MONITORING REPORT FORM (CDM –MR)
Version 01 – in effect as of: 28/09/2010

CONTENTS

MONITORING REPORT
Version 2, 12 January 2011

Project activity: Pakarab Fertiliser Co-generation Power Project
Reference number: 2687
Monitoring Period: 01/06/2010 – 31/12/2010

Section A. General description of the project activity

A.1. Brief description of the project activity:

The purpose of this monitoring report is to calculate and clarify GHG emission reduction quantity achieved by this CDM project activity for verification. The Pakarab Fertilizer Limited (PFL) is a major fertilizer complex producing both Nitrogenous and Phosphatic fertilizers. Power and steam for the fertilizer processes as well as for common consumers within the Pakarab Fertilizer area were before the implementation of project activity supplied by the captive power plant on-site, without any cogeneration. Power was generated by condensing steam turbines with low steam parameters and process steam for the factory in a heat-only process resulting in a high fuel consumption and high CO_2 emissions.

Therefore PFL was considering as CDM project activity to replace the existing captive condensing power plant with a new highly energy efficient co-generation plant. Primarily the new cogeneration plant (project activity) completely covers the power and steam demand of the fertiliser complex and the replaced captive power house is further used as backup and for standby purposes. The project activity comprises the co-generation of electricity and heat (steam): the waste heat of the gas turbines is used by heat recovery steam generators (HRSGs) to produce the steam that would have produced in heat-only mode in the replaced power house..

The construction period of the project activity was from January 2008 to July 2009. Commissioning and start of operation of GTG No. 1 was in April 2009, of GTG No. 2 in June 2009and of GTG No. 3 in July 2009.

The total emission reductions achieved in this monitoring period are 22,590 tCO_2

A.2 Project Participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Pakistan	Pakarab Fertiliser Limited	No
Germany	Fichtner GmbH & Co. KG (Consultant)	No

A.3. Location of the project activity:

Host party: Islamic Republic of Pakistan
Province: Punjab, which is Pakistan's second largest province at 205,344 km.
City/Town/community:
Multan is a city in the Punjab Province of Pakistan and the capital of Multan District. It is located in the southern part of the province. Relevant meteorological data for Multan for the years 1991 to 2005 have been summarised and are shown below:

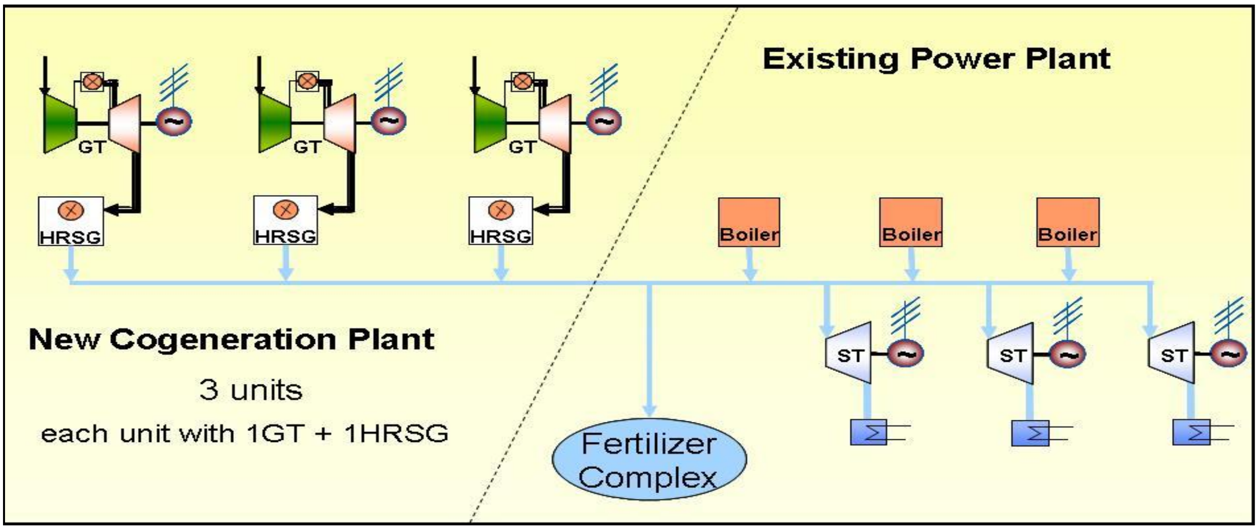
- Mean annual air temperature 25.4 °C
- Mean relative humidity 57%
- Extreme maximum air temperature 50 °C
- Extreme minimum air temperature 0 °C

Detail of physical location:
Pakarab Fertilizer factory is situated about 10 km north-east to the centre of Multan city, Pakistan, on the highway leading to Lahore.
The geographical coordinates of the project activity are as follows:
Latitude: 30°12′00″N
Longitude: 71°27′00″E

A.4. Technical description of the project

Description of the activities/measures being implemented within the project activity
As CDM project activity a highly energy efficient **cogeneration plant** is implemented. The new power plant shall almost completely cover the power and process steam demand of the fertiliser complex and the existing power plant will be used as backup and standby unit in case of forced or planned outages of units of the cogeneration plant (see figure below).

Figure 1: Overview of new cogen plant and existing power plant



For cogeneration of power and steam with the required parameter of 40 bar/405 °C, a **new gas-turbine cogeneration plant** with three gas turbines and three upstream heat recovery steam generators (HRSG) is implemented as project activity. Several units are chosen for redundancy purposes. The power output and efficiency of gas turbines depend on the site conditions with regard to elevation and ambient temperature. From several gas turbine types which are offered in the market, the one according to Table 1 has been selected for implementation for the project activity.

Table 1: Output of selected gas turbine type GE10-1 for cogeneration plant

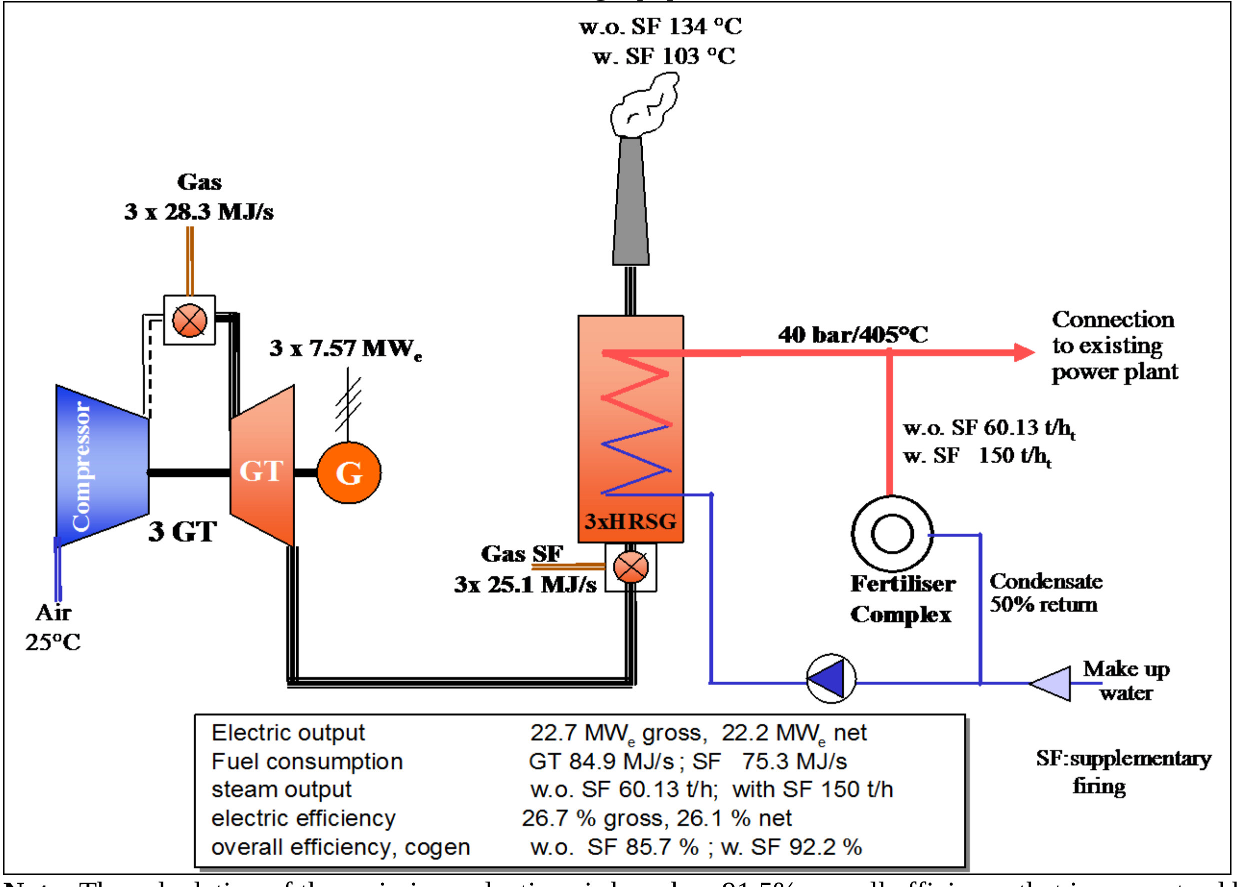
Ambient conditions and load	Output (gross) [MW]	Efficiency ***) [%]
ISO- rating *) and 100% load	10.70	30.36
Average site conditions **) and 100% load	9.70	29.25
Average site conditions **) and annual average load of 78%	7.57	26.70

*) atmospheric pressure 1.013 bar, temperature 15 °C, relative humidity 60 %
**) according to data sheet GT manufacturer for reference site conditions
***) gross electric output to firing duty as net calorific value (NCV)

At the annual average temperature of 25 °C the selected gas turbines can meet also the expected maximum power demand of 25 MW (3 x 9.7 MW = 29.1 MW). As the average power demand of the fertiliser complex is about 22 MW the gas turbines will have to be operated at part load during most of the time; the consequence will be a lower efficiency.

A simplified heat flow diagram of the cogeneration plant for operation at annual average conditions (25°C) and net power output (22.2 MW) is shown in the figure below. The in-house (own) power demand of 0.5 MW is derived from similar plants. In pure cogeneration mode, the plant can generate 55.8 t/h process steam. In order to meet the average demand of 150 t/h, the HRSGs are equipped with supplementary firing (SF). At average annual load conditions the electric efficiency declines due to the part load operation as it is typical for gas turbines. The overall efficiency, however, with supplementary firing obtains according to the cycle simulations a remarkable level of 92.2 %. The manufacturer of the plant guarantees 91.5% overall efficiency; this may contain some security margin to avoid penalties.

Figure 2: Simplified heat flow diagram of the cogeneration plant at annual average load conditions. Refer to Annex 2 to Annex 5 for exact locations of metering equipment.



Note: The calculation of the emission reductions is based on 91.5% overall efficiency that is guaranteed by the manufacturer of the plant.
The manufacturers of the major equipment are as follows:
1. HRSGs: UMAG Technologie GmbH
2. Gas turbines: GE Oil & Gas Nuovo Pignone
3. Generators: Ansaldo Italy

Also, for monitoring locations / positions please refer to the attached annexes 02, 03, 04 and 05.

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

- AM0014/Version 04 (EB33 decision)
- “Natural gas-based package cogeneration”.

No other methodologies or methodological tools where the methodology refers to were used.

A.6. Registration Date of the project activity:

- 21 December 2009

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

Start date of CDM project activity: 13 July 2007
Start date of crediting period: 21 December 2009
Crediting period: 3 x 7 years

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

Pakarab Fertiliser Limited:

Name of person	Role & Responsibilities	Phone Number	E-mail
Unit Manager (Instrument) Mr. Tariq Qasim Khan	Provide first end help for fixing technology, metering equipment, verify data gaps and calibrate metering equipment, undertake regular on-site checks	+92- 61- 9220022	pafl.uminst@fatima-group.com
Unit Manager (Utilities) 1) Mr. Abdul Rauf / 2) Mr. Tahir Sherazi	Oversee collected data regularly, analyse data, write up monitoring report, issue report to DOE, archive data, discuss proposed changes of the Monitoring plan with DOE	1) +92- 61- 9220022 Extension 3141 2) +92- 61- 9220022 Extension 3142	1)pafl.umutw@fatima-group.com 2) tahir.sherazi@fatima-group.com
Process Engineer (Utilities) Mr. Adnan Mahmood	Provide internal Quality Control and audit of the data and monitoring plan	+92- 61- 9220022 Extension 3169	adnan.mahmood@fatima-group.com

Fichtner GmbH & Co. KG (Consultant):
Dr. Ole Langniss, ole.langniss@fichtner.de, +49 711 8995 584
Ursula Baumgartner, ursula.baumgartner@fichtner.de, +49 711 8995 578

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

Starting date of operation of the project activity:

a) April 17, 2009: GTG No.1 commissioned
b) April 29, 2009: GTG No. 1 has been started and is connected on distribution network through busbar
c) May 20, 2009: GTG No.2 commissioned
d) June 19, 2009: GTG No. 2 has been started and is connected on distribution network through busbar
e) July 7, 2009: GTG No.3 commissioned
f) July 20, 2009: GTG No. 3 has been started and is connected on distribution network through busbar

The following table indicates information regarding trippings and normal stoppages.

Table 2: Trippings and normal stoppages

Start/Stop & Tripping record From June 01, 2010 to December 31,2010					
S.#	**DATE**	**EQUIPMENT**	**TIME**	**START/NORMAL STOP/TRIP**	**REMARKS**
GTGs					
1	June 8,2010	GTG # 2	0600	Tripped	Due to loss of flame
2	June 10,2010	GTG # 1	1500	Stopped	
3	June 10,2010	GTG # 1	1855	Started	Synchronized with busbar at 1915 hrs.
4	June 27,2010	GTG # 1	2105	Tripped	Due to HMI fault.
5	June 27,2010	GTG # 1	2155	Started	
6	June 30,2010	GTG # 1	1010	Normally Stopped	
7	June 30,2010	GTG # 1	1350	Started	Synchronized with the busbar at 1415 hrs.
8	July 5,2010	GTG # 2	0914	Normally Stopped	For IS limiter installation.
9	July 7,2010	GTG # 2	1010	Started	Synchronized with the busbar at 1415 hrs.
10	July 7,2010	GTG # 3	1714	Normally Stopped	For IS limiter installation.
11	July 9,2010	GTG # 1 & 2	1626	Tripped	Total Power failure occurred during installation & comissioning activity of IS limiter at GTG-III.
12	July 09,2010	GTG # 2	1645	Started	Synchronized with EDG at 1700.
13	July 09,2010	GTG # 1	1802	Started	Synchronized with GTG-II at 1838 hrs.
14	July 10,2010	GTG # 2	1150	Normally Stopped	For testing & commisioning of IS limiter.
15	July 10,2010	GTG # 2	2158	Started	Synchronized at 2220 hrs.
16	July 10,2010	GTG # 3	2318	Started	Synchronized at 2335 hrs.
17	July 10,2010	GTG # 3	1755	Tripped	Due to high generator winding temperature.
18	July 10,2010	GTG # 3	2027	Started	
19	August 09,2010	GTG # 2	2045	Stopped	Due to Natural Gas Limitation.
20	August 10,2010	GTG # 1	0745	Normally Stopped	Due to Natural Gas limitation.
21	August 12,2010	GTG # 2	1620	Started	Synchronized with GTG-III at 1640 hrs.
22	August 14,2010	GTG # 1	0315	Tripped	Due to loss of flame.
23	August 14,2010	GTG # 1	0415	Started	
24	Sep 08,2010	GTG # 2	0455	Normally Stopped	For rectification of battery charger fault.
25	Sep 09,2010	GTG # 2	2025	Started	
26	Sep 09,2010	GTG # 3	2115	Normally Stopped	Due to Natural Gas limitation.
27	Sep 09,2010	GTG # 1	2300	Normally Stopped	Due to Natural Gas limitation.
28	Sep 14,2010	GTG # 3	2300	Started	Synchronized with the busbar at 2320 hrs.
29	Sep 15,2010	GTG # 1	1730	Started	Synchoronized with the busbar at 1755 hrs.
30	Sep 15,2010	GTG # 2	1912	Tripped	Due to malfunctioning of exhaust gas thermocouple # 4.

31	Sep 15,2010	GTG # 2	2135	Started	
32	Sep 18,2010	GTG # 1	0115	Normally Stopped	Due to Natural Gas limitation.
33	Sep 21,2010	GTG # 1	1730	Started	Synchronized with busbar at 1800 hrs.
34	Oct 27,2010	GTG # 1	1515	Normally Stopped	Due to Natural Gas limitation.
35	Oct 27,2010	GTG # 2	2050	Normally Stopped	Due to Natural Gas limitation.
36	Nov 4,2010	GTG # 2	2130	Started	Synchronized with GTG-III at 2205 hrs.
37	Nov 5,2010	GTG # 1	1825	Started	Synchronized with busbar at 2010 hrs.
38	Nov 13,2010	GTG # 2	0430	Tripped	Due to 24V DC breaker opening.
39	Nov 14,2010	GTG # 2	1830	Started	Synchronized with busbar at 1845 hrs.
40	Nov 30,2010	GTG # 1	1235	Tripped	Indication of emergency push button.
41	Nov 30,2010	GTG # 1	1400	Started	
42	Dec 8,2010	GTG # 3	2230	Normally Stopped	Due to Natural Gas limitation.
43	Dec 28,2010	GTG # 2	1840	Normally Stopped	Due to Natural Gas limitation.

S.#	DATE	EQUIPMENT	TIME	START/NORMAL STOP/TRIP	REMARKS
HRSGs					
1	June 11,2010	HRSG # 3	1615	Stopped	For replacement of fresh air fan filters.
2	June 11,2010	HRSG # 3	1840	Started	
3	June 27,2010	HRSG # 1	2105	Tripped	As GTG # 1 tripped.
4	June 27,2010	HRSG # 1	0030	Started	
5	July 5,2010	HRSG # 2	0930	Tripped	Due to wrong indication of steam drum level as power supply card failed.
6	July 7,2010	HRSG # 2	0830	Started	
7	July 8,2010	HRSG # 3	1925	Stopped	For exhaust duct inspection of GTG # 3.
8	July 9,2010	HRSG # 1,2 & 3	1626	Tripped	Total Power failure occurred during installation & comissioning activity of IS limiter at GTG-III.
9	July 9,2010	HRSG # 1	1800	Started	
10	July 9,2010	HRSG # 3	1900	Started	
11	July 9,2010	HRSG # 2	2315	Started	
12	July 10,2010	HRSG # 1	1210	Normally Stopped	For leakage rectification from desuperheater header.
13	July 10,2010	HRSG # 1	0035	Started	
14	July 15,2010	HRSG # 3	1755	Tripped	Due to tripping of GTG # 3.
15	July 15,2010	HRSG # 3	1815	Started	
16	July 21,2010	HRSG # 2	1455	Normally Stopped	For installation of power supply card.
17	July 21,2010	HRSG # 2	1640	Started	
18	July 27,2010	HRSG # 3	0900	Normally Stopped	For sealing air valve fault rectification.
19	July 27,2010	HRSG # 3	0940	Started	
20	July 31,2010	HRSG # 1	1510	Normally Stopped	For leakage rectification from Natural gas totalizer.

21	July 31,2010	HRSG # 1	1900	Started	
22	August 07,2010	HRSG # 2	0340	Tripped	Due to low level in steam drum.
23	August 09,2010	HRSG # 2	1640	Started	
24	August 09,2010	HRSG # 2	2100	Normally Stopped	Due to Natural Gas limitation.
25	August 10,2010	HRSG # 1	0640	Normally Stopped	Due to Natural Gas limitation.
26	August 12,2010	HRSG # 3	0450	Tripped	Due to low natural gas pressure.
27	August 12,2010	HRSG # 2	0555	Started	
28	August 13,2010	HRSG # 3	0600	Tripped	
29	August 13,2010	HRSG # 3	0740	Started	
30	August 13,2010	HRSG # 1	1730	Started	
31	Sep 09,2010	HRSG # 1	0725	Normally Stopped	
32	Sep 09,2010	HRSG # 2	1550	Started	
33	Sep 09,2010	HRSG # 3	1700	Normally Stopped	Due to Natural Gas limitation.
34	Sep 14,2010	HRSG # 2	0815	Started	
35	Sep 14,2010	HRSG # 3	1800	Started	
36	Sep 16,2010	HRSG # 1	1610	Started	
37	Sep 18,2010	HRSG # 1	0350	Normally Stopped	Due to Natural Gas limitation.
38	Sep 21,2010	HRSG # 1	1600	Started	
39	Oct 27,2010	HRSG # 1	0420	Normally Stopped	Due to Natural Gas limitation.
40	Oct 27,2010	HRSG # 2	1650	Normally Stopped	Due to Natural Gas limitation.
41	Nov 3,2010	HRSG # 2	2145	Started	
42	Nov 5,2010	HRSG # 1	2330	Started	
43	Nov 30,2010	HRSG # 1	1245	Tripped	Due to tripping of GTG # 1.
44	Nov 30,2010	HRSG # 1	1415	Started	
45	Dec 8,2010	HRSG # 3	2230	Normally Stopped	Due to Natural Gas limitation.
46	Dec 15,2010	HRSG # 3	2120	Started	
47	Dec 16,2010	HRSG # 3	1615	Normally Stopped	Due to Natural Gas limitation.
48	Dec 26,2010	HRSG # 3	2255	Started	
49	Dec 27,2010	HRSG # 3	0830	Normally Stopped	Due to Natural Gas limitation.
50	Dec 28,2010	HRSG # 2	1840	Normally Stopped	Due to Natural Gas limitation.

B.2. Revision of the monitoring plan

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

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B.4. Notification or request of approval of changes

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SECTION C. Description of the monitoring system

Operational data relevant for emission accounting are logged by operator on daily basis using a Pre-prepared log-sheet form, as part of the data logging system. The log book will be signed and checked by the Unit Manager (Utilities) who is compile the report on weekly basis to determine:

- Cogeneration system heat output (CAHO) to the fertiliser complex.
- Cogeneration system electricity output (CEO) to the fertiliser complex.
- The natural gas consumption V_{NG}/AEC_{NG} at the cogeneration system

The Unit Manager (Utilities) consolidates the above data on monthly basis, and cross-checks them against sales invoices from gas suppliers. The consolidated information will be summarized into a monthly report, checked and signed by the Site General Manager.

Calibration Procedure

The instrumentations installed are new and have been calibrated to international standard before commissioning. Regular calibration will be performed on regular basis during the annual maintenance shut-down at the end of first year and subsequent years to all identified instrumentations up to error level of 4% or less for critical devices such as gas meter, electricity meter and heat measurement instruments. Every end of maintenance shut-down, the Unit Manager (Instruments) composes a Calibration Status Report listing all CDM-related instruments, their details, calibration status and expected error. The calibration reports can be found in Annex 1.

Archiving of Data

Field data will be stored on computer software, but daily log-sheet will serve as back-up purpose and archived at Project site. All the metered and the calculated parameters and data will be kept on paper for two years and in electronic form until 2 years after end of the crediting period (data on 1st crediting period will be kept until end of 2017 or beyond).

Role and Responsibilities:

Name of person	Role & Responsibilities	Phone Number	E-mail
Unit Manager (Instrument) Mr. Tariq Qasim Khan	Provide first end help for fixing technology, metering equipment, verify data gaps and calibrate metering equipment, undertake regular on-site checks	+92- 61- 9220022	pafl.uminst@fatima-group.com
Unit Manager (Utilities) 1) Mr. Abdul Rauf / 2) Mr. Tahir Sherazi	Oversee collected data regularly, analyse data, write up monitoring report, issue report to DOE, archive data, discuss proposed changes of the Monitoring plan with DOE	1) +92- 61- 9220022 Extension 3141 2) +92- 61- 9220022 Extension 3142	1)pafl.umutw@fatima-group.com 2) tahir.sherazi@fatima-group.com
Process Engineer (Utilities) Adnan Mahmood	Provide internal Quality Control and audit of the data and monitoring plan	+92- 61- 9220022 Extension 3169	adnan.mahmood@fatima-group.com

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:	**CO_2 emission factor for natural gas (EF_{NG})**
Data unit:	t CO_2 /TJ
Description:	CO_2 emission factor
Source of data used:	Default emission factor of 2006 IPCC guidelines, Chapter 2 Stationary Combustion, Table 2-2 (energy industries) and Table 2-3 (manufacturing industries and construction)
Value(s):	56.1 t CO_2 /TJ
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The Methodology AM0014 sets the following hierarchy for the natural gas emission factor to be chosen: 1. National GHG inventory 2. IPCC, fuel type and technology specific 3. IPCC, near fuel type and technology It has been verified that no specific emission factor other than the IPCC default value is used. Therefore, option "2. IPCC, fuel type and technology specific" has been applied.
Additional comment:	-

Data / Parameter:	**Thermal efficiency or heat rate for steam generation in heat-only mode (baseline)**
Data unit:	% (thermal efficiency boiler e_b), GJ_{NCV}/GJ_{th} (heat rate boiler FR_{th})
Description:	The thermal efficiency for steam generation in heat-only mode, or the heat rate as its inverse value, characterize the efficiency of the current system.
Source of data:	Default value according to AM0014
Value applied:	91.0 % or 1.10 GJ_{NCV}/GJ_{th}
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Selection according to the selected baseline scenario: 3. Industrial plant upgrades the thermal energy generating equipment and therefore increases the efficiency of boiler(s) immediately. (see Section B.3 of PDD)
Additional comment:	-

Data / Parameter:	**Net electric efficiency or net heat rate for electricity generation in condensing mode with existing steam turbines (baseline)**
Data unit:	% (electric efficiency e_{ST}), GJ_{NCV}/MWh_{elec} (heat rate FR_{elec})
Description:	The efficiency for electricity generation in condensing mode, or the heat rate as its inverse value, characterize the efficiency of the current system.
Source of data used:	Calculation with Fichtner's thermodynamic cycle simulation software KPRO® (see PDD, Annex 3e)
Value applied:	23.4 % or 15.38 GJ_{NCV}/MWh_{elec}
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The electric efficiency / heat rate were calculated with the use of Fichtner's thermodynamic cycle simulation software KPRO® (see PDD, Annex 3e), applying number-plate thermodynamic parameters of the steam turbines etc. (see PDD, Section B.3). Historic values couldn't be applied because steam generated for steam turbine supply and heat supply is not measured separately.
Additional comment:	-

D.2. Data and parameters monitored:

According to the monitoring methodology, monitoring involves the following:
- The fuel consumption (natural gas) at the cogeneration system
- Heat production at the cogeneration system
- Electricity production at the cogeneration system
- Fate of the electricity displaced by the project activity since the project activity displaces electricity from a fossil fuel based dedicated power plant

Data / Parameter:	**Cogeneration system heat output (CAHO)**
Data unit:	TJ
Description:	The cogen plant produces steam for the supply of the fertilizer complex in the heat recovery steam generators (HRSG), with use of the gas turbine waste heat and additional supplementary firing. This cogeneration system heat output (CAHO) is needed to calculate *ex-post* the baseline fuel consumption for heat supply $ABEC_{BF, th}$, and the Baseline CO_2 emissions from combustion of baseline fuel for heat supply, BE_{th}.
Measured /Calcuated / Default:	Calculated
Source of data:	The cogeneration system heat output (CAHO) to the fertiliser complex is determined by an appropriate metering device as the difference of the heat content of the steam minus the heat content of the returned condensate and minus the heat content of the make up water to balance the condensate losses. The steam amount (in t) and its pressure (in Pa) and temperature (in °C), as well as the returned condensate (in t) will be continuously metered. The heat supplied in form of steam to the fertilizer complex will be calculated by use of the metered values on average daily basis.
Value of monitored parameter:	Steam Equivalent to heat: 1172 TJ
Indicate what the data are used for (Baseline/Project/Leakag e emission calcualtion)	Baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(For point of installation of the following see Annex 3) Type: Steam flow sensor (FT-08): Measuring Method : Orifice Plate d/p cell Transmitter Model No : IDP10-T22B21F-M1 Serial number: 8470121 Instrument Range: 0 ~ 5000 mmH2O Instrument Vendor Defined Accuracy: ± 0.13 % Make : FOXBORO ,USA. Calibration frequency: monthly Date of last calibration: 31 December, 2010 Validity: 30 January, 2011 Type: Steam pressure sensor (PT-05): Measuring Method : Gauge Pressure Transmitter Model No : IDP10-T22E1F-M1L1V3 Serial number: 8470110 Instrument Range: 0 ~ 60 Barg Instrument Vendor Defined Accuracy: ± 0.10 % Make : FOXBORO ,USA. Calibration frequency: monthly Date of last calibration: 31 December, 2010 Validity: 30 January, 2011 Type: Steam temperature sensor (TT-05): Measuring Method : RTD , 4-Wire PT-100 Temperature Transmitter Model No : RTT15-T1EX4TXF Serial number: 8470033 Instrument Range: 0 ~ 450 DegC Instrument Vendor Defined Accuracy: ± 0.10 % Make : FOXBORO ,USA Calibration frequency: monthly Date of last calibration: 31 December, 2010 Validity: 30 January, 2011 Type: condensate flow meter (FT-09): Measuring Method : Orifice Plate d/p cell Transmitter Model No : IDP10-T22B21F-M1 Serial number: 8470122 Instrument Range: 0 ~ 2500 mmH2O

	<u>Instrument Vendor Defined Accuracy</u>: ± 0.13 % <u>Make :</u> FOXBORO ,USA <u>Calibration frequency:</u> monthly <u>Date of last calibration:</u> 4 December, 2010 <u>Validity</u>: 3 January,2011 <u>Type:</u> condensate temperature sensor (TT-06): <u>Measuring Method</u> : RTD , 4-Wire PT-100 Temperature Transmitter <u>Model No</u> : RTT15-T1ER4TXF <u>Serial number:</u> 8470022 <u>Instrument Range</u>: 0 ~ 200 DegC <u>Instrument Vendor Defined Accuracy</u>: ± 0.10 % <u>Make :</u> FOXBORO ,USA <u>Calibration frequency:</u> monthly <u>Date of last calibration:</u> 29 December, 2010 <u>Validity</u>: 28 January,2011 <u>Type:</u> condensate pressure sensor (PT-06): <u>Measuring Method :</u> Gauge Pressure Transmitter <u>Model No</u> : IDP10-T22E1F-M1L1V3 <u>Serial number:</u> 8470111 <u>Instrument Range</u>: 0 ~ 10 Barg <u>Instrument Vendor Defined Accuracy</u>: ± 0.10 % <u>Make :</u> FOXBORO ,USA <u>Calibration frequency:</u> monthly <u>Date of last calibration:</u> 31 December, 2010 <u>Validity</u>: 30 January,2011 (For point of installation of the following see Annex 4) <u>Type:</u> Demin/make-up water flow meter (FT-05) <u>Measuring Method</u> : Orifice Plate d/p cell Transmitter <u>Model No</u> : IDP10-T22B21F-M1 <u>Serial number:</u> 8470119 <u>Instrument Range</u>: 0 ~ 2500 mmH2O <u>Instrument Vendor Defined Accuracy</u>: ± 0.13 % <u>Make :</u> FOXBORO ,USA <u>Calibration frequency:</u> monthly <u>Date of last calibration:</u> 4 December, 2010 <u>Validity</u>: 3 January,2011 <u>Type:</u> Demin/make-up water temperature sensor (TT-02) <u>Measuring Method</u> : RTD , 4-Wire PT-100 Temperature Transmitter <u>Model No</u> : RTT15-T1EP4TXF <u>Serial number:</u> 8470017 <u>Calibration Range</u>: 0 ~ 100 DegC <u>Instrument Vendor Defined Accuracy</u>: ± 0.10 % <u>Make :</u> FOXBORO ,USA <u>Calibration frequency:</u> monthly <u>Date of last calibration:</u> 30 December, 2010 <u>Validity</u>: 29 January,2011 Heat energy content will be permanently determined by Supervisory Control System Standards used: ISO-5167 (for steam flow) Responsible person: plant manager <u>Calibration procedures:</u> Metering devices are flow calibrated as part of the manufacturing process. The purpose of this calibration is to determine a calibration factor which is applied to the flow calculations as an adjustment to correct for bias error from the ISO-5167 discharge coefficient equations. Accuracy of measurement: +/- 2.5%
Measuring/Reading/ Recording frequency:	Measurement interval: continuously, Values are recorded every two hours

Calculation method	Formula: **Heat content of steam:** Produced steam (at T_1, P_1) in t/day × Enthalpy (at T_1, P_1) in MJ/t /1000 = heat content of delivered steam (at T_1, P_1) in GJ/day **Heat content of feed water (condensate + make up water):** Condensate returned from Plants in t/day / Produced steam in t/day = condensate return rate in % Condensate return rate in % x Condensate Enthalpy (at T2) in MJ/ton + (1-condensate re-turn rate in %) x Make up Water Enthalpy (at T3) in MJ/t = Average Enthalpy of feed water in MJ/t Mass balance: Feed water in t/day = Delivered steam in t/day Average Enthalpy of feed water in MJ/t x Feed water in t/day / 1000 = Heat content of feed water in GJ/day **cogeneration system heat output (CAHO):** content of delivered steam (at T_1, P_1) in GJ/day - Heat content of feed water in GJ/day = cogeneration system heat output (CAHO) in GJ/day The cogeneration system heat output CAHO is calculated for each day. These daily results are aggregated for each month. Please refer also to log sheets. Calculation of Enthalpy: The calculation of the enthalpy which is necessary to determine the CAHO is based on WADA. WADA is a program for the exact calculation of thermic and calorific data on chemical media of water and steam in excel or as an independent application, which also allows graphical evaluations. Thereby resulting on the inputs following data are calculated: • Compression, temperature, steam mass fraction • Enthalpy, entropy, specific volume • Dynamic and kinematic viscosity • Specific heat capacity and heat conductivity For calculating in a high temperature region, pressures up to 50 MPa are covering a temperature range from 1073.15 K to 2273.15 K. Therefore this program is calculating with following data for water and steam: • h-s Diagram for Water and Steam, Kretzschmar, H.-J. and Stöcker, I., 2nd ed., 2008, Springer-Verlag, Berling (ISBN: 978-3-540-7487-8) • T-s Diagramm for Water and Steam, Kretzschmar, H.-J. and Stöcker, I., Springer-Verlag, Berlin (ISBN: 3-540-29484-9) WADA was developed in 1989 at the University of Applied Sciences Zittau/Görlitz under the direction of H.-J. Kretzschmar, whose area of expertise is technical thermodynamics. The licence of this program was sold to FICHTNER Consulting AG, who is the distribution partner of the University of Applied Siences Zittau/Görlitz. The Software is with costs and purchasable at the software operator FICHTNER Consulting AG at a price of 1,025,86 €. The precondition for operating this system software is the operating system of Win 7, Win Vista, Win XP, Win 2000, Win NT or Win ME.
QA/QC procedures applied:	Regular monthly sensor and meter checks and signed off records by plant manager; monthly data will be collected and stored both electronically and on paper; before compiling the annual monitoring reports, data will be cross-checked on consistency.

Data / Parameter:	Cogeneration system electricity output (CEO)
Data unit:	MWh
Description:	The cogen plant produces electricity for the supply of the fertilizer complex by the electric generators driven by the gas turbines. This cogeneration system electricity output (CEO) is needed to calculate *ex-post* the baseline fuel consumption for electricity supply $ABEC_{BF, elec}$, and the Baseline CO_2 emissions from combustion of baseline fuel for electricity supply, BE_{elec}.
Measured /Calcuated / Default:	Measured
Source of data:	The net electric energy supplied to the fertilizer complex excluding own electricity consumption of the cogen power plant will be metered and recorded. Formula: (Daily average power output of all GTs in MW - Daily average own consuption in MW)*24hours = Cogeneration system electricity output (CEO) in MWh/day The CEO is calculated for each day. These daily results are aggregated for each month. Please refer also to log sheets excel file
Value(s) of monitored parameter:	77,861 MWh
Indicate what the data are used for (Baseline/Project/Leakage emission calcualtion)	Baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(For point of installation of the following see Annex 5) Type: electricity meters (C4-Gas Turbine Generator-1) Model No :Simeas P50 Serial number: BF080895705 Calibration frequency: 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008 (factory calibrated) Validity: 22-01-2011 Type: electricity meters (C10- Gas Turbine Generator -2) Model No :Simeas P50 Serial number: BF0808095712 Calibration frequency: : 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008 (factory calibrated) Validity: 22-01-2011 Type: electricity meters (C16- Gas Turbine Generator -3) Model No :Simeas P50 Serial number: BF0808095707 Calibration frequency: : 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008(factory calibrated) Validity: 22-01-2011 Type: electricity meters (C11-Emergency diesel Generator) Model No :Simeas P50 Serial number: BF0808095702 Calibration frequency: : 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008 (factory calibrated) Validity: 22-01-2011 Type: electricity meters (C6-Station transformer- 1) Model No :Simeas P50 Serial number: BF0808095710

	Calibration frequency: : 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008(factory calibrated) Validity: 22-01-2011 Type: electricity meters (C14- Station transformer -2) Model No :Simeas P50 Serial number: BF0808095706 Calibration frequency: : 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008(factory calibrated) Validity: 22-01-2011 Standards used: according to NEPRA (National Electric Power Regulatory Authority) Grid Code and relevant IECs (note that the plant is not grid connected, and therefore Grid Code otherwise not applicable but used for CDM monitoring) Responsible person: plant manager Calibration procedures: according to meter supplier information with calibration package Accuracy of measurement: +/- 0.2%
Measuring/Reading/ Recording frequency:	Measurement interval: continuously, Values are recorded every two hours
Calculation method (if applicable):	--
QA/QC procedures to be applied:	Regular monthly sensor and meter checks and signed off records by plant manager; monthly data will be collected and stored both electronically and on paper; before compiling the annual monitoring reports, data will be cross-checked on consistency.

Data / Parameter:	**Natural gas consumption of cogen plant (V_{NG}):**
Data unit:	Nm³ (based on 15.55°C and 1.010 bar)
Description:	The cogen plant will use natural gas to be fired in the gas turbines and the supplementary firing of the HRSGs. This natural gas consumption (AEC_{NG}) is needed to calculate *ex-post* the project CO_2 emissions from combustion of fuel by the cogen system, PE_{CS}.
Measured /Calcuated / Default:	Measured
Source of data:	The natural gas consumption of both the gas turbines and the supplementary firing of the HRSGs of the cogen power plant is metered and recorded.
Value (s) of monitored parameter	Natural gas volume: 60,689,991 Nm³ (based on 15.55°C and 1.010 bar)
Indicate what the data are used for (Baseline/Project/Leakage emission calcualtion)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(For point of installation of the following see Annex 2) Type: Gas Flowmeter to GTGs (FT-01) Measuring Method : Orifice Plate d/p cell Transmitter Model No : IDP10-T22B21F-M1 Serial number: 8470118 Instrument Range: 0 ~ 5000 mmH2O Instrument Vendor Defined Accuracy: ± 0.13 % Make : FOXBORO ,USA Calibration frequency: monthly Date of last calibration: 31 December, 2010 Validity: 30 January,2011 Type : Natural gas to GTGs pressure Sensor (PT-01) Measuring Method : Gauge Pressure Transmitter Model No : IGP10-T22E1F-M1L1V3 Serial No : 08470107 Instrument Range: 0 ~ 60 Barg Instrument Vendor Defined Accuracy: ± 0.10 % Make : FOXBORO ,USA Calibration Frequency : Monthly. Date of Last Calibration: 31 December, 2010 Validity: 30 January,2011 Type : Natural gas to GTGs Temperature Sensor (TT-01) Measuring Method : RTD , 4-Wire PT-100 Temperature Transmitter Model No : RTT15-T1EM4TXF Serial No : 08470015 Instrument Range: 0 ~ 55 DegC Instrument Vendor Defined Accuracy: ± 0.10 % Make : FOXBORO ,USA Calibration Frequency : Monthly. Date of Last Calibration: 31 December, 2010 Validity: 30 January,2011 (For point of installation of the following see Annex 3) Type: Gas Flowmeter to HRSGs (FT-12) Measuring Method :Orifice Plate d/p cell Transmitter Model No : IDP10-T22B21F-M1 Serial number: 8470125 Instrument Range: 0 ~ 2500 mmH2O Instrument Vendor Defined Accuracy: ± 0.13 % Make :FOXBORO ,USA Calibration frequency: monthly Date of last calibration: 29 December, 2010

	Validity: 28 January ,2011 Type : Natural gas to HRSGs pressure Sensor (PT-10) Measuring Method : Gauge Pressure Transmitter Model No : IGP10-T22D1F-M1L1V3 Serial No : 08470117 Instrument Range: 0 ~ 20 Barg Instrument Vendor Defined Accuracy: ± 0.10 % Make : FOXBORO ,USA Calibration Frequency : Monthly. Date of Last Calibration: 29 December, 2010 Validity: 28 January ,2011 Type : Natural gas to HRSGs Temperature Sensor (TT-10) Measuring Method : RTD , 4-Wire PT-100 Temperature Transmitter Model No : RTT15-T1ER4TXF Serial No : 08470023 Instrument Range: 0 ~ 55 DegC Instrument Vendor Defined Accuracy: ± 0.10 % Make : FOXBORO ,USA Calibration Frequency : Monthly. Date of Last Calibration: 29 December, 2010 Validity: 28 January ,2011 Type : Gas Flowmeter (Old Power House) FT-1501 Measuring Method :Orifice Plate d/p cell Transmitter Model No : NDP22-2222 Serial No : 114.9166.0450.4 Instrument Range: 0 ~ 6400 mmH2O Instrument Vendor Defined Accuracy: ± 0.5 % Make :YAMATAKE-HONEYWELL, JAPAN Calibration Frequency : 5 Months Date of Last Calibration: 1 December, 2010 Validity: 30 April, 2011 Standards used: ISO-5167 Responsible person: plant manager **Calibration procedures:** Metering devices are flow calibrated as part of the manufacturing process. The purpose of this calibration is to determine a calibration factor which is applied to the flow calculations as an adjustment to correct for bias error from the ISO-5167 discharge coefficient equations. Accuracy of measurement: +/- 2.5%
Measuring/Reading/ Recording frequency:	Measurement interval: gas volume will be recorded continuously; conversion to energy on monthly basis via official calorific value of gas supplier Values are recorded every two hours
Calculation method (if applicable):	Formula: (Daily average gas consumption of all GTs in Nm^3/h + Daily average gas consumption of all HRSGs in Nm^3/h)*24h = Natural gas consumption of cogen plant (V_{NG}) in Nm^3/day The CEO is calculated for each day. These daily results are aggregated for each month. Please refer to log sheets excel file For method of temperature and pressure compensation see Annex 9.
QA/QC procedures applied:	Regular monthly meter checks and signed off records by plant manager; monthly data will be collected and stored both electronically and on paper; before compiling the annual monitoring reports, data will be cross-checked on consistency.

Data / Parameter:	**Natural gas Calorific values (NCV_{NG} ; GCV_{NG})**
Data unit:	kJ/Nm³ (Nm³ based on 15.55°C 1.010 bar)
Description:	The cogen plant will use natural gas to be fired in the gas turbines and the supplementary firing of the HRSGs. The Net Calorific Value NCV_{NG} will be used to calculate the annual natural gas consumption AEC_{NG} in TJ/yr
Measured /Calcuated / Default:	GCV: invoice of gas supplier, NCV: Calculated
Source of data:	Monthly invoices by gas supplier for GCV – NCV. Please refer to Annex 6, 7 and 8 Calorific Values mentioned in the log sheets are not used for the calculation.
Value(s) of monitored parameter:	GCV in BTU/Sft³: **June** 920, **July** 922, **Aug** 921, **Sep** 922, **Oct** 920, **Nov** 924, **Dec** 918 NCV in kJ/Nm³ based on based on 15.55°C and 1.010 bar: **June** 30,881.5, **July** 30,918.75, **Aug** 30,915.03, **Sep** 30,944.83, **Oct** 30,877.77, **Nov** 31,015.62, **Dec** 30810.71
Indicate what the data are used for (Baseline/Project/Leakage emission calcualtion)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**Method and equipment:** - Standards used: ISO 6976: Natural gas -- Calculation of calorific values, density, relative density and Wobbe index from composition Responsible person: plant manager The calculation procedure according to ISO6976 is described in Annex 6. **Calibration procedures:** -
Measuring/Reading/ Recording frequency:	Measurement interval: official calorific value of gas supplier provided on monthly basis by invoice for natural gas
Calculation method (if applicable):	--
QA/QC procedures to be applied:	Regular monthly records and cross checks by plant manager; monthly data will be collected and stored both electronically and on paper.

Data / Parameter:	**Fate of electricity generated by baseline dedicated power plant**
Data unit:	MWh
Description:	Represents the level of utilization of the baseline dedicated power plant
Measured /Calcuated / Default:	Measured
Source of data:	On-site check as long as old power plant is not scrapped
Value(s) of monitored parameter:	As absolute value and percentage compared to electricity generated by the project activity cogeneration plant
Indicate what the data are used for (Baseline/Project/Leakage emission calcualtion)	The project proponent is aware of the special note included in the monitoring methodology. It is planned to put the existing power plant out of regular operation, and to use it only as back-up plant when the new cogeneration plant as planned or unplanned outages. The project proponent will show in each Verification report the electricity produced by the baseline dedicated power plant, and indicate that during their operation the new co-generation plant has not been available. It will be also shown that the baseline dedicated power plant generation has been reduced by at least the same amount as the electricity generated by the project activity cogeneration plant (which has to be corrected for the increased capacity and demand). If for some reasons, this should not be the case, the credits for the electricity generation will be reduced to the equivalent of excess electricity produced by the baseline dedicated power plant, but takeing the demand increase into consideration. The project proponent will provide such reports as long as the old power plant will not be scrapped. In case the old plant will be scrapped, sufficient evidence will be provided to the Verifying DOE.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity	(For point of installation of the following see Annex 5) Type: electricity meters (Steam Turbo Generator-1) Model No :Simeas P50 Serial number: BF0808095703 Calibration frequency: 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008(factory calibrated) Validity: 22-01-2011 Type: electricity meters (Steam Turbo Generator -2) Model No :Simeas P50 Serial number: BF0808095704 Calibration frequency: 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008(factory calibrated) Validity: 22-01-2011 Type: electricity meters (Steam Turbo Generator -3) Model No :Simeas P50 Serial number: BF0808095709 Calibration frequency: 2 Yearly Commissioning Date: 22-01-2009 Date of last calibration: 26-08-2008(factory calibrated) Validity: 22-01-2011
Measuring/Reading/ Recording frequency:	Every second year
Calculation method (if applicable):	--
QA/QC procedures to be applied:	Regular monthly meter checks and signed off records by plant manager

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

The formulae, calculation and calculation procedure can be found in section D2, log sheets (excel file) and Monitoring protocol (excel file).

The baseline emissions are determined by *ex-post* monitoring of electricity and heat generation, and *ex-ante* calculation of the efficiencies for separate generation of electricty and heat in the baseline situation. The consumption of the fuel avoided in the baseline for the supply of heat is determined as follows:

Baseline emissions of CO_2 from combustion of baseline fuel for heat supply:

The energy consumption for heat supply at baseline plant $ABEC_{BF}$ (TJ) for the monitoring period is calculated accroding to following formula:

$$ABEC_{BF,th} = CAHO \times FR_{th} \qquad \textbf{(3.1)}$$

Where:

CAHO *(TJ)* = cogeneration system heat output in monitoring period

FR_{th} *(GJ_{NCV}/GJ_{th})* = fuel rate for heat of the existing power station

The CAHO is determined based on daily log sheets (2h resolution).

On a daily basis the difference ot the heat content of the steam minus the heat content of the returned condensate and minus the heat content of the make up water to balance the condensate losses is calcualted. In a second step the delivered daily heat content is summarized to a monthly value.

The energy consumption for heat supply at baseline plant ($ABEC_{BF,\ th}$) is determined *ex-post* by monitoring of cogeneration heat output (CAHO) and multiplication with the fuel rate for heat (FR_{tH}) of the existing power station. The following table shows the calculation and results of the $ABEC_{BF\ th}$:

Baseline energy consumption for heat supply ($ABEC_{BF,\ th}$)

Year	Month	CAHO (TJ)	FR_{th} (GJ_{NCV}/GJ_{th})	$ABEC_{BF,\ th}$ (TJ)
2010	June-10	178	1.10	195
	July-10	170	1.10	187
	August-10	169	1.10	186
	September-10	153	1.10	168
	October-10	180	1.10	198
	November-10	176	1.10	194
	December-10	147	1.10	162
Total in Monitoring Period		1,172		1,289

Source: calculated from daily log sheets, Pakarab

FR_{th}: standard value as per section D.1 Monitoring Report / B.6.2 PDD

The formula and calculation of CAHO can be found in section D2 and in the log sheets (excel file)

The Baseline CO_2 emissions from combustion of baseline fuel for heat supply, BE_{th} (t CO_2) are calculated according to following formula:

$$BE_{th} = ABEC_{BF,\ th}\ x\ EF_{BF} \qquad \textbf{(3.3)}$$

Where:

$ABEC_{FH}$ *(TJ)* = energy consumption for heat supply at baseline plant in monitoring period

EF_{BF} *(t CO_2/TJ)* = CO_2 emission factor of the fuel used to generate heat = EF_{NG}

According to the hierarchy for EF_{BF} as set by the applied AM0014, EF_{BF} will be determined according to the IPCC 2006 guidelines because no specific value from the National GHG inventory is available. Baseline CO_2 emissions from combustion of baseline fuel for heat supply (BE_{th}) is determined by multiplication of actual baseline fuel consumption for heat supply ($ABEC_{BF,\ th}$) with the CO_2 emission factor of the fuel used to generate heat (EF_{BF}) which is also known as EF_{NG}.

Baseline CO_2 emissons from combustion for heat supply (BE_{th})

Year	Month	$ABEC_{BF,\ th}$ (TJ)	$EF_{BF} = EF_{NG}$ (tCO_2/TJ)	BE_{th} (tCO_2)
2010	June-10	195	56.1	10,960
	July-10	187	56.1	10,492
	August-10	186	56.1	10,417
	September-10	168	56.1	9,425
	October-10	198	56.1	11,090
	November-10	194	56.1	10,863
	December-10	162	56.1	9,079
Total in Monitoring Period		1,289		72,326

EF_{NG}: standard value as per section D.1 Monitoring Report / B.6 PDD

According to the PDD Section B 3. CH4 and N2O emissions are, for conservative reasons, not considered to calcualte the project emissions as well as the baseline emissions (please refer also to section D.3.).

Baseline emissions of CO_2 from electricity supply to industrial plant, that are offset by electricity supplied from cogeneration system:

Because PFL is not connected to the power grid, the baseline is the dedicated fossil fuel power plant. The consumption of the fuel avoided in the baseline for the supply of electricity is determined in accordance with the following formula:

Electricity displaced, that would have to be generated through dedicated fossil fuel power plant
Baseline carbon dioxide emissions for electricity supplied, $BE_{elec\ fossil\ fuel}$ (t CO_2):

$$BE_{elec\ fossil\ fuel} = CEO \times BEF_{elec\ fossil\ fuel} \qquad \textbf{(3.11)}$$

Where:

CEO (*MWh*)	=	cogeneration electricity output in monitoring period
$BEF_{elec\ fossil\ fuel}$ ($t\ CO_2/MWh$)	=	baseline CO_2 emission factor for electricity from the dedicated fossil fuel power plant

The actual cogeneration electricity output (CEO) is determined *ex-post* by monitoring based on daily log sheets and monthly aggregated as follows:

Cogeneration system electricity output (CEO)

Year	Month	CEO (MWh)
2010	June-10	12,289
	July-10	11,710
	August-10	11,993
	September-10	10,380
	October-10	11,679
	November-10	10,567
	December-10	9,245
Total in Monitoring Period		77,861

Source: calculated from daily log sheets, Pakarab

Because there is only one dedicated power plant, which is fired by natural gas the formula 3.11 or 3.12 of PDD or 3.12 of AM0014 ist not applicable and formula 3.11 b and 3.11 c can be simplified as follows in order to calculate the baseline CO_2 emission factor for electricity from the dedicated fossil fuel power plant BEF $_{elec\ fossil\ fuel}$ (t CO_2/MWh):

$$BEF_{elec\ fossil\ fuel} = SEF_i = FR_{elec} \times EF_{BF}$$ **(3.11b and3.11c of PDD)**

Where:
FR_{elec} *(GJ/MWh)* = fuel rate for electricty of the existing steam turbine power station
EF_{BF} = EF_{NG} *(t CO_2/TJ)* = CO_2 emission factor of the fuel used to generate heat (natural gas)
SEF_i =*(t CO_2/MWh)* = specific CO_2 emission factor of the fossil fuel power generation sources

Baseline CO_2 emisson factor for electricity from fossil fuel power plant ($BEF_{elec\ fossil\ fuel}$ / SEF_i)

Year	Month	FR_{el} (GJ_{NCV}/MWh)	EF_{BF} = EF_{NG} (tCO_2/TJ)	$BEF_{elec\ fossil\ fuel}$ SEF_i (tCO_2/MWh)
2010	June-10	15.38	56.1	0.86
	July-10	15.38	56.1	0.86
	August-10	15.38	56.1	0.86
	September-10	15.38	56.1	0.86
	October-10	15.38	56.1	0.86
	November-10	15.38	56.1	0.86
	December-10	15.38	56.1	0.86

EF_{NG}/ FR_{el}: standard value as per section D.1 Monitoring Report / B.6 PDD

Baseline CO_2 emissions from combustion of baseline fuel for electricity supply (BE_{elec})

Year	Month	CEO (MWh)	$BEF_{elec\ fossil\ fuel}$ SEF_i (t CO_2/MWh)	BE_{elec} (t CO_2)
2010	June-10	12,289	0.86	10,603
	July-10	11,710	0.86	10,103
	August-10	11,993	0.86	10,348
	September-10	10,380	0.86	8,956
	October-10	11,679	0.86	10,077
	November-10	10,567	0.86	9,117
	December-10	9,245	0.86	7,976
Total in Monitoring Period		77,861		67,180

The ex-post calculated baseline CO_2 emissions (BE_{total}) are given by the following formula:

$$BE_{total} = BE_{th} + BE_{elec}$$

Where:
BEt_h *(t CO_2)* = baseline CO_2 emissions from combustion of baseline fuel for heat supply in monitoring period
BE_{elec} *(t CO_2)* = baseline CO_2 emissions from combustion of baseline fuel for electricity supply in monitoring period

Ex-post calculated baseline CO_2 emissions (BE_{total})

Year	Month	BE_{th} (t CO_2)	BE_{elec} (t CO_2)	BE_{total} (t CO_2)
2010	June-10	10,960	10,603	21,563
	July-10	10,492	10,103	20,596
	August-10	10,417	10,348	20,764
	September-10	9,425	8,956	18,381
	October-10	11,090	10,077	21,167
	November-10	10,863	9,117	19,980
	December-10	9,079	7,976	17,055
Total in Monitoring Period		72,326		139,506

Fate of electricity:

According to section D of this monitoring report and the PDD section B.7.1. and the AM0014 the fate of electricity . Electricity was produced by baseline plant from 6 February 2010 to 9 February 2010.

Fate of electricity generated by baseline dedicated power plant

Year	Month	Power generated by cogen plant (MWh)	Electricity generated by back up plant (MWh)	Fate of back up plant
2010	June-10	12,886	-	0.0%
	July-10	12,354	-	0.0%
	August-10	12,503	-	0.0%
	September-10	10,869	-	0.0%
	October-10	12,178	-	0.0%
	November-10	11,043	-	0.0%
	December-10	9,661	-	0.0%
Total in Monitoring Period		81,495	-	0.0%

Source: calculated from daily log sheets, Pakarab

The fate of electricity produced by the baseline dedicated power plant (back up plant) was monitored at about 0.4% of the production compared to the project activity. Therefore the main power source is the project activity and the baseline dedicated power plant was only running as a backup plant.

E.2. Project emissions calculation

The formulae, calculation and calculation procedure can be found in section D2, log sheets (excel file) and monitoring protocol (excel file).

The project emissions are calculated *ex-post* based on the gas consumption as measured and monitored by daily logsheets. Project emissions correspond to the consumption of natural gas by the cogeneration system. CO_2 emissions from combustion in the gas turbines and in the supplementary firing of the heat recovery steam generator are relevant. Carbon dioxide emissions from natural gas combustion in the cogeneration system, PE_{CS} (t CO_2) are calculated according to the following formula:

$$PE_{CS}* = AEC_{NG} \times EF_{NG} \quad \textbf{(4.1)}$$

Where:

AEC_{NG} *(TJ)* = natural gas consumption in monitoring period

EF_{NG} *(t CO_2/TJ)* = CO_2 emission factor of natural gas

*: PE is used instead of E as acronym for Project Emissions as indicated in the methodology.

The natural gas consumption AEC_{NG} of the new cogeneration plant is calculated as follows:

$$AEC_{NG} = V_{NG} \times NCV_{NG} \times 10^{-9} \quad \textbf{(4.1a)}$$

Where:

V_{NG} *(Nm³)* = annual natural gas consumption in monitoring period

NCV_{NG} *(kJ/Nm³)* = net calorific value of natural gas

From the daily log sheets (2h resolution) the daily average gas consumption is taken to calculate V_{NG} on a monthly basis. The natural gas consumtion during the monitoring period is stated in the figure below. The formulaand calculation of the natural gas consumption can be found in section D2 and log sheets (excel file).

Natural gas consumption (V_{NG})

Year	Month	V_{NG} Total (Nm³)
2010	June-10	9,759,680
	July-10	9,121,054
	August-10	8,688,342
	September-10	8,053,924
	October-10	8,928,292
	November-10	8,736,834
	December-10	7,401,865
Total Monitoring Period		60,689,991

Source: aggregated from daily log sheets, Pakarab

The gross calorific value (GCV_{NG}– BTU/SCF) is taken from the monthly invoices of the gas supplier. From this value the GCV and NCV of natural gas is converted and calcualted (in kJ/Nm³) – table below. The formula and caluclation procedure can be found in section D2 and Annex 6.

Natural gas calorific values (NCV, GCV)

Year	Month	GCV Invoice by SNGPL (BTU/Sft³)	GCV PFL Lab ISO-6976 (BTU/Sft³)	NCV PFL Lab ISO-6976 (BTU/Sft³)	NCV $(GCV_{SNGPL}*NCV_{PFL})/GCV_{PLF}$ (BTU/Sft³)	NCV (to be used) (kJ/Nm³)
2010	June-10	920.0	919.0	828.0	828.9	30,881.50
	July-10	922.0	921.0	829.0	829.9	30,918.75
	August-10	921.0	919.0	828.0	829.8	30,915.03
	September-10	922.0	918.0	827.0	830.6	30,944.83
	October-10	920.0	918.0	827.0	828.8	30,877.77
	November-10	924.0	919.0	828.0	832.5	31,015.62
	December-10	918.0	918.0	827.0	827.0	30,810.71

Source: taken from monthly invoices from gas supplier and GCV and NCV calculation procedure of PFL

Conversion factors: 1ft³ = 0.02832 m³ 1BTU = 1.0551 kJ

Energy consumption of natural gas in co-generation system (AEC_{NG})

Year	Month	V_{NG} (Nm^3)	NCV (kJ/Nm^3)	AEC_{NG} (TJ)
2010	June-10	9,759,680	30,881.50	301
	July-10	9,121,054	30,918.75	282
	August-10	8,688,342	30,915.03	269
	September-10	8,053,924	30,944.83	249
	October-10	8,928,292	30,877.77	276
	November-10	8,736,834	31,015.62	271
	December-10	7,401,865	30,810.71	228
Total in Monitoring Period		60,689,991		1,876

Total project emissions PE_{total} (t CO_2) are given by the sum of the components analyzed above:

$$PE_{total} = PE_{CS} + PE_{equiv\ met\ comb} + PE_{equiv\ N2Ocomb} + PE_{equiv\ fug} \quad \textbf{(4.8)}$$

According to the PDD Section B 3., CH_4 and N_2O emissions are, for conservative reasons, not considered to calculate the project emissions as well as the baseline emissions (please refer also to section D.3.). Therefore,

PE_{total}	=	PE_{CS}
PE_{total} *(t CO_2)*	=	total project emissions in monitoring period
PE_{CS} *(t CO_2)*	=	CO_2 emissions from natural gas combustion in the cogeneration system in monitoring period

Project emissions from natural gas combustion in the cogeneration system (PE_{total})

Year	Month	AEC_{NG} (TJ)	EFng (tCO_2/TJ)	PEcs = PEtotal (tCO_2)
2010	June-10	301.39	56.1	16,908
	July-10	282.01	56.1	15,821
	August-10	268.60	56.1	15,068
	September-10	249.23	56.1	13,982
	October-10	275.69	56.1	15,466
	November-10	270.98	56.1	15,202
	December-10	228.06	56.1	12,794
Total in Monitoring Period		1,875.95		105,241

EF_{NG}: standard value as per section D.1 Monitoring Report / B.6.2 PDD

E.3. Leakage calculation / Fate of electricity

According to the PDD Section B 3. CH_4 and N_2O emissions are, for conservative reasons, not considered to calculate the project emissions as well as the baseline emissions:
b) Methane emissions from natural gas combustion in cogeneration system are neglected.
c) Nitrous oxide emissions from natural gas combustion in cogeneration system are neglected.
d) Methane emissions from natural gas production and pipeline leaks in the transport and distribution of natural gas, including leakage within the industrial plant are neglected.

All these emissions will be smaller in the case of the project activity rather than the baseline situation, because the national gas consumption will be reduced.

Project emissions of CH_4 and N_2O as well as emissions from leaks by the production and distribution of the natural gas are lower than those of the baseline scenario due to the reduction in fuel consumption. Their consideration would result in a slightly higher reduction of emissions. As conservative approach they are not considered for the calculation of emissions reductions.

E.4. Emission reductions calculation / table

The emission reductions are calculated as the difference between the baseline and the project emissions on annual basis. Fuel consumption, electricity and heat production of the cogeneration system are metered and monitored (see also Section B7.2).

$$ER = BE_{total} - PE_{total}$$

Total emission reductions (ER)

Year	Month	BE_{total} (t CO_2)	PE_{total} (t CO_2)	ER_{total} (t CO_2)
2010	June-10	21,563	16,908	4,655
	July-10	20,596	15,821	4,775
	August-10	20,764	15,068	5,696
	September-10	18,381	13,982	4,399
	October-10	21,167	15,466	5,701
	November-10	19,980	15,202	4,778
	December-10	17,055	12,794	4,261
Total in Monitoring Period		139,506	105,241	34,265

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

According to the PDD the estimation of annual emission reductions is 119,481 tCO_2. Based on these annual emission reductions the expected emission reductions of the monitoring period (214 days) are 70,052 tCO_2.

Comparison expected emission reduction to real emisson reduction

Item	Ex-ante as per PDD	Ex-post as monitored	Difference
Total in Monitoring Period	70,052	34,265	35,787

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

The actual production of the cogeneration plant (project activity) during the monitoring period was lower as compared to the forecasted values in the PDD since plant never operated on forecasted peak load of 22.5 MW and three major shut downs were also faced during the monitoring period due to Gas curtailment from the supplier (SNGPL).

History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Guideline, Form **Business Function**: Issuance		

Annex 1: Calibration Report and Instrumentation List:

01/ 06/ 2010 TO 31/ 12/ 2010							
S.NO	INSTRUMENT TAG NO	CALIBRATION DATE	% Minimum Error Found	% Maximum Error Found	CALIBRATION FREQUENCY	NEXT CALIBRATION DUE DATE	% ACCEPTABLE ERROR (Acc. To PDD)
1	*FT-08*	4-Jun-2010	0	0.06	*Monthly*	4-Jul-2010	± 2.5
		4-Jul-2010	0	0.06	*Monthly*	3-Aug-2010	± 2.5
		3-Aug-2010	0	0.06	*Monthly*	2-Sep-2010	± 2.5
		2-Sep-2010	-0.06	0.06	*Monthly*	2-Oct-2010	± 2.5
		2-Oct-2010	0	0.06	*Monthly*	1-Nov-2010	± 2.5
		1-Nov-2010	0	0.06	*Monthly*	1-Dec-2010	± 2.5
		1-Dec-2010	-0.06	0.06	*Monthly*	31-Dec-2010	± 2.5
		31-Dec-2010	0	0.06	*Monthly*	30-Jan-2011	± 2.5
2	*PT-05*	4-Jun-2010	0	0.06	*Monthly*	4-Jul-2010	± 2.5
		4-Jul-2010	0	0	*Monthly*	3-Aug-2010	± 2.5
		3-Aug-2010	0	0	*Monthly*	2-Sep-2010	± 2.5
		2-Sep-2010	0	0	*Monthly*	2-Oct-2010	± 2.5
		2-Oct-2010	0	0	*Monthly*	1-Nov-2010	± 2.5
		1-Nov-2010	-0.06	0	*Monthly*	1-Dec-2010	± 2.5
		1-Dec-2010	0	0	*Monthly*	31-Dec-2010	± 2.5
		31-Dec-2010	0	0	*Monthly*	30-Jan-2011	± 2.5
3	*TT-05*	4-Jun-2010	-0.06	0	*Monthly*	4-Jul-2010	± 2.5
		4-Jul-2010	-0.06	0	*Monthly*	3-Aug-2010	± 2.5
		3-Aug-2010	0	0	*Monthly*	2-Sep-2010	± 2.5
		2-Sep-2010	-0.06	0	*Monthly*	2-Oct-2010	± 2.5
		2-Oct-2010	0	0.12	*Monthly*	1-Nov-2010	± 2.5
		1-Nov-2010	0	0	*Monthly*	1-Dec-2010	± 2.5
		1-Dec-2010	0	0	*Monthly*	31-Dec-2010	± 2.5
		31-Dec-2010	0	0	*Monthly*	30-Jan-2011	± 2.5
4	*FT-09*	7-Jun-2010	0	0.12	*Monthly*	7-Jul-2010	± 2.5
		7-Jul-2010	0	0.06	*Monthly*	6-Aug-2010	± 2.5
		6-Aug-2010	0	0.06	*Monthly*	5-Sep-2010	± 2.5
		5-Sep-2010	0.06	0.63	*Monthly*	5-Oct-2010	± 2.5
		5-Oct-2010	0	0.06	*Monthly*	4-Nov-2010	± 2.5
		4-Nov-2010	-0.06	0.06	*Monthly*	4-Dec-2010	± 2.5
		4-Dec-2010	0	0.06	*Monthly*	3-Jan-2011	± 2.5
5	*TT-06*	2-Jun-2010	-0.06	0	*Monthly*	2-Jul-2010	± 2.5
		2-Jul-2010	0	0	*Monthly*	1-Aug-2010	± 2.5
		1-Aug-2010	0	0.06	*Monthly*	31-Aug-2010	± 2.5
		31-Aug-2010	0	0.06	*Monthly*	30-Sep-2010	± 2.5
		30-Sep-2010	-0.13	0.06	*Monthly*	30-Oct-2010	± 2.5
		30-Oct-2010	0	0.06	*Monthly*	29-Nov-2010	± 2.5
		29-Nov-2010	0	0.62	*Monthly*	29-Dec-2010	± 2.5
		29-Dec-2010	0	0.06	*Monthly*	28-Jan-2011	± 2.5

01/ 06/ 2010 TO 31/ 12/ 2010

S.NO	INSTRUMENT TAG NO	CALIBRATION DATE	% Minimum Error Found	% Maximum Error Found	CALIBRATION FREQUENCY	NEXT CALIBRATION DUE DATE	% ACCEPTABLE ERROR (Acc. To PDD)
6	*PT-06*	4-Jun-2010	0	0	*Monthly*	4-Jul-2010	± 2.5
		4-Jul-2010	0	0	*Monthly*	3-Aug-2010	± 2.5
		3-Aug-2010	0	0	*Monthly*	2-Sep-2010	± 2.5
		2-Sep-2010	0	0	*Monthly*	2-Oct-2010	± 2.5
		2-Oct-2010	0	0	*Monthly*	1-Nov-2010	± 2.5
		1-Nov-2010	0	0	*Monthly*	1-Dec-2010	± 2.5
		1-Dec-2010	0	0	*Monthly*	31-Dec-2010	± 2.5
		31-Dec-2010	0	0	*Monthly*	30-Jan-2011	± 2.5
7	*FT-05*	7-Jun-2010	0	0.06	*Monthly*	7-Jul-2010	± 2.5
		7-Jul-2010	0	0.06	*Monthly*	6-Aug-2010	± 2.5
		6-Aug-2010	0	0.06	*Monthly*	5-Sep-2010	± 2.5
		5-Sep-2010	-0.06	0.06	*Monthly*	5-Oct-2010	± 2.5
		5-Oct-2010	-0.13	0	*Monthly*	4-Nov-2010	± 2.5
		4-Nov-2010	0	0.06	*Monthly*	4-Dec-2010	± 2.5
		4-Dec-2010	0	0.06	*Monthly*	3-Jan-2011	± 2.5
8	*TT-02*	3-Jun-2010	-0.06	0	*Monthly*	3-Jul-2010	± 2.5
		3-Jul-2010	0	0	*Monthly*	2-Aug-2010	± 2.5
		2-Aug-2010	0	0.06	*Monthly*	1-Sep-2010	± 2.5
		1-Sep-2010	0	0.06	*Monthly*	1-Oct-2010	± 2.5
		1-Oct-2010	-0.06	0.12	*Monthly*	31-Oct-2010	± 2.5
		31-Oct-2010	0	0.19	*Monthly*	30-Nov-2010	± 2.5
		30-Nov-2010	0.06	0.63	*Monthly*	30-Dec-2010	± 2.5
		30-Dec-2010	-0.06	0.06	*Monthly*	29-Jan-2011	± 2.5
9	*FT-01*	4-Jun-2010	0	0.06	*Monthly*	4-Jul-2010	± 2.5
		4-Jul-2010	0	0.06	*Monthly*	3-Aug-2010	± 2.5
		3-Aug-2010	0	0.12	*Monthly*	2-Sep-2010	± 2.5
		2-Sep-2010	0.06	0.12	*Monthly*	2-Oct-2010	± 2.5
		2-Oct-2010	0	0.06	*Monthly*	1-Nov-2010	± 2.5
		1-Nov-2010	0	0.06	*Monthly*	1-Dec-2010	± 2.5
		1-Dec-2010	-0.13	0.19	*Monthly*	31-Dec-2010	± 2.5
		31-Dec-2010	0	0.06	*Monthly*	30-Jan-2011	± 2.5
10	*FT-12*	2-Jun-2010	0	0.06	*Monthly*	2-Jul-2010	± 2.5
		2-Jul-2010	-0.06	0.06	*Monthly*	1-Aug-2010	± 2.5
		1-Aug-2010	-0.06	0.06	*Monthly*	31-Aug-2010	± 2.5
		31-Aug-2010	-0.06	0	*Monthly*	30-Sep-2010	± 2.5
		30-Sep-2010	0.06	0.12	*Monthly*	30-Oct-2010	± 2.5
		30-Oct-2010	0.06	0.19	*Monthly*	29-Nov-2010	± 2.5
		29-Nov-2010	0.06	0.12	*Monthly*	29-Dec-2010	± 2.5
		29-Dec-2010	-0.06	0.12	*Monthly*	28-Jan-2011	± 2.5

01/ 06/ 2010 TO 31/ 12/ 2010

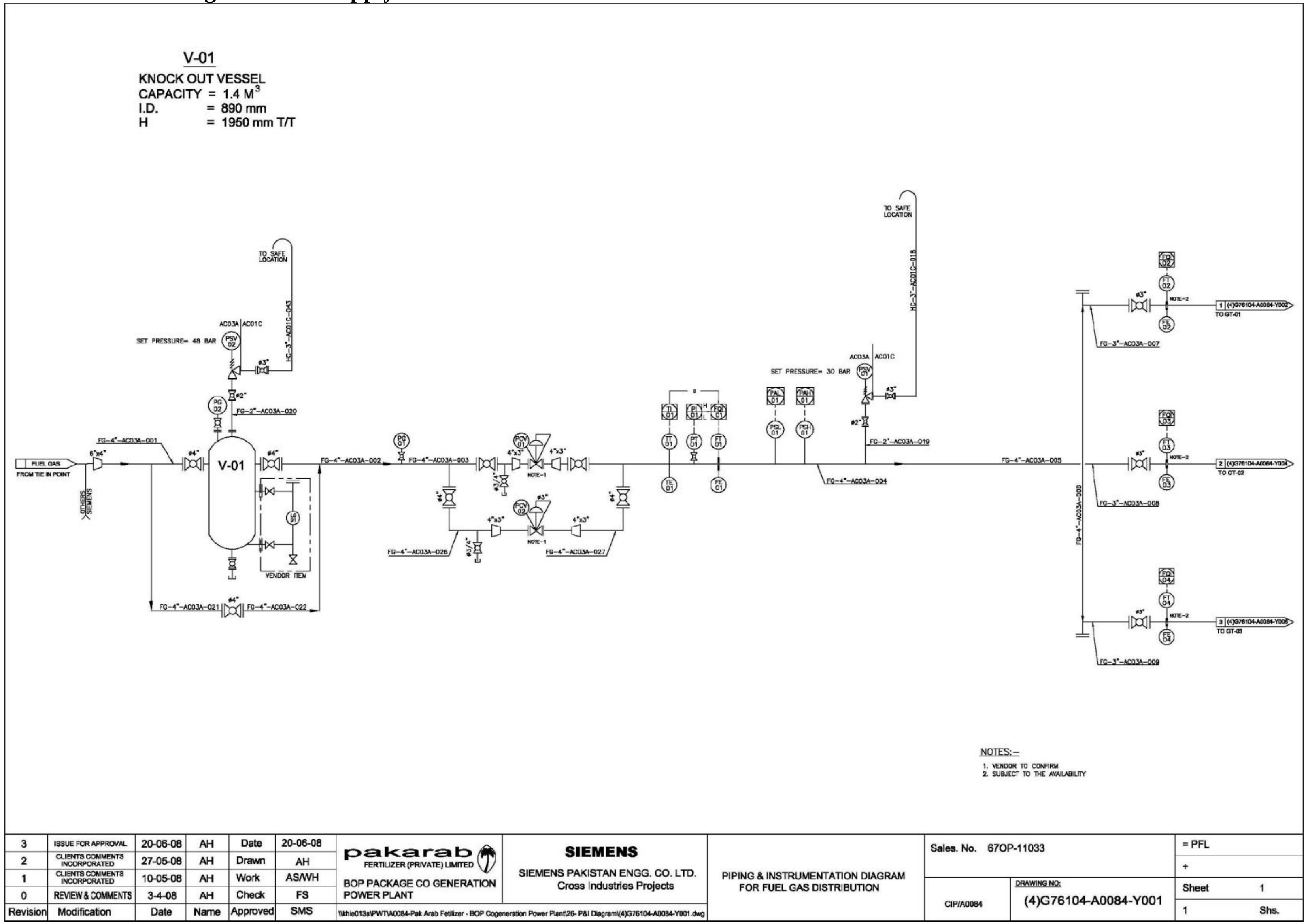
S.NO	INSTRUMENT TAG NO	CALIBRATION DATE	% Minimum Error Found	% Maximum Error Found	CALIBRATION FREQUENCY	NEXT CALIBRATION DUE DATE	% ACCEPTABLE ERROR (Acc. To PDD)
11	*FT-1501*	10-Jul-2010	0	0	*5- Months*	1-Dec-2010	± 2.5
		1-Dec-2010	0	0	*5- Months*	30-Apr-2011	± 2.5
12	*PT-01*	4-Jun-2010	-0.06	0	*Monthly*	4-Jul-2010	± 2.5
		4-Jul-2010	-0.06	0	*Monthly*	3-Aug-2010	± 2.5
		3-Aug-2010	0	0	*Monthly*	2-Sep-2010	± 2.5
		2-Sep-2010	0	0	*Monthly*	2-Oct-2010	± 2.5
		2-Oct-2010	0	0	*Monthly*	1-Nov-2010	± 2.5
		1-Nov-2010	0	0	*Monthly*	1-Dec-2010	± 2.5
		1-Dec-2010	0	0.06	*Monthly*	31-Dec-2010	± 2.5
		31-Dec-2010	0	0	*Monthly*	30-Jan-2011	± 2.5
13	*TT-01*	4-Jun-2010	-0.06	0	*Monthly*	4-Jul-2010	± 2.5
		4-Jul-2010	0	0	*Monthly*	3-Aug-2010	± 2.5
		3-Aug-2010	-0.06	0	*Monthly*	2-Sep-2010	± 2.5
		2-Sep-2010	0	0.12	*Monthly*	2-Oct-2010	± 2.5
		2-Oct-2010	0.06	0.12	*Monthly*	1-Nov-2010	± 2.5
		1-Nov-2010	-0.06	0	*Monthly*	1-Dec-2010	± 2.5
		1-Dec-2010	-0.06	0.19	*Monthly*	31-Dec-2010	± 2.5
		31-Dec-2010	-0.06	0.12	*Monthly*	30-Jan-2011	± 2.5
14	*PT-10*	2-Jun-2010	0	0.06	*Monthly*	2-Jul-2010	± 2.5
		2-Jul-2010	0	0	*Monthly*	1-Aug-2010	± 2.5
		1-Aug-2010	0	0.06	*Monthly*	31-Aug-2010	± 2.5
		31-Aug-2010	0	0.06	*Monthly*	30-Sep-2010	± 2.5
		30-Sep-2010	0	0	*Monthly*	30-Oct-2010	± 2.5
		30-Oct-2010	0	0.12	*Monthly*	29-Nov-2010	± 2.5
		29-Nov-2010	0	0	*Monthly*	29-Dec-2010	± 2.5
		29-Dec-2010	0	0.19	*Monthly*	28-Jan-2011	± 2.5
15	*TT-10*	2-Jun-2010	-0.06	0	*Monthly*	2-Jul-2010	± 2.5
		2-Jul-2010	-0.06	0.06	*Monthly*	1-Aug-2010	± 2.5
		1-Aug-2010	-0.06	0	*Monthly*	31-Aug-2010	± 2.5
		31-Aug-2010	-0.06	0.06	*Monthly*	30-Sep-2010	± 2.5
		30-Sep-2010	0	0.06	*Monthly*	30-Oct-2010	± 2.5
		30-Oct-2010	-0.06	0	*Monthly*	29-Nov-2010	± 2.5
		29-Nov-2010	0	0.19	*Monthly*	29-Dec-2010	± 2.5
		29-Dec-2010	-0.06	0.06	*Monthly*	28-Jan-2011	± 2.5

CDM - COGEN INSTRUMENTS LIST

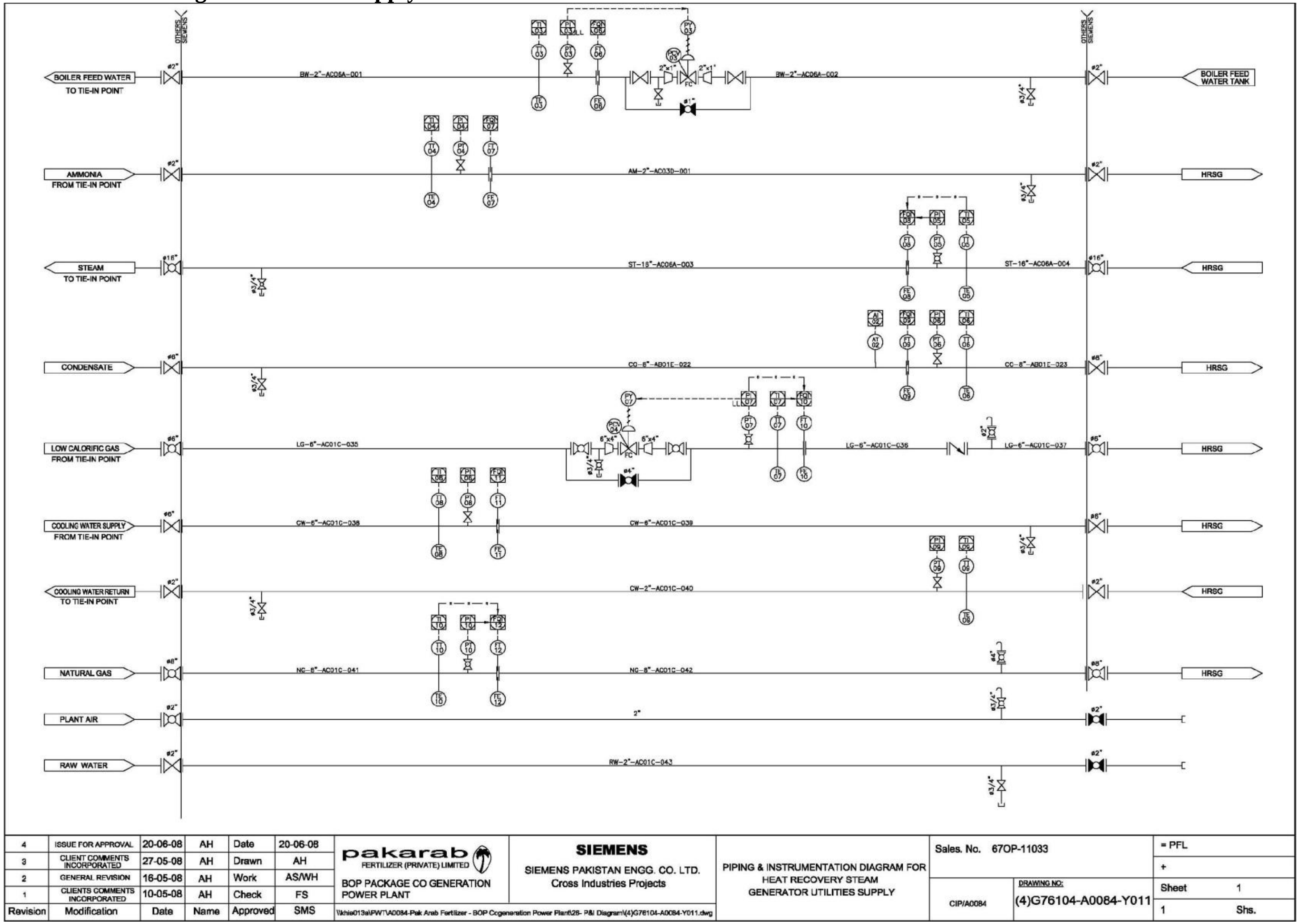
S.NO	TAG	SERVICE	MEASURING RANGE	PM FREQUEN-CY	PFL PROCEDURE #
1	FT-08	Steam Flow.	**0 ~ 5000 mmH2O**	Monthly	INS - WI - IMS - 011 Rev 01
2	PT-05	Steam Pressure.	**0 ~ 60 Barg**	Monthly	INS - WI - IMS - 011 Rev 01
3	TT-05	Steam Common Header Temp.	**0 ~ 450 DegC**	Monthly	INS - WI - IMS – 006 Rev 01
4	FT-09	Condensate Flow.	**0 ~ 2500 mmH2O**	Monthly	INS - WI - IMS – 011 Rev 01
5	TT-06	Condensate temp	**0 ~ 200 DegC**	Monthly	INS - WI - IMS – 006 Rev 01
6	PT-06	Condensate pressure	**0 ~ 10 Barg**	Monthly	INS - WI - IMS - 011 Rev 01
7	FT-05	Demin Water Flow.	**0 ~ 2500 mmH2O**	Monthly	INS - WI - IMS - 011 Rev 01
8	TT-02	Demin water Temperature	**0 ~ 100 DegC**	Monthly	INS - WI - IMS - 006 Rev 01
9	FT-01	Total Gas Flow on GTG's	**0 ~ 5000 mmH2O**	Monthly	INS - WI - IMS - 011 Rev 01
10	FT-12	Total Gas Flow to HRSG's	**0 ~ 2500 mmH2O**	Monthly	INS - WI - IMS – 011 Rev 01
11	FT-1501	Common gas flow at old power house	**0 ~ 6400 mmH2O**	5- Months	INS - WI - IMS - 019 Rev 01
12	PT-01	Natural Gas to GTGs Pressure.	**0 ~ 60 Barg**	Monthly	INS - WI - IMS – 011 Rev 01
13	TT-01	Natural Gas to GTGs Temperature.	**0 ~ 55 DegC**	Monthly	INS - WI - IMS – 006 Rev 01
14	PT-10	Natural Gas to HRSGs Pressure.	**0 ~ 20 Barg**	Monthly	INS - WI - IMS - 011 Rev 01
15	TT-10	Natural Gas to HRSGs Temperature.	**0 ~ 55 DegC**	Monthly	INS - WI - IMS - 006 Rev 01

Sr. No.	Installation Location	Energy Meter Data				Commissioning Date	Calibration Frequency	Next Due date
		Model	Serial no.	Make	Factory Calibration Date			
1	C4 - Gas Turbine Generator no.1	Simeas P50	BF0808095705	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
2	C10 - Gas Turbine Generator no.2	Simeas P50	BF0808095712	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
3	C16 - Gas Turbine Generator no.3	Simeas P50	BF0808095707	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
4	Steam Turbine Generator no.1	Simeas P50	BF0808095703	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
5	Steam Turbine Generator no.2	Simeas P50	BF0808095704	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
6	Steam Turbine Generator no.3	Simeas P50	BF0808095709	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
7	C11 – Emergency Diesel Generator	Simeas P50	BF0808095702	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
8	C6 - Station Transformer no.1	Simeas P50	BF0808095710	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011
9	C14 – Station Transformer no.2	Simeas P50	BF0808095706	Siemens	26-8-08	22-1-09	2 yearly	22-1-2011

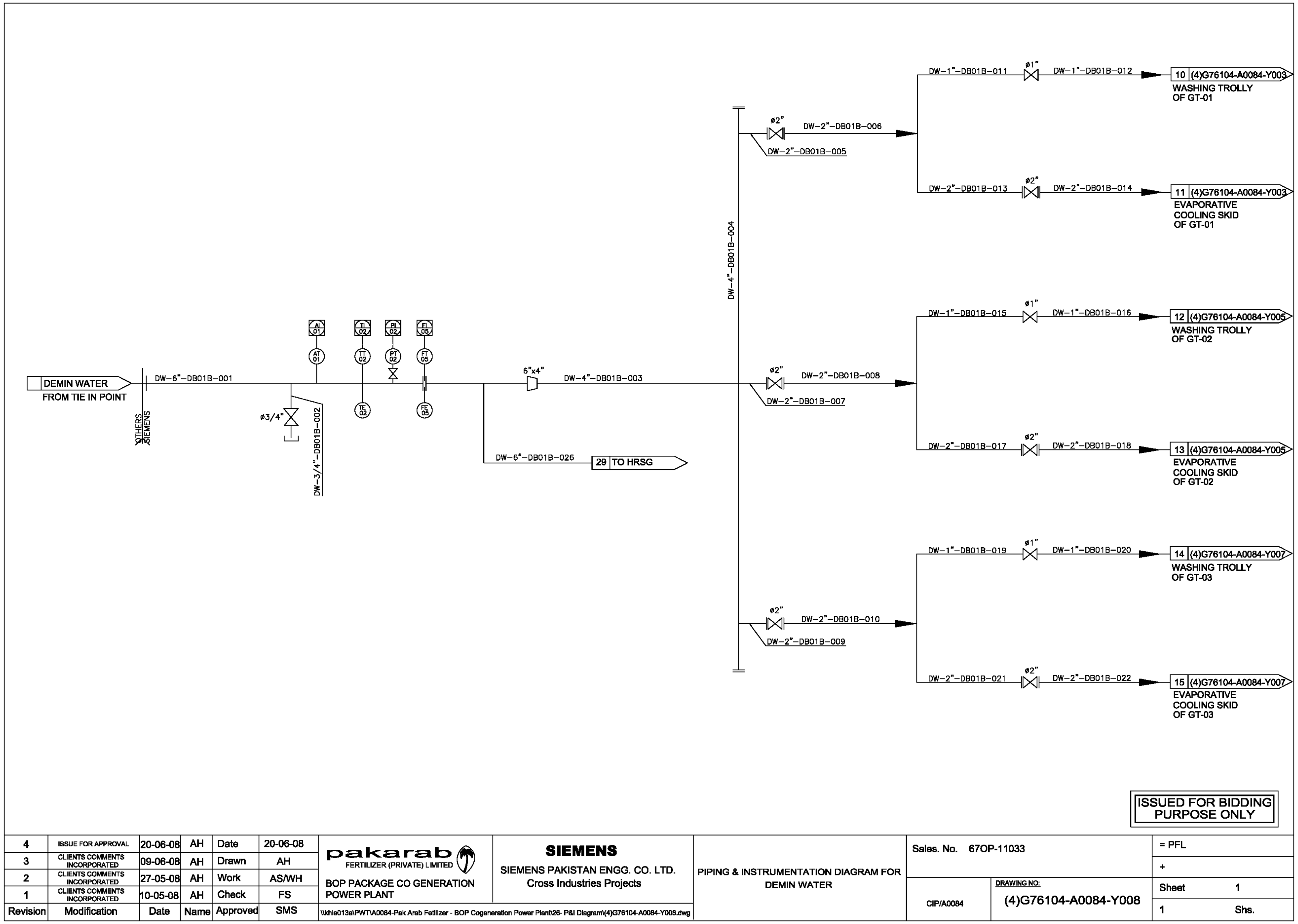
Annex 2: P & I Diagram – Gas supply to GTGs:



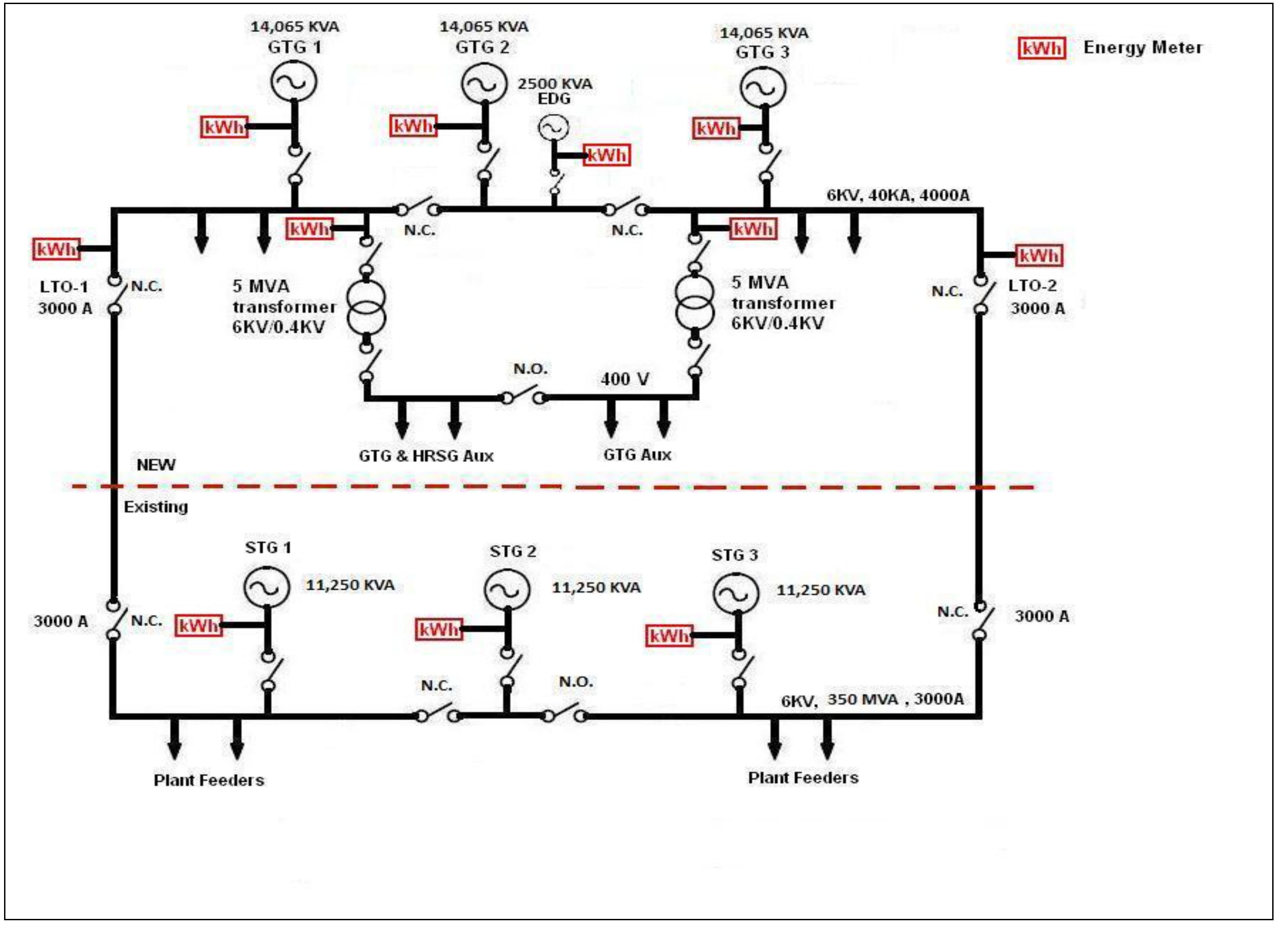
Annex 3: P & I Diagram – HRSGs supply:



Annex 4: P&I Diagram – Demin Water supply:



Annex 5: Simplified Interconnection Diagram:



Annex 6: GCV and NCV Calculation Procedure according to ISO 6976:

Description:
Gas Analysis on Volumetric Percentage Basis are done on the Apparatus of Gas Chromatograph for Argon (Ar), Carbon Di-oxide (CO_2), Nitrogen (N_2), Methane (CH_4), Ethane (C_2H_6), Propane (C_3H_8), n-Butane (C_4H_{10}) and n-Pentane (C_5H_{12}).

Apparatus Used:

Name	:	Gas Chromatograph (GC-1400)
Manufacturer	:	Varian Aerograph
Model #	:	142010-01

Formulas Used: **(**As per Standard ISO-6976**)**

$\tilde{H}\,[t_1,V(t_2,p_2)] = \Sigma(\tilde{H}_i^o\,[t_1,V(t_2,p_2)] \times x_i)$

Where, $\tilde{H}\,[t_1,V(t_2,p_2)]$ = Real-gas Calorific Value on volumetric basis (either superior (GCV) or inferior (NCV);

$V(t_2,p_2)$ = Volume of Natural Gas at Temperature t_2 and Pressure p_2

x_i = Volumetric Composition of each Hydrocarbon in BTU/SCF

$\tilde{H}_i^{15.5}\,[t_1,V(t_2,p_2)]$ = Calorific Value of component i at combustion temperature t_1 and Volume $V(t_2,p_2)$

t_1 = 15.00 ^oC

t_2 = 15.55 ^oC (60 ^oF)

p_2 = 14.65 psia

i = it refers to all Hydrocarbon Gases (Methane, Ethane, Propane, n-Butane and n-Pentane)

Month-Year	**GCV (BTU / Sft^3)**		**NCV (BTU / Sft^3)**	**NCV (BTU / Sft^3)**	**NCV to be used (KJ / Nm^3)**
	By SNGPL	*By PFL as per ISO-6976*	*By PFL Lab as per ISO-6976*	*By SNGPL * PFL NCV/PFL GCV*	*By SNGPL * PFL NCV/PFL GCV*
June – 2010	920	919	928	829	30,881.50
July – 2010	922	921	929	830	30,918.75
Aug – 2010	921	919	928	830	30,915.03
Sep – 2010	922	918	927	831	30,944.83
Oct – 2010	920	918	927	829	30,877.77
Nov - 2010	924	919	928	833	31,015.62
Dec - 2010	918	918	927	827	30,810.71

*Conversion Factor s: 1 ft^3 = 0.02832 m^3
1 BTU = 1.0551 KJ

Where, each components calorific values (at Combustion Temperature (^oC) / Metering Temperature (^oC)) are given in the table below:

Gas Component	**Calorific Value (in KJ / m^3)**	
	15 / 15** **(**at 14.696 psia**)**	**15/15.5** **(**at 14.65 psia**)*****
Methane	33,948	**33,777**
Ethane	60,430	**60,125**
Propane	86,420	**85,984**
n-Butane	112,400	**111,833**
n-Pentane	138,380	**137,681**

** ISO-6976 standard has provided all values at 15 ^oC temperature and 14.696 psia pressure, but our supplier has given at 15.5 ^oC and 14.650 psia pressure.

*** All values are simply multiplied with pressure ratio factor (14.65 psia / 14.696 psia) and Temperature ratio factor (288.15 Kelvin / 288.65Kelvin).

Annex 7: Invoices of Gas supplier SNGPL

SUI NORTHERN GAS PIPELINES LIMITED

PIRAN GHAIB ROAD, MULTAN.

INVOICE - INDUSTRIAL

FOR COST NATURAL GAS SOLD TO
PAKARAB FERTILIZERS (PVT) LTD. ,
KHANEWAL ROAD,
MULTAN.

G.S.T No: 03-91-9999-967-19

DUE DATE : 15.07.2010

CONSUMER No: 11/0010-003 | BILLING PERIOD: FROM: 01.06.2010 TO: 30.06.2010 | ISSUE DATE : 01.07.2010

CONSUMER GST No : 04-07-2806-001-91

CONSUMPTION CATEGORY	GROSS CALORIFIC VALUE IN BTU/SCF	CORRECTED VOLUME		TOTAL	RATE	DESCRIPTION	AMOUNT
		MCF	HM^3	MMBTU	Rs/MMBTU		Rs.
FEED STOCK	920	1267527	357111	1166124	102.01	GAS CHARGES	118,956,309
FUEL STOCK	920	355298	100101	326874	382.37	GAS CHARGES	124,986,811
						METER RENT	6,000
DETAILS OF LPS:						SUB TOTAL	243,949,120
						GST (16%)	39,031,859
Gas metering checked payment may be released.						ADJUSTMENT	-
				AMOUNT FOR THE MONTH			282,980,979
				ARREARS			-
				LATE PAYMENT SURCHARGE			-
				Total Amount Due			282,980,979

3/7/10

03/07

(MUHAMMAD SHAHID JAVED)

REGIONAL BILLING INCHARGE

SUI NORTHERN GAS PIPELINES LIMITED

PIRAN GHAIB ROAD, MULTAN.

INVOICE - INDUSTRIAL

FOR COST NATURAL GAS SOLD TO

PAK ARAB FERTILIZERS (PVT) LTD.,

KHANEWAL ROAD,

MULTAN.

G.S.T No: 03-91-9999-967-19

DUE DATE : 16.08.2010

CONSUMER No: 11/0010-003 BILLING PERIOD: FROM: 01.07.2010 TO: 31.07.2010 ISSUE DATE : 02.08.2010

CONSUMER GST No : 04-07-2806-001-91

CONSUMPTION CATEGORY	GROSS CALORIFIC VALUE IN BTU/SCF	CORRECTED VOLUME MCF	CORRECTED VOLUME HM³	TOTAL MMBTU	RATE Rs/MMBTU	DESCRIPTION	AMOUNT Rs.
FEED STOCK	922	1222966	344557	1127576	102.01	GAS CHARGES	115,024,028
FUEL STOCK	922	344409	97033	317544	382.37	GAS CHARGES	121,419,299
						METER RENT	6,000
DETAILS OF LPS:						SUB TOTAL	236,449,327
						GST (17%)	40,196,386
						ADJUSTMENT	-
				AMOUNT FOR THE MONTH			276,645,713
				ARREARS			-
				LATE PAYMENT SURCHARGE			-
				Total Amount Due			276,645,713

Metering checked,
Payment may be released.

ok

ok

BILLING DEPARTMENT SNGPL MULTAN REGION

(MUHAMMAD SHAHID JAVED)

REGIONAL BILLING INCHARGE

SUI NORTHERN GAS PIPELINES LIMITED

PIRAN GHAIB ROAD, MULTAN.

INVOICE - INDUSTRIAL

FOR COST NATURAL GAS SOLD TO

PAKARAB FERTILIZERS (PVT) LTD. ,

KHANEWAL ROAD,

G.S.T No: 03-91-9999-967-19 MULTAN. DUE DATE : 15.09.2010

CONSUMER No: 11/0010-003 BILLING PERIOD: FROM 01.08.2010 TO: 31.08.2010 ISSUE DATE : 01.09.2010

CONSUMER GST No : 04-07-2806-001-91

CONSUMPTION CATEGORY	GROSS CALORIFIC VALUE IN BTU/SCF	CORRECTED VOLUME MCF	CORRECTED VOLUME HM^3	TOTAL MMBTU	RATE Rs/MMBTU	DESCRIPTION	AMOUNT Rs.
FEED STOCK	921	1182586	333180	1089162	102.01	GAS CHARGES	111,105,416
FUEL STOCK	921	327694	92324	301806	382.37	GAS CHARGES	115,401,560
						METER RENT	6,000
DETAILS OF LPS:						SUBTOTAL	226,512,976
						GST (17%)	38,507,206
						ADJUSTMENT	-
				AMOUNT FOR THE MONTH			265,020,182
				ARREARS			276,645,713
				LATE PAYMENT SURCHARGE			2,046,420
				Total Amount Due			543,712,315

Gas metering checked, payment may be released.

Asifa Sateel
05/9/10

To be checked by finance.

Approved Rs265020713 for the month of August.

6/9/10

(MUHAMMAD SHAHID JAVED)
REGIONAL BILLING INCHARGE

SUI NORTHERN GAS PIPELINES LIMITED

PIRAN GHAIB ROAD, MULTAN.

INVOICE - INDUSTRIAL

FOR COST NATURAL GAS SOLD TO

PAKARAB FERTILIZERS (PVT) LTD. ,
KHANEWAL ROAD,
MULTAN.

G.S.T No: 03-91-9999-967-19

DUE DATE : 15.10.2010

CONSUMER No: 11/0010-003 BILLING PERIOD: FROM 01.09.2010 TO 30.09.2010 ISSUE DATE : 01.10.2010

CONSUMER GST No : 04-07-2806-001-91

BILLING DEPARTMENT SNGPL

CONSUMPTION CATEGORY	GROSS CALORIFIC VALUE IN BTU/SCF	CORRECTED VOLUME MCF	CORRECTED VOLUME HM³	TOTAL MMBTU	RATE Rs/MMBTU	DESCRIPTION	AMOUNT Rs.
FEED STOCK	922	968806	272951	896239	102.01	GAS CHARGES	91,119,310
FUEL STOCK	922	298465	84089	275184	382.37	GAS CHARGES	105,222,106
DETAILS OF LPS:						METER RENT	6,000
						SUB TOTAL	196,347,416
						GST (17%)	33,379,061
						ADJUSTMENT	-
				AMOUNT FOR THE MONTH			229,726,477
				ARREARS			-
				LATE PAYMENT SURCHARGE			136,428
				Total Amount Due			**229,862,905**

MULTAN REGION

Gas metering checked,
Payment may be released.
Asifa Saleem -

6/11/2011

(PERVAIZ IQBAL BUTT)
REGIONAL BILLING INCHARGE

SUI NORTHERN GAS PIPELINES LIMITED

PIRAN GHAIB ROAD, MULTAN.

INVOICE - INDUSTRIAL

FOR COST NATURAL GAS SOLD TO

PAKARAB FERTILIZERS (PVT) LTD. ,
KHANEWAL ROAD,
MULTAN.

G.S.T No: 03-91-9999-967-19

DUE DATE : 15.11.2010

CONSUMER No: 11/0010-003 | BILLING PERIOD: FROM: 01.10.2010 TO: 31.10.2010 | ISSUE DATE : 01.11.2010

CONSUMER GST No : 04-07-2806-00[illegible]

CONSUMPTION CATEGORY	GROSS CALORIFIC VALUE IN BTU/SCF	CORRECTED VOLUME		TOTAL	RATE	DESCRIPTION	AMOUNT
		MCF	HM³	MMBTU	Rs/MMBTU		Rs.
FEED STOCK	920	1150003	324000	1058002	102.01	GAS CHARGES	107,926,784
FUEL STOCK	920	330104	96003	303696	382.37	GAS CHARGES	116,124,240
DETAILS OF LPS:						METER RENT	6,000
						SUB TOTAL	224,057,024
						GST (17%)	38,089,694
						ADJUSTMENT	-
				AMOUNT FOR THE MONTH			262,146,718
				ARREARS			-
				LATE PAYMENT SURCHARGE			-
				Total Amount Due			**262,146,718**

BILLING DEPARTMENT SNGPL MULTAN REGION

Gas metering checked, Payment may be released.

OK

(MUHAMMAD SHAHID JAVED)
REGIONAL BILLING INCHARGE

SUI NORTHERN GAS PIPELINES LIMITED

PIRAN GHAIB ROAD, MULTAN.

INVOICE - INDUSTRIAL

FOR COST NATURAL GAS SOLD TO

PAKARAB FERTILIZERS (PVT) LTD. ,
KHANEWAL ROAD,
MULTAN.

G.S.T No: 03-91-9999-967-19

DUE DATE : 15.12.2010

CONSUMER No: 11/0010-003 | BILLING PERIOD: FROM 01.11.2010 TO: 30.11.2010 | ISSUE DATE : 01.12.2010

CONSUMER GST No : 04-07-2806-001-91

BILLING DEPARTMENT
SNGPL
MULTAN REGION

CONSUMPTION CATEGORY	GROSS CALORIFIC VALUE IN BTU/SCF	CORRECTED VOLUME		TOTAL	RATE	DESCRIPTION	AMOUNT
		MCF	HM³	MMBTU	Rs/MMBTU		Rs.
FEED STOCK	924	1217787	3480[illegible]	1125234	102.01	GAS CHARGES	114,785,120
FUEL STOCK	924	326651	[illegible]2830	301825	382.37	GAS CHARGES	115,408,825
						METER RENT	6,000
DETAILS OF LPS:						SUB TOTAL	230,199,945
						GST (17%)	39,133,991
						ADJUSTMENT	-
				AMOUNT FOR THE MONTH			269,333,936
				ARREARS			-
				LATE PAYMENT SURCHARGE			-
				Total Amount Due			269,333,936

Gas metering checked, Payment may be released.
Atifa Iqbal

OK
QK
Dec 3, 2010

(PERVAIZ IQBAL BUTT)
REGIONAL BILLING INCHARGE

SUI NORTHERN GAS PIPELINES LIMITED

PIRAN GHAIB ROAD, MULTAN.

INVOICE - INDUSTRIAL

FOR COST NATURAL GAS SOLD TO

PAKARAB FERTILIZERS (PVT) LTD. ,
KHANEWAL ROAD,
MULTAN.

G.S.T No: 03-91-9999-967-19

DUE DATE : 15.01.2011

CONSUMER No: 11/0010-003

BILLING PERIOD: FROM 01.12.2010 TO: 31.12.2010

ISSUE DATE : 01.01.2011

CONSUMER GST No : 04-07-2806-001-91

CONSUMPTION CATEGORY	GROSS CALORIFIC VALUE IN BTU/SCF	CORRECTED VOLUME MCF	CORRECTED VOLUME HM^3	TOTAL MMBTU	RATE Rs/MMBTU	DESCRIPTION	AMOUNT Rs.
FEED STOCK	918	1099864	30[illegible]674	1009675	102.01	GAS CHARGES	102,996,947
FUEL STOCK	918	289970	84696	266193	382.37	GAS CHARGES	101,784,217
						METER RENT	6,000
DETAILS OF LPS:						SUB TOTAL	204,787,164
						GST (17%)	34,813,818
						ADJUSTMENT	-
				AMOUNT FOR THE MONTH			239,600,982
				ARREARS			-
				LATE PAYMENT SURCHARGE			-
				Total Amount Due			**239,600,982**

BILLING DEPARTMENT SNGPL MULTAN REGION

(MUHAMMAD SHAHID JAVED)
REGIONAL BILLING INCHARGE

Annex 8: GCV and NCV according to PFL Laboratory:

PFL **NATURAL GAS ANALYSIS** June, 2010 LABORATORY

Date	Time	Ar	CO_2	N_2	CH_4	C_2H_6	C_3H_8	$C_4H_{10}+C_5H_{12}$	Heating Value (Calculated) Low	Heating Value (Calculated) Gross
	Hrs.	%	%	%	%	%	%	%	BTU/Cu.ft.	BTU/Cu.ft.
01.06.10	0820	0.02	1.86	8.97	87.93	0.80	0.22	0.20	828	919
02.06.10	0840	0.02	1.79	9.06	87.86	0.85	0.22	0.20	828	919
03.06.10	0830	0.02	1.79	8.88	88.09	0.80	0.22	0.20	829	920
04.06.10	0830	0.02	1.86	8.97	87.88	0.85	0.22	0.20	828	919
05.06.10	0945	0.02	1.83	8.97	87.90	0.86	0.22	0.20	828	919
06.06.10	0830	0.02	1.79	9.06	87.92	0.79	0.22	0.20	827	918
07.06.10	0940	0.02	1.79	8.80	88.14	0.83	0.22	0.20	830	921
08.06.10	1030	0.02	1.79	9.06	87.86	0.85	0.22	0.20	828	919
09.06.10	0820	0.02	1.97	8.95	87.68	0.98	0.20	0.20	828	919
10.06.10	0900	0.02	1.97	8.95	87.56	1.07	0.23	0.20	829	920
11.06.10	0820	0.02	2.06	8.78	87.72	0.99	0.23	0.20	829	920
12.06.10	0820	0.02	1.97	8.87	87.69	0.96	0.29	0.20	830	921
13.06.10	1100	0.02	2.01	8.78	87.77	0.99	0.23	0.20	830	921
14.06.10	0900	0.02	2.01	8.87	87.68	0.99	0.23	0.20	829	920
15.06.10	0830	0.02	2.06	8.95	87.59	0.98	0.20	0.20	827	918
16.06.10	0845	0.02	2.10	8.95	87.51	0.99	0.23	0.20	827	918
17.06.10	0830	0.02	2.01	9.04	87.49	1.01	0.23	0.20	827	918
18.06.10	1130	0.02	2.01	9.04	87.49	1.01	0.23	0.20	827	918
19.06.10	1130	0.02	2.01	9.04	87.49	1.01	0.23	0.20	827	918
20.06.10	0915	0.02	2.06	9.04	87.42	1.03	0.23	0.20	827	918
21.06.10	0845	0.02	2.06	8.95	87.51	1.03	0.23	0.20	828	919
22.06.10	1230	0.02	2.10	8.95	87.51	0.99	0.23	0.20	827	918
23.06.10	0940	0.02	2.12	8.86	87.56	0.95	0.29	0.20	828	919
24.06.10	0900	0.02	2.04	8.95	87.56	0.94	0.29	0.20	828	919
25.06.10	1200	0.02	2.08	9.03	87.40	0.98	0.29	0.20	827	918
26.06.10	0830	0.02	2.04	8.86	87.76	0.89	0.23	0.20	828	919
27.06.10	0815	0.02	2.08	8.86	87.75	0.86	0.23	0.20	827	918
28.06.10	0830	0.02	2.00	8.78	87.97	0.80	0.23	0.20	828	919
29.06.10	1000	0.02	2.04	8.62	87.93	0.96	0.23	0.20	830	922
30.06.10	0845	0.02	2.00	8.62	87.97	0.96	0.23	0.20	831	922
Average		**0.02**	**1.98**	**8.92**	**87.72**	**0.93**	**0.23**	**0.20**	**828**	**919**

Heating Value	HHV(BTU/Cu.ft.)	LHV(BTU/Cu.ft.)		HHV(Kcal/NM³)	LHV(Kcal/NM³)
Minimum	918	827		8624	7770
Maximum	922	831		8664	7806
Average	919	828		8637	7781

Section Head Lab.

FAT 01/07

Unit Manager (P.E.)

CC.
Unit Manager (Ammonia)
Unit Manager (CDM)
Unit Manager (Utilities)

PFL NATURAL GAS ANALYSIS — LABORATORY

July, 2010

Date	Time	Ar	CO_2	N_2	CH_4	C_2H_6	C_3H_8	$C_4H_{10}+C_5H_{12}$	Heating Value (Calculated) Low	Heating Value (Calculated) Gross
	Hrs.	%	%	%	%	%	%	%	BTU/Cu.ft.	BTU/Cu.ft.
01.07.10	0845	0.02	2.08	8.80	87.69	0.98	0.23	0.20	829	920
02.07.10	0845	0.02	2.16	8.80	87.63	0.96	0.23	0.20	828	919
03.07.10	0945	0.02	2.16	8.80	87.61	0.98	0.23	0.20	828	919
04.07.10	1230	0.02	2.04	8.80	87.72	0.99	0.23	0.20	829	920
05.07.10	0850	0.02	2.00	8.62	87.97	0.96	0.23	0.20	831	922
06.07.10	0815	0.02	2.00	8.71	87.88	0.96	0.23	0.20	830	921
07.07.10	1220	0.02	2.00	8.80	87.83	0.92	0.23	0.20	829	920
08.07.10	0830	0.02	1.96	8.80	87.85	0.94	0.23	0.20	829	921
09.07.10	0845	0.02	2.00	8.88	87.71	0.96	0.23	0.20	828	920
10.07.10	0930	0.02	1.92	8.62	88.03	0.98	0.23	0.20	832	923
11.07.10	0915	0.02	1.92	8.71	88.01	0.91	0.23	0.20	830	922
12.07.10	1520	0.02	1.96	8.80	87.80	0.99	0.23	0.20	830	921
13.07.10	2040	0.02	2.00	8.80	87.86	0.89	0.23	0.20	829	920
14.07.10	0845	0.02	2.16	8.97	87.41	0.98	0.26	0.20	827	918
15.07.10	0830	0.02	2.16	8.80	87.58	0.98	0.26	0.20	828	919
16.07.10	0830	0.02	2.12	8.89	87.55	0.96	0.26	0.20	828	919
17.07.10	1530	0.02	2.04	8.80	87.65	1.03	0.26	0.20	830	921
18.07.10	1245	0.02	2.00	8.89	87.62	1.01	0.26	0.20	829	920
19.07.10	0845	0.02	1.96	8.89	87.71	0.96	0.26	0.20	829	920
20.07.10	1210	0.02	2.04	8.72	87.81	1.01	0.20	0.20	829	921
21.07.10	1030	0.02	2.00	8.72	87.89	0.94	0.23	0.20	830	921
22.07.10	0830	0.02	2.04	8.64	87.87	0.94	0.29	0.20	831	922
23.07.10	0830	0.02	2.04	8.72	87.88	0.91	0.23	0.20	829	920
24.07.10	1245	0.02	2.04	8.72	87.84	0.92	0.26	0.20	830	921
25.07.10	1230	0.02	2.00	8.80	87.76	0.96	0.26	0.20	830	921
26.07.10	1000	0.02	1.96	8.72	87.89	0.98	0.23	0.20	830	922
27.07.10	1000	0.02	2.00	8.80	87.68	0.98	0.32	0.20	831	922
28.07.10	1430	0.02	2.04	8.72	87.79	0.94	0.29	0.20	830	922
29.07.10	1500	0.02	2.06	8.75	87.71	0.98	0.28	0.20	830	921
30.07.10	0830	0.02	2.14	8.75	87.69	0.99	0.21	0.20	828	919
31.07.10	1230	0.02	2.10	8.84	87.63	0.98	0.23	0.20	828	919
Average		**0.02**	**2.03**	**8.77**	**87.76**	**0.96**	**0.25**	**0.20**	**829**	**921**

Heating Value	HHV(BTU/Cu.ft.)	LHV(BTU/Cu.ft.)		HHV(Kcal/NM^3)	LHV(Kcal/NM^3)
Minimum	**918**	**827**		**8622**	**7768**
Maximum	**923**	**832**		**8673**	**7815**
Average	**921**	**829**		**8649**	**7792**

Incharge Lab.

Unit Manager (P.E.)
cc.
Unit Manager (Ammonia)
Unit Manager (CDM)
Unit Manager (Utilities)

PFL

NATURAL GAS ANALYSIS

August, 2010

LABORATORY

Date	Time	Ar	CO_2	N_2	CH_4	C_2H_6	C_3H_8	$C_4H_{10}+C_5H_{12}$	Heating Value (Calculated) Low	Heating Value (Calculated) Gross
	Hrs.	%	%	%	%	%	%	%	BTU/Cu.ft.	BTU/Cu.ft.
01.08.10	1130	0.02	2.06	8.75	87.78	0.96	0.23	0.20	829	920
02.08.10	0830	0.02	2.01	8.75	87.89	0.94	0.19	0.20	829	920
03.08.10	1000	0.02	2.01	8.57	88.05	0.94	0.21	0.20	831	922
04.08.10	0800	0.02	2.06	8.57	87.98	0.94	0.23	0.20	831	922
05.08.10	1000	0.02	1.97	8.57	88.07	0.96	0.21	0.20	831	923
06.08.10	0800	0.02	2.01	8.75	87.87	0.94	0.21	0.20	829	920
07.08.10	0800	0.02	1.93	9.02	87.66	0.96	0.21	0.20	828	919
08.08.10	1600	0.02	1.93	9.02	87.61	1.01	0.21	0.20	828	919
09.08.10	1015	0.02	1.99	9.32	87.27	0.99	0.21	0.20	824	915
10.08.10	0845	0.02	2.04	9.23	87.30	0.98	0.23	0.20	825	916
11.08.10	1200	0.02	1.90	7.31	89.32	1.04	0.21	0.20	844	937
12.08.10	0900	0.02	1.95	7.13	89.53	0.96	0.21	0.20	845	937
13.08.10	0820	0.02	2.04	8.59	87.98	0.96	0.21	0.20	830	922
14.08.10	1500	0.02	2.13	8.68	87.94	0.82	0.21	0.20	828	919
15.08.10	0645	0.02	2.13	8.86	87.63	0.95	0.21	0.20	827	918
16.08.10	0830	0.02	2.17	9.23	87.19	0.96	0.23	0.20	824	914
17.08.10	1130	0.02	2.08	9.04	87.46	0.97	0.23	0.20	826	917
18.08.10	0830	0.02	2.04	8.95	87.73	0.87	0.19	0.20	826	917
19.08.10	0845	0.02	1.99	9.04	87.70	0.86	0.19	0.20	826	917
20.08.10	1130	0.02	2.08	8.95	87.67	0.89	0.19	0.20	826	917
21.08.10	0900	0.02	2.06	8.95	87.76	0.82	0.19	0.20	826	917
22.08.10	1210	0.02	2.04	8.95	87.69	0.91	0.19	0.20	827	917
23.08.10	0845	0.02	2.13	8.95	87.58	0.92	0.20	0.20	826	917
24.08.10	0830	0.02	2.17	8.86	87.67	0.89	0.19	0.20	826	917
25.08.10	0830	0.02	2.13	8.95	87.55	0.96	0.19	0.20	826	917
26.08.10	1000	0.02	2.13	8.95	87.57	0.92	0.21	0.20	826	917
27.08.10	0830	0.02	2.13	8.95	87.62	0.89	0.19	0.20	826	916
28.08.10	0900	0.02	2.11	9.00	87.56	0.92	0.19	0.20	825	916
29.08.10	1300	0.02	2.13	8.95	87.59	0.92	0.19	0.20	826	917
30.08.10	0830	0.02	2.13	9.04	87.46	0.96	0.19	0.20	825	916
31.08.10	1010	0.02	2.08	9.04	87.51	0.94	0.21	0.20	826	917
Average		**0.02**	**2.06**	**8.80**	**87.79**	**0.93**	**0.21**	**0.20**	**828**	**919**

Heating Value	HHV(BTU/Cu.ft.)	LHV(BTU/Cu.ft.)		HHV(Kcal/NM^3)	LHV(Kcal/NM^3)
Minimum	914	824		8590	7739
Maximum	937	845		8808	7936
Average	919	828		8637	7781

Section-Head Lab FA7 01/09/10

Unit Manager (P.E.)

cc.

Unit Manager (Ammonia)
Unit Manager (CDM)
Unit Manager (Utilities)

PFL

NATURAL GAS ANALYSIS

September, 2010

LABORATORY

Date	Time	Ar	CO_2	N_2	CH_4	C_2H_6	C_3H_8	$C_4H_{10}+C_5H_{12}$	Heating Value (Calculated) Low	Heating Value (Calculated) Gross
	Hrs.	%	%	%	%	%	%	%	BTU/Cu.ft.	BTU/Cu.ft.
01.09.10	0830	0.02	2.08	8.95	87.58	0.96	0.21	0.20	827	918
02.09.10	0830	0.02	2.13	9.04	87.42	0.98	0.21	0.20	826	916
03.09.10	1000	0.02	2.04	9.04	87.57	0.92	0.21	0.20	826	917
04.09.10	1015	0.02	2.08	9.32	87.21	0.96	0.21	0.20	823	914
05.09.10	1320	0.02	2.13	9.14	87.44	0.86	0.21	0.20	824	914
06.09.10	0830	0.02	2.13	8.95	87.62	0.89	0.19	0.20	826	916
07.09.10	0945	0.02	2.13	8.95	87.59	0.90	0.21	0.20	826	917
08.09.10	0830	0.02	2.08	8.77	87.84	0.90	0.19	0.20	828	919
09.09.10	0810	0.02	2.08	8.86	87.70	0.91	0.23	0.20	828	919
10.09.10	0715	0.02	1.90	8.95	87.80	0.92	0.21	0.20	828	919
11.09.10	1100	0.02	1.95	9.04	87.67	0.91	0.21	0.20	827	918
12.09.10	1000	0.02	1.95	8.95	87.76	0.91	0.21	0.20	828	919
13.09.10	1430	0.02	2.04	8.31	88.35	0.87	0.21	0.20	832	924
14.09.10	1100	0.02	2.04	8.41	88.25	0.87	0.21	0.20	831	923
15.09.10	1040	0.02	2.08	8.59	87.98	0.92	0.21	0.20	830	921
16.09.10	1715	0.02	2.08	7.06	89.57	0.86	0.21	0.20	843	936
17.09.10	0830	0.02	1.99	9.04	87.61	0.91	0.23	0.20	827	918
18.09.10	0830	0.02	1.99	9.04	87.63	0.91	0.21	0.20	826	917
19.09.10	1030	0.02	1.99	9.14	87.51	0.91	0.23	0.20	826	917
20.09.10	0840	0.02	2.04	9.04	87.53	0.94	0.23	0.20	826	917
21.09.10	1145	0.02	2.08	8.95	87.68	0.86	0.21	0.20	826	917
22.09.10	0810	0.02	2.08	9.04	87.47	0.96	0.23	0.20	826	917
23.09.10	0810	0.02	2.22	9.04	87.33	0.96	0.23	0.20	825	916
24.09.10	0800	0.02	1.92	8.98	87.64	1.01	0.23	0.20	829	920
25.09.10	0915	0.02	1.78	9.25	87.56	0.98	0.21	0.20	827	918
26.09.10	1230	0.02	2.16	9.16	87.26	0.99	0.21	0.20	824	915
27.09.10	0840	0.02	1.92	9.16	87.50	0.99	0.21	0.20	827	917
28.09.10	0945	0.02	1.84	9.25	87.50	0.96	0.23	0.20	827	917
29.09.10	0840	0.02	1.84	9.25	87.52	0.96	0.21	0.20	826	917
30.09.10	0830	0.02	1.88	9.16	87.53	0.98	0.23	0.20	827	918
Average		**0.02**	**2.02**	**8.93**	**87.69**	**0.93**	**0.21**	**0.20**	**827**	**918**

Heating Value	**HHV(BTU/Cu.ft.)**	**LHV(BTU/Cu.ft.)**		**HHV(Kcal/NM^3)**	**LHV(Kcal/NM^3)**
Minimum	914	823		8587	7737
Maximum	936	843		8795	7924
Average	918	827		8628	7774

Section Head Lab. FAT
01-10-10

Unit Manager (P.E.)
CC.
Unit Manager (Ammonia)
Unit Manager (CDM)
Unit Manager (Utilities)

PFL

NATURAL GAS ANALYSIS

October, 2010

LABORATORY

Date	Time	Ar	CO_2	N_2	CH_4	C_2H_6	C_3H_8	$C_4H_{10}+C_5H_{12}$	Heating Value (Calculated) Low	Heating Value (Calculated) Gross
	Hrs.	%	%	%	%	%	%	%	BTU/Cu.ft.	BTU/Cu.ft.
01.10.10	0900	0.02	1.88	9.25	87.43	0.99	0.23	0.20	826	917
02.10.10	1000	0.02	1.88	9.25	87.52	0.92	0.21	0.20	826	916
03.10.10	0900	0.02	1.88	9.25	87.43	0.99	0.23	0.20	826	917
04.10.10	0900	0.02	2.00	9.16	87.38	1.01	0.23	0.20	826	917
05.10.10	0845	0.02	1.96	9.16	87.36	1.07	0.23	0.20	827	918
06.10.10	0830	0.02	1.84	9.25	87.53	0.98	0.18	0.20	826	917
07.10.10	1000	0.02	1.88	9.16	87.52	1.01	0.21	0.20	827	918
08.10.10	0845	0.02	1.88	9.16	87.52	1.01	0.21	0.20	827	918
09.10.10	0830	0.02	1.84	9.07	87.68	0.98	0.21	0.20	828	919
10.10.10	1315	0.02	1.88	9.16	87.57	0.96	0.21	0.20	827	918
11.10.10	0845	0.02	1.92	9.16	87.50	0.99	0.21	0.20	827	917
12.10.10	0930	0.02	1.84	9.16	87.56	1.01	0.21	0.20	827	918
13.10.10	0815	0.02	1.84	9.16	87.58	0.99	0.21	0.20	827	918
14.10.10	0915	0.02	1.84	9.25	87.50	0.98	0.21	0.20	826	917
15.10.10	0815	0.02	1.84	9.35	87.37	1.01	0.21	0.20	826	916
16.10.10	0830	0.02	1.84	9.16	87.58	0.99	0.21	0.20	827	918
17.10.10	1145	0.02	1.84	9.16	87.58	0.99	0.21	0.20	827	918
18.10.10	0930	0.02	1.96	9.16	87.41	0.99	0.26	0.20	827	918
19.10.10	1015	0.02	1.90	9.25	87.42	0.98	0.23	0.20	826	917
20.10.10	1430	0.02	1.88	9.25	87.44	0.98	0.23	0.20	826	917
21.10.10	0820	0.02	1.84	9.12	87.58	1.01	0.23	0.20	828	919
22.10.10	0815	0.02	1.84	9.12	87.60	1.01	0.21	0.20	828	919
23.10.10	0915	0.02	1.88	9.16	87.57	0.96	0.21	0.20	827	918
24.10.10	1130	0.02	1.92	9.16	87.54	0.95	0.21	0.20	826	917
25.10.10	1230	0.02	1.92	9.07	87.62	0.96	0.21	0.20	827	918
26.10.10	1230	0.02	1.88	9.16	87.57	0.96	0.21	0.20	827	918
27.10.10	0830	0.02	1.92	9.35	87.29	1.01	0.21	0.20	825	916
28.10.10	0815	0.02	1.92	9.35	87.26	1.02	0.23	0.20	825	916
29.10.10	1100	0.02	1.88	9.25	87.41	1.01	0.23	0.20	827	917
30.10.10	1145	0.02	1.96	9.07	87.60	0.94	0.21	0.20	827	918
31.10.10	1615	0.02	1.96	9.25	87.35	1.01	0.21	0.20	826	916
Average		**0.02**	**1.89**	**9.19**	**87.50**	**0.99**	**0.22**	**0.20**	**827**	**918**

Heating Value	**HHV(BTU/Cu.ft.)**	**LHV(BTU/Cu.ft.)**	**HHV(Kcal/NM^3)**	**LHV(Kcal/NM^3)**
Minimum	**916**	**825**	**8603**	**7751**
Maximum	**919**	**828**	**8636**	**7781**
Average	**918**	**827**	**8621**	**7767**

FAT
02/11/10
Section Head Lab.

Unit Manager (P.E.)
CC.
Unit Manager (Ammonia)
Unit Manager (CDM)
Unit Manager (Utilities)

MNK.

PFL NATURAL GAS ANALYSIS LABORATORY

November, 2010

Date	Time	Ar	CO_2	N_2	CH_4	C_2H_6	C_3H_8	$C_4H_{10}+C_5H_{12}$	Heating Value (Calculated) Low	Heating Value (Calculated) Gross
	Hrs.	%	%	%	%	%	%	%	BTU/Cu.ft.	BTU/Cu.ft.
01.11.10	0915	0.02	1.92	9.25	87.39	0.99	0.23	0.20	826	917
02.11.10	1100	0.02	1.90	9.35	87.29	1.01	0.23	0.20	825	916
03.11.10	0915	0.02	1.92	9.35	87.27	1.01	0.23	0.20	825	916
04.11.10	1010	0.02	1.88	8.61	88.03	1.03	0.23	0.20	833	924
05.11.10	1145	0.02	1.98	7.98	88.66	0.96	0.20	0.20	836	928
06.11.10	1230	0.02	1.94	8.32	88.35	0.96	0.21	0.20	834	926
07.11.10	1300	0.02	1.94	8.41	88.23	0.99	0.21	0.20	833	925
08.11.10	0945	0.02	2.02	9.01	87.47	1.05	0.23	0.20	828	919
09.11.10	0635	0.02	2.08	8.93	87.51	1.03	0.23	0.20	828	919
10.11.10	1040	0.02	2.04	9.01	87.47	1.03	0.23	0.20	827	918
11.11.10	1300	0.02	2.00	9.08	87.48	0.99	0.23	0.20	827	918
12.11.10	0830	0.02	1.93	9.08	87.57	1.02	0.18	0.20	827	918
13.11.10	1240	0.02	1.93	9.12	87.58	0.97	0.18	0.20	826	917
14.11.10	1300	0.02	1.93	9.16	87.54	0.97	0.18	0.20	826	917
15.11.10	0900	0.02	1.97	9.16	87.46	1.01	0.18	0.20	826	917
16.11.10	1000	0.02	1.93	8.77	87.91	0.97	0.20	0.20	830	921
17.11.10	0900	0.02	1.97	8.69	87.95	0.97	0.20	0.20	830	921
18.11.10	0830	0.02	1.97	8.77	87.85	0.99	0.20	0.20	830	921
19.11.10	1015	0.02	2.00	8.85	87.74	0.99	0.20	0.20	829	920
20.11.10	0900	0.02	1.98	9.08	87.55	0.99	0.18	0.20	826	917
21.11.10	0950	0.02	2.00	9.08	87.51	1.01	0.18	0.20	826	917
22.11.10	0715	0.02	2.15	9.08	87.36	1.01	0.18	0.20	825	916
23.11.10	0830	0.02	2.08	9.16	87.35	1.01	0.18	0.20	825	915
24.11.10	0845	0.02	2.08	9.16	87.37	0.99	0.18	0.20	825	915
25.11.10	0830	0.02	2.04	9.08	87.49	0.99	0.18	0.20	826	917
26.11.10	0830	0.02	2.04	9.00	87.59	0.97	0.18	0.20	826	917
27.11.10	1000	0.02	1.93	8.85	87.86	0.94	0.20	0.20	829	920
28.11.10	0630	0.02	1.89	9.08	87.62	1.01	0.18	0.20	827	918
29.11.10	1100	0.02	1.89	8.93	87.82	0.94	0.20	0.20	828	920
30.11.10	1030	0.02	1.89	8.85	87.88	0.96	0.20	0.20	829	920
Average		**0.02**	**1.97**	**8.94**	**87.67**	**0.99**	**0.20**	**0.20**	**828**	**919**

Heating Value	HHV(BTU/Cu.ft.)	LHV(BTU/Cu.ft.)		HHV(Kcal/NM^3)	LHV(Kcal/NM^3)
Minimum	915	825		8600	7748
Maximum	928	836		8723	7859
Average	919	828		8634	7779

Section Head Lab. 01-12-2010

Unit Manager (P.E.)

cc.

Unit Manager (Ammonia)

Unit Manager (CDM)

Unit Manager (Utilities)

PFL

NATURAL GAS ANALYSIS

December, 2010

LABORATORY

Date	Time	Ar	CO_2	N_2	CH_4	C_2H_6	C_3H_8	$C_4H_{10}+C_5H_{12}$	Heating Value (Calculated)	
									Low	Gross
	Hrs.	%	%	%	%	%	%	%	BTU/Cu.ft.	BTU/Cu.ft.
01.12.10	0845	0.02	1.87	8.93	87.76	1.04	0.18	0.20	829	920
02.12.10	0915	0.02	1.81	9.08	87.69	1.02	0.18	0.20	828	919
03.12.10	0945	0.02	1.89	8.85	87.90	0.94	0.20	0.20	829	920
04.12.10	0915	0.02	1.89	8.85	87.94	0.92	0.18	0.20	829	920
05.12.10	0630	0.02	1.91	8.93	87.77	0.99	0.18	0.20	828	919
06.12.10	1130	0.02	1.89	8.85	87.87	0.99	0.18	0.20	829	920
07.12.10	1130	0.02	1.87	8.93	87.79	1.01	0.18	0.20	829	920
08.12.10	0845	0.02	1.91	9.01	87.67	1.01	0.18	0.20	828	919
09.12.10	0830	0.02	1.91	9.19	87.51	0.99	0.18	0.20	826	917
10.12.10	1020	0.02	1.83	9.10	87.62	1.03	0.2	0.20	828	919
11.12.10	1210	0.02	1.83	9.10	87.71	0.96	0.18	0.20	827	918
12.12.10	1600	0.02	1.85	9.10	87.69	0.94	0.20	0.20	827	918
13.12.10	1445	0.02	1.91	9.01	87.72	0.96	0.18	0.20	827	918
14.12.10	0900	0.02	1.89	9.16	87.50	0.97	0.26	0.20	827	918
15.12.10	1500	0.02	1.81	9.16	87.62	0.96	0.23	0.20	828	919
16.12.10	0700	0.02	1.99	9.42	87.10	1.04	0.23	0.20	824	915
17.12.10	1230	0.02	1.97	9.42	87.15	1.01	0.23	0.20	824	915
18.12.10	1515	0.02	1.95	9.42	87.19	0.99	0.23	0.20	824	915
19.12.10	1150	0.02	1.95	9.25	87.34	1.01	0.23	0.20	826	917
20.12.10	1045	0.02	1.89	9.25	87.40	1.01	0.23	0.20	826	917
21.12.10	0945	0.02	1.97	9.25	87.30	1.03	0.23	0.20	826	917
22.12.10	0850	0.02	1.99	9.25	87.34	0.99	0.21	0.20	825	916
23.12.10	1000	0.02	2.01	9.16	87.39	0.99	0.23	0.20	826	917
24.12.10	1000	0.02	1.97	9.16	87.43	0.99	0.23	0.20	826	917
25.12.10	1040	0.02	1.97	9.16	87.39	1.03	0.23	0.20	827	918
26.12.10	1040	0.02	1.91	9.16	87.52	0.96	0.23	0.20	827	918
27.12.10	0900	0.02	2.01	9.16	87.39	0.99	0.23	0.20	826	917
28.12.10	0830	0.02	2.05	9.08	87.45	0.97	0.23	0.20	826	917
29.12.10	1630	0.02	2.01	9.16	87.41	0.97	0.23	0.20	826	917
30.12.10	0845	0.02	2.05	9.16	87.35	0.99	0.23	0.20	826	916
31.12.10	1115	0.02	2.05	9.08	87.43	0.99	0.23	0.20	826	917
Average		**0.02**	**1.93**	**9.12**	**87.53**	**0.99**	**0.21**	**0.20**	**827**	**918**
Heating Value		**HHV(BTU/Cu.ft.)**		**LHV(BTU/Cu.ft.)**			**HHV(Kcal/NM^3)**		**LHV(Kcal/NM^3)**	
Minimum		**915**		**824**			**8595**		**7744**	
Maximum		**920**		**829**			**8648**		**7791**	
Average		**918**		**827**			**8623**		**7769**	

Section-Head Lab. FAT 01/01/11

Unit Manager (P.E.)

C.C.

Unit Manager (Ammonia)

Unit Manager (CDM)

Unit Manager (Utilities)

Annex 9: Temperature and Pressure Compensation:

The Flow meters referred below are neither temperature nor pressure compensated. The compensation entered in the BOP panel is given below:

For Gas meter (Orifice Mass Flowmeter) (FT-01; Serial number: 8470118)

Design Actual Temperature	=	38.0	^oC
Design Base Pressure	=	14.696	psia
Actual SNGPL Base Pressure	=	14.650	psia
Actual Running Temperature	=	(From TT-01; temperature guage at common line for GTG in ^oC)	
Actual Operating Pressure	=	28.0	barg

Formula Used for Temperature Compensation : (F_{TD})

F_{TD} = (Actual Running temp in Kelvin / Design Actual Temp in Kelvin)^$^{0.5}$

Formula Used for Pressure Compensation to revert to SNGPL base Pressure: (F_{PD})

F_{PD} = (Design base Pressure / Actual SNGPL base Pressure)

In BOP the Actual Reading of FT-01 is multiplied with the above quoted factors:

Compensated Flow = Actual FT-01 Flow reading in Nm^3/hr at design base conditions × F_{TD} × F_{PD}

For Gas meter (Orifice Mass Flowmeter) (FT-12; Serial number: 8470125)

Design Actual Temperature	=	10.0	^oC
Design Base Pressure	=	14.696	psia
Actual SNGPL Base Pressure	=	14.650	psia
Actual Running Temperature	=	(From TT-10; temperature guage at common line for HRSG in ^oC)	
Actual Operating Pressure	=	08.0	barg

Formula Used for Temperature Compensation : (F_{TD})

F_{TD} = (Actual Running temp in Kelvin / Design Actual Temp in Kelvin)^$^{0.5}$

Formula Used for Pressure Compensation to revert to SNGPL base Pressure: (F_{PD})

F_{PD} = (Design base Pressure / Actual SNGPL base Pressure)

In BOP the Actual Reading of FT-12 is multiplied with the above quoted factors:

Compensated Flow = Actual FT-12 Flow reading in Nm^3/hr at design base conditions × F_{TD} × F_{PD}