles and responsibilities:

The General Director of the TIS Eco Ltd Company implements a project management scheme in cooperation with the managers and operators responsible for project activities. The General Director of the TIS Eco Ltd controls information exchange with project developer SEC Biomass Ltd for monitoring management activities and emission reduction calculation.

The General project manager supervises and coordinates activities of his subordinate, such as Chief engineer and Monitoring manager. The Chief engineer coordinates the activities with On-site manager and control the technical operation of the system (including monitoring). On-site management is implemented by On-site manager who directs On-site operator responsible for system functionality and data collection. Two mechanics are involved in operation during daytime. They are responsible for preventive measures and maintenance of all technological equipment and metering instruments.

The process parameters and monitoring data continuously transmitted and archived in the on-site operator computer. Operator checks the process parameters of the system and controls the monitoring data before daily transfer. In parallel all information can be downloaded on the both computers at SEC Biomass headquarter controlled by Monitoring manager and TIS Eco headquarter controlled by Chief engineer. The Monitoring manager is checking data and making calculations of emission reduction. These calculations are made on a monthly basis. The results of calculations are used for the internal report which sends to the General project manager for revision. In term Chief engineer checks the data on a daily basis and executes the general supervision of the collection and utilization system (including monitoring system).

C.1.2. Trainings:

During the testing and trials period the en-closed Flare HOFGAS-Ready 800 produced by Hofstetter (Austria) was delivered and installed in Prymorsky landfill by Ukrainian company CHNPP Sinapse. The representatives of CHNPP Sinapse Company passed an educational training on the equipment operation in Austria and obtained a permission certificate. The CHNPP Sinapse representatives have performed training during installation and commissioning of Flare in Prymorsky landfill. During the training the HOFGAS-Ready 800 Operation manual with Monitoring scheme description was transferred to the on-site operational staff. The end of training was confirmed by CHNPP Sinapse official letter (№713 from November 18, 2010).

C.2. Involvement of Third Parties:

Donetsk Centre for Standardization, Metrology and Certification and is the Third Parties involved.

C.3. Internal audits and control measures:

The utilization system of the project is equipped by modern automation and control system. The on-line process and monitoring data are displays at on-site operator computer. All deviations from programmed process parameters could be immediately noticed and source of such deviations could be identified. Therefore in case of any deviation On-site operator enable quickly coordinate actions of his assistance staff that will improve operational process and eliminate any deviations.

Additionally the process parameters and monitoring data are controlled by Chief engineer and Monitoring manager on daily basis. In case of any deviations missed by On-site operator or references Chief engineer can make an order to the last ones. Also Monitoring manager is daily checks and controls the monitoring data and quality performances of monitoring procedure (including data measuring, calibration and other). This two stage management control system considerably improved operational and monitoring process.

C.4. Troubleshooting procedures:

In case of collection and utilization system break down (depressurization of wells or header pipelines, clogging of filters and separators, increasing of LFG temperature or fire and other) the automation system will immediately stop the blower. The shut off valve will close LFG supply pipeline. The flame arrestors will prevent the flame spread (in case of fire) along pipelines. The control system will generate an alarm and it will be send by GSM mobile phone to the On-site operator.

SECTION D. Description of GHG emission reduction calculation

D.1. Emissions reduction:

The methodology ACM0001 “Consolidated baseline and monitoring methodology for landfill gas project activities” uses following formula for calculation of the GHG emissions reduction:

$$ER_p = BE_p - PE_p = \left[\left(MD_{project,p} - MD_{BL,p}\right) * GWP_{CH4} + EL_{LFG,p} * CEF_{elec,BL,p} + ET_{LFG,p} * CEF_{ther,BL,p}\right] - \\ - \left[PE_{EC,p} + PE_{FC,p}\right]$$

(1)

where,

- ER_P – GHG emissions reduction during a monitoring period p (tCO_{2e});
- BE_p – baseline emissions during the monitoring period p (tCO_2e);
- PE_p – project emissions during a monitoring period p (tCO_{2e});
- $MD_{project,\ p}$ –amount of methane that will be destroyed/combusted during the monitoring period p (tCH_4) in project scenario;
- $MD_{BL,\ p}$ – amount of methane that would have been destroyed/combusted during the monitoring period p in absence of the project due to regulatory and/or contractual requirement (tCH_4);
- GWP_{CH4} – Global Warming Potential value for methane for the first commitment period (=21 tCO_2e/CH_4);
- $EL_{LFG,p}$ – net quantity of electricity produced using LFG during the monitoring period p which in the absence of the project activity would have been produced by power plants, (MWh);
- $CEF_{elec,BL,p}$ – emissions intensity of the electricity displaced (=0,807 tCO_2e/MWh);
- $ET_{LFG,p}$ – quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler/air heater (TJ);
- $CEF_{ther,BL,y}$ – emissions intensity of the fuel used by boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation (0.0561=$ktCO_{2e}$/TJ);
- $PE_{EC,p}$ – project emissions from consumption of electricity during the monitoring period p (tCO_{2e});
- $PE_{FC,p}$ – project emissions from consumption of heat during the monitoring period p (tCO_{2e}).

The amount of methane that would have been destroyed/consumed during the monitoring period p in the absence of the project activity is as follows:

$$MD_{BL,p} = MD_{projact,p} * AF \quad (2)$$

where,

- AF – adjustment factor that is defined as the ratio of the destruction efficiency of the collection and destruction system mandated by regulatory or contractual requirements to that of the collection and destruction system in the project activity. Equal 0%, as regulatory and contractual requirements is not considered for this project activity.

In general case the amount of methane that will be destroyed/combusted during the monitoring period p in project scenario is as follows:

$$MD_{project,p} = MD_{flared,p} + MD_{electricity,p} + MD_{thermal,p} \quad (3)$$

where,

- $MD_{flared,p}$ – the quantity of methane destroyed by flaring during the monitoring period p (tCH_4);
- $MD_{electricity,p}$ – the quantity of methane destroyed for the generation of electricity during the monitoring period p (tCH_4);
- $MD_{thermal,p}$ – the quantity of methane destroyed for generation of thermal energy (tCH_4).

In project activity following formula is applied (see PDD section D):

$$MD_{project,p} = MD_{flared,p} \quad (3a)$$

The quantity of methane destroyed by flaring option during the monitoring period p is calculated based on following equation:

$$MD_{flare,p} = \left(\sum_{h=1}^{p} LFG_{flare,h} * W_{CH4,h} * D_{CH4} \right) - \left(\frac{PE_{flare,p}}{GWP_{CH4}} \right) \quad (4)$$

where,

- $LFG_{flare,h}$ – amount of LFG flared in the hour h, in normal conditions (Nm^3/h);
- $W_{CH4,h}$ – methane fraction in LFG in the hour h on dry basis (m^3 CH_4 /m^3 LFG);
- $PE_{flare,p}$ – emissions from flaring of the residual gas stream during monitoring period p (tCO_{2e});
- D_{CH4} – methane density at normal condition (=0.0007168 tCH_4/m^3CH_4);
- GWP_{CH4} – Global Warming Potential value for methane (=21).

In equation above the methane fraction in LFG is measured on dry basis. The amount of LFG is calculated automatically to normal conditions on dry basis. Therefore, the density of methane is set 0.0007168 tCH_4/m^3CH_4 and the formula for its calculation is not applied.

The emissions from flaring of the residual gas stream during monitoring period p are calculated according the latest version "Tool to determine project emissions from flaring gases containing methane" (Version 01, August 2008) as following:

$$PE_{flare,p} = \sum_{h=1}^{p} LFG_{flare,h} * W_{CH4,h} * D_{CH4} * \left(1 - \eta_{flare,h}\right) * \frac{GWP_{CH4}}{1000} \quad (5)$$

where,

- $\eta_{flare,h}$ – flare efficiency in hour h;

The flare efficiency in hour h is determined according to the Option 1 of the Tool. Therefore, it will be 99%, 50% or 0% depending on the combustion and exhaust gas temperature.

As the result, the GHG emissions reduction calculation equation takes the following formula:

$$ER_p = BE_p - PE_p = \lfloor MD_{flare,p} * GWP_{CH4} \rfloor - \lfloor PE_{EC,p} + PE_{FC,p} \rfloor \quad (6)$$

D.2. Baseline emissions:

Baseline emissions are calculated from the following equation (with the use of equation 4 and 5):

$$BE_p = MD_{flared,p} * GWP_{CH4} \quad (7)$$

D.3. Project emissions:

Project emissions are calculated from the following equation:

$$PE_p = PE_{EC,p} + PE_{FC,p} \quad (8)$$

The project emissions from electricity consumption during the monitoring period p ($PE_{EC,p}$) are calculated following the latest version of “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (Version 01, August 2008). The calculation equation below based on the quantity of electricity imported, an emissions factor for electricity generation and factor for transmission losses:

$$PE_{EC,p} = \sum_{h=1}^{p} EC_{PJ,h} * EF_{EL} * (1 + TDL_h) \quad (9)$$

where,

- $EC_{PJ,h}$ – quantity of electricity consumed by the collection and utilization system in hour h (MWh);
- EF_{EL} – emissions factor for electricity consumption (=0.896 tCO_{2e}/MWh);
- TDL_h – average technical transmission and distribution losses. Equal to 0, as a long transmissions line is disregarded in the project.

The project emissions from consumption of heat during the monitoring period are equal to 0, as heat consumption is not supposed in project scenario.

The possible project emissions from methane combustion are not included in the calculation, because biodegradable carbon (biomass), which is present in the organic fraction of the waste, is part of the carbon biocycle. Inside the landfill body under anaerobic condition the biodegradable carbon is converted into LFG. LFG is approximately half consisting of methane. The combustion of methane from LFG is releases carbon that was recently sequestered by the organic fraction of the waste. Therefore, the carbon dioxide emissions from the combustion of methane are considered CO_2-neutral.

Therefore, the final project emission equation is following:

$$PE_p = PE_{EC,p} \tag{10}$$

D.4. Leakages:

No leakages to be accounted

SECTION E. Results of GHG emission reduction calculation

E.1. Baseline emissions calculation results:

The summary of the baseline emissions calculation results are presented in the table below.

Table 15. *The summary of the baseline emissions in tCO_{2e}*

Monitoring period from 15.02.2010 to 30.06.2011		
The baseline emissions	BE_p	**13,655**

E.2. Project emissions calculation results:

The summary of the project emissions calculation results are presented in the table below.

Table 16. *The summary of the project emissions in tCO_{2e}*

Monitoring period from 15.02.2010 to 30.06.2011		
Project emissions = Project emissions from electricity consumption	$PE_p=PE_{EC,p}$	**38**

E.3. Emissions reduction calculation results:

The summary of the emissions reduction calculation results are presented in the table below.

Table 17. *The summary of the emissions reduction in tCO_{2e}*

Monitoring period from 15.02.2010 to 30.06.2011		
The emissions reduction	ER_p	**13,617**

E.4. Presentation of emissions reduction calculation in Excel file:

The files named “ERU_Calculations_PL_15.02-31.12.10” and “ERU_Calculations_PL_01.01-30.06.11” for Prymorsky landfill. The files consist of worksheets which contain one month information. The first and the last worksheets are presented general information about the project and summary of the monitoring results correspondingly. The raw data from database of measuring equipment are imputed to “Month_In^Out” worksheet. The calculation of emission reduction is conducted in “Month_ERU” worksheet. The detailed description of the Excel file work is presented below.

The methane content data and exhaust gas temperature and combustion temperature of the Flare are inputs to the columns “B” “C” and “D” of “Month_In^Out” worksheet correspondingly. The columns “E” “F” and “G” of this worksheet are used for automatically checking of manufacturer’s specification which are presented in the Table above. For instance, if the exhaust gas temperature and combustion temperature within the set limits of manufacturer’s specification (1000-1200 ^{0}C), an indicator "1" will appear in column "E". This indicator shows that during a minute the Flare works with the efficiency of 99% (see cell "E11").

Then the column “J” is used for hourly averaging of the methane content data. The column "K" is used for determine hourly Flare efficiency under the Option 1 of the *“Tool to determine project emissions from flaring gases containing methane*” (Version 01, August 2008). For instance, if the sum of column "E" is more than 40 during hour h the Flare efficiency is set 99%.

The standard LFG flared flow data are inputs to the column “N” of “Month_In^Out” worksheet. The automatically recalculation from standard to normal conditions flow data is outputted in columns “R”. The quantity electricity consumed data are inputs to the columns “V” of “Month_In^Out” worksheet. But once a mathematical channel has been added to the Memograph M RSG40 the normal flared flow data are inputs to the columns “N” and the quantity of electricity consumed data are inputs to the columns “R”.

The “Month_ERU” worksheet contains the results of project emission reduction calculation according to the input/output data of the previous “Month_In^Out” worksheet. The hourly quantity of methane destroyed by flaring ($MD_{flared,p}$) under equation 4 are calculated in the column “B”. The hourly project emissions from flaring ($PE_{flare,p}$) under equation 5 are calculated in the column “E”. The hourly project emissions from consumption of electricity ($PE_{EC,p}$) under equation 9 are calculated in the column “F”. Consequently, the hourly sum of the project emissions (PE_p) under equation 8 is calculated in the column “G”. The hourly sum of baseline emissions (BE_p) under equation 7 is calculated in the column “H”. And the hourly emission reduction (ER_p) under equation 6 is calculated in the column “I”. The results of calculation of all variables are additionally summarized by month.

ANNEX 1

SUMMARY OF THE MONTHLY EMISSION REDUCTION
during the monitoring period
February 15, 2010 to June 30, 2011

Month	Prymorsky landfill			Ordzhonikidze landfill		
	Baseline emissions	Project emissions	Emissions reduction	Baseline emissions	Project emissions	Emissions reduction
	BE_p, tCO_{2e}	PE_p, tCO_{2e}	ER_p, tCO_{2e}	BE_p, tCO_{2e}	PE_p, tCO_{2e}	ER_p, tCO_{2e}
February 2010	521	1	520	0	0	0
March 2010	1,385	2	1,383	0	0	0
April 2010	1,082	5	1,078	0	0	0
May 2010	1,214	3	1,211	0	0	0
June 2010	958	5	954	0	0	0
July 2010	1,000	3	997	0	0	0
August 2010	935	3	932	0	0	0
September 2010	650	2	648	0	0	0
October 2010	926	2	924	0	0	0
November 2010	741	2	739	0	0	0
December 2010	666	2	664	0	0	0
January 2011	749	2	746			
February 2011	655	2	653			
March 2011	728	2	726			
April 2011	549	1	548			
May 2011	588	1	587			
June 2011	307	1	307			
Total	**13,655**	**38**	**13,617**	**0**	**0**	**0**
Total ER_p Two Landfills	**13,617**					

ANNEX 2

SUMMARY OF THE MONTHLY MONITORING VARIABLES during the monitoring period February 15, 2010 to June 30, 2011

Month	Prymorsky landfill				Ordzhonikidze landfill			
	Methane destroyed by flaring	Methane combusted in CHP unit	Electricity produced	Electricity consumed	Methane destroyed by flaring	Methane combusted in CHP unit	Electricity produced	Electricity consumed
	$MD_{flared,p}$, tCH_4	$MD_{electricity,p}$, tCH_4	$EL_{,LFG,p}$, MWh	$EC_{PJ,p}$, MWh	$MD_{flared,p}$, tCH_4	$MD_{electricity,p}$, tCH_4	$EL_{,LFG,p}$, MWh	$EC_{PJ,p}$, MWh
2010-02	25	0	0	1	0	0	0	0
2010-03	66	0	0	2	0	0	0	0
2010-04	52	0	0	5	0	0	0	0
2010-05	58	0	0	3	0	0	0	0
2010-06	46	0	0	5	0	0	0	0
2010-07	48	0	0	4	0	0	0	0
2010-08	45	0	0	3	0	0	0	0
2010-09	31	0	0	3	0	0	0	0
2010-10	44	0	0	2	0	0	0	0
2010-11	35	0	0	2	0	0	0	0
2010-12	32	0	0	2	0	0	0	0
2011-01	36	0	0	2	0	0	0	0
2011-02	31	0	0	2	0	0	0	0
2011-03	35	0	0	2	0	0	0	0
2011-04	26	0	0	1	0	0	0	0
2011-05	28	0	0	1	0	0	0	0
2011-06	15	0	0	1	0	0	0	0
Total	**650**	**0**	**0**	**43**	**0**	**0**	**0**	**0**

ANNEX 3

FLARE TESTING PROTOCOL

ПРОТОКОЛ
испытаний факела

УТВЕРЖДАЮ
Директор ЧНПП «СИНАПС»
____________С.Д. Федоров
«23» марта 2010

Наименование и адрес собственника:
ООО «Тис Эко», г. Мариуполь, Приморский полигон ТБО

Характеристики:

Тип	HOFGAS-Ready(800) № H10550		Топливо	БИОГАЗ	
Расход топлива	макс. 800	нм³/час	Концентрация метана	30-50	% об.
	мин. 160	нм³/час	Температура горения	макс. 1200	°C
				мин. 1000	°C
Давление на горелке	110	мбар	Время удержания	≥ 0,3	с
Мощность	макс. 4 000	кВт			
	мин. 800	кВт			

Результаты испытаний

Параметр		Размерность	Обозначение	Оборудование HOFGAS-Ready(800) № H10550
Топливо (Биогаз)	Количество рабочих горелок	шт.	-	4
	Рабочее давление на горелке (относительное)	мбар	P_G	100
	Температура топлива	°C	t_G	20
	Влажность топлива	%	φ_G	25
	Состав топлива:			
	- Метан	% об.	fv_{CH_4}	49,5
	- Сероводород	% об.	fv_{H_2S}	0,0
	- Углекислый газ	% об.	fv_{CO_2}	34,9
	- Азот	% об.	fv_{N_2}	10,5
	- Кислород	% об.	fv_{O_2}	2,0
	- Пары воды	% об.	fv_{H_2O}	3,0
	Плотность	кг/м³	ρ_G	1,23
	Теплотворная способность	кДж/м³	Hc	19,25
	Молекулярный вес	кг/кмоль	M	26,9
Воздух	Давление воздуха перед горелкой (абсолютное)	мбар	P_A	1 013,0
	Температура воздуха	°C	t_A	15
	Влажность воздуха	%	φ_A	63
Продукты сгорания	Содержание кислорода	% об.	$fv_{O_2,FG}$	9,753
	Содержание углекислого газа	% об.	$fv_{CO_2,FG}$	4,842
	Содержание метана	% об.	$fv_{CH_4,FG}$	0,001
	Содержание азота	% об.	$fv_{N_2,FG}$	74,059
	Содержание оксидов азота	% об.	$fv_{NO_x,FG}$	0,000
	Содержание оксидов серы	% об.	$fv_{SO_2,FG}$	0,000
	Содержание паров води	% об.	$fv_{H_2O,FG}$	11,345
	Температура горения в камере сгорания факела	°C	T_{Flare}	1 056
	Температура отходящих газов на выходе из камеры сгорания факела	°C	$T_{Flue\ gas}$	972
	Коэффициент избытка воздуха	-	α	2,1
РП	Эффективность сжигания (разрушения) метана на факеле	%	η_{flare}	99,8

Исполнитель испытательных работ ____________ Е.П. Трегуб