

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

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**MONITORING REPORT**  
**VERSION 01 Date 01/07/2011**  
**“UP-GRADATION OF GAS TURBINE 1 (GT 1) AND GAS TURBINE 2 (GT 2) AT CO-GENERATION PLANT OF HAZIRA GAS PROCESSING COMPLEX (HGPC) OF OIL AND NATURAL GAS CORPORATION LIMITED (ONGC)”**  
Reference No. 0847  
**01<sup>st</sup> Monitoring period (first and last days included (01/04/2007 – 30/06/2011))**

**SECTION A. General description of the project activity**

**A.1. Brief description of the project activity:**

**Purpose of the project activity and the measures taken to reduce greenhouse gas emissions:**

ONGC's Hazira Gas-Processing Complex (HGPC) consists of facilities for receiving natural gas (NG) along with associated condensate from an off-shore field at a rate of 20 Million Metric Newton M<sup>3</sup>(MMNM<sup>3</sup>) per day. After separating the condensate, which is processed in condensate fractionation units, the gas is processed through various steps to recover liquefied petroleum gas (LPG) and there is a reduction in its dew point to less than 5 degrees centigrade (C) in order to make it suitable for transportation over long distances. Prior to gas processing, the gas is sent to gas sweetening unit where the acid gas is recovered and further processed to obtain sulphur. The major products manufactured at HGPC are lean sweet gas, LPG, natural gas liquids (NGL) and sulphur.

The HGPC receives economical, quality and uninterrupted supply of electrical power and steam from the cogeneration plant at ONGC, Hazira which was set up in the financial year (FY) 1987 - 1988. The cogeneration plant consists of three nos. of Gas Turbine Generators (GTG) to cater the power demand of Hazira Plant. GT-1 & GT 2, which are of General Electric (GE) make were commissioned in 1988 and fitted with standard technology components. GT-3 is of Bharat Heavy Electricals Limited (BHEL) make was commissioned in 1997 and fitted with up-rated parts.

Gas turbines are high-tech capital equipments and are vital for operations hence Original Equipment Manufacturers (OEM) continuously strive to augment the gas turbine's performance by improving the design/ material of its components through research and development (R&D). Such developments are extensively tested and offered to customers in the form of new components commonly called up-rated parts. Aim of these up-rated parts, is to satisfy varied requirement of gas turbine owners, such as improvement in output, efficiency or reduction in maintenance intervals and related. New machines are traditionally supplied with up-rated parts. For older machines, these up-rated parts are available as retrofit and usually suggested for installation at the time of scheduled inspections, so that separate outage of gas turbine is not required for fitment of up-rated parts.

As the existing GT 1 and GT 2 will be completing their expected life time, ONGC is required to replace the entire hot gas path (HGP) components fitted in the gas turbine machines as at present ONGC does not have spare HGP components in stock. Under such circumstances ONGC has the option either to: (a) procure new HGP components of standard technology (Old Design) or (b) opt for up-rated components, which offer higher efficiency and output.

A comparative analysis was made to assess both scenarios (a) and (b) described above by considering one, major inspection cycle (i.e. of 6 years, which is the normal life span of the components). Accordingly maintenance costs (including cost of spares, component repairs and services) have been compared for two scenarios.

It was assessed that the purchase of up-rated spares in place of old technology spares requires an incremental cost of Rs 4.78 Crores / gas turbine and further, the IRR of the project is below the hurdle rate of 10 % for ONGC. Despite unfavourable financial indicators (like higher incremental costs and lower IRR of scenario (b)), ONGC has decided to go for the up-rated components in order to achieve their objective of continuous thrust towards energy conservation and therefore reduction in greenhouse gas (GHG) emissions. The purpose of undertaking the project is to reduce the fossil fuel consumption (NG), and therefore reduce the CO<sub>2</sub> emissions that would otherwise have been released by burning of natural gas (NG) in the GTG. The project would result in reduction of heat rate by 3.3% which would result in saving of 3,926,673 Standard Cubic Meter (SCM) of NG annually. In absence of the project activity, equivalent quantity of NG would have been burnt, thereby resulting in **7802.2** tonCO<sub>2</sub> emission annually.

The project would contribute to sustainable development of the host country India in the following ways:

The project activity saves NG for better applications and contributes to environmental protection.

The project activity would help in minimizing environmental pollution by reducing emissions of CO<sub>2</sub> and other air pollutants (SPM, SO<sub>2</sub>, NO<sub>x</sub>). The project is based on the noble principle that 'energy saved is energy generated'. The project would contribute to enhancement of skills in employees and workers, and would provide benefits to equipment suppliers and technical consultants.

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

The Project has been completed as planned and as described in the Registered Project Design Document (PDD) Version 05 Dated 27/12/2006.

Up-gradation of GT 1 was completed and re commissioning was done on 05.04.2010.

Up-gradation of GT 2 was completed and re commissioning was done on 03.07.2010.

**Total emission reductions achieved in this monitoring period:**

Total emission reductions achieved in the 1<sup>st</sup> Monitoring Period 01/04/2007 – 30/06/2011 (first and last days included) is 8673 tCO<sub>2</sub>e.

## A.2. Project Participants

Host Country	India
Name of Party involved Private and/or public entity(ies)	Public Entity
Project Participants	M/s Oil and Natural Gas Corporation Limited (ONGC)
Kindly indicate if the Party involved wishes to be considered as project participant (Yes/ No)	No

## A.3. Location of the project activity:

<b>Place</b>	Hazira
<b>Post Office</b>	ONGC Nagar
<b>City</b>	Surat
<b>Pin</b>	394 518
<b>State</b>	Gujarat
<b>Country</b>	India



GPS Co-ordinates of ONGC, Hazira, Surat are 21°9'39"N 72°43'31"E

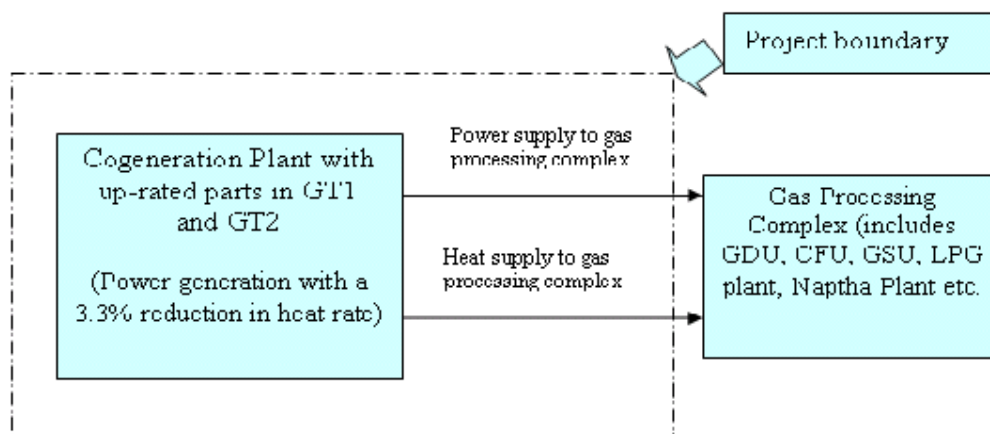
#### A.4. Technical description of the project

The technology adopted for the project activity is the MS5001 P N/T turbine model which incorporates the latest gas turbine technology that has been adapted to the MS5001 turbines. It is the maximum hot gas path up rate for MS5001P turbines.

The new technology hardware includes the hot gas path hardware from the combustion liners through to the second stage bucket. The P N/T package improves output power significantly due to improved aerodynamics, primarily due to an increase in firing temperature. Output is further improved with the recommended options of reduced camber Inlet Guide Vane IGV's and advanced seals. Fuel efficiency is also improved.

Several of these improvements can be purchased individually with the prime consideration being increase in component life, however, the full New Technology (N/T) package has been proposed in order to facilitate the increase in firing temperature, which accounts for the major part of the output and heat-rate performance improvement. This new-technology includes all the necessary parts for the extension of inspection intervals.

The net reduction in heat rate would be 3.3% after implementation of the project activity.



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

**Title:** Small scale methodology AMS-II.D – Version 08  
Type II. Energy efficiency improvement projects.  
Category D - Energy efficiency and fuel switching measures for industrial facilities.

**Reference:** Paragraph '3 and 4' as provided in Type II.D of Appendix B of the simplified modalities and procedures for small-scale CDM project activities - Indicative Simplified Baseline and Monitoring Methodologies for Selected Small-Scale CDM Project Activity Categories.

#### A.6. Registration date of the project activity:

The project has been registered on 01/03/2007.

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

01/04/2007 – 31/03/2017 (Fixed)

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

Organization:	M/s Oil and Natural Gas Corporation Limited (ONGC)
Street/P.O.Box:	Energy centre, 10 floor
Building:	South Tower, SCOPE Minar Laxmi Nagar
City:	Delhi
State/Region:	-
Postfix/ZIP:	110092
Country:	India
Telephone:	91 11/22440829/ 22406479
FAX:	91 11/22011783
E-Mail:	<a href="mailto:chakraborty_ab@ongc.co.in">chakraborty_ab@ongc.co.in</a>
URL:	<a href="http://www.ongcindia.com">www.ongcindia.com</a>
Represented by:	
Title:	General Manager
Salutation:	Mr.
Last Name:	Chakraborty
Middle Name:	-
First Name:	Ashok B.
Department:	Alternate Energy
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Direct FAX:	+91-011-2201 1783
Direct tel:	+91-011-22440829
Personal E-Mail:	<a href="mailto:chakraborty_ab@ongc.co.in">chakraborty_ab@ongc.co.in</a>

## SECTION B. Implementation of the project activity

### B.1. Implementation status of the project activity

Up-gradation of GT#1 was completed and re commissioning was done on 05.04.2010. Up-gradation of GT#2 was completed and re commissioning was done on 03.07.2010.

The following are the details of the shut down for the monitoring period (05/04/2010 to 30/06/2011).

GT#1			GT#2		
Date	Running hours	Downtime hours	Date	Running hours	Downtime hours
05.04.2010	0	24	03.07.2010	13.50	10.50
06.04.2010	0	24	04.07.2010	14	10
07.04.2010	11.25	12.75	05.07.2010	16	8
10.04.2010	13.75	10.25	07.07.2010	13	11
11.04.2010	0	24	08.07.2010	0	24
12.04.2010	0	24	09.07.2010	11	13
13.04.2010	13.50	10.50	11.07.2010	21	3
27.12.2010	14.50	09.50	20.07.2010	23.50	0.50
03.01.2011	23.75	0.25	21.07.2010	18.25	5.75
04.01.2011	21.00	3.00	02.08.2010	10.25	13.75
01.03.2011	9.75	15.25	03.08.2010	0	24
02.03.2011	0	24	04.08.2010	19	5
03.03.2011	10	14	04.09.2010	11.25	12.75
02.04.2011	21.75	02.25	13.09.2010	8	16
			14.09- 24.09.2010	0	264
			25.09.2010	01.50	22.50
			26.09.2010	17	7
			09.10.2010	18.50	05.50
			02.11.2010	23.25	0.75
			03.11.2010	17.50	06.50
			27.12.2010	20	4
			28.12.2010	11.25	12.75
			22.02.2011	14	10
			03.03.2011	20.50	03.50
			17.03.2011	19.25	04.75
			18.03.2011	0	24
			19.03.2011	12	12
			06.04.2011	22.50	01.50
			16.04.2011	12	12
			17.04.2011	12.50	11.50
			03.05.2011	22	2
			04.05.2011	13.75	10.25
			24.06.2011	18.75	5.25

GT	Downtime hours	Reasons
1	223.75	GT repair and maintenance and other operational requirements
2	577	267.5 Hrs (GT repair and maintenance and other operational requirements); 309.5 Hrs (GT performance test)

### B.2. Revision of the monitoring plan

There has been no deviation in monitoring plan from that of the registered PDD

<b>B.3. Request for deviation applied to this monitoring period</b>
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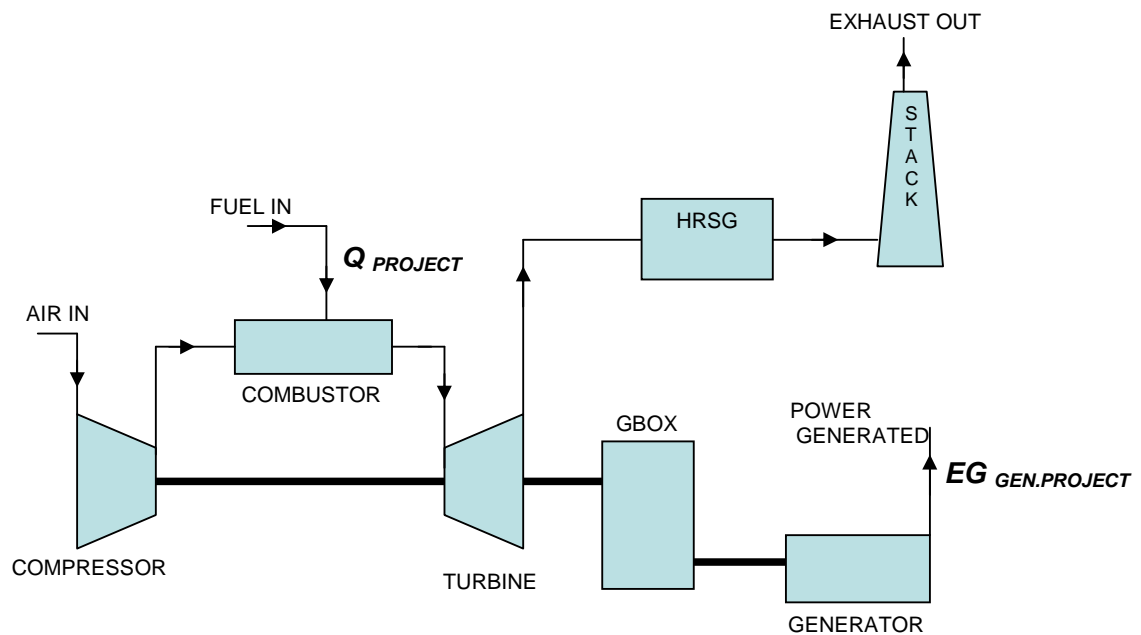
No deviation is applied to the monitoring period.

<b>B.4. Notification or request of approval of changes</b>
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Not applicable.

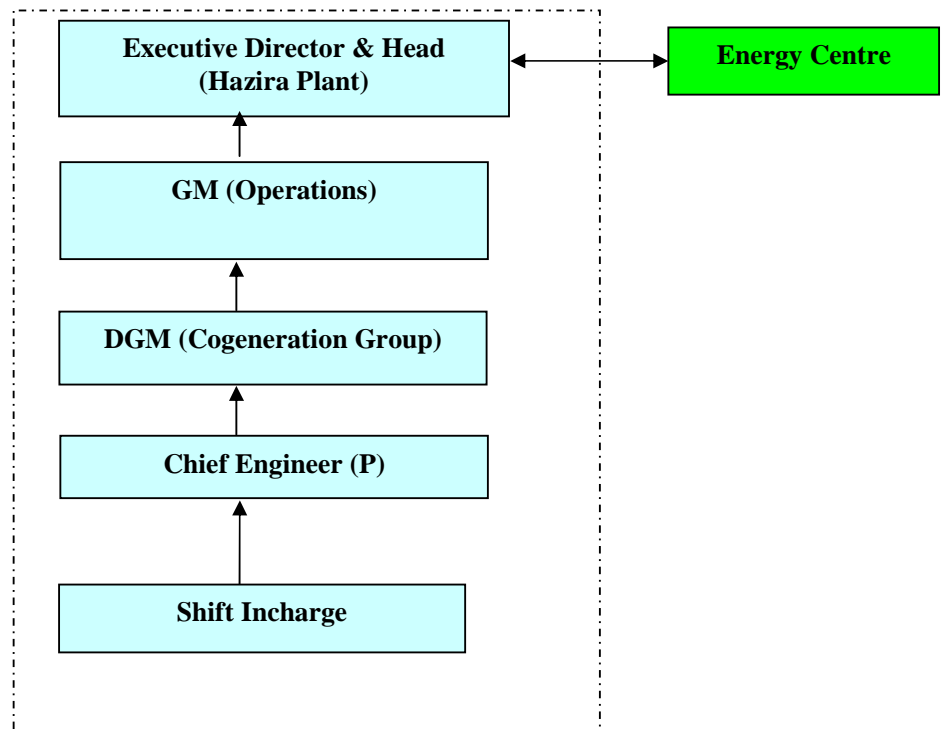


## SECTION C. Description of the monitoring system



### Roles & Responsibilities:

The operational and management structure that will monitor the project activity is described in Fig D.1 below and the monitoring activities and responsibility is also listed in Table D.1 below:



Organisation structure and responsibility for CDM data gathering and reporting

### Monitoring activities and responsibility

Monitoring activities	Procedure and responsibility
Data source and collection	ONGC has state of the art computerised monitoring system installed in the plant. This ensures accurate and continuous monitoring of all the data.
Frequency	Monitoring frequency would be as per section D.3 of PDD
Review	All received data would be reviewed by the engineers in the CDM cell.
Data compilation	All the data would be compiled and stored in the CDM cell.
Emission calculation	Emission reduction calculations will be done annually based on the data collected and recorded. Engineers/Executives of CDM cell will do the calculations

### Emergency procedures for the Monitoring system:

The equipment will either be repaired or replaced as the case is and the intervening period is shown as operational shut down. There is no alternative measurement system and emission reduction is shown zero for those periods.

### 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

<b>Data / Parameter:</b>	$Q_{baseline}$
Data unit:	SCM
Description:	Quantity of fuel used(NG)
Source of data used:	Plant Data maintained in the log book
Value(s) :	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Three year average data before project is used for Base line calculations
Additional comment:	Not Applicable

<b>Data / Parameter:</b>	$NCV_{baseline}$
Data unit:	GJ/SCM
Description:	Net Calorific value of fuel
Source of data used:	Plant Data maintained in the log book
Value(s) :	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Pre project calorific value is used for Base line calculations
Additional comment:	Not Applicable

<b>Data / Parameter:</b>	$EG_{gen. baseline}$
Data unit:	KWh
Description:	Gross quantity of electricity generated
Source of data used:	Plant Data maintained in the log book

Value(s) :	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Three year average data before project is used for Base line calculations
Additional comment:	Not Applicable

<b>Data / Parameter:</b>	<b><i>Heat Rate<sub>pre project</sub></i></b>
Data unit:	<b>Kcal/KWh</b>
Description:	Heat rate
Source of data used:	Plant Data maintained in the log book
Value(s) :	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Three year average data before project is used for Base line calculations
Additional comment:	Not Applicable

<b>D.2. Data and parameters used to calculate project emissions</b>	
<b>Data / Parameter:</b>	<b><i>Q<sub>project</sub></i></b>
Data unit:	SCM
Description:	Quantity of fuel used(NG)
Measured /Calculated /Default:	Measured
Source of data:	Onsite measurements by online volumetric flow meters.
Value(s) of monitored parameter:	Refer Excel sheet
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data will be used for project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Gas flow meter(23FT541/24FT541) , Calibration:10.03.2010, 08.03.2011, 22.09.2009 &23.09.2010 Validity: Each calibration is for one year interval.
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	The parameter would be monitored continuously. The flow meters will be calibrated regularly as per the requirements specified by the OEM.

<b>Data / Parameter:</b>	<b><i>NCV<sub>project</sub></i></b>
Data unit:	GJ/SCM
Description:	Net Calorific value of fuel
Measured /Calculated /Default:	Measured
Source of data:	In-house sampling and calculations.
Value(s) of monitored parameter:	Refer Excel sheet
Indicate what the data are	This is used for project emission calculation.

used for (Baseline/ Project/ Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Gas Chromatograph(HZR/ISO/EQL071) Calibration: 19.06.2009, 10.06.2010, 29.04.2011. Validity: Each calibration is for one year interval.
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Calibration of the Chromatograph has been done annually.

<b>Data / Parameter:</b>	<b><i>EG<sub>gen. project</sub></i></b>
Data unit:	<b>KWh</b>
Description:	Gross quantity of electricity generated
Measured /Calculated /Default:	Measured
Source of data:	Onsite measurements by online energy meters. Plant Data is maintained in the log book.
Value(s) of monitored parameter:	Refer Excel sheet
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This is used for project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Energy Meters(GJUO4102 & GJUO4103) Calibration: 06.01.2007 Validity: Each calibration is for Five (5) year interval.
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	The parameter would be monitored continuously. The energy meters will be calibrated regularly as per the requirements specified by the OEM and the Statutory Bodies.

<b>Data / Parameter:</b>	<b><i>Heat Rate<sub>project</sub></i></b>
Data unit:	<b>Kcal/KWh</b>
Description:	Heat rate
Measured /Calculated /Default:	Calculated
Source of data:	Plant Data maintained in the log book.
Value(s) of monitored parameter:	Refer Excel sheet
Indicate what the data are used for (Baseline/ Project/ Leakage emission)	This is used for project emission calculation.

calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Plant Data maintained in the log book.
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	$Heat\ Rate_{project} = (Q_{project} * NCV_{project}) / EG_{Gen.\ project}$
QA/QC procedures applied:	

#### **SECTION D.3. Data and parameters used to calculate leakage emissions**

Not applicable.

#### **SECTION D.4. Other relevant data and parameters**

No other relevant parameter.

## SECTION E. Emission reductions calculation

### E.1. Baseline emissions calculation

#### Baseline emissions Calculations

#### The baseline emissions have been calculated as explained below

The step by step procedure to compute *BE* (baseline emission) is shown below:

$$Heat\ Rate_{preproject} = Q_{baseline} * NCV_{baseline} / EG_{Gen, baseline} \quad (1)$$

where:

$Heat\ Rate_{preproject}$	Heat rate in Kcal / Kwh
$Q_{baseline}$	Quantity of fuel consumed in baseline scenario (SCM)
$NCV_{baseline}$	Net Calorific value of the fuel in baseline scenario (Kcal/SCM)
$EG_{Gen, baseline}$	Electrical energy generated in baseline (Kwh)

$$TEC = Q_{project} * NCV_{project} \quad (2)$$

Where,

$TEC$	Total energy content of the fuel in Kcal
$Q_{baseline}$	Quantity of fuel consumed in SCM
$NCV_{baseline}$	Net Calorific value of the fuel in Kcal/SCM

$$BE = TEC * EF \quad (3)$$

Where,

$BE$	Baseline emission in tCO <sub>2</sub> e
$TEC$	Total energy content of the fuel in TJ
$EF$	IPCC emission factor of the gas in tCO <sub>2</sub> e/TJ

## E.2. Project emissions calculation

The step by step procedure to compute *PE* (project emission) is shown below:

$$Heat\ Rate_{project} = (Q_{project} * NCV_{project}) / EG_{Gen,project} \quad (1)$$

where:

*Heat Rate<sub>project</sub>* Reduced heat rate in Kcal / Kwh

*Q<sub>project</sub>* Quantity of fuel consumed in SCM

*NCV<sub>project</sub>* Net Calorific value of the fuel in Kcal/SCM

*EG<sub>Gen,project</sub>* Electrical energy generated in Kwh

$$REI = (Heat\ Rate_{preproject} - Heat\ Rate_{project}) * EG_{Gen,project} \quad (2)$$

Where,

*REI* Reduced energy input in Kcal

*EG<sub>Gen,project</sub>* Electrical energy generated in Kwh

$$PE = REI * EF \quad (3)$$

Where,

*PE* Project Emission in tCO<sub>2</sub>

*REI* Reduced energy input in TJ

*EF* IPCC emission factor of the gas in tCO<sub>2</sub>/TJ

**E.3. Leakage calculation**

Not Applicable

**E.4. Emission reductions calculation / table**

The TG wise reduced energy input and emission reduction calculated is as under for the period 01/04/2007 to 30/06/2011.

GT 1			GT 2		
	Reduced energy input (TJ)	Emission Reduction (tCO <sub>2</sub> )		Reduced energy input (TJ)	Emission Reduction (tCO <sub>2</sub> )
Mar 07 to Mar 10	Nil	Nil	Mar 07 to Mar 10	Nil	Nil
Apr 2010	151.4372	289.9232	Apr 2010	Nil	Nil
May 2010	203.5113	389.6179	May 2010	Nil	Nil
Jun 2010	196.561	376.3116	Jun 2010	Nil	Nil
Jul 2010	171.8739	329.0488	Jul 2010	133.0322	254.6872
Aug 2010	126.8437	242.8395	Aug 2010	135.1708	258.7814
Sep 2010	161.3816	308.9614	Sep 2010	68.9955	132.0904
Oct 2010	171.2457	327.8461	Oct 2010	171.3526	328.0508
Nov 2010	179.1851	343.046	Nov 2010	177.207	339.2588
Dec 2010	177.902	340.5894	Dec 2010	186.0954	356.2755
Jan 2011	194.9437	373.2154	Jan 2011	200.0495	382.9904
Feb 2011	180.4683	345.5025	Feb 2011	178.7842	342.2783
Mar 2011	161.3147	308.8335	Mar 2011	177.4609	339.745
Apr 2011	158.548	303.5366	Apr 2011	182.0856	348.5988
May 2011	168.5591	322.7027	May 2011	159.3366	305.0463
Jun 2011	186.5632	357.1711	Jun 2011	170.3903	326.2084
Total	2590.3386	4959	Total	1939.9605	3714

**Total Emission Reduction for GT1 & GT2 = (4959+3714) tCO<sub>2</sub> = 8673 tCO<sub>2</sub>**

Total emission reduction for the period is 8673 tCO<sub>2</sub>e.



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

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Pro rata for duration of the Monitoring Period	Actual values reached during the monitoring period
Emission reductions (tCO <sub>2</sub> e)	7802	33808	8673

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

The reason for the lower CER is GT repair and maintenance, GT performance test and other operational requirements during the monitoring period.

**History of the document**

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